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A CASE-CONTROL STUDY OF RISK FACTORS FOR MALNUTRITION AMONG PRESCHOOL CHILDREN IN A SEMI URBAN AREA ADJOINING INDORE (MADHYA PRADESH)

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Abstract

Background: Childhood malnutrition is a multi-dimensional problem. The prevalence of malnutrition among children in developing countries is very high. An increase in household income is not sufficient to reduce childhood malnutrition if children are deprived of food security, education, access to water, sanitation and health services. The aim of this study is to identify the characteristics of malnourished children between 3 to six years of age and to ascertain the risk factors of childhood malnutrition in a semi urban adjoining Indore (Madhya Pradesh, Central India.

Objective: The objective of this case control study was to determine the risk factors for malnutrition among preschool children in a semi urban area adjoining Indore (Madhya Pradesh).

Materials and Methods: A case-control study was carried out among preschool children, aged between three to six years, attending the Anganwadi centres and their mothers in a semi urban area of Tehsil & district Indore of Madhya Pradesh, India from 1 st April to 30th June 2019. Case was a child with moderate to severe malnutrition with z-scores < −2SD from the median of WHO reference. Control was a child without malnutrition with z-scores between -2SD and +2SD and the age matched with case's. Face to face interviews with the respective child's mother and measurements of the respective child's weight and height were carried out. Information on socio-economic characteristics, household food security status, child's dietary intake, caregiver's practices and resources were enquired. A total of 1140 children (380 cases and 760 controls) were selected by multistage cluster sampling technique. A semi-structured risk factors questionnaire was used to identify the risk factors for malnutrition among children.

Results: The majorities (45.8 and 45.5%) of the children in the study were in the age group of 3.0 to 4.0 years in case and control groups respectively. There was a slight preponderance of illiterate parents among cases in comparison to the controls. Largely, 87.4% of the children belonged to poor socio-economic status in the case groups compared to 82.4% in the control group. After adjusting for the confounders, underweight status was significantly associated with socio-economic status of the parents (aOR: 2.05, 95% CI: 1.06, 3.96), birth weight < 2000 g (aOR: 25, 95% CI: 0.10, 0.59), recurrent diarrhoea (aOR: 2.74, 95% CI: 1.56, 4.83), recurrent cold and cough (aOR: 3.88, 95% CI: 1.96, 7.67), worm infestation (aOR: 2.0, 95% CI: 1.19, 3.38) and pre-lacteal feed given (aOR: 3.64, 95% CI: 2.27, 5.86).

Conclusion: Parental education, childhood illness, short birth interval, open defaecation, type of weaning and complimentary food given to children were some of the significant determinants of underweight that were found in the study. Information, Education and Communication (IEC) campaigns alleviating food habits and taboos and promoting birth spacing is the need of the hour for preventing the occurrence of malnutrition among preschool children.

Keywords: Malnutrition, Anganwadi centres, preschool children, pre-lacteal feed, socio-economic characteristics, Information, Education and Communication (IEC), Adjusted Odds Ratio (aOR), Integrated Child Development Services (ICDS), Statistical Package for Social Sciences (SPSS).

Introduction

Nutrition is a fundamental pillar of human life, health and development across the entire life span. From the earliest stages of foetal development, at birth, through infancy, adolescence, and on into adulthood and old age, good nutrition is essential for survival, physical growth, mental development, performance, health and well-being[1]. Malnutrition means "badly nourished" but it is more than a measure of what we eat, or fail to eat. Clinically, malnutrition is characterized by inadequate intake of protein, energy, micronutrients and by frequent infections or disease. Under-nutrition is one of the utmost significant universal health problems, and it affects a large number of children in the developing countries[2]. Proper nutrition of children, leading to adequate growth and good health is

the essential foundation of human development[3]. UNICEF, in the year 2006, reported the causes of childhood malnutrition as insufficient diet, frequent infections, poor breastfeeding practices, delayed introduction of complementary foods and inadequate protein in the diet. Other factors that influence food intake include health status, food taboos, growth and personal choice related to diet. Malnutrition can also develop due to neglect, abnormal mealtimes, insufficient quantities of food and insufficient parental knowledge[4].

Chronic under nutrition is associated with serious health impairments later in life. Under nutrition in young child results in delayed physical growth and motor development, impedes behavioural and cognitive development that results in diminished academic performance and social skills. Moreover malnutrition during early childhood leads to serious long term consequences later in life which increases risk of developing diseases or disabilities and even death. Despite these consequences, malnutrition is treatable with prompt identification, anticipation and management[4].

Malnutrition is largely a treatable condition. Therefore, prompt identification, prevention and treatment is vital. Malnutrition in children, relics a substantial problem in India, in spite of global efforts on maternal child health improvement, and specific programmes such as Integrated Child Development Services (ICDS). The percentage of underweight, stunting and wasting among children under three years of age are reported to be 47%, 45% and 16% respectively in India[5]. There is also a wide disparity in the prevalence of under-nutrition of children among the states of India, ranging from high (Madhya Pradesh - 55%) to relatively low (Tamil Nadu - 25%)[6]. National Family Health Survey-4 (2015–16) reported that the prevalence of underweight, stunting, wasting and severe wasting among children under five years is 36.5%, 34.6%, 29.8% and 11.7% respectively in Madhya Pradesh State [7]. Even though severe under nutrition is more pronounced in states like Bihar, Madhya Pradesh, Orissa, Uttar Pradesh and Rajasthan, even in well-endowed states like Kerala, Goa and Sikkim the levels of mild under nutrition is unacceptably high[8].

Studies from Udupi district has reported the magnitude and the predictors of malnutrition. Kumar et al. (2010) conducted a cross-sectional study in Udupi taluk. The result showed that 32.3% children were malnourished, of which girls were 46.2% and boys 33.6%[9]. Chakravarthy, Soans and Hanumanth (2015) reported that underweight among children of 1–3 years was 14.8%[10]. Prabhat and Malya (2015) reported that the prevalence of underweight among 2–5 year old children was 46%[11]. A case-control conducted by Basit et al. (2012) reported that less birth spacing with more than two children in the family, low birth weight and sickness in the past one month to be significant predictors of under nutrition. There was significant association with under nutrition for a diet without milk or with diluted milk[12]. Many studies were conducted on fragmental basis, to find an association of nutritional status with either feeding practices or socio-economic status. Studies on other risk factors were not commonly attempted. Thus, this study was aimed to determine and analyse the comprehensive risk factors leading to under nutrition among preschool children attending Anganwadi centres in a semi urban area adjoining Indore (Madhya Pradesh).

Materials and Methods

Study design

A community-based case-control study was conducted among preschool children in a semi urban area adjoining Indore (Madhya Pradesh), India.

Study participants

The study was conducted among the drawn sample of preschool children between three to six years and their mothers, attending Anganwadi centres in a semi urban area adjoining Indore (Madhya Pradesh).

Sampling technique and sample size

A Survey was carried out to identify the preschool children with malnutrition. Multistage cluster sampling technique was adopted to select the Anganwadi centres. Semi urban area adjoining Tehsil & District Indore, Madhya Pradesh was selected for the study. Fifteen villages were randomly selected by chits. A cluster of 93 Anganawadi centres were selected from these 15 villages. A total of 2970 preschool children were assessed for nutritional status from 93 selected Anganwadi centres.

Among these 2970 children, 724 were identified as malnourished based on new WHO child growth standards 2006 (weight for age) [13].

Assuming 20% poor practices among the cases, anticipated odds ratio of 2%, at the power of 80% and considering 10% non-response, the sample size required for cases was 380. The control group was selected based on 1:2 ratio. Thus, a sample of 380 cases and 760 controls were included in the study. For each malnourished child identified (case), two normal weight children (controls), who met the inclusion criteria were selected, succeeding registered next to child's register number in the attendance register maintained in the Anganwadi centre.

Measurements

Measurement of weight of the preschool children was done to identify the malnutrition. The nutritional status was graded as per the new WHO child growth standards 2006[13]. Children in the age group of 3–6 years, with weight for age ratio less than – 2 SD (– 2Z Scores) and not suffering from any chronic / severe illness were considered a case. Controls were healthy children in the same age group with weight for age ratio above – 2 SD (> – 2Z scores).

Data was collected using tools such as Demographic Performa, Socio-economic status scale and semi-structured Risk factors questionnaire[14, 15]. Demographic Performa and semi structured risk factors questionnaire was developed by the researcher initially in English and it was validated (CVI-1) and checked for the reliability ($r = 0.96$). Socio-economic status (SES) was assessed using a modified "Scale for measuring socio -economic status of a family" developed by O. P. Aggarwal & et al [16]. Then tools were translated to Hindi language (local language), then re-translated to English to check the language validity (Additional file).

Ethical approval

Ethical approval was taken from Institutional Ethics Committee to conduct the study. Permission was also obtained from Child development project officer (CDPO) to visit Anganawadi centres and approach preschool children and their mothers. Written informed consent was obtained from the mothers for participation of their children as well as their own participation.

Procedure for data collection

After obtaining informed consent from the mothers, anthropometric measurements of the children were assessed using standard calibrated instruments. Weight was recorded using a standard calibrated weighing scale, kept on a firm horizontal surface to the nearest 500 gms with zero error. Based on the recorded weight, nutritional status was graded as per the new WHO child growth standards 2006[13]. Mothers of selected children were contacted at their residence to collect the information on risk factors. Initial rapport was developed with the mothers. They were asked to cooperate in the filling up of the questionnaire. Information pertaining to risk factors such as childbirth history, illness history, environmental factors, and feeding practices of the child were obtained using a semi-structured risk factors questionnaire. The average time taken by each mother to respond to the questionnaires was 25 minutes.

Data analysis

The collected data were analysed using Statistical Package for Social Sciences (SPSS) version 16. The findings were reported in terms of frequency and percentage, along with 95% confidence interval (CI). The risk was estimated using odds ratio with 95% CI. Univariate & Multivariate logistic regression was done to identify the risk factors for under nutrition.

Results

The data presented in Table 1 shows that, there was an almost equal distribution among the cases and controls, with regard to characteristics such as age, gender, religion and family type. It was observed that, majority of the children, i.e., 45.8% among cases and 45.5% among controls were in the age group of 3 to 4 years. There was a slight preponderance of illiterate parents among cases. In both the groups, large number (87.4% in cases and 82.4% in control) of children belonged to poor socio-economic status, whereas none of the children were from higher socio-economic status.

Univariate analysis of risk factors for malnutrition

Chi-square was computed to find the association between malnutrition and risk factors. A logistic regression of 95% confidence interval was then carried out to adjust for the confounders and identify the factors that were truly associated with malnutrition.

Socio -demographic determinants: Gender, type of family, immunization status of the child, education and socio-economic status of the parents were the factors focused on this area. Statistically, a significant association was found between malnutrition and immunization status of the child as well as the educational status of mother (χ^2 (df) = 15.8 (3), $p < 0.001$) and the father ($\chi 2$ (df) = 22.2(3), $p < 0.001$). A child's risk of malnutrition was higher when he/she was partially immunized, as compared to a child who was completely immunized [OR 2.31, 95% CI (1.58–3.36) $p < 0.001$].

The Child related risk factors presented in Table 2 depicts that children with birth weight less than 2000 gms were 1.9 times, and those between 2000 and 2500 gms were 3.9 times at a higher risk of being malnourished, as compared to children with birth weight more than 2500 gms. Second and third birth order children were at 3.8 times and 2.7 times higher risk of being malnourished as compared to the first born. The birth interval between the first and the second child and between the second and the third child, if less than 3 years, had a high risk of malnutrition ($p < 0.001$).

The Child illness factors are shown in Table 3. A malnourished child was noted to have 6.9 time's higher risk of having suffered from recurrent cold and cough, and 10 times the risk of having recurrent diarrhoea in the previous year. Also, a malnourished child has 4.6 times and 6.8 times higher risk of having suffered from worm infestation and poor appetite respectively.

Environmental risk factors (water and sanitation characteristics)

Children practicing open defecation were more among cases (14.7%) than in controls (6.8%), and they also tend to have a 2.3 times higher risk of being malnourished, compared to children using a sanitary latrine [95%CI (1.37–4.14), $p = 0.002$]. Children whose families had open drainage system around the house was noted to be more in cases (74.7%) than controls (58.2%), and were at 2.0 times higher risk of being malnourished than families that had underground and piped drainage system [95%CI (1.329–3.29), $p < 0.001$. Factors such as a source of water and method of water storage in the house did not have any association with malnutrition, but the method of extracting the drinking water (for example, immersing both the glass and the hand into the stored water) by the children had the significant association with malnutrition. Children who had the habit of immersing both their hand and the glass to extract drinking water, and children who had the habit of immersing only the glass and not their hand, was noted to be more in cases compared to controls. They had 4.7 times [95%CI 2.02–11.05, $p < 0.001$] and 7.25 times [95%CI: 3.00–17.49, $p < 0.001$] higher risk, respectively, of being malnourished as compared to children using a long spoon ladle to extract drinking water from a storage vessel.

Table 4 depicts the association of infant feeding and dietary practices with malnutrition, which shows that among cases, 60% of the mothers gave a pre-lacteal feed (either plain water, sugar water or glucose water) to their children, as compared to 20.3% in controls. This was found to have a 5.9 times higher risk of being malnourished [95%CI 4.02–8.6, $p < 0.001$]. The proportion of children who were exclusively breastfed up to six months were higher among cases (58.9%), and those children who received exclusive breastfeeding more than six months were higher among controls (56.8%). and the risk of being malnourished was 1.89 [95%CI 1.32– 2.69, $p < 0.001$] times. Neither the time of initiation of weaning nor the time at which the complementary food was given ($p = 0.065$) influenced the nutritional status, but the type of weaning ($p < 0.001$) and the type of complementary food given ($p = 0.003$) highly influenced the nutritional status of the children. The mothers who restricted certain foods for their children during childhood were found to have a statistically significant association ($p < 0.001$) of having malnourished children with an Odds ratio of 2.57. Likewise, mothers who had the practice of providing nutritious food to their children during their infancy and childhood, were found to have normal weight children, as compared to the mothers who had the practice of giving their children bakery products and candies or chocolates ($p < 0.001$).

Further, to identify the independent risk factors, multiple logistic regression with a stepwise Backward LR was computed and expressed as adjusted odds ratio at 95% confidence interval, presented in Table 5.

A logistic regression analysis confirmed the factors such as socioeconomic status of the parents, birth weight < 2500 gms, recurrent diarrhoea, recurrent cold and cough, poor appetite of the child, worm infestation, pre-lacteal feed and special food prepared as the risk factor for Malnutrition.

Table 1: Demographic characteristics of the participants (N = 1140)

From: Risk factors for malnutrition among preschool children in a semi urban area adjoining Indore (Madhya Pradesh).: a case-control study

Demographic characteristics	Cases n = 380 (%)	Controls n = 760 (%)
Age in years		
3.0–4.0	174 (45.8)	346 (45.5)
4.1–5.0	126 (33.2)	276 (36.3)
5.1–6.0	80 (21.1)	138 (18.2)
Gender		
Male	170 (44.7)	368 (48.4)
Female	210 (55.3)	392 (51.6)
Religion		
Hindu	364 (95.8)	702 (92.4)
Muslim	16 (4.2)	58 (7.6)
Demographic characteristics	**Cases n = 380 (%)**	**Controls n = 760 (%)**
Type of family		
Nuclear	220 (57.9)	428 (56.3)
Joint/Extended	160 (42.1)	332 (43.7)
Education of father		
Illiterate	36 (9.5)	10 (1.3)
Primary and <10th std.	292 (76.8)	602 (79.2)
10th std. and below	50 (13.2)	144 (18.9)
graduation		
Graduation and above	2 (0.5)	4 (0.5)
Education of mother		
Illiterate	26 (6.8)	12 (1.6)
Primary and <10th std.	286 (75.3)	538 (70.8)
10th std. and below	68 (17.9)	208 (27.4)
graduation		
Graduation and above	0	2 (0.3)
Caretaker		
Mother	374 (98.4)	744 (97.9)
Grandmother/Other	6 (1.6)	16 (2.1)
member in the family		
Socio-economic status		

Demographic characteristics	Cases n = 380 (%)	Controls n = 760 (%)
Middle	48 (12.6)	134 (17.6)
Poor/BPL	332 (87.4)	626 (82.4)

Table 2: Pre-School Child related risk factors for malnutrition

From: Risk factors for malnutrition among preschool children in a semi urban area adjoining Indore (Madhya Pradesh): a case-control study

Factors	Cases *n* = 380 (%)	Controls *n* = 760 (%)	Odds ratio (95%CI)	p value
Child born				
Preterm	72 (18.9)	130 (17.1)		0.587
Full term	308 (81.1)	630 (82.9)		
Birth weight in grams				
<2000	48 (12.6)	32 (4.2)	1.97 (0.95–4.07)	
2000-2500	108 (28.4)	142 (18.7)	3.92 (2.01–7.66)	0.001
>2500	224 (58.9)	586 (77.1)	1	
Birth order of the child				
First	224 (58.9)	506 (66.6)	1	
Second	132 (34.7)	238 (31.3)	3.38 (1.34–8.51)	0.018
Third and more	24 (6.3)	16 (2.1)	2.70 (1.05–6.95)	
Birth interval (from previous birth)				
First born	108 (28.4)	334 (43.9)		
less than or 1 year	10 (2.6)	6 (0.8)	0.28 (.17–.48)	
1 to 2 years	90 (23.7)	80 (10.5)	0.50 (.31–.80)	0.001
2 to 3 years	100 (26.3)	156 (20.5)	0.82 (.50–1.35)	
> 3 years	72 (18.9)	184 (24.2)	1	
Birth interval between 2nd and 3rd child				
First born and 2nd child	326 (85.8)	722 (95.0)		
2 and less years	34 (8.9)	10 (1.3)	0.35 (.07–1.66)	0.001
2–3 years	8 (2.1)	18 (2.4)	2.70 (0.50–14.3)	
> 3 years	12 (3.2)	10 (1.3)	1	

Table 3 Association between Child illness and Malnutrition in Pre-School Children

From: Risk factors for malnutrition among preschool children in a semi urban area adjoining Indore (Madhya Pradesh).: a case-control study

Factors	Cases *n* = 380 (%)	Controls *n* = 760 (%)	Odds ratio (95%CI)	*p* value
History of present Illness of the child				
No	358 (94.2)	734 (96.6)		0.184
Yes	22 (5.8)	26 (3.4)	1.73 (0.76–3.94)	
Had Chronic infection (past)				
No	366 (96.3)	742 (97.6)		0.370
Yes	14 (3.7)	18 (2.4)	1.57 (0.57–4.30)	
Recurrent diarrhoea				
No	220 (57.9)	688 (90.5)		0.001
Yes	160 (42.1)	72 (9.5)	6.94 (4.44–10.87)	
Recurrent cold and cough				
No	24 (6.3)	304 (40.0)		0.001
Yes	356 (93.7)	456 (60.0)	9.99 (5.38–18.57)	
Poor appetite				
No	134 (35.3)	600 (78.9)		0.001
Yes	146 (64.7)	160 (21.1)	6.88 (4.67–10.13)	
Had worm infestation in the past				
No	214 (56.3)	652 (85.8)		0.001
Yes	166 (43.7)	108 (14.2)	4.68 (3.11–7.03)	

Table 4: Association of Infant feeding and dietary practices with malnutrition in Pre-School Children

From: Risk factors for malnutrition among preschool children in a semi urban area adjoining Indore (Madhya Pradesh).: a case-control study

Factors	Cases *n* = 380 (%)	Controls *n* = 760 (%)	Odds ratio (95%CI)	p value
Colostrum given				
Yes	354 (93.16)	730 (96.1)		
No	26 (6.84)	32 (3.9)		0.111
Pre-lacteal feed				
No	152 (40.0)	606 (79.7)		
Yes	228 (60.0)	154 (20.3)	5.90 (4.02–8.6)	0.001
Exclusive breast feed given				
Up to 6 months	224 (58.9)	328 (43.2)	1.89 (1.32–2.69)	0.001
6 and more than 6 months	156 (41.1)	432 (56.8)		
Type of weaning food				
Rice	96 (25.3)	118 (15.5)	1.41 (0.89–2.22)	
Rice, milk	200 (52.6)	342 (45.0)	2.81 (1.69–4.6)	0.001
Rice, milk, veg/pulses	84 (22.1)	300 (39.5)		
Type of complimentary food given				
Veg/pulses	32 (8.4)	28 (3.7)	0.30 (.14–.66)	
Veg/pulses and egg/fish	238 (62.6)	418 (55.0)	0.61 (.42–.90)	0.003
Veg/pulses, egg/fish and meat/ chicken	110 (28.9)	314 (41.3)		
Bottle feed				
No	274 (72.1)	562 (73.9)		0.639
Yes	106 (27.9)	198 (26.1)		
Food restriction				
No	218 (57.4)	590 (77.6)		
Yes	162 (42.6)	170 (22.4)	2.57 (1.7–3.75)	0.001
Special food prepared and given				
No	322 (84.7)	542 (71.3)		
Yes	58 (15.3)	218 (28.7)	2.23 (1.41–3.51)	0.001
Frequency of candies/chocolate given				
Daily/alternative days	286 (75.3)	456 (60.0)	2.02 (1.37–2.99)	0.001
Once/twice week	94 (24.7)	304 (40.0)		

Table 5: Adjusted odds ratio of risk factors for malnutrition - a multivariable analysis (N = 1140)

From: Risk factors for malnutrition among preschool children in a semi urban area adjoining Indore (Madhya Pradesh).: a case-control study

Variables at risk	Adjusted Odds ratio (95%CI)	*p* value
Socio-economic status	2.05 (1.06–3.95)	0.031
Birth weight < 2000 g	0.25 (0.10–0.59)	0.002
Birth weight 2000 - 2500 g	0.52 (0.30–0.91)	0.022
Recurrent diarrhoea	2.74 (1.56–4.82)	0.001
Recurrent cold and cough	3.88 (1.96–7.67)	0.001
Less of appetite	4.90 (3.03–7.93)	0.001
Worm infestation	2.00 (1.19–3.38)	0.009
Pre-lacteal feed	3.64 (2.27–5.86)	0.001
Special food prepared and given	0.50 (0.28–0.88)	0.016

Discussion

Malnutrition is a multi-dimensional entity. The nutritional status of children under the age of five is affected by different factors. The present study identifies certain risk factors which were found to be significantly higher in children with malnutrition compared to normal children. In our research study we found that the educational status of the parents, was associated with the nutritional status of the child, these findings are consistent with earlier reports[17, 18, 19, 20, 21].

The socio-economic status of the family was independently associated with under-nutrition as the study population were from semi urban areas, a supportive study done in India and Africa reveals that families with low economic status have significant association with under nutrition[22, 23].

As per the recommendation of global public health, for achieving optimum growth, development and health, a child should be breast fed exclusively during the first six months of life. To evolve as a healthy individual, the infant should be continued with adequate and appropriate safe complimentary food along with breast milk up to two years of age or beyond[24]. In the present research study, it was found that exclusive breastfeeding for less than six months was higher among cases (58.9%) than controls (43.2%), and was associated with the nutritional status of the children. It was also noted that the chances of being malnourished were 1.89 times higher among those children who did not receive exclusive breastfeeding. Various research studies have shown that lack of exclusive breastfeeding for the first six months was significantly associated with malnutrition[18, 19, 25, 26]. A study done in Bangladesh reported that there was a four-fold increased risk of malnutrition with the lack of breastfeeding[27].

WHO (2000) has reported that the children who are underweight are at an increased risk of mortality from infectious illnesses such as diarrhoea and pneumonia. Infections play a major etiological role in under nutrition because they result in increased needs and high energy expenditure, lower appetite, nutrient loss due to vomiting, diarrhoea, poor digestion, malabsorption and the utilization of nutrients and disruption of metabolic equilibrium[28, 29]. In this research study, no association was found between children suffering from current or chronic infections (such as tuberculosis, malaria, etc.) in the past and the nutritional status. But the risk of malnutrition was independently associated with recurrent cold and cough, recurrent diarrhoeal illness, poor appetite and worm infestation that occurred over the previous year. Multivariate logistic regression analysis reiterated the association of these factors with malnutrition. This research study showed the high prevalence of current infection among those who were malnourished, and it was suggested that the malnourished children had a higher incidence of infections due to poor immune factors as a result of inadequate nutrition. This is consistent with the findings of a research study done in Karnataka, India[12]. The relationship between the child's nutritional status and illness is bi-directional[30]. Being underweight increases the likelihood of illness because malnutrition suppresses immunity [31]. Conversely, an acute infection can lead to weight loss through the increase in metabolic demand, impaired nutrient absorption or anorexia[32, 33].

The present research study showed the association of low birth weight i.e., < 2500 gms, birth order of second or third and a birth interval of fewer than three years with malnutrition, which is consistent with other research studies. Research studies were done in India and Bangladesh also reported that low birth weight and inadequate birth spacing as a risk factor for malnutrition[12, 27].

The current research study revealed that environmental factor is also a strong predictor of malnutrition. A higher number of children who practiced open defaecation were found malnourished (14.7%) than the normal (6.8%). Unhygienic conditions such as an open drainage around or near the house and waste dumped near the house, practices such as the children and the household members drinking unprotected water or drinking the water stored in open containers, immersing both the glass and the hand while extracting drinking water etc, was observed more in a malnourished child. Research studies have also reported that poor sanitation status, lack of personal hygiene and low socioeconomic statuses have an impact on malnutrition. Unhygienic latrines, defaecation within premises and use of unprotected surface water have an increased association with malnutrition. Children from unclean households were more underweight ($p = .037$) than the children whose households were clean[29, 34, 35]. It revealed that poor environmental conditions may increase the risk of acquiring an infectious disease, which in turn may lead to malnutrition.

Malnourishment is also associated with pre-lacteal feeding. In the present study the risk of developing malnutrition is 3.64 times higher ($p = 0.001$) among the children who were given pre-lacteal feeds. Many studies conducted in India also reported higher percentage of malnutrition in infants who were given pre-lacteal feeds[36, 37].

There is an increased risk of malnutrition, either with an early introduction or with delayed initiation of complementary feeding. Independent association of

malnutrition with the consistency of complementary feeds was found in studies from other parts of India[18, 25]. Our research study showed that the type of weaning and the complementary feeding highly influenced the nutritional status of the children. But, our study could not demonstrate any association between the time of introduction of weaning and the time of complementary feeding with the nutritional status of the children. Similar findings were reported in another study[18]. Our research study also found an association between food restrictions and special food fed and malnutrition among the children.

A higher percentage of sweets and candies / chocolate consumption among the children was observed among malnourished children as compared to normal children. The higher risk of malnutrition among children who ate more sweets or candies might be due to the lack of intake of nutritious food which is required for the growth of the child.

Conclusion

As the quality of the future human resources depends on the children of today, improvement of their nutritional level should be given top priority. Being underweight is associated with many factors which at times are modifiable and at times non-modifiable. Considering the modifiable factors, the nutritional level can be improved. There should be some training or education about nutritional knowledge, environmental sanitation, personal hygiene, breastfeeding, weaning practices, nutritional deficiency diseases, nutritional value of food and dietary practices to increase the awareness of semi urban parents to feed their children with a balanced diet, so that they can easily overcome the problems of malnutrition.

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