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Oral health and nutrition for children under five years of age: a paediatric food-based dietary guideline

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Keywords: food-based dietary guidelines, FBDGs, oral health, nutrition in children, five years

Abstract

Good nutrition is essential for good health and the development and integrity of the oral cavity. Oral health is integral to general health and essential to well-being. Dental caries is the most common oral disease in children under five years of age, and although preventable, still affects many children, particularly those from disadvantaged socio-economic backgrounds. High consumption levels of sugary food and drinks have been implicated as an important dietary cause of obesity, diabetes, coronary heart disease and dental caries. The global obesity epidemic has attracted policy-makers' attention to the relationship between diets that are rich in added sugars (particularly glucose, sucrose and high-fructose corn syrup) and obesity, diabetes, metabolic syndrome and cardiovascular disease risk factors. The aim of this paper is to review the literature and summarise the evidence that relates to diet and nutrition as a cause of oral diseases, such as dental caries, and early childhood caries. The Common Risk Factor Approach will be described as a way in which health promotion and preventive initiatives that advance oral health and nutrition in children under five years of age can be achieved. Recommendations are provided on public health strategies with regard to nutrition education, food policies, diet counselling and the promotion of adequate fluoride exposure via appropriate vehicles.

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S Afr J Clin Nutr 2013;26(3)(Supplement):S150-S155

Introduction

Good nutrition is essential for good health and the development and integrity of the oral cavity. Oral health is integral to general health and essential to well-being.¹ A nutritious diet that protects against other major health conditions, such as obesity, may also reduce dental caries. Oral health and noncommunicable diseases share risk factors, such as diet, tobacco and alcohol, and have high co-morbidity (cancer and diabetes). The World Health Organization (WHO) recommends that member states focus their policies on the determinants of health, of which diet is a main influential factor. Therefore, policies that aim to promote health should include the provision of safe, adequate and affordable food for the whole population.²

The prevalence of dental caries is high, but has received insufficient attention because it is not a life-threatening condition. The most recent National Children's Oral Health Survey (1999-2002) showed that dental caries was more severe in primary than permanent dentition. The Western Cape province had the highest prevalence of dental caries in all age groups. Based on weighted national means, the Unmet Treatment Needs index was 92% for children aged 4-5 years. The report concluded that "the prevention of early childhood caries should be an important priority for provinces", and that "every effort should be made to encourage and promote positive oral health habits".³

Dental caries is the most common oral disease in children under five years of age, and although preventable, still affects many children, particularly those from disadvantaged socio-economic backgrounds.⁴ The presence of dental caries greatly impacts on the quality of life of a child and his or her family because of pain and discomfort, the disruption of eating patterns, sleepless nights and an increase in the risk of chronic infection.⁵ In addition, high consumption levels of sugary food and drinks have been implicated as an important dietary cause of obesity, diabetes, coronary heart disease and dental caries. The global obesity epidemic has attracted policy-makers' attention to the relationship between diets that are rich in added sugars (particularly glucose, sucrose and high-fructose corn syrup) and obesity, diabetes, metabolic syndrome and cardiovascular disease risk factors.⁶

The nutrition transition

Global economic growth has given rise to what has been termed the "nutrition transition".⁷ As incomes have risen and populations became more urban, there has been a shift in diet from complex carbohydrates, fibre, whole grains, vegetables and fruit to a Western diet that has a high proportion of fat, salt and added sugar.^{7,8} The progression through the nutrition transition in many low-income countries where Western diets have been adopted has resulted in increasing rates of caries levels, weight gain, obesity and related diseases. The cost of food poses

a significant barrier to many consumers trying to balance good nutrition with affordability, and consequently diets consist mainly of cheap, highly processed food and drink (soft drinks and fruit juice), sugar, sweets and ready-to-eat cereals. Over the past 50 years, sugar consumption has tripled worldwide.⁹ It is important to distinguish between sugar that is naturally present in vegetables, fruit, grains and milk for oral health and general health purposes (as evidence shows that these foods are not associated with dental caries), and sugar that is added.¹⁰ Published research has examined the association between key risk factors and the development of dental caries cross-sectionally and longitudinally.¹¹ However, little is known of the vertical interaction in the paradigm between molecular impact and psychosocial impact in developing countries, and particularly within and between ethnically diverse or disadvantaged, impoverished populations.

Sugar, sugar-sweetened beverages, health and oral health in children

Literature from a growing body of epidemiological evidence, including human observational and intervention studies, animal experiments and experimental laboratory studies, has shown that sugar is the principal cause of dental caries,^{10,12-14} and is a threat to oral health from infancy into old age.¹³ There is no good evidence, with the exception of lactose, that the cariogenicity of the different sugars, such as sucrose, glucose and fructose, varies.¹⁵ Population studies have shown that there is a low risk of developing dental caries from consuming starch-rich staple food, without the addition of sugar. Starchy staple food is of little importance in the development of caries. Cooked staple starchy food, such as rice, potatoes and bread, is of low cariogenicity in humans. The cariogenicity of uncooked starch is very low.^{10,16} In general, people who consume high-starch, low-sugar diets experience caries less often than those who consume low-starch, high-sugar diets.¹⁰

In addition to the harmful effects on the teeth, experimental, epidemiological and intervention studies have shown that sugar consumption and, in particular, fructose, induces all the diseases associated with metabolic syndrome,¹⁷ such as obesity, hypertension, high triglyceride levels, insulin resistance and diabetes from increased liver glucose production.^{12,18-20} Lustig, Schmidt and Brindis²¹ consider that fructose exerts a toxic effect on the liver, similar to that of alcohol. The harmful effect of added sugars, such as high-fructose corn syrup and sucrose, has led to requests to regulate and tax products with high levels of those sugars. The effect of an excess intake of sugar on nutrient adequacy is of concern. Soft drinks, sugar and sweets are more likely to have a negative impact on diet quality. Johnson et al showed a direct relationship between an energy-dense, low-fibre, high-fat dietary pattern and increased obesity in childhood in a prospective study.²²

Experimental, epidemiological and intervention studies have suggested that sucrose and other free sugars contribute to the development of chronic diseases, including the global epidemic of weight gain and obesity.^{12,18,19,22} (The term "free sugars" includes sugar added by manufacturers, cooks or consumers, as well as sugar that is present in fruit juices, honey and syrups.) Consensus international and national guidelines already exist on the need to reduce sugar consumption.¹² Governments should develop strategies to implement the recommendations of the report of the joint WHO/Food and Agricultural Organization of the United Nations expert consultation on diet and the prevention of chronic diseases. They should also support food-based dietary guidelines (FBDGs).¹⁰

Sugar-sweetened beverages contain added caloric sweeteners, such as sucrose, high-fructose corn syrup or fruit juice concentrates. They include soft drinks, carbonated soft drinks, fruit juices, sports drinks, energy and vitamin drinks, sweetened iced tea, cordials, squashes and lemonade,²³ and contribute from 35% to more than 50% to the total intake of added sugar in some children's diets.²⁴ Dental erosion is the chemical dissolution of dental hard tissue by extrinsic and intrinsic acid without bacterial involvement,²⁵ and if not controlled, can result in severe tooth surface loss, tooth sensitivity and poor aesthetics.²⁶ Dental erosion is commonly associated with the frequent intake of sugar-sweetened beverages,²⁷ which weakens the integrity of the tooth and increases caries risk. The prevalence of dental erosion is associated with dietary factors.²⁸⁻³⁰ Malik et al found that the use of vitamin C supplements, frequency of the use of fizzy drinks and the consumption of fruit syrup from a feeding bottle at bedtime or during naps by babies significantly increased the prevalence of erosion. They reported that in a survey of 3.5- to 4.5-year-old children who drank carbonated drinks on most days of the week, 22% had erosion, compared to only 8% of children who consumed this type of drink less often.³⁰

A higher intake of soft drinks has been associated with a lower intake of milk, calcium and other nutrients, greater energy intake and body weight, and less desirable health indices.²⁹⁻³² Ludwig et al³³ showed that for each additional serving of sugar-sweetened drink that was consumed, body mass index and frequency of obesity increased. Evidence from systematic reviews and a meta-analysis of prospective studies has found a clear association between the consumption of sugar-sweetened beverages and the increased risk of developing type 2 diabetes³⁴ and cardiovascular disease.^{23,34} High regular consumption of sugar-sweetened beverages by young children is a risk indicator for dental caries in the primary dentition.³⁵⁻³⁷ Overweight children appear to consume more sweet drinks than normal-weight children.³⁸

In summary, there is evidence to show that high levels of sugar consumption lead to an increase in a number of chronic diseases, including dental caries. International recommendations suggest that sugar should provide less than 10% of total energy intake, or less than 60 g per person per day. This should be approximately 30 g/day in young children.¹⁰ The frequency of sugar-containing food and drinks should be limited to a maximum of four per day. When sugar is consumed more than four times a day, caries levels increase. Parents and caregivers needed to be alert to the presence of "hidden sugar", which is found in many processed and manufactured food and drink.¹⁰

Sugar in baby foods and paediatric medicine

Sugar should not be added to food or drink that is given to babies, as this can lead to tooth decay when the first teeth come through. Governments should set stringent codes of practice on the sugar content of commercial baby food. Paediatric medicine and medicine that is sold over the counter should not contain sugar. Health professionals should always check if a medicine contains sugar and prescribe or offer sugar-free alternatives, wherever possible. In addition, government control on advertising, including on the Internet, of sugar-rich items directed at children, needs to be implemented. Food manufacturers could produce low-sugar or sugar-free alternatives to products that are rich in free sugars, including baby drinks.^{10,12,13}

The role of fluoride in caries prevention

The role of fluoride in protecting teeth against dental caries is well established,³⁹ and optimal exposure to fluoride remains the cornerstone of caries prevention. Exposure to fluoride alters the sugar-caries relationship. When there is good exposure to fluoride, sugar consumption is a moderate risk factor for caries. With widespread use of fluoride, sugar consumption still has a role to play in the prevention of caries, but this role is not as strong as it is without exposure to fluoride.¹⁰ At a biological level, fluoride promotes the remineralisation and inhibits the demineralisation of the tooth structure. The sustained presence of low concentrations of ionic fluoride in the oral environment enhances remineralisation and has a bacteriostatic effect.^{39,40} The twice-daily use of a pea-sized amount of fluoridated toothpaste is an important preventive practice to reduce dental caries and, if available, fluoride varnishes are also useful.⁴¹ Improving access to affordable fluoride toothpaste is an essential component of a caries-prevention programme. Many countries are undergoing nutritional transitions and may not have adequate exposure to fluoride. There is a call for the promotion of fluoride via appropriate vehicles, like affordable toothpaste, water, salt and milk.⁴² Water fluoridation, when feasible and culturally acceptable, could be considered as a public health option, particularly in populations with high levels of caries.⁴²

Early childhood caries

Early childhood caries is a complex, multifactorial, but preventable dental disease in infants and preschool children. It is a public health concern because of widespread and increasing prevalence, inequitable distribution in preschool children and its negative consequences on children, their families and public health programmes.⁴³ Early caries affects a disproportionate number of children from low socio-economic groups and ethnic minorities. Epidemiological data have shown consistent patterns of inequalities in early childhood caries that is determined by socio-economic status.⁴⁴ Milnes⁴⁵ reported that, while the prevalence rate of early childhood caries varied from 1-12% in developed countries, in developing countries and within disadvantaged populations of developed countries (immigrants and ethnic minorities), the prevalence rate was as high as 70%. Many barriers to obtaining dental care exist for young children in many parts of the world, but there appears to be a clear stepwise social gradient, replicating the pattern found in other childhood conditions.^{46,47} In addition, different cultural beliefs about health, diet, disease, hygiene and the importance of primary teeth may create additional oral health risk factors through dietary and feeding practices and child-rearing habits.⁴⁸

As described by Fass,⁴⁹ the presentation of a child suffering from rampant caries is a shocking experience. He published the first comprehensive description of caries in infants, which he termed "nursing bottle mouth". The clinical appearance of early childhood caries includes the presence of one or more decayed (noncavitated or cavitated lesions), missing (due to caries) or filled teeth in any primary tooth in a child 71 months or younger.⁵⁰ Noncavitated lesions appear as smooth, dull, white or brown spots on the primary maxillary (upper) teeth. Cavitated lesions appear as brownish, rough breaks, normally on the smooth enamel surfaces. This is indicative of severe early childhood caries in a child who is younger than three years of age.⁵¹

Diet and nutrition have a direct influence on the progression of tooth decay. It is widely recognised that dental caries is a preventable infectious disease that is strongly modified by diet. The caries process is influenced by the susceptibility of the tooth, the bacterial profile, the quantity and quality of saliva and the presence of fluoride, which promotes remineralisation and inhibits demineralisation of the tooth enamel. Prevention, intervention and reversal of dental caries can be enhanced by either reducing the pathological factors or enhancing the protective factors.⁴⁰ However, in young children, bacterial flora and host defence systems are still being developed, and carers need to negotiate the dietary transition through breast and bottle feeding, first solids and children's food preferences. It has been reported that there may be unique risk factors for dental caries in infants and

young children.⁵² Early childhood caries is preventable and, with proper oral hygiene and regular exposure to fluoride, the risk of caries can be reduced.⁵³ Contributing factors that predispose children to early childhood caries include prolonged and night-time bottle feeding of milk and sweetened juice by infants and toddlers, nocturnal breastfeeding after 12 months of age, linear hypoplasia of the primary teeth associated with malnutrition, and the prolonged use of a pacifier covered with honey, sugar or other sweetened foods.^{54,55} The risk of developing early childhood caries increases in a very young child whose older siblings have a history of dental caries.⁵¹

The implications of early childhood caries

Early childhood caries is characterised by a high prevalence,⁴⁶ high impact⁴⁴ and high resource requirements.⁴⁴ If left untreated, it results in pain, bacteraemia, reduced growth and development, speech disorders and premature tooth loss, with its sequelae of compromised chewing, loss of self-esteem and harm to the permanent dentition.⁵⁶ Its seriousness and societal costs continue to be a significant public health issue, especially in racial or ethnic minorities.⁵⁵ There is considerable evidence that children who experience early childhood caries continue to be at high risk of new lesions as they grow older, both to the primary and permanent dentitions.⁵⁷ Treatment of early childhood caries is expensive and time consuming, often requiring extensive restorative treatment and extraction of teeth at an early age.⁵⁸

Early childhood caries has also been implicated in contributing to other health problems. Children with early childhood caries were shown to weigh less than 80% of their ideal weight, and to be in the lowest tenth percentile for weight.⁵⁹ The mean age of "low-weight" patients with early childhood caries was significantly greater than that of patients at, or above, their ideal weight, indicating that the progression of early childhood caries may affect growth adversely. In addition, the quality of life of the child suffers. Pain or infections associated with early childhood caries may make it difficult for the child to eat. Alternatively, poor nutritional practices may be responsible for reduced weight and caries. Severe dental caries affects nutrition, growth and weight gain.^{60,61} Intervention studies have shown that children with severe caries weighed less than their matched controls, and that after treatment of decayed teeth, there was more rapid weight gain.^{62,63} The association between dental caries and growth is thought to be because dental pain restricts dietary intake. The chronic inflammation caused by caries is also known to suppress growth through a metabolic pathway, and to reduce haemoglobin as a result of depressed erythrocyte production.⁶⁴

Breastfeeding and early childhood caries

The evidence that suggests that prolonged and nocturnal breastfeeding is associated with an increased risk of early childhood caries is limited and inconsistent, and is based primarily on cross-sectional studies that rely on the retrospective recall of infant feeding practices.⁶⁵⁻⁶⁸ Furthermore, these studies and subsequent longitudinal studies have failed to adequately measure and control for confounding variables in their study design, such as dental hygiene practices, fluoride usage and dietary factors, including the intake of sugar-based food or beverages, and noncariogenic food, such as milk and dairy products. Scientific evidence of the beneficial effects of breastfeeding on general health is well accepted. Epidemiological studies have also shown minimal adverse effects from breastfeeding on caries development.^{14, 69,70}

The prevention of early childhood caries

Any healthcare worker who cares for children under five years of age is in an ideal position to assist in the prevention of early childhood caries. The education of mothers or caregivers in the prenatal period, prior to the first tooth eruption and following eruption of the first tooth, is critical. The goal of the educational initiative is to increase the knowledge of the mother of causes and risk factors associated with early childhood caries, encourage breastfeeding, promote good oral hygiene and improve the dietary habits of mothers through positive role modelling. It is assumed that an increase in the knowledge of mothers or caregivers will influence their self-care habits and dietary practices and, in turn, improve the dietary and oral hygiene habits of infants, leading to the prevention of early childhood caries.⁵⁶

The primary emphasis of diet counselling should be on sugar intake frequency. The combination of infant feeding practices and repeated consumption of fermentable carbohydrates, such as sweetened beverages or highly processed starchy or sugary foods, increases caries risk.⁷⁰ Bottle-fed infants should not be put to sleep with the bottle. Weaning from the bottle should be encouraged at 12-14 months of age.⁷⁰ Established dietary recommendations emphasise that the selection of a variety of foods, a low intake of fat, saturated fat and cholesterol, and moderate use of salt and sodium reduce the risk of chronic disease.⁴ However, dental diseases, especially caries, are rarely addressed. Dietary advice that is given for general development and well-being needs to be integrated with oral health counselling.⁷¹

Nutrition education and counselling for the purposes of reducing caries in young children aims to teach parents the importance of reducing high-frequency exposure to obvious and hidden sugar.

Guidelines include:

- Avoiding the frequent consumption of juice or other sugar-containing drinks.
- Discouraging the child from sleeping with a bottle.
- Promoting noncariogenic foods as snacks.
- Fostering eating patterns that are consistent with healthy eating guidelines.
- Limiting cariogenic food to mealtimes.
- Rapidly clearing cariogenic food from the child's oral cavity, either by brushing his or her teeth, or ensuring the consumption of protective foods, e.g. cheese and nuts.
- Restricting sugar-containing snacks that are slowly eaten, e.g. sweets, lollipops and suckers.

A reduction in sugar, in line with the WHO recommendations, promotes good oral health and also has a significant impact on reducing levels of overweight and obesity in children.¹⁴

Together with nutritional factors, a comprehensive approach and a paradigm shift in preventive approaches is urgently needed³ to prevent dental caries in preschool children. Changing eating and drinking patterns requires a coordinated strategic approach, which addresses underlying influences on food consumption and creates a more supportive environment promoting healthier nutrition. Food policies and health promotion initiatives need to adopt a range of complementary intervention strategies. A coalition of partners working together is required to achieve a common goal.⁷¹ In addition, efforts should focus on ensuring that there is a wide range of processed baby food and medicine for children that is sugar-free. Policy makers need to make healthy choices the easier choices.

Appropriate advice which targets mother from disadvantaged backgrounds on infant feeding, dietary practices and oral hygiene measures should be a major focus. Furthermore, health professionals require nutrition training so that they are able to offer evidence-based nutritional preventive support in primary healthcare and other community settings, particularly at strategic times in the life course, such as during pregnancy. Infant feeding policies which promote exclusive breastfeeding and appropriate complementary food choices are critically important.³ The South African paediatric FBDGs include specific advice pertaining to oral health. The following FBDGs have been proposed: "Avoid giving tea, coffee and sugary drinks and high-sugar, high-fat and salty snacks" to children aged 6-36 months; and "Use sugar and food and drinks high in sugar sparingly"⁷¹ in children aged 3-5 years. The paediatric FBDGs still need to be field tested to ensure accurate communication of the oral health message.

Conclusion

This paper has reviewed the literature and summarised the evidence that shows that diet and nutrition are associated with oral diseases such as dental caries, early childhood caries and dental erosion in children under five years of age. Evidence-based strategies to prevent and improve oral health and nutrition need to be integrated into policies, programmes and practices that reduce the overall caries burden. In addition, partnerships between local, national and international governmental structures and the private sector need to be forged at all levels. A paradigm shift in health promotion and preventive initiatives is needed to promote oral health in children under five years of age, and to alleviate the barriers (physical, cultural, racial, ethnic, social, educational, environmental and those pertaining to health care) that prevent optimal oral health from being achieved.

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