Undernutrition & risk of infections in preschool children

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Background & objectives: It is well documented that in preschool children undernutrition is associated with immune depression and increased risk of infections; infections aggravate undernutrition. Underweight is the most widely used indicator for assessment of undernutrition for investigating undernutrition and infection interactions. In India, nearly half the children are stunted and underweight; but majority of children have appropriate weight for their height and less than a fifth are wasted. The present study was undertaken to explore which of the five anthropometric indices for assessment of undernutrition (weight for age, height for age, wasting, BMI for age, and wasting and stunting with low BMI) is associated with more consistent and higher risk of morbidity due to infection in preschool children.

Methods: The National Family Health Survey-3 (NFHS-3) database provided the following information in 56,438 preschool children: age, sex, weight, height, infant and young child feeding practices and morbidity due to infections in the last fortnight. Relative risk (RR) of morbidity due to infections was computed in infants and children with stunting, underweight, low BMI for age, wasting and stunting with low BMI (< mean-2SD of WHO 2006 standards).

Results: Comparison of the RR for infections in undernourished children showed that the relative risk of morbidity due to infections was higher and more consistently seen in children with low BMI and wasting as compared to stunting or underweight. The small group of children who had stunting with wasting had the highest relative risk of morbidity due to infection.

Interpretation & conclusions: In Indian preschool children, RR for infection was more consistently associated with BMI for age and wasting as compared to weight for age and height for age. Low BMI for age and wasting indicate current energy deficit; early detection and correction of the current energy deficit might reduce the risk of infection and also enable the child to continue in his/her growth trajectory for weight and height.

Key words Body mass index - morbidity due to infections - preschool children - stunting - undernutrition - underweight - wasting

It is well recognised that preschool children are a nutritionally vulnerable segment of population, also very susceptible to morbidity due to infections. Undernutrition is associated with impaired immune function and consequent increased susceptibility to infections; infections aggravate undernutrition; if this vicious cycle continues it can result in death of the child. Interactions between nutrient intake, nutritional status and morbidity in preschool children are complex. Major factors which modulate nutritional status during early childhood include birth weight, infant and young child feeding practices, morbidity due to infections, treatment of infections, nutrition care during infection and convalescence. Prevalence, severity and frequency of morbidity due to infections depend upon infant and young child feeding and caring practices, nutritional status of the child, and environmental hygiene. Effect of morbidity on nutritional status depends upon severity
and duration of infection, health care provided and feeding during illness and convalescence. Because of multiplicity of factors influencing undernutrition and morbidity, the relative risk (RR) of infection with any one factor is low.

Data from national surveys have shown that in India nearly half the preschool children are under-weight or stunted and less than a fifth are wasted. Weight for age is the most widely used index for assessment of nutritional status in children. In spite of the very high undernutrition rates (higher than sub-Saharan Africa), and high prevalence of morbidity due to infections (between 20-30% of preschool children are suffering from morbidity due to infections), under-five mortality rates in India are relatively low - so called “South Asian Enigma”. In India where stunting rates are high, there has been growing concern about appropriateness of using weight for age for assessment of undernutrition. WHO growth standards provide standards for BMI for age in preschool children and state that BMI could be used for assessment of both under- and over-nutrition in preschool children. There is global and Indian acceptance that BMI for age is an appropriate index for assessment of overnutrition, because there are ample published data indicating that biochemical markers for increased risk of non-communicable diseases are seen in children with high BMI. However, as yet there has not been a consensus that BMI for age is the appropriate indicator for assessment of undernutrition especially in countries with high stunting rates; this is perhaps due to the lack of published data from the developing countries indicating that BMI for age is a better indicator than weight for age for assessment of risk of infection associated with undernutrition. The present study was undertaken to explore which of the five anthropometric indices for assessment of undernutrition (weight for age, height for age, wasting, BMI for age, and wasting and stunting with low BMI) is associated with more consistent and higher risk of morbidity due to infection in preschool children.

**Material & Methods**

The National Family Health Survey-3 (NFHS-3) database provides the following information in about 56,438 preschool children: age, sex, weight, height, infant and young child feeding practices and morbidity due to infections in the last fortnight. Data from NFHS-3 were obtained and analysed for infant and young child feeding practices, prevalence of morbidity due to infections and nutritional status using WHO standards. Relative risk of morbidity due to infections was computed in relation to undernutrition (< mean-2SD of WHO 2006 standards) as assessed by the five anthropometric indices (weight for age, height for age, BMI for age, wasting and stunting and low BMI) in three different age groups 0-5 months, 6-11 months and 12-59 months.

**Results**

The number of children available for analysis from the NFHS-3 database included 52,868 infants and children 0-59 months of age. Of these, 45,377 infants and children had valid data on age, sex, weight and height (23724 male, 21653 female), infant feeding and morbidity.

**Infant feeding practices and infant nutrition:** Less than 50 per cent of infants were exclusively breastfed up to six months. Very few infants received complementary food at 6 months. Most of the infants over six months of age continued to be breastfed and were also given household food (Fig. 1). Data from NFHS3 showed that exclusively breastfed infants weighed more as compared to those receiving additional milk in the first few months. After six months exclusively breastfed infants weighed less than those receiving complementary feeds/household food.

![Fig. 1. Infant feeding practices; no bf, not breast fed; ebf + water, exclusive breast feeding + water; bf + fluids, breast fed and other fluids such as animal milk given; fluids + ss, fluids and semisolid foods; hh foods; household foods. Fig. drawn from the NFHS-3 database.](image1)

![Fig. 2. Prevalence of underweight/stunting in relation to age.](image2)
Prevalence of stunting and underweight in relation to age is shown in Fig. 2. There was a progressive increase in stunting and underweight between 3-23 months; stunting and underweight rates plateau after the second year.

Relative risk (with confidence interval) of undernutrition as assessed by the five anthropometric indices was computed in relation to exclusive breastfeeding in 0-5 months age group. Risk of underweight, wasting and low BMI was lower in infants in the age group 0-5 months who were exclusively breast-fed (Fig. 3).

**Morbidity due to infection**: Prevalence of morbidity was low in the first 3 months when infants were mostly solely breastfed and had lower exposure to poor environmental hygiene. There was a progressive increase in prevalence of morbidity due to infections between 3-6 months. Diarrhoea was the most common infection; prevalence of diarrhoea and fever showed a progressive increase between 3-23 months (Fig. 4). After the first two years there was some reduction in morbidity due to infection.

**Morbidity and nutritional status**: Analysis of data showed that children who had morbidity during the preceding fortnight had lower mean body weight as compared to those did not have morbidity during that period. There were no significant differences in the mean height between infants and children who had morbidity due to infections in the preceding fortnight. Children who had morbidity during the preceding fortnight had lower BMI as compared to those who did not (Fig. 5). Prevalence of morbidity due to infection (one or more episodes in the preceding fortnight) was higher in children who were underweight, wasted, had low BMI or in the small number of children who were stunted and wasted (Fig. 6).

Analysis of data on prevalence of undernutrition in relation to number of episodes of morbidity due to infection in the preceding fortnight showed that underweight, low BMI and wasting rates were higher in children who had more than one morbidity in the preceding fortnight. Prevalence of undernutrition as assessed by any parameter was higher in children who had diarrhoea. Underweight, low BMI and wasting were higher in those with fever in the last fortnight.

Relative risk of diarrhoea in undernutrition as assessed by different anthropometric indices in the age group 12-59 months was computed. Indices associated with current energy deficiency such as wasting, low BMI and stunting with low BMI were associated with higher risk of diarrhoea (Fig. 7).
Relative risk (with CI) of morbidity was computed in relation to different anthropometric indices used for assessment of undernutrition (<-2SD of the index). Relative risk of morbidity was not high in stunted children perhaps because stunting had occurred earlier and does not have any relationship with the morbidity due to infection which occurred in the preceding fortnight. Relative risk of morbidity was higher and seen more consistently in children with current energy deficiency which is manifested as wasting, low BMI for age or in the small group of children who were stunted and wasted. Undernourished children (except those having stunting) were less likely to have no morbidity in the preceding fortnight as compared to normally nourished children (Table).

### Discussion

Analysis of data from NFHS-3 using the WHO 2006 standards\(^6\) indicated that majority of infants in the 0-2 months were exclusively breastfed. Prevalence of undernutrition in the first three months was about 30 per cent. Exclusive breast-feeding by majorities of mothers in this period protects the infant from further deterioration in nutritional status (low birth-weight rates in India is about 30%)\(^7\). A small rise in the prevalence of undernutrition between three and six months may be due to early introduction of milk substitutes and consequent higher morbidity in this period. A further rise in the undernutrition rate between six and twelve months may be due to late introduction or inadequate amount of complementary feeds to children in this age group as well as increase in morbidity and inadequate care during infections. Further increase in undernutrition between 12-23 months is likely to be due to low energy intake, because children are not fed often enough with household food. These data clearly bring out the importance of too early introduction of breast milk substitutes, too late introduction of complementary feeds, too few feeds with household food and poor care during morbidity as major factors associated with rising prevalence of undernutrition in infant and young child.

Computation of relative risk of undernutrition (as assessed by different anthropometric indices) in relation to infant feeding practices in 0-5 and 6-11 months age group showed that exclusive breast-feeding in the first 6 months protects against underweight, wasting and low BMI. Exclusive breast-feeding in 6-11 age group is associated with higher risk of stunting with low BMI. Importance of infant and young child feeding practices as determinants of infant and young child nutrition is well recognized. However the relative risk of undernutrition in relation to feeding practices is rather low. This is probably due to the multiplicity of factors that influence nutritional status during infancy. The fact that appropriate infant feeding practices protect against current energy deficit as well as infection in infancy could be used as a powerful message in advocacy, awareness building and nutrition education efforts to improve appropriate infant and child feeding practices.

Morbidity due to infection is lowest in the first three months when infants were solely breastfed. Too early introduction of milk substitutes and too late or inadequate complementary food were associated with increased risk of infection. If infections are not detected early and treated effectively, there is deterioration in nutritional status and severe infection may lead to death. It is computed that exclusive breast-feeding and appropriate complementary feeding will lead to a 20 per cent reduction in infant mortality rate (IMR)\(^8\). Improvement in infant and young child feeding and caring through co-ordinated efforts of Integrated Child Development Services (ICDS) and National Rural Health Mission (NRHM) can result in substantial improvement in nutrition and health status and survival during the critical first two years of life.

Computation of relative risk of morbidity due to infection in relation to undernutrition as assessed by weight for age, height for age, BMI for age, wasting, stunting with low BMI showed that prevalence of morbidity due

### Table. Relative risk (RR) of morbidity in relation to undernutrition in preschool children (0-59 months)

<table>
<thead>
<tr>
<th>Morbidity</th>
<th>Stunted</th>
<th>Underweight</th>
<th>Wasted</th>
<th>Low BMI</th>
<th>Stunted and low BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>One and more</td>
<td>RR</td>
<td>CI</td>
<td>RR</td>
<td>CI</td>
<td>RR</td>
</tr>
<tr>
<td></td>
<td>0.967</td>
<td>0.935-1.000</td>
<td>1.029</td>
<td>0.935-1.000</td>
<td>1.197-1.839</td>
</tr>
<tr>
<td>Two and more</td>
<td>0.983</td>
<td>0.919-1.052</td>
<td>1.035</td>
<td>0.919-1.052</td>
<td>1.209</td>
</tr>
<tr>
<td>Three morbidity</td>
<td>0.831</td>
<td>0.687-1.006</td>
<td>1.194</td>
<td>0.687-1.006</td>
<td>1.209</td>
</tr>
<tr>
<td>No morbidity</td>
<td>1.01</td>
<td>1.000-1.020</td>
<td>0.977</td>
<td>1.000-1.020</td>
<td>1.216</td>
</tr>
</tbody>
</table>

Computation of relative risk of undernutrition (as assessed by different anthropometric indices) in relation to infant feeding practices in 0-5 and 6-11 months age group showed that exclusive breast-feeding in the first 6 months protects against underweight, wasting and low BMI. Exclusive breast-feeding in 6-11 age group is associated with higher risk of stunting with low BMI. Importance of infant and young child feeding practices as determinants of infant and young child nutrition is well recognized. However the relative risk of undernutrition in relation to feeding practices is rather low. This is probably due to the multiplicity of factors that influence nutritional status during infancy. The fact that appropriate infant feeding practices protect against current energy deficit as well as infection in infancy could be used as a powerful message in advocacy, awareness building and nutrition education efforts to improve appropriate infant and child feeding practices.

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Computation of relative risk of morbidity due to infection in relation to undernutrition as assessed by weight for age, height for age, BMI for age, wasting, stunting with low BMI showed that prevalence of morbidity due
to infection (one or more episodes in the last fortnight) was higher in children who were underweight, wasted, had low BMI or in a few children who were stunted and wasted. Undernutrition as assessed by wasting and low BMI for age was found to be more consistently associated with infection in preschool children. Undernutrition (low BMI) could be the cause (increased susceptibility to infections) or effect (increased nutrient requirement and greater nutrient loss) of infection.

The association between anthropometric indices of current energy deficit and increased risk of morbidity indicate the urgent need for two interventions: screen for and correct current energy deficit through appropriate nutrition education / supplementary feeding; promptly and effectively treat infections through appropriate primary health care in order to reduce the nutritional toll of infections. Both these interventions can be effectively implemented through convergence and co-ordination between the functionaries of Integrated Child Development Services and National Rural Health Mission.

International Obesity Task Force has recommended that body mass index for age (BMI in kg/m²) be used for assessment of overweight/fatness in children and adolescents⁵. The WHO (2006 and 2007)⁶,¹⁰ has provided the standards for BMI in children and adolescents for use by member countries for detection of both under- and over-nutrition. The present analysis indicated that that low BMI for age and wasting which take into account the weight for height, have a more consistent association with infection in Indian preschool children as compared to weight for age.

It is hoped that this analyses from secondary data analysis from the large NFHS-3 database would pave way to research studies with primary data collection exploring the usefulness of BMI for age for assessment of risk of infections as compared to weight for age. More studies may lead to the wider use of BMI for age for assessment of undernutrition in clinical settings and surveys in India. This in turn might lead to increasing use of a single indicator (BMI for age) for assessment of both under- and over-nutrition. In view of the known high stunting rates in Indian children, use of BMI for age for monitoring nutritional status of children might help in early detection of children having low or high BMI and effective management of both under- and over-nutrition; such interventions could result in reduction in the immediate risk of morbidity due to infections and long term risk of non communicable diseases.

The demonstration of association between current energy deficit and morbidity may have policy and programme implications also. In India only about one fifth of the children have low BMI for age; it might therefore be possible to focus the attention on detection of undernutrition (low BMI) and correction through increase in dietary intake under programme conditions. Early detection and correction of low BMI, might reduce the risk of infection and also enable the child to continue in the growth trajectory for weight and height. Nearly one third of preschool children suffer from morbidity due to infections; early detection and treatment of infections through primary health care may go a long way in preventing deterioration in nutritional status of children.

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References


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