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Understanding and Combating Undernutrition[1]

A.K. Nigam
Institute of Applied Statistics & Development Studies, Lucknow, India

THE VISIONARY

I feel honored in giving a lecture in the memory of Late Dr. V.G. Panse. While Dr. Panse was a strict administrator he was also a very kindhearted person. He was a terror to incompetence, but impetus to the conscientious work. I had opportunity to interact with him both as a student and as a Research Apprentice and I have been witness to his kindness, care and support on several occasions.

His contributions to agricultural statistics are monumental and it would do no justice if one tries to enumerate them. Not only he was instrumental in the creation of IASRI, he was also a Founder Member of the Indian Society of Agricultural Statistics. He was also an outstanding player of Bridge and I was fortunate to play the finals of the IASRI open tournament against him at his residence. The subject of agricultural statistics owes a lot to his stewardship and I am sure all of us here would join me in paying rich tributes to such a Visionary.

1. INTRODUCTION

India has serious challenges of population and poverty. About one-third of the population still lives below the poverty line. Although, we have achieved self-sufficiency in food grains, a large segment of the population still finds it hard to meet nutritional requirements.

The nutritional status of women and young children is an important indicator not only for judging their health status, but also is indicative of development. Besides food security and level of poverty, it is also closely related to access, practices and behavior of the population to health, education, safe drinking water, environmental sanitation, hygiene and other social services. Lowered economic productivity and increased expenditures on health services resulting from under-nutrition significantly affect the national economy.

Undernutrition is widely prevalent in India especially among children below 5 years, adolescent girls and women. In our country, mothers are the main care providers for infants, children and the other family members; they tend to protect their children and their family members and ignore their own health and this in turn makes the women, both in rural and urban areas vulnerable to undernutrition. Most of the women in developing countries are vulnerable to undernutrition throughout their life cycle, for which the main reasons are both social and biological in nature. Girls, particularly adolescents, are usually discriminated against in access to health care, education and diet. An undernourished mother is more likely to produce a child with low birth weight and hence an undernourished child. This completes the cycle of under-nourishment:

Undernourished mother $\rightarrow$ Undernourished children and an Undernourished girl child $\rightarrow$ Undernourished mother.

Undernutrition is no longer considered as an outcome of only food deficiency or a health problem but as a multi-dimensional problem inter-facing various aspects of access, practices and behavior. Malnutrition encompasses both undernutrition and overnutrition that may be due to deficiency or excess, respectively, of Macronutrients (Protein Energy Malnutrition (PEM) and obesity) or caused by Micronutrients (like vitamin-A, iron and iodine among others).

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The focus in the present write-up is on undernutrition (both PEM and micronutrient deficiencies) among young children and women though many of the aspects discussed apply to other groups also. Obesity, which also comes under malnutrition, is not discussed here, as the two problems are different. The issues discussed are manifold – risk factors associated with undernutrition, vulnerable groups, gaps in methodology, steps in vogue for combating undernutrition, and what needs to be further done to tackle the menace. Many of the crucial statistical issues addressed are based upon analyses of the studies done in Uttar Pradesh (UP), though it is believed that these have wider implications.

2. CURRENT NUTRITIONAL STATUS

At all India level, National Nutrition Monitoring Bureau (NNMB) and National Institute of Nutrition (NIN) have assessed nutritional status of different age groups in a number of states. National Family Health Surveys (NFHS) has also conducted two countrywide surveys in 1992-93 (NFHS-1) and 1998-99 (NFHS-2), though, recently launched NFHS-3 is nearing completion. These studies also cover assessment of anemia and other nutritional deficiency disorders though the coverage by NFHS is limited to anemia only. While NFHS-1 gave State level nutritional status of children below 4 years, NFHS-2 gave region wise (within each State) estimates for children below 3 years and women in the age group 15-49.

Institute of Applied Statistics & Development Studies (IASDS) carried out nutrition survey in 1995 for UNICEF in 17 selected districts of UP (including Uttaranchal), using multistage stratified sampling design for children up to 5 years and women in the age group 15-45. It gave regional and district profiles of the nutritional status in all the districts covered. NIN and IASDS have jointly carried out the most recent study to assess the district-wise nutritional status of the population in 2000 under the overall framework of the project – Nutrition profile of community in all the districts of Uttar Pradesh (including Uttaranchal). Though the sampling designs in these studies varied, the focus was on deriving estimates of crucial indicators with reasonable precision.

2.1 Protein Energy Malnutrition

PEM is an important nutrition problem among preschool children. This leads to various degree of growth retardation. When growth retardation is severe, functional deficiencies like resistance to infection, and poor intellectual development may result. Severe PEM leads to significantly higher risk of death among young children. The assessment of the status of undernutrition and their causal factors among children is therefore quite important.

2.1.1 Nutritional status of children

The extent of PEM is reflected by anthropometric indicators based upon age, height and weight of children and adults in comparison to established standards. Nutritional status of children can be gauged from weight-for-age, height-for-age and weight-for-height indicators. The three indicators are expressed in standard deviation units (z-scores) from the median for an international reference population recommended by World Health Organization. Children who fall more than 2 standard deviation (sd) and 3sd below reference median are treated respectively, as undernourished and severely undernourished. Weight-for-age is a composite measure, which reflects both chronic and acute undernutrition. Children who are more than 2sd below the reference median are considered underweight. The height-for-age index measures linear growth retardation among children and is a measure of long-term effects of undernutrition. Children who are more than 2sd below the reference median are considered short for their age or stunted. Stunting indicates chronic (long term) undernutrition, which often leads to recurrent diarrhea. It is typically associated with poor feeding practices, inadequate food intake and poor environmental conditions. The weight-for-height measure is an index reflecting body mass in relation to body length. Children who are more than 2sd below the reference median are considered to be too thin or wasted. The weight-for-height measure indicates the prevalence of acute undernutrition and is the only index, which does not depend upon accurate age reporting.

As per NFHS-2, 47 percent of children under age 3 in India were underweight (52% in NFHS-1), while 46 percent were stunted and 16 percent wasted. In UP, the undernutrition was at higher levels as can be seen in Table 1. It may be mentioned here that comparisons among different studies may not be strictly valid as sampling frame and design; geographical coverage and target groups differed in these studies. However, all these studies aimed at similar degree of precision. Over the years, there does not seem to be much change in

underweight; but while stunting shows increasing trend, wasting seems to decline.

Table 1. Changes in prevalence of undernutrition in children in UP

Undernutrition Index	NFHS-1* 1992-93 (n=5,586)	IASDS 1995 (n=6,113)	NFHS-2 1998-99 (n=2387)	NIN/ IASDS** 1999-2000 (n=10096)
	(1-47 months)	(6-59 months)	(1-35 months)	(12-59 months)
Weight-for-age (underweight)				
<-2sd	49.8	52.0	51.7	53.2
<-3sd (severe)	19.2	22.4	21.9	23.3
Height-for-age (stunted)				
<-2sd	49.2	59.3	55.5	72.2
<-3sd (severe)	27.6	36.2	31.0	45.6
Weight-for-height (wasted)				
<-2sd	16.2	19.5	11.1	12.6
<-3sd (severe)	2.6	5.1	2.1	3.2

* *NFHS-1 estimates were subsequently revised as 59, 24.6 for WA, 59.5, 35.6 for HA and 16.1, 2.7 for WH respectively.*

** *The estimates are for UP, while all other estimates reported here are for undivided UP which included Uttaranchal. To make a comparative reading, one has to look in to NIN/IASDS estimates for undivided UP, which were 52, 22.5 for WA, 71.5, 44.4 for HA and 12.1, 3.1 for WH respectively.*

According to IASDS study, of all the regions, Eastern region had highest prevalence of undernutrition on the basis of all three measures. Children of Bundelkhand region had better nutritional status in comparison to other regions. The NFHS-2 study, for children under age 3 years, however, reported Central and Bundelkhand regions as those with maximum undernutrition. According to all (IASDS, NFHS-1, and NFHS-2) studies, children of rural areas had higher percentage of children suffering from undernutrition.

Out of selected 17 districts in IASDS study, almost all the districts of the Eastern region showed greater undernutrition among children. Basti (75% underweight, 79% stunted and 25% wasted) and Bahraich (73% underweight, 73% stunted and 29% wasted) districts were the worst affected.

2.1.2 Nutritional status of women

The levels and trends in women's nutritional status can be assessed through anthropometry, incidences of low birth weight and maternal mortality. The focus here is on assessing nutritional status on the basis of anthropometric measurements only. One important indicator of undernutrition is body mass index (BMI), which is defined as the ratio of weight (in kg) to height or length (in m^2). Women with BMI < 18.5 (WHO, 1995) are considered undernourished and those with BMI<16 are taken to be suffering from severe undernutrition.

About 36 percent of women in the age group 15-49 had BMI below 18.5 in the country (NFHS-2). According to IASDS study in UP, 30 percent of women suffered from undernutrition (BMI < 18.5) out of which 5 percent were severely undernourished (BMI<16). The prevalence of undernutrition increased to about 35 percent in subsequent studies (NFHS-2 and NIN/ IASDS). According to both IASDS and NFHS-2 studies, women from rural areas had higher prevalence of undernutrition. However, their results were at variance in terms of region-wise prevalence of undernutrition.

Table 2. Changes in prevalence of undernutrition in women in UP

Body Mass Index (BMI)	IASDS 1995 (n=8070)	NFHS-2 1998-99 (n=5744)	NIN/IASDS* 1999-2000 (n=25204)
	(15-45 years)	(15-49 years)	(>=18 years)
<16	4.9	–	7.1
<18.5	29.7	35.8	34.4

* *The estimates are for UP, while all other estimates reported here are for undivided UP which included Uttaranchal. To make a comparative reading, one has to look in to NIN/IASDS estimates for undivided UP, which were 6.7 for BMI<16 and 33.6 for BMI<18.5 respectively.*

It is observed from Table 2 above that though there was increase in undernutrition initially, from 30 percent in 1995 to 36 percent in 1998-99, it almost remained static thereafter.

IASDS study also assessed prevalence of undernutrition among women in 17 selected districts. Out of these, 5 districts from Eastern region, on an average had higher undernutrition among women as compared to other districts. Bahraich district had a very dismal picture as 53 percent women had BMI < 18.5.

2.2 Micronutrient Deficiencies

Micronutrients are life-sustaining nutrients, which are needed only in small quantities for effective

functioning of brain, the immune system and energy metabolism. Micronutrient undernutrition, often called hidden hunger, makes a considerable negative impact on the health, learning abilities, and cognitive development, and hence work capacity. Among women, it affects the pregnancy outcome. Deficiencies of micronutrients lead to childhood illness and mortality. These deficiencies are largely preventable and diet diversification, food fortification, supplementation and public health measures are the ways to prevent and control micronutrient undernutrition.

Large population of our country suffers from micronutrient deficiency disorders, especially of the three important micronutrients, i.e., vitamin A, iron and iodine, adversely affecting the quality of life of a large segment of India's population. Majority of the population consumes diets predominantly based on cereals, and to some extent, pulses. These foodstuffs provide protein and energy, and some amount of other nutrients except vitamin A and vitamin C. The intake of protective foods like pulses, green leafy and other vegetables, milk, fruits, fats and oils are quite low especially in the diets of poor. Dietary deficiency of these nutrients occurs more frequently and to a greater degree among children, pregnant and lactating women whose requirements of nutrients are higher than others. General deficiency of these nutrients in their diet leads to widespread prevalence of deficiency diseases like anemia, PEM, vitamin A and B complex deficiencies and goiter.

Anemia (iron deficiency) is widely prevalent among children and women in the reproductive age group. The worst affected by this deficiency amongst women are the pregnant women (prevalence as high as 50-90 percent; 1996 *Report of the Task Force on Micronutrients*: MHRD, DWCD). Prevalence of anemia during pregnancy has a direct impact on the birth weight and maternal mortality, which is highest in UP.

In children, the prevalence of anemia amongst children below 3 years was 74 percent (NFHS-2). There is also a sizeable proportion of vitamin A deficiency amongst women and children (5-7% children suffering from vitamin A deficiency). Amongst these, the prevalence of Bitot's spots, the clinical manifestation of vitamin A deficiency, was found in 0.2 percent children up to five years (India Nutrition Profile, DWCD, GOI, 1998).

In UP, NFHS-2 revealed that nearly three quarter of the children were suffering from anemia, while according to another study in 8 districts of UP on children (12-35 months) carried out by IASDS/KGMU (2002), the prevalence of anemia was found to be 78 percent and the prevalence of night blindness in children in 2-6 years was 3.8 percent. In a study by ICMR (2001), the prevalence of Bitot's spots in 2-6 year children was lowest (nil) in Badaun, and highest in Kheri (2.1%). In another study in 4 districts (SNRC, 2002) covering over 14000 children aged 6 months to 6 years in each district, the prevalence of Bitot's spots ranged from 1.9 percent in children of Etawah to 10.5 percent in Mirzapur. Until recently, NIN/NNMB had been reporting prevalence of Bitot's spots in children at the district level with a sample size around 250. The prevalence reported ranged from nil to less than 1 percent. In UP also, NIN/IASDS results at the district level were of similar nature.

At the national level, regular assessments of Iodine Deficiency Disorders (IDD) have been done through a series of surveys conducted under National IDD Control Program. In 310 districts out of 582 districts in the country 253 were endemic. The percentage prevalence of goiter among children of 6 to 12 years declined from 26 up to nineties to 10 in subsequent period. All this was because of ban on sale of non-iodized salt throughout the country. IDD was also assessed through a series of surveys carried out in 45 districts in UP during the period 1960-1993 and a prevalence of goiter in the districts was reported in the range from less than 1 percent to more than 30 percent. However, a reduction in the prevalence of goiter over a period of time is clearly visible in the districts known to be highly endemic earlier.

2.3 Vulnerable Groups

Poor women have fewer employment opportunities than men; their wages are significantly lower than men's; they have less access to resources and information; and are less involved in household decision-making processes. Even decisions relating to how many children a woman should have are made by others. Girls, for example, are less likely to be enrolled in school and drop out earlier than boys. In some countries, including India, socio cultural norms also dictate that girls should be married during adolescence and have their first child soon thereafter. Taken together, these constraints of livelihood insecurity limit women's abilities to improve their own and their children's nutritional status.

Gender equality is a good indicator for nutritional status (Oniang'o and Mukudi 2002). In unequal conditions, women and girls have poorer nutrition outcomes throughout the life cycle, higher rates of mortality, less access to health care, and greater household food insecurity. Findings pointing towards inequality favoring males in the group of adolescents were also reported by two studies carried out by IASDS for CSO (2002, 2005); first on gender bias in intra-household consumption expenditure, which also included analysis on dietary intakes and the other on gender inequality on dietary intakes and pattern from huge data sets of NIN/IASDS surveys.

No rigorous analysis seems to have been done so far to assess the relative impact of livelihood security on nutritional status. However, it may be worthwhile to discuss first some analytical results from UP, which are based upon the data set from NIN/IASDS studies. These results indicate that severe undernutrition is associated with factors involving socio-economic structure and livelihood security. These factors are community, type of house, and type of family, land ownership, per-capita income, occupation, family size, and literacy. Severe undernutrition was significantly higher among children of scheduled castes, among those living in kutcha houses, those from families with no or marginal land ownership, with low income group, having occupation as laborers or artisans, and from illiterate parents. While children of non-working women and those from families with size exceeding 10 had lowest prevalence of severe undernutrition, it was higher among children from nuclear families; and in addition, families having low standard of living index (SLI) were reported to have highest severe undernutrition prevalence. SLI is an index reported in NFHS-2 as summary of the household measures like house type, toilet facility, source of lighting, fuel for cooking, source of drinking water, separate room for cooking, ownership of house, agricultural land, irrigated land, livestock and durable goods. Similar associations were found with regard to undernutrition in women. As per NFHS-2 the prevalence of anemia was found to be highest in children whose mothers were employed by someone else as compared to others.

2.4 Risk Factors Associated with Undernutrition

According to the IASDS study, (and also DWCD, UP, 1999 report, *Nutritional Status of Women and Children*, which gives some further analysis of data from IASDS study) it is reported that the risk of severe undernutrition is 2.04 times higher among children of illiterate mothers than of the literate mothers. Literacy was found to be the most potential risk factor for severe undernutiriton among children followed by child's age (12-35 months), disease (diarrhea, ARI etc.), mother's nutritional status and care during the last three months of pregnancy.

Besides the above factors, another finding, which must be highlighted, is that micronutrient deficiency disorders lead to PEM. Quite interestingly, even if one has sufficient levels of protein and energy, but is deficient in terms of micronutrients, then he is most likely to be undernourished (PEM). The study by NIN/IASDS shows that vast majority in UP, especially the Eastern region is only cereal based and has extremely low intakes of pulses, green leafy and other vegetables, milk, fruits, and as a result is terribly deficient in the intakes of micronutrients. Clearly, this is a myth that one has a good diet if the levels of protein and energy are sufficient.

3. PRESENT SCENE OF VARIOUS NUTRITION INTERVENTIONS

3.1 Welfare Programs

A number of rural development plans have been launched since independence. These gained momentum in the recent past with intense involvement of international agencies including World Bank. Most of the Government supported projects are mainly poverty alleviation oriented, while those supported by outside agencies are participatory and demand driven, and aim at technology generation, empowerment (with focus on women) and self-reliance.

Some of the recently launched projects have thrust towards *Food Security and Employment in Rural Areas.* Most important among these projects are the *National Food For Work Program (NFFWP), National Employment Guarantee Bill 2004* providing at least 100 days of guaranteed wage employment in a year to every household whose adult members volunteer for unskilled manual work and *Sampoorna Grameen Rozgar Yojna (SGRY)* and *Swarnjayanti Gram Swarozgar Yojna (SGSY).* The SGRY and SGSY projects are self-targeting and self-employment type programs for vulnerable sections with special emphasis on providing wage

employment to women, SCs, STs and parents of children withdrawn from hazardous occupations. Managing *Potable drinking water for all* under *Swajaldhara* and promoting *Cleanliness and Hygiene* in rural areas (a follow up after the success of World Bank aided *Swajal* project) is another project in this direction.

In India, the Public Distribution System (PDS) is one of the world's largest food based social protection program, serving over 218 million cardholders through a network of almost half a million fair price shops (FPS). Almost 68 million users of this system are below the official poverty line (BPL). The PDS provides a significant portion of the food needs of vulnerable households. Perhaps the greatest achievement of the PDS is its role as a safety net during emergencies like droughts, floods, cyclones etc. Its presence is one of the major factors that have helped India to exercise the demon of famine that plagued the country periodically throughout its pre-independence history.

Despite its national character and reach, the performance of the PDS as a delivery mechanism varies considerably across States. The weakest links seem to be in the States with the highest concentration of the poor. Despite increased allocations by the central government, these States have not been able to devise efficient delivery systems that could ensure that the target population, especially those in the BPL category, can rely on the PDS for their monthly entitlement of subsidized food.

3.2 Supplementary Food

Integrated Child Development Services (ICDS) is another program by the Government in this direction. It is the single largest outreach program of its kind in the whole world. The program focuses on health and nutrition components - growth monitoring and supplementary nutrition, pre-school education, nutrition and health education, immunization, health checkups and referral services.

Government has launched a program called the mid day meal (MDM) in schools all over the country. Under the program, primary school children are being provided by the Government, free wholesome cooked meals as per children's taste, *viz.*, dal-roti, subzi-roti, subzi-rice or its variants at school premises on every teaching day throughout the year. The purpose of MDM is essentially to enhance the nutritional and health status of children as also the attendance, attention span and learning capacity. In the long term, it is also expected to improve enrolment, decrease drop out rate and consequently, improved literacy status.

Some recent studies conducted by IASDS gives some interesting data on the nutritive gap, which still persists even after the introduction of MDM in schools. The nutrient intake of students derived from two sources of food intakes, at home and through MDM, when compared with the recommended dietary intake (RDI) gives the nutritive gap for the nutrient. A negative gap indicates surplus intakes, while a positive gap indicates deficiency.

The gap values in selected districts across some north-central States indicate that significant deficiencies exist for calorie, iron, vitamin A and calcium. The gap is nearly 50 percent of RDI for iron and vitamin A. This strongly suggests that real answer lies in food fortification.

3.3 Food Fortification

Fortification of food staples with iron, vitamin A, iodine and other micronutrients is the most cost-effective, sustainable option for eliminating micronutrient deficiencies. While fortification of foods with iron is an effective way of addressing anemia, fortification with vitamin A reduces the prevalence of Bitot's spots among other manifestations of vitamin A deficiency. Salt iodization, reaching an additional 1.5 billion consumers worldwide since 1990 and sparing millions of babies from mental retardation each year, is testimony to how successful fortification programs can be.

The success of fortification depends on a number of factors: those at risk of the deficiency must consume the fortified food regularly in sufficient quantities and the fortified food must not only be palatable, but also cost effective to be within easy reach of the consumers.

India-mix is a blended food fortified (Panjiri) with essential micronutrients developed and promoted by World Food Program (WFP) for distribution on a pilot basis to ICDS beneficiaries. It is a cost-effective versatile fortified, blended food commodity from wheat and soybean and fortified with essential vitamins and minerals as per the norms specified by the World Health Organization and Food and Agricultural Organization. The cost of fortification is only Rs 0.07 per 100g of

micronutrient - fortified supplementary food. Appropriate fortification levels of India-mix ensure that the beneficiaries get adequate proportion of their recommended dietary allowances (RDA) for vitamins and minerals. Panjiri is being provided daily as a supplementary food to each beneficiary at selected Anganwadi Centers (AWC) under ICDS in a number of States, like Madhya Pradesh, Chhattisgarh, Orissa, UP and Uttaranchal. In yet another pilot study, primary school children are being given fortified biscuits under Food for Education Project of WFP in operation in Madhya Pradesh, Chhattisgarh and Uttaranchal. While through India-mix the children get 300 calories, 10 gm protein and 70-80 percent of their RDA for vitamins and minerals, a packet of fortified biscuits (75 gm) provides, besides other vitamins and minerals, approximately 337.5 calories, 7.5 gm protein and 8.3 mg of iron and 187.5 mcg of vitamin A.

3.4 Genetically Modified Crops

Some research efforts in the development of crop varieties with high quantity of micronutrients are also in progress. Shakatiman-I and Shakatiman-II are the protein rich maize varieties; and Monsanto developed some varieties of rice rich in vitamin A. Similarly, BT Cotton and other genetically modified crops and varieties are in the process of evaluation and adoption.

4. IMPACT ASSESSMENT STUDIES ON FORTIFIED FOOD

Though there are several success stories of iron, vitamin A and iodine fortification world over, the Latin American and African attempts on iron and vitamin A are very encouraging. National Institute for Medical Statistics (NIMS), and IASDS have conducted impact assessment studies for WFP in several States, involving both ICDS beneficiary children, in the age group 6 months to less than 6 years, and school going children, at primary level. While, first set of beneficiaries were given panjiri fortified with iron and vitamin A (and other nutrients and minerals including zinc), the second group was given biscuits fortified with these nutrients. While for some studies, the provisional results are available; for others, they are still awaited. The provisional findings are promising indeed, and reveal considerable improvements in anemia and vitamin A status, wherever, there was regularity of supplies, distribution and consumption of fortified foods. Declines were also noted in related indicators like diarrhea incidence and prevalence of Bitot's spots.

5. IDENTIFICATION OF GAPS FOR COMBATING UNDERNUTRITION – CRUCIAL STATISTICAL ISSUES

5.1 Sample size

An attempt is made to identify gaps, mostly in methodology, which must be addressed for combating undernutrition. In many large-scale surveys, often a compromise is made with the sample size resulting into highly unreliable and imprecise estimates of crucial indicators. Another major gap relates to reporting of indicators in large-scale surveys, by disaggregated groups like caste, religion, gender, age group, grades of nutritional status, grades of anemia etc. This type of reporting is prevalent virtually in all studies. However, in most situations sample size for some of these subgroups is terribly inadequate. This is true of surveys like NNMB, NFHS, and Reproductive Child Health to name a few. The sample size is usually determined for all groups together, keeping in mind the desired precision, complexity of the design and expected non-response. The inadequate sample size for each subgroup leads to highly imprecise and unreliable estimates for these subgroups. Nigam (2005a) has discussed this and other related issues in details, and it may be a good idea to reproduce some examples from that work.

In NFHS-2, nutritional status was reported for only 77 children in Hill Region, for 57 children of ST and for 65 children of Self-employed parents. The reporting has further division according to grades of nutritional status. The reported prevalence of malnutrition ranged from 40-60 percent for below 2sd and 16-30 percent for below 3sd in these groups. Similarly, any anemia among children is reported for 72 children in Hills, 73 in Bundelkhand and for 33 children of ST, with further division according to grades of anemia (severe, mild etc.). The reported prevalence of any anemia ranged 73-80 percent and for severe anemia, between 5-13 percent. One easily notices that sample sizes are not adequate for any of these subgroup estimates.

5.2 Sampling and Pattern of Undernutrition

It has been noticed [Vir and Nigam (2000)] that the prevalence of undernutrition in children has three distinct patterns according to age group – (i) rising up to about 11-12 months, (ii) plateau from 12-35 months and (iii) declining thereafter. Nigam (2001) showed through fitted regression that the maximum undernutrition is attained at 11 months. These findings revealed that the plateau began at 12 months itself, instead of 24 months, as was reported by earlier workers. Clearly, infants are the right targets for prevention of undernutrition, and the age period when there is a plateau, is the right age of intervention for control of undernutrition. Any sampling, which is done ignoring these patterns, is bound to be less precise. While, very few samples may suffice for the age group 12-35, which exhibits, almost uniform levels of undernutrition; higher number of children needs to be sampled from the other two age groups.

An increased sample size for the age group up to 11-12 months would also ensure carrying out critical in-depth analysis of associated risk factors. The undernutrition sets in at the early stage and gets accelerated from 7-8 months; and causative factors like breastfeeding and complementary feeding practices, hygiene, diseases like diarrhea and ARI operate crucially during this period of child's growth.

5.3 Using Appropriate Cut-offs

Undernutrition is broadly assessed using three classifications namely – Gomez, Indian Association of Pediatricians (IAP) and sd classifications. Although sd classification has distinct statistical advantages over others, its use is not widespread, mainly because it involves relatively cumbersome calculations. ICDS uses IAP classification at each AWC, where the Aganwadi worker has to prepare and monitor growth chart for each child using 60 percent of median (standard) weight-for-age to identify severely undernourished children. It is known that the prevalence of severe undernutrition as derived by ICDS functionaries is far below in comparison to that reported by NFHS, NNMB and other nutrition surveys that use sd classification and use 3sd as the cut-off point for severely undernourished children.

Nigam (2003) showed that 3sd cut-off matches with the 67 percent of median (standard) weight-for-age. Thus, there is a gap of 7 percentage points between the two classifications, and the IAP classification provides an underestimate of severe undernutrition. The equivalence relation facilitates the use of sd classification under field conditions and also by research workers. The growth charts, in terms of both IAP and sd classifications are given in another paper by Nigam (2005) separately for boys and girls. These charts can replace the existing growth charts at AWC.

A comparison was made by Nigam (2005b) between the two approaches, 60 percent and 67 percent of median, to evaluate the percentage of severely undernourished children being left out by IAP classification, which is being used by agencies like ICDS. For this, district level results from the NIN/IASDS district level reports from the study – Nutrition Profile of Community in UP, were utilized for UP and Uttaranchal States. It was noticed that percentages of children left out by IAP classification were very high across all the districts. The analysis showed that at the State level, 61.1 percent of severely undernourished children were left out in UP. At the regional level, in Uttar Pradesh, these left out percentages were 58.1 in Western region, 59.9 in Central region, 67 in Eastern region and 53.4 in Bundelkhand region. In numbers, in UP alone, out of about 6 million estimated severely undernourished children; over 3.5 million such children were likely to be left out.

In most intervention projects, only severely malnourished children are targeted and monitored. A closer look into the left out severely undernourished children under currently used IAP cut-offs (60% instead of 67% of median) reveals that these children are closer towards moderate undernutrition and hence are on the fence. They are likely to be upgraded easily with little care/follow-up from severe to moderate undernutrition. Clearly, this golden opportunity is being missed at present because of misclassification by using IAP cut-offs.

Lately, there has been an increasing concern on the cut-offs and the standard reference population that is being currently used. WHO undertook a comprehensive review of the uses and interpretation of anthropometric references and concluded that the statistical methods available in the past were too limited to correctly model the pattern and variability of growth in early infancy. In view of this, a new methodology has been developed to generate for children aged 0-60 months - percentile and z-score curves for weight-for-age, length/height-for-age, weight-for-height and, for the first time, BMI-for-age [WHO (2006)].

6. CHALLENGES FOR THE FUTURE

Based upon the above analysis of gaps in understanding and combating undernutrition, some suggestions are given below, which if implemented, would prove to be very effective in reducing undernutrition.

As ICDS uses IAP classifications for growth monitoring and identifying severely undernourished children, it is not difficult to realize the gravity and magnitude of the problem with regard to left out severely undernourished children at the national level. Corrective measures in this direction would prove to be very effective in tackling undernutrition.

Assessing nutritional status of adolescents using arbitrarily defined single BMI cut-offs common to all ages for selecting adolescents at high risk of nutritional or health disorders may be highly erroneous. A preliminary look into the BMI of adolescents derived from NCHS (WHO/NCHS 1983) standards reveals that BMI values change according to age (Range: 17.6-21.4 kg/m^2) and are skew distributed. Effort is being made by IASDS to derive reference curves for assessing nutritional status of the adolescents.

Government has taken two bold and far reaching decisions – one, MDM in all schools, and all children up to 6 years for supplementary food in ICDS. It would be better advised to include all adolescent girls as ICDS beneficiaries, against only 3 girls as at present. There should be in-depth studies and focus towards care for mother and infants, as it is only below one year when undernutrition is preventable; it is foolish to wait for later ages when the problem is blown and the only correction is through treatment.

Although welfare schemes for the poor like PDS, Food for work etc. have been launched with good intentions, their implementation needs to be effectively monitored. As a matter of fact, this is high time that the Government decides to include in PDS not only cereals, but also a whole range of food stuffs like vegetables, milk, fruits, fats etc. at highly subsidized rates to BPL families.

As stated earlier, the success of fortification depends on a number of factors. The regularity of supplies, distribution and consumption of fortified foods has to be ensured if desired results are to be achieved. Further, the quantity, target group and the duration up to which fortified food should be given, may be an area of intense research. For example, should we continue to give supplementary (and fortified) food for several years as at present under ICDS (6 months to 6 years) or we should restrict to only children below 2 years?

Combating undernutrition is not limited to improving nutritional status and enhancing food security among women and children in households but there is an urgent need to focus on women empowerment through improved literacy status and livelihood opportunities for providing balanced food, nutrition and livelihood security. The intake of protective foods like pulses, green leafy and other vegetables, milk, fruits, fats and oils are extremely low in the diets of poor and those with limited livelihood security. Even well to do families have this phenomenon. Nutrition education of masses through effective IEC is, therefore, need of the hour to combat undernutrition.

It has been discussed that under the present system of reporting, the sample sizes for different subgroups, like age group, caste, grades of nutritional status, grades of anemia etc., are grossly inadequate which in turn render unreliable and imprecise estimates of crucial indicators. The remedy to this is either to increase the sample sizes for each subgroup, which may be highly cost prohibitive, or to derive Small Area Estimates. An exercise towards developing methodology for small area estimates has been initiated by IASDS in collaboration with other experts in this area.

UP has taken the lead in launching State Nutrition Mission to combat the problem of undernutrition in mission mode for 11th Five Year Plan. It is hoped that other States also adopt similar aggressive attitude towards this menace.

REFERENCES

CSO (2002). *Gender Inequality in Intra-Household Consumption Expenditure.* Institute of Applied Statistics & Development Studies, Lucknow.

CSO (2005). *Some Statistical Investigations to Assess Gender Bias and Nutritional Deficiency in the States of U.P. and Uttaranchal.* Institute of Applied Statistics & Development Studies, Lucknow.

DWCD (1996). *Report of the Task Force on Micronutrients.* Ministry of Human Resource Development, Department of Women and Child Development, Government of India.

DWCD (1999). *Nutritional Status of Women and Children in Uttar Pradesh.* Department of Women and Child Development, Government of U.P.

IASDS (1995). *Nutritional Status of Women and Children in Uttar Pradesh.* Project Report for UNICEF, Institute of Applied Statistics & Development Studies, Lucknow.

IASDS/KGMU (2002). *Situation Analysis on Iron Deficiency Anemia and Vitamin A in Rural Population of Uttar Pradesh, India.* Institute of Applied Statistics & Development Studies, Lucknow.

ICMR (2001). *Micronutrient Deficiency Disorders in 16 Districts of India.* Indian Council of Medical Research, New Delhi.

India Nutrition Profile (1998). Ministry of Human Resource Development, Department of Women and Child Development, Government of India.

NFHS-1 (1992-93). *National Family Health Survey.* International Institute for Population Sciences, Mumbai.

NFHS-2 (1998-99). *National Family Health Survey.* International Institute for Population Sciences, Mumbai.

Nigam, A.K. (2001). Analysis of malnutrition data - Revisited. Invited talk at the International Conference on Statistics, Combinatorics and Related Areas held at Wollongong, Australia.

Nigam, A.K. (2002). Nutrition awareness and protein energy malnutrition. Invited talk in the Symposium on Nutrition and Food Security at the International Agronomy Congress, New Delhi.

Nigam, A.K. (2003). Determining grades of malnutrition in children: Standard deviation classification and the alternative. *Demography India*, 137-155

Nigam, A.K. (2005a). Large scale surveys in nutrition. National Workshop on Issues Concerning Large Scale Surveys on Health and Nutrition – Critical Appraisal, organized by National Institute for Medical Statistics, New Delhi.

Nigam, A.K. (2005b). Managing severely malnourished children: Clue from analysis of nutrition data. *Demography India*, 53-61.

NIN/IASDS (2000). *Nutritional Profile of Community in Uttar Pradesh, District Reports.* National Institute of Nutrition, Hyderabad and Institute of Applied Statistics & Development Studies, Lucknow.

Oniang'o, R. and Mukudi, E. (2002). *Nutrition and Gender in Nutrition: A Foundation for Development.* United Nations Standing Committee on Nutrition, Geneva.

SNRC (2002). Minutes of the meeting of the State task Force for Control of Micronutrient Deficiencies in U.P., 6 Feb, 2002, State Nutrition Resource Centre, Department of Social & Preventive Medicine, KGMU, Lucknow.

Vir, Sheila and Nigam, A.K. (2000). Nutritional status of women and children in Uttar Pradesh. *Nutrition Foundation of India Bulletin,* 4-6.

WHO (1983). *Measuring Change in Nutritional Status: Guidelines for Assessing the Nutritional Impact of Supplementary Feeding Programmes for Vulnerable Groups.* WHO, Geneva.

WHO (1995). *Report of the Expert Committee on Physical status: The Use and Interpretation of Anthropometry.* WHO Technical Report Series 854. WHO, Geneva.

WHO (2006). *WHO Child Growth Standards: Weight-for-Age, Length/Height-for-Age, Weight-for-Height and BMI-for-Age: Methods & Development.* WHO, Geneva.