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Nutrition And Dental Caries: Strong Teeth For Good Eat

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Abstract:

Dietary quality and nutrition are important in the promotion and maintenance of health throughout one's life span. It occupies an important part in health promotion and disease prevention. Nutrition is an integral component of oral health. Caries occurs due to damage and dissolution of tooth structure resulting from a highly localized decrease of the pH at the plaque- tooth interface and tooth demineralization. The elimination of bio-elm activity of which can result in mineral loss. There is a clear synergy between oral health and nutrition; nutrition plays a crucial role in maintaining the integrity and normal function of the oral cavity. Appropriate nutrition early in life represents a major determinant of the child's dental, as well as general health.

Keywords – diet, nutrition, dental caries, fluoride

Introduction

In the fast-paced, technologically driven world, it has been noted, that the most important foundation of normal living is being neglected i.e. health. As a consequence of the busy courses of people's lives, they tend to forget some of the vital fragments in maintaining a healthy lifestyle- diet and nutrition. Dietary quality and nutrition are important in the promotion and maintenance of health throughout one's life span. It occupies an important part in health promotion and disease prevention. When combined with other modifiable factors like habits or physical activity, diet & nutrition may have an additive or multiplier effect on an array of chronic/ systemic diseases **(WHO 2002)** [(19)]. It also determines responses to medical therapy in a number of physical and iatrogenic conditions. A child's diet has a profound ability to influence cognition, behaviour and emotional development in addition to ultimate physical growth and development. Eating patterns and food choices among children and teens are important factors that affect how quickly youngsters may develop tooth decay.

The Convergence

The terms "diet" and "nutrition" are defined into two different sentences but are greatly connected. Diet refers to the food and liquid intake of a person while nutrition pertains to the science of dealing with food and nourishment and studies the relationship between diet and health ***(Jeremy Low 2007)*** [(6)]

It is rightly said that ***the road to good health begins in the mouth*.** Nutrition is an integral component of oral Health". Oral health and nutrition have a synergic graph. Oral infectious diseases and certain systemic diseases with oral manifestations affect the functional ability to eat as well as diet and nutrition. Likewise, nutrition may affect the development and integrity of the oral cavity. In no time the influence upon future health is more evident than the period of early development in the mother's womb. The pregnant woman needs to gain optimum weight and have an adequate supply of essential nutrients so that the developing foetus does not suffer from any orofacial deformity ***(Committee on maternal Nutrition of national research 1990, Maternal Nutrition and the course of human pregnancy 1970)*** [(9)]

Looking at the broader context today, the role of good nutrition in improving the health of the population cannot be disputed as it also helps in tackling child and adult obesity, heart disease, cancer, diabetes, stroke, high blood pressure and high cholesterol.

Nutrients and Their Role

Nutrients are organic and inorganic complexes contained in food and can be divided into

1. **Macronutrients**: These are proteins, fats and carbohydrates which are often called "Proximate principles" because they form the main bulk of food.

    Proteins: 7 - 15 percent

    Fats: 10 - 30 percent

    Carbohydrates: 65 - 80 percent

2. **Micronutrients:** These are vitamins and minerals. These are called so because they are required in small amounts which may vary from a fraction of a milligram to several grams.

The Effect of Nutritional Deficiencies

Child malnutrition includes under-nutrition and over-nutrition, both of which are deficiency diseases caused by inadequate nutrition (Ge & Chang 2001). During childhood, under-nutrition causes children to have less energy and less interest for learning, which negatively influences cognitive development and academic performance. Under-nutrition will also affect physical growth and maturation, thus affecting growth rate, body weight and ultimately height.

Obesity is a special form of malnutrition, as this type of diet is likely to have low nutrient-density as well as high fat and high carbohydrate content (Tanumihardjo et al. 2007). There is growing concerns of the prevalence of paediatric obesity, as this comes with an increased risk of developing cardiometabolic disease in adolescence and adulthood. Obesity in children also affects confidence and competence during physical activity and thus further compounds proper growth and development.

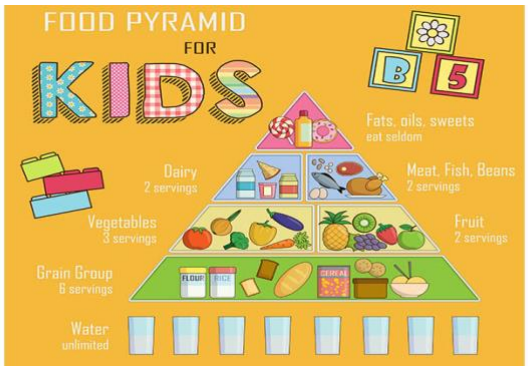

Figure 1- Food pyramid for kids

Nutrition plays an important role in the growth and development of children, with a healthy diet synergistically enhancing physical and mental abilities. Malnutrition in children is detrimental to the development of their physical growth, cognitive abilities, and psychosocial skills, with multiple downstream effects in the short-term and long-term. Healthcare professionals are ideally placed to have a frank, open, and respectful conversation with parents about child nutrition, and should be encouraged to do so. [17]

Effects of protein deficiency on the jaw & teeth

Synthesis of protein in a cell is disrupted resulting in disturbed tissue growth and development. Teeth of children who suffer from protein caloric malnutrition tend to be crowded and rotated **(Trowell HC, Davies JNP et al.,1954, Enwonwu CO 1969).** There can be delayed eruption and hypoplasia of deciduous teeth.

Effect of protein deficiency on Dental caries

The following factors probably contributed reduced salivary flow and therefore reduced total buffering capacity, a reduced in demineralization and antibacterial activity, altered morphology of dentition, decrease in the immune response.

3. **Lipids**

Lipids are a group of compounds that are not of uniform composition but are related by both relative insolubility and solubility solvents such as ether, alcohol and chloroform. The term lipid is an all-inclusive one for fat and fat like substances. It embraces the:

1) True fats- e.g. –butter, margarine vegetable oil and body deposit fat

2) Substances whose molecular structure includes fatty acids or fatty acid derivatives

3) Compounds present in minor amounts associated with lipids in nature-ergosterol

Sources

In the food 90% of the fat comes from

a) Salad and cooking oil, butter and margarine

b) Meat, poultry and fish

c) Milk cheese and yoghurt

Fats and Oral Health

The mechanism whereby fat reduces dental caries are probably as follows-

1. Coating of the tooth surface with an oily substance would mean that food particles will not be readily retained.
2. A fatty protective layer over plaque would prevent fermentable sugar from being reduced to acids.
3. High concentration of fatty acids may interfere with the growth of cariogenic bacteria.
4. Increased dietary fat will decrease the amount of dietary fermentable carbohydrates necessary for organic acid formation.

4. **Carbohydrates**

These are organic compounds of the elements, carbon, hydrogen and oxygen. The carbohydrate molecule is composed of a hydrated carbon atom CH_2O. Carbohydrates are the principal source of energy in the diet and are starting materials for the synthesis of fatty acids and amino acids. They are also a part of structure of biologically important structures like glycolipids, glycoproteins, nucleic acids and heparin.

Fluorides and Dental Health

Fluorine, a trace element, is a halogen like chlorine, bromine, and iodine.

It is found everywhere throughout nature. The major source of ingested fluoride is water, particularly from deep artesian wells. It is found in soils rich in fluorspar (calcium fluoride), cryolite (sodium aluminium fluoride), and other minerals. It is also found in plants, foodstuffs, and body tissues. In humans, fluoride is found mainly in the calcified structures - the teeth and the skeleton.

It is a nutrient beneficial to dental health and it is included in the 1980 Recommended Dietary Allowances, which emphasizes its importance in nutrition **(Committee on dietary Allowances 1980)** [3].

For temperate climates the optimal fluoride level in water supplies for reduction of dental caries without undesirable mottling is 1 ppm (part per million). Based on infants' and young children's normal intake of between 2 and 4 glasses of water or the equivalent per day, this level of 1 ppm would provide a total daily intake of 0.5 to 1 mg of fluoride per day. For older children, adolescents, and adults, the intake from water would be equivalent to 1.5 to 2 mg of fluoride per day because they may drink between 6 and 8 glasses of water or the equivalent (1500 ml) per day.

A study on "Fluoride Concentration in Saliva following Professional Topical Application of 2% Sodium Fluoride Solution" has shown that remineralization in the presence of fluoride and saliva is more resistant to decay. A short-term use of topical fluoride is used to raise the fluoride level of tooth surface. The fluoride level is maintained using fluoride toothpaste daily. It can also desorb bacteria from hydroxyapatite because it can bind more effectively to positively charged areas on the apatite crystal than can bacteria.

Prenatal Fluoride Supplement

Infants exposed prenatally will have higher plasma, skeletal, and developing enamel fluoride levels than those not exposed to prenatal fluoride **(Drinkard CR 1986, Parker PR and Bawden JH 1986)**.

It is deposited in the enamel via the systemic (affecting the body as a whole) route when the lattice is developing and maturing because mature adult tooth enamel has no cells, it is not affected directly by systemic fluoride.

In the mouth penetrates the enamel surface by diffusion through the minute spaces between the enamel crystals and through remineralization of the tooth surface. This local effect is increased when the crown is newly erupted into the mouth.

Fluoride in the tooth enamel of individuals who regularly drink water containing 1 ppm of fluoride can reach 800 to 900 ppm in the outer layers **(Issac S, Brudevold F et al., 1958).** In the developing enamel fluoride is deposited within the body of the crystal, whereas in the fully formed enamel fluoride is mainly deposited in the surface layer of the tooth.

Table 1. Recommended Daily Fluoride Supplements for Children in Three Age Categories, Based on Fluoride Concentration in the Water Supply

Age of Child(years)[b]	**Supplementation (ppm) Corresponding to Three Levels of Fluoride in the Water Supply (ppm)**		
	<0.3	**0.3 to 0.7**	**>0.7**
0 to 2	0.25	0.00	0.00
2 to 3	0.50	0.25	0.00
3 to 13	1.00	0.50	0.00

a. Adapted from Levy (1986). Recommended by the Council on Dental Therapeutics of the American Dental Association, by the Committee on Nutrition of the American Academy of Pediatrics, and by the American Academy of Pediatric Dentistry.

b. American Academy of Pediatrics recommends providing tablets from 2 weeks of age through at least 16 years of age.

Fluorides and Prevention of Dental Caries

The salivary fluoride level is derived from systemic fluoride and exerts a topical effect on the tooth during the early post eruptive period when the enamel surface can be altered by the chemistry of the oral environment. Higher the fluoride level in the water, the greater is the initial rate of deposition during tooth mineralization.

There are three mechanisms by which fluoride inhibits caries, and usually more than one is involved. These mechanisms are –

(1) an increase in the enamel's resistance to acid solubility as a result of a high concentration of fluoride in the outer enamel surface

(2) the ability of fluoride to remineralize demineralized or hypomineralized enamel

(3) fluoride's antibacterial effects on plaque growth, glycolysis, glycogen synthesis; acid production, production of extracellular polysaccharides necessary for plaque adhesion to tooth surface, and solubility of calcium phosphate deposits within plaque. The greater the concentration of fluoride released from the dissolved enamel or already present in the plaque; more remineralization will be favoured and carious process will be slowed.

Pigman W, Cueto H 1964 and **Kolourides, Fiegan F et al., 1965** have shown that fluoride level as low as 1 ppm enhances remineralization.

If fluoridated table salt is considered 200 to 300 mg of fluoride should be added to a kilogram of salt ***(Wespi J 1961, Muhlemann HR 1967)***

Antibacterial action

Fluoride will inhibit many enzymes for carbohydrate metabolism. It also has an inhibitory effect on glycolysis. Lower the surface energy of the tooth, thereby making bacterial attachment and plaque formation difficult **(Shoultaus JD and Arends J 1986)**

Diet and Dental Caries

Apart from the systemic effect, diet also exerts local effect on oral health and especially on the teeth, commonly known as dental caries. Dental caries is one of the most prevalent diseases in children (**Wei SHY 1974)**. It is a pathological disease process resulting from bacterial and dietary interactions (**Bowen WH, Amsbaugh SM et al., 2002)** [(17).] It is a multifactorial disease requiring the presence of a susceptible tooth, cariogenic microflora (plaque), and a diet conducive to enamel demineralization **(Newbrun E 1978)** [(16)]**.** It is primarily affected by dietary choices but may be secondarily influenced by nutritional status that may vary over the course of the life span.

Caries occurs due to damage and dissolution of tooth structure resulting from a highly localized decrease of the pH at the plaque- tooth interface and tooth demineralization. The local pH drop occurs as a result of plaque metabolism. Only mature plaque with high concentration of mutans streptococcus and Lactobacillus can produce sufficiently low pH to cause demineralization of the tooth. A single exposure to cariogenic diet results in rapid metabolism of the nutrients to organic acids.

The organic acids (primarily lactic acid) dissociate to lower the local pH. Many episodes of long duration demineralization (lowered pH) occurring over long periods, produces the characteristics of caries.

It is a disease that dates back to antiquity and occurs in populations that have never used the modern diet. However, the prevalence of dental caries appears to increase with civilization, urbanization, and affluence. There is presently an alarming rate of increase in the prevalence of dental caries in developing countries. The introduction of the modern diet has been associated with increased caries prevalence. On the other hand, most developed countries have seen a significant and continuing reduction in caries prevalence in the last 30 years in spite of living on the same food **(Murray JJ, Rugg-Gunn AJ et al., 1991)**.

Formation of a salivary pellicle on the tooth surface supports the initiation of dental plaque, the first overt clinical evidence of the interaction between diet and oral bacteria. Over a period of time food (specifically fermentable carbohydrate) metabolism supports the colonization of the bacteria on the tooth surface and orchestrates a change in the acid base milieu. More specifically it is the bacteria from the mutans streptococci and lactobacilli species that are the more prolific producers of lactic acid responsible for removing calcium and phosphate from the tooth leading to the carious lesion. At a critical pH of about 5.5, demineralization occurs especially when this acidic environment is maintained over a period of time. When this pH exceeds above 5.5 for a significant time remineralization of the enamel can repair or reverse the initial damage. However specific food groups, food ingredients and dietary pattern may influence the strength of direction that this dynamic process maintains over time.

Proteins and dental caries

It is known that carnivores hardly develop dental caries and persons on high protein diet have no particular susceptibility to dental caries. At the same time there is very little information to indicate that the presence of protein in carbohydrate containing diet may influence the caries producing ability. The protein of wheat gliadin and glutenin possess the property of forming gluten when moistened with water. Gluten in bread, decreases the salivary sugar enhancing effect of the bread**.**

Fats and Dental caries

Evidence proves that fat has a limiting effect on dental caries. fatty acids of six to twelve carbon in length show inhibition of oral microbial growth e.g. Lactobacilli, staphylococci, streptococci. Certain fatty acids like oleic acid when applied to a tooth surface prior to its exposure to acid saliva affords protection against decalcification. **(10)**

Carbohydrates and dental caries

Sugars are a form of fermentable carbohydrate. Fermentable carbohydrates are carbohydrates (sugars and starch) that begin digestion in the oral cavity via salivary amylase. Numerous lines of evidence have conclusively established the role of sugars in caries aetiology and the importance of sugars as the principal dietary substrate that drives the caries process has not been scientifically challenged. While sugars appear to differ little in acidogenic potential, sucrose has been given special importance, as the sole substrate for synthesis of extracellular glucans.

It is indisputable that mutans streptococci's role in caries development is conditional upon a frequent intake of fermentable sugars. They are strongly dependent on dietary carbohydrates. Mutans streptococci are able to rapidly metabolize dietary sugars to acid, creating locally a low pH **(Marsh PD 1998)**.

The presence of sucrose-specific glucosyltransferases (GTFs) in mutans streptococci led to a presumption of a unique relationship between these bacteria and sucrose. Sucrose is split into glucose and fructose by mutans streptococci invertase, fructosyltransferase or GTFs. The three pathways by which S. mutans may dissimilate sucrose are –

1) Conversion of sucrose to adhesive extra cellular carbohydrate polymer by cell bound and extracellular enzymes.

2) The transport of sucrose into the cell interior accompanied or followed by direct phosphorylation for energy utilization through the glycolytic pathway leading to lactic acid production

3) The degradation of sucrose to free glucose and fructose by invertase. The intermediary metabolites from sucrose enter the glycolytic cycle and may be utilized in intracellular polymer synthesis in order to provide a reservoir of energy

Sucrose can polymerize the glucose and fructose moieties of sucrose to synthesize two types of extracellular polymers, glucans and fructans.

Two type of glucose homopolymers are formed; one type is called dextran and the other type is mutans. Mutans is an important constituent of the fibrillar plaque matrix and is less soluble and more resistant to enzymatic attack.

Intracellular glucans and extracellular polysaccharide serve as substrate reservoirs which the organism may utilize for energy production.

Sucrose adapted S. mutans strains possess significant levels of invertase activity. This enzyme hydrolyses sucrose intracellularly to free glucose and fructose.

The importance of oral hygiene in the production of tooth decay

The elimination of bio-elm activity of which can result in mineral loss. Therefore, from the point of view of the physio pathological mechanism, it is plausible that tooth brushing is a legitimate action of dental caries.

AAPD Guidelines (Revised 2017)

Based on accepted guidelines, the following recommendations can be made:

1. Infants should be breast-fed during the first year of life, although ad libitum nocturnal breast-feeding should be discouraged after the first primary tooth erupts.

2. Bottle-fed infants should not be put to sleep with the bottle.

3. Children should be weaned from the breast or the bottle by 12 to 14 months of age.

4. Infants older than 6 months and with exposure to less than 0.3 ppm fluoride in their drinking water need dietary fluoride supplements of 0.25 mg fluoride per day.

5. Parents should be advised to reduce their child’s sugar consumption frequency.

6. Infants should be allowed to consume only 4 to 6 oz of fruit juice per day. They should not be given powdered beverages or soda pop, as these drinks pose increased risk for dental caries.

7. Only iron-fortified infant cereals along with breast milk or infant formula should be given to infants who are older than 6 months of age. Cow's milk should be completely avoided in the first year of life and restricted to less than 24 oz per day in the second year of life.

8. Parents should be counselled on the potential of various foods that constitute a choking hazard to infants.(1)

CONCLUSION

Nutrition is vital to human growth and development. The health care paradigm has shifted; physicians, dentists and registered dieticians, as well as other health professionals, are increasingly responsible for the conduct of comprehensive health screening, discipline specific management and referral to the appropriate to provide more comprehensive care.

There is a clear synergy between oral health and nutrition; nutrition plays a crucial role in maintaining the integrity and normal function of the oral cavity. As oral cavity reflects the systemic health status, most of the disease manifestations, including nutritional disorders can be seen in oral cavity and it will be important on part of dentist to aid in early diagnosis, intervention & prevention of these disorders. Nutrient deficiencies and oral manifestations of diseases which alter the integrity contribute to compromised dietary intake, resulting in deficiency states and malnutrition.

Appropriate nutrition early in life represents a major determinant of the child's dental, as well as general health. Caregivers need information and guidance to help foster positive dietary and dental health behaviours that enable an early start in preventing dental caries in their children. Dietary guidance should begin with the mother before birth and continue through infancy and childhood. These nutritional and oral care strategies should have a meaningful impact on the child's growth and development and diminish the caries experience.

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