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Multidimensional Poverty Analysis: assessing poverty patterns among different demographic groups of India

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Abstract.

The concept of Multidimensional Poverty Index (MPI), which is relied upon the idea that many intertwined aspects of poverty might not be always possible to be measured in terms of fixed prices, has gained considerable familiarity over the last decades and there have been various experimentations to determine the aspects which should be most imperative to review in order to determine who are poor and who are not. In almost all studies, education, health and standard of living have been singled out as the three obligatory aspects that cannot be avoided if we are rightly trying to estimate poverty and the Alkire-Foster counting approach is the most widely acknowledged and implemented method for constructing Multidimensional Poverty Index. In this paper we have extended the idea, by using the latest 2021 Alkire and Kanagaratnam proposition, for 2015 Indian National Family Health Survey Data and we have observed significant changes (compared to the previous case studies for 2015 NFHS survey data where any older MPI computing methods were used) in the counts and ratios across India's different states, caste groups, religious groups. The paper also looks for a method to extend the MPI counting from household level to individual level. The exploratory analysis wrt almost all possible diverse indicators of deprivation across different religions, caste groups, states and other demographic groups, is another key research aspect of this paper with the motivation to make the results easily interpretable and reusable even outside the scope of MPI construction. It's certain that the poverty level in India is not same for different demographic groups. This paper implements statistical tools such as Multiple Regression and Principal Component Analysis to assess the significance of the findings from the exploratory studies.

Keywords: Multidimensional Poverty; Multiple Correspondence Analysis; Empirical Knowledge Efforts. Poverty Index; Caste in India; Individual level Multidimensional Poverty

1. Introduction

Historically poverty line computation in India has been on the basis of the nutritional intakes that are requisite. But even in the 1970's when the first poverty line was derived for the Indian Population, it was not exactly one-dimensional as it was decided that nutritional requirements for an individual from rural or urban background would be different. [1][2][3][4] Not only that, the gap between the cost of living indices for the industrial labors and agricultural workers was also taken in account, when the monthly minimum earning needed was Rs 49.09 for rural and Rs 56.69 for urban population. In 2005 Suresh Tendulkar Committee updated the poverty line including education and health in the purview [7] and certainly that says that social scientists always viewed poverty as more composite. Yet conventional poverty lines have always been only in terms of income. Multidimensional Poverty measures also capture poverty in terms of health, education and standard of living, very similar to the recommendation of the Tendulakar committee but it does not describe the health or education in terms of money. In 2010 Oxford Poverty & Human Development Initiative (OPHI) and the United Nations Development Program first computed the global Multidimensional Poverty Index (MPI) for 107 countries including India.[8] Since then there has been much discussions on whether the human resource departments of countries would restyle their poverty measurement using MPI. Also, much deliberation and exploratory research is ongoing to make MPI more robust including more dimensions like social security or discrimination. In this paper we have followed the recent proposal by Alkire and Kanagaratnam (2021) for the updated cut-offs. [6]

Of late, administration in India is also gearing up to officially transition towards MPI. NitiAyog of India has already published the headcount ratios [9] obtained from National Family Health Survey-5 conducted in 2019-20 where they have updated the original Alkire-Foster [5] method for global MPI computation adding one more indicator – 'whether a household has Bank Account'.

However, Multidimensional Poverty Index is a headcount ratio based index like most other poverty indices. Hence sometimes it might not capture the labyrinthine patterns of inter community inequality and might fail to elaborate incidence of phenomena related to varied dissimilar impoverishments. Indian population is very heterogeneous with 36 states and union territories (37 at present after the bifurcation of Jammu and Kashmir into J&K and Ladakh union territories) where each state or UT has geographic and demographic distinctiveness. That is why this article conducts rigorous granular exploratory scanning over diverse cohorts of Indian population and goes beyond simply computing the percentage contribution of a dimension namely health or education or standard of living to the consolidated index. We explored which community is necessitous for which indicator of poverty.

What this paper offers is threefold. First, revising the Indian MPI using the up-to-date cut-offs proposed in 2021 by Alikre and Kanagaratnam. Secondly, deriving an individual level MPI disaggregating the household level deprivations into individual level deprivations, [10] so that irrespective of the status of a household being poor wrt a certain indicator, a member of the household may or may not be poor. Thirdly, furnishing with meticulous exploratory investigation across communities of India at individual and household level. The exploratory findings are of course verified with more robust statistical tests using linear regression and principle component analysis. We have used Multiple Correspondence Analysis (MCA) which is almost a generalization of the idea of Principle Component Analysis for categorical variables [11]. It's useful for reducing possible correlated categories into fewer uncorrected categories. Indian population shows diverse patterns of correlation between states, religion groups, and caste groups. For example, large percentage of households in Meghalaya and Assam were found to be following rudimentary or undeveloped practices for flooring and cooking fuel. Now this high volume of below poverty households from these states belong to specific religion groups as well and thus this below poverty households from these states are also increasing the national poverty percentage of the religion groups they belong to, although in general there's no strong correlation between states and religion groups. These kind of inter-category correlations are important to learn in order to discern the multidimensional poverty pattern comprehensively.

The paper proceeds as follows: Section 2 presents the updated MPI methodology and some theoretical intuition of the statistical tools used. Section 3 reports the findings of the exploratory inspection, linear regression and the results from our MCA. The final section concludes with comparison of MPI with the existing income poverty standard.

2. Revised household level MPI methodology and intra household MPI

2.1 Intra Household Individual level Multidimensional Poverty score extending Alkire-Foster method:

In this article multidimensional poverty scores have been calculated at two layers. The global MPI design by United Nations Development Program's Human Development Report (UNDP 2010) followed the Alkire-Santos (2015) methodology [5] where data from 10 indicators explaining three dimensions of poverty namely, education, health and standard of living, were combined. We have carried out the intra household MPI by extending almost the same reasoning for variables where individual level indexing is possible. For example, in a household any child under 5 being underweight or any adult under 70 years of age having BMI below 18.5 kg/m2 was considered as indicative of nutrition deficiency for the entire household in the household level computation by UNDP following Alkire& Santos(2014) methodology. For individual level poverty computation, we have disaggregated the cut-offs based on sex and age. For example, if a child is under 5 years old, depending on the sex, the nutrition deficiency is measured for that child comparing with the median height-for-age/gender and median BMI-for-age/gender according to WHO. The information gained by separate deprivation calculation for each individual is helpful to understand which age or gender group in the households are not deprived. But there can also be deprivation indicators like sanitation/cooking fuel that can't be disaggregated. However, we have not added any new indicator specifically for assessing individual level multidimensional poverty. In Table 1 we have denoted the poverty cutoffs for each of the ten indicators and respective weights for intra household multidimensional poverty computation.

Table 1: Individual level poverty cut-offs for all 10 indicators and respective weights:

Indicator	Individual MPI	Weight
EDUCATION		
Education-1 (E1)	Any individual aged 10+ is poor if they don't have at least 6 years of education. If a member is less than 10 years old, they are not poor wrt this indicator.	0.1667
Education-2 (E2)	If a child between ages 6 to 15 years is not attending school the child is poor. However the other members of the household will not be poor even if the household is poor wrt this indicator at household level.	0.1667
HEALTH		
Health-1(H1)	Irrespective of the status of household level deprivation, each member is deprived based on their age and gender. For children under 5 age-gender specific ideal BMI, for members between age 6 and age 15 age specific BMI and for elders (below 70) 18.5kg/sq m –are the respective cut-offs	0.1667
Health-2(H2)	If child mortality has been observed in 5 years, every household member is marked as poor.	0.1667
STANDARD OF LIVING		
Living Standard-1(L1)	Poor if individual has been living without electricity	0.0556
Living Standard-2(L2)	Poor if individual uses pit latrine with slab, open pit, no flushing toilets like dry toilet or composting toilet, bucket flush toilet at open places, shared toilet.	0.0556
Living Standard-3(L3)	Poor if household uses unprotected spring/surface water, unprotected or open well, river / dam/ lake / ponds/streams/canal/irrigation channel, rain water , water from uncategorized water source as drinking water or if the time taken to fetch water is more than 30 minutes walking..	0.0556
Living Standard-4(L4)	Poor if household's floor is made of earth, dung or other basic materials or the roof or walls are made of thatch/palm leaf, sod /mud and grass, rustic mat, plastic/polythene sheet, palm/bamboo, wood planks. (Roof or wall was added in the revised cut-off)	0.0556
Living Standard-5(L5)	Poor if firewood, straw, shrub, grass, agricultural crop-based fuels, dung, charcoal as cooking fuel [12]	0.0556
Living Standard-6 (L6)	Poor if household doesn't have has any one of radio, TV, telephone, computer, animal cart, bicycle, motorbike, or refrigerator.	0.556

2.2 Household level Multidimensional Poverty Index using updated 2021 cut-offs:

While, the global MPI design by United Nations Development Program's Human Development Report (UNDP 2010) uses the indicators following Alkire-Santos (2015) methodology, in our article the cut-offs used for each indicator of deprivation, are according to Alkire& Kanagaratnam (2021). There are 6 modifications that we have adopted for household level MPI computation.

Table 2: Household Level Poverty cut-offs and their respective weights

Indicator	Household level cut-off	Weight
EDUCATION		
Education-1	Poor if no 10+ years old household member has >= 6 years *(instead of 5 years in original MPI)* education.	0.1667
Education-2	Poor if any child between aged between 6 to 15 years is not attending school. Not poor if household doesn't have any child.	0.1667
HEALTH		
Health-1	Poor if a household has any child (age <5) with stunting/low BMI(compared with WHO median BMI for a child of certain age in months) or any member between ages 6 to 19 years has low BMI (BMI to age in years) or BMI below 18.5 kg/ sq m, for other age groups (below 70). (For our computation we have computed BMI from height and age and compared with the WHO specified BMI/height for age group up to 19 depending on their sex.)	0.1667
Health-2	Poor if any child death happened in last 5 years. (the 5 years limit is new amendment in the revised cut-off)	0.1667
STANDARD OF LIVING		
Living tandard-1	Poor if household has been living without electricity	0.0556
Living Standard-2	Poor if household uses pit latrine with slab, open pit, no flushing toilets like dry toilet or composting toilet, bucket flush toilet at open places, shared toilet.	0.0556
Living Standard-3	Poor if household uses unprotected spring/surface water, unprotected or open well, river / dam/ lake / ponds/streams/canal/irrigation channel, rain water , water from uncategorized water source as drinking water or if the time taken to fetch water is more than 30 minutes walking.	0.0556

Living Standard-4	Poor if household's floor is made of earth, dung or other basic materials or the roof or walls are made of thatch/palm leaf, sod /mud and grass, rustic mat, plastic/polythene sheet, palm/bamboo, wood planks. (Roof or wall was added in the revised cut-off)	0.0556
Living Standard-5	Poor if firewood, straw, shrub, grass, agricultural crop-based fuels, dung, charcoal as cooking fuel	0.0556
Living Standard-6	Poor if household doesn't have has any one of radio, TV, telephone, computer, animal cart, bicycle, motorbike, or refrigerator.	0.0556
Note : The Alkire& Kanagaratnam's revised cut-offs did not mention exactly which cooking fuel, drinking water sources or roof/wall/floor material would be considered as rudimentary or unimproved but based on our data we have defined the category.		

After we have each indicator's values for each household or individual, we multiply them by their respective weights and then add them .Finally we multiply that sum by the total number of non-missing indicators. For example, in the below illustration column I is the number of non missing indicators and poverty score is in column m. We apply the dual cutoff on this score –if greater than 3 then a household is poor; else, not poor. The headcount ratio H is the ratio of poor households and the total households.

Here is an illustration of the MPI calculation method for a sample of three households

Table 3: An illustration for MPI Calculation

Household ID(a)	**101**	**102**	**103**
E1	0.1667	NA	0.1667
E2	0	0	0
H1	0.1667	0.3334	0.1667
H2	0.1667	NA	0
L1	0.0556	0	0.0556
L2	0.0556	0	0.0556
L3	0	0	0
L4	0	0	0
L5	0.0556	0	0
L6	0	0	0
No of non missing indicators (x)	10	8	10
Poverty score (s)	6.67	2.6672	4.346
Poor?(if poverty score>3)	Yes	No	Yes
No of members if poor (m)	5	0	5
Intensity factor-numerator(I)	5*.667=3.334	0	5*.434=2.173

Step-1: (E1+E2+H1+H2+L1+L2+L3+L4+L5+L6)* x

This value is our poverty score. We would consider zero if indicator is missing. Here, 'x' is the number of non missing indicators. For household 102 we had missing value for Education-1 indicator i.e. the years of education of the household members are not known to us. So, the entire weight for Education has been accrued to Education-2 only and thus the weight for Education-2 is 0.334. This same logic will be applied for other dimensions as well if we get missing information. However in our study we did not have missing information for any of the living standard parameters for any household.

Step-2: After we have calculated the poverty scores for each household, we check if the value is less below 3 or above. (The second cut-off of dual cut-off method). If it is above 3 for a household then the household is marked as poor. This result is given in column n. Household 101 and 103 are poor and household 102 is not poor.

Step-3: Headcount ratio of poor households. Like any headcount ratio we will calculate the ratio

$$H = \frac{\text{Total number of poor households}}{\text{Total number of households}}$$

Step-4: Next we compute the intensity factor A. This is constituted of three components, the poor households, their poverty scores, and the number of household members in each poor household. First, to compute the numerator, we will do (E1+E2+H1+H2+L1+L2+L3+L4+L5+L6)* I. Here, 'I' is zero if a household is not poor; else it is the number of household members. In our case the value of 'I' is zero for household 102 as this household had poverty score below 3. Now the above product is computed for each poor household (given in column p). A $= \frac{\text{Sum of s for all housheolds}}{\text{Sum of I for all households}}$.

In our illustration A $= \frac{3.334+2.173}{5+5}$ = 0.5507

Step-5: The final MPI is H*A .

In our example H= 2/3 = 0.667 and A = 0.5507. So for this hypothetical three household country the MPI would be 0.367.

For intra household MPI, we don't have the idea of intensity factor. So, we will only compute the Headcount ratio.

C. Identifying the pattern of multidimensional poverty in India across demography and geography

We performed two multiple linear regressions taking the aggregated poverty scores (i.e. the value after adding the 10 weighted indicators, before applying the second cutoff of the dual cutoff method. In case of any missing indicator for any household - the value after adding all the non missing indicators multiplied by the respective weights) for households and individuals respectively as the independent variables:

Poverty Score$_{household}$ = intercept+ Urban/Rural status+ State/UT of the household+ Religion+ Caste

Poverty Score$_{individual}$= intercept+ Urban/Rural status+ State/UT of the household+ Religion+ Caste +Gender+ Age

Furthermore, to find the most and the least deprived sections of the population in terms of combinations of demographic, geographic and ethnic characteristics of the households/individuals, lower p-value for a certain population group indicates a different pattern of poverty for that group. If thus found significant, by the sign of the regression coefficients we identify whether there's more deprivation than the average population level or lesser deprivation that the average for that concerned group of population. Additionally, we have executed a Multiple Correspondence Analysis. Although we only have four household-level and two more individual-level covariates in the above models, if we can interpret the categorical covariates as several dummy variables, the set of covariates becomes large – so we will need to reduce the dimensions. We apply the MCA using FactoMineR package in R and at the back-end the R function MCA()encapsulates the entire set of observations on MPI poor/not poor as well as other categorical covariates into multivariate contingency tables . Following that, from the contingency tables, step by step the R function MCA() [13] computes the row level profiles, column level profiles, and by singular value decomposition of the weighted Chi-square matrix we determine the principle components. Using the fviz_mca_var() function, we get the perception map showing association/noise among categories across and between variables.

3. Primary findings from The Indian Demographic Health Survey (2015-16)

3.1 Data Description

The Indian Demographic Health Survey in 2015-16 conducted by the International Institute of Population Sciences (IIPS) covered 601,509Indian households with 2,869,043 individuals. In this survey, the data is stored as five different samples according to different sample units – women, men, children, births, household members. We have

employed the 'by births' and 'by household' samples. In the births sample each row is children ever born in the household .From here we obtained the data on child death and two other supplementary variables namely religion and caste of the household. Rest of the data is from household unit sample. For BMI comparison we calculated the BMI from the height and weight and for households where BMI information could not be calculated, we doubled the weight for Health-1 indicator. BMI could be computed for 497,320 Households. We did not drop any sample in our study but exploratory analysis was performed for non missing records only.

3.2 Key statistics using the revised MPI methodology

For Individual or intra household MPI, the headcount is almost 46% using the cut-offs according to Table-1.As the refurbished 2021 MPI cut-offs are different from the ones used during UNDP global MPI evaluation and actually the new cut-offs set the standard higher than the original MPI methodology, our revised headcount of MPI poor households in India increased almost by 8.7% above the UNDP estimate and stands at 34.2% compared to 27.5 % as recorded in the 2010 global MPI. After adjusting this with the intensity factor, we get the MPI for India to be 0.1541.

3.3 Exploratory patterns of multidimensional poverty in India across demographic groups and regions:

Before, we dive into the coefficients and their interpretations and more detailed visualization of the patterns using Multiple Correspondence Analysis perception maps, we shall report the exploratory analysis results.

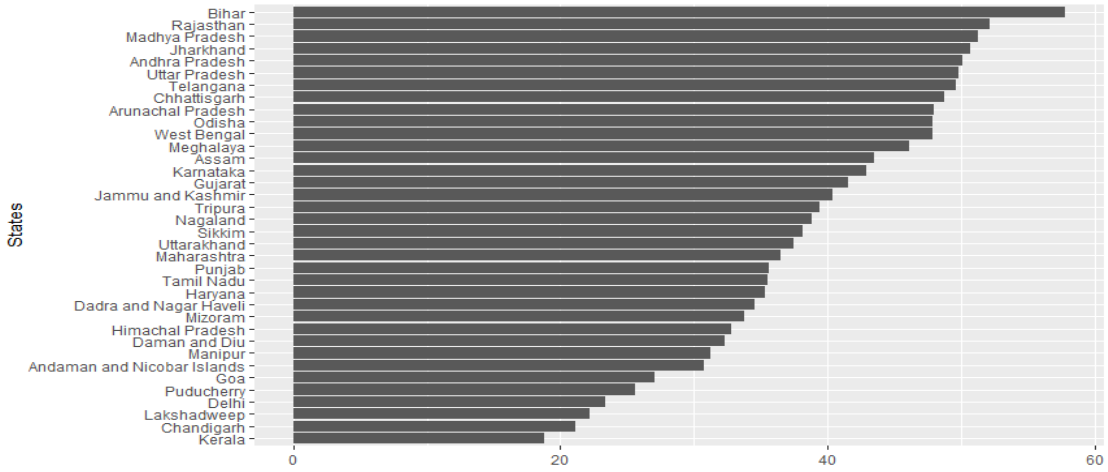

Fig 1: Average % of members with less than 6 years of education in a household

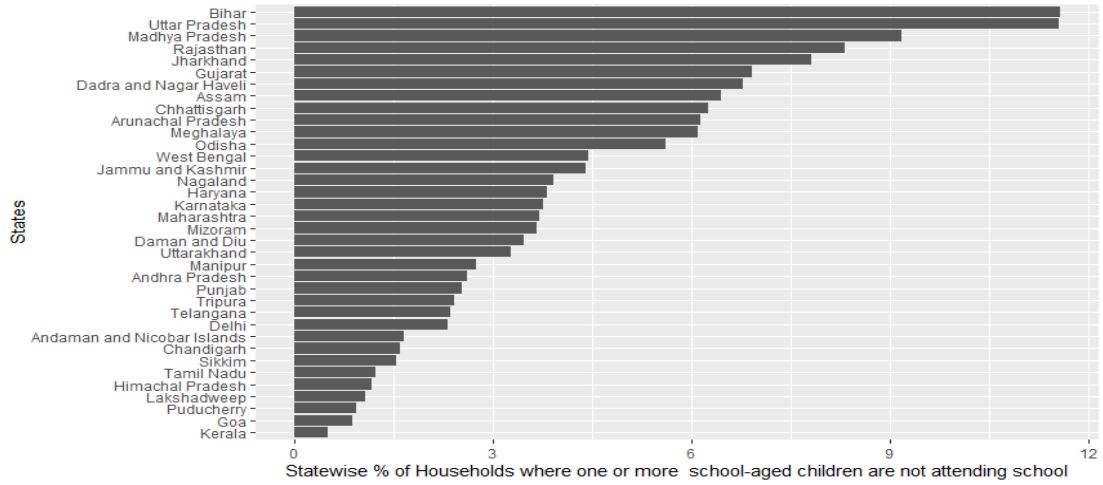

Fig 2 : % of households with one or more school-aged children not going to school

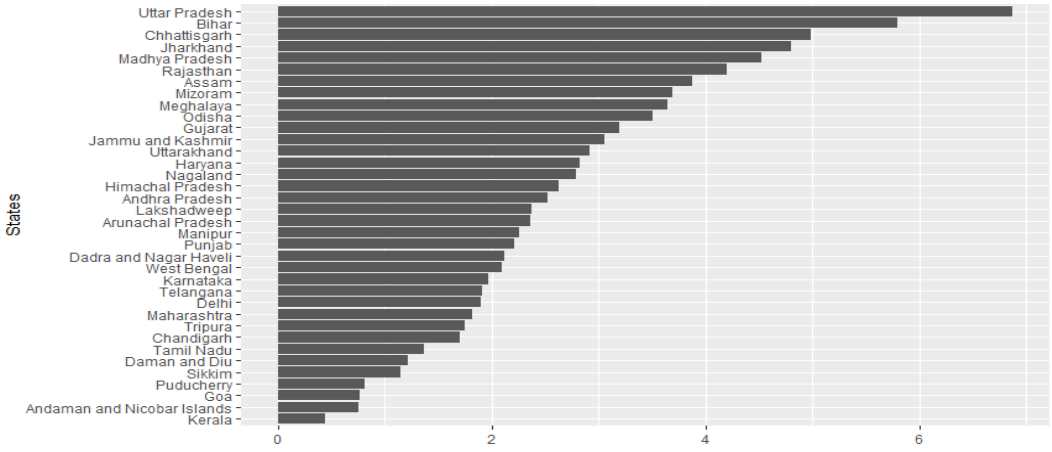

Fig 3: % households where one or more clidren deaths have occurred.

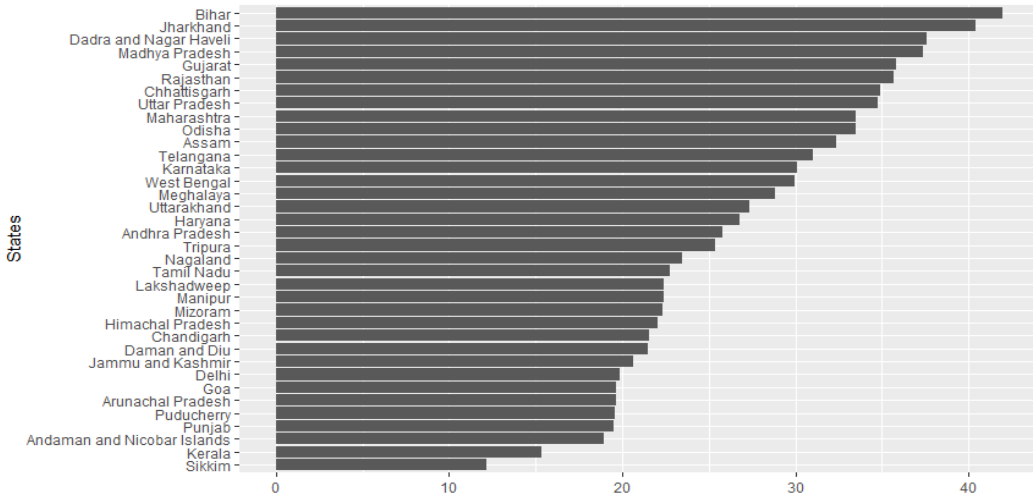

Fig 4 : Nutrition deficiency % among children statewise .

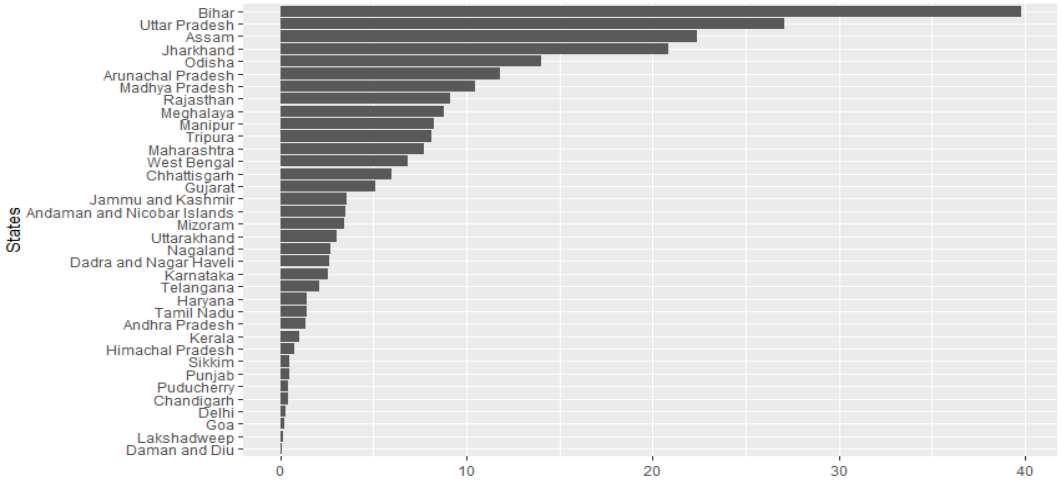

Fig 5 : % Households without Electricity

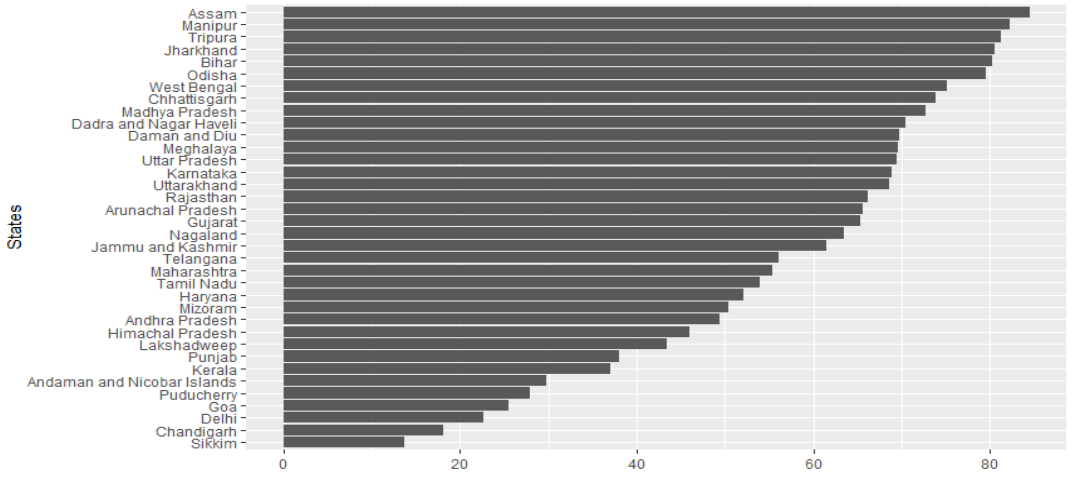

Fig 6 : % Househols without Toilet

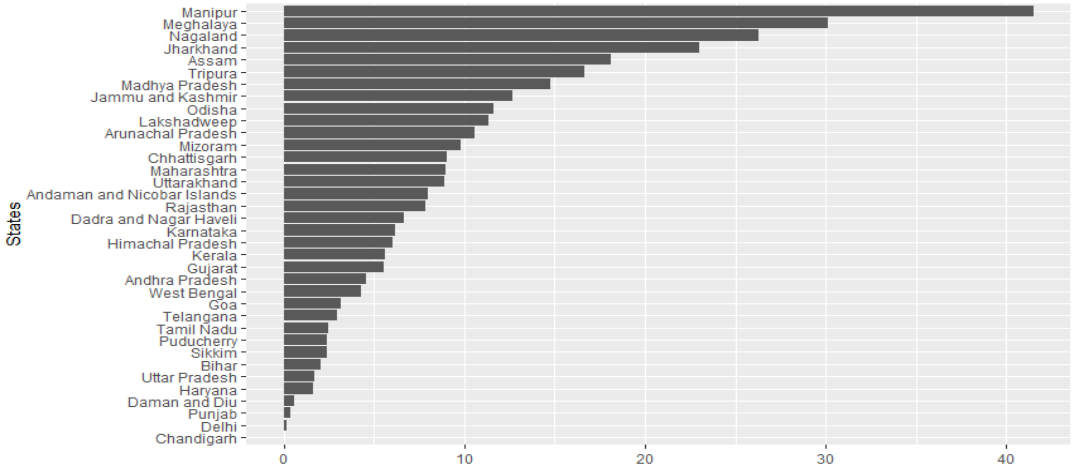

Fig 7 : % Househols without Drinking Water

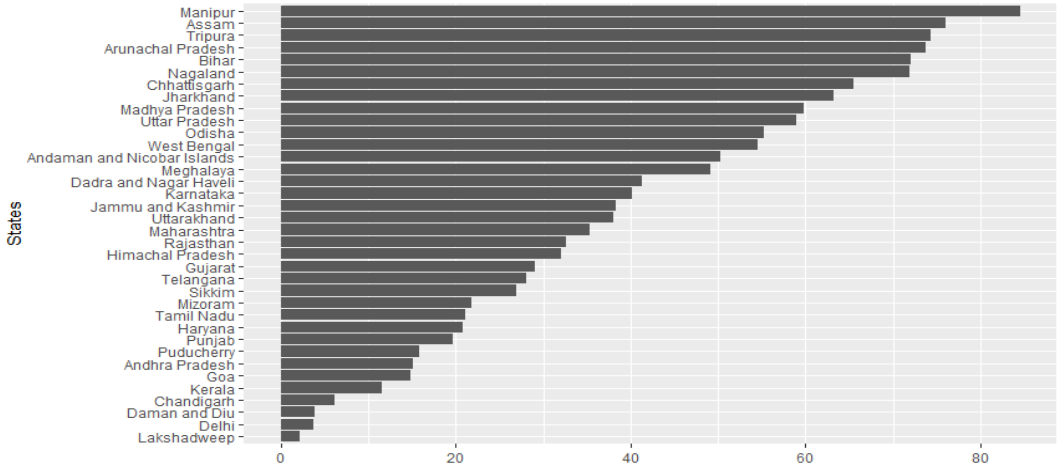

Fig 8 : % Households having roof/wall/floor with elementary material

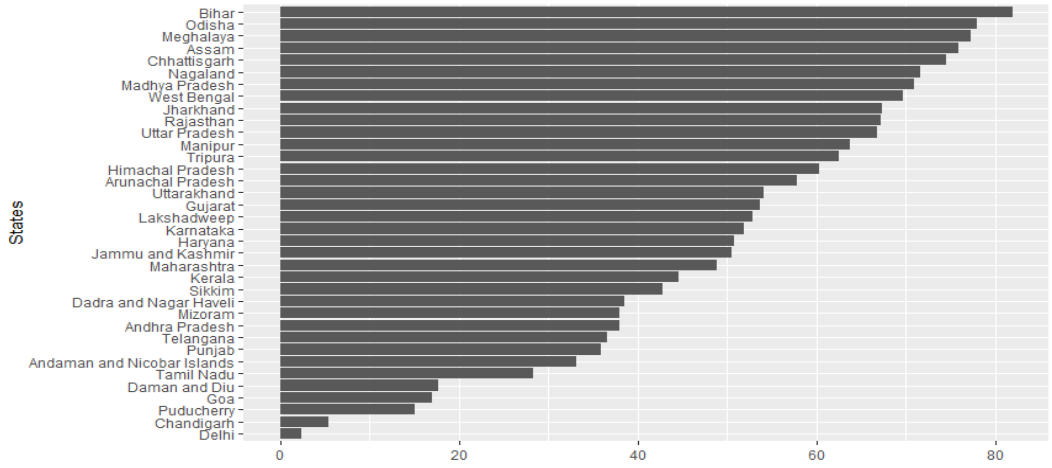

Fig 9 : % Housholds that don't have access to LPG or standard cooking fuel

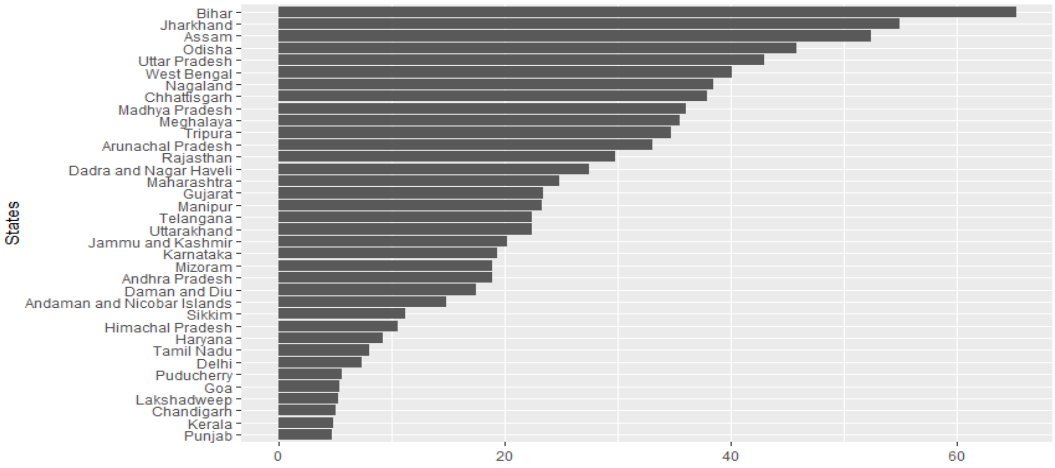

Fig 10 : % Housholds do not have TV/radio/motorcycle/Fridge/Car/Phonr/Tractor

We see a consistently Bihar has been the most impoverished state wrt 6 out 10 indicators along with Jharkhand, Assam, Manipur also being poor. In contrast, Kerala, Delhi, Goa being the least impoverished. We have also observed imbalance in poverty between urban and rural as expected.

For example, in two graphs indicate households where all (100%) household members pursued less than 6 years of formal education.

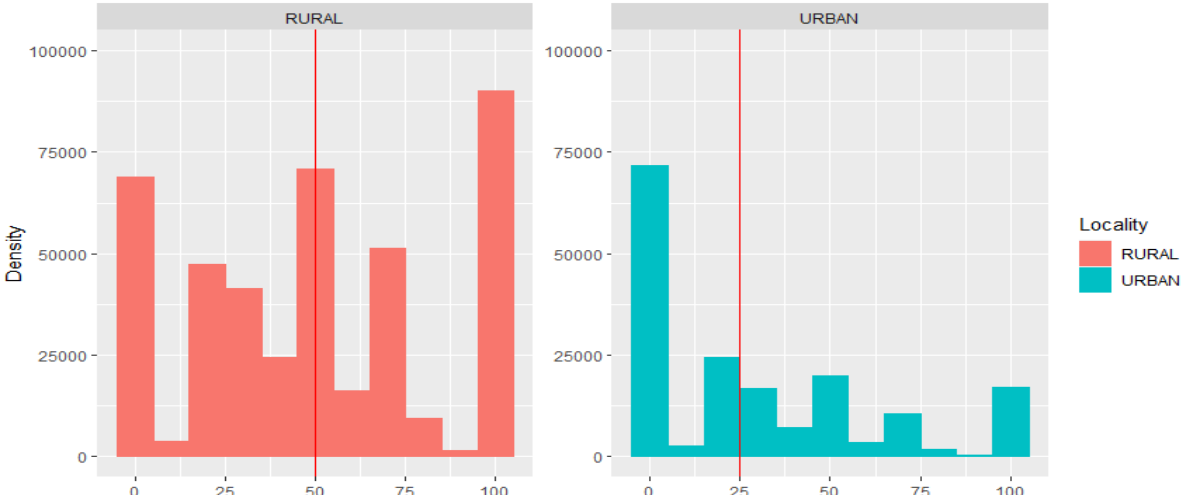

Fig 11: Household counts for % of adult household members with less than 6 years of education

Here the column bars indicate count of households where corresponding percentage of adult household members have less than 6 years of education. For example, the last column bars (i.e. count of households where every adult member is deprived of education) is much lesser in urban India compared to Rural India. On an average (median) 50% household members in rural households are deprived and in urban households 25% household members are deprived.

Not only can we see how depending on geographical location the poverty level changes, we also observe for few indicators (out of the 10 MPI indicators) the poverty level is noticeably below the aggregate MPI headcount percentage. For example, Bihar, where most school-aged children are not attending school, the percentage of households poor wrt this indicator is only 10%, much below the aggregate MPI poverty national headcount percentage of 34.2%. In contrast, wrt other indicators like sanitation for Manipur, Assam, Tripura we see above 80% poverty. Even within the same dimension (out of the 3 dimensions), for example, two indicators of deprivation in education, show different levels of poverty and different patterns too. The other two demographic or ethnic factors that show interesting patterns of poverty are caste and religion. These two factors, especially caste is very important for India in discussion of ability to put money into performance.

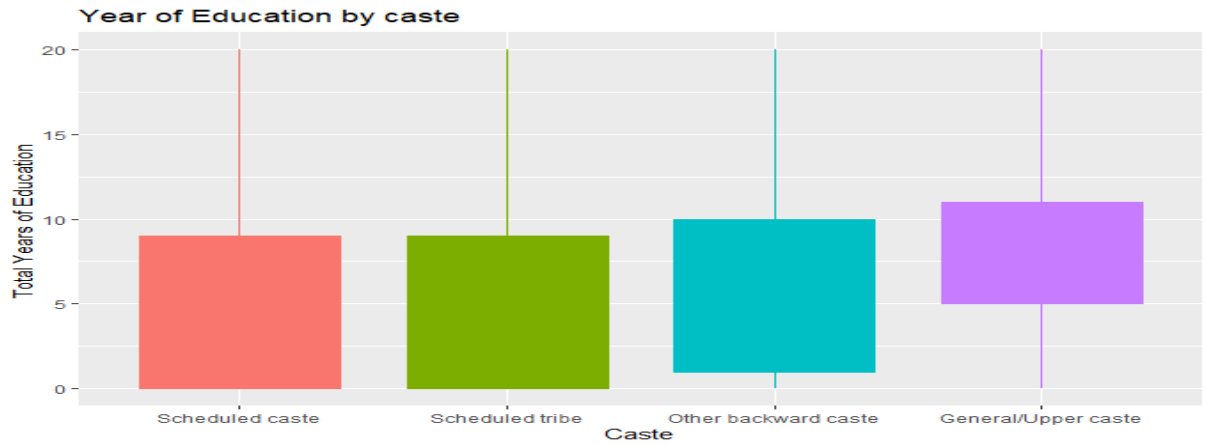

Fig 12: Average individual years of education by caste categories.

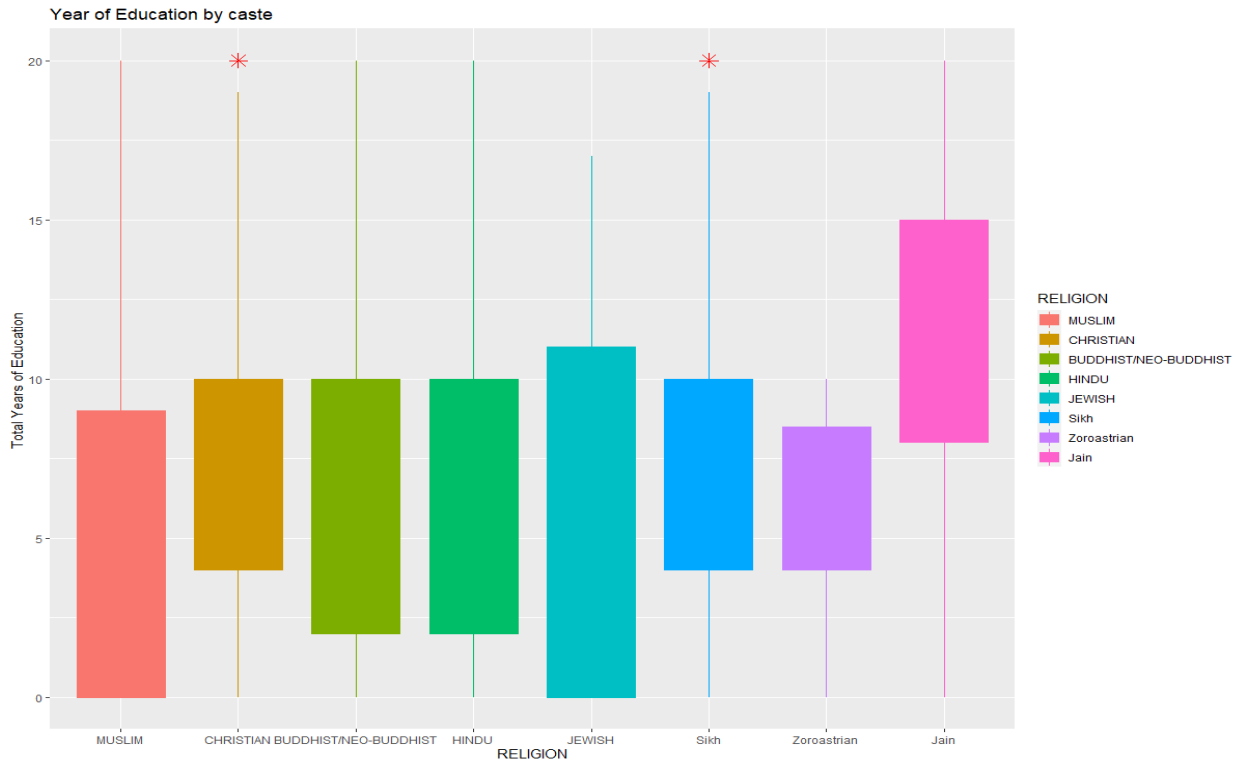

Fig 13 : Average individual years of education for different religions .

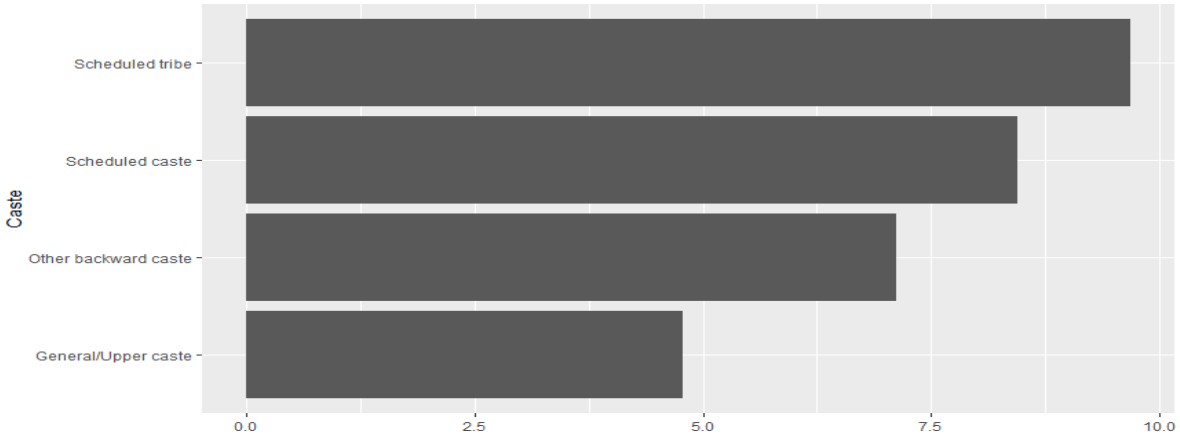

Fig 14 : % of households with one or more school-aged children not going to school

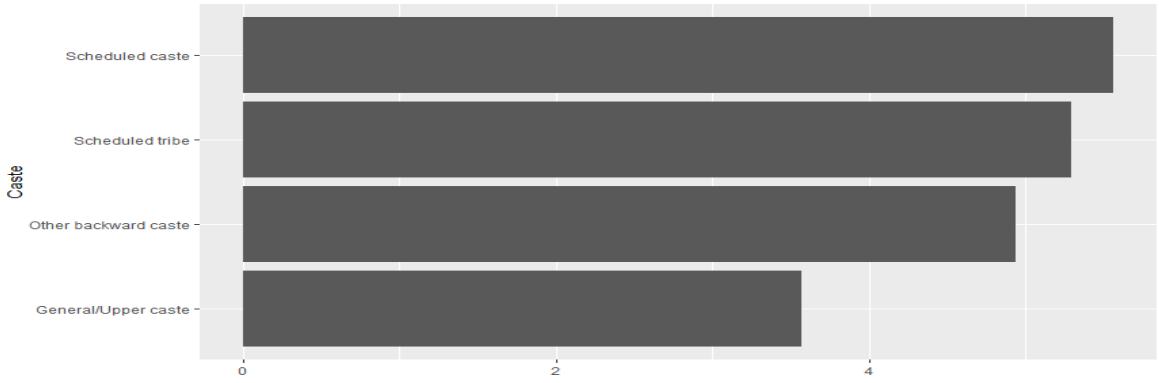

Fig 15: % households where one or more clidren deaths have occurred.

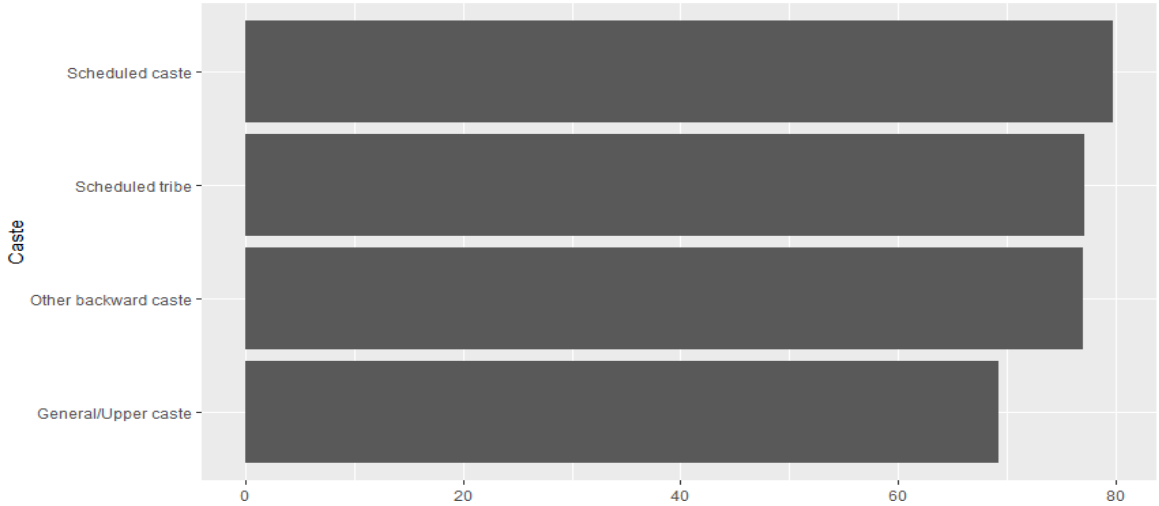

Fig 16 : Nutrition deficiency % among children

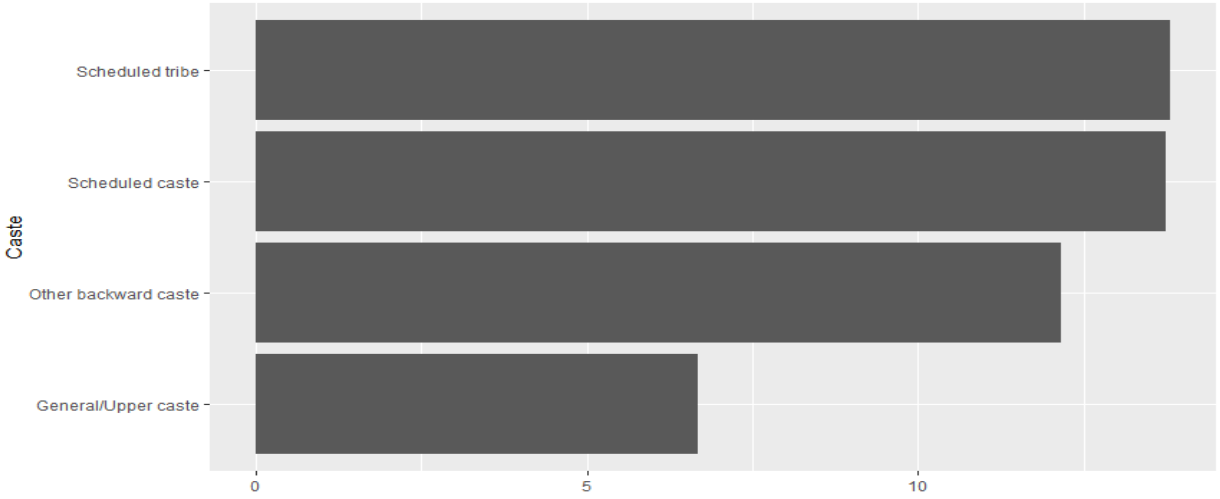

Fig 17 : % Households without Electricity

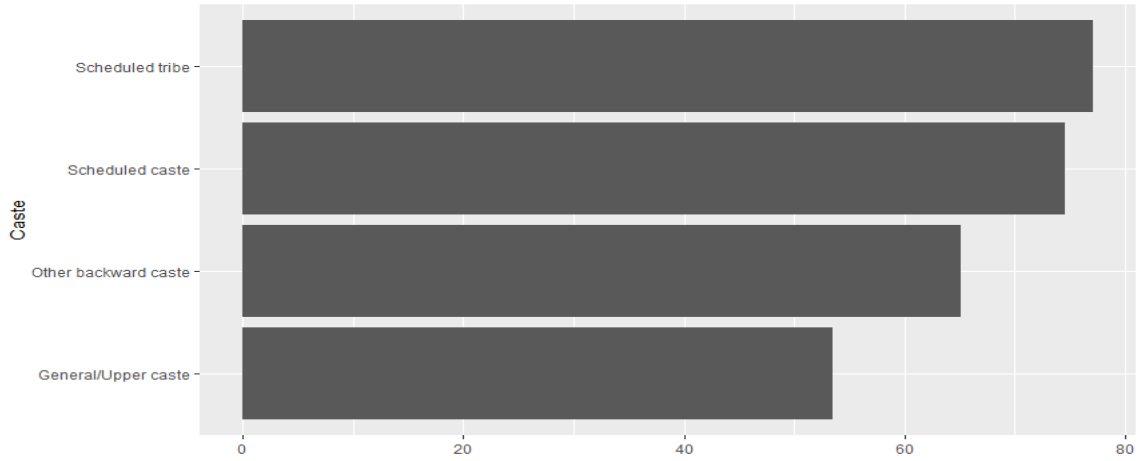

Fig 18 : % Households without Proper Toilet

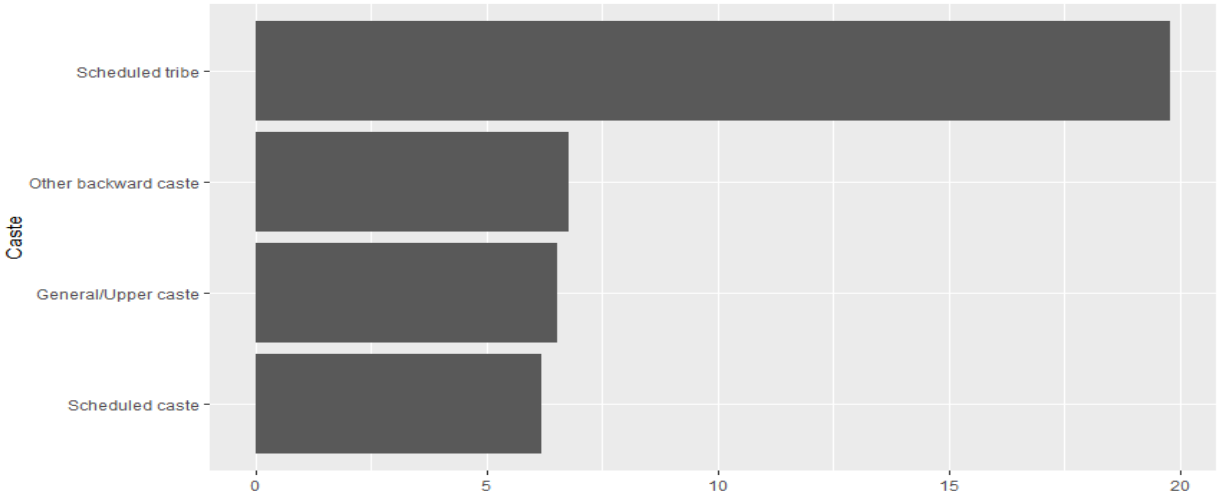

Fig 19 : % Households without Drinking Water

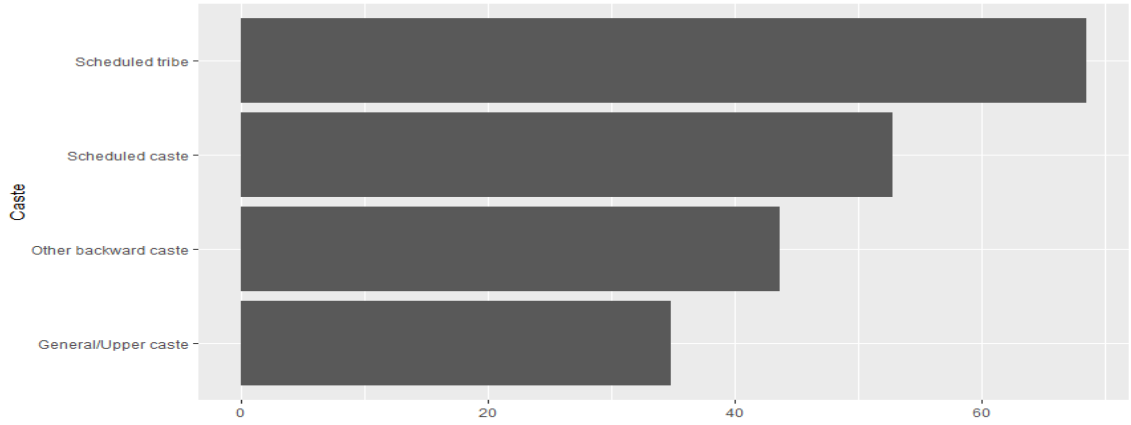

Fig 20 : % Househols having roof/wall/floor with elementary material

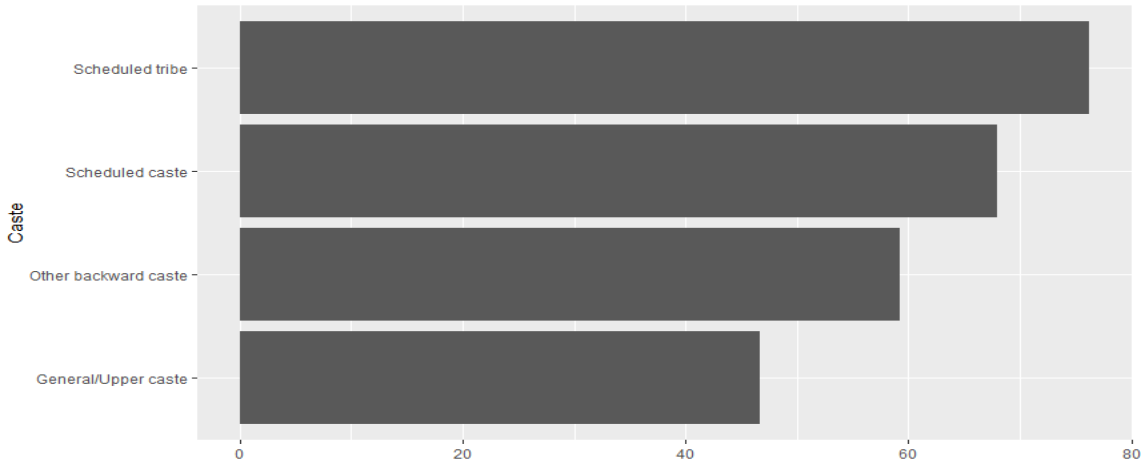

Fig 21 : % Househols that don't have access to LPG or standard cooking fuel

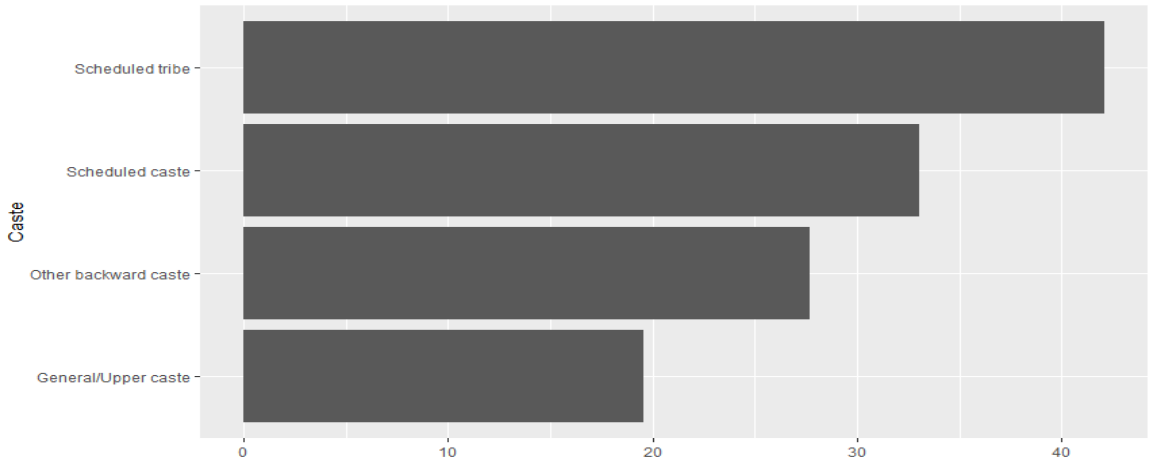

Fig 22 : % Househols do not have TV/radio/motorcycle/Fridge/Car/Phonr/Tractor

It's obvious that all three historically backwards castes, which constitute more than 70% of the Indian population show consistent higher level of poverty wrt all 10 indicators, despite several government policies in place. Another important observation is, although in India the highest percentage of households with school-aged children not going to school observed was 10%(Bihar) and highest percentage of households with one or more child death was 7%(Uttar Pradesh), almost 80% of Indian children are either stunted or suffers from malnutrition and this percentage is very high even for the general caste/upper caste (70%). So, again we can see how intrinsic India's poverty pattern is as among the children even two indicators of poverty wrt the same dimension health, show very

unalike degrees of deficiency. Exploratory analysis for religion also showed intrinsic patterns. (Our exploratory analysis included all religions as we did not want to drop more samples, but for the Jewish and Zoroastrian, case counts in our sample was 12 and 13 only respectively. So, while analyzing these plots we will stress on the other religions more.)

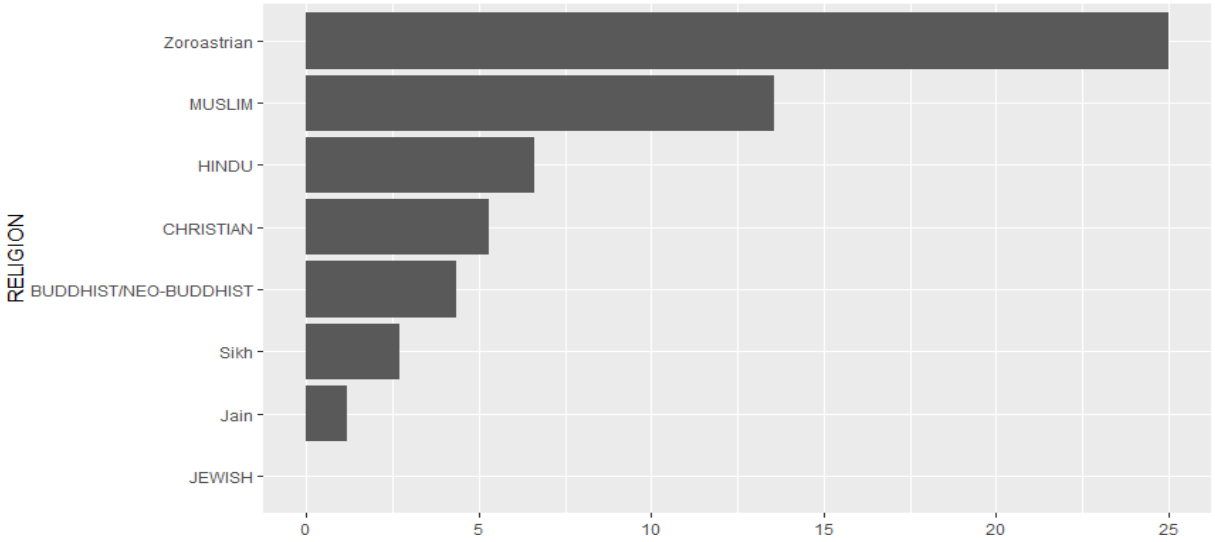

Fig 23 : % of households with one or more school-aged children not going to school

We observe 13% of the Muslim households have one or more children not going to school. Comparing with the state level poverty with children's school attendance percentage, which was highest 10% for Bihar, we observe that the Muslim community has even higher poverty level for this indicator. With respect to both the education related poverty indicators Jain community has the lowest poverty. For the other indicators:

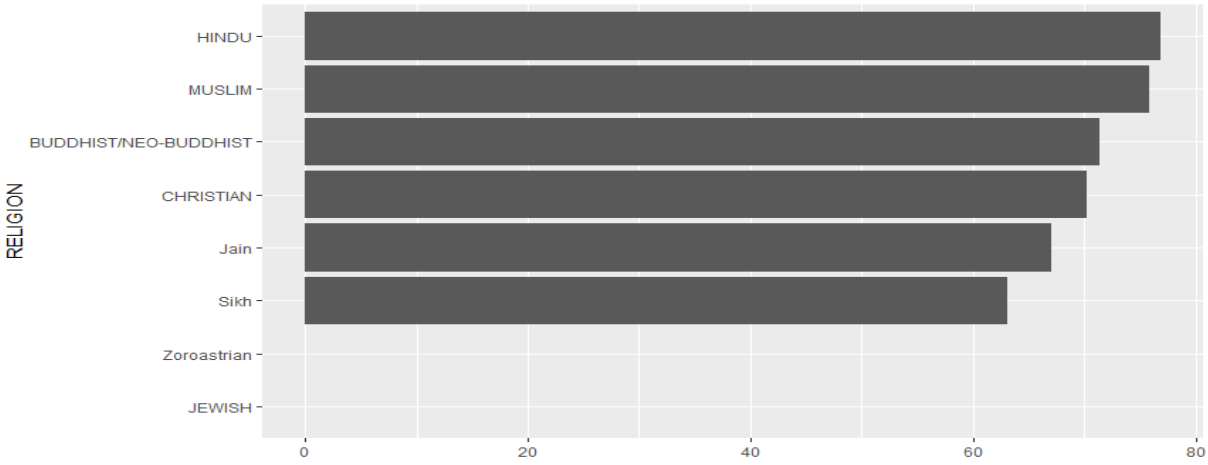

Fig 24 : Nutrition deficiency in population

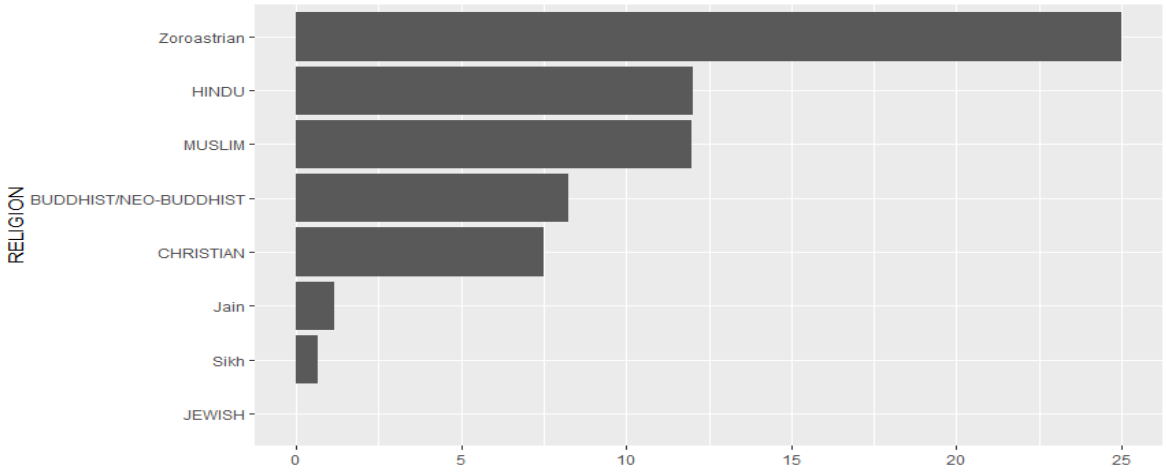

Fig 25 : % Housholds without Electricity

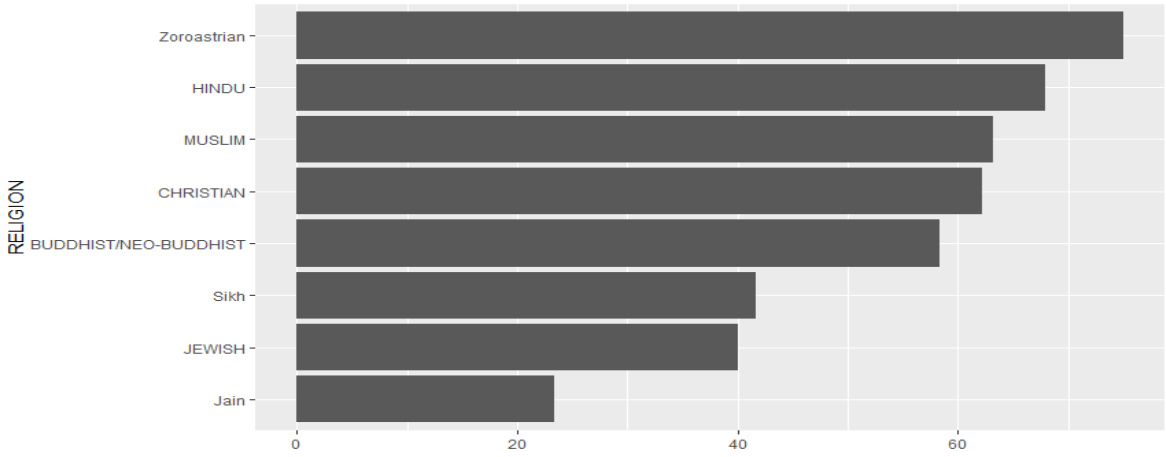

Fig 26 : % Housholds without Toilet

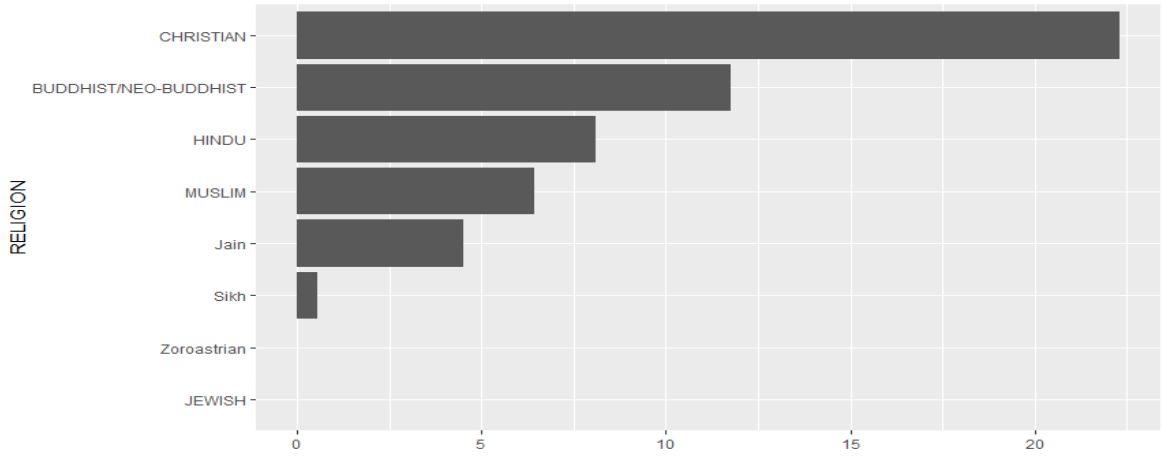

Fig 27 : % Housholds without Drinking Water

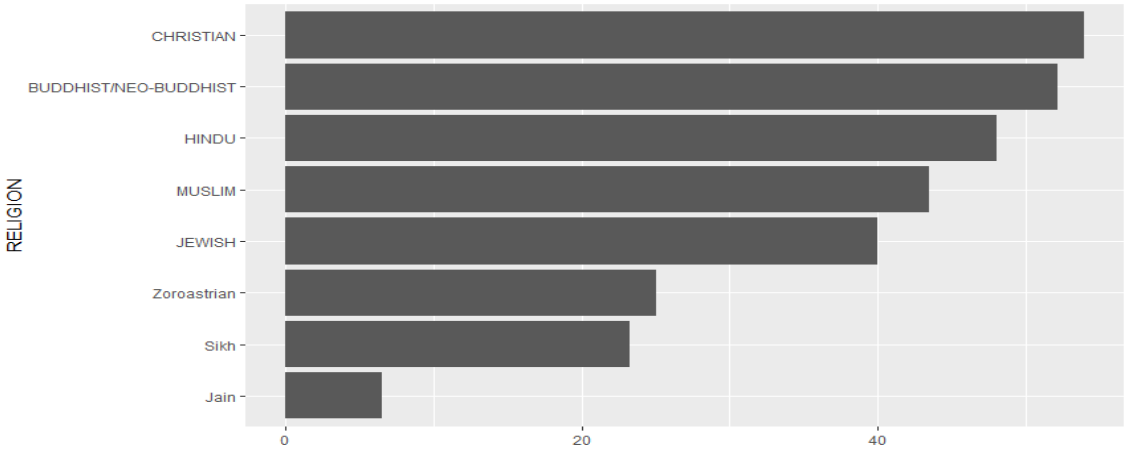

Fig 29 : % Househols having roof/wall/floor with elementary material

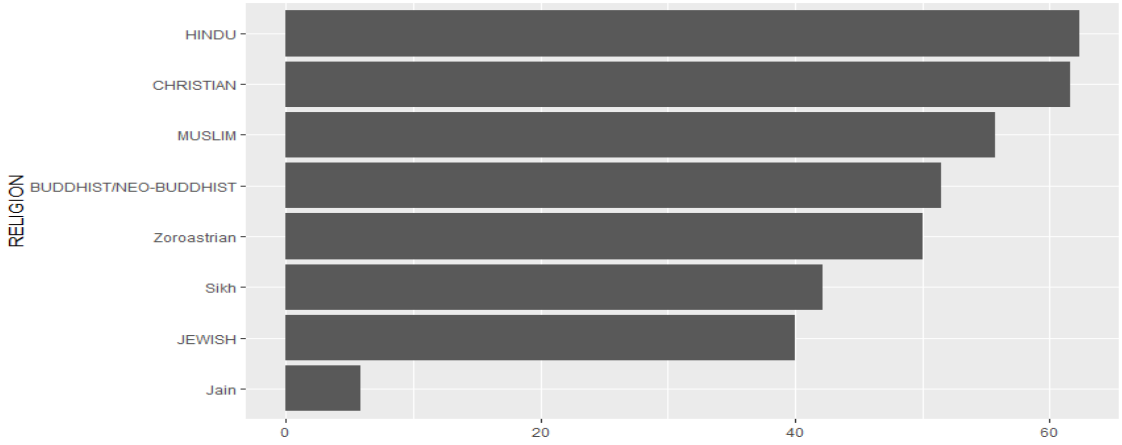

Fig 28 : % Househols that don't have access to LPG or standard cooking fuel

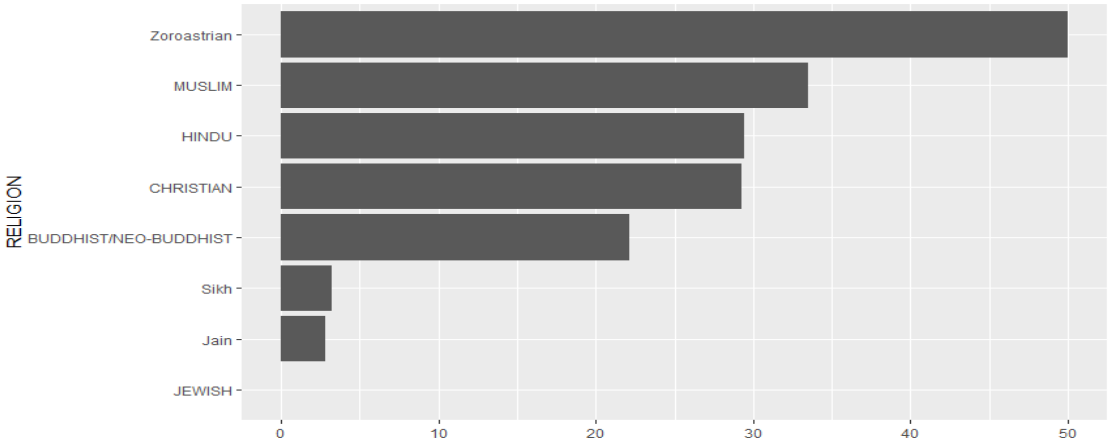

Fig 30 : Househols do not have TV/radio/motorcycle/Fridge/Car/Phonr/Tractor

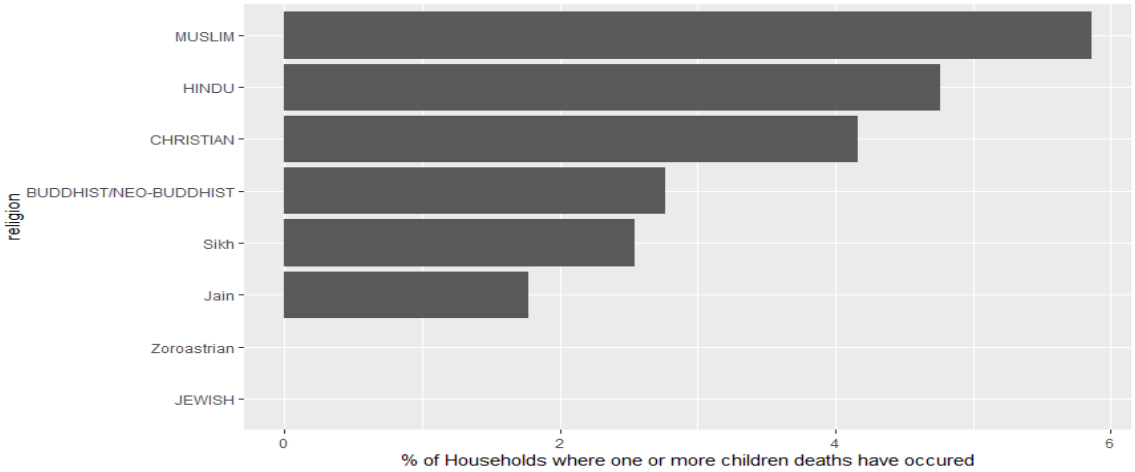

Fig 31: % households where one or more clidren deaths have occurred.

We can recall we noticed Manipur, a Christian majority state, showed the highest level of poverty for housing and drinking water. For these two parameters, now we see Christians households have the highest likelihood for poverty - 50% and 25 % respectively. We will have more insight on this while doing the MCA. Lastly we will present some individual level exploratory diagrams.

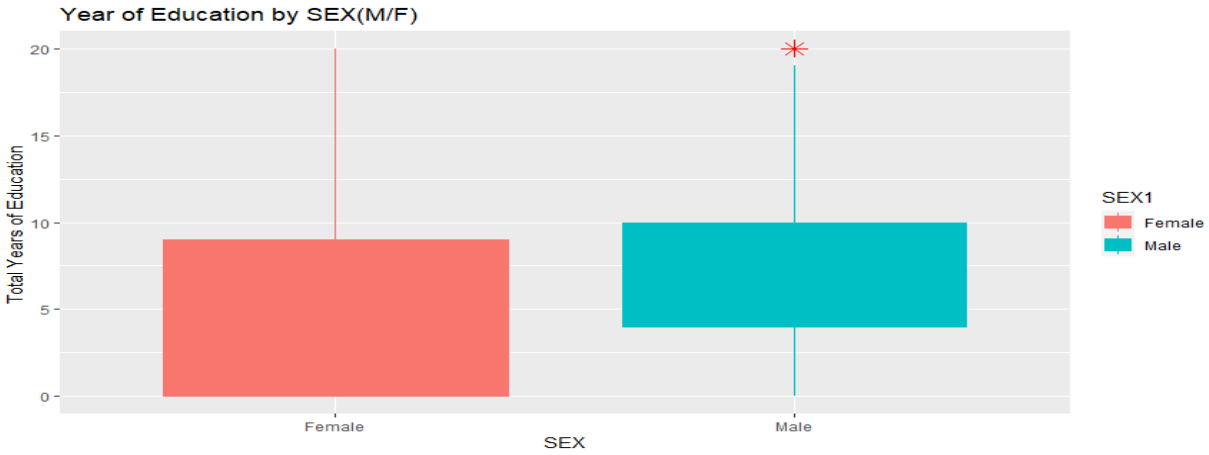

Fig 32 : Average Years of Education for men and women in India

We have alos observed that Nutrition deficiency is higher among younger people – especially among children below aged 5.

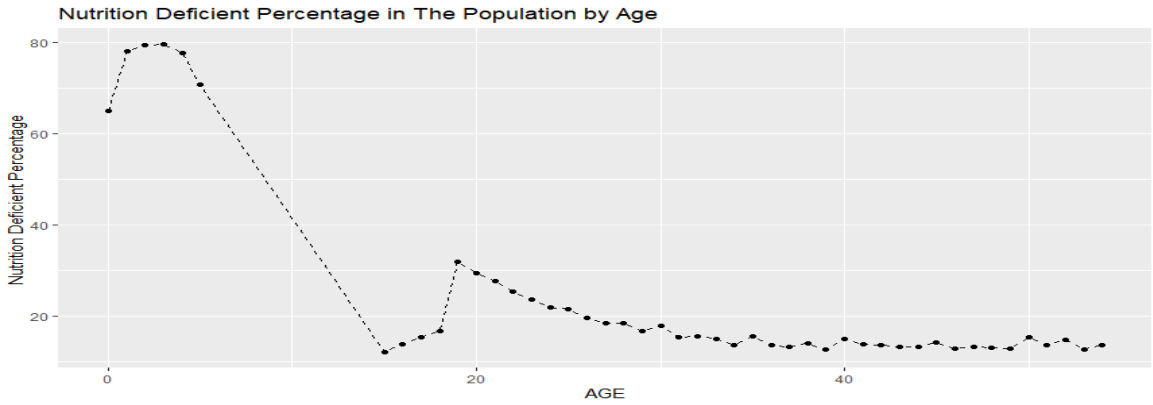

Fig 33 : Nutrition deficiency perecentage wrt age.

3.3 Regression and MCA: Now we recognize that poverty in India is not impacted by any single factor and except stunting in children for no other indicator the intensity of deprivation is not equal for different castes/religions/states/sex/age group. As now we have identified the cofactors [14]we can move on to the regression equations which we introduced at the beginning of this section:

Poverty $Score_{household}$ = intercept+ Urban/Rural status+ State/UT of the household+ Religion+ Caste

Poverty $Score_{individual}$= intercept+ Urban/Rural status+ State/UT of the household+ Religion+ Caste +Gender+ Age

We have summarized the coefficients and corresponding P-values in Table2 and Table 3:

Table 4: Coefficients linear regression Household Level Poverty Score

Cofactor	Estimate	std.error	statistic	p.value
(Intercept)	0.10096	0.015224	6.631568	3.32E-11
factor(URBAN/Rural) Rural	1.206031	0.00212	568.7974	0
factor(States)Andhra Pradesh	0.206085	0.016795	12.2703	1.31E-34
factor(States)Arunachal Pradesh	0.662547	0.016329	40.57535	0
factor(States)Assam	1.355364	0.015712	86.26319	0
factor(States)Bihar	1.961274	0.01546	126.8586	0
factor(States)Chandigarh	0.377421	0.03084	12.23795	1.95E-34
factor(States)Chhattisgarh	1.136318	0.015872	71.59351	0
factor(States)Dadra and Nagar Haveli	0.778145	0.030095	25.85639	2.1E-147
factor(States)Daman and Diu	0.425806	0.024861	17.12724	9.37E-66
factor(States)Goa	0.084699	0.024319	3.482821	0.000496
factor(States)Gujarat	0.828668	0.015835	52.33051	0
factor(States)Haryana	0.40126	0.015926	25.19598	4.6E-140
factor(States)Himachal Pradesh	0.008273	0.016861	0.49065	0.623674
factor(States)Jammu and Kashmir	0.179275	0.015927	11.25571	2.17E-29
factor(States)Jharkhand	1.482255	0.015663	94.6345	0
factor(States)Karnataka	0.592984	0.015768	37.60785	0
factor(States)Kerala	-0.20841	0.016627	-12.5349	4.82E-36
factor(States)Lakshadweep	-0.44224	0.028656	-15.4326	9.94E-54
factor(States)Madhya Pradesh	1.34136	0.015366	87.29139	0
factor(States)Maharashtra	0.645646	0.015656	41.24012	0
factor(States)Manipur	1.173933	0.016317	71.94345	0
factor(States)Meghalaya	0.914695	0.017057	53.62542	0
factor(States)Mizoram	0.214471	0.016583	12.93287	2.94E-38
factor(States)Nagaland	0.825441	0.016676	49.49823	0
factor(States)Delhi	0.259451	0.017736	14.62854	1.85E-48
factor(States)Odisha	1.140676	0.01563	72.97932	0
factor(States)Puducherry	0.138765	0.02003	6.927704	4.28E-12
factor(States)Punjab	0.200955	0.016669	12.05577	1.81E-33
factor(States)Rajasthan	1.043658	0.015498	67.3434	0

factor(States)Sikkim	-0.38061	0.018844	-20.1978	1.04E-90
factor(States)Tamil Nadu	0.092046	0.015831	5.814166	6.09E-09
factor(States)Tripura	0.862008	0.018841	45.75206	0
factor(States)Uttar Pradesh	1.488594	0.015254	97.5858	0
factor(States)Uttarakhand	0.701273	0.01614	43.45018	0
factor(States)West Bengal	0.984684	0.016156	60.95025	0
factor(States)Telangana	0.373072	0.017364	21.48502	2.2E-102
factor(CASTE)Scheduled caste	0.588969	0.044102	13.35463	1.12E-40
factor(CASTE)Scheduled tribe	0.987533	0.044007	22.44043	1.6E-111
factor(CASTE)Other backward caste	0.136983	0.044071	3.108219	0.001882
factor(CASTE)General/Upper caste	-0.22813	0.044093	-5.1739	2.29E-07
factor(CASTE)Don’t know	0.748249	0.046125	16.22218	3.54E-59
factor(RELIGION)MUSLIM	0.97211	0.044121	22.03266	1.4E-107
factor(RELIGION)CHRISTIAN	-0.04681	0.044069	-1.06222	0.288138
factor(RELIGION)BUDDHIST/NEO-BUDDHIST	0.037754	0.044944	0.840025	0.400895
factor(RELIGION)HINDU	0.260299	0.044027	5.912301	3.37E-09
factor(RELIGION)JEWISH	-0.14184	0.315142	-0.45009	0.652647
factor(RELIGION)Sikh	-0.02866	0.044931	-0.63787	0.523557
factor(RELIGION)Zoroastrian	2.148588	0.363095	5.91742	3.27E-09
factor(RELIGION)Jain	-0.34238	0.051696	-6.6228	3.53E-11
factor(RELIGION)OTHER	0.21165	0.044873	4.716684	2.4E-06

The intercept value is the predicted poverty score when our subject is at the baseline wrt all four categorical variables. Baseline categories are chosen in a way so that the intercept value is close to zero as that helps us understand the contribution of the other non-baseline categories to the total poverty score. We have selected Andaman & Nicobar Island to be baseline state/UT, those with unreported caste and unreported religion at baseline caste and religion respectively so that we can have P-values for all other caste and religion groups and urban population to be baseline for urban/rural. As for any given demographic combination (urban/rural, state, religion, caste), we want to predict the poverty score, we did not try to reduce the number of covariates. For example, for a hypothetical demographic group where caste = other backward caste, state= West Bengal, religion = Hindu, locality= urban the predicted poverty score would be 0.10096+0.136938+0.98468+0= 1.222.

Table 5: Coefficients linear regression Individual Poverty Score

Cofactor	Estimate	std.error	Statistic	p.value
(Intercept)	1.528703	0.026732	57.18595	0
factor(URBAN/RURAL) Rural	1.254724	0.003722	337.07	0
factor(SEX) Male	-0.28704	0.003944	-72.7858	0
factor(States)Andhra Pradesh	0.39288	0.029353	13.38465	7.49E-41
factor(States)Arunachal Pradesh	0.638674	0.02839	22.49628	4.8E-112
factor(States)Assam	1.281306	0.027147	47.19953	0
factor(States)Bihar	1.800654	0.026697	67.44729	0
factor(States)Chandigarh	0.421488	0.058587	7.19418	6.29E-13

factor(States)Chhattisgarh	1.067089	0.027336	39.03607	0
factor(States)Dadra and Nagar Haveli	0.791966	0.052064	15.2115	3E-52
factor(States)Daman and Diu	0.269036	0.043948	6.121757	9.26E-10
factor(States)Goa	-0.03972	0.039527	-1.00493	0.314929
factor(States)Gujarat	0.793292	0.027389	28.96349	2.2E-184
factor(States)Haryana	0.340842	0.027527	12.38229	3.28E-35
factor(States)Himachal Pradesh	-0.0563	0.029158	-1.93094	0.05349
factor(States)Jammu and Kashmir	0.200564	0.027437	7.310133	2.67E-13
factor(States)Jharkhand	1.445849	0.02712	53.31359	0
factor(States)Karnataka	0.635641	0.027331	23.25724	1.3E-119
factor(States)Kerala	-0.32407	0.028986	-11.1805	5.1E-29
factor(States)Lakshadweep	-0.61418	0.049558	-12.3932	2.86E-35
factor(States)Madhya Pradesh	1.307294	0.026544	49.24991	0
factor(States)Maharashtra	0.617173	0.027156	22.72671	2.6E-114
factor(States)Manipur	1.061543	0.028135	37.73033	0
factor(States)Meghalaya	0.652618	0.029405	22.19432	4.1E-109
factor(States)Mizoram	0.031484	0.028808	1.092878	0.274447
factor(States)Nagaland	0.715173	0.029094	24.58125	2.2E-133
factor(States)Delhi	0.392877	0.032901	11.94119	7.25E-33
factor(States)Odisha	1.141648	0.026993	42.29355	0
factor(States)Puducherry	0.030024	0.033827	0.887571	0.374772
factor(States)Punjab	0.185879	0.029147	6.377232	1.8E-10
factor(States)Rajasthan	1.014623	0.026784	37.88134	0
factor(States)Sikkim	-0.35487	0.032633	-10.8747	1.53E-27
factor(States)Tamil Nadu	0.065456	0.027239	2.403038	0.01626
factor(States)Tripura	0.85664	0.032539	26.3265	1.1E-152
factor(States)Uttar Pradesh	1.357115	0.026353	51.49761	0
factor(States)Uttarakhand	0.667867	0.02795	23.89483	3.7E-126
factor(States)West Bengal	1.012188	0.027913	36.2626	9.5E-288
factor(States)Telangana	0.476807	0.030487	15.63961	3.97E-55
AGE	-0.03673	0.000113	-324.791	0
factor(CASTE)Scheduled caste	0.789568	0.072481	10.89352	1.24E-27
factor(CASTE)Scheduled tribe	1.143014	0.072329	15.80296	3.01E-56
factor(CASTE)Other backward caste	0.353051	0.07243	4.874405	1.09E-06
factor(CASTE)General/Upper caste	-0.03849	0.072469	-0.53114	0.595325
factor(CASTE)Dont know	1.003361	0.076053	13.19298	9.7E-40
factor(RELIGION)MUSLIM	0.692783	0.072439	9.563644	1.14E-21
factor(RELIGION)CHRISTIAN	-0.1547	0.072339	-2.13858	0.03247

factor(RELIGION)BUDDHIST/NEO-BUDDHIST	-0.05273	0.073769	-0.7148	0.474731
factor(RELIGION)HINDU	0.134457	0.072279	1.860248	0.062851
factor(RELIGION)JEWISH	-0.11088	0.496545	-0.22331	0.823293
factor(RELIGION)Sikh	-0.14646	0.073986	-1.97954	0.047755
factor(RELIGION)Zoroastrian	1.370184	0.580655	2.359722	0.018289
factor(RELIGION)Jain	-0.66984	0.08606	-7.78338	7.07E-15
factor(RELIGION)OTHER	0.109366	0.073657	1.484802	0.137596

So, household level multidimensional poverty is acute for rural Muslim or Scheduled Tribes households from the states Assam, Bihar, Chhattisgarh, Gujarat, Jharkhand, Manipur, Meghalaya, Madhya Pradesh, Nagaland, Odisha, Rajasthan, Tripura, Uttar Pradesh and West Bengal. In contrast, the less disadvantaged households are urban upper caste Hindu or Jain households from Goa, Lakshadweep, Kerala and Sikkim.The rest of the states or combinations of states, caste, and religions do not show any distinct pattern. This is one of the most important findings of our study that although many categories like Scheduled Caste, Other Backwards Castes, Christians, Hindus showed high poverty for some indicators and are often taken as disadvantaged groups, at the aggregate level they don't show any evident pattern. Similarly Delhi was seen as least disadvantaged wrt some indicators, but it doesn't show any evident pattern either maybe because of the intersections of different castes and religion groups in the capital. Whether these other groups which seemingly showed some pattern in our exploratory analysis (and might be popularly perceived as more or less disadvantaged) really do not show any pattern as their regression coefficients are suggesting, can be verified using a Multiple Correspondence Analysis . We extracted the household level data for only these categories which have been identified to be not acutely poor/not poor. We can see that no principle component of those categories has well enough ability to explain the variability and also the perception map puts poor or no poor categories near the centre indicating the categories we kept were no significant.

Fig 34 : Perception map showing association/noise among categories across and between demographic groups.

For the Individual level linear regression both Sex and Age show significant impact.

As we have seen some categories from all the covariates are significant and despite the category combinations being large, the number of covariates is not large, we have not gone for dimension reduction. The exploratory analysis, linear regression and principle component analysis have helped us understand which categories are likely to be more disadvantaged and who are less disadvantaged. From the exploratory analysis we identified the demographic aspects. From the regression we understood which categories are significant and to what extent. Lastly, MCA is more of a confirmatory analysis of our findings from the regression. And after the exhaustive analysis we confirm our final models as :

Poverty $Score_{household}$ = intercept+ Urban/Rural status+ State/UT of the household+ Religion+ Caste

Poverty $Score_{individual}$ = intercept+ Urban/Rural status+ State/UT of the household+ Religion+ Caste +Gender+ Age

Where the coefficients are given in Table 2 and Table 3

From our exploratory analysis, regression and MCA, we can categorize the different demographic, geographic, ethnic groups as:

Table 6: The disadvantaged and not disadvantaged demographic groups

Disadvantaged groups	**Does not show any evident pattern of aggregate MPI poverty**	**Not disadvantaged groups**
Female		Male
Rural	Urban	
Scheduled Tribes	Scheduled Caste, Other Backward Caste	General/Upper Caste
Muslim	Hindu, Christian, Buddhist, Sikh	Jain
Assam, Bihar, Chhattisgarh, Gujarat, Jharkhand, Manipur, Meghalaya, Madhya Pradesh, Nagaland, Odisha, Rajasthan, Tripura, Uttar Pradesh and West Bengal.	Daman and Diu, Chandigarh, Andhra Pradesh, Arunachal Pradesh, Haryana, Himachal Pradesh , Jammu and Kashmir, Karnataka, Maharashtra, Delhi, Mizoram, Punjab, Puducherry, Tamil Nadu, Uttarakhand, Telangana, Andaman & Nicobar Islands	Goa, Lakshadweep, Kerala and Sikkim

Sometimes, a certain demographic group can be very large and hence we would need more information wrt other demographic indicators to single out the likely disadvantaged groups. For example in India the Scheduled Caste and Other Backward Castes have been generally perceived as disadvantaged [15] But as this demographic group constitutes more than 70% of the population [16] , we will expect varied levels of impoverishment within this group based on state/district, gender, age group, urban/rural status etc. Also this raises the importance of collecting sub-castes during census.

Finally, NFHS also collect data on BPL card holder status for each household/individual. BPL (below poverty line) is the traditional way of marking ‘poor’ or ‘not poor’ based on an individual’s daily income. We will conclude this discussion with a contingency table comparing MPI poor with BPL card holders, for our understanding of the association between the two measurements.

Table 7: MPI and BPL comparison

	BPL Card Holder- Income poverty	**Not BPL Card Holder**	**BPL Status Unknown**
MPI Poor	491957	488103	1430
Not MPI Poor	626406	1257224	3923

4. Conclusion:

In Table 7 the Chi-square statistics is 77734.1 with DF1, if we ignore the BPL status-unknown households for the test of independence. The important observation is how poverty wrt one indicator might not imply overall poverty and vice versa. There could be many other aspects to include in the analysis or computation for MPI, for example, job security, child labor, migration and violence/domestic violence. But we concentrated on the aspects that money could mitigate and then our approach to improve the multidimensional poverty situation would be twofold, firstly as we see that the findings from conventional yardstick (BPL card) of measuring poverty is not in high contrast with MPI findings, the disadvantaged groups will need to be empowered so that they can financially secure themselves first. Secondly, not all disadvantaged groups can prudently utilize the finance identifying which area (or MPI indicator) the finance needs to be directed to. The granular exploratory analysis helps us see the disparity between different indicators wrt different communities, is present and the correct policies to address the holistic poverty (BPL or MPI) situation should start with distilling pressing socioeconomic areas for any community and tailor policies depending on the intensity to assure no estate of the realm have all the money and no community is put behind.

Acknowledgement

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