Relationship between Severe Early Childhood Caries and Body Mass Index

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Aim: *This study was undertaken to evaluate the relationship between Severe Early Childhood Caries (S-ECC) and Body Mass Index (BMI) in the absence of any underlying medical condition for the school going (3 to 6 years old) children of Mathura city, India.* ***Method:*** *One hundred caries free children (50 boys and 50 girls) and one hundred children (50 boys and 50 girls) affected with S-ECC in the age range of 3-6 years without any contributing medical history were included in the study. Measurements of the weight (kg) and height (m) were done using a standard balanced beam scale and stadiometer. The BMI (kg/m^2) was determined and the body weight status was evaluated using CDC based classification for each child. Independent t-test was used to evaluate whether the weight, height and BMI of S-ECC children is significantly different from caries free children.* ***Result:*** *Although the weight of the S-ECC children is more when compared to the normal children, the difference is not statistically significant. However, the mean BMI of S-ECC children is more when compared to the caries free children which was found to be statistically significant at $p<0.05$. The body weight status of the Normal and S-ECC affected children based on the CDC classification revealed that 48% have been classified in underweight category and 43% in normal weight category and very few children are found to be at risk of overweight and overweight.* ***Conclusions:*** *A positive correlation between the BMI and S-ECC was observed in this study. 51% of caries free children and 45% of S-ECC children were classified in underweight category based on CDC classification.*

Keywords: *Severe Early Childhood Caries, Body Mass Index, Body weight status, Underweight, Overweight*

INTRODUCTION

The emphasis of dental research has shifted from the etiology of dental diseases to how dental diseases affect the general health. Despite the changes in the emphasis, the growing evidence on the probable effects of untreated dental caries on the growth and the health of a child has been ignored.[1-4] The American Academy of Pediatric Dentistry (AAPD) recognizes Early Childhood Caries (ECC) as a significant public health problem. ECC has been defined as "the presence of one or more decayed (cavitated or non cavitated), missing (due to caries), or filled tooth surfaces in any primary tooth in a child seventy one month of age or younger. In the children younger than three years of age, any sign of smooth-surface caries is indicative of severe early childhood caries (S-ECC). From the ages 3 through 5, 1 or more cavitated, missing (due to caries), or filled smooth surfaces in primary maxillary anterior teeth or a decayed, missing, or filled score of ≥4 (age 3), ≥5 (age 4), or ≥6 (age 5) surfaces constitutes S-ECC.[5]

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If a common condition, such as untreated severe dental caries does affect the growth and well being of millions of young children, then dental intervention to eradicate dental pain and pulpitis is an important way to enhance the growth and well-being in such children. Under nutrition is the result of insufficient food intake, repeated infectious diseases and lack of care. It stunts children's growth and development and, in girls, their later ability to bear healthy children.[6] Severe dental decay can also be a contributing etiological factor in Failure to Thrive (FTT). By definition, FTT consists of: 1. Weight or height below the third percentile for age; 2. Weight less than 80% of ideal weight for age; 3. Failure to maintain a previously established growth pattern; and /or 4. Growth failure of unknown origin.[7] Oral pain and discomfort, on the other hand, can reduce the nutritional and fluid intake to dangerous levels. Alverez *et al* [8] revealed that children with chronic malnutrition and stunted growth have higher caries prevalence, suggesting a relationship to FTT.

The physical growth measurements are convenient criteria for evaluating the physical development in the early years of a growing child. Hence, the measurement of height and weight are basic procedures in pediatric clinical practice being particularly useful for monitoring the growth of individual children during the first six years of life.[9] Body weight of a population can be viewed as a continuum from underweight to obesity. Deviation from the normal weight results from an imbalance between the caloric consumption and energy expenditure. Both underweight/malnutrition and overweight/obesity have significant adverse implications on the health of an individual.[10] An accepted method to evaluate an individual's body weight relative to population norms is through the calcula-

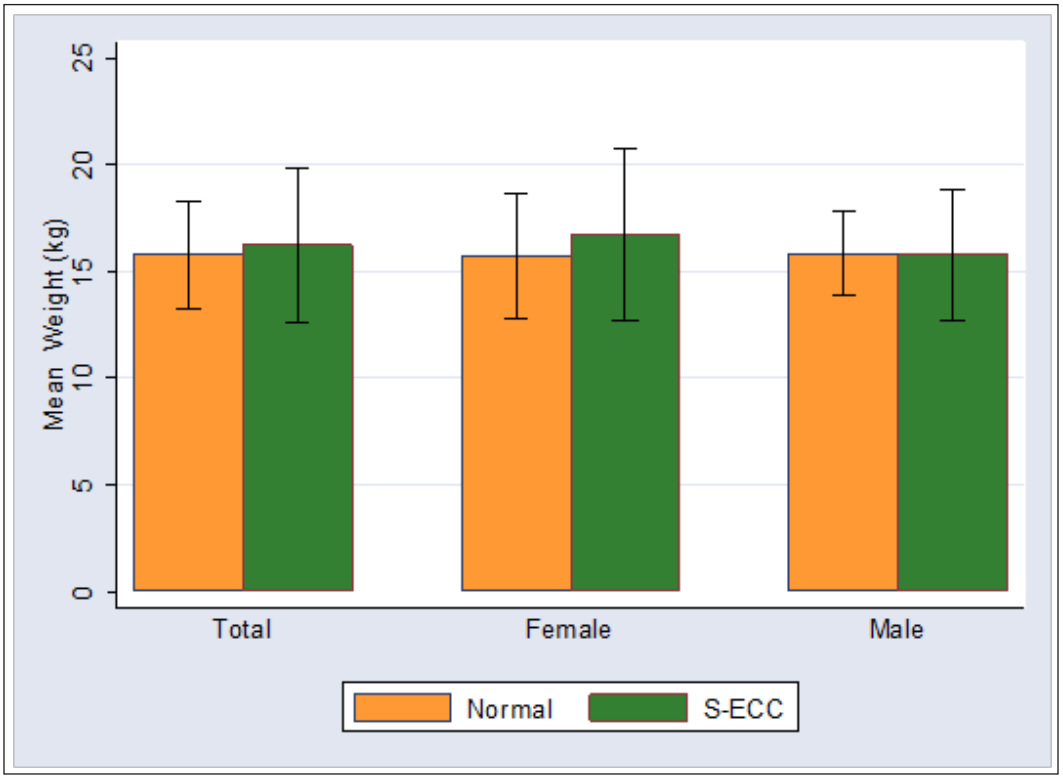

Diagram 1. Comparison of the mean weight between caries free and S-ECC affected children.

tion of body mass index (BMI) using the formula: BMI=weight in kilograms/height in square meters.[11] For 2 to 20 years old, BMI is combined with age and gender and expressed as a percentile.[12] The Centers for Disease Control and Prevention (CDC) use BMI percentiles to classify 2 to 20 year old children into 4 weight groups. Age-and-gender-specific BMI percentiles (AGS BMI) are categorized as: 1) under weight (<fifth percentile), 2) normal weight (fifth to 84th percentile), 3) at risk for overweight (>85th to 95th percentile) and 4) overweight (>95th percentile).[13]

Hence, this study was undertaken to evaluate the effect of the S-ECC on the general physical growth of the children, if any, by utilizing BMI as the criteria in the absence of any medical condition.

MATERIALS AND METHOD

This study was carried out in the Department of Pedodontics and Preventive Dentistry, K D Dental College and Hospital, Mathura as well in various schools of the Mathura city, India. Institutional Ethical Committee Clearance was obtained prior to the beginning of this study. An informed written consent was also obtained from the parents of the children who participated in the study.

Out of the total 2018 children examined, one hundred caries free children (50 boys and 50 girls) and one hundred children (50 boys and 50 girls) affected with Severe – Early Childhood Caries ((S-ECC)[5] ranging in the age between 3 to 6 years were included in this study using stratified sample method.[14] All the children underwent medical evaluation to expose any contributing medical conditions. To rule out the geographical variations, only those children who were residents of Mathura city were included in this study. The economic status of the children chosen in this study was above the Poverty Line (India) according to the eleventh five-year plan (2007-2012).[15]

A single trained, calibrated examiner (BW) performed a comprehensive clinical examination with the assistance of one recorder. The intra-oral hard tissue examination included the recording of the caries experience decayed, missing, or filled surfaces (defs)[16] index using sterilized mouth mirror and periodontal probe. The children were then divided into two groups, Group – 1: 100 children (50 boys and 50 girls) with defs=0 (caries free), Group – 2: 100 children (50 boys and 50 girls) affected with S-ECC according to AAPD[5] definition. Measurements of the weight (kg) and height (m) were done using a standard balanced beam scale (SAMSO, New Delhi, India) and stadiometer (SAMSO, New Delhi, India) respectively. The height was measured to the nearest 0.1cm and the weight was measured in kilograms to the nearest 100 grams. All the measurements were recorded with children wearing light clothing and without shoes. The BMI (kg/m^2) was calculated according to the Centers for Disease Control and Prevention (CDC) (USA)[12], formula: weight in kilograms (Kg) divided by height in meter square (m^2).

$$\text{BMI} = \frac{\textit{Weight in kilograms (kg)}}{\textit{Height meters (m)}^{\,2}}$$

All the children were categorized as 1) under weight (<fifth percentile), 2) normal weight (fifth to 84th percentile), 3) at risk for overweight (>85th to 95th percentile) and 4) overweight (>95th percentile) utilizing age and gender specific CDC BMI percentiles. The data thus obtained was analyzed using SPSS Software (Statistical Package for Social Science) version 11.5 for windows and independent t-test was used to evaluate whether the weight, height and BMI of S-ECC children is significantly different from caries free children. Similar comparisons were also made to evaluate

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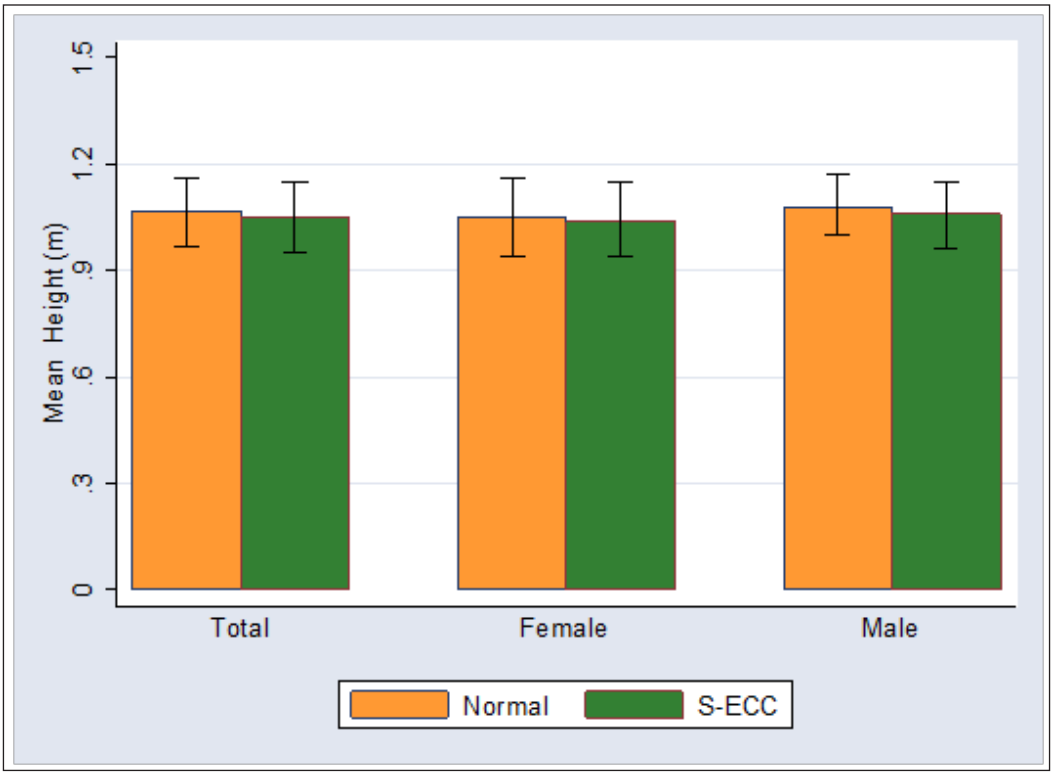

Diagram 2. Comparison of the mean height between caries free and S-ECC affected children.

gender variation and also among different age groups. Significance for all the statistical tests was pre-determined at $p<0.05$ (5%).

RESULTS

The comparison of the weight, height and BMI among the caries free and S-ECC children as well the gender variation are shown in Table 1, Bar diagrams 1, 2, 3 and Tables 2, 3 respectively.

Although the weight of the S-ECC children is more when compared to the caries free children but the difference is statistically not significant. However, the S-ECC children have higher BMI than the normal children which is statistically significant at $p<0.05$. No gender variation was observed except that S-ECC affected female children have higher BMI than the caries free counterpart and is statistically significant at $p<0.05$. Pie diagram 1, 2 and Table-4 shows the distribution of the caries free and S-ECC affected children according to their weight status based on CDC classification. For the caries free children 51% are underweight, 45% are normal, 1% at risk of overweight and 3% were observed to be overweight. In the S-ECC affected children 45% are underweight, 41% normal, 4% at risk of overweight and 10% were observed to be overweight. The age wise comparisons among 3, 4, 5 and 6 years are shown in Table 5 and were observed to be statistically not significant.

DISCUSSION

Some significant and important determinants of the quality of life include oral health and healthy teeth,[17] as abnormal oral changes and/or disorders can result in physical as well as psychological problems. There is some evidence that an impaired dentition can affect the individuals by causing dietary restrictions via difficulty in chewing, possibly compromising their nutritional status and well-being.[18,19] It is known that feeding problems have a great potential effect on the health status, because of which the dentition and oral mucosa are affected. Additionally loss of weight, hormone problems, thermoregulatory and electrolyte balances are broken down.[20] This study was conducted to correlate the effect of the S-ECC on the general physical growth of children, if any, by using the BMI in the absence of any medical conditions.

Race and ethnicity seem to influence children's oral health both directly and indirectly;[21-25] mixed results on the impact of race / ethnicity appear to stem from socioeconomic and demographic confounding. Height and weight expand our understanding of children's oral health, both individually and combined: shorter height[26] (as a proxy for inadequate nutrition) and lower birth weight[27] are both associated with higher DMFT risk; increased BMI in some studies has been linked with increased periodontitis also.[28] To rule out the geographical and racial variations, children who were residents of Mathura city were included in this study. The income also works both at the family and community levels in influencing health, both directly and indirectly. A higher income promotes improved living conditions, such as safe housing and ability to buy sufficient, healthy food. There is evidence of powerful biochemical and physiologic links between the individual socioeconomic experience for the economically disadvantaged children and adverse health events.[29] Hence the selection of the children above the Poverty Line and from the same socio-economic status in the study helped in eliminating the bias and the cause of nutritional deficiency due to poverty.

Linking the weight to oral health in children has been controversial. It is unclear if there is a correlation between dental caries and obesity, or they just coexist, since they have common etiologic factors such as diet and the socioeconomic status.[30] Owing to recent

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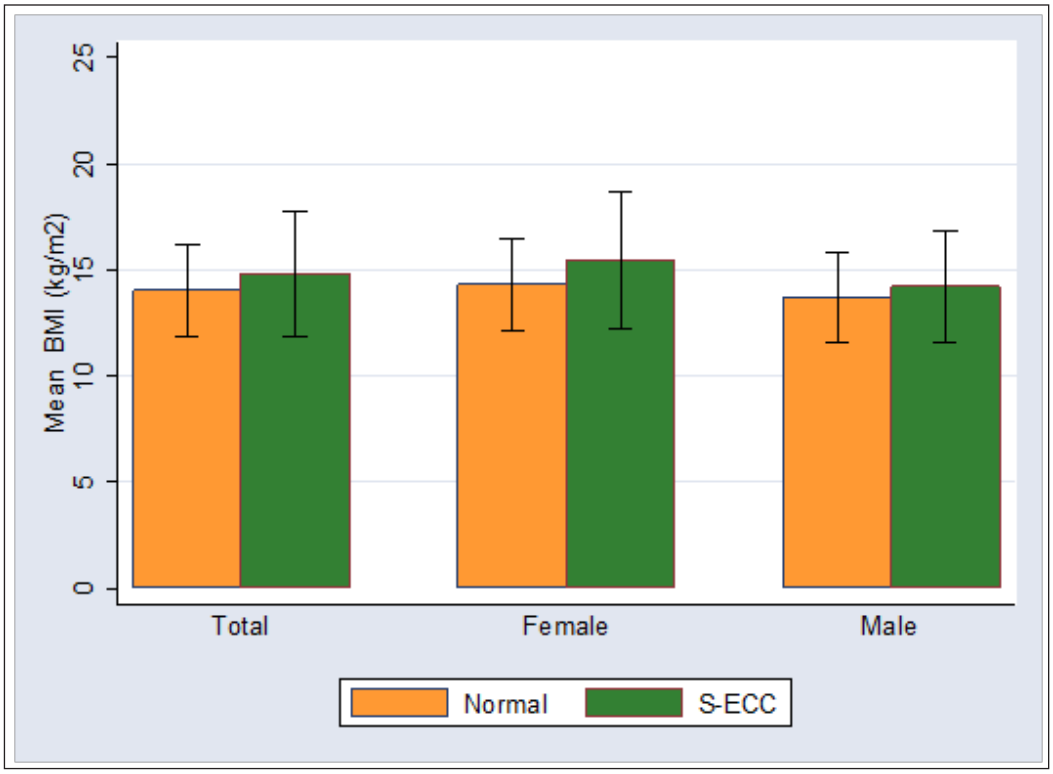

Diagram 3. Comparison of the mean BMI scores between caries free and S-ECC affected children.

increase in global prevalence of obesity, a plausible biological gradient between obesity and dental caries was proposed in the literature using diet as a common risk factor. A systematic review by Kantovitz *et al* [31] reported inconclusive results. Bimstein *et al* [32] also reviewed the relationships between childhood oral diseases and obesity. Some reports suggest a connection between caries and obesity while others do not, and it is unclear if they correlate. However, the deleterious effects of dental caries and obesity on the systemic condition are clear; they may potentiate each other, and facilitate the development and progress of chronic or acute systemic conditions.[32] Although some of the etiologic factors of dental caries and obesity may interrelate, others may just be common to both diseases: dental caries is a multi factorial infectious disease which can be affected by oral hygiene, diet composition and frequency, socioeconomic status, salivary immune globulins, bacterial load, and fluoride intake;[33,34] obesity is a disease in which diet energy intake exceeds the body energy requirements resulting in an excess in body fat.[35] One could expect that as the result of dietary habits, obese children will have a higher prevalence of dental caries when compared to the children who are with a normal or lower than normal weight. On the other hand, it may be possible that the children with severe caries have difficulty during eating and therefore, be under-weight.[36] Chen *et al*,[37] investigated the correlation between obesity and oral heath in a total of 5133 Chinese children at the age of 3 years. However, no significant correlation between the BMI and the df-t values could be found. Whelton *et al*,[38] conducted a study in Ireland in the years 2001 and 2002, the statistical data on carious lesions from 12- (n = 3823) and 15-year-old children (n = 3458) also found no correlation between the BMI and caries prevalence. Another study by Hong *et al* [39] and Alm *et al*,[40] showed no relationship between dental caries and body weight status at 3 years of age. Pinto *et al* [41] also found no correlation between the dental decay in the obese and non-obese children. Kopycka-Kedzierawski DT *et al*,[42] Showed a data from the Third National Health and Nutrition Examination Survey (NHANES III), (1988–1994) and National Health and Nutrition Examination Survey (NHANES) (1999–2002) providing no evidence to suggest that overweight children were at an increased risk for dental caries. Dye *et al*,[43] however found no relationship between the weight status and caries experience in the primary dentition of the US children 2-5 years of age. Tripathi *et al* [44] also assessed the association between obesity and dental caries by means of an anthropometric study using height/weight indices according to the BMI, WHO criteria and National Center for Health Statistics guidelines. The results showed no correlation between dental decay in obese and non-obese children. D'mello *et al* [45] determined whether deciduous dental caries experience was associated with BMI. They found no association between BMI and dental caries experience. Sadeghi *et al* [46] also reported no association between DMFT scores and BMI-for-age scores in 12 to 15 year old adolescent in Iran. The current study also observed similar outcome in which there is no effect of S-ECC on the body weight status since underweight is prevalent in both caries free as well as S-ECC children also. However, there exist a statistically higher BMI among these children compared to the caries free children.

Theoretically, obesity should be associated with dental caries, since obesity and caries are, in principle, caused by the same factors. Miller *et al*,[47] stated that the prevalence of dental caries has been correlated with carbohydrate around the teeth, and the prevalence of obesity has been associated with high calorie intake which probably implies a high carbohydrate intake, most dental workers

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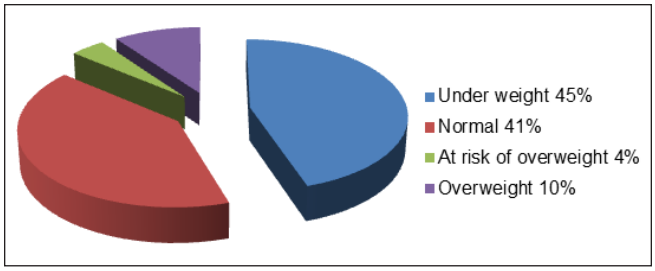
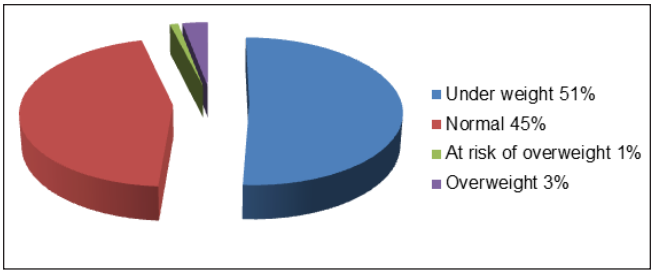


Pie diagram 1. Frequency distribution of the body weight status of caries free children based on CDC classification.



Pie diagram 2. Frequency distribution of the body weight status of S-ECC children based on CDC classification.

have consequently tended to presume that dental caries would be associated with overweight children. It has been demonstrated that children who consumed more soft drinks relative to milk and 100 percent fruit juice were at a greater risk of developing dental caries as they grew older.[48] Willershausen *et al*,[49] showed an association between an increase of dental caries and high weight in elementary school children. Hedge AM *et al*,[50] found that children with obesity and overweight had increased prevalence of dental caries in both the primary and permanent dentition as compared to the normal weight children, which was statistically significant. The current study also observed similar effects that the children affected with S-ECC weighed significantly more as compared to the normal caries free children. Children's dietary habits are a significant contributor to the childhood obesity and dental caries epidemics. Many children consume too much fat, saturated fats, sodium and insufficient amounts of fruits, vegetables and calcium. A key dietary factor associated with increased risk of caries; particularly in children is the duration of the exposure time that fermentable carbohydrates are in direct contact with dental plaque. Fruit drink and other beverages also represent high sugar sources, which may contribute to their cariogenic potential. Soft drink consumption has been associated with increased caloric intake, increased body weight, pediatric obesity and dental caries.[51] Honne *et al* [52] observed a significant association between overweight / obesity and caries experience among school children of Udupi District (India). Obesity and dental caries have common risk determinants and require a comprehensive multidisciplinary approach to pediatric patients by both medical and dental healthcare professionals. Trikaliotis *et al* [53] investigated the relationship between dental caries (dmfs) and BMI categories in 3-5.5 year old children in Thessaloniki, Greece. The overweight children were found to show statistically significant differences in dmfs values compared with both children of normal weight and those underweight. Vázquez-Nava *et al* [54] also observed obesity appears to be associated with dental caries in the primary dentition of preschool 4 to 5 year old Mexican children. It is difficult and complex to establish the mechanism by which obesity is associated with dental caries. One attractive hypothesis[55] is that the putative association between obesity and caries is caused by the link between refined carbohydrate consumption and the development of obesity, and to the link between refined carbohydrate consumption and caries development. Vázquez-Nava *et al* [54] support this hypothesis and shown that children who consume fermentable carbohydrates have a 2.34 times greater risk for developing caries than children who do not consume these. Bearing this association in mind will permit reinforcement of dental caries prevention program strategies, to exert a positive effect on families so that children do not consume food and drinks containing refined sugar. Childhood obesity and childhood dental caries are coincidental in many populations, probably due to common confounding risk factor such as intake frequency, cariogenic diet and poor oral hygiene.

Some studies suggested that the manifestations of nursing caries may go beyond pain and infection. Acs *et al*,[20] stated that although pain and infection may be the primary effects of nursing caries, the condition also may affect general health. The potential for increased glucocorticoid production in response to pain, decreased growth hormone secretion in response to disturbed sleep patterns, and the overall increased metabolic rate during the course of infection may all conspire to retard normal growth and development in the patients with nursing caries. They also found that children with nursing caries weighed significantly less than their matched controls. Clarke *et al*,[56] described the nutritional status of children with S-ECC using clinical measurements. They concluded that all

Table 1. Comparison of the mean weight, height and BMI scores in the caries free and S-ECC children.

	Weight (kg)		Height (meters)		BMI(kg/m$_2$)	
Group	Caries free	S-ECC	Caries free	S-ECC	Caries free	S-ECC
n	100	100	100	100	100	100
Mean	15.79	16.26	1.07	1.05	14.04	14.84
S.D	2.51	3.60	0.10	0.10	2.14	2.96
t -test	1.076		1.186		2.191	
p-Value	0.283*		0.237*		0.030**	

*= Not Significant, **= Significant

Table 2. Comparison of the mean weight, height and BMI scores in the caries free and S-ECC female population.

	Weight (kg)		Height (meters)		BMI(kg/m$_2$)	
Group	Caries free	S-ECC	Caries free	S-ECC	Caries free	S-ECC
n	50	50	50	50	50	50
Mean	15.74	16.74	1.05	1.04	14.34	15.45
S.D	2.96	4.03	0.11	0.10	2.15	3.19
t -test	1.418		0.341		2.043	
p-Value	0.159*		0.734*		0.044**	

*= Not Significant, **= Significant

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Table 3. Comparison of the mean weight, height and BMI scores in the caries free and S-ECC male population.

	Weight (kg)		Height (meters)		BMI(kg/m$_2$)	
Group	Caries free	S-ECC	Caries free	S-ECC	Caries free	S-ECC
n	50	50	50	50	50	50
Mean	15.84	15.78	1.08	1.06	13.74	14.23
S.D	1.98	3.07	0.09	0.09	2.12	2.61
t -test	0.116		1.439		1.034	
p-Value	0.908*		0.153*		0.303*	

*= Not Significant

of the nutrition tests detected malnourishment in a group of young children with severe early childhood caries. Acs *et al*,[57] explained the possible effects of nursing caries or rampant caries upon somatic growth and development. The catch–up growth observed in the patients following comprehensive dental rehabilitation suggests that untreated nursing caries was responsible for the age-adjusted weight differences observed between the groups. Sheller *et al*,[58] found a significant number of children with severe early childhood caries were underweight. Köksal *et al* [59] observed that children with low body weight have a higher risk of developing dental caries than overweight-obese children and the height, weight, BMI and percent of fat mass were found to be negatively correlated with dmft indices. Means[60,61] stated that chronic inflammation from pulpitis and chronic dental abscess of untreated severe caries affects the growth via chronic inflammation. He explained the metabolic pathways where cytokines and inter-leukinin-1 (IL-1) can induce the inhibition of erythropoiesis. This suppression of hemoglobin can lead to anemia of chronic disease as a result of depressed erythrocyte production in the bone marrow. Vania *et al* [62] in their study of 3 to 5 year old children observed significantly, more children in the ECC population were underweight than in the caries free group and stated that the underweight finding in a significant number of S-ECC children may be due to the chewing alteration related to the dental pain due to caries and to missing teeth after hard tissues breakdown. Gaur *et al* [63] in their study found that 46% of children with S-ECC were underweight which was observed to be less than that of caries free children. They also complained of pain (40%), avoidance of hard food (24%), noticed weight loss (18%) and sleep disturbances (12%). After 6 months of dental rehabilitation, there was a significant improvement in their weight and quality of life. Nevertheless, these explanations do not go well with the AAPD definition of S-ECC, which states "….in the children younger than three years of age, any sign of smooth-surface caries is indicative of severe early childhood caries (S-ECC)".[5] There is a question to think over that how a sign of smooth-surface caries will affect the metabolic pathways, impair the masticatory efficiency, disturb the nutritional status and retard the growth, or is there a need to modify and elaborate the definition of S-ECC.

In the present study it was observed that the S-ECC affected children showed higher mean weight than the caries free children, except for the male children. Whereas the mean height was found to be almost similar with the caries free and S-ECC affected children. The mean BMI of the S-ECC children is statistically more than the normal children, whereas there is no correlation between S-ECC and obesity. For the caries free children 51% are underweight, 45% are normal, 1% at risk of overweight and 3% were observed to be overweight. In the S-ECC affected children 45% are underweight, 41% normal, 4% at risk of overweight and 10% were observed to be overweight. Hence, the body weight is independent on the caries status. When distributing the total population including the normal and S-ECC affected children according to the weight status based on CDC classification, 48% of the children were classified as underweight, 43% were normal weight, 2.5% children were found to be at risk of overweight and 6.5% as overweight. Further studies are needed to ascertain the underlying cause for the children having underweight body status. The applicability of the CDC based weight status classification to the school going children (3-6 years) should further be explored.

CONCLUSIONS

1. A positive correlation between the BMI and S-ECC was observed in this study.
2. The body weight status based on the CDC classification shows that among the caries free children 51% are underweight, 45% are normal, 1% at risk of overweight and 3% were observed to be overweight. In the S-ECC affected children 45% are underweight, 41% normal, 4% at risk of overweight and 10% were observed to be overweight.
3. Underweight is prevalent in caries free children as well as in S-ECC children.
4. Further studies are needed to find out the major contributing factors of these children classified in underweight category and formulation of an action plan.

Table 4. Distribution of caries free and S-ECC children according to the weight status based on CDC classification.

CDC based classification	Caries free			S-ECC			Total (Caries free +S-ECC)		
	Female	Male	**Total**	Female	Male	**Total**	Female	Male	**Total**
Underweight	18	33	**51**	19	26	**45**	37	59	**96**
Normal	29	16	**45**	20	21	**41**	49	37	**86**
At risk of Overweight	0	1	**1**	4	0	**4**	4	1	**5**
Overweight	3	0	**3**	7	3	**10**	10	3	**13**
Total	50	50	**100**	50	50	**100**	100	100	**200**

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Table 5. Age wise comparison between BMI and defs among 3, 4, 5 and 6 years old children.

Sex	Group	Age (years)	BMI			defs		
			N	Mean	S.D.	N	Mean	S.D.
Total (female + male)	Normal	3	22	15.09	3.16	22	0.00	0.00
		4	35	13.79	1.86	35	0.00	0.00
		5	32	13.91	1.47	32	0.00	0.00
		6	11	13.10	1.53	11	0.00	0.00
		Total	**100**	**14.04**	**2.14**	**100**	**0.00**	**0.00**
	S-ECC	3	31	15.75	2.65	31	6.77	4.88
		4	30	15.31	4.16	30	8.70	8.86
		5	22	13.79	1.51	22	8.09	5.39
		6	17	13.70	1.37	17	16.06	11.15
		Total	**100**	**14.84**	**2.96**	**100**	**9.22**	**8.17**
	Total	3	53	15.48	2.87	53	3.96	5.01
		4	65	14.49	3.20	65	4.02	7.39
		5	54	13.86	1.47	54	3.30	5.25
		6	28	13.47	1.44	28	9.75	11.73
		Total	**200**	**14.44**	**2.61**	**200**	**4.61**	**7.39**

5. The applicability of the CDC based weight status classification to the school going children (3-6years) of Mathura city should be further explored.

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