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The effect of dietary intervention on paraffin-stimulated saliva and dental health of children participating in a randomized controlled trial

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ABSTRACT

Objectives: The aim was to study the impact of dietary intervention on the properties of paraffin-stimulated saliva, and on dental caries.

Study design: At 7 months of age 1062 infants (540 intervention; 522 controls) started in the prospective, randomized Special Turku Intervention Project (STRIP) aimed at restricting the child's saturated fat and cholesterol intake to prevent atherosclerosis of adult age (www.clinicaltrials.gov NCT 00223600). At 3 years of age, every fifth child was invited to an oral substudy, and 148 (78 boys) children attended. At 6, 9, 12 and 16 years of age 135, 127, 114 and 88 children were restudied, respectively. Dietary intakes of carbohydrates, protein, saturated fat, calcium, phosphate, and fibre were regularly recorded using 4-day food records. Height and weight were regularly monitored. Paraffin-stimulated saliva samples were collected at 6, 9, 12 and 16 years of age, and analyzed for flow rate, buffer capacity, calcium, phosphate and proteins. Dental health was recorded and expressed as $d_3$mft/D_3MFT, and as time of caries onset.

Results: Dietary intakes of calcium, phosphate and fibre, and salivary flow rate increased with time in both groups ($p < 0.001$, GLM for repeated measures). Fibre intake and salivary flow rate were higher in the intervention than in the control group ($p = 0.042$ and $p = 0.0394$, respectively, GLM for repeated measures). There were no correlations between dietary intakes and salivary concentrations of calcium or phosphate. Children who did not have caries experience ($d_3$mft/D_3MFT = 0) during the entire follow-up had higher salivary calcium than those who had caries already at 3 years of age. The association between salivary calcium and caries onset was significant up to 12 years of age. Toothbrushing frequency was statistically significantly associated with caries-onset at ages 6 (gamma statistic 0.457, $p = 0.046$) and 12 years (gamma statistic 0.473, $p = 0.019$).

Conclusions: The current long-term dietary intervention increased children's paraffin-stimulated salivary flow rate. The concentration of salivary calcium was directly correlated to dental health. Higher salivary flow rate in the intervention group is believed to be due to higher fibre intake in the intervention group.

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1. Introduction

Nutrition affects general health in many ways but surprisingly little is known about the effects of nutrition, except those of acids and fermentable sugars, on oral health. Extreme conditions such as severe malnutrition in early childhood may affect salivary glands causing decrease in salivary flow rate and changes in salivary composition. So far it is not known if these salivary changes are permanent in humans as in animals.[1,2] Impaired salivary function in early childhood may increase the risk of caries at least in the primary dentition.[2]

Saliva is essential for the maintenance of oral health. Saliva protects against soft tissue damage and hard tissue loss. The higher the salivary flow rate, the faster the sugar and acid clearance.[3] Carbonic acid/bicarbonate buffer is the main buffering system in stimulated saliva. High salivary flow rate is usually associated with high salivary pH and buffering capacity.[4,5] The effect of diet on buffering capacity itself is not clear.

In addition to buffering, mechanical cleaning and antimicrobial properties, saliva remineralises the outer enamel surface after acid challenge. Calcium and phosphate are of particular importance in this respect. Saliva, supersaturated with calcium and phosphate, acts as a reservoir of these electrolytes. There are some studies showing that high salivary calcium is associated with dental health. Sewón and Mäkelä[6] found a positive correlation between high salivary calcium and the number of intact teeth in young adults. Recently Preethi et al.[7] studied physicochemical properties of unstimulated saliva in caries free and caries active children. In caries active children salivary calcium levels were lower than in caries-free children. So far there are no studies on the relationship between dietary intake and salivary level of calcium.

Though the association between sugar intake and dental caries is widely accepted, the effect of other ingredients or fibre content of the diet has been scarcely studied. Diets being hard, containing much fibre and requiring mechanical chewing are known to be beneficial for dental health because of the resulting increase in salivary flow rate. In general, when salivary flow rate increases, buffering capacity increases. Bioactive compounds found in some foods e.g. bioactive casein phosphopeptides in dairy products, tea and cranberry-derived polyphenols may protect teeth e.g. from erosion[8,9] and caries.[10,11] Studies on the effect of other type of diets on dental health are scarce and derived mainly from individuals on vegetarian/lactovegetarian diets.[12,13] During short-time fasting salivary flow rate, calcium and phosphate are reduced.[14,15] In a recent longitudinal study (STRIP project) we showed that the current early-onset counselling of saturated fat- and cholesterol-restricted diet decreased not only serum but also salivary cholesterol concentration.[16] This was the first time to show that dietary intervention is reflected in saliva. However, it is not known, if this finding has any effects on dental health.

Diet considered beneficial for general health may not always be the case for dental health. Restriction of saturated fat and cholesterol is part of a strategy to prevent heart diseases. Little is known about the effect of this kind of dietary restriction on oral health. In the current prospective randomized STRIP project we investigated the impact of dietary intervention on the properties of paraffin-stimulated saliva, and on dental health from infancy to late adolescence. As children of the intervention group of the STRIP-study had a higher fibre intake than the control children[17] our aim was to study if this was the case in our oral sub-study, and if it had an effect on salivary flow and its properties. In addition, our aim was to study if daily intakes of dietary calcium and phosphorus are reflected in the level of salivary electrolytes. Data on children's height, weight and body mass indexes were included to reveal any differences in general growth between groups which could be reflected in the size and/or function of the salivary glands. The intakes of saturated fat, protein, carbohydrates and sucrose were studied partly to make sure that the children of the oral sub-study were representative of the main study, and partly to study the effect of sucrose and carbohydrate intake among the three dental health groups. Children's oral hygiene habits were included to reflect the use of fluoridated products among the three dental health groups.

2. Material and methods

2.1. Subjects

From 1990 to 1992, 1062 infants (56% of the eligible cohort) had been recruited to the Special Turku Intervention Project (STRIP) at the age of 5 months by nurses at well-baby clinics of the city of Turku, Finland.[18] The sample size was determined according to the expected difference in serum cholesterol concentration between the intervention and control groups and according to the anticipated dropouts during the follow-up.[19] Altogether 1062 infants participated in the study. At the 7-month visit the infants were allocated by random numbers to receive individualized counselling aimed at controlling coronary heart disease risk factors (n = 540) or to a control group (n = 522) as shown in Fig. 1. The counselling has been described in detail previously.[20] In brief, in STRIP, the intervention families received individualized counselling aimed at decreasing the child's intake of saturated fat and cholesterol and at increasing the intake of monounsaturated and polyunsaturated fat at 1- to 3-months interval until the infants were 2 years old and at 6-month intervals thereafter until the participants were 20-years old.[21,22] The control children received basic health education including nutrition recommendations routinely given at Finnish well-baby clinics and at school health care.[23] All measurements and laboratory tests were carried out blinded.

At 3 years of age, every fifth child of the main study was invited to an oral sub-study (Fig. 1). At this point 83% (n = 883) of those who had been recruited continued in the main trial. Eighty-three percent (n = 148, 78 boys and 70 girls; 80 from the intervention and 68 from the control group) of the invited children (n = 178) attended. Genders were evenly distributed between the STRIP-groups. As 13, 8, 13 and 26 participants discontinued trial participation during the four subsequent