Identifying prevalence, aetiology and associations in malnourished hospitalized children: A cross-sectional study

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ABSTRACT
Introduction: Malnutrition is the cause of substantial health problems that need significant consideration in children. Malnutrition is caused by multiple aetiologies; it has a direct association with infections. This study aimed to evaluate the prevalence of moderate and severe (Grade II, III and IV) malnutrition, aetiological factors in the causation of Malnutrition, and prevalence and type of anaemia, vitamin deficiencies and infections in hospitalized malnourished children. Methodology: The research was designed as a cross-sectional observational study in the paediatric malnourished population at Acharya Vinobha Bhave Rural Hospital, Sawangi, India. The study included the children between 6 months to 5 years with Grade II, III and IV malnutrition, who were admitted in the paediatric ward and excluded those with neurological problems, syndromes, and chronic diseases affecting development. Result: The Prevalence of moderate and severe malnutrition (Grade II, III and IV) in admitted patients below 5 yrs at AVBRH was 10.18%. Majority of malnourished children were under the age of 3 years with males as the major bulk overall. Acute respiratory infections were the most common presenting problem among these children followed by diarrhoea. Stunting was present in 60.14% of children.
indicating chronic malnutrition while rest had acute malnutrition. Vitamin deficiencies were significant in all grades of malnutrition.

**Conclusion:** In a developing country like India, malnutrition is one of the biggest health problems. Our study demonstrated that the majority of malnourished children were males, and presented with respiratory infections. Besides, the most common findings included anaemia, vitamin deficiencies, and skin and hair changes.

**Keywords:** Malnutrition, India, Health Problems

1. **INTRODUCTION**

Child malnutrition is the prevalent public health issue in developing countries, which is the main reason for child morbidity and mortality (Yirga et al., 2019). The most vulnerable are children, who are less than five years old. The nutrition of infants and young children is a major concern to any society (Black et al., 2013). Malnutrition is the cause of substantial health problems that need significant consideration in children. For that reason, reducing malnutrition of children is equal to improving the health status of the children. This is important for economic growth and development of the society under consideration (Getahun et al., 2001; Yirga et al., 2019). Historically, undernutrition and overweight were considered distinct issues affecting specific populations and with opposing risk factors (Dutta et al., 2019). Under-nutrition is associated with food insecurity, poverty, and infection, while obesity is associated with dietary richness, affluence, and sedentary behaviour. These two types of malnutrition are rapidly co-occurring within populations, families and even individuals, such as those who are both overweight and stunted (Doak et al., 2005; Dutta et al., 2019). Protein Energy Malnutrition (PEM) happens when the body does not obtain the nutrients required for its physiological metabolism due to a lack of energy and protein intake or a deficiency in the usage of the nutrients provided (Bhutia, 2014; Vieira et al., 2020). This adds greatly to the global burden of many diseases (Khan et al., 2019; Tekile et al., 2019). According to the World Health Organization (WHO) at least 155, 52 and 99 million children under the age of five were stunted, wasted and underweight worldwide in 2016 (Black et al., 2013; Dutta et al., 2019). Besides, around 6 million children were reported stunting and wasting at the same time (Khara et al., 2018).

In developing countries, particularly Africa and South Asia, malnutrition is clustered (Black et al., 2013; “WHO | UNICEF-WHO-The World Bank,” n.d.). In South Asia, the condition has an especially high prevalence in Pakistan, India, and Bangladesh (Headey et al., 2016; Khan et al., 2019). According to the recently released National Family Health Survey, NFHS-4 conducted in 2015-16, 36 per cent of India’s children under the age of three are underweight, 38 per cent are stunted and 21 per cent waste (NFHS-4, 2015-16, 2017). Comparable estimates are 40 per cent, 45 per cent and 20 per cent respectively for NFHS-3 (2005-06) (National Family Health Survey (NFHS-3), 2005; Paul and Bagga, 2019). In India, child malnutrition is responsible for 22 per cent of the disease burden in the country (Choudhary et al., 2019; Gragnolati et al., 2005). Mostly, it is the result of high rates of infection exposure and inadequate practice of feeding and caring for infants and young children, and has its roots almost exclusively during the first two to three years of life (Narayan et al., 2019).

Malnutrition and infections are interlinked, and both potentiate the influence of each other. Malnutrition and infection form a toxic cycle in which malnourished children suffer from chronic infection due to immune deficiency, and this repeated infection, in turn, worsens malnutrition even more (Paul and Bagga, 2019). It has been estimated that malnutrition is associated with around half of all child deaths and more than half of deaths from major diseases (Pravana et al., 2017). Both forms of malnutrition, that is primary and secondary nutrition occurs widely. Primary malnutrition and secondary malnutrition apply to malnutrition as a result of insufficient food intake and malnutrition as a result of reduced nutrient absorption, increased nutritional requirements, and/or increased nutrient losses, respectively (Prost et al., 2019). This aim of the study is to evaluate the prevalence of moderate and severe (Grade II, III and IV) malnutrition, aetiological factors in the causation of malnutrition, and prevalence and type of anaemia, vitamin deficiencies and infections in hospitalized malnourished children.

2. **METHODOLOGY**

**Study Duration**

The study was conducted from August 2020 to October 2020 for 3 months.

**Study design and site**

This research was a cross-sectional observational study of a prospectively recruited paediatric population admitted to the Department of Pediatrics of the Acharya Vinobha Bhave Rural Hospital at Sawangi, Wardha, India over 2 years.
Sample characteristics and size
The study sample consisted of 273 male and female children aged 6 to 60 months enrolled at the in the city of Wardha, state of Maharashtra, India. The study participants consisted of children between 6 months to 60 months of age, with Grade II, III, IV malnutrition (as per IAP classification), who were admitted in the paediatric ward. Age of the children was calculated based on the date of birth of the child as informed by parents. The minimum duration of admission for all the children was 2 weeks and the anthropometric parameter was done 1 week after complete recovery from acute illness and establishment of feeding. Children with Neurological problems, Syndromes and chronic diseases, which affect development, were excluded from the study.

Procedure
Detailed history, including the presenting complaints like diarrhoea, vomiting, fever, cough, breathlessness, loss of appetite, weight loss along with any other significant complaints, were noted in detail. Past history of any illnesses and infections like diarrhoea, respiratory tract infections or any other infections along with the history of hospitalizations due to similar complaints were noted. Dietary history was asked in details from the parents of the children as per “24 hours recall with emphasis on the diet of a representative day”. Test weighing of the child before and after breastfeeding for one day in children on breastfeeding was noted for calculation of calories from breast milk. Calories and proteins were measured and were compared with total calorie, and protein intake recommended for each age and deficit was calculated. The requirement of calories was calculated as 100cals/kg until 1 year of age. The requirement of Proteins was calculated as 2g/kg body weight until 1 year of age. Anthropometry included Weight and Length/Height of the children. All the above information was entered in a pre-tested and validated proforma.

Statistical analysis
The results were presented as mean and standard deviation, and as percentages. Statistical significance was calculated using Pearson’s chi-square test. A statistical significance level of p < 0.05 was determined. The software version SPSS Statistics 17.0 was used for the data analysis.

3. RESULTS AND OBSERVATIONS
The Prevalence of moderate and severe malnutrition (Grade II, III and IV) in admitted patients below 5 yrs at AVBRH was 10.18% during the study period. Majority of malnourished children were under the age of 3 years (91.39%) with a maximum number between 6 months to 1 year (51.75%). Males were the major bulk overall (58.39%) and in each group, though it was not statistically significant (P>0.05) as shown in Table 1. It is similar to NFHS 4. Moderate malnutrition using Indian Academy of Paediatrics subcommittee classification (Grade II) was more common (51.36%) as compared to severe forms. Table 2 and figure 1 presents distribution as per Grade of PEM ((wt/Age) as Per IAP), table 3 presents the distribution of Stunting in patients as Per ((Ht/Age) WHO Classification), and table 4 presents Etiological Classification of Malnourished patients. Acute respiratory infections (24%) were the most common presenting problem among these children followed by diarrhoea (10.54%). Stunting was present in 60.14% of children indicating chronic malnutrition while rest had acute malnutrition. Around 40% of children fitted in SAM (severe acute malnutrition). Secondary malnutrition (56.25%) was more common than Primary (43.75%) as it was a hospital-based study (P < 0.001). Amongst causes for Secondary malnutrition, Hemolytic anaemia (23.26%) was most common as it is a Sickle cell belt area. Congenital heart disease (16.31%) was the second major cause. Increased frequency and severity of infections (denoted by hospitalization) was more commonly associated with severe forms of malnutrition. Table 5 presents the correlation of malnutrition severity with frequency and severity of the infection. Majority of children (80%) with severe forms of malnutrition (Grade III and IV) were incompletely immunized as compared to milder form (%) (Grade II). (x² = 42.75, Significant). Around 88.69% of grade III patients and all patients of grade IV received either improper breastfeeding or not received breastfeeding at all. About 64.43% of grade III and 100% patients of grade IV had faulty weaning practices (x² =27.25, Significant) and have not started weaning at all though they were above 6 months. Improper breastfeeding and weaning practices directly affected the child’s nutritional status and increased chances for severe malnutrition. In grade II, 49.80% of children had a caloric deficit of 10-30% whereas 76.56% of grade III children had a caloric deficit of 31-50%, and 20.50% had a deficit of more than 50%. As far as grade IV was concerned, all patients had a deficit of more than 50%. The caloric deficit was significantly more (P<0.0001) in severe grades of malnutrition as compared to milder form. Pallor was noted in 61.21% of grade II and 61.92% of grade III patients and 100% in grade IV children. Pallor along with skin and hair changes was significantly more in all grades of malnutrition. (x²=168.02, significant). Vitamin A and B deficiencies were found to be significantly more in all Grades of malnutrition (Vitamin A, x² =13.49, Significant) (Vitamin B, x² =63.28, Significant) whereas vitamin D deficiency though it was present, it was not significantly more in any Grade (Vitamin D, x²=2.08, not significant). Table 6 shows the relationship between malnutrition with vitamin deficiencies.
**Table 1** Showing Age and Sex Wise Distribution of Patients

<table>
<thead>
<tr>
<th>AGE (YEARS)</th>
<th>MALE</th>
<th>FEMALE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 – 1</td>
<td>155(58.49%)</td>
<td>110(41.50%)</td>
<td>265(51.75%)</td>
</tr>
<tr>
<td>&gt;1 – 2</td>
<td>88(59.06%)</td>
<td>61(40.93%)</td>
<td>149(29.10%)</td>
</tr>
<tr>
<td>&gt;2 – 3</td>
<td>35(64.81%)</td>
<td>19(35.18%)</td>
<td>54(10.54%)</td>
</tr>
<tr>
<td>&gt;3 - 4</td>
<td>03(60%)</td>
<td>02(40%)</td>
<td>05(9.76%)</td>
</tr>
<tr>
<td>&gt;4 – 5</td>
<td>18(46.15%)</td>
<td>21(53.84%)</td>
<td>39(7.61%)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>299(58.39%)</td>
<td>213(41.60%)</td>
<td>n= 512</td>
</tr>
</tbody>
</table>

**Table 2** Showing distribution as per Grade of PEM ((wt/Age) Per IAP)

<table>
<thead>
<tr>
<th>GRADE</th>
<th>MALE</th>
<th>FEMALE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>154(58.55%)</td>
<td>109(41.44%)</td>
<td>263(51.36%)</td>
</tr>
<tr>
<td>III</td>
<td>137(57.32%)</td>
<td>102(42.67%)</td>
<td>239(46.67%)</td>
</tr>
<tr>
<td>IV</td>
<td>08(80%)</td>
<td>02(20%)</td>
<td>10(1.95%)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>299</td>
<td>213</td>
<td>512</td>
</tr>
</tbody>
</table>

**Table 3** Showing distribution of Stunting in patients as per ((Ht/Age) WHO Classification)

<table>
<thead>
<tr>
<th>NUMBER OF PATIENTS</th>
<th>NORMAL</th>
<th>MODERATE STUNTING</th>
<th>SEVERE STUNTING</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>204(39.84%)</td>
<td>133(25.97%)</td>
<td>175(34.17%)</td>
<td>512</td>
</tr>
</tbody>
</table>

\[X^2=14.93, \text{Significant (stunting versus normal)}\]

**Table 4** Showing Etiological Classification of Malnourished patients

<table>
<thead>
<tr>
<th>GRADES(n=512)</th>
<th>PRIMARY MALNUTRITION</th>
<th>SECONDARY MALNUTRITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRADE II (n=263)</td>
<td>169(64.25%)</td>
<td>94(35.74%)</td>
</tr>
<tr>
<td>GRADE III (n=239)</td>
<td>55(23.01%)</td>
<td>184(76.98%)</td>
</tr>
<tr>
<td>GRADE IV (n=10)</td>
<td>00</td>
<td>10(100%)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>224(43.75%)</td>
<td>288(56.25%)</td>
</tr>
</tbody>
</table>

\[X^2=102.1,P<0.001, \text{Significant}\]

**Table 5** showing correlation of malnutrition severity with frequency and severity of infection

<table>
<thead>
<tr>
<th>PREVIOUS INFECTION</th>
<th>GRADE II</th>
<th>GRADE III</th>
<th>GRADE IV</th>
<th>$\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO INFECTIONS</td>
<td>149(56.65%)</td>
<td>41(17.15%)</td>
<td>00</td>
<td>61.38</td>
</tr>
<tr>
<td></td>
<td>Significant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-2/YEAR WITHOUT HOSPITALIZATION</td>
<td>19(7.22%)</td>
<td>38(15.89%)</td>
<td>00</td>
<td>6.33</td>
</tr>
<tr>
<td></td>
<td>Significant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-2/YEAR WITH HOSPITALIZATION</td>
<td>55(20.91%)</td>
<td>84(35.14%)</td>
<td>02(20%)</td>
<td>73.57</td>
</tr>
<tr>
<td></td>
<td>Significant</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
>2/YEAR WITHOUT HOSPITALIZATION & 00 & 20(8.36%) & 00 & 40, Significant \\
>2/YEAR WITH HOSPITALIZATION & 40(15.20%) & 56(23.43%) & 08(80%) & 34.46, Significant \\
TOTAL & 263 & 239 & 10 & \\

Total patients to be hospitalised were 245

Table 6 Showing relationship between Malnutrition With Vitamin Deficiencies

<table>
<thead>
<tr>
<th>VITAMINS</th>
<th>GRADE II (n=263)</th>
<th>GRADE III (n=239)</th>
<th>GRADE IV (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>47(17.87%)</td>
<td>80(33.47%)</td>
<td>10(100%)</td>
</tr>
<tr>
<td>B</td>
<td>19(7.22%)</td>
<td>99(41.42%)</td>
<td>10(100%)</td>
</tr>
<tr>
<td>D</td>
<td>19(7.22%)</td>
<td>29(12.13%)</td>
<td>00</td>
</tr>
</tbody>
</table>

Figure 1 Showing distribution as per Grade Of PEM ((wt/Age) as Per IAP

4. DISCUSSION

The aetiology of malnutrition is multifactorial and hence manifestations are protean. The complications may be related to aetiology, associations or malnutrition per se and hence they tremendously increase the magnitude of the problem. The prevalence of malnutrition in this hospital-based study is 10.18%. In a community-based study done by Matariya et al, (2016) the proportion of malnutrition was highest in primary health centre (PHC) area (29.1%) followed by Community health centre (CHC) area (23.0%) and lowest in urban health centre (UHC) areas (18.2%).

A nationwide study of malnutrition in hospitalized patients in Netherland showed a prevalence of 20%, whereas in other European countries it varied from 14-24% (Sullivan, 2010). This difference from ours is supposedly due to less frequent utilization of the facility. A maximum number of malnourished children varied from 6 months to 1 year, thus showing the importance of complementary feeding age and nutritional status. Sengupta et al found in their study that 74% in children were found to be stunted, 42% were wasted and 29.5% were underweight in Ludhiana below the age of 5 years (Sengupta et al., 2010). Besides, female children, children aged 48-59 months, children born to older mothers aged 30-49 years, children with more than three siblings, low birth weight, those exclusively breastfed for more than 6 months or less than 4 months, were observed to be at the highest risk of being under-nourished (Sengupta et al., 2010). In a hospital-based study, Bruno et al in Africa (Mombasa) found that 75% of malnourished children were below 2 years of age (Sunguya, 2006). This showed that malnutrition is common below 2 years of age. Besides, if the age of onset of malnutrition is less than 1 year, it heads towards marasmus, making it more common than kwashiorkor (Parthasarathy, 2013). In a community-based study by Garg et al. (2018) in rural areas of Wardha also found that males
(52%) were more affected than females (48%), which corresponds with our study. This contrasted with the NFHS 4, according to which under age of 3 years, males and females are almost equally malnourished probably due to the reason that female malnourished patients are usually not taken to the hospitals as compared to males, and ours is hospital-based study. Sengupta et al. (2010) in Ludhiana found that majority of malnourished children were males. Sunguya et al. (2006) in African (Mombasa) hospital-based study also found that 55% of malnourished children were males.

Acute respiratory infection (ARI) (20.11%) was the most common presenting complaint followed by irritability and diarrhoea. According to NFHS 4, under three years of age, the most common infection among malnourished children is ARI (NFHS-4, 2015-16, 2017). Amongst the study group, 60.14% had stunting indicating chronic malnutrition while the rest were having normal stature for age indicating acute nature. Similar to the present study, Kumar et al. (2006) in a community-based study at Allahabad found that 51% of the children under the age of 5 were stunted. Rehman et al. (2009) in a follow-up study of neighbouring slums at Vellore found that 51% of the total children were stunted by three years of age. Similar to our study, Ghosh et al. (2020) also found that majority of children were affected by primary malnutrition in urban slums. In the present study, non-dietary causes of malnutrition were more common as it was a hospital-based study (Table 5).

The most common systemic illness in our children was Hemolytic anaemia (23.26%) as Wardha comes in sickle cell belt area followed by congenital heart disease (16.31%). Local causes of malnutrition included affected-feeding, cleft lip and palate in our study, as our hospital is the runs smile train project. Besides, malnutrition and infection form a vicious cycle in which malnourished children suffer from recurrent infections due to immune deficiency and recurrent infections in turn further worsens malnutrition. With an increase in the number of infections and hospitalization, more severe was the grade of malnutrition ($\chi^2=34.46$, significant). Schable et al. in their study concluded that infections and malnutrition are interrelated and form a vicious cycle (Schable and Kaufmann, 2007). Kaware et al. in a study at Solapur found that 72% of the ARI patients under 5 years of age were malnourished and concluded that malnutrition increases the chances of ARI (Kaware et al., 2017). A hospital-based study by Sunguya et al. in Africa (Mombasa) that patients having infection and malnutrition (comorbidity) both had higher case fatality rates that patients with infection alone and infection also worsens the severity of malnutrition (Sunguya, 2006) (Table 6).

A significant association was found between birth order as well as the number of siblings and malnutrition ($P<0.0001$). Higher the birth order and the number of siblings more severe was malnutrition. Similar findings were observed by Verma et al. (Verma et al., 2007). Nahar et al. (Nahar et al., 2010) found that higher birth order is an important risk factor for severe malnutrition in Bangladesh indicating malnutrition has similar risk factors all over the globe. A significantly higher number of severely malnourished (grade III and IV) children were incompletely immunized than milder variant ($\chi^2=42.75$, significant), thereby implying that partially immunized children were at higher risk of malnutrition. Severe grades of malnutrition (grade III and grade IV) were associated with faulty weaning practices ($\chi^2=27.25$, significant) and the children did not receive proper and exclusive breastfeeding ($\chi^2=8$, significant). Khokhar et al. (Khokhar et al., 2003) in their study at Delhi resettlement colony found a significant correlation between malnutrition and improper breastfeeding and delayed introduction of complementary food in children between 6 months to 2 years of age ($P<0.05$).

A similar finding was found in a study by Saha et al. at Kolkata in a hospital-based study (Chatterjee and Saha, 2007). Nahar et al. also in their study found that poor child feeding practices were associated with malnutrition (Nahar et al., 2010), which implies that proper breastfeeding and weaning is of utmost importance in the child’s nutritional status below 5 years of age. We found that in our subjects as the calorie deficit increased, the grade of malnutrition also worsened ($\chi^2=291.7$, $P<0.0001$) and a maximum number of severely malnourished children (grade III and IV) had a calorie deficit of >30%. We also found that the mean calorie and protein intake was significantly less in all the grades of malnutrition and it further decreased as the grade of malnutrition increased. Singh et al. also found similar results (Singh et al., 2006). Verma et al. found that calorie deficit was more than 20% in the maximum number of patients who were malnourished, which was similar to our study (Verma et al., 2007). Pallor along with skin and hair changes was significantly more common in all grades of malnutrition, ($\chi^2=168.02$, Significant) which is already known to be a common clinical finding in malnourished children (Elizabeth, 2020). Begum et al. in her study at Bangladesh found that around 42% of the malnourished children under the age of 1 year had skin and hair changes (Begum et al., 2010). Vitamin A, B, and D were mainly deficient in our study. Vitamin A and B deficiency were significantly more in grades III and IV as compared to grade II ($\chi^2=63.28$, significant). Vitamin D deficiency was the same in all grades ($\chi^2=2.08$, not significant). Fitwi et al. at Addis Ababa found that Vitamin D deficiency was significantly affected in malnourished children as compared to controls (Lulseged and Fitwi, 1999).

Anaemia is the major comorbidity with malnutrition. In this study, about 57% of the malnourished children below the age of 5 had anaemia and it was significantly more in severe grades of malnutrition (grade III and IV) ($\chi^2=117.05$, significant). Mean Hb also came down with increasing severity. A higher percentage of anaemic children in this study was because it was a hospital-based study. A community-based study at Wardha by Sinha et al. also had similar finding (Sinha et al., 2008). In this study, 10 children had
megaloblastic or dimorphic anaemia. However, vitamin D deficiency was rare but observed in those children who were advised Vitamin D supplementation. Delayed motor milestones in rickets are a known feature most probably due to hypotonia and myopathy (Bener et al., 2009).

5. CONCLUSIONS
The research demonstrates a significant relationship of malnutrition with prevalence, aetiology, anaemia, vitamin deficiencies, and infections. Malnutrition is very common in developing countries like India, and the aetiology of malnutrition is multifactorial. Prevalence of malnutrition in admitted children of AVBRH was 10.18%. The most affected age group included the children below 1 year. Males outnumbered females and respiratory infections were the most common presentation. Besides, about 60% of patients were stunted. As it was a hospital-based study, secondary malnutrition was more common. Anaemia and infections were found to have the most common association. Most of the children with severe malnutrition were incompletely immunized. Defects in breastfeeding and weaning practices have an important impact. The most common findings included anaemia, vitamin deficiencies, and skin and hair changes.

Authors’ contribution
All author made best contribution for the concept, assessment and Evaluation, data acquisition and analysis and interpretation of the data.

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Conflict of interest
The authors declare that there are no conflicts of interests and participated equally for the study.

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Ethical approval for study design
The study was approved by ethical review board (IRB) with a registration number FPP/2020/2/7/32.

Informed consent
Written & Oral informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this manuscript.

Data and materials availability
All data associated with this study are present in the paper.

REFERENCES AND NOTES


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