

## SYSTEMATIC REVIEW ARTICLE

**Effect of Dietary Quality on Dental Caries in Children – A Review**Neerja Singh<sup>1</sup>, Neha Neharika<sup>2</sup>, Abhishek Verma<sup>3</sup>, Mandeep Jolly<sup>4</sup>**ABSTRACT**

The purpose of this paper was to review all published material reporting the Dietary Quality of children with dental caries, and to evaluate if there is any correlation between diet quality and dental caries. The review aimed to search for published material, studies as well review articles assessing the dietary quality of children and evaluating the relationship between dietary quality and dental caries in children, while also assessing the effect of socio-demographic variables on it. Amongst all the papers reviewed, only few have considered the overall effect of diet on dental caries. The results show that children having healthy eating practices depicted lower prevalence of dental caries. Studies relating dental caries and sugar exposures are enormous in number, however, studies correlating the overall diet and dental caries are scarce, especially in younger age groups. Additionally, the correlation between the dietary quality of Indian children, and their oral health status, especially that of dental caries has been largely unexplored. There is a need to study the overall quality of diet and establish a relationship of dietary quality with dental caries in Indian Children.

**Keywords:** Diet, Nutrition, Dental Caries, Children

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<sup>1</sup>Professor & Head; <sup>2</sup>Post graduate student; Department Of Pedodontics and Preventive Dentistry, Babu Banarasi Das College of Dental Sciences, <sup>3</sup>Senior Lecturer; Department of Public Health Dentistry, Sardar Patel Post Graduate Institute of Dental and Medical Sciences, Lucknow, Uttar Pradesh, <sup>4</sup>Senior Lecturer, Department of Pedodontics, Uttranchal Dental & Medical Research Institute, Dehradun, Uttarakhand, India.

**Corresponding author:** Dr. Neha Neharika, c/o Dr. Abhishek Verma, 9/A, Bramhapuri, P.O. Narain-Nagar, Lucknow-226016, Uttar Pradesh, India

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**INTRODUCTION**

Dental caries, one of the most widespread diseases of mankind is the single most common chronic diseases of childhood.<sup>1</sup> It is an infectious disease of the oral cavity that de-

stroys the tooth structure. Caries is a multifactorial disease with interplay of three principal factors, the host, microflora and substrate as explored by Keyes and Jordan, 1960.<sup>2</sup> The caries process begins when bacteria from the oral microflora (e.g. *Streptococcus mutans*) produce acids as a result of metabolism of dietary carbohydrates. Newbrun et al, in 1982 added an additional factor, time, to the existing caries triad.<sup>3</sup> This dissolution usually occurs if the oral cavity does not have sufficient defensive mechanisms to protect enamel from the detrimental effects of frequent acid attacks. The loss of minerals from the tooth structure progresses into cavitation, tooth ache due to pulpal involvement and tooth loss if left untreated.

Unfavourable and unhealthy eating patterns have been regarded as the greatest contributors of dental caries in children. Refined carbohydrates especially sucrose have been labelled as prime culprit in the etiology of dental caries. They serve as substrate, which cariogenic bacteria ferment to cause dental decay. In addition to this well known fact, the overall nutritional value of diet also has a role in oral health maintenance. Dental caries and gingival diseases are highly prevalent in Indian children. Deficiency of vitamins and minerals may decrease immunity which in turn can affect the oral health adversely,<sup>4</sup> as has been seen in case of gingival problems<sup>5,6</sup> but there is scarcity of literature on the effect of nutrition on dental caries.

Urbanization and economic development have resulted in rapid changes in diet and lifestyles. The changes in the World Food Economy are reflected in the dietary patterns, which are continuously shifting. Globalisation has resulted in the opening of multinational fast food chains in Indian cities, even the smaller ones. The changes in lifestyles and dietary patterns being followed largely by children is promoting obesity and other diseases.

The diet patterns that the children follow these days are a major factor in increasing the rate of chronic diseases like Type 2 Diabetes, hypertension, cardiovascular diseases, cancers, etc (Dietary Guidelines For Indians, 2010).<sup>7</sup> These days there is an increased consumption of energy rich diets, particularly saturated fats and refined carbohydrates. This diet can be harmful for the general health as well as the oral health of an individual if it lacks the balance of nutrients. The quality of children's and adolescents' diet is of concern to us because poor eating patterns established in childhood may be carried onto adulthood (Douglass C et al 2003).<sup>8</sup>

Long-term nutritional disorders like Protein Energy Malnutrition (PEM) also leads to stunting and wasting, non-communicable chronic diet related disorders, increased morbidity

ty and mortality and reduced physical work output (Ministry of Health, New Zealand, 2012).<sup>6</sup> The developing economies as India have a large section of population which thrives mainly on nutritionally deficient diet resulting in diet related health disorders and oral health problems.

Dietary guidelines are a translation of scientific knowledge of nutrients into specific dietary advice. They represent the recommended dietary allowances of nutrients in terms of diets that should be consumed by the population. The guidelines promote the concept of nutritionally adequate diets and healthy lifestyles (National Oral Health Survey & Fluoride Mapping, India 2002-2003).<sup>9</sup> The established dietary recommendations also emphasize the selection of a variety of foods, low intake of saturated fat and cholesterol, and moderate use of salt and sodium, primarily to reduce the risk of chronic diseases. This reinforces the importance of quality and adequacy of nutrients in daily diet in relation to age, sex and physiological status.

Various dietary indices have been formulated to evaluate an individual's diet as per the Dietary Guidelines. The Healthy Eating Index (HEI) is one such index of Overall Diet Quality based on the Food Pyramid (United States Department Of Agriculture, 1995).<sup>10</sup> HEI assesses adequacy, moderation and diversity of food choices. The association of oral health status to nutritional status using dietary guidelines has been explored earlier in older adults (Ervin RB 2008; Savoca MR et al, 2010)<sup>11,12</sup> but very few studies have been reported in young children;<sup>13</sup> with none of them being carried out in Indian population.

The aim of this study was to review all published material reporting the Dietary Quality of children with dental caries, and to evaluate if there is any correlation between diet quality and dental caries. Furthermore, the effect of socio-demographic variables on dietary quality and dental caries has also been explored.

## MATERIALS AND METHODS

The review aimed to search for published material, studies as well review articles assessing the dietary quality of children and evaluating the relationship between dietary quality and dental caries in children.

### Criteria for considering studies for this review

The following criteria was required in order for a study to be included in this review:

1. Types of study subjects: Healthy children and adolescents, including boys and girls aged 0-18 years.
2. Types of outcome measures: Studies reporting correlation between the dietary quality of children with dental caries and also those, which showed no correlation between both the variables, were considered while reviewing data for the present study. Whilst the primary objective of the review was to find out the effect of overall diet quality on dental caries, information on socio-economic

descriptors was also gathered, where possible, for all studies, so that interactions between these and other risk factors could be taken into account.

3. Types of study: Blinding of patients or the operator was not used as an entry criteria for this review. Evidence was ranked according to the results obtained regarding the relationship between dietary quality and dental caries.
4. Source of data: Reference books and databases, including published articles in indexed journals assessing the dietary quality of children with dental caries while evaluating the relationship between them as well as the effect of socio-demographic variables on dietary quality and dental caries in children, were included in this study.

### Search Methods for identification of literature published earlier

In view of the large body of literature, the review is limited to studies identified by online searching. Handsearching of journals and gathering of unpublished reports and conference proceedings was outside the scope of the review at this stage. The online database was searched using a combination of controlled vocabulary and free-text terms as (diet AND dental caries), (nutrition AND dental caries) and (healthy eating AND dental caries). The search included all literature published from 1989 onwards and was last updated in August 2015.

### Data collection and analysis

The titles, authors, abstracts and manuscripts from all studies identified by the electronic search were printed and reviewed on the basis of keywords, title and abstract, to determine whether these met the inclusion criteria. A full copy of all relevant articles selected for the review was obtained prior to commencement of the analysis of the data. Review author was not blinded to the journal of publication or the author's names on the papers. The descriptive data recorded are shown in Table 1.

## RESULTS

Out of all the papers that followed the research results, reviews, opinions, published conference reports, Letters to Editor and articles not in english were excluded. Out of the remaining studies, an enormous number out of them were excluded which correlated only the effect of sugar with dental caries. Many of them did not meet the age group criteria, others were studies based on cariogenicity of diet rather than the nutrient value, some out of them related snacking habit pertinent only to cariogenic food, and dental caries and thus had to be excluded. Of the remaining, studies regarding nutrition evaluation tools and dietary patterns, and those citing relationship between fluoridation and dental caries, obesity and dental caries, saliva and dental caries, the microbiological aspect of dental caries, those that focussed on the pre-

ventive aspect of dental caries with no focus on proper diet counselling, and those not in humans were again excluded (Table 2). And finally the studies included for full text review included<sup>15-28</sup> a total of fourteen articles. Data from these papers are summarised in Table 3.

Studies from all over the world have been considered in this review. The subjects included in the papers were all randomly selected, except for one study by Marshall TA et al 2003<sup>19</sup> wherein the study subjects were members of the Iowa

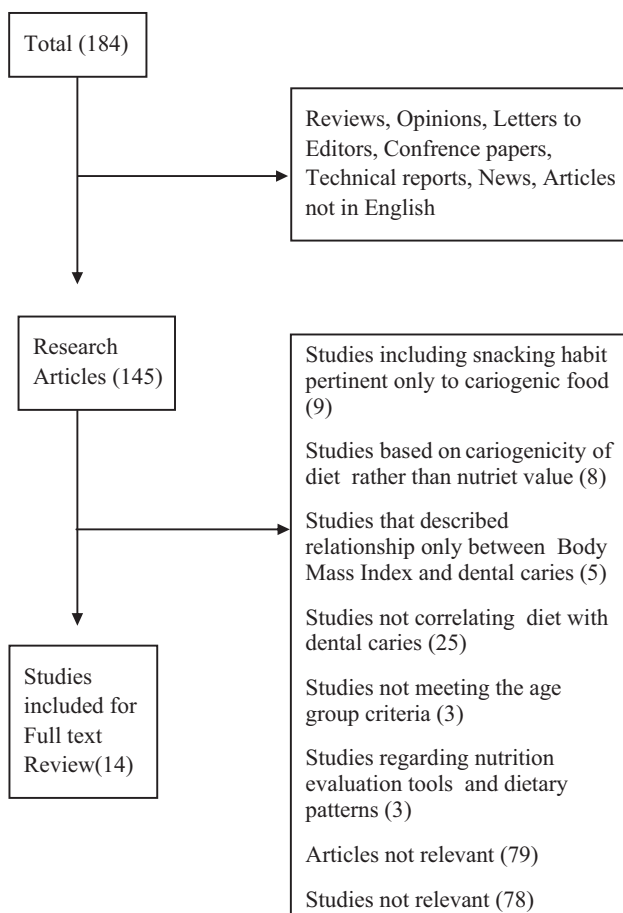
Fluoride Study, a cohort followed from birth. Age group of selected children varied from 1 year upto 18 years. Amongst all the papers reviewed, only few have considered the overall effect of diet on dental caries. Some authors have considered Body Mass Index (BMI) as a tool to measure the nutritional quality of children and correlate it with dental caries. Many authors have also explored other socio-demographic characters and their co-relation with dental caries as well. Dental caries has been declining globally in the general population, more so among adults, but its prevalence in younger age groups has not shown a significant decline. Prevalence of caries is comparatively higher in the children residing in developing countries than those in developed countries.

**DISCUSSION**

The purpose of a systematic review is to locate, appraise and synthesise evidence from scientific studies in order to provide informative empirical answers to scientific research questions.<sup>29</sup> This review assessed all the published material reporting the Dietary Quality of children with dental caries, and to evaluate if there is any correlation between diet quality and dental caries. Many systematic reviews include a variety of methods for identifying relevant studies such as hand-searching journals as well as computerised literature searches. However, the body of literature is significant in this area and handsearching, which is a significant task in itself, was beyond the scope of this review.<sup>29</sup> The review was therefore limited to computerised searching. However, this may mean that some relevant studies may not have been encompassed by the search terms used and therefore may have been omitted on this basis. The comprehensiveness of the review could be improved by the addition of papers identified by handsearching.

The results of this review show that those children who had healthy eating practices showed lower prevalence of dental caries. It was observed that amongst the literature obtained so far, some authors have also considered Body Mass Index (BMI) as a tool to measure the diet of the child while some have recorded only snacking habits which does not give a proper picture of the actual nutrition the child is taking.<sup>30</sup> Many of the studies would have been improved by using validated measures to collect information on dietary habits. The diet quality is a recent dietary concept which refers to both, the nutritional adequacy of an individual's dietary patterns, and also the closeness of food patterns in relation to the National Dietary Guidelines for that population. Another study by Zaki NA, Dowidar KM, and Abdelaziz WE in 2014 was carried out on sixty preschool children (3-6 years) belonging to Egyptian population where they assessed the relationship of dietary intake, as measured by the Healthy Eating Index-2005 (HEI-2005) to Early Childhood Caries.<sup>31</sup> Their results showed that caries free children ha higher intake of whole fruits, milk, sodium and hence Total HEI score. Since this study was available online as 'Epub ahead

1) Year study started, if not available, year it was published
2) Authors who conducted the study
3) Country study was carried out in
4) Number of children examined
5) Age group of included children
6) Prevalence of dental caries in the age group
7) The effect of dietary factors on dental caries (where available)
8) All sociodemographic variables used in the study to find a co-relation between dental caries (where available)
9) Socioeconomic status of the family to which the child belonged
10) The overall diet quality of child (where available)
11) Association between dental caries experience and other variables (as gender) where data was available
<b>Table-1:</b> Descriptive data recorded (where available)



**Table 2 :** Summary of method followed for inclusion of studies chosen for Full-text Review

Author, year of publication	Sample size, Population	Age group	Effect of diet on dental caries	Whether socio-economic status was considered	Whether diet quality of children was assessed	Method of assessment of diet of the child	Other specific findings seen
Petridou E et al ; 1996	380; Greek children	12-17 years	Intake of vegetables and milk products was associated with lower prevalence of dental caries	Yes	-	Semi-quantitative food frequency questionnaires were used	DMFT or DMFS significantly better among younger age groups and male adolescent and among higher socioeconomic class urban residents
Mazengo MC, Tenovuo J, Housen H; 1999	Tanzanian children	12 years	Decayed teeth increased significantly with total carbohydrates (P = 0.002) and fiber (P = 0.002).	No	-	Mean of two 24-h recalls was used for the assessment of food intake	Did not reveal any strong association between total energy intake and dental caries
Kwen-Ho et al ; 1997	651, Korean children	12-13 years	DMFS scores positively associated with daily intake amount of carbohydrate and niacin and negatively associated with total energy intake	Yes	No	Food frequency questionnaire used which assessed how frequently selected foods were eaten during last six months	Girls showed higher prevalence of caries than boys ; Effect of various nutrients on dental caries has been explored
Venugopal T et al; 1998	2000 ; Indian children	1-14 years	Prevalence of dental caries was low in well-nourished children and in those taking vegetarian type of diet.	Yes	-	-	Parental income was not shown to have any bearing on caries prevalence. Parental literacy, particularly maternal literacy was shown to influence caries prevalence in children.
Marshall TA et al ; 2003	642; children from Iowa fluoride study	1-5 years	In adequate intake of nutrients like riboflavin, copper, vitamin D, vitamin B12 were associated with increased caries experience and low adequate intakes of nutrients like Vitamin B12 and vitamin C were associated with decreased caries experience	No	-	Diet quality was calculated as a ratio of nutrient intake to Recommended dietary allowance./Adequate Intake	Vitamin E, either low or high adequate intakes were associated with increased caries experience
Dye BA et al ; 2004	American children	2-5 years	Caries experience was found to be significantly greater in those who ate less than five servings of fruits and vegetables per day	Yes	No	Authors have used data from the 3 <sup>rd</sup> National Health and Nutrition Examinations Survey to investigate the relationship between healthful eating practices.	Caries experience in primary teeth was significantly greater in non poor children who did not eat breakfast daily.

Ohlund I et al ; 2007	124 ; Swedish children	4 years	High protein content diet showed caries protective effect where overall caries experience is low and children are exposed to fluoride toothpaste	No	No	History regarding breast-feeding, eating breakfast and consuming five servings of fruits and vegetables a day was asked	Caries experience was not correlated with intake frequency or amount of carbohydrate containing food or with daily intake of energy, carbohydrate or any other micro or macro nutrients.
Nunn ME et al ; 2009	3912 ; American children	2-5 years	Children with best dietary practices (better HEI Index) were 44% less likely to exhibit severe ECC compared to children with worst dietary practices (poor HEI scores)	Yes (poverty income ratio)	Yes	Diet history recorded through 24 hour recall data obtained in interviews with the child's parent or caregiver.	High ECC prevalence was noted among children belonging to a family with a Poverty Income Ratio (PIR) <1.3
Johansson I et al ; 2010	1,206 ; American pre-school children	1-4 years	Lesser caries prevalence was found in children who drank milk and did not snack candies, cookies and ice cream, dry cereals and dried fruit	Yes	No	Feeding habits (breast-feeding or use of bottle) and snacking habits were obtained from parents or guardians	-
Chattarjee M and Bandopadhyay AR ; 2012	544 ; Indian girls	Girls in age group of 6 - 19 years	A significant association with occurrence of dental caries among the underweight girls has been found compared to that of the overweight and normal	Yes	No	Nutritional status was evaluated by anthropometry taken from each girl	
Narang R et al ; 2012	600; Indian children	12 to 15 year	Predisposition to dental caries were higher among mal-nourished children	Yes	No	Nutritional status was assessed using BMI index	Mean DMFT among male subjects was significantly higher than that in female subjects
Bener et al ; 2013	1752; Qatar population	6- 15 years age	Number of children consuming sea food, cod liver oil, and vitamin-D-fortified milk less than once a week were significantly higher in the dental caries group compared with those without caries	Yes	No	Questionnaire including data on dietary intake	Being female is an independent risk indicator for dental caries.

DoichinovaL, BakkardjievP, Peneva M; 2015	100 ;Bulgarian children	6-12 years	Low carbohydrate food intake is a risk factors for caries development	No	No	The child or parent was asked to document all nutrition intake for a period of 7 days, in a diary	A correlation was seen between the frequency of low carbohydrates intake and a intensity of dental caries.; children who consume less amount of milk and 100% of fruit juice compared to soft drinks, are at a higher risk of developing dental caries.
Punitha VC et al, 2015	916; Indian children	13-19 years	Higher caries experience in non-vegetarians (38.4%) compared to vegetarians (31.6%)	No	No	Questionnaire on frequency of visit of fast food restaurants, habit of skipping meals, habit of snacking in between meals, types of diet(veg or non-veg) and milk	DMFT is not significantly correlated with milk fruits, vegetables, non vegetarian food or fresh fruit juices

**Table-3:** Summary of studies fulfilling the inclusion criteria

of print' and was not available as a full article in the form of a hardcopy, therefore we have not included this study in our review. Diet quality considers all aspects including whole food and beverage intakes, which in turn are influenced by geographical location, lifestyle behaviours, cultural & social determinants and environment.<sup>14</sup> Interpretation of study findings is hampered by the large number of different measures used to assess very similar factors (for example Body Mass Index, Body Weight, Amount of sugar frequency and amount or Any particular or specific nutrients). Use of fewer, validated measures, such as use of proper, complete dietary history based on the Recommended Dietary Allowance developed for the children, would help to get a clearer picture of the overall nutrition that the child is taking considering all the nutrients and would help improve comparability.

Oral diseases like dental caries and gingival diseases are highly prevalent in Indian children. National Oral Health Survey and Fluoride Mapping by the Dental Council of India (2004) found caries prevalence among 5 year –old children to be 50%. Among 12 year old children, the prevalence was reported to be 52.5%, while among 15 year old children it was 61.4%.<sup>9</sup> The lack of awareness towards the preventive measures is the primary factor leading to large unaddressed needs in community.

Diet and nutrition affect oral health and the dynamic process of tooth demineralization and remineralization in many ways. Sugars are a substrate for bacteria in dental plaque, resulting in low pH and growth of cariogenic bacteria. Nutrient rich balanced diet helps in improving immunity as well as oral health. Studies relating dental caries and sugar exposures are enormous in number, however, studies assessing the overall diet and dental caries are scarce and have mostly been carried out in the older adults<sup>11,12</sup>

We conclude that though a number of studies have been carried out to explore the effect of various possible predisposing factors, but the effect of nutrition on dental caries has hardly been explored. Additionally, the correlation between the dietary quality of Indian children, and their oral health status, especially that of dental caries has been largely unexplored. There is a need to study the overall quality of diet and establish a relationship of dietary quality with dental caries in Indian Children.

#### Why this paper is important to pediatric dentists?

- There is lack of available scientific evidence concerning the overall quality of diet and establishing a relationship of dietary quality with dental caries in children, especially in Indian children.
- This paper reveals that there is a shortage of high quality studies, particularly those using validated measures for dietary studies
- This review emphasises that though studies have been conducted in different countries, on different social and ethnic groups, but due to lack of use of standardised data collection, a link in understanding how socio-economic background and ethnicity along with dietary patterns help determine which young children develop dental caries, could not be established.

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