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Assessment of Child Malnutritional Indicators in India with PCA

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Abstract: Despite the recent achievements in the progress of child health indicators in India such as mortality, morbidity and malnutrition, the fruits of the development has failed to distribute the achievements evenly among the States and also within states, being one State performing well in one indicator and not in other indicator. This paper focuses on the nutritional indicators of children in India namely stunting, underweight and bmi by analysing the major determinants of these indicators. The National Family Health Survey (NFHS 3) data was employed which gives information for nearly 51555 children of 0-59 months. It applies the technique of Principal Component Analysis (PCA) for creating the malnutrition index which is composed of the variables such as child height child weight and bmi. Factor scores were then used to derive standardized indices and quintiles. A KMO test was conducted to assess the appropriateness of using PCA. By considering the major indicators like height, weight and bmi, three factors were discovered which explains 65% of total variation. Gender of the child, birth order, birth size, age, mother education, wealth index are turning out to be highly significant variables and influences the under nutrition index. The North-Eastern and the Southern States are performing better when compared with other central and western States. In India, the performance of the index varies because of the major variations in religion, caste and income equality. Since nutrition depends on various factors, the linkage of nutrition with sanitation policies, environment policies, agriculture related policies and infrastructure is extremely needed to address this under nutrition.

Key Words: Malnutrition Index, Principal Component Analysis (PCA), Stunting, underweight.

JEL Codes: C51, I12, I13, I14, J13, O15.

Introduction:

Every country, no matter at what stage of their social and economic development, will have a concern in meeting the healthy needs of their people. Investments in the health sector will pay higher returns in the form of labour productivity. As defined by the WHO, health is not merely a state of absence of disease, it helps the human beings both children and adult to adapt to the everyday changes in life, defend against infections and interact with surroundings (WHO, 2001)

Why focus on children's health?

Once child health is considered as an end in itself then any health outcome variable based on child health automatically becomes a significant component for economists and policy makers to assess the triumph or malfunction of the various policy interventions. They need special attention because they are more vulnerable. Anytime a healthy child can fall sick. The current generation child suffers from diseases like HIV/AIDS, juvenile diabetes, cancer and mental faculties where with adequate attention and care, some of them may also be curable and preventable. Furthermore, children are increasingly being diagnosed with life style diseases like obesity which were otherwise diagnosed only in adults. All of these add to the burden of disease among children. More importantly the nature, type and distribution of disease in childhood differ from adults.

Maintaining the health of children is a broad and comprehensive issue and cannot be addressed by paediatricians alone. Combined effort is needed among social scientists (economists in particular), academicians, researchers, community workers and other health professionals to improve their status.

Background:

Any country or an individual always wants to maximise their stock of health capital through investment to acquire better health status. In the theoretical model given by Grossman, the individuals are assumed to inherit the stock of health capital, by considering health as a human capital. Through health investments, the individual can increase or decrease the desired health stock. But investment cannot be negative as the individual cannot sell his/her health with the rate of depreciation.

In olden days, child development researchers were focussing on child's biological characteristics to describe the growth or development of the child. Nowadays, the attention has grown in exploring the child's growth outcomes using a multi-dimensional approach by incorporating the social, economical, technological,

medical interventions and cultural factors along with the biological factors in explaining the overall growth of the child. Mosley and Chen (1984) noted a disparity between social science research and medical research, where the former focuses on the inclusion of all socio economic variables and cultural variables for child deaths and the latter focuses on specific disease processes and used morbidity as the most common outcome variables. They developed an analytical framework which integrates the two research methodologies and introduces a single outcome variable. The medical determinants are proximate which includes maternal factors, environmental contamination, nutrition deficiency, injury and personal illnesses control and the social determinants as distal that include income, traditions/norms, access to health services and sanitation. The conceptual core of their framework was the hint that all socio-economic and cultural variables have to operate through a limited set of proximate determinants for the child growth or survival outcomes.

Child's height and weight or the nutritional status can be viewed as an outcome of the health production function where the inputs include intake of nutrients, diet patterns, exposures to infections, genetic dispositions and access to health care. The record of various countries in child health indicators is still a challenging task. Socio-economic inequalities in health outcomes are becoming the emerging area of research in health literature which ultimately affects the economic growth of the country. The recent report of State of World Children (2014) reveals that in spite of tremendous progress the gains and deprivations are unevenly distributed among the countries. In South Asia moderate and severe stunting is around 38% in 2012 and in Latin America it is around 11%. Some 6.6 million children under 5 years of age died in 2012, mostly from preventable causes.

Significance of the study:

Child under nutrition places a massive burden on the macro economy and also it is a pressing alarm being addressed by the government, and it is prominent to note according to the Summary of Progress towards Meeting the Millennium Development Goals, 2012, the child malnutrition target only has a small likelihood of being met, further increasing the severity of the situation. At individual level, the child loses their educational performance and where they miss more school days due to illness and in future it affects the labour productivity. To solve this issue, the clinical and non clinical interventions have to be planned accordingly by clearly understanding the issue. As Nutrition is multi factorial one it should be inter- linked with poverty, agriculture, infrastructure and diet patterns policies

Child health and its status:

Earlier, people will not spend on the children until they are sure about their survival which resulted in high birth rates and high death rates. Child health was a part of adult medicine. But in 18^{th} century, there was a remarkable change in the medical field, where people started to become aware that special provision of care is needed for children and social awareness gradually emerged. In 19^{th} and 20^{th} century, child health has emerged as a special target since it has been acknowledged that health problems among children are different from adults. Their exposures, bodily absorption, developmental phase, ability of transformation differs from adults which increases the risk of being diseases (Bearer, CF, 1995).

The Alma Ata declaration of 1978 was the first international declaration which stressed the importance of primary health care. It widens the scope of health as a human right and for adopting a slogan as health for all by 2000. However several criticisms were raised against this as it was unrealistic, unspecific and it did not provide any tangible reforms (Cueto, 2004). 36 years after the declaration there is still evidence from Africa on the effectiveness of community health workers (CHW's) who delivers curative interventions against the major causes of mortality in children such as pneumonia, malaria, diarrhoea, HIV etc.(Christopher, et al., 2011).

Then United Nations adopted the declaration of child rights in 1989 which was the result of the ten years of negotiation following the International year of the child in 1979. It has created international standards, principles, guidelines for the treatment of children. Under the survival and development it includes the right to life and an adequate standard of living and healthcare. By adopting this convention, there comes an obligation for the countries to ensure and protect the rights of the children and all the countries are accountable before the international community.

In 2000, various leaders from 189 countries signed a UN millennium declaration to eradicate extreme poverty by the year 2015. It includes 8 MDG's with 21 targets and 60 indicators, time bounded, targeted on human capital, infrastructure and human rights. Several of the 8 goals are related to the improvement of children's health and education. Eg: improving educational opportunities, decrease poverty and hunger, providing health facilities and safeguarding environment. Specifically, MDG 4 is to decrease child mortality by two-thirds, from an incidence of 93 deaths per 1000 children under age five to 31 per 1000 in 2015. Most countries with high values are struggling hard to achieve their targets by 2015. But the world is not on the track to meet the goals within 2015 especially in MDG 4 despite these improvements, statistics on each of the indicators like mortality, underweight, stunting illustrated there are barriers to healthy childhoods. Every one in four children under age 5 worldwide had stunted growth in 2013. Boys are more likely to be stunted than girls in most of the countries and children from poorest 20 percent are more stunted than those from the richest quintile. In India, progress

against underweight in children is steady among the richest children, but has stagnated among the poorest. (UNICEF Report, 2013).

To arrive at estimates of health status, various indicators have to be measured and assessed. Hence, the status of health is often measured by indicators such as mortality, incidence of diseases, life expectancy, anthropometric variables (low birth weight, height, weight, waist and arm circumference etc), utilization of health care inputs and behavioural changes.

Why measurement and usage of child health data is important?

Measurement of health indicators by using appropriate data will help the countries' policy makers to design appropriate the policies and programmes. It helps to achieve planning efficiency by identifying the problems with the right estimates through measurements. Measurement estimates also helps to plan specific interventions at local levels by identifying the geographical regions where the problems are heavily concentrated. It helps to compare and diagnose the outcomes where it lacks and ahead off in the performances.

With the prevailing measures and methodologies, various research studies have estimated the most powerful indicators of child health such as *underweight, stunting and wasting,* which embraces the child level variables, household characteristics, parental (mother and father) characteristics and policy related variables. The methodologies for defining child health outcomes are new and still in development. Major approaches which have been used in the literature are factor analysis, cluster analysis, index methodologies (Concentration indices, child under nutrition index, composite index, infant and feeding index) and multivariate analysis. Some of the recent studies are highlighted here.

Determinants:

Several studies have acknowledged the income related inequalities in health, where the lower socio – economic strata people experience poor health outcomes. In relation to this, with NFHS-3, income related health inequality was assessed empirically with concentration curves and indices. By considering underweight, stunting, child immunisation and child mortality variables, it was found that national average is negative and the poorer sections are continue to remain in disadvantage. Therefore the health inequalities are increasing when there is a rise in average income inequality (Joe and Mishra, 2008). Another study in this similar line with all three rounds of NFHS studied the trends and patterns of malnutrition by using underweight as a proxy variable among different economic groups. The regression results clearly show that the decline in underweight percentages among children in the poorest and the richest quintile are 32% and 45% respectively from 1992-2006 (Pathak and Singh, 2011).

Recent methodologies help us to create an achievement index to exhibit the relationship between equity and efficiency, by employing the extended concentration index model as proposed by (Wagstaff, 2002). The concentration index along with its concentration curves has been used by many studies to show the income related inequality with ill health. It was widely shown in the literature that the stunting prevalence is evenly distributed in the lower wealth quantiles and wasting is more concentrated in poor people. States with low and high average health achievement has higher health inequalities and poor health achievement states has lower income related health inequalities (Arokiaswamy and Pradhan, 2011).

But construction of index in malnutrition is a challenging task since most of the anthropometric indicators overlap with each other. To avoid the overlap confusion, composite index has been suggested where six combination of anthropometric failures are used. The combination of indicators such as no failure, wasting only, stunting only, underweight and stunted, wasted and underweight, wasted, underweight and stunted was made to capture better nutritional status (Svedberg, 2007). Using this Composite Index Anthropometric Failure(CIAF), recent paper analyzed the IHDS data and results depicted that combination of stunting and underweight was highest among the poor quantile and this index also been analyzed with infectious diseases, where the combination of stunting and underweight proportion was higher (Gaiha, R, et.al, 2010).

Growing body of literature shows that besides wealth and income, other socio-demographic factors have a significant impact on malnutrition. Other than the social and economic determinants, environmental factors do play a role in nutritional levels. Several studies proved that because of lack of access to safe drinking water, increase in open defecation rates (Deaton, 2013) improper drainage facilities, risk of proneness to diseases increases and thereby influence the underweight and stunting rates. Recent study critically examined how the various accesses to water and sanitation affects the child's height and weight in Nigeria below 5 years. Pipe and borehole water and access to flush toilets are significant for the child growth when compared to other sources where usage of well water increases the stunting and underweight among Nigerian children. (Visser and Adewara, 2011). Global model was estimated to study the impact of climate change on future stunting with WHO, FAO, World Bank dataset. With bilinear regression models, it was estimated that climate change does have significant effects on severe stunting from 23% to 62% by 2050 (Llyod, SJ, et. All, 2011). Another study critically examined the role of diseases which is influenced by water and sanitation on under nutrition. It reflects the fact that the improvements in stunting are more in top quintile of wealth and in underweight, the gap

between top and poorer quintile is even more severe. Since developing countries are in developing stage the nutritional indicators also changes considerably. (Desai, 2013).

However, the current child developmental literature does not have a uniform approach which combines all the indicators together that results in a composite index and it also lacks its application in capturing the inequalities in early child development outcomes. No single measure or indicator of child health is available to capture health status of a child. Rather than using various abstract variables, it is better to use a single index as a relative measure which quantifies the complex conditions or circumstances for understanding the factors more precisely which affects child development.

Methodology and Analysis:

As an alternative, this paper proposes and implements a methodology of statistical measure in the indicators such as height, weight and bmi which is not usually used in the multidimensional literature and brings out the practical need for statistical and empirical assessments. The paper estimates malnutrition indices which incorporates the indicators to derive a uni- dimensional malnutrition index after removing the outliers in height, weight and bmi.

Construction and Estimating Malnutrition Index:

Principal Component Analysis (PCA) is a statistical technique which uses orthogonal transformation to alter a set of observations of likely correlated variables into a set of values of linearly uncorrelated variables. It is also a device to trim down the multidimensional data to lower dimensions while retaining most of the information. It covers standard deviation, covariance, and eigenvectors and as well does not require large computations. It focuses on the directions which have widest variations. In the literature, this method has been widely applied in the construction of asset indices, dietary indices and so far it is not been applied to child growth indicators. So the paper is an attempt to employ this methodology for the physical growth indicators of child and with that index further econometric analysis has been carried out.

Suppose, we have a set of *J* explanatory variables, then *J* principal components can be constructed, each will be orthogonal to the others in the matrix. If the regression is run on the *J* principal components then it produces estimates β with smaller variance. Variables such as height, weight, bmi are expressed as a linear combination of a set of components for each child i in the household.

$$X_{1j} = v_{11} \times C_{1j} + v_{12} \times C_{2j} + ... + v_{1N} \times C_{Nj}$$
$$\dots \qquad j = 1,...J$$
$$X_{Nj} = v_{N1} \times C_{1j} + v_{N2} \times C_{2j} + ... + v_{NN} \times C_{Nj} \ , \qquad (1)$$

Where the Cs are the components and the *v*s are the coefficients on each component for each variable. The first principal component C_{1j} gives the maximum variance and then finding a second linear combination of the variables, orthogonal to the first and so on. After this, λ_n (also known as eigenvalues) and their associated eigenvectors, $\mathbf{v}_n$ are produced and factor scores can be calculated for each of the principal component.

After estimating the index, ordered probit model was used to estimate the coefficients. With this the different degrees of malnutrition can be assessed, where the dependant variable takes the values of 1,2,3,4,5 according to the level of nourishment of the children. Suppose,

$Q_{ij} = x'\beta + \varepsilon_{ij.}$

Where Q is unobserved and β are the set of regression parameters and ε is the random disturbance term which follows a normal distribution with zero mean and constant variance. Therefore, the ordered outcomes are 1 if well nourished and 5 is severely nourished.

Data and the Empirical Model:

This paper uses the nationally representative household survey of NFHS which is a 3 year retrospective collection of information and records on maternal and child health practice outcomes, along with socio-economic, demographic information on women, men, children and other selected members in the family. NFHS-3 (2005-06) data was used for the children aged 0-59 months.

The model is estimated as follows with child set of variables, household variables and parental variables.

Mindex = H (child level variables(child age in months, age square, gender of the child(dsex), birth order, birth size, vaccination, fever, cough, diarrhea, household level variables (caste, religion, place of residence, occupation of the head of the household, wealth index, family size and quality of water, household has BPL card sanitation facility, gender of the household head) and mother level variables(mother height, mother education, gave child food, mother bmi, breastfeeding,), policy variable(ICDS) and state dummies).

Variables	**Mean**	**Std. dev**
Child Variables		
Age in months	29.54	17.21
Age square	1169.04	1051.04
Gender (0- Male 1- Female) Base- Male	0.48	0.50
Birth Size(Base- Very Large)		
Larger than average	0.19	0.39
Average	0.56	0.50
Smaller than average	0.14	0.35
Very small	0.06	0.24
Birth Order (Base- One child)		
Two child	0.28	0.45
Three and > than 3 child	0.40	0.49
Household Variables		
Caste (Base- Sc)		
ST	0.17	0.38
OBC	0.34	0.47
Others	0.30	0.46
Religion (Base- Hindu)		
Muslim	0.17	0.34
Christian	0.10	0.30
Other religion	0.05	0.21
Place of Residence (Base- Urban)		
Rural	0.62	0.48
Water Boiled (0 No 1 Yes) (base No)	0.20	0.40
Wealth Index (Base Poorest)		
poorer	0.19	0.39
middle	0.21	0.40
richer	0.22	0.41
richest	0.21	0.41
Family size (base small family)		
Large family	0.43	0.50
Household Head Occupation (base Not working)		
Professional	0.02	0.15
clerical	0.01	0.08
sales	0.02	0.13
Agriculture	0.22	0.41
services	0.02	0.14
manual	0.07	0.26
Household has BPL card (base No)		
Yes BPL card	0.22	0.41
Household head(base male)		
Female	0.10	0.31
Sanitation Facility(base No facility)		
Flush	0.43	0.49

Variables	Mean	Std. dev
Pit	0.09	0.29
Others	0.02	0.13
Parental Variables		
Mother education (base Illiterate)		
primary	0.14	0.35
secondary	0.37	0.48
higher	0.08	0.27
Breast feeding (base Never)		
<3 months	0.11	0.31
3-6 months	0.09	0.28
>6months	0.76	0.43
Gave child food(base veg)		
child food	0.12	0.32
Mother BMI(Base <18.5)		
18.5-24.9	0.56	0.50
25.0-29.9	0.08	0.28
>30.0	0.02	0.15
Access to ICDS services	0.74	0.44
State Dummies		
North	0.18	0.38
Centre	0.23	0.42
West	0.11	0.31
North-East	0.19	0.39
East	0.16	0.36

Ordered Probit Results:

Following from the equation, three sets of explanatory variables have been used in estimation. They are child level variables(child age in months, age square, gender of the child(dsex), birth order, birth size, household level variables (caste, religion, place of residence, occupation of the head of the household, wealth index, family size and quality of water, household has BPL card sanitation facility, gender of the household head) and mother level variables(mother height, mother education, gave child food, mother bmi, breastfeeding,), policy variable(ICDS) and state dummies.

Table 2: Ordered probit Estimates of the variables.

Variable	Coefficient	T-ratio
Age	0.0002*	0.67
Gender Male: ref		
Female	-.354***	-32.91
Birth Size Very Large: ref		
Larger than average	-.152***	-4.93
Average	-.203***	-6.90
Smaller than average	-.405***	-12.73
Very small	-.483***	-13.24
Birth Order 1 child: ref		
2 child	-.0752***	-5.36
3 and >3 child	-.111***	-7.45

Variable	Coefficient	T-ratio
Vaccination No: ref		
At least two vaccination	.234***	0.11
One vaccination	.113***	4.61
Fever Yes: ref		
No	.0759***	4.15
Diarrhoea Yes: ref		
No	.0451*	2.40
Cough Yes: ref		
No	-.0666***	-3.92
Initiation of bfeed Within 1 hour : ref		
Later 1 hour	-0.00559	-0.48
Food Groups zero food: ref		
One food group	0.0239	1.71
Atleast two Food group	.135***	10.52
Mother height Q1: ref		
Q2	.163***	9.51
Q3	.272***	15.71
Q4	.355***	20.23
Q5	.507***	28.61
Mother weight <18.5: ref		
18.5-24.9	.219***	18.28
25-29	.423***	18.22
>30	.448***	10.56
Age of Mother 11-14: ref		
15-19	0.0101	0.34
19 & above	0.0256	0.85
Mother education Illiterate: ref		
Primary	.0536**	3.15
Secondary	.116***	7.44
Higher	.296***	10.39
Women Autonomy		
Household Purchases	0.00931	0.36
healthcare	-0.006	-0.49
Family ties	-0.0112	-0.53
Household Daily Needs	0.0122	0.94
Money	-0.0107	-0.40
Mother lost child no: ref		
Yes	0.0106	0.67
Mother Working no: ref		
Yes	-0.00672	-0.53
Family size large family: ref		
Small family	.0292*	2.55

Variable	Coefficient	T-ratio
Place of Residence Urban: ref		
Rural	-.00417	-0.26
Caste Sc: ref		
ST	-.0439*	-2.05
OBC	0.0247	1.55
Others	.0917***	5.31
Religion Hindus: ref		
Muslim	-0.0453	-1.66
Christian	-.01**	-3.21
Others	0.0526	1.59
Father Occupation Professional: ref		
Self employed in agriculture	-0.0232	-1.24
Self employed in non agriculture	-.0646***	-3.34
Wage labour in agriculture	-0.0376	-1.80
Wage labour in non agriculture	-.0827***	-5.57
Not working	-0.0125	-0.24
Wealth Poorest: ref		
Poor	.103***	5.60
Middle	.169***	8.62
Richer	.251***	10.73
Richest	.413***	13.59
Sanitation no facility: ref		
Flush	.0563**	3.16
Pit	0.021	0.88
Others	0.0844*	1.97
Quality of water untreated: ref		
Treated water	0.00871	-0.66
Bpl card No: ref		
Yes	-.036**	-2.63
ICDS No: ref		
Yes	.0774***	5.49
Gender of the HH female: ref		
Male headed family	0.00627	0.35
Fuel dirty fuel: ref		
Clean fuel	0.0155	0.81
Region North East: ref		
South	-.127***	-5.13
North	-.23***	-9.40
Centre	-.285***	-11.83
West	-.325***	-12.73
North East	-.175***	-7.13
U1	-.711***	
U2	-0.0626	
U3	.501***	
U4	1.16***	

Note: *p<.05, **p<.01, ***p<.001
LR chi2(66) = 8325.01 Prob > chi2 = 0.0000
Log likelihood = --60288.501 Pseudo R2 = 0.0646
No. of Observations: 40219

Interpretation of the results:

A positive coefficient implies that the particular variable increases a child's risk for severe stunting and a negative coefficient suggests that the variable can improve a child's nutritional status. For continuous variables (wealth index v190), the marginal probit says that, given a unit change in the explanatory variable with the other variables evaluated at the mean, there would be either an increase or decrease in the probability that a child would be placed in a particular category of malnutrition (i.e., normal, under- nourished, or severely stunted). For binary variables, the probits indicated a decrease (or increase) in the probability that a given binary variable would take on a value of one. The table show the marginal values for the different categories of malnutrition for all the variables. The log likelihood suggests that model is converging.

Child level variables:

Age is significant among the sample children such that older children have greater likelihood of being malnourished, however, age square is significantly negative suggesting that the probability of being malnourished increases less than proportionately with age. Female child is highly significant and negative so that other things remaining identical they are more likely to be malnourished than comparable male children. The child's birth order is also significant where old ones face a higher risk of malnutrition than the new born. Finally, the birth size of the child is also highly significant except the average size when compared with the very large size of the child during birth is likely to be highly malnourished. Vaccination has a significant effect on child nourishment. The short term morbidity variables such as fever cough and diarrhoea increases the risk of being malnourished.

Parental variables:

Significance of mother BMI and mother height and being literate confirms that the possibility of child being malnourished is less when compared with non literate and undernourished mothers. The feeding practices shows negative coefficient for less than 3 months when compared with never breastfed category of children which gives an idea that when child is properly breastfed at least up to 6 months the severity of undernourishment will be less. WHO recommends the feeding of child solid foods should start when the child is 6 months old along with breastfeeding, the survey collected information about whether the mother gave liquid food, solid food such as non- veg, vegetables and other dairy products. Children who consumed non- vegetarian food, being significant variable are less likely nourished when compared with the vegetarian consumed children.

Household level variables:

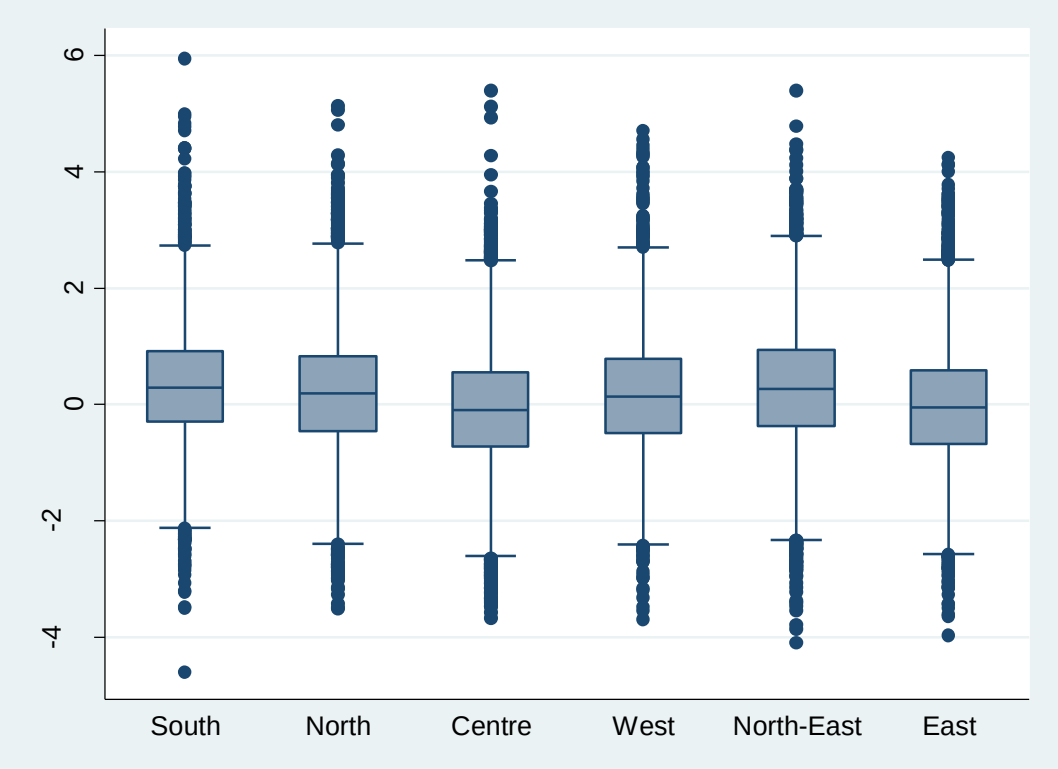
Regarding the caste, comparing to SC, the children from ST are in the high risk of malnourishment and OBC and other categories coefficients are positive and illustrating that they are better off when compared to SC children. In religion, with comparison to Hindus, the probability of being in the risk of under nutrition is less among Muslims and high among Christians. When family size increases, the menace of malnourishment increases thereby indicative negative and significant coefficient.

In contrast to the children who reside in urban areas, the results shows that the rural children are in the risk of severe stunting so there is a remarkable difference between rural and urban areas. All the wealth index variables turned out to be significant and positive by depicting the risk of malnourishment is high among poorer households than to the richer class children which also reflected in occupation of the household head where when compared with not working, the professional people are significant having positive coefficient which might be because of income effect, by getting more salary they are afford to hire care givers for their child and look after them properly and they will be likely less malnourished they are negative. But the manual and the agricultural labourers even though they are significant the coefficient is negative which implies the energy effect since the type of work, time and energy spent in the work makes them not able to give proper care for their children and they are in the risk of higher under nutrition. Regarding the quality of water, the variable was defined as dummy with whether the water is treated as boiled or not, it is positive which explains that children are safe that is they are well nourished if they have safe boiled drinking water. With respect to sanitation facilities, the variable has been grouped into flush toilet, pit latrine and others. When compared with open defecation that is with no facility, all are positive and flush toilet users are being significant and denote the higher risk of undernourishment without proper sanitation facility. And a household who possess the BPL card are significant and negative where the risk of malnutrition is lesser among the children. Another important variable women headed families are performing better than the male headed families by indicating a negative coefficient.

The policy variable of access to integrated child services is significant, where the access reduces the likelihood of children getting malnourished. μ1,μ2,μ3,μ4 are the four outcomes and the base is the best outcome(μ5).

The State dummies reflects the distribution of undernourishment of children in all states, when compared to South, the West, North, Centre and East are performing poorer.

Graph 1: Region wise distribution of malnutrition factor scores



The predicted factor scores has been plotted with the state dummies where South region includes States of Tamil Nadu, Kerala, Karnataka and Andhra Pradesh, North region includes Jammu, Punjab, Himachal, Uttaranchal, Haryana, Delhi and Rajasthan. Central region comprises of UP, MP and Chhattisgarh, In West, Gujarat, Goa and Maharashtra were included. In East, Bihar, West Bengal, Jharkhand and Orissa and in North-East it includes Sikkim, Arunachal, Nagaland, Mizoram, Manipur, Tripura, Meghalaya and Assam. This box plot sheds an idea that South is performing better when compared with West, Centre and North because of maximum variance.

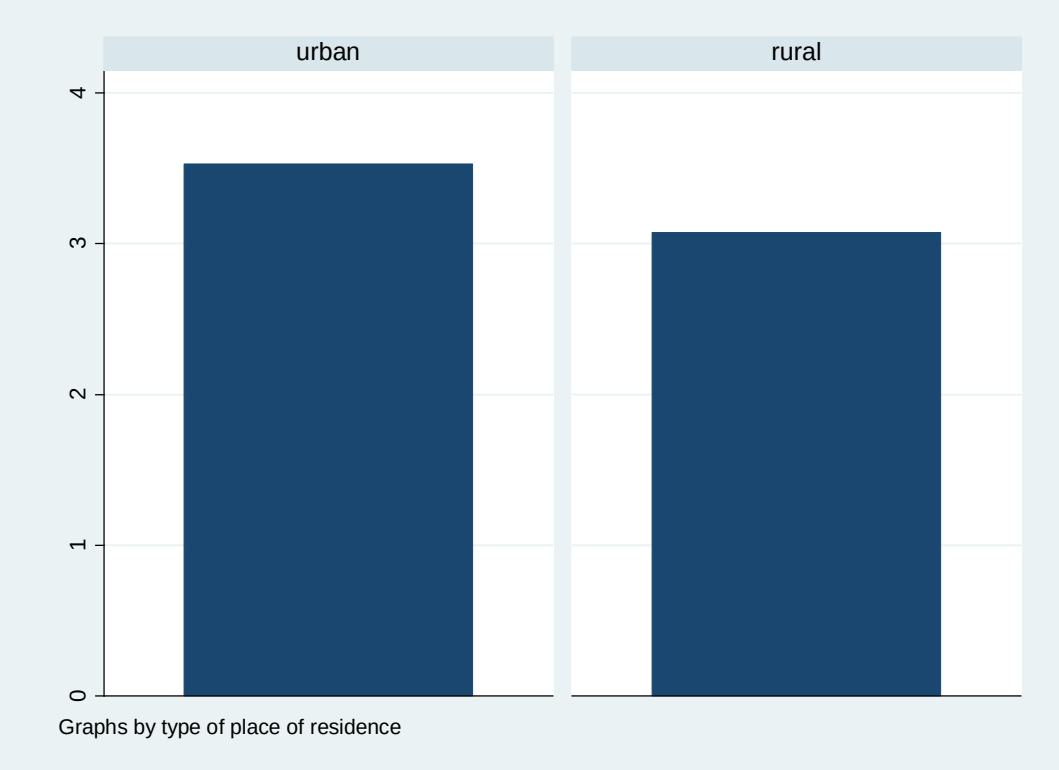
Table 3: Marginal Effects for selected variables

Variables	Marginal Effects(1)	Standard errors	Marginal Effects(5)	Standard errors
Caste				
SC	0.176***	0.0032	0.230***	0.00378
ST	0.188***	0.0042	0.216***	0.00443
OBC	0.170***	0.0025	0.237***	0.00297
Others	0.153***	0.0027	0.258***	0.00330
Religion				
Hindu	0.169***	0.0020	0.240***	0.00233
Muslim	0.190***	0.0040	0.215***	0.00422
Christian	0.154***	0.0052	0.259***	0.00677
Other	0.160***	0.0059	0.250***	0.00748
Place of residence				
Urban	0.169***	0.0030	0.240***	0.00315
Rural	0.170***	0.0021	0.238***	0.00265

Variables	Marginal Effects(1)	Standard errors	Marginal Effects(5)	Standard errors
Wealth Index				
Poorest	0.217***	0.0044	0.173***	0.00430
Poorer	0.186***	0.0036	0.202***	0.00409
Middle	0.168***	0.0030	0.223***	0.00365
Richer	0.146***	0.0031	0.251***	0.00377
Richest	0.111***	0.0035	0.307***	0.00554

The marginal effects displays the probability of being malnourished is reduced or increased by coefficient points with respect to outcomes. In particular, the child resides in urban when compared with 1st severely undernourished to 5th well nourished outcome, the children in 5th outcome are better off.

Graph 2: Mean distribution of Index among Rural and Urban areas



This graph shows that urban children are having higher mean where the risk of stunting, underweight, anaemic are higher in rural areas. This difference highlights area specific interventions for solving the undernourishment.

Conclusions and Policy Implications:

This study examined the determinants of nutritional indicators with the help of Principal Component analysis for children aged 5 and under. The effect of female literacy was highly significant which necessitates the importance of women education and maternal education. A well educated mother can make their decisions on their own and raise the child in a proper way. The magnitude and differences in wealth index and rural and urban areas in under nutrition calls for the urgent need to focus policies on the targeted specific interventions.

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