WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.074
Volume 7, Issue 17, 547-567. Review Article ISSN 2277– 7105

THE ROLE OF DIET IN CARIES PREVENTION

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Article Received on
31 July 2018,
Revised on 20 August 2018,
Accepted on 11 Sept. 2018
DOI: 10.20959/wjpr201817-13406

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INTRODUCTION

Over the last three decades in Saudi Arabia, the condition of the teeth of children has improved tremendously. This has generally been attributed to the increased use of fluoride toothpaste. During this period the total amount of sugars disappearing into the population *per capita* has hardly changed. This suggests that the relationship between diet and caries has to be reassessed, which provokes different opinions among dental experts.

Some suggest a maximum threshold level for the daily amount of sugars to prevent caries. Others propose that in general the amount of sugars eaten is not an important determinant of caries experience. The scientific evidence for the various opinions on the role of diet in caries development will be discussed.[1]

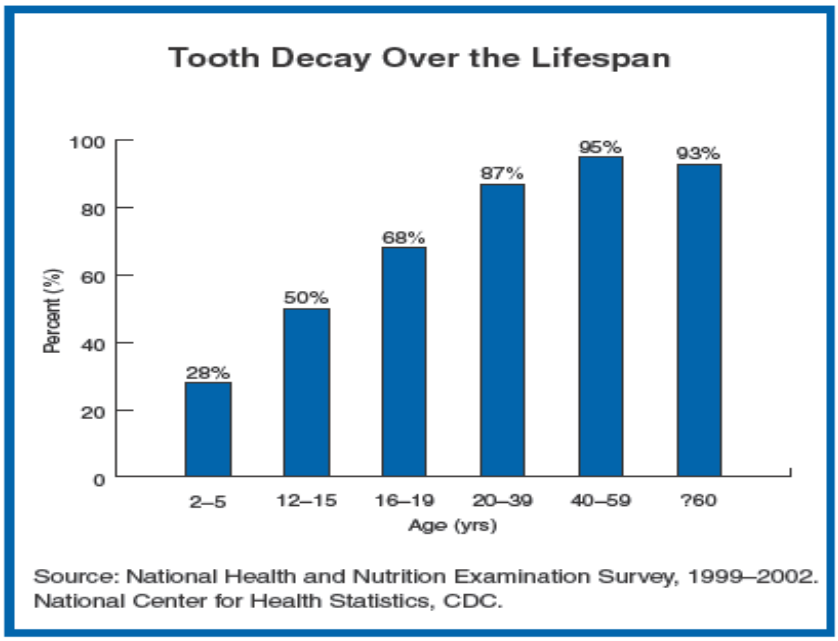
A dynamic relation exists between sugars and oral health. Diet affects the integrity of the teeth; quantity, pH, and composition of the saliva; and plaque PH. Sugars and other fermentable carbohydrates, after being hydrolyzed by salivary amylase, provide substrate for the actions of oral bacteria, which in turn lower plaque and salivary PH. The resultant action is the beginning of tooth demineralization. Consumed sugars are naturally occurring or are added.[2]

Many factors in addition to sugars affect the caries process, including

- The form of food or fluid,
- The duration of exposure,
- The nutrient composition,
- The sequence of eating,
- The salivary flow,

- The presence of buffers, and
- The oral hygiene.

Studies have confirmed the direct relation between intake of dietary sugars and dental caries across the life span. Since the introduction of fluoride, the incidence of caries worldwide has decreased, despite increases in sugars consumption. Other dietary factors (example: the presence of buffers in dairy products; the use of sugarless chewing gum, particularly gum containing xylitol; and the consumption of sugars as part of meals rather than between meals) may reduce the risk of caries. The primary public health measures for reducing caries risk, from a nutrition perspective: are the consumption of a balanced diet and adherence to dietary guidelines and the dietary reference intakes; from a dental perspective: are the primary public health measures are the use of topical fluorides and consumption of fluoridated water.[3,4]



Graph 1: Tooth decay percent over the life span.

OBJECTIVES OF THE STUDY

AIM: To determine the role of diet in the prevention of caries.

Objectives

1. The objective of this study is to provide the relationship evidence between Dental Caries and the diet.
2. To assess the cariogenic potential of food stuff.
3. To study about the sugar substitutes or sweetener alternatives.

4. To carry dietary scanning and to educate the people about dental practice.
5. To provide dietary recommendations.

MATERIALS AND METHODS

The study of the role of diet in caries prevention is studied by the different types of investigation including human studies (both observational and intervention), carried out in a defined group of population.

STUDY AREA

The Cross Sectional studies are carried out in the area of Saudi Arabia.

STUDY SUBJECTS

Inclusion criteria were as follows:

1. Human participants;
2. Publication in the English language;
3. Patients who had been exposed to fluoride supplements
4. Evidence provided to answer the clinical questions;
5. Reported outcomes of either caries or enamel fluorosis;
6. Examination of patients to determine presence of caries or enamel fluorosis;
7. For caries-prevention studies, a study design that included both control and experimental groups.

STUDY DESIGN

Cross Sectional type of study design

In addition to diet, some cross-sectional studies can also consider tooth brushing habits and exposure to fluoride.

DATA COLLECTION METHODS

The study of the role of diet in caries prevention involves the data collection using Questionnaire, observation recording, etc.

Dental diseases are a costly burden to health care services. The treatment of dental caries is expensive for governments of both developed and developing countries and costs between 5 and 10% of total health care expenditures in industrialized countries exceeding the cost of treating cardiovascular disease, cancer and osteoporosis . In most developing low-income

countries, the prevalence rate of dental caries is high and more than 90% of caries is untreated. The level of caries is higher for the primary dentition than the permanent dentition for children of several developing countries. The severity of disease in the permanent teeth is generally low and mostly limited to the occlusal and buccal/lingual surfaces. Available data show that the mean DMFT at age 12 years of low-income countries is 1.9 compared with 3.3 DMFT for middle-income countries and 2.1 DMFT for high-income countries. In low-income countries, the cost of traditional restorative treatment of dental disease is disproportionately expensive in light of the low public health priority and it would exceed the available resources for health care. The large financial benefits of preventing dental diseases should be emphasized to countries where current disease levels are low.[17]

The impact of dental diseases on quality of life despite a low mortality rate associated with dental diseases, they have a considerable impact on self-esteem, eating ability, nutrition and health both in childhood and older age. Teeth are important in enabling consumption of a varied diet and in preparing the food for digestion. In modern society, the most important role of teeth is to enhance appearance; facial appearance is very important in determining an individual's integration into society. Teeth also play an important role in speech and communication. The second International Collaborative Study of Oral Health Systems (ICSII) revealed that in all countries covered by the survey substantial numbers of children and adults reported impaired social functioning due to oral disease, such as avoiding laughing or smiling due to poor perceived appearance of teeth. Throughout the world, children frequently reported apprehension about meeting others because of the appearance of their teeth or that others made jokes about their teeth. In addition, dental diseases cause considerable pain and anxiety. These factors are likely to be exacerbated in less developed societies where pain control and treatment are not readily available. Dental decay also results in tooth loss, which reduces the ability to eat a varied diet. It is, in particular, associated with a diet low in fruits, vegetables and non-starch polysaccharides (NSP), and with a low plasma vitamin C level. NSP intakes of less than 10 g/d and fruits and vegetable intakes of less than 160 g/d have been reported in edentulous subjects13–15. Tooth loss may, therefore, impede the achievement of dietary goals related to the consumption of fruits, vegetables and NSP. Tooth loss has also been associated with loss of enjoyment of food and confidence to socialise13. It is, therefore, clear that dental diseases have a detrimental effect on quality of life both in childhood and older age.

Eating has a multiple role in our lives: we grow up and develop because of getting nourishing food, and after growth is over, we use food as the energy source for daily activities. In addition, eating is, and has always been, a social event, and a good meal can be delightful when enjoyed with family members or shared with good friends. But, eating has its negative sides too − the most recent problem is the alarmingly increasing rates of obesity among children and young adults. The high risk of chronic diseases related to obesity we have known for quite a while but, since obesity is now rapidly increasing, we can forecast large scale health problems in the future. A long list of chronic diseases is associated with obesity − atherosclerosis, high blood pressure, other cardiovascular diseases and diabetes. In addition, excess weight is an extra load to the skeleton and hence increases the risk of hip and knee problems. One of the main reasons for increasing obesity throughout the world is the changing eating habits.[26]

In the past 20 years, the Saudi fast-food restaurants providing fried and other high-energy food products have been accepted throughout the world. Because of long working hours, people seem to have fewer regular mealtimes and, instead, seem to be snacking, that is eating and drinking continuously. These habits are easily picked up by children. Among the diet-related oral problems we can mention developmental defects of tooth enamel (Figures 4-5) which may be due to the following:

Figure 4: Incisor hypo-mineralization of unknown origin.

- Gluten intolerance;
- Dioxide in breast milk;
- A vitamin deficient diet.
- D deficient diet.

Figure 5: Frontal view and intraoral details of hypo mineralization affecting first permanent molars and maxillary and mandibular incisors.

The prevalence of molar incisor-hypo mineralization is reported to be around 10−19%, but estimations as to which proportion is diet-dependent have not been given so far. Occasionally, we see lesions, which are mostly related to frequent use of erosive fruit juices and drinks (Figure 6) and, in children, the frequency ranges from 2−57%.

Figure 6: Localised lesions in a patent.

The most important diet-related health problem in the oral cavity is dental caries. The picture of a 3-year-old child with early childhood caries is included to make two points (Figure 7). First, it seems that at this young age the association between poor eating habits and dental caries can still be clearly seen and, secondly, because at this age healthier eating habits can be adopted. As caries lesions today can be examined by several methods and with considerable accuracy, it is only reasonable to use similar accuracy to examine etiologic factors.

Figure 7: Advanced early childhood caries in a 3-year-old girl.

Frequency of Sugar Consumption

There is only weak correlation between the total intake of sugar and the incidence of dental caries. However, as noted in the Vipeholm study, the frequency of ingestion, as well as the form of the carbohydrate is the critical factors in the cariogenicity of foodstuffs.

Products that are sticky, retained for long periods in the mouth, or consumed with high frequency have a higher cariogenicity than foods that are eliminated quickly from the oral cavity. Therefore, frequent ingestion of hard candies, throat lozenges, etc. that contain fermentable carbohydrates can be extremely harmful to the teeth.

A study using programmed feeding machines clearly demonstrated that rats exposed to a high sugar diet will experience caries according to the number of times per day a high sugar diet is presented to them. Conversely, rodents fed sugar infrequently (three times a day) experience no smooth surface caries, suggesting that the natural defenses in the mouth can counteract the damage done by bacterial acid production from moderate sugar exposure.[15]

Likewise, human pH telemetry studies show that subjects consuming three meals a day have periods of demineralization counteracted by periods of re-mineralization; however, if meal and snack periods are frequent, demineralization periods are increased and there are no re-mineralization periods.

Aside from the well-documented harm of high sugar intake on teeth, excessive sugar intake is also a concern to the general health of children. High sugar-containing foods generally are low in essential nutrients and may be substituted for more nutritious foods in a child's diet.

The United States Department of Agriculture's Food Guide Pyramid clearly shows that sugar should be a very small component of the diet.[16]

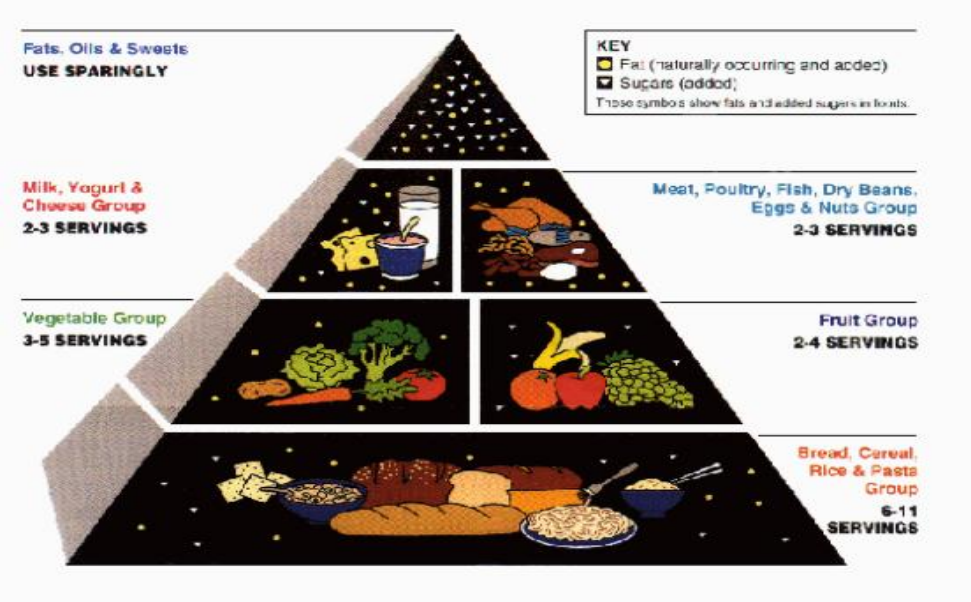


Figure 8: Food guide pyramid by United States Department of Agriculture.

One example of high frequency sugar consumption is prolonged or night time bottle-feeding practices. Yet recent evidence suggests that, while sleeping with a bottle is an important risk factor, it is perhaps, an over simplification of the cause of the rampant caries process. In another study, 90% of children in a population with and without caries were bottle-fed between 12 and 18 months of age, yet the prevalence of "nursing caries" was only 20%.[20] Since this feeding pattern is pervasive, it follows that parents of children with early childhood caries often respond affirmatively to the question, "Do you put your child to bed with a bottle?". Thus, it is logical that the bottle-tobed habit is inferred as the "cause" of Early Childhood Caries. Reisine and Douglass[21] have recently reviewed the studies on infant feeding patterns and found little support for the conclusion that use of a night time bottle is a major caries risk factor. However, despite the findings of Reisine and Douglass, it is still appropriate to discourage the bottle-to-bed habit because sleeping with a bottle, especially those containing sugar, will certainly contribute to high frequency contact of substrate to the bacteria. Another controversial, yet poorly documented caries risk is the potential cariogenicity of prolonged or nigh ttime breastfeeding. However, one cannot dismiss a possible association between reported rampant caries in these cases and other cariogenic dietary practices. Further study is required to determine the prevalence of early childhood caries in exclusively breastfed children, and whether child-rearing practices, such as lack of restriction in getting snacks[26] could contribute to caries in breastfed children as well as in bottle-fed children.

Caries and Diet – A Complex Relationship

Eating dietary carbohydrates does not imply that dental caries will develop. Not only what we eat, but also the behavioral aspects and circumstances related to consumption play a role. This was first demonstrated in the Vipeholm study where one and the same sugary item resulting in large variations in caries prevalence depending on whether it was consumed at or in between meals (Gustafson et al. 1954). This is applicable also for today's generation where a variation in intake of one and the same intake frequency may have varying impact on the outcome of caries. The composition of dietary intake of the modern human population has changed dramatically.

Lately, also sugar amount has been put into focus and a new understanding of the relationship between sugars and dental caries has been suggested. The recommendation of sugar intakes ≤10% of the daily energy intake (E) does not, due to the still high remaining caries burden internationally, suffice, and a daily intake of <5% E has instead been suggested (Moynihan & Kelly 2014, Sheiham & James 2015).

The likelihood that a person consuming dietary carbohydrates will develop caries depends also on caries-preventive factors, including genetics, which may counter-act for negative dietary habits (Bretz et al. 2006). The final outcome is an end result of the balance between caries-promoting and protective factors.

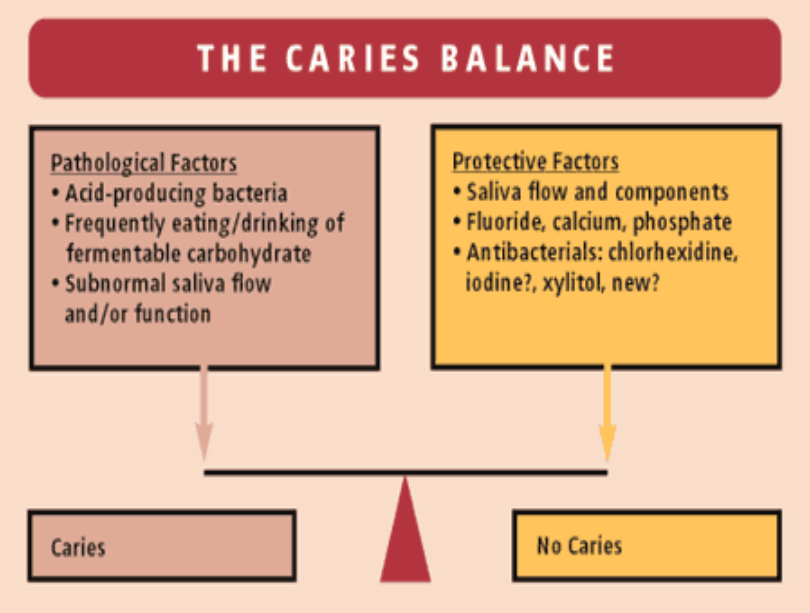


Figure 13: Schematic Representation of Pathological Factors and Protective Factors that can cause and prevent Caries respectively.

CROSS SECTIONAL STUDIES

Recording diet (sugar intake)

In many earlier studies national averages of annual sugar consumption were compared to average levels of dental health: today, when dental caries is no longer evenly distributed, national averages cannot be used any longer. Individual sugar intake data are needed to explain the level of dental health of a particular individual. Currently, there are three methods to obtain food consumption data. The first two are used the most, and the third only in specific conditions. The main use, advantages and disadvantages of each method are described in Table 1.

Method	Use	Limitations	Advantages	Disadvantages
Food records / Food Diary/ Diet Diary	Prospective, Counselling, Research.	None	Accurate	Time-consuming. Relies on patient's Accuracy and Truthfulness
24-hour recall	Population studies	Not for young children nor for the very old	Rapid, cheap 20 min	Underestimates sugar and alcohol intake
Retrospective diet history	Diet consumed 10-20 years earlier	Not for patient Groups with impaired memory	Excellent to study dietary aspects of chronic diseases	Underestimates sugar and alcohol Time-consuming

1. Diet diary

The food diary or diet diary is recorded during 3 or 7 consecutive days. From among the recorded days both weekdays and weekend days should be represented. Subjects asked to keep a diet diary need clear instructions how to record the quality and the amount of food consumption. Exact descriptions of the time, type, brand and preparation method of all foods and drinks are needed. The amount consumed is asked to be recorded using ordinary household measures like glasses, cups or tablespoons. Pictures of portions can be used for further assistance. The method is used for prospective purposes, and is the best method for dietary counselling. The method is suitable for scientific purposes, accurate (provided the patient records thoughtfully and accurately) and allows recording of nutrient intake at 10% accuracy level. A disadvantage is that it is time consuming to record and analyze.

2. 24-hour recall

The 24-hour recall is perhaps the most common. It records the diet of the previous day, and is suitable for population studies. The method is rapid, taking only about 20 minutes to record,

and is therefore inexpensive. Unfortunately, it is inappropriate for very young or very old subjects and may underestimate the consumption of alcohol and sweets.

3. Retrospective diet history

The Retrospective diet history is relatively seldom used since the method was developed to record diet 1−2 decades earlier. Diet history can be used for subjects up to old age. It gives reliable information about diet of regular meals and is suitable for dietary risk assessment of chronic diseases. However, the method is expensive as it needs about 60−90 minutes to record. Apart from patients with obvious memory dysfunctions, no age-related limitations are known to prevent the use of this method. Underestimation of sugar, fat and alcohol are the known disadvantages.

DISCUSSION

The early 1990s represented a turning point for oral health professionals. Dental health had improved substantially without concomitant changes in sugar intake. Indeed, studies from Saudi Arabia showed that, although the average sugar intake had remained the same during the past 30 years, the intake of sweets and soft drinks had increased. This did not match with the basic information we used to have about the etiology of caries. There was then a 10-year period of confusion among both health professionals and academics. However, much of the confusion disappeared when it was realized that daily exposure to fluoride in the form of toothpaste was the factor that raised the sugar tolerance of tooth enamel and was the major cause for the improvement of dental health and for the weakened correlation between sugar intake and dental caries. Systematic literature reviews on dietary factors in prevention of dental caries have modified our current concept of the association between sugar intake and dental health.

In the pre-fluoride era, the correlation between the average DMFT score in 12-year-olds and the average sugar consumption in 47 countries has been described with a straight line. Later a sigmoidal curve has been presented to illustrate the relationship between sugar intake and dental health. At low levels of sugar intake caries is very low, but when sugar consumption is between 15 and 35 kg per year, dental caries increases with increasing sugar intake. At high levels of sugar intake, the curve flattens out and a saturation level is reached. Further increase of sugars content of the diet does not seem to increase caries on population level. Keeping in mind that the annual sugar consumption in many Middle East Gulf countries is clearly above

35 kg, we can understand partly why the correlation between sugar intake and caries has become weaker.

Another fictional way to describe the association between sugar intake and dental health is to include the effect of fluoride. This modification shows that individuals with good oral hygiene and regular fluoride exposure tolerate higher sugar intake levels before caries occurs than their counterparts without regular use of fluorides. In other words, the widespread exposure to fluoride may raise the threshold level of safe intake of sugar. However, it is important to keep in mind when giving dietary advice for caries prone patients that, in spite of the correlation between sugar intake and caries being weak, there is still a clear correlation between the amount and frequency of sugar intake.

To study the current relationship between sugar intake and dental health in young age groups, we had accurate data on children's sugar intake since infancy as the children were participants of a long-term dietary study. The parents kept food diaries of 3−4 days biannually until the children reached six years of age. Dental examinations were carried out at 3 and again at 6 years of age. At the age of 6 years, the children were divided in two groups according to caries status. The daily sugar intake of children with caries was 8 grams higher than the intake of children with no caries. When the sugar intake information from 3 years earlier was examined, it was noted that both groups had increased their daily sugar intake but the difference between the two groups was exactly the same, 8 daily grams. There were no differences in fluoride exposure or social class between these two groups of children.[36]

From this study it became apparent that sugar intake habits start early in childhood, but it was still not known quite how early. So we made another study with a group of children selected from the same area in Saudi Arabia. From among the whole group of nearly 900 children, the two 5% extremes of sugar intake were selected and their sucrose intake studied from infancy. At 10 years of age, the dental health of these children was examined. The results showed that the children in the low sucrose intake group had clearly better dental health than their counterparts in the high intake group. There were no differences in salivary variables, fluoride or xylitol exposure or social class between these two groups of children. This work also investigated the sources of sugar children used to obtain their daily need. It was known from earlier studies that the sale of juices and sweets had increased by 12% and 28%, respectively, and that about half of the weekly allowances of the adolescents are spent on

sweets. It was also known that the consumption of sweets was about 60% higher than ten years earlier.

Our findings showed that the ten most usual sources of sugars were:

- Cocoa;
- Different types of fruit juices and soft drinks;
- Breakfast cereals;
- Yoghurt;
- Lemonades;
- Ice-cream;
- Cookies;
- Sweet fruits;
- Chocolate; and
- Jams.

The most frequent sources of added sugar were in the form of sweet liquids, and this did not seem to have anything to do with seasonal variation of the outside temperature.

When we enter a supermarket today, almost anywhere in the world, we get the same picture: we see huge walls of soft drinks, the bottles and the servings are getting bigger and bigger. According to the latest sale reports, the soft drink consumption has more than doubled during the last decades. The new drinking habits expose our children to the risks of obesity and tooth erosion in addition to dental caries. Today, erosive drinks are used on a daily basis and we start to see the unfortunate results of the new drinking habits in our offices. We should be aware that the results about the weak relationship between sugar intake and dental health are carefully read by representatives of the soft drink and the confectionary industry. The soft drink companies sponsor vending machines to schools to promote soft drink sale. For those school authorities or health professionals who are hesitant or resistant to accept these machines these companies produce a list of scientific publications, showing that there are no health risks involved because, in developed countries, there does not seem to be any correlation between sugar intake and dental health. ‘On the contrary’ they say, ‘children need the extra energy from soft drinks to survive the exhausting school-days’.

Human behavior is a major determinant of health but how can we intervene to improve both general and oral health. Further collaboration with behavioral scientists should explore eating

patterns of children under 2 years of age, and study behavioral aspects of sweets and soft drink consumption. There is also a need to know more about the dietary habits of elderly citizens who are at higher risk of root caries. Finally, dietary intervention studies should be designed, aiming at healthier eating and drinking habits.

Therefore, all health professionals should join forces and work towards the same goal. All efforts are needed to promote better eating and drinking habits and, even if dental health were under control, we should do our best to prevent our children from consuming sugar too much and too many times.

CONCLUSIONS

It is concluded that the role of diet is not so much related to the diet itself but to the individual behavior of people. Where oral hygiene and fluoride supplementation are adequate, the diet has become a lesser factor in caries prevention. However, those diets may cause caries when there is too little fluoride.

The dental health with low levels of sugar consumption is better than that of their counterparts using excessive amounts of sugar, in spite of the current level of fluoride exposure. Moreover, there are still patient groups whose fluoride exposure is insufficient, like the very young children with recently erupted teeth and elderly citizens with large areas of exposed root surfaces.

NUTRITION EDUCATION AND COUNSELING

Nutrition education for the purposes of reducing caries incidence is aimed at teaching parents the importance of reducing dietary exposures to sweet foods and hidden sugars. Education is necessary, but not sufficient to change eating behaviors. Diet counseling aims to help parents change their and their children's dietary behaviors so that they choose diets with low or non-cariogenic snacks, limit sweet foods to mealtimes and perform tooth brushing after sugar exposures. Dietary recommendations must be realistic and always based on current dietary behaviors of the family. It is pointless to prescribe changes that a patient cannot or will not implement. Additionally, modifications to the diet can only be made over time, aided by repetition and reinforcement. The goal must be to help caregivers develop lifelong dietary habits, which promote general and oral health for themselves and for those whom they influence. Two studies in Saudi Arabia have tested the effect of preventive education programs for new mothers on the subsequent caries experience of their children. One study

provided diet and oral hygiene counseling to the test group at 6, 12 and 24 months of age, as well as fluoride supplements. This study observed a 65% lower caries experience in the 4-year-old children of 9 mothers who received counseling as compared to the control group.[41] Another study with a similar program found a 42% decrease in caries prevalence after 4 years.[42] There also is limited evidence that preventive diet counseling can be effective for people who have serious caries problems. Two studies conducted with caries active individuals show that dietary counseling and reinforcement reduced caries increment 85%[43] and 60%[44] Although the results of these few studies are encouraging, it is not clear why there have not been more studies to explore the potential of dietary counseling in reducing dental caries. Clearly, there needs to be more information regarding the counseling procedures, the magnitude of effect and the costs before dietary counseling can be recommended as a routine caries preventive procedure. With the current information regarding the effect of diet counseling on caries incidence, the emphasis should be on utilizing counseling for those individuals who are at high caries risk.

DIETARY ADVICE

Dietary advice for parents/care taker of infants

Breast milk provides the best source of nourishment for the early months of life. Mothers are encouraged and supported in breast-feeding and may choose to continue to breast-feed as the weaning diet becomes increasingly varied.

Children have high energy needs for growth and development. It is important that children are given energy rich foods that are nutritious such as cereals, breads, dairy foods, and meats, chicken and eggs. Foods from the first four shelves of the food pyramid should be used to replace foods from the very top shelf that are high in added sugars/fats such as chocolate, cakes and sweets.

Practical tips

Foods

- Do not add sugar to home prepared weaning foods.
- Limit baby foods sweetened with added sugars.

Drinks

- Milk and water are the best drinks for children.

- Breast milk is the best form of nourishment for young infants. If is it not possible to breast feed, a suitable iron-fortified infant formula should be used. Cow's milk is not advisable for infants less than 1 year old but is a suitable drink for older infants. Milk is a good source of calcium which is necessary for the development of teeth and bones.
- For children allergic to cow's milk, soy milk (also called soya milk, soybean milk or soy juice) is an alternative. Soy milk contains sugar and can cause dental decay if children are allowed drink it on demand throughout the day from a feeding bottle. Soy milk should be used as a "feed" and not as a drink.
- Plain tap water is a suitable drink for all ages but should be boiled – just once, for about 1 or 2 minutes – and cooled for infants less than 1 year. Natural mineral/bottled waters may not be suitable for infants because of their mineral levels.
- Fruit juices should be unsweetened, well diluted to diminish their acidity and natural sugar content (1 measure to 4 or 5 measures of boiled water) and given only at mealtimes from a cup. Baby juices and herbal drinks are not needed, but if given should be used sparingly and only at mealtimes from a cup.
- Colas, squashes, fizzy drinks and diet drinks are unsuitable for infants as they are highly erosive to tooth enamel and have no nutritional value.
- Foods should never be added to the baby bottle as babies can choke from the added food.
- Infants should be weaned from using baby bottles by their first birthday.

Baby Bottle/Nursing Decay

Parents of infants should be warned particularly about the dangers of putting fruit juices or sugar-sweetened drinks into feeding bottles or reservoir feeders and giving these to the baby/toddler to hold, especially in bed. Such practices result in almost continuous bathing of the enamel with sugars and leads to severe and rapid tooth destruction, a condition described as baby bottle/nursing decay.

"Children should be fed and put to bed - NOT, put to bed and fed"

- Do make sure that your child does not sleep with a bottle in his or her mouth
- Do avoid all sugar-containing liquids in nap or bedtime bottle
- Do encourage drinking from a cup
- Do discontinue bottle feeding by your child's first birthday
- Do avoid dipping a soother in sugar, honey or anything sweet before giving to your child.

School children/adolescents

Changes in eating habits due to relative independence from family influences and the influence of peers can result in changes in health behaviors and diet, specifically in relation to sugar.

Overall, there has been a slight improvement in the dietary habits of school-aged children in recent years: the 2012 Saudi Health Behavior of School-Aged Children. Study reports a slightly higher percentage of children consuming fruits and vegetables more than once daily and a slightly lower percentage consuming sweets and soft drinks daily or more often, compared with 2006.

Practical tips

Foods

- Suggestions for between meal snacks are fruit, crisp raw vegetables, sandwiches, variety of breads, yoghurts, low fat cheese, plain popcorn and scones
- Cereals such as porridge and shredded wheat are excellent energy providers, but avoid the sugar-coated types. In general, the sugar and salt content of breakfast cereals should be checked as some breakfast cereals are high in one or the other or both.

Drinks

- Milk and water are suitable to drink between meals.
- Pure juices, fruit squashes and smoothies should be consumed at meal times.
- Drinks containing added sugars, including probiotic and yoghurt type drinks, should be consumed at meal times.
- Regular intake of carbonated drinks, including sparkling water, can lead to enamel erosion of the teeth and should be avoided.

Adults and Older people

Loss of natural teeth is associated with poor nutritional status in the elderly. Consumption of sugars seems to be higher in older adults than in younger adults.

A tendency towards reduced salivary flow together with a higher sugar intake and increased gum recession, places the older person with natural teeth at greater risk of dental caries (root caries) than younger adults.

This population group tend to be frequent users of over the counter medicines, e.g. cough drops, laxatives, antacids and various tonics, which are generally high in sugar. The most important cause of dental erosion in adults is regurgitation and acidic drinks. Dietary advice for dental health for adults with natural teeth should be consistent with general health dietary guidelines.

Practical tips

Foods

- Older people should be encouraged to eat a variety of healthy foods (e.g bananas, nuts, berries, yoghurts, vegetables and wholegrains) as snacks from the food pyramid and limit foods from the top level of the Food Pyramid that are high in sugar, fats and salts but low in nutrients such as cakes, sweets, biscuits and soft drinks.

Drinks

- The consumption of 8-10 cups of fluid a day is important for this age group.

REFERENCES

1. Aine L. Dental enamel defects and dental maturity in children and adolescents with coeliac disease. Proc Finn Dent Soc, 1986; 82(III): 73. Thesis, Institute of Dentistry, University of Turku.
2. Alaluusua S, Lukinmaa PL, Koskimies M et al. Developmental dental defects associated with long breast feeding. Eur J Oral Sci., 1996; 104: 493−497.
3. Alaluusua S, Calderara P, Gerthoux PM et al. Developmental dental aberrations after the dioxin accident in Seveso. Environ Health Perspect, 2004; 112: 1313−1318.
4. Mejàre I, Bergman E, Grindefjord M. Hypomineralized molars and incisors of unknown origin: treatment outcome at age 18 years. Int J Paed Dent, 2005; 15: 20−28.
5. Linnett V, Seow WK. Dental erosion in children: a literature review. Pediatr Dent, 2001; 23: 37−43.
6. Karvetti RL, Knuts LR. Validity of estimated food diary: comparison of 2- day recorded and observed food and nutrient intakes. J Am Diet Assoc, 1992; 92: 580−584.
7. Birkhed D, Sundin B, Westin SI. Per capita consumption of sugar containing products and dental caries in Sweden from 1960 to 1985. Community Dent Oral Epidemiol, 1989; 17: 41−43.
8. Scottish Intercollegiate Guidelines Network. Preventing Dental Caries in Children at High Caries Risk – A National Clinical Guideline. SIGN Publication, 2000; 47: 32.

9. Lingström P, Holm AK, Mejàre I et al. Dietary factors in the prevention of dental caries: a systematic review. Acta Odontol Scand, 2003; 61: 331−340.
10. Zero DT. Sugars − the arch criminal? Caries Res 2004; 38: 277−285.
11. Burt BB, Pai S. Sugar consumption and caries risk: a systematic review. J Dent Educ, 2001; 65: 1017−1023.
12. Grindefjord M, Dahllöf G, Nilsson B, Modeer T. Stepwise prediction of dental caries in children up to 3.5 years of age. Caries Res., 1996; 30: 256−266.
13. Petti S, Tarsitani G, Panfili P, Simonetti D, Arca A. Oral hygiene, sucrose consumption and dental caries prevalence in adolescent systemic fluoride non-users. Community Dent Oral Epidemiol, 1997; 25: 334−336.
14. Sreebny LM. Sugar availability, sugar consumption and dental caries. Community Dent Oral Epidemiol, 1982; 10: 1−7.
15. Moynihan P. Diet and dental caries. In: Prevention of Oral Diseases. Murray JJ, Nunn JH, Steele JG eds. New York: Oxford University Press, 2003; 1−34.
16. Rugg-Gunn AJ, Hackett AF, Appleton DR et al. Relationship between dietary habits and caries increment assessed over two years in 405 English adolescent schoolchildren. Arch Oral Biol., 1984; 29: 983−992.
17. Karjalainen S, Sewón L, Söderling E et al. Oral health of 3-year-old children and their parents after 29 months of child-focused anti-atherosclerotic dietary intervention in a prospective randomized trial. Caries Res., 1997; 31: 180−185.
18. Ruottinen S, Karjalainen S, Penihäkkinen K et al. Sucrose intake since infancy and dental health in 10-year-old children. Caries Res., 2004; 38: 142−148.
19. www.etl.fi/english/stat. Domestic sales of Finnish Food products.
20. Nordblad A, Suominen-Taipale L, Rasilainen J, Karhunen T. Sugar consumption. In: Oral Health Care at Health Centres from the 1970s to the year 2000. Helsinki: National Research and Development Centre for Welfare and Health (STAKES) Reports, 2004; 278: 56.
21. Van Loveren C, Duggal MS. Experts' opinions on the role of diet in caries prevention, 2004; 38(1): 16−23.
22. Kalsbeek H, Verrips GH: Consumption of sweet snacks and caries experience of primary school children. Caries Res., 1994; 28(6): 477-483.
23. Gustafsson BE, Quensel CE, Lanke LS, Lundqvist C, Grahnen H, Bonow BE, Krasse B: The Vipeholm dental caries study; the effect of different levels of carbohydrate intake on

caries activity in 436 individuals observed for five years. Acta Odontol Scand, 1954; 11(3–4): 232-264.

24. Palmer CA, Kent R, Loo CY, Hughes CV, Stutius E, Pradhan N, Dahlan M, Kanasi E, Vasquez SSA, Tanner ACR: Diet and caries-associated bacteria in severe early childhood caries. J Dent Res., 2010; 89(11): 1224-1229.
25. Evans EW, Hayes C, Palmer CA, Bermudez OI, Naumova EN, Cohen SA, Must A: Development of a pediatric cariogenicity index. J Public Health Dent., 2013; 73(2): 179-186.
26. Shirota T, Yoshizumi F: A study on convenient dietary assessment. Nihon Koshu Eisei Zasshi, 1990; 37(2): 100-108.
27. Yoshihara A, Watanabe R, Hanada N, Miyazaki H: A longitudinal study of the relationship between diet intake and dental caries and periodontal disease in elderly Japanese subjects. Gerodontology, 2009; 26(2): 130-136.
28. Tanaka K, Miyake Y, Sasaki S, Ohya Y, Miyamoto S, Matsunaga I, Yoshida T, Hirota Y, Oda H: Magnesium intake is inversely associated with the prevalence of tooth loss in Japanese pregnant women: the Osaka Maternal and Child Health Study. Magnes Res., 2006; 19(4): 268-275.
29. Tanaka K, Miyake Y, Sasaki S, Ohya Y, Matsunaga I, Yoshida T, Hirota Y, Oda H: Relationship between intake of vegetables, fruit, and grains and the prevalence of tooth loss in Japanese women. J Nutr Sci Vitaminol (Tokyo), 2007; 53(6): 522-528.
30. Sasaki S, Yanagibori R, Amano K: Self-administered diet history questionnaire developed for health education: a relative validation of the test-version by comparison with 3-day diet record in women. J Epidemiol, 1998; 8(4): 203-215.
31. Vellas B, Guigoz Y, Garry PJ, Nourhashemi F, Bennahum D, Lauque S, Albarede JL: The Mini Nutritional Assessment (MNA) and its use in grading the nutritional state of elderly patients. Nutrition, 1999; 15(2): 116-122.
32. Rubenstein LZ, Harker JO, Salvà A, Guigoz Y, Vellas B: Screening for undernutrition in geriatric practice: developing the short-form mini-nutritional assessment (MNA-SF). J Gerontol A Biol Sci Med Sci., 2001; 56(6): M366-M372.
33. Furuta M, Komiya-Nonaka M, Akifusa S, Shimazaki Y, Adachi M, Kinoshita T, Kikutani T, Yamashita Y: Interrelationship of oral health status, swallowing function, nutritional status, and cognitive ability with activities of daily living in Japanese elderly people receiving home care services due to physical disabilities. Community Dent Oral Epidemiol, 2013; 41(2): 173-181.

34. Kuzuya M, Kanda S, Koike T, Suzuki Y, Satake S, Iguchi A: Evaluation of Mini-Nutritional Assessment for Japanese frail elderly. Nutrition, 2005; 21(4): 498-503.
35. Yokoyama Y, Kakudate N, Sumida F, Matsumoto Y, Gilbert GH, Gordan VV: Dentists's dietary perception and practice patterns in a dental practice-based research network. PLos One, 2013; 8(3).
36. Evens CC: Snacking patterns as a risk factor for early childhood caries. 1997, PhD Thesis. University of Washington.
37. Papas AS, Palmer CA, Rounds MC, Herman J, McGandy RB, Hartz SC, Russell RM, DePaola P: Longitudinal relationships between nutrition and oral health. Ann N Y Acad Sci., 1989, 561: 124-142.
38. Nakai Y, Shinga-Ishihara C, Kaji M, Moriya K, Murakami-Yamanaka K, Takimura M: Xylitol gum and maternal transmission of mutans streptococci. J Dent Res., 2010; 89(1): 56-60.
39. Nunally JC, Bernstein IH: The assessment of reliability. Psychometric theory, New York: McGraw-Hill, 1994; 248-290; 3.
40. Shrout PE, Fleiss JL: Intraclass correlations: uses in assessing rater reliability. Psychol Bull, 1979; 86(2): 420-428.
41. Kleinknecht RA, Thorndike RM, McGlynn FD, Harkavy J: Factor analysis of the dental fear survey with cross validation. JADA. 1984; 86: 842-848.
42. Kolodziejczyk JK, Merchant G, Norman GJ: Reliability and validity of child/adolescent food frequency questionnaires that assess foods and/or food groups. JPGN, 2012; 55(1): 4-13.
43. Tanabe Y, Park JH, Tinanoff N, Turng BF, Lilli H, Minah GE: Comparison of chairside microbiological screening systems and conventional selective media in children with and without visible dental caries. Pediatr Dent, 2006; 28(4): 363-368.
44. Twetman S, Mattiasson A, Varela RJ, Bratthall D: Mutans streptococci in saliva and dental caries in children living in a high and a low fluoride area. Oral Microbiol Immunol, 1990; 5: 169-171.
45. Thorild I, Lindau B, Twetman S: Effect of maternal use of chewing gums containing xylitol, chlorhexidine or fluoride on mutans streptococci colonization in the mother's infant children. Oral Health Prev Dent, 2003; 1(1): 53-57.