At the time of Independence, India was not self-sufficient in food production and regional food shortages were common. Poverty was rampant; 3/4th of Indians were poor, spent 3/4th of their income on food but 3/4th of the children were underweight; child mortality rates were very high. The country recognised the importance of the health and nutritional status of children in nation building and initiated steps to improve access to nutrition and health services with special efforts to reach poor and marginalised segments of population. India has been self-sufficient in food production since 1970s, public distribution system has improved access to subsidised food for the poor. Over the years, the infrastructure and human resources for manning the health and nutrition services have been built up and currently cover the entire country; but there are inadequacies in terms of coverage, content and quality of all these services and often the most needy have the least access to services. India has the largest food supplementation programmes in the world; Integrated Child Development Services and school Mid Day Meal programme cover all children up to 14 years of age. Inspite of rapid economic growth and ready access to affordable food and food supplementation programmes for children nearly half the under five children are underweight. Paradoxically the last two decades have recorded a progressive increase in overnutrition and obesity especially but not confined only to the urban affluent children. Health professionals warn that unless effective interventions are implemented there will be a huge increase in obesity and risk of diabetes and cardio vascular diseases when these children become adults. People are puzzled by these paradoxes and want to know what is happening, why and how child malnutrition can be combated.

Assessment of nutritional status in children

Weight, height and Body Mass Index (BMI) for age are three anthropometric parameters

In India under nutrition is still the major problem; about 18 percent of preschool children and about a quarter of school children are undernourished.
widely used for assessment of nutritional status in children. The WHO has provided the standards for weight, height and BMI in preschool children (WHO 2006) and school-age children (WHO 2007). Given the well known large differences in height between different population groups and the emergence of the dual nutrition burden (under- and over-nutrition) the WHO has advocated the use of BMI-for-age for early detection and effective management of both under-nutrition and over-nutrition in children. The use of BMI for assessment of current nutritional status in Indian children is essential in all settings where length/height measurements are possible because:

- early detection of current energy inadequacy (low BMI) and its correction can reverse wasting and prevent stunting; this is critical because stunting cannot be reversed;
- stunting in childhood leads to low adult height and in women leads to for lower birth weight in their offsprings – the trans-generational impact of childhood under-nutrition;
- the majority of Indian stunted children have appropriate weight for their height (normal BMI/age); increased energy intake may make them prone to over-nutrition; and
- under-nutrition in early childhood followed by rapid increase in body mass index in early/late childhood/adolescence may predispose to over-nutrition and non-communicable diseases in early adult life.

**Magnitude of the problem**

Prevalence of under-nutrition (<=-2SD) and over-nutrition (<+2 SD) as assessed by weight for age, height for age, BMI for age in under five children from the NFHS – 3 data base is shown in (Figure-1) Stunting and underweight are seen in nearly half of the preschool children. In contrast only 16.9 percent show current energy deficit ie low BMI for age. Focus on early detection of low BMI for age and its expeditious correction with increase in food intake and treatment of infections can be achieved through convergence of services under health and ICDS and can substantially accelerate the pace of reduction in stunting and under-nutrition rates. It is noteworthy that if BMI for age is used as the indicator 1.9 percent of these children were over-nourished. It is obvious that dual nutrition burden begins in infancy and early childhood.

Unlike preschool children, there is comparatively very little data on nutritional status of school age children. Data from NFHS 3 on nutritional status of preschool children and adults (Fig 2) indicate that both under...
and overnutrition rates in adults (as assessed by BMI) are higher than under and over-nutrition rates in preschool children. Some of this increase must have occurred during school age. Small studies have highlighted that under-nutrition is a problem in school age children from poorer segments of the population and limits the adolescent growth spurt and adversely affects the adult height. Alarming increase in over-nutrition had been reported in urban affluent children.

It is essential to assess nutritional status of all children by measuring height, weight and computing BMI. Based on their BMI, children who are undernourished and those who are over-nourished can be identified. Providing undernourished children food supplements (additional helping from MDM) and treating infections if any detected through the school health system can reduce undernutrition rates. Increased physical activity both in school and at home can be useful in combating over-nutrition.

The observed changes in undernutrition rates as assessed by weight, height and BMI for age can be explained on the basis of the response of these indices to chronic energy deficiency. Data from NFHS showed sustained reduction in stunting rates because the progression from wasting to stunting has been prevented. Under these circumstances stunting rates will decline and wasting rate may rise. It is essential to take note of the consistent reduction in stunting rate between NFHS 1, 2 and 3 as an encouraging sign that there is a progressive but slow decline in overall undernutrition rates.

Factors affecting undernutrition rates in preschool children

The three major determinants of growth during infancy and early childhood are: birth weight, feeding practices and infections.

Birth weight

Full-term low birth-weight Indian infants had a lower growth trajectory as compared to children...
with normal birth weight and underweight rates are higher in low birth weight infants (Fig 4).

Feeding practices

Breast milk provides all the nutrients that infant needs and protects them from infections. Infants grow normally if they are exclusively breast fed for the first six months. In India breast feeding is nearly universal and the majority of mothers exclusively breast feed their infant during the first three months. During this period, there is no further increase in underweight and stunting rates in infants. Introduction of animal milk between 3-5 months and rise in morbidity rates results in increase in underweight and stunting rates during this period. Between 6-11 months infants have to be fed semisolid household food 3-5 times a day to meet their growing energy needs. Late introduction, inadequate quantity and low calorie density of semisolid food is responsible for increase in underweight and stunting rates between 6-11 months. Between 12-23 months most children are shifted to the general family diet. Adult food is bulky and not calorie-dense. Children have small stomach capacities and cannot get enough calories if they are fed only 3-4 times a day. The observed increase in the underweight and stunting rates between 12-23 months is the result of inadequate energy intake when children are shifted to the general household diet (Figure 5).

Infections

Under nutrition, especially current undernutrition as indicated by low BMI for age, is consistently associated with infection in preschool children (Figure 6). Under.

Under-nutrition (low BMI) could be the cause (increased susceptibility to infections) or effect (increased nutrient requirement and greater nutrient loss) of infection. Early detection and effective management of infections can play a very important role in reducing the under nutrition rates in preschool children.

Dietary intake of children

Malnutrition in children is due to imbalance between energy intake and expenditure. It is therefore essential to find out how much food do children eat and what is the gap/excess between requirement and actual food intake. In the last two decades, newer technologies which allow computing human nutrient requirements especially energy requirements with greater precision under free living conditions over a relatively long period have become available. There have been major changes in lifestyles and physical activity patterns in the last decade.

Taking all these into account Indian Council of Medical Research has revised the nutrient requirements and recommended dietary intake of Indians in November 2010. Taking cognizance of the need to compute energy requirements for varying stature and physical activity, RDA has defined energy requirements /per Kg body weight and as level of physical activity. Computed energy requirements for current average weight in moderately active individuals
of varying age, their actual food intake as reported by National Nutrition Monitoring Bureau and the average gap between intake and expenditure is given in Table 1. The gap is relatively small in preschool children and could readily be bridged by improving infant and young child feeding practices. The gap between the requirements and the intake is highest in the adolescent girls and boys. This period provides the last opportunity for linear growth; providing adequate energy intake will enable optimal growth during adolescence and improve adult height. Viewed in this context the initiation of the MDM for the upper primary school children is an appropriate step to bridge the gap in adolescent girls.

**Child malnutrition: spectrum of manifestations**

Child malnutrition is due to difference between energy intake and energy expenditure. When the food intake is equal to the requirement the child is normally nourished. When food intake is less than the requirement the child become undernourished; when the intake is higher than required the child becomes overweight and obese.

The child A in Figure 7 is normally nourished i.e. height weight and BMI are appropriate to age. This child requires no intervention except advice to continue with balanced diet and adequate physical activity. Growth has to be monitored periodically to ensure that the child continues to grow normally. When food intake is insufficient to meet the requirements the child becomes undernourished.

Depending on the severity and duration, energy deficiency can result in wasting, underweight, and stunting in various permutations and combinations. The initial impact of energy deficit is wasting because energy is mobilized from fat deposits and muscle to bridge the gap between energy requirement and energy intake. Child B is underweight and wasted but height is appropriate for age. If energy deficit is quickly corrected by supplementary feeding and/or treatment of infections, wasting

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**Table 1 Computed energy requirements for actual current weight in different groups**

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean wt NNMB</th>
<th>Req for mean wt</th>
<th>Actual intake</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult man</td>
<td>51</td>
<td>2346</td>
<td>2000</td>
<td>-346</td>
</tr>
<tr>
<td>Adult woman</td>
<td>46</td>
<td>1886</td>
<td>1738</td>
<td>-148</td>
</tr>
<tr>
<td>Pregnant</td>
<td></td>
<td>2236</td>
<td>1726</td>
<td>-510</td>
</tr>
<tr>
<td>Lactating</td>
<td></td>
<td>2386</td>
<td>1878</td>
<td>-518</td>
</tr>
<tr>
<td>1 – 3 y</td>
<td>10.5</td>
<td>840</td>
<td>714</td>
<td>-126</td>
</tr>
<tr>
<td>4 – 6 y</td>
<td>14.6</td>
<td>1095</td>
<td>978</td>
<td>-117</td>
</tr>
<tr>
<td>7 – 9 y</td>
<td>19.7</td>
<td>1379</td>
<td>1230</td>
<td>-149</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 - 12 y</td>
<td>26.6</td>
<td>1729</td>
<td>1473</td>
<td>-256</td>
</tr>
<tr>
<td>13 – 15 y</td>
<td>36.8</td>
<td>2208</td>
<td>1645</td>
<td>-563</td>
</tr>
<tr>
<td>16 – 17 y</td>
<td>45.7</td>
<td>2514</td>
<td>1913</td>
<td>-601</td>
</tr>
<tr>
<td>Girls</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 – 12 y</td>
<td>26.7</td>
<td>1469</td>
<td>1384</td>
<td>-85</td>
</tr>
<tr>
<td>13 – 15 y</td>
<td>36.9</td>
<td>2030</td>
<td>1566</td>
<td>-464</td>
</tr>
<tr>
<td>16 – 17 y</td>
<td>42.6</td>
<td>2130</td>
<td>1630</td>
<td>-500</td>
</tr>
</tbody>
</table>
will be reversed and the linear growth of children will continue normally. If however the energy deficit persists, growth falters and the child becomes stunted.

Child C is stunted and underweight but has appropriate BMI for his age. His energy intake has been chronically insufficient in the past resulting in stunting. However, current intake is adequate for the height and age and so weight is appropriate for current height and age. Such children should be advised to eat a balanced diet and their growth carefully monitored so that growth faltering if it occurs can be detected early and corrected.

Child D is stunted, underweight and wasted. Height, weight and BMI are low for age. Such children had suffered from both acute and chronic under nutrition and would require supplementary feeding over some months to reverse wasting and restore appropriate weight for height (normal BMI). Careful monitoring for growth faltering and appropriate intervention over the next year or so will be essential.

When the ‘food intake is higher than what is required children put on weight due to accumulation of fat (Figure 8). Fat children may be stunted because of past chronic low food intake (Child C) or normal in height because of past normal food intake (child B). All overnourished children irrespective of their current height should be advised to increase physical activity by playing at least for one hour every day and avoid eating too much of calorie dense food such as fried, food sweets and ice creams etc.

**Paradoxes in the child nutrition scenario in India**

India is one of the fastest growing economies of the world during the last two decades and there has been sustained large investment in nutrition services for children. However even to day about half the preschool children are underweight and stunted. The persistent high stunting and underweight rates have been a matter of concern. Long term follow up studies in Delhi low middle income group children has shown that these stunted and underweight children grew into short over weight adults with high BMI; at 30 years of age one sixth of them had high blood pressure and pre-diabetes or diabetes. Undernutrition and stunting in early childhood and adolescence have made them vulnerable to overnutrition adult life. Nutrition and health professional have been worrying about the future health status of these adults as they reach middle age and become elderly. Last two decades have also recorded a progressive increase in overnutrition and obesity in children, especially the urban affluent children. Health professionals warn that, unless effective interventions are implemented, these children will face a serious risk of diabetes and cardiovascular diseases in adult life.

**The “fat thin child”**

Right from birth, through childhood, adolescence and adult life Indians have higher body fat and lower muscle mass than Caucasians having similar BMI. Even Indian underweight and low BMI children have relatively high fat and low muscle mass. The thin fat Indian children are more prone to develop metabolic syndrome and cardiovascular diseases during their adult life.

**Conclusion**

Dual nutrition burden in children is a global problem affecting both the developing and the developed countries. Taking cognizance of the emerging problem of dual
Under nutrition is still the major problem; about 18 percent of preschool children and about a quarter of school children are undernourished. At present coverage under ICDS and midday meal programmes is universal; they provide one meal for all children who come to anganwadi or school and want to take the meal. But neither of these programmes screen children and provide double rations for those who are undernourished. Convergence with health system can ensure that all children are screened for undernutrition and infections. Those with infections can be treated and undernourished children can be given double rations; these interventions can be achieved with existing infrastructure and investments and lead to accelerated reduction in wasting and prevent stunting.

In most developed countries overnutrition is the major problem (overnutrition rates ranging between 20-40 percent); overnourished children often grow into overnourished adults and incur increased risk of noncommunicable diseases which require life long expensive interventions. Only 2 percent of Indian preschool children and about 5-10 percent of school age children are overnourished. Screening all children will lead to early detection of over nutrition in preschool and school age children; with appropriate counseling, parents can intervene correct overnutrition by altering food habits and increasing physical activity of children.

Combating dual nutrition burden has globally been viewed as a major challenge especially in countries with high burden of overnutrition. Fortunately in India overnutrition has been recognised when the burden due to this is quite low and vigorous intervention have been initiated to control and combat the problem. Under nutrition is a problem but can be readily addressed through convergence and focused attention through existing programmes. Therefore in the Indian context dual nutrition burden can be viewed as an opportunity to demonstrate how the country can cope with major challenges in health and nutrition sectors effectively, with the existing programmes and manpower, within a short period and at an affordable cost.

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