Association of Age Specific Body Mass Index, Dental Caries and Socioeconomic Status of Children and Adolescents

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Aims and Objectives: *The purpose of this study was to determine the association of BMI-for-age with dental caries and socioeconomic status.* ***Method:*** *A random sample of 2033 school going children aged 6-15 years were selected from ten different schools located in the south of Bangalore city. Height and weight of each child was recorded to obtain BMI-for-age. The socioeconomic status (SES) was assessed based on educational status, profession and annual income of parents. Dental caries was recorded according to WHO criteria. A diet recording sheet was given to each child to record his/her dietary intake of the four basic food groups and snacks for 5 consecutive days including one weekend day. The data obtained was subjected to statistical analysis.* ***Results:*** *The results showed that a higher number of children who were overweight and at a risk of overweight were seen in the upper SES and both showed a higher mean dietary intake of all the four food groups and snacks. The mean deft score was significantly higher in underweight children. A significantly higher mean DMFT score was observed in children at risk of overweight and overweight children.* ***Conclusions:*** *Children from the upper classes consumed more food, including snacks and were either at a risk of overweight or overweight. They had more caries in their permanent dentition. Underweight children were seen in the lower class. Although their intake of snacks was less, they had higher caries in their primary dentition.*

Keywords: *BMI-for-age, dental caries, dietary intake, socioeconomic status.*
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INTRODUCTION

Childhood obesity and overweight children are now a major public health concern all over the world. The prevalence of childhood obesity has been steadily increasing over the past several decades. In developing countries, changing lifestyles and economic growth have contributed to decreased physical activity and altered eating patterns. This is more evident in children and adolescents living in cities.[1]

The most commonly used index of obesity and over weight is BMI.[2] Children's growth should be monitored using the Body Mass Index (BMI) and risk factors assessed through a dietary and physical activity history. The increase in obesity is attributed to increased carbohydrate consumption among children. Obesity and caries are diet related with the common causative factor being excessive and frequent ingestion of fermentable carbohydrates. Oral health is strongly influenced by the intake of sugar-rich foods and high dental decay scores are associated with unbalanced dietary patterns.[3]

Given the causative relation between refined carbohydrates and dental caries and also the link between dietary intake and increase in weight, it is appropriate to hypothesize that being overweight might also be a marker for dental caries in children and teenagers.[4] One of the principal predictors of BMI and dental health is socioeconomic status(SES).[5]

While obesity as a global epidemic is described in adult populations, not much data is available regarding prevalence of obesity/overweight among children or adolescents in developing countries. There is limited data available in India regarding the association between Body Mass Index-for-age and oral health outcomes. Thus, the present study was conducted to determine the association between Body Mass Index, dental caries and socio-economic status.

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MATERIALS AND METHODS

The present study was conducted on a random sample of 2033 boys and girls, aged 6-15 years. The children were selected from schools located in the south of Bangalore City, Karnataka.

Exclusion criteria:

1. Children with handicapping conditions including medically compromised subjects
2. Children on long term medication and
3. Children undergoing orthodontic treatment were excluded from the study population.

A proforma was used to record children's demographic details and the educational qualification, profession and annual income of parents. Information on educational status, profession and parental annual income was provided by the parents. The socioeconomic status (SES) was assessed according to Kuppuswamy scale.[6]

In order to obtain BMI-for-age, the height and weight of each child was recorded. The weight of each child without footwear was measured to the nearest 0.1kg, using a portable glass electronic scale. The height was measured to the nearest 0.5cm, using a portable height measuring unit.[7] Body Mass Index (BMI) was calculated using the following formula i.e. weight in kilograms divided by height in meter square (weight/height^2).[8] The number obtained was plotted for age and gender specific percentile curves on Centre of Disease Control 2000 growth charts.[3]

Based on these percentile curves, the children were grouped according to the following categories:

1. *Underweight*: BMI-for-age less than the fifth percentile
2. *Normal*: BMI-for-age greater than or equal to the fifth percentile and less than the 85th percentile
3. *Risk of overweight*: BMI-for-age, greater than or equal to the 85th percentile and less than the 95th percentile and
4. *Overweight*: BMI-for-age greater than the 95th percentile.

Dental caries was recorded according to WHO criteria.[9] For this purpose, children were seated upright on a chair and were examined in adequate natural day light so as to receive maximum illumination. The CPI probe was used to confirm visual evidence of caries on the occlusal, buccal and lingual surfaces. Training and calibration for examination of dental caries was carried out in our department. Examination of the child was done by only one examiner in order to avoid interexaminer variability. Caries was recorded by another dentist sitting besides the examiner, so that the codes given by the examiner could be easily heard. Ten percent of children were examined twice for intra-examiner reliability. The kappa value for intra-examiner agreement of the tooth status was 0.88.

A diet recording sheet was given to each child to record his/her dietary intake for 5 consecutive days, including one weekend day.[4] Diet recording sheet was presented both in English and local language for easy understanding and convenience of the children and parents. From the data obtained, the mean daily dietary intake of each of the four basic food groups and snacks was calculated.

The data obtained was tabulated and subjected to statistical analysis using Chi-square test, Fischer exact test and multiple linear regression method. Multivariate regression analysis was carried out to find the significant correlation of independents with caries.

RESULTS

Among the 2033 children examined, 1021 (50.2%) were males and 1012 (49.8%) were females. A higher percentage of underweight children (54%) belonged to the lower class, whereas higher percentages of risk of overweight (13.9%) and overweight children (9.2%) were observed in upper middle and upper classes, respectively (Table 1). Among all the children, those in the upper middle class and upper class were observed to have a highly significant ($p \leq 0.01$) mean daily intake of all the food groups and snacks (Table II and IIa). Risk of overweight children and overweight children were observed to have a significantly higher mean daily dietary intake than that of underweight children ($p \leq 0.01$). Except for vegetables and fruits, the mean daily dietary intake of all other food groups was significantly higher ($p \leq 0.01$) in children at risk of overweight and overweight children (Table III and IIIa). The mean deft score was highest

Table I. Comparison of BMI-for-age with socioeconomic status

BMI for age	SOCIOECONOMIC STATUS			
	Lower class (N= 1162) n (%)	Lower middle class (N=528) n (%)	Upper middle class (N=223) n (%)	Upper class (N=120) n (%)
Under weight	627(54%)	118 (22.3%)	45(20.2%)	22(18.3%)
Normal	511 (44%)	342 (64.8%)	134(60.1%)	76 (63.3%)
Risk of overweight	17 (1.4%)	41 (7.8%)	31 (13.9%)	11 (9.2%)
Overweight	7(0.6%)	27 (5.1%)	13 (5.8%)	11 (9.2%)

Table II. Mean daily dietary intake according to socioeconomic status

Socio-Economic Status	Meat, Meat Products & Poultry	Milk & Milk Products	Veg & Fruits	Cereals & Pulses	Snacks, Sweets & Confectionary Pdts
Lower class	0.31±0.34	1.19±0.53	0.75±0.61	1.86±0.99	0.99±0.58
Lower Middle	0.45±0.49	1.46±0.69	0.94±0.76	2.42±1.05	1.78±0.78
Upper middle	0.56±0.81	2.01±1.98	1.32±2.21	2.98±1.18	2.66±1.14
Upper class	0.54±0.75	2.09±1.18	1.50±1.12	3.49±1.87	3.77±2.12

Table IIa. Comparison of mean daily dietary intake between classes of socioeconomic status

Pair	Meat, Meat Products & Poultry	Milk & Milk Products	Veg & Fruits	Cereals & Pulses	Snacks, Sweets & Confectionary Pdts
Lower class vs. Lower middle	<0.001**	<0.001**	0.002**	<0.001**	<0.001**
Lower class vs. Upper middle	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**
Lower class vs. Upper class	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**
Lower middle vs. Upper middle	0.029	<0.001**	<0.001**	<0.001**	<0.001**
Lower middle vs. Upper class	0.212	<0.001**	<0.001**	<0.001**	<0.001**
Upper middle vs. Upper class	0.996	<0.001**	0.339	<0.001**	<0.001**

p≤0.01** = is highly significant

Table III. Mean daily dietary intake according to BMI-for-age

BMI-for-age	Meat, Meat Products & Poultry	Milk & Milk Products	Veg & Fruits	Cereals & Pulses	Snacks, Sweets & Confectionary Pdts
Under-weight	0.32±0.37	1.24±0.64	0.82±0.76	1.89±1.17	1.22±0.94
Normal	0.38±0.46	1.45±0.74	0.94±1.17	2.34±1.09	1.67±1.19
Risk of over weight	0.76±1.06	2.01±2.81	1.24±0.85	3.06±1.33	2.21±1.41
Over-weight	0.58±0.77	1.76±0.98	1.16±1.24	3.23±1.81	2.52±1.71

Table IIIa. Comparison of mean daily dietary intake between BMI-for-age groups

Pair	Meat, Meat Products & Poultry	Milk & Milk Products	Veg & Fruits	Cereals & Pulses	Snacks, Sweets & Confectionary Pdts
Underweight vs. Normal	0.018	<0.001**	0.054	<0.001**	<0.001**
Underweight vs. Risk of over weight	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**
Under weight vs. Over weight	0.001**	<0.001**	0.130	<0.001**	<0.001**
Normal vs. Risk of over-weight	0.001**	<0.001**	0.019	<0.001**	<0.001**
Normal vs. Over weight	0.022	0.072	0.552	<0.001**	<0.001**
Risk of over-weight vs. Overweight	0.106	0.384	0.867	0.828	0.345

p≤0.01** = is highly significant

(1.29) in underweight children which was highly significant compared to that of children with normal BMI-for-age (0.89). The DMFT scores of children at risk of overweight (1.36) as well as of overweight children (1.26) were significantly higher when compared to that of underweight children (0.6) ($p \leq 0.01$) (Table IV and IVa). Almost 43% of children from the lower class had caries in their primary dentition, whereas 40% of children from the upper class had caries in their permanent dentition (Table V). A multivariate regression analysis showed a significant relationship between caries and certain independent variables of BMI-for-age, socioeconomic status and dietary intake (Table VI).

Table IV. Caries score according to BMI-for-age

BMI-for- age	deft score	DMFT score
	Mean ±SD	Mean ±SD
Underweight	1.29±1.89	0.62±1.17
Normal	0.89±1.47	0.72±1.37
Risk of over weight	0.82±1.21	1.36±1.89
Overweight	1.21±1.55	1.26±1.38

Table IVa. Comparison of caries score according to BMI-for-age groups

Pair	deft score	DMFT score
Underweight – Normal	<0.001**	0.443
Underweight – Risk of overweight	0.031	<0.001**
Underweight – Overweight	0.976	0.002**
Normal – Risk of overweight	0.974	<0.001**
Normal – Overweight	0.494	0.013
Risk of overweight – Overweight	0.486	0.967

p, ≤ 0.01**= is highly significant

Table V. Percentage of children affected with caries according to Socioeconomic status

SES status (No. of children)	Total no. of children affected with caries n (%)	Caries in primary dentition n (%)	Caries in permanent dentition n (%)
Lower class (1162)	843 (72.5)	498 (42.9)	345 (29.7)
Lower middle (528)	389 (73.7)	184 (34.8)	205 (38.8)
Upper middle (223)	164 (73.5)	89 (39.9)	75 (33.6)
Upper class (120)	93 (77.5)	45 (37.5)	48 (40.0)

Table VI. Relationship of caries with BMI-for-age socioeconomic status and dietary intake

Independents	B co-efficient	SE	Beta	P value
Normal	Referent			
Underweight	0.28	0.10	0.07	0.003**
Risk of overweight	0.56	0.21	0.06	0.008**
Overweight	0.74	0.27	0.06	0.006**
Lower class	Referent			
Lower middle	0.10	0.11	0.03	0.371
Upper middle	-0.08	0.16	-0.01	0.611
Upper class	0.26	0.22	0.03	0.246
Meat, Meat products & Poultry	0.24	0.09	0.06	0.010**
Milk & Milk products	0.07	0.05	0.04	0.147
Veg & Fruits	-0.10	0.05	-0.05	0.033*
Cereals & Pulses	-0.21	0.05	-0.13	<0.001**
Snacks & confectionary pdts	0.11	0.06	0.07	0.05*

$0.01<P \leq 0.05$* = is moderately significant,
$P \leq 0.01$** = is highly significant

DISCUSSION

Despite the escalating problem of obesity, underweight also remains a major problem in the developing countries.[10] Overweight and underweight both exhibit the cumulative environmental effects of dietary factors, which could also be responsible for the higher rates of dental caries in these children.

In this study, a wide age group of children were selected because as individuals grow, their dietary needs and habits are constantly change. Also, the amount of body fat in boys and girls changes with age representing a dynamic phase in the growth and development of a child. The gender differences in the amount of body fat is due to differences in the growth milestones, body structure and hormonal effects. The CDC BMI-for-age growth charts which are separate for boys and girls take into account these differences and allow the translation of a BMI number into a percentile for a child's sex and age. Percentiles are the most commonly used indicators to assess the size and growth patterns of individual children.[11]

The WHO has estimated that the prevalence of overweight school going children for Asia Pacific region is approximately 4.1%.[12] Studies done on school children in North India found the prevalence of overweight to be 14.2% and obesity to be 7.8%.[13] In our study, 4.9% of children were at a risk of overweight and 2.9% children were overweight. Various surveys have emphasized the prevalence of underweight children to be higher in rural areas. However, it is interesting to observe that nearly 40% of children in our study were underweight, although they were living in the city.

Determination of social class is complicated. SES encompasses income, education, social, family and cultural beliefs. The Kuppuswamy scale followed in this study is a widely used and accepted scale to assess SES in Indian populations.[6] A child's economic background has also been shown to influence the probability of seeking dental care.[14] The relationship between overweight and SES varies across countries. Children from a higher SES were more likely to be obese in India, China and Russia.[15] Similarly, a higher percentage of underweight children (54%) in our study belonged to the lower SES. Whereas, a higher percentage of risk of overweight (13.9%) and overweight (9.2%) children belonged to upper middle and upper classes, respectively. However, in the United States low SES is associated with overweight children.

In developing countries such as India, few important changes have occurred with improvements in SES. These changes relate to improved capacity to purchase, flexibility in the choice of diet and activity pattern.[16] Nutritional transition in India has shown substitution of coarse grains by the more prestigious and often highly polished cereals. There is also a progressive increase in the intake of edible fat, sugar and sweets.[12] This is evident in our study, where in the mean daily intake of all food groups and snacks was observed to be higher in children belonging to the upper middle and upper classes. However several developed countries show socioeconomic gradient in diet, wherein, persons in higher socioeconomic strata tend to follow healthier diets, characterized by greater consumption of fruits, vegetables and low-fat milk, with a lesser consumption of fats.[17]

BMI-for-age of an individual is influenced by daily dietary intake. In our study, besides cereals and pulses, all the children were observed to consume more snacks when compared to other food groups. However underweight children showed a significantly less intake of cereals and pulses when compared to other children. This could be a major contributing factor to their lower body weight. Whereas, overweight children and those at risk of overweight consumed more of cereals, pulses and snacks. In many Indian homes, traditional food preparations are being gradually replaced by 'ready to eat' products like highly refined cereals and bakery products. Foods eaten at fast food restaurants have huge portion sizes and are low on healthful foods such as fruits, vegetables and dairy products. This is particularly evident in cosmopolitan cities such as Bangalore, where both parents are employed. Due to the lack of time, they are compelled to consume/rely on 'fast foods,' most of which are rich in carbohydrates.

Both childhood obesity and dental decay are multifactorial in nature and result from complex interactions among these factors. Caries in the primary dentition was significantly higher in underweight children and children belonging to lower SES. These findings suggest that the relationship between BMI and dental caries in children is far more complex than can be explained by carbohydrate consumption alone.[3] Studies have suggested that caries in the primary dentition is associated with under nutrition during early childhood. Nutrients such as vitamins A and D, calcium and phosphorus have an effect on the gross and microscopic morphology, chemical composition and tooth eruption

patterns.[18] These factors in turn determine the susceptibility of a tooth to dental caries. Also, we found the milk consumption of underweight children to be low. Teeth appear to have a biological priority over bone when calcium is limited in the diet. Moreover, dental treatment may not be accessible to all children from lower class families.

Caries in permanent dentition was significantly higher in children with increased BMI-for-age. Caries is higher in overweight children due to increased intake and prolonged exposure to carbohydrates in various dietary forms.[7]

Indian studies,[19,20] primarily cross-sectional surveys that have assessed the association between SES and caries present conflicting reports. While Sogi and Bhaskar,[20] found children in the low SES to have more caries; another study reported of a higher caries prevalence in children belonging to the upper classes.[19] In our study, a higher number of children from the lower class were underweight. Their intake of vegetables, fruits, milk and milk products was low. Poor nutrition combined with an unbalanced diet during the formative years could be a contributing factor to increased caries in the primary dentition. With increasing age, children become more independent in their choices of food. Caries in the permanent dentition was higher in upper class, probably because these children were seen to consume more snacks. They have an easier access to money and are generally indulged. Changes in lifestyle including frequent consumption of aereated drinks, carbohydrate-rich foods and unsupervised oral hygiene practices may make them more susceptible to caries.

Further studies on the association of BMI with factors such as sugar exposure, glycemic index of diets particularly that of carbohydrates are essential. The role of pediatric dentists in diet counseling is important as it influences both BMI and dental health.

CONCLUSION

1. The number of overweight children and those at a risk of overweight were higher in the upper SES. A higher number of children from lower SES were underweight.
2. Children belonging to upper middle and upper SES showed a higher mean dietary intake of all the four food groups and snacks.
3. The mean daily dietary intake of all the four food groups and snacks was observed to be higher in children who were overweight and at risk of overweight.
4. The mean deft score was significantly higher in underweight children. A significantly higher mean DMFT score was observed in children at risk of overweight and in overweight children.
5. The percentage of children affected with caries was higher in the upper SES.

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