Impact of Wealth Inequality in Child Immunisation: A Household Level Study in Rural Barak Valley, India

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Abstract: India initiated the Expanded Programme on Immunisation in 1978 to reduce the burden of vaccine preventable diseases (VPDs). Following the years of health and medical advancements, children in India still suffer from VPDs and substantial differences can also be traced in immunisation coverage across socio economic strata. This article attempted to identify and quantify the inequality in socio economic factors in explaining inequality in Child immunisation. Multistage stratified random sampling was used to collect information on immunisation and related variables by using a pre-tested questionnaire from the universe of children aged between 12-23 months of rural Barak Valley. Using Erreyger's decomposition technique the study identified that unequal access to ante-natal care and birth order of the child were the prime factors associated with inequality in child immunisation in the region.

Keywords – Wealth Based Inequality, Child Immunization, Decomposition, Barak Valley

I. INTRODUCTION

Immunisation is one of the most cost effective interventions that contribute to healthcare system efficiency [1]. It is recognized as a significant preventive measure that enhances health and enables individuals to contribute to economic growth through improved physical, cognitive and educational performance [2-3]. Globally, the immunisation program began with the goal of reducing the VPDs, but poor immunisation coverage is still a hurdle in achieving the goal in many regions. India was one of the first countries to adopt the World Health Organization's Expanded Programme on Immunisation (EPI), it was launched in India in 1978[4]. The target was kept to ensure a minimum 80 percent coverage of immunisation against the VPDs during infancy period. In 1985, the Government of India launched the Universal Immunisation Programme (UIP) a trial programme in 31 districts with a target of immunisation all the pregnant women and at least 85 percent of the infants against six VPDs. However, even after completing almost four decades India has failed to achieve the target and significant proportion of VPDs are still reported. As revealed by the NFHS reports full child immunisation coverage during the 1980s was below 20%, which further increases to 36% in the early 1990s and to 62% in 2015–16 [5]. These figures, though they look a little satisfactory, but, do not say anything about the existing disparities in the immunisation coverage. Previous studies have revealed prevalence of disparities in child immunisation by economic status in India [6]. But there is no explanation for wealth-based inequality in immunisation? And despite the importance of the question, very few studies have been conducted in India to understand and identify the factors associated with inequality in child immunisation [7-8].

Considering these facts, a scientific study is initiated to estimate the wealth based inequality in child immunisation in rural Barak Valley of Assam. Data about immunisation are collected from randomly selected children of the three districts of the valley. This article depicts the results of the study.

II. MATERIALS AND METHODS

2.1 Data Source -

The design of the study was cross sectional and was based on household investigation. Infants aged between 12 to 23 months were included in the study. A multistage stratified random sampling has been followed to collect primary data. At the initial stage, development blocks have been selected randomly from each of the three districts. Three development blocks from Cachar district, two from Karimganj and 1 from Hailkandi district has been selected. In the second stage from each of the randomly selected development blocks, two villages have been selected randomly. And at the final stage, from each of the selected villages 30 households have been selected purposively, depending on the availability as per the requirement of the study. This gives us a total of 360 sample size (12 x 30=360). The list of variables used in the study, along with their definitions, is given in Table 1.

Table -1 Description of the Explanatory Variables and the Expected Sign of Their Coefficient

Variables	Description of Variables	Mean	SD	Expected Sign
Full Vaccination (FV)	**Living children aged 12–23 months who received one dose of BCG, three injections against DPT, three doses of polio (excluding polio 0) and one vaccine against measles**	**0.5444**	**0.49871**	**----**
Religion (Rel)	**Household belonging to Muslim religion.**	**0.5417**	**0.49895**	**-ve**
Caste (CT)	**Household belonging to General category.**	**0.6167**	**0.48688**	**+ve**
Gender (GD)	**If the child is boy.**	**0.5056**	**0.50066**	**+ve**
Birth Order (BO)	**Birth order of child is 3 or more.**	**0.6611**	**0.47399**	**-ve**
Age of Mother (Age)	**Above 25 years of age of ever-married women at time of birth of youngest child.**	**0.6500**	**0.47763**	**+ve**
Education of Mother (Edu)	**Ever-married women with minimum primary schooling.**	**0.2861**	**0.45257**	**+ve**
Occupation of Father (Occ)	**Father of the child who is engaged to agricultural or manual works.**	**0.6000**	**0.49058**	**-ve**
Ante-Natal Check-ups (ANC)	**Ever-married women aged 15–49 who received three antenatal care during pregnancy.**	**0.3694**	**0.48333**	**+ve**
24 months Gap (Gap)	**Maintained a gap of minimum 24 months between the last two child births.**	**0.3250**	**0.46903**	**+ve**
Interaction (Int)	**Interaction between boy child and minimum 24 months of gap between births.**	**0.1889**	**0.39197**	**+ve**
Number of observations - 360				

2.2 Concentration Index -

Socioeconomic inequalities in health have been observed to be prominent in some areas than in other. This is an important issue and requires to be addressed as it may shed light on the causes of persistent health inequalities. To quantify the inequality in full immunisation across economic class, we have used full immunisation concentration index (CI) as introduced by Erreygers in 2009 [9]. Erreygers' concentration index (generally denoted by E) for binary variable is expressed as:

$$E(h) = \frac{8}{n^2}\sum_{i=1}^{n} Z_i h_i \ldots\ldots\ldots (2)$$

Where h_i is a binary variable, in case of full immunisation coverage, h_i is equal to 1 if the i^{th} child is fully immunised and 0 if the i^{th} child is not fully immunised. And $Zi = \frac{n+1}{2} - \gamma_i$, where n is the number of individuals in the given population and γ_i denotes the socioeconomic rank of the individual which ranges from the richest to the poorest. For the richest γ_i takes the value as 1 and for the poorest γ_i is equal to n.

2.3 Decomposition Analysis-

Decomposition is the final phase of explaining inequality in child immunisation across economic class. This quantifies the contribution of inequality in those factors in explaining inequality in child immunisation. Erreygers (2009) provided the following definition for decomposition technique based on his concentration index.

$$E(h) = 4\left[\sum_{j=1}^{q} \theta_j^* V(X_j) + V(\varepsilon^*)\right] \ldots\ldots\ldots (4)$$

Where θ_j^* represents the regression coefficient of the j^{th} variable, $V(X_j)$ is the Generalised Concentration Index of $X_j$and $V(\varepsilon^*)$ is that of errors[10], where,

$$V = \frac{2}{n^2}\sum_{i=1}^{n} Z_i h_i \ldots\ldots\ldots (5)$$

Expression (4) has been used in the present study to quantify the contribution of inequality in explanatory variables in explaining the inequality in full immunisation.

III. RESULTS AND DISCUSSION

3.1 Spatial Variation in Full Immunisation of Children in Rural Barak Valley

In rural Barak Valley, it was observed that around 54.60 percent of children were fully vaccinated and around 45.40 percent children aged 12-23 months did not receive all the UIP recommended vaccines. It was also noticed that out of the 45 percent (approximately) drop out cases, around 41.79 percent were partially vaccinated and 3.61 percent were not at all vaccinated. Considerable variation in full immunisation coverage has been found across the districts in the valley. Table 2 demonstrates the status of immunisation of all the age specific vaccines across districts in rural Barak Valley. No uniformity was observed in the coverage of specific doses of vaccines required for full immunization among the children who had at least one vaccine. The number of children receiving a measles vaccine was around 65%, while the BCG, which is mostly used against tuberculosis, had a coverage of 90%. It is important to remember here that the percentages of children receiving first dose of DPT and first dose of Polio were as high as 86% and 88%, respectively, but those figures dropped dramatically to 64% and 72% respectively for 'three doses of DPT' and 'three doses of Polio. This suggests that some children who initiated the immunisation schedule did not complete the same adequately.

Table -2: Immunisation Status across Districts in Rural Barak Valley (%)

Area / Vaccine	Cachar	Karimganj	Hailakandi	Barak Valley
BCG	**88.00**	**92.00**	**90.00**	**90.00**
DPT1	**90.00**	**81.00**	**83.00**	**86.00**
DPT2	**78.00**	**70.00**	**65.00**	**73.00**
DPT3	**69.00**	**63.00**	**55.00**	**64.00**
Polio 1	**90.00**	**85.80**	**86.00**	**88.00**
Polio 2	**87.00**	**76.00**	**75.00**	**81.00**
Polio 3	**75.00**	**71.00**	**66.00**	**72.00**
MEASLES	**64.40**	**59.20**	**51.70**	**60.60**
Full Immunisation	**57.20**	**53.30**	**48.30**	**54.40**

Source: Computed by the researcher from Field Survey

3.2 Wealth-Based Inequality in Child Immunisation-

Figure 1 shows a concentration curve demonstrating the wealth-based inequality in immunisation in the study area. This curve was drawn by plotting the cumulative proportion of children aged 12–23 months with full immunisation (ranked by wealth quartile, beginning with the lowest quartile) against the cumulative percentage of population (ranked by wealth quartile).

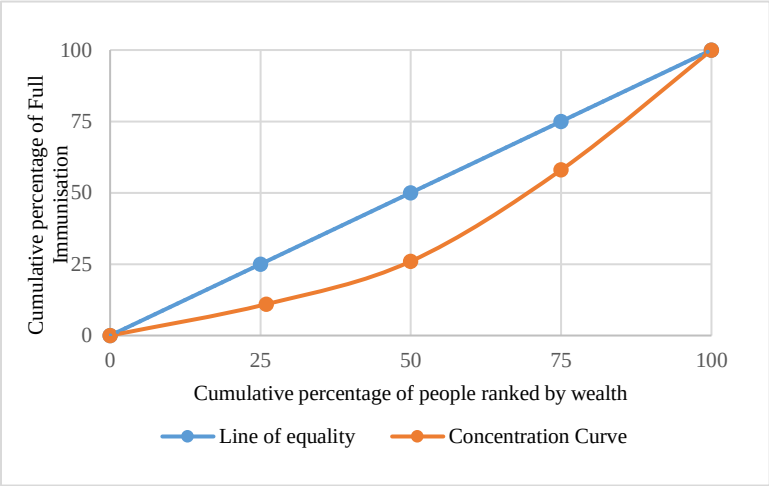

Figure 1. Concentration Curve
Source: Computed by the Researcher from Field survey

The closer the concentration curve to the diagonal, the less is the inequality and further lies away from the diagonal, the more is the inequality. If the concentration curve coincides with the diagonal line, this implies everyone enjoys the same health. As in the present study the concentration curve lies far below the line of equality, this implies that full immunisation coverage is concentrated towards the richer section of the population.

3.3 Decomposition of Inequality in Full Immunisation-

Decomposition analysis indicates quantification of the contribution of inequality in explanatory variables in explaining inequality in child immunisation. As a first step towards decomposition, it is necessary to identify the factors affecting child immunisation in India. For this purpose, the following model was estimated:

$$P_i = P\,(FV_i = 1 \mid X_j) = \frac{1}{1+e^{-(\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\ldots\ldots+\beta_kX_k+\varepsilon_i)}} \quad \ldots\ldots\ldots\ldots (1)$$

$$Pi = \frac{1}{1+e^{-Zi}}$$

Where, $Z_i = \beta_0 + \beta_1X_1 + \beta_2X_2 + \ldots\ldots + \beta_kX_k + \varepsilon_i$

Expression 1[1] has been used in the present study to identify the determinants of child immunisation rural Barak Valley. The results of the estimated model, along with decomposition measures, are given in Table 3.

Table-3: Decomposition of Inequality in Full Immunisation

Indicators	Coefficient	Marginal Effect	CI	Contribution to CI of Full Immunisation	Relative Contribution (%)
Religion (Muslim)	**-0.53**	**-0.438**	**-0.098**	**0.018**	**2**
Caste (General)	**0.49**	**0.400**	**0.252**	**0.043**	**4**
Gender (Boy)	**0.57**	**0.463**	**0.252**	**0.050**	**5**
Birth Order (Higher)	**-0.84**	**-0.688**	**-0.406**	**0.119**	**12**
Age of Mother (Older)	**1.79**	**1.469**	**0.203**	**0.127**	**13**
Education of Mother (Above primary)	**0.70**	**0.576**	**0.436**	**0.107**	**11**
Occupation of Father (Agricultural/Manual)	**-1.05**	**-0.861**	**-0.669**	**0.246**	**25**
Ante Natal Checkups (Full ANCs)	**0.87**	**0.714**	**0.403**	**0.123**	**12**

[1] Since our dependent variable is binary in nature, so we cannot make the model linear by applying log transformation technique. Thus we estimate a nonlinear logistic regression by maximum likelihood technique.

24 months Gap (Maintained)	**1.66**	**1.364**	**0.297**	**0.173**	**17**
Interaction	**0.83**	**0.684**	**0.249**	**0.072**	**7**
Total					**100**
Scaled Deviance	**169.03 (Value / df = 1.04)**				
Scaled Pearson X^2	**167.72 (Value / df = 1.03)**				
Log Likelihood	**-105.29**				
LR X^2	**202.152*** **				

Note: (i) Since the value of the intercept term is not required to identify the determinants of child immunisation, so it is not reported here.
(ii) The study could not include place of delivery and availability of immunisation card in the present study as most of the babies are in institutional set up and availability of immunisation card has also been observed in most of the cases. Working status of mother has also excluded as minimum percentage of eligible mothers have been found to be working,
*(iii) *p < 0.1; **p < 0.05; ***p < 0.01.*
Source: Computed by the Researcher from Field survey

It is necessary to remember that the appropriateness of the model is justified by various diagnostic tests, as stated in the final row of Table 3. In the second and third columns, respectively, regression coefficients and their marginal effects are reported, while the CI and the contribution of the CI are reported in the fourth and fifth columns. Finally, in the sixth column, the relative contribution of each explanatory variable is presented to illustrate inequalities in full immunisation.

The regression result shows that religion is highly predictive of a child's immunisation status. The negative sign of the coefficient indicates that children belong to Muslim families had a lower probability of being fully vaccinated as against Non-Muslim children. The finding is also supported by previous studies conducted in the line of determining the determinants of child immunisation in India [11-13]. Similar to religion, caste reflects a deeply rooted cultural designation that influence parental beliefs and attitude towards health seeking behaviors including immunisation decision about their children [14-16]. However, in contrast with the previous studies [8, 11] in the present study we observed that social class did not have any impact on child immunisation.

Persistent preference for son, often lead to gender discrimination in many aspects and the discrimination was also observed in terms of health seeking behaviours [14, 17]. And, in the present stud we also observed gender disparity in receiving full immunisation. More precisely, we observed that in rural Barak Valley, boy child had a higher likelihood of receiving full immunisation compare to girl child. The finding is also in consistent with the findings of the previous study [15, 18]. Birth order had also found to be an important determinant of full immunisation. As the number of children in a family increases, the mother becomes busier in fulfilling the needs of the children and more often the mother's attention gets divided between children if she has many children [19-20]. Previous studies unveiled that children of higher birth order had a lower probability of receiving full immunisation [12, 21]. In consistent with the previous studies, we also found that children of higher birth order were less likely to receive full immunisation compare to children of lower birth order. In the present study we also found that chances of childhood immunisation increases with maternal age. That is children born to older mothers had a higher probability of being fully vaccinated compare to their counter parts. This is may be due to the effect of the factors like knowledge and experience accumulated over time [12, 22-23]. Occupation of father was also identified as a predictor of child immunisation. We found that across occupational group, children born to father engaged to agricultural/manual work were less likely to receive full immunisation compare to their counter parts [21]. The positive coefficient of ante- natal checkups and gap between last two births indicate that mothers who sought all the recommended ante natal checkups and who maintained a recommended gap of minimum 24 months between last two children birth were associated with a higher likelihood of their children being fully vaccinated compare to their counter parts. This may be due to the fact that ante natal checkup provide an opportunity to the would be mothers to promote health care utilization, including institutional deliver, immunisation and family planning [12, 24]. We also observed the composite effect of maintaining gap between last two births and the last born child being a boy having positive impact on receiving full immunisation, however, the resultant outcome is not statistically significant.

From the decomposition analysis, the CI value of the first explanatory variable, religion, was negative. This indicates that the individuals belong to Muslim religion are concentrated towards the poorer section of the society and this contributes around 2 percent inequality in full immunisation coverage across economic class. Given the CI value of general caste, it was found that the individuals belong to general category were more concentration towards the richer section of the society and this existing inequality contributes around 4 percent inequality in full immunisation coverage. The CI value of gender of the child was found to be positive, indicating the concentration of boy child towards more towards economically advantageous section of the society. This is perhaps because of the reason that

wealthier people are at a better position regarding gender section of the new born baby. And the observed differences in the boy child is also a factor that contributes in the inequality in full immunisation. The relative contribution of the variable has been observed to be around 5 percent. The CI value of birth order was found to be negative from the decomposition analysis, indicating that higher birth order is concentrated towards poorer section of the society and this further brings about 12 percent inequality in the full immunisation coverage [12]. The differences in mother's age and education also contributed positively to the biased distribution of child immunisation. This result is quite expected because mothers belonging to higher income groups tend to have higher education and are slightly older at first delivery, and have better knowledge of health care and its benefits. Thus, they are more conscious of the need for immunisation, and hence avail the immunisation doses appropriately and these differences found to bring about an increase in inequality in the coverage by around 13 percent and 11 percent respectively. Occupation of the father of the child turned out to be the most vital factor of the variation in full immunisation across wealth strata. Most of the individuals engaged with agricultural and manual sort of works were found to be concentrated towards the poorer section of the society. This is quite expected and this variation contributes around 25 percent inequality in full immunisation. This is probably due to the fact that wealthier people tend to make better use of health services and thus regularly receive information about the benefit of child immunisation. On the other hand, high travel costs and long distances to health facilities can restrict poor people's willingness to immunize their children [14, 25]. Antenatal care and maintaining a minimum gap of 24 months between last two births were also found to be important factors that bring inequality in full immunisation. The positive CI value of the ANCs indicates that mothers of the wealthier section have received all the recommended ante natal checkups. Similarly, parents belong to wealthier section of the society was found to maintain the minimum gap of 24 months. The variables found to contribute inequality in full immunisation by 12 percent and 17 percent respectively. The probable justification for this finding may be that those women who receive antenatal care remain in touch with the institutional health care arrangements during pregnancy, and thus can easily be convinced about the need for immunisation. Moreover, ANC visits provide an opportunity to promote health care utilization, including institutional delivery, Post Natal Check-up, and family planning and promotes the acceptance of immunisation and enhances the consciousness about health [26].

IV. CONCLUSION

It has been observed that immunisation coverage remains unexpectedly low in rural Barak Valley, with slightly more than half of the children aged 12-23 months fully vaccinated with UIP recommended vaccines and the remainders are either under vaccinated or not at all vaccinated. The status of full immunisation in the valley depends on a number of factors. It has been observed that cultural factors like religion and caste are strong predictors of full immunisation in the valley. Children belong to Muslim religion are less likely to be fully vaccinated compare to Non-Muslim children. Similarly, children belong to general category of the social class are more likely to receive all the recommended vaccines during their infancy period. The existing difference in the cultural predictors also found to increase the inequality in child immunisation by a minimum margin across the economic class. We have also found that gender of the child and birth order are important decisive factors in explaining the status of full immunisation. Girl child and children of higher are less likely to be dully vaccinated and these difference also contribute in the wealth based inequality in full immunisation. Children born to slightly older mothers have been found to be more vaccinated compare to their counter parts. Similarly, the eligible mothers who have attained minimum primary level of educated has also been observed to be an important determinant of full immunisation in the valley. The existing difference in age of mother and educational attainment of the mother also increases the inequality in full immunisation across the wealth strata. Occupation of father has been identifies as a vital determinant of full immunisation. More precisely, children born to fathers who are engaged with agricultural and manual activities are less likely to receive all the recommended vaccines compare to their counter parts and this difference increases the inequality in full immunisation across economic class by a significant margin. WHO recommended ANCs and the family planning norms have been found to be positively associated with the status of full immunisation. And, this is probably because of the reason that ANC visits provide an opportunity to promote health care utilization, including institutional delivery, Post Natal Check-up, immunisation, and family planning. The explained difference contributed by these factors across the income class have also found to be noticeable.

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