Extended Abstract

Introduction

The prevalence of high undernutrition levels in the world have always invited debates over the measurement issues. The existing methods (FAO's per capita calorie availability, requirements and consumption; and the UNICEF/ WHO anthropometric indicators) suffer from underestimation problems and also do not represent the actual number of undernourished people (Srinivasan, 1981; Svedberg, 2000; WHO). Development economist, Peter Svedberg, therefore, in 2000, constructed a new method called the Composite Index of Anthropometric Failures (CIAF) which encompasses the drawbacks of the erstwhile methods of measuring nutrition. The CIAF presents the data for a person having multiple anthropometric failures and allows for the calculation of total number of malnourished population in a country. In India, Nandy et al (2005) were the first to calculate the nutrition levels using the CIAF. Second round of NFHS data was used in this study to measure the nutrition levels and its relationship with the morbidity levels among children in India. It was found that, the estimates given by CIAF exceed those given by traditional measures by more than 20%. Another study conducted by Nandy and Svedberg in 2012 using NFHS 3 data also confirmed similar results. It also stated that CIAF proves to be a stronger predictor of dysentery and diarrhea. A study conducted on the Tribal children of Assam found that 51% of children suffer from multiple anthropometric failures and these are sensitive to the sex of the children (Kramsapi et al 2018). There are a plethora of academic debates and studies hovering around the measurement issues and ways of reducing the undernutrition. No study have by far presented a trend analysis of the CIAF across the background characteristics. Therefore, this study attempts to analyze the CIAF across the background characteristics; drawing comparisons with the traditional methods. The current study tries to analyze the level of child undernutrition in India with CIAF using the four rounds of National Family and Health Survey data.

Data and Methodology

Four rounds of National Family Health Survey (NFHS) of India conducted during 1993-93 (NFHS 1), 1998-99 (NFHS-2), 2005-06 (NFHS-3) and 2015-16 (NFHS-4) respectively are used in the current study. NFHS is a large scale, multi-round survey conducted in a representative sample of households throughout India. The data were collected using similar interview schedules in each round. To make the estimates representative and comparable across the four survey rounds, and to account for the multi-stage sampling design adopted in the four rounds, appropriate weights are used in the analysis. For this study, data on child nutrition, household characteristics and mother's characteristics are taken from the Kids record of

the NFHS data. Because of the similar sampling scheme, the estimates across the four rounds are comparable (Misra et al, 2004; Ram and Roy, 2004). Also, the NFHS data is comparable with DHS data (IIPS, 1995).

Methodology

For studying the trends in multiple anthropometric failures, a new variable, CIAF is generated in each of the rounds by grouping the three indicators. Cross tabulations are done in each of the rounds between CIAF and the background characteristics. Multinomial logistic regression was done to see the association between the CIAF and the background characteristics. The dependent variable, CIAF is categorized as 1= Stunted wasted and underweight, 2= stunted and underweight only, 3=stunted only, 4= wasted and underweight, 5= wasted only, 6= underweight only and 7= no failures. The independent variables are Type of place of residence, Caste of the household head, Religion of the household head, Wealth index, Sex of the household head, Household size, Number of living children, Number of children under five years, Current age of the child, Mother's age, Mother's occupation and Mother's educational status.

Results

The results presented in the table 2 show that there is a decline in the stunting, wasting and underweight from NFHS-1 to NFHS-4. Similar declines are shown in the CIAF indicators. It can also be seen from the tables that the total number of undernourished presented in the CIAF is greater than the one given by the Anthropometric Indicators. The regression results confirm that the relationship between nutrition levels and the background characteristics did not change significantly over time. Child nutrition is positively related to the mother's education and occupation of the household head. Also, the caste is positively related to the child nutrition. The multinomial logistic regression results for the relationship between CIAF and background characteristics are presented below. The Table 4 shows the Relative Risk Ratios of the children having multiple anthropometric failures across the various socio-economic and demographic indicators in NFHS-4. It can be seen from the RRRs that in case of type of place of residence, the RRR for children residing in rural areas is 0.843. This implies that the children residing in rural areas are more likely to have no failures compared to those in urban areas. The differences in RRRs can be seen in the children belonging to different households. The RRRs for Christians is very low at 0.262 compared to 0.793 among Muslims. On the other hand, in case of the association between caste of the household and CIAF, it can be seen that people belonging to the SCs have a greater RRR at 1.029. Stark differences can be seen in the RRRs of the wealth index. The poorest have the highest RRR (0.640) compared to 0.26 among the richest households; i.e., the poor are 6 times more likely to suffer from all the three failures compared to the rich. It can be seen that the female headed households' RRR is 0.986 which is lesser than the reference male headed households. This implies that the children in female headed households are less likely to develop all the three failures. The child nutritional status varies significantly across different levels of mother's education and occupation. In case of the mother's education, the RRR for children of highly

educated mother to have all failures is 0.653 compared to those with uneducated mothers (1.207). Also, the results show that the RRR of children to have all the failures differs widely in the different age of the mother. Compared to the children of 15 to 24 year old mothers, the RRR of the children of 25 to 34 and 35 to 49 year old mothers is less (0886 and 0.857 respectively). Also, it can be seen from the table that with the increase in age of the child, the likelihood of having all the three failures declines (RRR at age 6-11 months is 2.939 and at age 24 to 35 months, it is 2.393).

Conclusions

The staggering amounts of child nutrition in an era of fast growth and technology are quite puzzling. There existed many measurement issues in measuring the nutritional status, income, poverty in the country. These have been the focal point of discussion in the academia and policy level.

The traditional methods of measuring nutrition suffering from the problem of underestimation are evident in this study. The exorbitant differences of 20-30% in each round of NFHS poses serious concerns regarding the measurement techniques used to measure one of the world's most serious problems. The CIAF provides an aggregate measure. It facilitates the measurement of the child's nutritional status at various levels, thus allowing for easy identification of the core failures. It is found in the study that, there has not been a significant decline in the percentage of children undernourished across all the rounds of NFHS. Measurement of the child nutritional status using the CIAF also confirmed the same. Looking at the different levels of stunting, wasting and underweight respectively, the severely undernourished population has declined over the time but the moderately undernourished have increased in comparison. One of the limitations of using CIAF is that, it is constrained only to the measurement of undernutrition and is not useful in measuring the problem of over-nutrition, which is a rising concern in many parts of the world, including among some of the affluent societies in the developing nations. However, it serves the purpose at hand. A major advantage of the CIAF is that it allows for the measurement of nutrition at various levels and can be helpful in easy identification and targeting purposes at the policy level.

Table 1: Trends in Multiple Anthropometric Failures from NFHS-1 to 4

Multiple Anthropometric Failure	NFHS 1		NFHS 2		NFHS 3		NFHS 4	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
No Failure (A)	9001	33.70	10044	40.19	11880	38.31	75651	43.9
Wasting Only (B)	624	2.34	645	2.58	1366	4.41	11627	6.75
Wasting and Underweight (C)	1788	6.69	1524	6.1	2177	7.02	14535	8.44
Wasting, Stunting and Underweight (D)	2282	8.55	1798	7.2	3678	8.90	11742	6.81
Stunting and Underweight (E)	8839	33.10	6966	27.88	7361	23.73	30730	17.83
Stunting Only (F)	2776	10.40	2527	10.11	4615	14.88	24023	13.94
Underweight Only (Y)	1396	5.23	1482	5.93	704	2.27	3998	2.32

Table 2: Trends in Stunting, Wasting and Underweight from NFHS 1 to 4

Anthropometric Indices	NFHS Rounds							
	1992-1993		1998-1999		2005-2006		2015-2016	
	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Stunted (Height-for-Age)								
Severe	7,739.00	29.00	5,692.00	22.78	7,683.00	23.63	28,689.00	16.65
Moderate	6,150.00	23.05	5,599.00	22.41	7,750.00	23.84	37,806.00	21.94
Wasted (Weight-for Height)								
Severe	857.00	03.21	732	02.91	2,210.00	06.80	13,759.00	07.99
Moderate	3,832.00	14.36	3,262.00	12.99	4,595.00	14.13	24,145.00	14.01
Underweight (Weight-for-Age)								
Severe	5,810.00	21.77	4,471.00	17.89	5,204.00	16.01	19,388.00	11.25
Moderate	8,485.00	31.80	7,300.00	29.22	8,493.00	26.12	41,618.00	24.15

Table 5.4 Multinomial Logistic Estimates: Association between Multiple Anthropometric Failures and Background Characteristics in NFHS-4

Explanatory Variables	Multiple Anthropometric Failures											
	Stunted Wasted and Underweight (Base Outcome)											
	No failure				Stunted & Under				Stunted only			
	RRR	S td. Err.	95% CI		RRR	Std. Err.	95% CI		RRR	Std. Err.	95% CI	
Household Characteristics												
Type of Place of Residence												
Urban®												
Rural	0.843***	0.025	0.795	0.894	0.877***	0.018	0.843	0.912	0.994	0.02	0.955	1.033
Caste												
Others®												
SC	1.029**	0.035	0.964	1.099	0.841***	0.021	0.801	0.883	0.887***	0.024	0.842	0.935
ST	0.793***	0.021	0.752	0.836	0.826***	0.016	0.796	0.857	0.856***	0.017	0.823	0.891
Religion												
Hindu®												
Muslim	0.793***	0.025	0.746	0.843	0.899***	0.018	0.863	0.935	1.066***	0.023	1.023	1.111
Christian	0.262***	0.016	0.234	0.295	0.489***	0.017	0.457	0.523	1.046**	0.032	0.986	1.111
Others	0.690***	0.041	0.615	0.774	0.660***	0.028	0.608	0.717	0.896***	0.035	0.83	0.967
Wealth Index												
Poorest®												
Poorer	0.640***	0.018	0.606	0.676	0.707***	0.014	0.681	0.735	0.869***	0.019	0.833	0.907
Middle	0.467***	0.015	0.438	0.498	0.507***	0.012	0.485	0.531	0.751***	0.018	0.716	0.787
Richer	0.339***	0.014	0.313	0.367	0.370***	0.01	0.351	0.39	0.625***	0.017	0.592	0.659
Richest	0.260***	0.013	0.235	0.288	0.266***	0.009	0.249	0.285	0.532***	0.018	0.499	0.568
Sex of the Head of the Household												
Male®												
Female	0.986	0.032	0.926	1.05	1.041*	0.023	0.998	1.087	1.044*	0.024	0.999	1.091
Size of the Household												
1 to 4®												
5 to 9	1.058*	0.029	1.002	1.117	1.030**	0.02	0.993	1.07	0.996	0.019	0.959	1.034
10 and above	1.068**	0.043	0.987	1.156	1.068*	0.029	1.011	1.127	0.971**	0.028	0.918	1.027
Number of Living Child												
1 Child®												
2 children	0.949**	0.032	0.888	1.014	0.980**	0.023	0.936	1.026	1.002	0.023	0.957	1.049
3 to 5	1.041**	0.041	0.964	1.124	1.137***	0.03	1.078	1.198	1.140***	0.031	1.08	1.202
5 and above	1.266***	0.087	1.106	1.449	1.401***	0.068	1.275	1.54	1.359***	0.07	1.229	1.502
Number of Children Under Five Years												
1 Child®												
2 children	1.195***	0.034	1.13	1.265	1.231***	0.024	1.185	1.28	1.141***	0.023	1.097	1.187
3 to 5	1.254***	0.046	1.167	1.348	1.352***	0.034	1.287	1.421	1.202***	0.032	1.141	1.266
5 and above	1.865***	0.285	1.383	2.516	1.693***	0.187	1.363	2.103	1.496***	0.18	1.181	1.894
Mother's Characteristics												
Mother's Age												
15 to 24®												
25 to 34	0.886***	0.022	0.843	0.931	0.846***	0.015	0.818	0.875	0.863***	0.015	0.833	0.893
35 to 49	0.857***	0.039	0.784	0.936	0.778***	0.024	0.732	0.828	0.827***	0.027	0.776	0.881
Mother's Occupation												
Not Working®												
professional	0.779***	0.025	0.732	0.829	0.852***	0.019	0.816	0.89	0.967**	0.023	0.923	1.014
not professional	0.611***	0.017	0.58	0.645	0.631***	0.012	0.608	0.655	0.801***	0.016	0.77	0.833
Agriculture	0.405***	0.023	0.362	0.453	0.414***	0.016	0.385	0.446	0.675***	0.023	0.631	0.721
manual labor	0.771**	0.213	0.449	1.327	1.022	0.159	0.753	1.387	0.926	0.127	0.708	1.212
Mother's Education												
No Education®												
primary	0.653**	0.206	0.352	1.211	1.039	0.173	0.749	1.441	1.178**	0.177	0.878	1.581
secondary	1.191***	0.074	1.054	1.345	1.094*	0.05	1	1.197	1.036**	0.052	0.939	1.142
higher	1.207*	0.108	1.013	1.437	1.073**	0.07	0.944	1.219	0.988	0.069	0.861	1.133
Current Age of the Child												
0 to 5 months®												
6 to 11 months	2.939***	0.099	2.752	3.139	2.207***	0.051	2.109	2.31	2.393***	0.054	2.289	2.502
12 to 23 months	2.476***	0.086	2.314	2.649	2.692***	0.061	2.575	2.815	2.036***	0.048	1.945	2.131
24 to 35 months	2.393***	0.083	2.236	2.562	2.836***	0.064	2.712	2.965	2.030***	0.047	1.939	2.125

Explanatory Variables	Multiple Anthropometric Failures										
	Stunted Wasted and Underweight (Base Outcome)										
	Wasted and underweight				Wasted only				Underweight only		
	RRR	S td. Err.	95% CI		RRR	Std. Err.	95% CI		RRR	Std. Err.	95% CI	
Household Characteristics											
Type of Place of Residence											
Urban®											
Rural	0.856***	0.021	0.815	0.899	0.971**	0.026	0.922	1.024	0.875***	0.04	0.799	0.957
Caste											
Others®											
SC	1.156***	0.037	1.086	1.23	1.139***	0.042	1.06	1.223	1.01	0.059	0.901	1.132
ST	0.908***	0.023	0.865	0.954	0.967**	0.027	0.915	1.022	0.866***	0.039	0.793	0.945
Religion											
Hindu®											
Muslim	0.787***	0.022	0.745	0.831	0.890***	0.027	0.839	0.945	0.878***	0.044	0.796	0.968
Christian	0.406***	0.018	0.372	0.444	0.605***	0.028	0.553	0.662	0.336***	0.032	0.28	0.404
Others	0.684***	0.035	0.618	0.756	0.877***	0.045	0.793	0.97	0.650***	0.064	0.535	0.789
Wealth Index											
Poorest®											
Poorer	0.732***	0.02	0.695	0.772	0.880***	0.028	0.828	0.936	0.754***	0.037	0.685	0.83
Middle	0.601***	0.018	0.567	0.638	0.835***	0.028	0.781	0.892	0.672***	0.036	0.605	0.747
Richer	0.532***	0.018	0.498	0.569	0.759***	0.029	0.705	0.818	0.534***	0.034	0.472	0.604
Richest	0.442***	0.018	0.408	0.48	0.761***	0.033	0.698	0.829	0.447***	0.034	0.385	0.52
Sex of the Household Head											
Male®											
Female	0.959**	0.028	0.906	1.015	0.898***	0.029	0.843	0.957	0.956**	0.051	0.861	1.061
Size of the Household											
1 to 4®											
5 to 9	0.999	0.024	0.954	1.047	0.973**	0.025	0.925	1.025	1.002	0.044	0.919	1.093
10 and above	0.931*	0.034	0.868	1	0.940**	0.037	0.871	1.015	0.984	0.064	0.866	1.119
Number of Living Children											
1 Child®											
2 children	0.980**	0.029	0.925	1.037	0.998	0.031	0.938	1.061	1.033	0.055	0.93	1.147
3 to 5	1.021	0.035	0.954	1.093	0.998	0.038	0.927	1.075	1.062**	0.067	0.938	1.203
5 and above	1.122*	0.077	0.98	1.284	1.116**	0.087	0.958	1.3	1.318*	0.163	1.034	1.679
Number of Under Five Children											
1 Child®											
2 children	1.045*	0.027	0.993	1.099	1.028**	0.029	0.972	1.087	1.002	0.047	0.914	1.099
3 to 5	1.02	0.035	0.954	1.09	0.991	0.037	0.92	1.067	1.056**	0.064	0.937	1.19
5 and above	0.924	0.162	0.655	1.303	1.089	0.192	0.77	1.539	1.115	0.316	0.639	1.943
Mother's Characteristics											
Mother's Age											
15 to 24®											
25 to 34	0.903***	0.02	0.865	0.943	0.965**	0.023	0.92	1.012	0.892***	0.036	0.824	0.966
35 to 49	0.808***	0.035	0.743	0.879	0.919*	0.043	0.838	1.008	0.682***	0.056	0.581	0.8
Mother's Occupation											
Not Working®											
Professional	0.952**	0.028	0.898	1.01	0.928*	0.033	0.866	0.994	0.961**	0.052	0.864	1.069
Not professional	0.809***	0.02	0.77	0.85	0.895***	0.026	0.846	0.947	0.837***	0.038	0.765	0.915
Agriculture	0.618***	0.027	0.567	0.673	0.911*	0.04	0.836	0.992	0.737***	0.058	0.631	0.859
manual labor											
Mother's Education	**0.949**	**0.178**	**0.657**	**1.37**	**1.092**	**0.178**	**0.793**	**1.504**	**0.107***	**0.108**	**0.015**	**0.765**
No Education®											
primary	1.011	0.222	0.657	1.555	0.673**	0.188	0.389	1.163	0.634**	0.321	0.235	1.712
secondary	1.048**	0.066	0.927	1.186	1.081**	0.079	0.938	1.247	0.98	0.116	0.777	1.236
higher	1.045	0.091	0.881	1.24	0.99	0.1	0.812	1.206	0.876**	0.15	0.626	1.227
Current Age of the Child											
0 to 5 months®											
6 to 11 months	0.865***	0.022	0.823	0.909	0.481***	0.013	0.456	0.508	0.672***	0.034	0.609	0.743
12 to 23 months	0.828***	0.021	0.788	0.871	0.474***	0.013	0.448	0.5	0.945**	0.044	0.862	1.035
24 to 35 months	0.711***	0.019	0.675	0.749	0.396***	0.012	0.374	0.42	1.009	0.047	0.922	1.105

Note: St Er= Standard Error, 95% CI= 95 percent Confidence Interval, RRR= Relative Risk Ratio, ***p<0.01 **p<0.05 *<0.1 , ®= Reference Category\

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