ORIGINAL ARTICLE

Nutritional Status and its Relationship with Dental Caries among 3–6-year-old *Anganwadi* Children

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Abstract

Aim: The purpose of this study is to determine dental caries status in 3–6-year-old malnourished children.

Materials and methods: A total of 500 children aged 3–6 years enrolled in *anganwadi* were selected for this study. The nutritional status was evaluated by anthropometric measurements such as body weight and height [body mass index (BMI)-for-age]. Dental caries status was recorded according to WHO criteria. The obtained data were subjected to statistical analysis.

Results: The prevalence of underweight was 41% and prevalence of dental caries was 61%.

Conclusion: Low BMI-for-age is a risk factor for dental caries.

Clinical significance: Inclusion of BMI-for-age calculation in routine case history pro forma helps in timely diagnosis, prevention, and treatment of children suffering from malnutrition.

Keywords: *Anganwadi*, BMI-for-age, Dental caries, Malnutrition.

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Introduction

"Malnutrition is the cellular imbalance between the supply of the nutrients and the energy and the body's demand for them to ensure growth, maintenance, and specific functions."[1] Malnutrition is one of the largest suppressing factors in India's spectacular growth. Malnutrition is widespread in rural, tribal, and urban slum areas, and it is a significant public health problem described as a silent killer, silent emergency, and invisible enemy.

The children of India are malnourished because of factors attributed to overpopulation, poverty, large family size, poor maternal health, adverse cultural practices, destruction of the environment, lack of education, gender inequality, and inaccessible medical care. Growing malnourished children exhibit behavioral changes, including irritability, apathy, decreased social responsiveness, anxiety, attention deficits, impaired growth, poor school performance, and decreased intellectual achievement. However, malnutrition is also known to produce high morbidity and mortality and considering its effect on oral cavity, malnutrition is shown to have preeruptive and posteruptive effects.[2] According to a recent National Family Health Survey (NFHS-3), infant mortality rate due to malnutrition is 45 per 1,000 live births in India and 55 per 1,000 live births in Karnataka.[3]

Oral health conditions, dietary practices, nutritional status, and general health status are all interrelated factors.[4] Malnutrition adversely affects the oral structures. Studies have shown that early malnutrition affects tooth structure, delay in tooth eruption, and results in increased dental caries.[5–7] It is also associated with enhanced susceptibility to caries because of impaired saliva secretion due to salivary glandular hypofunction and saliva compositional changes.[8]

The issue of malnourishment and infant mortality is rampant across the state of Karnataka. To overcome malnutrition, the Government of India has introduced Integrated Child Development Services (ICDS) program for children below 6 years and pregnant and nursing mothers. This program includes preschool education for children in the 3–6-year-age group, immunization of children and mothers, health checkup by medical officers, referral services for health, and education about importance of nutrition. In Karnataka, ICDS program was first launched as a pilot project at T-Narasipura taluk in Mysore district on 2 October 1975. However, malnourishment continues to be a concern in this area.

Anganwadi center is a focal point for activities of ICDS program. Hence, this study was carried out to determine nutritional status and dental caries status in 3–6-year-old children visiting *anganwadi* centers of T-Narasipura taluk, Mysore district, Karnataka.

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Materials and Methods

The study was carried out in *anganwadi* centers of T-Narasipura taluk, Mysore district, Karnataka. Ethical clearance was obtained from the Institutional Review Board to conduct the study. Permission was taken from the Department of Women and Child Development, Government of Karnataka, Bengaluru and Mysore to carry out anthropometric measurements and oral examination of the children. The nature of the study was explained

to the authorities of *anganwadi* centers and parents/guardians/caretakers.

Prior to the commencement of the study, a list of all *anganwadi* centers in T-Narasipura taluk, Mysore district, Karnataka, was obtained from the Department of Women and Child Development, Government of Karnataka, Bengaluru. A random sample of 500 children, both males and females aged between 3 years and 6 years, was screened.

The following criteria were used for the selection of children for screening purpose. Cooperative children, children who are residents of T-Narasipura from birth, children without any preexisting medical conditions, and children who are able to stand unsupported were included in the study. Children who are unable to participate due to severe malnutrition, children who are absent on the day of examination, and children with special healthcare needs were excluded from the study.

To evaluate the nutritional status of children, anthropometric measurements such as body weight and height were measured. All measurements were done by a single investigator to avoid interobserver bias and to maintain uniformity and accuracy in techniques.

Determination of Body Weight

Children were weighed using a portable glass electronic digital scale (Model Perfect™, PET 0030) in kilograms to the nearest 100 g, without footwear and minimal clothing. For the measurement to be precise, care was taken to see that the children did not lean forward or hold other support nearby which may alter the reading.[9] Accuracy of the weighing scale was checked every morning before starting the survey by measuring a known weight.

Measurement of Height

Children were made to stand without footwear, with heels together and shoulder, buttocks, and heels touching the vertical support. A tape vertically fixed perpendicular to the ground on the wall was used as the scale. This tape was nonstretchable. It was fixed with transparent adhesive tape, and care was taken to see that there was no fold or tilting to any side.[10] The child was made to look straight so that the Frankfort plane is parallel to the floor. The height was measured (in centimeters) by keeping the scale parallel to the floor at the highest point of the vertex.[9] During recording, the scale was repeatedly checked for loosening of adhesive tapes or tilting of the scale. Height was recorded to the nearest 1 cm.

Determination of Body Mass Index

Body mass index (BMI) was calculated using the formula, that is, weight in kilograms divided by height in meter square (kg/m^2) to determine if weight is appropriate for height.

$$\text{Body Mass Index} = \frac{\text{Weight (kilograms)}}{\text{Height}^2 \text{ (meter)}}$$

The obtained BMI value was plotted on age- and gender-specific charts from the Centers for Disease Control and Prevention (CDC) 2000.[11]

Based on these percentile curves, the children were grouped according to the following categories given by Macek and Mitola.[12]

- Underweight: BMI-for-age less than the fifth percentile.
- Normal: BMI-for-age greater than or equal to the fifth percentile and less than the 85th percentile.
- At risk of overweight: BMI-for-age, greater than or equal to the 85th percentile and less than 95th percentile.
- Overweight: BMI-for-age greater than the 95th percentile.

Oral examination was carried out using a noninvasive technique [mouth mirror, community periodontal index (CPI) probe, and cotton roll]. Examination was carried out with the child sitting in upright position under good natural daylight. Sterile mouth mirror and CPI probe were used for examination of each child. Dental caries status was recorded according to WHO criteria.[13]

An average of 10 minutes was taken per child for anthropometric measurements and oral examination. A pro forma was designed to record information about demographic data, anthropometric measurements, and dental caries status. Obtained data were subjected to statistical analysis using analysis of variance, Student's *t* test, Chi-square test, and SPSS 15.0 software.

Results

An epidemiological study was conducted on 500 preschool children enrolled in *anganwadi* of T-Narasipura taluk. Out of the 500 *anganwadi* children, 226 (45.2%) were males and 274 (54.8%) were females (Table 1). The number of children in *anganwadi* in 3–4 years, 4.1–5 years, and 5.1–6 years age groups was 265 (53.0%), 173 (34.6%), and 62 (12.4%), respectively (Table 2).

With respect to BMI-for-age (Table 3), it was found that a maximum number of subjects were of normal category: 283 (56.6%). A total of 207 (41.4%) were categorized as underweight, 3 (0.6%) were at risk of overweight, and 7 (1.4%) were overweight.

Table 4 shows distribution of children according to age and BMI. In 3–4 years, 90 (34%) were underweight, 167 (63%) were normal, 2 (0.8%) were at risk of overweight, and 6 (2.3%) were overweight. In 4.1–5 years, 85 (49.1%) were underweight, 86 (49.7%) were normal, 1 (0.6%) were at risk of overweight, and 1 (0.6%) were overweight. In 5.1–6 years, 32 (51.6%) were underweight, 30 (48.8%) were normal, and no children were in category of risk of overweight and

Table 1: Distribution of children according to gender

Gender	*Number of children*	*Percentage*
Female	274	54.8
Male	226	45.2
Total	500	100

Table 2: Distribution of children according to age

Age in years	*Number of children*	*Percentage*
3–4	265	53.0
4.1–5	173	34.6
5.1–6	62	12.4
Total	500	100.0

Table 3: Distribution of children according to BMI-for-age

BMI classification	*Number of children*	*Percentage*
Underweight	207	41.4
Normal	283	56.6
Risk of overweight	3	0.6
Overweight	7	1.4
Total	500	100

BMI, body mass index

overweight. Body mass index category is significantly associated with age with $p < 0.001$.

Table 5 shows distribution of children according to gender and BMI. Out of 226 males, 85 (37.6%) were underweight, 135 (59.7%) were normal, 1 (0.4%) were at risk of overweight, and 5 (2.2%) were overweight. Out of 274 females, 122 (44.5%) were underweight, 148 (54%) were normal, 2 (0.7%) were at risk of overweight, and 2 (0.7%) were overweight. Body mass index category is not statistically associated with gender with $p = 0.235$.

Table 6 shows the prevalence of dental caries of 61%. In total, 195 (39%) children were without dental caries, 1–5 teeth were affected in 193 (38.6%) children, 6–10 teeth were affected in 87 (17.4%) children, and 11–20 teeth were affected in 25 (5%) children. Mean deft of subject in the study group was 2.82 ± 3.46 standard deviation (SD).

Table 7 shows the prevalence of dental caries according to age group. In 3–4 years, 4.1–5 years, and 5.1–6 years, the prevalence of dental caries was 147 (55.4%), 112 (64.7%), and 46 (74.1%), respectively. The mean deft score showed an increasing trend with age; this difference was statistically significant with $p = 0.021$.

Dental caries experience in relation to gender is revealed in Table 8. Statistically significant difference was found in caries experience between boys and girls ($p = 0.035$), but the deft score was higher among females 179 (65.3%) than males 126 (55.7%).

Table 9 shows that a strong association between caries prevalence was seen in all the subjects suffering from malnutrition. Higher caries prevalence was seen in underweight category with deft scores of 142 (68.6%). Dental caries is significantly associated with BMI category with $p = 0.050$.

Table 4: Distribution of BMI-for-age according to age groups

	Age in years		
BMI-for-age	*3–4*	*4.1–5*	*5.1–6*
Underweight	90 (34%)	85 (49.1%)	32 (51.6%)*
Normal	167 (63%)	86 (49.7%)	30 (48.8%)
Risk of overweight	2 (0.8%)	1 (0.6%)	0 (0%)
Overweight	6 (2.3%)	1 (0.6%)	0 (0%)
Total	265 (100%)	173 (100%)	62 (100%)

BMI category is significantly associated with age with *$p < 0.001$
BMI, body mass index

Table 5: Distribution of BMI-for-age according to gender

	Gender	
BMI-for-age	*Female*	*Male*
Underweight	122 (44.5%)	85 (37.6%)
Normal	148 (54%)	135 (59.7%)
Risk of overweight	2 (0.7%)	1 (0.4%)
Overweight	20 (0.7%)	5 (2.2%)
Total	274 (100%)	226 (100%)

BMI category is not statistically associated with gender with $p = 0.235$
BMI, body mass index

Table 6: Distribution of dental caries

Number of teeth affected with dental caries (def)	*Number of children*	*Percentage*
Nil	195	39.0
1–5	193	38.6
6–10	87	17.4
11–20	25	5.0
Total	500	100.0

Mean ± SD: 2.82 ± 3.46
SD, standard deviation

Discussion

Malnutrition increases susceptibility to infections while an infection aggravates malnutrition by decreasing appetite, inducing catabolism, and increasing demand for nutrients. The increased susceptibility to infections may be caused by the impairment of immune function due to malnutrition.[14] Malnutrition and infections are the two most important factors that affect the growth of children.

The magnitude of the problem of malnutrition among children under 5 years of age is high throughout India. About 2.3 crores children in India, up to 6 years of age, are suffering from malnourishment and are underweight. Forty-eight percentage of Indian children under 5 years of age are stunted due to chronic undernutrition and 20% of children suffer from wasting due to acute undernutrition. In Karnataka, the prevalence of underweight, stunting, and wasting was estimated to be 43.9%, 36.6%, and 20%, respectively (NFHS-3).[3]

Government of India has implemented ICDS program to curb malnutrition. This program provides six services, namely, *anganwadi* supplementary nutrition, preschool education, immunization, health checkup, referral services, and nutrition and health education. In Karnataka, this program was first introduced in T-Narasipura taluk, Mysore district.

The people of T-Narasipura taluk are not much exposed to urbanization. They do not encourage the dilution of their native culture. Thus, people shifting or moving to this place are very

Table 7: Distribution of dental caries according to age

Dental caries (def)	*Age in years*		
	3–4	*4.1–5*	*5.1–6*
With dental caries	147 (55.4%)	112 (64.7%)	46 (74.1%)*
Total	265 (100%)	173 (100%)	62 (100%)

Dental caries is significantly associated with age in years with $p = 0.021$*

Table 8: Distribution of dental caries according to gender

	Gender	
Dental caries (def)	*Female*	*Male*
With dental caries	179 (65.3%)*	126 (55.7%)
Total	274 (100%)	226 (100%)

Dental caries is significantly associated with gender with $p = 0.035$*

Table 9: Relationship of BMI-for-age with dental caries

	BMI-for-age			
Dental caries (def)	*Underweight*	*Normal*	*Risk of overweight*	*Overweight*
With dental caries	142 (68.6%)*	158 (55.8%)	2 (66.7%)	3 (42.9%)
Total	207 (100%)	283 (100%)	3 (100%)	7 (100%)

Dental caries is significantly associated with BMI category with $p = 0.050$*
BMI, body mass index

limited. The diet of this population is still native and stable in nature unlike the diet of children in cities or other districts. Although ICDS program was first introduced in T-Narasipura, malnourishment continues to be an issue of concern in this place.

Preschool children form the most vulnerable segment of any community. More than 30% of children under 5 years of age are malnourished. Undernutrition is the most common cause of death in this age group in India. The major issue was the deaths associated with malnutrition that occur in children who are marginally malnourished. Their nutritional status is a sensitive indicator of their health. Hence, children aged 3–6 years from T-Narasipura were selected for assessment of their nutritional status.

Malnutrition appears to have multiple effects on the oral tissues and subsequent development of oral disease. It results in altered tissue homeostasis, reduced resistance to microbial biofilms, and tissue repair capacity. Malnutrition is associated with enamel hypoplasia, dental caries, and salivary gland changes. Change in the salivary characteristics reduces the defense mechanism of saliva and its ability to buffer the plaque acids.

Reliable data on general and oral health of malnourished children are a prerequisite for monitoring and improving their growth and development. However, there are a paucity of studies on nutrition and oral health status of children. Hence, this prevalence study was undertaken to assess the nutritional and dental caries status of 3–6-year-old children belonging to T-Narasipura taluk, Mysore district.

Status of malnutrition in children is widely estimated using anthropometric methods such as WHO, Indian Academy of Pediatrics (IAP) standards, BMI, mid upper arm circumference (MUAC), weight for age, and height for age. Assessment of nutritional status provides information on growth and body composition. Obtaining such data is important for evaluating underweight, stunting, wasting, or overweight associated with increased risk for adverse health outcomes.[14]

Height, weight, or height and weight of a child is considered in all the indices used to estimate the status of malnutrition. Height and weight of healthy children vary in different parts of the world, due to varied ethnicity and cultural background. Centile charts have been developed to represent height and weight in a standard format. These centile charts represent the average population of children from specific areas along with SDs. Charts brought out by CDC and NCHS are examples of such charts used worldwide.[15]

Body mass index is the ratio of an individual's weight to height in kilogram per meter square (kg/m^2) and is used to estimate a person's risk of weight-related health problems. It is often used to assess weight status, because it is relatively easy to measure and correlate with body fat. Studies have shown that BMI is one of the best methods to assess malnutrition.[16–18] Hence, BMI was used in our study to assess the malnutrition status.

Assessment of nutritional status showed 41.4% of children to be underweight in this study. A higher prevalence of malnutrition was reported from Kancheepuram district (50%) of Tamil Nadu and Aligarh district (56.4%) of Uttar Pradesh.[19]

A lower prevalence of malnutrition of 27% and 33% was observed in Faridabad[20] and Allahabad district, respectively. National Family Health Survey-3 also reported an overall prevalence of 43.9% underweight children in Karnataka.[3] A higher prevalence of 60.4% of underweight children was reported in a tribal population from Mysore district.[21]

In this study, there was difference in the nutritional status between male and female children. In the Indian scenario, particularly in the rural areas, preference is still given to a male child. Providing better quality of food and healthcare facilities preferable to male children increases the possibility of malnutrition among female children. However, a contradictory study reported higher prevalence of underweight males than females.

In this study, the prevalence of dental caries was 61%. This 61% completely composed of decayed component without any filled or missing component of deft. Shakya et al. also reported a high prevalence of dental caries (70%) in malnourished children.[22] A systematic review by Hooley et al. highlighted the inverse relationship between dental caries and BMI from studies done in developing countries.[23]

It has been suggested that early malnutrition may produce defects in teeth during the period of tooth development so that they are more susceptible to subsequent dental caries after eruption. The important point is that there was no single tooth with filling and all deft was due to untreated decayed tooth which tells about the unmeet dental treatment needs in this area. This was similar to study conducted in Bengaluru where the prevalence was 37.3%. Very few studies in India have shown the prevalence of caries below 40%.[24]

The high prevalence of dental caries could be due to low literacy rates, especially among mothers, no access to dental care, nonfluoride exposure, lack of balanced diet, and low-calorie diet, and above all lack of awareness about proper oral hygiene measures.

This study showed that the prevalence was increased as the age increases, which was similar to some caries prevalence studies.[24–26] Studies have shown a higher prevalence of dental caries among females than males,[25,26] which has not been significant but this study showed that dental caries was more in females than males and was significant.

To reduce the high caries burden in this population, prevention and intervention should be initiated at the earliest. Regular oral hygiene aids along with remineralizing agents should be provided free of cost or at subsidized prices so that hypoplastic teeth do not progress to dental caries. It is evident from this study that malnourished children are prone to compromised oral health. Community-based oral preventive measures should be taken to reduce the oral health problems in these children. Oral health education should be given to the mothers on feeding and dietary practices. Both parents and children should be made aware of oral hygiene measures and continuous reinforcement should be carried out at regular intervals. Motivation of *anganwadi* workers is necessary to explain the oral health-related problems through nonconventional ways such as short plays, videos, and games. Establishment of dental home is utmost important in these children, so that their unmet dental caries needs can be treated.

Due to constraints of time, cost, and facility, the present cross-sectional study was restricted to clinical examination and anthropometric measurements. Further longitudinal studies on nutritional status and oral health of children need to be carried out along with implementation of health promotion programs.

Conclusion

Low BMI-for-age is a risk factor for dental caries. The high prevalence of dental caries among *anganwadi* children could be due to the lack of balance diet and low-calorie diet, nonfluoride exposure, and

above all lack of awareness about proper oral hygiene measures because of low literacy rates, especially among parents.

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