

Child Health in India: An Application of Machine Learning

Bishweshwar Bhattacharjee^a, Bireshwar Bhattacharjee^b

^aFormer Research Scholar, Department of Economics, Assam University, Silchar, Email: bbishweshwar@yahoo.co.in, Phone:9859044684.

^bResearch Scholar, Department of Statistics, Assam University, Silchar, Email:bireshwarbhattacharjee09@gmail.com, Phone:9531045037

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Abstract: Child health has a crucial role in the progress of a country like India where more than a tenth of the population are children. As children of today are tomorrow's citizen, thus it is extremely important to ensure good health for children. This study tried to build an comprehensive state wise child health index compressing various child health indicators namely NNR, IMR and U5MR into a single indicator through the tool of machine learning. The analysis on CHI indicates that Kerala ranked first while Bihar becomes the worst performing state. On the categorisation of states across regions by various levels of Child Health it emerged that southern region have performed well followed by western region. On the other hand, Northern, eastern and north eastern regions performed poorly. Coming to evaluating a difference between the performance of the states with regard to child health during the span of two NFHS Surveys, there seems to be no significant enhancement in child health index(CHI) during the period as far as conclusion of the t-test is concerned.

Keywords:

1. Introduction

A country's wealth can be understood in the health status of a country. A country with a better health status is going to be much prosperous. So maintaining a good health status around the country is must. Among all the health indicators child health is one of the most important factors to consider. In other words, maintaining good health of a child allow him or her to grow with a great well-being. The early years of children's live are very crucial for their future health and development. The inequalities that occur in health of child's first few years tend to increase with age. So health becomes the primary thing after which everything else follows. It not only represents physical health but also mental and social health. Physical health stresses on being fit physically with absence from any kind of disease, mental health connotes to psychological and emotional wellbeing while social health refers to maintaining effective communication with others. So, child health plays a crucial role in the progress of the country. Despite the fact, India does not enjoy a very privileged status in child health with high child mortality rates and large number of malnourished child (Khurmi et.al)[1]; (McGuire)[2]. There is large scale prevalence of stunted, underweight children (Khan and Mohanty)[3] ; (Bheemeshwar et al) [4]. So these fact paint a bleak picture of child health and nutrition. Taking all this in to consideration, the study aims to measure the child health status of India. Region specific and also state wise study is undertaken to know their performance with regard to child health.

2 Review of Literature

Dhirar et al [5] compares the child health indicators across NFHS-3 and NFHS-4. Their study found that there has been an improvement in almost all child health indicators from NFHS-3 to NFHS-4. Their study considered infant mortality rates for measuring child health in India.

Vaid et al [6] considered infant and neonatal child mortality as important indicators of the level of child health. Their study reflected that the infant mortality rate was not at satisfactory level. Neonatal deaths were mainly due to perinatal asphyxia, pre-maturity and aspiration pneumonia or acute respiratory distress.

Aghai et al [7] while investigating gender differences in child health considered rates of stillbirths, early neonatal mortality (1–7 days), late neonatal mortality (8–28 days), mortality between 29–42 days and the number of infants hospitalized for measuring child health.

Chalasani [8] attempts to explain wealth-based inequalities in child mortality and malnutrition using a regression-based decomposition approach and explored Neonatal and child mortality rates for the purpose.

Chalasani and Rutstein [9] while examining the relationship between household wealth and child health explored various mortality and malnutrition outcomes: infant, child, and under-5 mortality; stunting, wasting, and being underweight for the purpose.

Thus, from the literature survey it becomes evident that although there are various studies on child health in India but there is no such studies which tried to build an comprehensive child health index using machine learning.

3 Objectives

- (i) To develop a state wise composite index for child health in India.
- (ii) To test whether there is any improvement in the child health status of India overtime.

4 Methodology

4.1 The Composite Child Health Index(CHI)

For developing a composite child health index for India, secondary data is collected from NHFS 5. State wise data is collected for child health indicators namely Neonatal Mortality Rate(NNR), Infant Mortality Rate(IMR), Under Five Mortality Rate(U5MR). Neonatal mortality rate is given by, Number of deaths during the first 28 completed days of life per 1, 000 live births in a given year or period. Infant mortality rate is the probability of a child born in a specific year or period dying before reaching the age of one. Again, Under five mortality rate is the probability of a child born in a specific year or period dying before reaching the age of 5 years, if subject to age-specific mortality rates of that period, expressed per 1000 live births (**Indicator Metadata Registry Details**)[10]. Now for developing a composite child health index state wise the following algorithm is used. The notations that are used in the following algorithm are given in the Appendix section.

Step 1: Selected Crude Death Rate as Independent Variable.

Step 2: Selected NNR, IMR, U5MR as Dependent Variable.

Step 3: Model is developed using the Machine Learning Algorithm namely Random Forest.

Step 4: Using Caret Package in R.

Step 5: Under Caret Package, Variable Importance tool is used to get relative weight(w) of the dependent variables.

Step 6: Compute the value of $P_i = \sum w(n_j + l_k + U_l)$

Step 7: Since all three dependent variables are negatively impacting, thus we compute

$$C_i = \frac{1}{P_i}$$

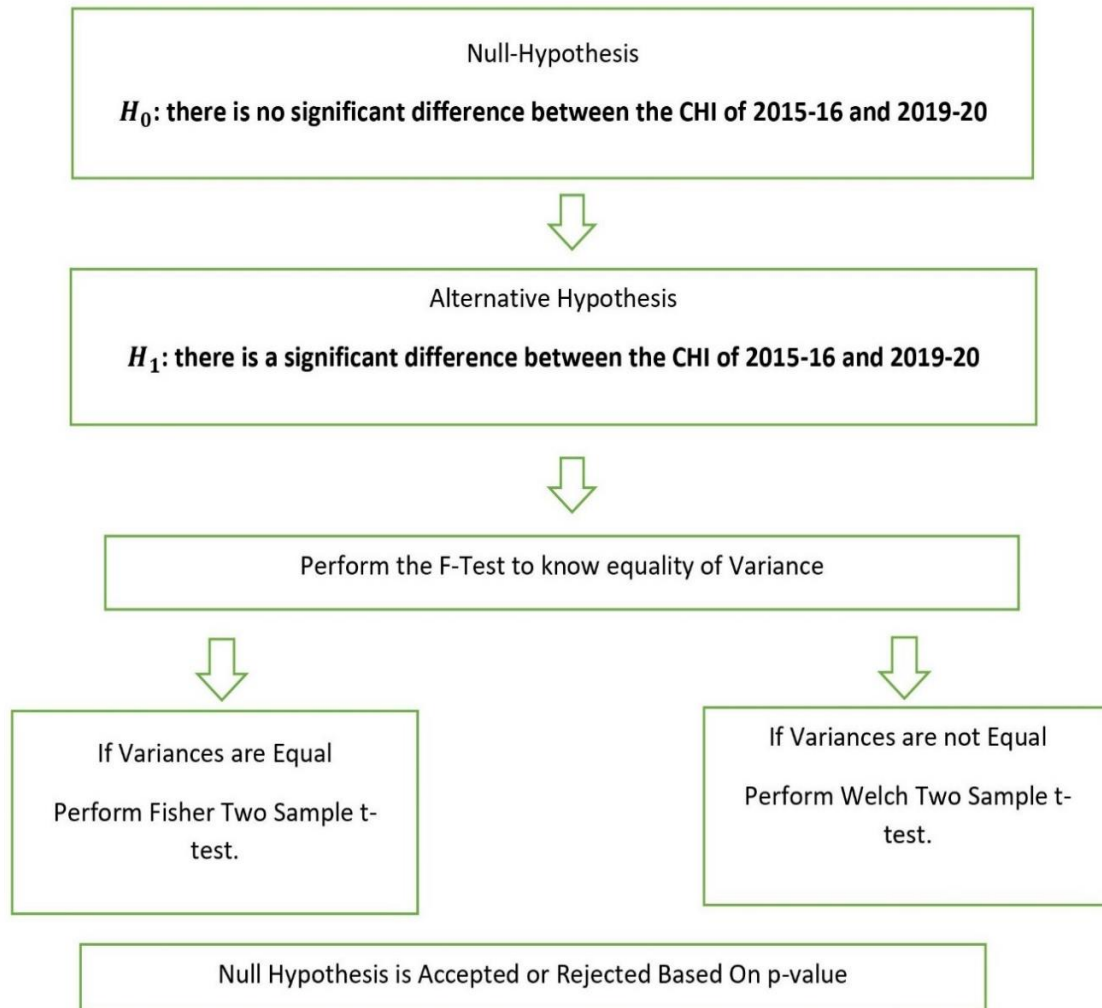
Step 8: Finally Composite Health Index is Computed using

$$CHI_i = \frac{C_i}{\sum C_i}$$

Step 9: All the states are ranked according to the values of CHI_i .

4.1 Dynamisms in Child Health Index

Figure 1: Procedures Adopted in Examining the Dynamisms Child Health Index



Source: Developed by authors

For gauging fluctuations in Child Health Index the data got generated from the Composite Child Health Index calculated by authors following the methodology as described in section 4.1 for NFHS 4 and NFHS 5. Simple graphical statistical tools are being employed for such purpose. To test whether there is any improvement in the child health status of India from the year 2015-16 to 2019-20 we have resorted to F test. The procedure followed for such purpose is illustrated as flowchart in Figure 1

5. Results and Discussions

5.1 Composite Child Health Index(CHI)

The composite child health index leads us to the weights of different child mortality rates which signifies the importance of various mortality rates in the computation of child health. This is illustrated in Table 1.

Table 1: Weight of Different Child Health Indicator

Head	Weight(w)
Neo Natal Mortality Rate	0.32108
Infant Mortality Rate	0.34711
Under Five Mortality Rate	0.33181

Source: Author's computation based on NFHS-4 data

From Table 1, among three child health indicators taken in this study the weight for Infant Mortality Rate is the highest. In second position is taken by the Neo Natal Mortality rate followed by Under Five mortality rate. Thus from this table it is clear that Infant Mortality Rate has the highest impact over the child health indicators. The weights obtained are used to evaluate the performance of the states. To gauge an understanding of the pattern of child health an analysis of ranking various states has been undertaken in Figure 2. The analysis on CHI indicates that Kerala ranked first followed by Goa and Sikkim. On the other hand, Bihar becomes the worst performing states with Tripura and Assam above it[Figure 2].

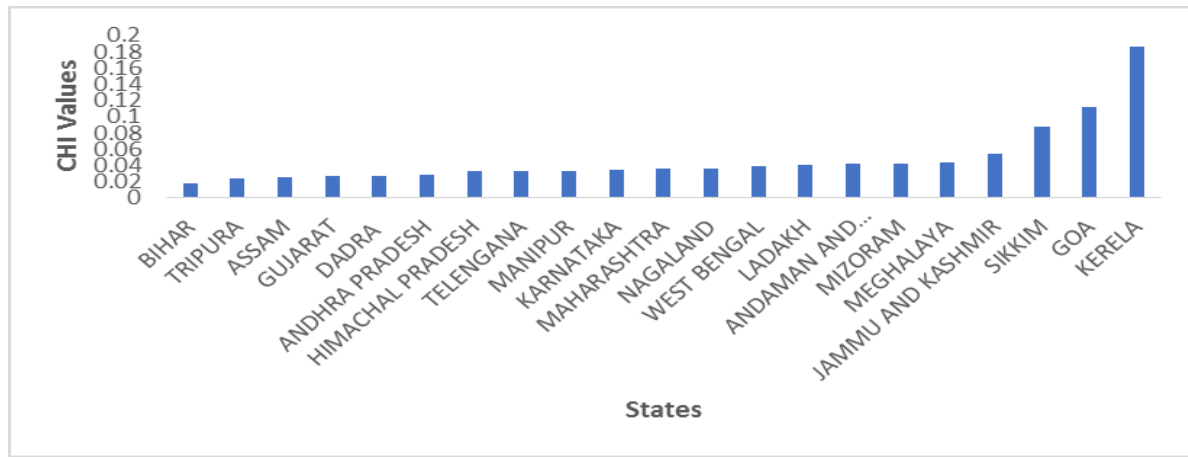


Figure 2: Value of CHI by various states

Source: Author's computation based on NFHS-5 data

To realize the situation of child health across various regions in India, we have tried to categorised the states across regions by various levels of Child Health. The states are classified in line with the criteria followed in NFHS Surveys. In Northern regions, fifty percent states are having low level of child health, whereas rest are having medium levels of child health. The same applies for eastern and north eastern regions. In western region, thirty three percent states are having low level of child health, whereas rest (sixty seven percent) are having medium levels of child health. In southern region thirty three percent states are having low level of child health, whereas a majority of sixty seven percent are having high levels of child health.

Table 2: States across regions by various levels of Child Health

Regions	Level of Child Health		
	Low	Medium	High
North	50	50	0
East	50	50	0
West	33	67	0
South	33	0	67
NER	50	50	0

Source: Author's computation based on NFHS-5 data

Note: The figures represents the percentage of states in the region falling in various levels of child health.

5.2 Dynamisms in Child Health Index

To know whether there is any difference between the performance of the states with regard to child health during the span of two NFHS Surveys, we perform t-test. Now to perform the t-test we need to check whether the

variances are same or not. To investigate this we use the F-test for checking the equality of variance. The results gets reflected in Table 3.

Table 3: Result of F-test

F-test	F = 1.5582
	95% Confidence Limit (0.6322443 and 3.8400514)
	p-value = 0.3293

Source: Author's computation based on NFHS-4 and NFHS-5 data

The p-value for the F-test is 0.3293, thus at 5% level of significance we accept our null hypothesis that the variances are equal. So now we proceed with Fisher t-test for difference of means to check whether there is any improvement in the child health status of India from the year 2015-16 to 2019-20.

Table 4: Result of Fisher t-test

Fisher t-test	t = 0.37844
	95% Confidence Limit (- 0.009094559 and 0.013285035)
	p-value = 0.7071

Source: Author's computation based on NFHS-5 data

The p-value for the t-test is 0.7071, which is greater than 0.05. Thus at 5% level of significance we accept our null hypothesis and conclude that there is no significant difference between child health index(CHI) of 2015-16 and 2019-20. Thus, from this test it may be concluded that the child health status as a whole in the country has not improved significantly.

5. Conclusion

This study tried to build an comprehensive state wise child health index using various child health indicators namely Neonatal Mortality Rate(NNR), Infant Mortality Rate(IMR), Under Five Mortality Rate(U5MR) through the tool of machine learning. The analysis on CHI indicates that Kerala ranked first while Bihar becomes the worst performing state. On the categorisation of states across regions by various levels of Child Health it emerged that southern region have performed well followed by western region. On the other hand, Northern, eastern and north eastern regions performed poorly. Coming to evaluating a difference between the performance of the states with regard to child health during the span of two NFHS Surveys, the t-test shows that there is no significant enhancement in child health index(CHI) during the period.

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