Exploring the relation between dental caries and body mass index among primary dentition, mixed dentition and permanent dentition children - A systematic review

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**Abstract**
The research on the association of the Body mass index and Dental caries has indicated inconsistent results in the previous studies. Therefore, the present review intended to reanalyse the relationship between Body mass index and Dental caries. The databases used to search were Pubmed, Embase, Journal of the web using the following mesh terms, Body mass index, overweight, underweight, Obesity, DMFT, Tooth decay, child. The other methods were the manual searches of the reference lists of all selected studies, reviews, conference proceedings with complete information. The results were evaluated based on the 3 groups as an association of Dental caries and BMI for Primary teeth, mixed dentition and permanent teeth. The studies should consider the review based on the individual country specific BMI-for-age centiles to reduce the heterogeneities in the results as it causes inconclusive results.

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**INTRODUCTION**
Oral health is an essential aspect of good health and fundamental to overall well-being. Among the spectrum of oral diseases, dental caries is the most common and still a major concern in public health globally (Shivakumar et al., 2018). Considering the Global scenario, the prevalence of caries is on a decline in developed countries, on an increase in less-developed countries, and epidemic in countries in an emerging economy. This remarkable decline observed in the prevalence of dental caries in developed countries has been associated with a more realistic approach in sugar consumption reduction, reinforced oral hygiene regimens and practice and increased preventive programs. However, a steep increase in caries prevalence in developing countries is primarily due to the nonprotocol based oral health care systems in such countries, which emphasizes curative care and, on the contrary, negligence of community-based prevention and oral health promotion programs.

Considering the grass root etiology in the causation of dental caries, it can be classified to modifiable and nonmodifiable factors. The modifiable risk factors being diet, water fluoride levels, oral hygiene regimen and nonmodifiable risk factors such as socioeconomic status and past caries experience. So, among the modifiable risk factors, specifically, diet is gaining a prime focus in the prevention of dental caries. To date, in the stream of caries research, the diet has probably gained more attention than
any other modifiable risk factors. Gustafsson et al. (1953) is one of the epitome research study relating diet and caries, the results of which inferred that the frequency and nature of the form of sugar intake markedly influenced the caries activity. The other concern about the modifiable factors, specifically diet, is not only responsible for dental caries but also a major concern in the causation of obesity.

World Health Organization has considered obesity as a "global epidemic disease" (Alm et al., 2008) and posing an alarming threat to every country having overweight adults population of more than one billion and globally is a significant contributor to the burden of chronic disability and disorders (World Health Organization, 2003). Therefore, obesity is considered in serious social and psychological dimensions, virtually affecting all age groups and socio-economic status. In this preview, societal changes and nutrition transition worldwide are making an effort to drive away from the obesity epidemic. Among the forces that can probably influence the present epidemic are the economic status of the country, urbanization in the lifestyle and eating patterns and food market globalization. In the process, as incomes rise and populations become more urbanised, a diet rich in complex carbohydrates make way to a varied diet pattern with a higher proportion of saturated fats and sugars. Despite an increase in carious experience in obese/overweight children, obesity may also cause serious diseases, reduced life expectancy, the risk for Type 2 diabetes, risk of cardiovascular disease, increase in the occurrence of asthma, arthritis and overall prognosis of poor general health (Sinha et al., 2002). Thus, the eating pattern of children with overweight or obesity may be a risk factor for overweight, caries and common for many other diet-related conditions.

Studies conducted in developed countries so far presented an inconsistent association between dental caries occurrence and the body's adiposity Gerdin et al. (2008); Kantovitz et al. (2006); Larsson et al. (1995); Alm et al. (2008) reported a positive correlation between dental caries occurrence and BMI, whilst a few other systematic reviews published from 1984 to 2004 presented an inconclusive relationship between obesity and dental caries occurrence.

However, considering few limitations of the meta analysis presented previously, such as very few underweight was not listed as a categorization of body mass index, irrespective of the evidence which displayed the underweight children were commonly undernourished/malnourished and deficient in vitamin A and D, Calcium and phosphorus, which contributes significantly in the morphology, mineralization and maturation and eruption of their teeth and thus increased the threat or make the tooth more conducive to the development of dental caries. Although the results of the study by Chen et al. has included these parameters, there was no significant difference in dental caries among children with Complete BMI categories for primary and permanent teeth. Sensitivity analyses of the primary teeth showed that the obese group had more caries than the normal weight (Chen et al., 2018). Remarkably increased dental caries was evidenced among the overweight and obese categories children in primary and permanent teeth of high-income countries, but not in low and middle income countries.

There is a vast literature existing related to the present status of dental caries globally. Despite innumerable attempts to prevent the disease, its incidence and prevalence have increased over the last few decades. Therefore, the changing trends in the incidence and prevalence of dental caries and demand continuous understanding and investigation in the field. Thus, the need of the hour is to review the past and prediction of the future synergistically to reduce dental caries.

Thus, the objective of the current study is to associate dental caries with a complete range of BMI classes in children through a systematic review.

**METHODOLOGY**

The observational studies were selected from 2009-2019 using the prospective protocol of study objective, inclusion criteria and exclusion criteria.

**Literature search strategy**

The databases used to search were Pubmed, Embase, Journal of the web using the following mesh terms. Body mass index, overweight, underweight, Obesity, DMFT, Tooth decay, child. The other methods were the manual searches of the reference lists of all selected studies, reviews, conference proceedings with complete information.

**Inclusion and exclusion criteria**

The Down's and Black criteria (Downs and Black, 1998) was applied to assess the standards of the scientific evidence in the observational studies. Studies that included standard caries indices and BMI classification by WHO/IOTF were considered for the review. Studies with no standard index, no direct comparison or incompleteness of the data like a letter to the editor, unpublished/inaccessible full articles were excluded.
RESULTS

Total of 21 articles fulfilled the selection criteria’s [Figure 1].

The systematic review of these studies were conducted by classifying the findings based on dentition and age. Primary dentition (2-6 yrs, n=6), Mixed dentition (6-12 yrs, n=9), Permanent dentition (12-18 yrs, n=6). List of studies, including the Author details, year of the study published, sample size, the age range of the child, along with the results and conclusion represented in the tables according to the age.

The results were evaluated based on the 3 groups and the association was presented as follows, Association of Dental caries and Body Mass Index of primary teeth, among the selected 21 studies, 6 articles investigated the primary teeth, the interpretation of the results were further categorized to 4 associations as negative association, positive...
association, inverse association and U-shaped association. Martins et al. (2014); Pikramenou et al. (2016) research concluded as the negative association between dental caries and BMI of primary teeth.

Sadeghi and Bagherian (2013) put forth a positive association between dental caries and BMI of primary teeth. An inverse association was noted by Norberg et al. (2012); Subramaniam and Singh (2011) studies. BMI was negative associated with caries experience in primary dentition (Sukhabogi et al., 2019), (Table 1).

### Association of Dental caries and BMI of mixed dentition teeth

From the nine articles, Pinto et al. (2007); Cinar and Murtomaa (2008); Elangovan et al. (2012); Lempert et al. (2014) revealed a negative association between dental caries and BMI for mixed dentition teeth. Willerhausen et al. (2007) suggested a definitely positive relation between dental caries and BMI for mixed dentition teeth. Costacurta et al. (2011); Creske et al. (2013); Liang et al. (2016) suggested an inverse relation between dental caries occurrence and BMI for mixed dentition teeth. (Subramaniam and Singh, 2011) revealed a U-shaped relation between the mean dmft score, which was higher among the children of the underweight category and a significantly higher mean DMFT score among the children who proved to be at risk of overweight and in the overweight category Shahraki et al. (2013), (Table 2).

### Association of Dental caries and BMI of permanent dentition teeth

The 6 articles Sadeghi et al. (2011); Sharma and Hegde (2009); Frias-Bulhosa et al. (2015) revealed

### Table 2: Association of Dental caries and BMI in mixed dentition

<table>
<thead>
<tr>
<th>Sl no</th>
<th>First author</th>
<th>Year</th>
<th>Sample size</th>
<th>Age/ys</th>
<th>Results and conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Willerhausen et al. (2007)</td>
<td>2007</td>
<td>1298</td>
<td>6-11</td>
<td>Statistical significant positive association was observed between BMI and caries in both deciduous and permanent dentition</td>
</tr>
<tr>
<td>2</td>
<td>Pinto et al. (2007)</td>
<td>2007</td>
<td>135</td>
<td>8-10</td>
<td>No co-relation between obese and non obese children</td>
</tr>
<tr>
<td>3</td>
<td>Cinar and Murtomaa (2008)</td>
<td>2008</td>
<td>338</td>
<td>10-12</td>
<td>No association was present between BMI and dental caries from the analysis</td>
</tr>
<tr>
<td>4</td>
<td>Elangovan et al. (2012)</td>
<td>2012</td>
<td>510</td>
<td>6-12</td>
<td>Statistically, no significant difference in mean caries score between children belonging to various BMI for age categories.</td>
</tr>
<tr>
<td>5</td>
<td>Shahraki et al. (2013)</td>
<td>2013</td>
<td>1213</td>
<td>6-11</td>
<td>Statistically significant association between BMI and DFT. BMI for age values presented 34 children were caries free in the normal weight cases, while 28 children in the overweight and obese group were caries free.</td>
</tr>
<tr>
<td>6</td>
<td>Costacurta et al. (2011)</td>
<td>2011</td>
<td>107</td>
<td>6-12</td>
<td>Non significant association between an increase in dmft-DMFT and Pre-obesity/obesity</td>
</tr>
<tr>
<td>7</td>
<td>Creske et al. (2013)</td>
<td>2013</td>
<td>117</td>
<td>6-11</td>
<td>Statistically significant lower rate of DMFT in the obese category than the children of healthy weight category.</td>
</tr>
<tr>
<td>8</td>
<td>Lempert et al. (2014)</td>
<td>2014</td>
<td>385</td>
<td>9.6</td>
<td>Higher BMI association with lower odd caries, children of the overweight and obese category were more likely to be primary dental caries free among 7-9 years old.</td>
</tr>
<tr>
<td>9</td>
<td>Liang et al. (2016)</td>
<td>2016</td>
<td>32,461</td>
<td>7-9</td>
<td></td>
</tr>
</tbody>
</table>
dental caries and BMI of permanent teeth are not associated. Subramaniam and Singh (2011) presented that dental caries and BMI for permanent teeth are positively associated (Narksawat et al., 2009; Shailee et al., 2013). Revealed an inverse association between dental caries and BMI (Table 3).

### DISCUSSION

In the present systematic review, 6 studies were included evaluating the primary dentition dental caries relation with respect to BMI, 9 studies from mixed dentition and 6 studies from the permanent dentition to analyze a relationship between dental caries and Body Mass Index. The observational studies were selected from the year 2009-19 using the prospective protocols of the study objective and also adhering to the inclusion and exclusion criteria's. The studies having the following protocol for Anthropometric measurements were included, Bodyweight of the study subjects was measured with the help of a standardized digital weighing scale. The fractional weight below and above 500 grams were considered to be rounded off to the nearest whole number. The height was measured with the help of a stadiometer. Measurements of the weight and height were executed on barefoot but with their school dress on. The BMI calculation is done using the formula: Weight(kg)/height(m)^2.

Most of the studies considered the universally accepted WHO guidelines and a few followed the individual country based guidelines due to the disparity in the growth pattern of a population, which alters with time and hence it is recommended that references growth chart to be updated regularly such that they reflect child’s current growth patterns and are representative of secular trends (Khadilkar et al., 2015).

In support to the above statement, another study states that for children between the ages 5-18 years, standard prescriptive growth charts are not recommended as the environmental variables in this age group cannot be controlled and hence, charts by the WHO for 5-18 years old children are based on the statistical reconstruction of 1977 National Centre for Health Statistics data and are called “growth references” and not “standards” (Buckler, 1994). However, in different populations, the growth patterns to differ; primarily in children above the age of 5 years due to the nutritional, environmental and genetic factors, and timing of puberty seem to play a major role not only in attaining the final height but also in

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**Table 3: Association of Dental caries and BMI in permanent dentition**

<table>
<thead>
<tr>
<th>Sl no</th>
<th>First author</th>
<th>Year</th>
<th>Sample size</th>
<th>Age/yrs</th>
<th>Results and conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Narksawat et al. (2009)</td>
<td>2009</td>
<td>920</td>
<td>12-14</td>
<td>Multiple logistics regression analysis presented, normal weight and thin school children were more likely to have a DMFT at least 1 by 1.94 times and 2.22 times higher, respectively</td>
</tr>
<tr>
<td>2</td>
<td>Subramaniam and Singh (2011)</td>
<td>2011</td>
<td>2033</td>
<td>6-15</td>
<td>Significantly higher mean deft score in underweight children and higher mean DMFT score was observed in children at risk of overweight and overweight children</td>
</tr>
<tr>
<td>3</td>
<td>Sadeghi et al. (2011)</td>
<td>2011</td>
<td>747</td>
<td>12-15</td>
<td>Statistically, no significant difference between DMFT scores between the BMI for age groups. However, males were likely to have more caries than females.</td>
</tr>
<tr>
<td>4</td>
<td>Shailee et al. (2013)</td>
<td>2013</td>
<td>1011</td>
<td>12-15</td>
<td>Results showed a negative correlation between BMI and DMFT</td>
</tr>
<tr>
<td>5</td>
<td>Sharma and Hegde (2009)</td>
<td>2014</td>
<td>504</td>
<td>13-17</td>
<td>Statistically, no significant association between BMI and caries was with a p value of 0.661 irrespective of the genders.</td>
</tr>
<tr>
<td>6</td>
<td>Frias-Bulhosa et al. (2015)</td>
<td>2015</td>
<td>181</td>
<td>13</td>
<td>No significant results between DMFT and BMI for age.</td>
</tr>
</tbody>
</table>
the characteristics of the growth curve. Therefore, it is recommended to follow country-specific growth charts to monitor the growth of children between 5-18 years. Therefore unifying the obtained results universally may not be the appropriate method to compile the literature for a systematic review as it would provide inconsistent results (Onis et al., 2007).

**Dental Caries determination**

Studies following the WHO method and criteria were selected to maintain uniformity and standards for comparison.

In our opinion, the DMFT indices only quantify the caries occurrence and not qualify. The newer indices such as ICDAS (International caries detection and assessment system), PUFA (pulp-ulcer-fistula-abscess) and CAST (caries assessment spectrum and treatment) provides comprehensive information on the caries progression, including the treatment aspect. Further, studies should consider one of these indices for evaluation or only the CAST indices as it is built on the strength of the ICDAS, DMFT and PUFA indices as it could help us in understanding the caries pattern and distribution and its correlation to the oral hygiene practice.

Therefore, based on the present review, the conclusive agreement cannot be reached as the studies selected had not considered the various confounding factors as the socioeconomic status, the oral health awareness level of the parents/oral health literacy, Diet record, oral hygiene regimen practice which could have been a prime aspect in the establishment of the co-relation.

As supported in an article by Sisson et al. (2001), children from countries with a higher income could have developed more addiction to electronic gadgets leading to sedentary lifestyles, erratic eating habits, which could indirectly cause obesity and caries. On the contrary, children of low and middle income countries could have an appropriate diet but lack preventive oral hygiene practices, which could lead to caries (Kumar et al., 2017). But with the recent advances in globalization, there comes a drawback of lifestyle modifications leading to ultra refined food consumption and multimedia usage, which could lead to both obesity and caries.

Therefore, each and every confounding factor has a very important role in the causation of the association of caries and BMI.

**CONCLUSIONS**

In the present review, due to the heterogeneities in the results obtained, no agreement could be reached in unison conclusion on the relation between the BMI and caries. Further recommendations to include the above mentioned limitations to obtain a definite relation considering the BMI and caries.

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**Conflict of Interest**

The authors declare that they have no conflict of interest for this study.

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