1. Does socio-economic inequality exist in micro-nutrients deficiency among children aged 1-59 months in India? Evidence from National Family Health Survey 2005-06 and 2015-16

1. Shobhit Srivastava*

   **Affiliation:** PhD Research Scholar, International Institute for Population Sciences, Mumbai, Maharashtra, India-400088.
   **Phone number:** +918104292884
   **Email:** shobhitsrivastava889@gmail.com

2. Shubham Kumar

   **Affiliation:** PhD Research Scholar, International Institute for Population Sciences, Mumbai, Maharashtra, India-400088.
   **Email:** shubhamk98@gmail.com

*Corresponding author
Abstract

**Background:** The decadal change in Vitamin A and iron supplement deficiency changed at significant levels but still a matter of issue in India. The deficiency of Vitamin-A decreased from 81.9% to 40.5%, and iron supplement deficiency decreased from 95.3% to 73.9% from 2005-06 to 2015-16 among children aged 6-59 months in India. The present study determines the socio-economic inequalities in Vitamin A deficiency (VAD) and Iron deficiency (ID) among children aged 6-59 months in India and to estimate the change in the percent contribution of different socio-economic correlates for such inequality from 2005-06 to 2015-16.

**Methods:** Data from National Family Health Survey (NFHS) 2005-06 and 2015-16 was used for the analysis. Bivariate analysis and logistic regression analysis was used to carve out the results. Moreover, Wagstaff decomposition analysis was used to carry out socio-economic inequality analysis.

**Results:** It was revealed that Vitamin A deficiency was reduced from 85.5% to 42.1% whereas ID was reduced from 95.3% to 73.9% from 2005-06 to 2015-16 respectively. Child’s age, mother’s educational status, birth order, breastfeeding status, place of residence and empowered action group (EAG) status of states were the factors which were significantly associated with Vitamin A deficiency and Iron deficiency among children. Moreover, it was found Vitamin A deficiency and Iron deficiency got more concentrated among children from lower socio-economic strata. A major contribution for explaining the gap for socio-economic status (SES) related inequality was explained by mother’s education, household wealth status, empowered action group status of states for both Vitamin A deficiency and Iron deficiency among children under five years in India.
Conclusion: Schemes like the Integrated Child Development Scheme (ICDS) would play a significant role in reducing SES related gap for micro-nutrient deficiency among children in India. Proper implementation of ICDS will be enough for reducing the gap between rich and poor children regarding micro-nutrient deficiency.

Keywords: Vitamin A deficiency; Iron deficiency; socio-economic inequality; NFHS; India.
Background

Globally about 25% of children suffer from subclinical vitamin A deficiency (VAD) [1] and approximately 300 million children globally had anaemia as per 2011 estimates [2]. Micronutrient deficiencies are generally referred to as “hidden hunger” because these deficiencies developed gradually [3]. The damages are long run, and devastation is no visible until the irreversible damages have been done [3].

The decadal change in Vitamin A and iron supplement deficiency changed at significant levels but still a matter of issue in India. The deficiency of Vitamin-A decreased from 81.9% to 40.5%, and iron supplement deficiency decreased form 95.3% to 73.9% from 2005-06 to 2015-16 among children aged 6-59 months in India [4].

Iron supplements

Evidence suggests that iron deficiency causes negative effects on cognitive development among children [5]. Moreover, decreased physical capacity and reduced immunity are associated with iron-deficiency among children [6]. Reduced immunity causes children to be at higher susceptibility of infectious diseases [7]; additionally, iron deficiency causes retarded growth of pre-school and school-going children’s [7]. Children from lower socio-economic status (SES) had higher iron deficiency than children from higher SES [8]. Previous studies found a significant association between iron deficiency among children and breastfeeding status [9]. Educational status of parents and wealth status of the family is the strong correlates of iron deficiency among children [10]. Further birth order of children was carved out to be a strong predictor of iron deficiency among children [6]. Further, the study by found that there is high spatial autocorrelation of anaemia among children in India, i.e. anaemia, was highly correlated with spatial factors [11].

Vitamin A
It was concluded in previous studies that vitamin A deficiency was magnified by poverty status and higher prevalence of infectious diseases [12] and VAD is the underlying cause of measles, diarrhoea and malaria globally [12]. Additionally, VAD causes night blindness problem, Bitot’s spots and other morbid conditions [13]. Further, VAD was positively associated with stunting and wasting among children [14]. Interestingly, it was too argued that VAD deficiency was highly correlated with the development of anaemia because it plays an important role in red blood cell production and iron metabolism [13].

Vitamin A deficiency was strongly associated with maternal educational level [15], breastfeeding practices [15], being a male child [16], child age 48-59 months [16] and children from poor socio-economic status [15]. Moreover, children from lower levels of social and economic development and higher birth orders had 50% lesser likelihood to receive vitamin A supplements [15].

There is existing literature which focuses on determinants of micro-nutrients deficiency among children aged 6-59 months in India. Various literature found the important correlates of VAD and ID among children aged 6-59 months in India. However, there seems a scarcity of studies which aimed to focus on the change in socio-economic inequality for VAD and ID. Therefore the present study determines the socio-economic inequalities in VAD and ID among children aged 6-59 months in India and to estimate the change in the percent contribution of different socio-economic correlates for such inequality from 2005-06 to 2015-16. The study hypothesized that there was no change in inequality in terms of VAD and ID among children aged 6-59 months in India from 2005-06 to 2015-16.

**Methods**

The study used data from two rounds of National Family Health Survey (NFHS) as NFHS-3 and NFHS-4 collected in 2005-06 and 2015-16, respectively. The nodal agency for conducting
these surveys, is International Institute for Population Sciences, Mumbai. The NFHS-3 and NFHS-4 are national representatives; the cross-sectional survey used a systematic, two-stage, cluster sample of the household. The survey provides information on several new and emerging issues, including family planning, nutrition, education, adolescent reproductive health and morbidities. Women’s questionnaire collected all eligible women aged 15-49 years in both rounds of the survey. We included 46,890 samples of children for 2005-06 and 236,977 children for 2015-16 [4].

**Dependent Variable**

The dependent variable for this study was vitamin A and iron supplement. The response was recorded by asking the question ‘vitamin A dose was given in the last six months’? The responses were recorded either ‘yes’ or ‘no’. Likewise, the question on iron supplements was asked ‘in the last seven days, was given iron pills or iron syrup? The response was recorded as 0 “yes” and 1 “no”.

**Covariates**

The covariates included in the analysis are children’s age in months (6-23, 24-59), sex of the child (male and female), mother’s education (no education, primary, secondary and higher), birth order (1, 2-4 and 2-6), currently breastfeeding (yes and no), wealth index (poor, middle and rich), caste (SC/ST and non-SC/ST), religion (Hindu, Muslim and others), place of residence (rural and urban) and Empowered Action Group (EAG) and non-EAG states (EAG and Assam, non-EAG states) [17].

**Statistical Analysis**

Bivariate analysis was carried out to estimate the prevalence of vitamin A deficiency (VAD) and iron deficiency (ID). Association between VAD and ID and their mothers and children’s characteristics was examined through binary logistic regression. To examine inequalities VAD
and ID, a concentration index, concentration curve and decomposition analysis was employed to represent the degree of inequality.

The concentration curve is obtained by plotting the cumulative proportion of outcome variables (VAD and ID) on y-axis against the increasing percentage of the population ranked by the socio-economic indicator (wealth index) on x-axis. The curves shows that whether the socio-economic status related inequality in the outcome variable (on x-axis) prevails or not. If the curve is above the line of equality (45 degree line) that means the index value is negative hence it shows that the outcome variable is disproportionally concentrated among the poor and vice-versa. Income-related inequality in VAD and ID was measured by the concentration index (CI) and the concentration curve (CC), using the wealth score as the socio-economic indicator and binary outcome as VAD and ID. The concentration index is defined as twice the area between the concentration curve and the line of equality. Concentration index measures the inequality of one variable (say VAD and ID) over the distribution of another variable (wealth index). The index ranges from -1 to +1, where the index value of 0 (zero) shows no socio-economic inequality. However, positive value of index shows pro-rich inequality and vice-versa. Additional on the either scales higher the value, higher the extent of socio-economic inequality. The study used Wagstaff decomposition analysis to decompose the concentration index. Wagstaff’s decomposition demonstrated that the concentration index could be decomposed into the contributions of each factor to the income-related inequalities [18]. For any linear regression model on health outcome (y) (say VAD and ID), such as

\[ y = \alpha + \sum k \beta_k x_k + \varepsilon \ldots \ldots (1) \]

The concentration index for y, C , can be written as follows,

\[ C = \sum_k (\beta_k \bar{x}_k / \mu) C_k + G C_e / \mu \ldots \ldots \ldots \ldots \ldots (2) \]
Where $\mu$ is the mean of $y$, $\bar{x}_k$ is the mean of $x_k$, $C_k$ is the concentration index for $x_k$ (defined analogously to $C$), and $GC_\varepsilon$ is the generalized concentration index for the error term ($\varepsilon$). Equation (2) shows that $C$ is equal to a weighted sum of the concentration indices of the $k$ regressor, where the weight for $x_k$ is the elasticity of $y$ with respect to $x_k$ ($\eta_k = \beta_k \bar{x}_k / \mu$). The residual component captured by the last term reflects the socio-economic status related inequality in health that is not explained by systematic variation in the regressor by income, which should approach zero for a well-specified model. Each contribution is the product of elasticity with the degree of economic inequality. Moreover, the percentage contribution is obtained by dividing each absolute contribution by total absolute contribution multiplied by 100 to obtain the estimates.

**Results**

Table 1 revealed that VAD was reduced from 85.5% to 42.1% whereas ID was reduced from 95.3% to 73.9% from 2005-06 to 2015-16, respectively.

Table 2 presents the percentage of children aged 6-59 months who didn’t receive vitamin A and iron supplements in the last five years preceding the survey for the two rounds of the survey as 2005-06 and 2015-16. The VAD and ID found higher among 24-59 months aged children. In both rounds of the survey, VAD and ID reported higher among children whose mother were illiterate. The percentage of VAD and ID found increasing among higher birth (i.e. 3-4 birth order) order. The result shows that the proportion of VAD and ID were relatively higher among poor wealth quintile in both rounds of the survey. Surprising results came out from this study is that ID was higher in non-EAG states in 2005-06, but it reversed in 2015-16 as ID reported higher among EAG states and the same trend also found for ID as well.

Table 3 presents the odds ratio for VAD and ID with respect to socio-economic and demographic characteristics of mother and children for 2005-06 and 2015-16. The odds for
VAD has found higher among 24-59 months children compared with 6-23 months children in 2005-06 and 2015-16 as well. Children whose mother had a higher level of education (OR=0.50 and 0.69) were significantly lower odds found for VAD compared with illiterate mother in 2005-06 and 2015-16 respectively. The study suggests that the odds for VAD was higher among higher birth order (2-3 & 4-6 birth order), currently not breastfeeding who is poor and live in urban areas. Likewise, for ID, higher odds found in female child and it getting lower with the increasing level in education among mother in both round of the survey. Similarly, greater odds found for ID among higher birth order (i.e. 4-6 birth order) currently not breastfeeding among poor children. Despite that, significantly higher odds found for ID in non-EAG states (OR=1.97) in 2005-06 and lower odds (OR=0.48) in 2015-16 compared with EAG states in India.

Figure-1 and figure-2 shows the concentration curve for vitamin A deficiency and iron deficiency for 2005-06 and 2015-16, shows the amount of socio-economic inequality in micronutrients deficiency (VAD & ID). Concentration curve for both rounds lies above the 45-degree diagonal line that indicates a higher level of micronutrient deficiency (VAD & ID) concentrated to poor wealth quintile. The curve in 2015-16 for VAD and ID got higher than the curve for 2005-06, indicating increasing wealth-based inequality VAD and ID among children aged 6-59 months.

Table 4 contains the information of decomposition analysis for the contribution of the various explanatory variable for VAD among children age 5-59 months from 2005-06 to 2015-16. The table contains information about coefficient, elasticity, CI, absolute contribution to CI and percent contribution. The value of absolute contribution indicates the extent of inequality contributed by the explanatory variables. The value of negative sign in CI indicates the more concentration of VAD among the poor where a positive value indicates concentration among the rich for the same. Children with age group 24-59 months, mother’s education, birth order,
wealth index, place of residence and EAG and non-EAG states were major contributors towards socio-economic inequalities for VAD. For example, 24-59 months aged children were responsible for 2 percent inequalities in 2005-06 which reduced to zero percent 2015-16 for the same age group. The secondary level of education among mothers was explained 80 percent socio-economic inequality in 2005-06 and 24 percent in 2015-16 for the same. Children who’re associated with the rural area was explained -20 percent and -11 percent in 2005-06 and 2015-16, respectively. VAD in non-EAG states made a substantial contribution towards inequality, explaining 8 percent and 64 percent inequality in 2005-06 and 2015-16 respectively.

Table 5 contains information of decomposition analysis for the contribution of various explanatory variables for supplementary iron deficiency (ID) among 6-59 month aged children from 2005-06 to 2015-16. Mother’s education, wealth index, place of residence EAG and non-EAG states are major contributors to inequality for ID. The secondary level of education among mothers was explained by 24 percent and 13 percent inequality to ID in 2005-06 and 2015-16, respectively. Children associated with rich wealth quintile was responsible for 41 percent inequality in 2005-06 and 22 percent inequality in 2015-16 for ID. Non-EAG states explained 4 percent inequality in 2005-06 which increased to 70 percent in 2015-16.

**Discussion**

As it was found in the present paper that VAD and ID were more prevalent among children aged 24-59 months. This finding was consistent with the previous one that (26). Mother’s educational status played a protective role for VAD and ID for children. Educated mother has better knowledge about the nutritional levels to be attained for their children, and hence their children receive adequate micronutrients [21]. Higher birth order plays a destructive role in VAD and ID, and this finding was in parallel with previous studies. Earlier studies also discussed that children from higher birth order had a higher deficiency of vitamin A and iron.
as the first-order child receives much attention and higher allocation resources as a comparison to higher-order births [15]. Reduction in VAD was witnessed in children who were breastfed, and this finding was consistent which the previous studies which commented that breastfeeding was less common among children with problem of nigh-blindness and Bitot’s spot [22]. Interestingly VAD was not associated with wealth status of household; however, children from rich households had lower odds for ID than children from a poor household. The finding was consistent from the previous one, which argued that iron deficiency was high among households with poor food security and low-income status [23].

It was found that children from rural areas had a higher prevalence of VAD and ID; however, surprisingly for adjusted estimates, children from rural areas had lower odds for VAD. However, it was cited that children from rural areas had a higher prevalence of micronutrient deficiency [24]. In 2005-06 it was found that odds for VAD and ID was higher among children from non-EAG states; however, in 2015-16, the results revealed an opposite situation. The result was interesting and needed further research to look into the possible reasons.

The contribution of maternal education towards explaining SES related inequality for both VAD and ID was high in 2005-06, but the contribution declined in 2015-16. However, in both the time periods, the contribution was positive and significantly high. The result was consistent with the previous study that children of educated mothers’ had health advantageous due to their higher socio-economic status (32). Moreover, with the recent advancement of the Integrated Child Development Scheme (ICDS), even women with no education are getting aware of optimum micronutrient intake among their child [27]. The contribution of household wealth status was also a significant contributor towards explaining the SES related inequality for VAD and ID. The result was consistent with previous studies that wealth status explains a large SES related gap for micro-nutrient intake status among children [28]. The contribution of the rural place of residence was negative for VAD in 2005-06, and 2015-16 as children from rural areas
had lower likelihood for VAD and children from rural areas too belonged to poor SES hence producing negative contribution [29]. The contributing also declined as due to better nutritional food received by children in rural areas because of the proper implementation of ICDS programmes in rural India [30]. Surprisingly, in 2005-06 it was found that non-EAG states were having a higher likelihood of VAD and ID; however, the situation got reverse in 2015-16. Moreover, children from non-EAG states were disproportionally poor (negative concentration index) in 2005-06, and their situation was better (positive concentration index) in 2015-16. The huge change in contribution was due to a significant change in the value of the concentration index in 2005-06 and 2015-16 [29].

The study had some limitations too. For instance, in VAD and ID was self-reported and not clinically tested. Moreover, the study was cross-sectional, so cannot capture the true picture of change in VAD and ID at the individual level. However, beyond all the limitation, the study provides a broad glimpse of increasing VAD and ID among poor children.

**Conclusion**

It was revealed that VAD and ID got more concentrated among children from the lower socio-economic status from 2005-06 to 2015. Mother’s educational status, birth order, breastfeeding status and residential status were the factors that were significantly associated with VAD and ID. Additionally, it was found that maternal education, wealth status and EAG and non-EAG status of states contributed most towards explaining SES related inequality for VAD and ID among children in India. Therefore there is a need to focus on children from lower socio-economic strata who are more prone to VAD and ID. Schemes like ICDS would play a significant role in reducing SES related gap for micro-nutrient deficiency among children in India. Proper implementation of ICDS will be enough for reducing the gap between rich and poor children regarding micro-nutrient deficiency.
Abbreviations:

ID: Iron deficiency
VAD: Vitamin A Deficiency
SC/ST: Scheduled Caste/Scheduled Tribe
OR: Odds Ratio
CI: Confidence Interval
EAG: Empowered Action Group
SES: Socio-economic status
CC: Concentration Curve
Declarations

Ethics approval and consent to participate: The data is freely available in public domain and survey agencies that conducted the field survey for the data collection have collected a prior consent from the respondent. Local ethics committee of International Institute for Population Sciences (IIPS), Mumbai, ruled that no formal ethics approval was required to carry out research from this data source.

Consent for publication: Not applicable

Availability of data and materials: The study utilizes secondary sources of data that are freely available in the public domain through https://dhsprogram.com/methodology/survey/survey-display-355.cfm. Those who wish to access the data may register at the above link and thereafter can download the required data free of cost.

Competing Interests: The authors declare that they have no competing interests.

Funding: Authors did not receive any funding to carry out this research.

Author’s Contribution: The concept was drafted by SS; SS contributed to the analysis design, SK and SS advised on the paper and assisted in paper conceptualization. SK and SS contributed in the comprehensive writing of the article. All authors read and approved the final manuscript.

Acknowledgements: Not applicable

Author’s Information:

Shobhit Srivastava completed his M.Phil in Population studies and currently pursuing his PhD in Population studies from International Institute for Population. His area of interest is Nutrition and Public health issue among children in India.
Shubham Kumar completed his M.Phil in Population studies and currently pursuing his PhD in Population studies from International Institute for Population. His area of interest is Nutrition and Public health issue among children in India.
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## Table 1: Socio-economic characteristics of children under five years in India, 2005-06 and 2015-16

| Background Characteristics | Categories | 2005-06 | 2015-16 |
|----------------------------|------------|---------|---------|
|                            |            | n  | %       | n  | %       |
| Vitamin A deficiency       | No         | 6,379 | 14.5   | 1,30,252 | 57.9   |
|                            | Yes        | 37,634 | 85.5   | 94,481   | 42.1   |
| Iron deficiency            | No         | 2,053 | 4.7     | 58,686   | 26.1   |
|                            | Yes        | 41,961 | 95.3   | 1,66,406 | 73.9   |
| Age of the Child           | 6-23 months| 14,422 | 33.2   | 74,132   | 33.4   |
|                            | 24-59 months| 28,997 | 66.8   | 1,47,726 | 66.6   |
| Sex of the Child           | Male       | 24,487 | 52.0   | 1,23,433 | 52.0   |
|                            | Female     | 22,403 | 47.8   | 1,13,544 | 47.9   |
| Mother's Education         | No Education | 19,230 | 41.0   | 75,010   | 32.0   |
|                            | Primary    | 6,777 | 14.5   | 34,790   | 15.0   |
|                            | Secondary  | 17,346 | 37.0   | 1,05,722 | 45.0   |
|                            | Higher     | 3,536 | 7.5     | 21,455   | 9.0     |
| Birth Order                | 1st order  | 32,220 | 68.7   | 1,68,425 | 71.0   |
|                            | 2-3 order  | 14,562 | 31.1   | 68,099   | 29.0   |
|                            | 4-6 order  | 108   | 0.2     | 453       | 0.0     |
| Currently Breastfeeding    | No         | 18,018 | 38.4   | 90,797   | 38.0   |
|                            | Yes        | 28,872 | 61.6   | 1,46,180 | 62.0   |
| Wealth Index               | Poor       | 17,021 | 36.0   | 1,18,786 | 50.0   |
|                            | Middle     | 9,697 | 21.0   | 47,265   | 20.0   |
|                            | Rich       | 20,172 | 43.0   | 70,926   | 29.9   |
| Caste                      | SC/ST      | 44,673 | 96.6   | 92,221   | 41.0   |
|                            | Non SC/ST  | 1,594 | 3.5     | 1,34,150 | 59.0   |
| Religion                   | Hindu      | 32,273 | 69.9   | 1,71,115 | 73.0   |
|                            | Muslim     | 7,818 | 16.9   | 37,412   | 16.0   |
|                            | Others     | 6,066 | 13.1   | 25,607   | 10.9   |
| Place of Residence         | Urban      | 17,782 | 37.9   | 56,298   | 24.0   |
|                            | Rural      | 29,108 | 62.1   | 1,80,679 | 76.0   |
| EAG and non-EAG States     | EAG and Assam | 8,776 | 18.7   | 1,43,219 | 60.4   |
|                            | Non-EAG    | 38,114 | 81.3   | 93,758   | 39.6   |

*EAG states include Bihar, Jharkhand, Uttar Pradesh, Uttarakhand, Madhya Pradesh, Chhattisgarh, Orrisa, Rajasthan and Assam.

*Non-EAG states include rest of Indian states except EAG and Assam. SC/ST: Scheduled Caste/Scheduled Tribe.
| Background Characteristics | Categories                  | 2005-06 | 2015-16 | 2005-06 | 2015-16 |
|----------------------------|------------------------------|---------|---------|---------|---------|
| Age of the Child           | 6-23 months                  | 79.1    | 40.0    | 95.0    | 74.2    |
|                            | 24-59 months                 | 88.5    | 43.1    | 95.5    | 73.9    |
| Sex of the Child           | Male                         | 85.5    | 42.1    | 95.0    | 73.8    |
|                            | Female                       | 85.5    | 42.2    | 95.6    | 74.1    |
|                            | No Education                 | 89.4    | 50.6    | 97.4    | 79.1    |
| Mother's Education         | Primary                      | 84.9    | 44.8    | 95.5    | 75.5    |
|                            | Secondary                    | 80.5    | 37.3    | 93.1    | 71.0    |
|                            | Higher                       | 80.6    | 35.3    | 88.6    | 69.7    |
| Birth Order                | 1st order                    | 83.4    | 40.7    | 94.9    | 73.3    |
|                            | 2-3 order                    | 90.2    | 46.0    | 96.3    | 75.5    |
|                            | 4-6 order                    | 91.6    | 60.7    | 98.8    | 83.5    |
| Currently Breastfeeding    | No                           | 87.4    | 41.9    | 94.1    | 72.5    |
|                            | Yes                          | 84.6    | 42.3    | 96.0    | 74.8    |
| Wealth Index               | Poor                         | 87.5    | 46.7    | 97.2    | 77.4    |
|                            | Middle                       | 84.6    | 40.2    | 95.7    | 72.6    |
|                            | Rich                         | 83.2    | 37.0    | 92.5    | 69.9    |
| Caste                      | SC/ST                        | 85.6    | 41.9    | 95.3    | 73.2    |
|                            | Non SC/ST                    | 84.0    | 42.4    | 95.8    | 74.6    |
| Religion                   | Hindu                        | 85.5    | 41.2    | 95.3    | 73.6    |
|                            | Muslim                       | 85.6    | 47.9    | 96.1    | 76.8    |
|                            | Others                       | 85.1    | 35.4    | 93.7    | 68.2    |
| Place of Residence         | Urban                        | 84.5    | 39.2    | 93.0    | 70.9    |
|                            | Rural                        | 85.9    | 43.3    | 96.2    | 75.2    |
| EAG and non-EAG States     | EAG and                       | 78.0    | 50.3    | 91.8    | 80.7    |
|                            | Assam                        |         |         |         |         |
|                            | Non-EAG                      | 87.1    | 32.5    | 96.1    | 65.9    |

VAD: Vitamin A deficiency; ID: Iron supplement deficiency; SC/ST: Scheduled Caste/Scheduled Tribe
EAG states include Bihar, Jharkhand, Uttar Pradesh, Uttarakhand, Madhya Pradesh, Chhattisgarh, Orissa, Rajasthan and Assam.
Non-EAG states include rest of Indian states except EAG and Assam.
Table-3 Logistic regression estimates for VAD and ID deficiency among children under years by background characteristics in India, 2005-06 and 2015-16.

| Background Characteristics | Categories          | VAD          | ID          | VAD          | ID          |
|----------------------------|---------------------|--------------|-------------|--------------|-------------|
|                            |                     | 2005-06 (OR) | 2015-16 (OR)| 2005-06 (OR) | 2015-16 (OR) |
| Age of the Child           | 6-23 months         | Ref.         | Ref.        | Ref.         | Ref.        |
|                            | 24-59 months        | 1.85***      | 1.08***     | 1.03         | 0.96**      |
| Sex of the Child           | Male                | Ref.         | Ref.        | Ref.         | Ref.        |
|                            | Female              | 0.98         | 0.99        | 1.11         | 1.02        |
| Mother's Education         | No Education        | Ref.         | Ref.        | Ref.         | Ref.        |
|                            | Primary             | 0.71***      | 0.88***     | 0.68***      | 0.92*       |
|                            | Secondary           | 0.51***      | 0.73***     | 0.53***      | 0.85***     |
|                            | Higher              | 0.50***      | 0.69***     | 0.36***      | 0.82***     |
| Birth Order                | 1st order           | Ref.         | Ref.        | Ref.         | Ref.        |
|                            | 2-3 order           | 1.28***      | 1.09***     | 1.15**       | 1.03        |
|                            | 4-6 order           | 1.22         | 1.53*       | 2.48         | 1.43        |
| Currently Breastfeeding    | No                  | Ref.         | Ref.        | Ref.         | Ref.        |
|                            | Yes                 | 0.80***      | 0.90***     | 1.14**       | 0.99        |
| Wealth Index               | Poor                | Ref.         | Ref.        | Ref.         | Ref.        |
|                            | Middle              | 0.94         | 1.02        | 0.81**       | 0.98        |
|                            | Rich                | 1.00         | 0.99        | 0.59***      | 0.95        |
| Caste                      | SC/ST               | Ref.         | Ref.        | Ref.         | Ref.        |
|                            | Non SC/ST           | 1.14         | 1.01        | 1.21         | 1.08***     |
| Religion                   | Hindu               | Ref.         | Ref.        | Ref.         | Ref.        |
|                            | Muslim              | 0.94         | 1.27***     | 1.07         | 1.16***     |
|                            | Others              | 1.09         | 1.11*       | 0.94         | 1.10***     |
| Place of Residence         | Urban               | Ref.         | Ref.        | Ref.         | Ref.        |
|                            | Rural               | 0.84***      | 0.90***     | 1.08         | 0.97        |
| EAG and non-EAG States     | EAG and Assam       | Ref.         | Ref.        | Ref.         | Ref.        |
|                            | Non-EAG             | 1.74***      | 0.50***     | 1.97***      | 0.48***     |

Note- Significant at *p<0.10, **p<0.005, ***p<0.01; OR: Odds Ratio

EAG and non-EAG States include Bihar, Jharkhand, Uttar Pradesh, Uttarakhand, Madhya Pradesh, Chhattisgarh, Orissa, Rajasthan and Assam.

*Non-EAG states include rest of Indian states except EAG and Assam.
**VAD**: Vitamin A deficiency

**Figure-1**: Change in concentration curve for VAD among children (6-59 months) in India, 2005-06 and 2015-16

**ID**: Iron supplement deficiency

**Figure-2**: Change in concentration curve for ID among children (6-59 months) in India, 2005-06 and 2015-16
| Background Characteristics | Categories | 2005-06 |  | 2015-16 |  |
|-----------------------------|------------|---------|--------|---------|--------|
|                            |            | Coefficient | Elasticity | CI | Absolute Contribution to CI | Percentage Contribution | Coefficient | Elasticity | CI | Absolute Contribution to CI | Percentage Contribution |
| Age of the child (months)   | 06-23      | 0.514    | 0.047  | -0.005 | -0.001 | 1.9 | Ref. | 0.030 | 0.004 | -0.002 | 0.000 | 0.0 |
|                            | 24-59      | Ref.     | -0.020 | -0.001 | -0.009 | 0.0 | Ref. | -0.007 | -0.002 | -0.01 | 0.000 | -0.1 |
| Sex of the Child            | Male       | Ref.     | -0.336 | -0.005 | -0.02  | 0   | -0.8 | Ref. | -0.118 | -0.004 | -0.169 | 0.003 | -2.6 |
|                            | Female     | -0.679   | -0.026 | 0.375  | -0.038 | 79.8 | -0.303 | -0.033 | 0.187 | -0.024 | 23.6 |
|                            | No Education | Ref. | -0.709 | -0.004 | 0.804  | -0.014 | 28.9 | -0.371 | -0.009 | 0.642 | -0.023 | 22.3 |
|                            | Primary Education | Ref. | -0.336 | -0.005 | -0.02  | 0   | -0.8 | Ref. | -0.118 | -0.004 | -0.169 | 0.003 | -2.6 |
|                            | Secondary Education | -0.679 | -0.026 | 0.375  | -0.038 | 79.8 | -0.303 | -0.033 | 0.187 | -0.024 | 23.6 |
|                            | Higher Education | -0.709 | -0.004 | 0.804  | -0.014 | 28.9 | -0.371 | -0.009 | 0.642 | -0.023 | 22.3 |
| Birth Order                | 1st order  | 0.332    | 0.011  | -0.076 | -0.003 | 6.9 | Ref. | 0.133 | 0.008 | -0.11 | -0.004 | 3.5 |
|                            | 2-3 order  | Ref.     | 0.292  | 0.000  | -0.239 | 0.000 | 2.2 | 0.462 | 0   | -0.301 | 0.000 | 0.2 |
|                            | 4-6 order  | Ref.     | 0.292  | 0.000  | -0.239 | 0.000 | 2.2 | 0.462 | 0   | -0.301 | 0.000 | 0.2 |
| Currently breastfeeding    | No         | 0.220    | -0.017 | -0.082 | 0.006  | -11.4 | Ref. | -0.104 | -0.016 | -0.081 | 0.005 | -4.9 |
|                            | Yes        | Ref.     | 0.164  | 0.001  | -0.077 | 0.000 | 0.2 | Ref. | 0.009 | -0.002 | 0.1   | -0.001 | 0.6 |
| Wealth Index               | Poor       | Ref.     | -0.075 | -0.002 | 0.155  | -0.001 | 2.5 | Ref. | 0.010 | -0.001 | 0.145 | -0.001 | 0.6 |
|                            | Middle     | Ref.     | -0.026 | 0.001  | 0.676  | -0.002 | 4.8 | Ref. | -0.020 | -0.003 | 0.672 | -0.007 | 6.5 |
|                            | Rich       | Ref.     | -0.026 | 0.001  | 0.676  | -0.002 | 4.8 | Ref. | -0.020 | -0.003 | 0.672 | -0.007 | 6.5 |
| Caste                      | SC/ST      | 0.164    | 0.001  | -0.077 | 0.000  | 0.2 | Ref. | 0.009 | -0.002 | 0.1   | -0.001 | 0.6 |
|                            | Non SC/ST  | Ref.     | 0.164  | 0.001  | -0.077 | 0.000  | 0.2 | Ref. | 0.009 | -0.002 | 0.1   | -0.001 | 0.6 |
| Religion                   | Hindu      | Ref.     | -0.074 | -0.002 | 0.003  | 0.000  | 0.0 | Ref. | 0.238 | 0.011  | 0.022 | 0.001 | -1.0 |
|                            | Muslim     | Ref.     | 0.076  | 0.000  | 0.308  | 0.001  | -1.0 | 0.109 | 0.001  | 0.302 | 0.002 | -1.5 |
|                            | Others     | Ref.     | 0.076  | 0.000  | 0.308  | 0.001  | -1.0 | 0.109 | 0.001  | 0.302 | 0.002 | -1.5 |
| Place of residence         | Urban      | Ref.     | 0.000  | 0.000  | 0.000  | 0.000  | 0.0 | Ref. | 0.000  | 0.000  | 0.000  | 0.000  | 0.0 |
|                            | Rural      | -0.150   | -0.014 | -0.168 | 0.01   | -19.8 | 1.000 | -0.092 | -0.016 | -0.181 | 0.011 | -10.8 |
| EAG and non-EAG            | EAG and Assam | 1.000 | 0.000  | 0.000  | 0.000  | 0.0 | Ref. | 1.000 | 1.000  | 1.000  | 1.000  | 1.000  | 1.000  |
### Table 1: Concentration Index for Vitamin A Deficiency

|          | Non-EAG | 0.567 | 0.066 | -0.015 | -0.004 | 7.9   | -0.684 | -0.074 | 0.222 | -0.066 | 63.7 |
|----------|---------|-------|-------|--------|--------|-------|--------|--------|-------|--------|------|
| Explained CI |         | -0.048 | 100   |        |        |       | -0.103 | 100    |       |        |      |
| Actual CI   |         | -0.014 |       |        |        |       | -0.065 |        |       |        |      |
| Residuals   |         | 0.034  |       |        |        |       | 0.039  |        |       |        |      |

*CI: concentration index; Ref: Reference; EAG: empowered action group; VAD: Vitamin A deficiency; SC/ST: Scheduled Caste/Scheduled Tribe

EAG states include Bihar, Jharkhand, Uttar Pradesh, Uttarakhand, Madhya Pradesh, Chhattisgarh, Orissa, Rajasthan and Assam.

*Non-EAG states include rest of Indian states except EAG and Assam.
| Background Characteristics | Categories | 2005-06 | 2015-16 |
|-----------------------------|------------|---------|---------|
|                             |            | Coefficient | Elasticity | CI | Absolute Contribution to CI | Percentage Contribution | Coefficient | Elasticity | CI | Absolute Contribution to CI | Percentage Contribution |
| Age of the child (months)   | 06-23      | 0.096     | 0.003    | -0.005 | 0.000 | 0.2 | Ref. | -0.043 | -0.004 | -0.002 | 0.000 | 0.0 |
|                             | 24-59      |           |          |        |      |     |     |      |      |      |      |     |
| Sex of the Child            | Male       | Ref.      | 0.016    | 0.002  | -0.009 | 0.000 | 0.2 | Ref. | 0.015 | 0.001 | -0.01  | 0.000 | 0.0 |
|                             | Female     |           |          |        |      |     |     |      |      |      |      |     |
| Mother's Education          | No Education | Ref.       | -0.379  | -0.002 | -0.02  | 0.000 | -0.2 | Ref. | -0.073 | -0.002 | -0.169 | 0.001 | -1.3 |
|                             | Primary    |           | -0.622  | -0.008 | 0.375  | -0.012 | 24.5 | -0.160 | -0.013 | 0.187  | -0.01  | 12.7 |
|                             | Secondary  |           | -0.983  | -0.003 | 0.804  | -0.01  | 20.5 | -0.195 | -0.003 | 0.642  | -0.008 | 10.7 |
| Birth Order                 | 1st order  | Ref.      | 0.090   | 0.001  | -0.076 | 0.000 | 0.6 | 0.038 | 0.002 | -0.11  | -0.001 | 1.2 |
|                             | 2-3 order  |           | 0.847   | 0.000  | -0.239 | 0.000 | 0.0 | 0.364 | 0     | -0.301 | 0.000  | 0.1 |
|                             | 4-6 order  |           |          |        |      |     |     |      |      |      |      |     |
| Currently breastfeeding     | No         | Ref.      | 0.135   | 0.004  | -0.082 | -0.001 | 3.0 | Ref. | -0.010 | -0.002 | -0.081 | 0.001 | -0.8 |
|                             | Yes        |           |          |        |      |     |     |      |      |      |      |     |
| Wealth Index                | Poor       | Ref.      | -0.193  | -0.001 | 0.155  | -0.001 | 1.3 | Ref. | -0.012 | -0.001 | 0.145  | -0.001 | 0.8 |
|                             | Middle     |           | -0.505  | -0.007 | 0.676  | -0.019 | 40.7 | -0.056 | -0.006 | 0.672  | -0.017 | 22.4 |
|                             | Rich       |           |          |        |      |     |     |      |      |      |      |     |
| Caste                       | SC/ST      | Ref.      | 0.173   | 0      | -0.077 | 0    | 0.2 | Ref. | 0.081 | 0.008 | 0.1    | 0.003 | -4.3 |
|                             | Non SC/ST  |           |          |        |      |     |     |      |      |      |      |     |
| Religion                    | Hindu      | Ref.      | 0.071   | 0.001  | 0.003  | 0.000 | 0.0 | Ref. | 0.150 | 0.007 | 0.022  | 0.001 | -0.8 |
|                             | Muslim     |           | -0.049  | 0.000  | 0.308  | 0.000 | 0.2 | 0.097 | 0.000 | 0.302  | 0.001  | -0.7 |
|                             | Others     |           |          |        |      |     |     |      |      |      |      |     |
| Place of residence          | Urban      | Ref.      | 0.071   | 0.003  | -0.168 | -0.002 | 4.7 | Ref. | -0.028 | -0.012 | -0.181 | 0.008 | -10.9 |
|                             | Rural      |           |          |        |      |     |     |      |      |      |      |     |
| EAG and non-EAG             | EAG and Assam | Ref.    |          |        |      |     |     |      |      |      |      |     |
|                             | Ref.       |           |          |        |      |     |     |      |      |      |      |     |
|               | Non-EAG | 0.676 | 0.032 | -0.015 | -0.002 | 4.1   | -0.718 | -0.061 | 0.222 | -0.054 | 70.8 |
|---------------|---------|-------|-------|--------|--------|-------|--------|--------|-------|--------|------|
| Explained CI  |         | -0.047| 100   |        |        |       | -0.076| 100    |       |        |      |
| Actual CI     |         | -0.013|       |        |        |       | -0.029|        |       |        |      |
| Residuals     |         | 0.033 |       |        |        |       |        |        | 0.048 |        |      |

*CI: concentration index; Ref: Reference; EAG: empowered action group; ID: Iron supplement deficiency; SC/ST: Scheduled Caste/Scheduled Tribe

EAG states include Bihar, Jharkhand, Uttar Pradesh, Uttarakhand, Madhya Pradesh, Chhattisgarh, Orissa, Rajasthan and Assam.

*Non-EAG states include rest of Indian states except EAG and Assam.