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Dietary and oral hygiene intervention in secondary school pupils

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Background. To enhance the well-being of secondary school pupils by improving their eating habits, especially school-based eating, a joint project, including oral health intervention, was conducted during the academic year 2007–2008.

Aim. The aim was to study the effect of a dietary intervention on schoolchildren's eating habits and laser fluorescence (LF) values of teeth.

Methods. Twelve schools in three cities, Finland, were randomly assigned to be intervention and control schools. Two of the intervention schools were further assigned in the instruction of oral hygiene. In 2007 and 2008, the pupils (n = 739 and 647, respectively) answered a questionnaire on dietary and oral health habits, and LF values on the occlusal surfaces of molars and premolars were determined.

Results. The frequency of eating a warm meal and drinking water at school to quench thirst increased in the intervention schools but decreased in the control schools ($P < 0.001$ and $P = 0.005$, respectively). LF values in molars decreased in schools with dietary intervention only ($P = 0.024$).

Conclusions. The 1-year dietary intervention was long enough to show improvement in eating habits and in habits for quenching thirst, and some decrease in the LF values of molars.

Introduction

In Finland, all schoolchildren in compulsory education are offered a free lunch at the school canteen every school day. According to the recommendations of the National Nutrition Council, this lunch should cover about a third of the child's daily energy requirement. Yet, not all pupils eat the school lunch or pupils eat only some parts of it. In a nationwide survey conducted among pupils in elementary and upper secondary schools in 2006, almost all respondents ate a school lunch daily, 90% of the boys and 80% of the girls. On the other hand, 20% of the girls and 12% of the boys almost always skipped the warm course or the whole meal. Only 35% of the respondents ate all parts of the meal each day[1]. To enhance the well-being of the of seventh and eighth grade secondary school pupils by improving their eating habits, especially school-based eating, a joint project was conducted during the academic year 2007–2008 by The Finnish Innovation Fund Sitra, the National Public Health Institute of Finland, The Finnish Bread Information, The Finnish Heart Association, and the University of Oulu[2]. The main aim was to reduce the intake of sugar, increase the intake of fibre and the consumption of vegetables and fruit, as well as to improve the quality of snacks eaten during the school day. An additional aim was to enhance the use of xylitol products after meals. The association between sugar consumption and tooth decay among adolescents and adults in industrialized countries is not strong[3]. According to recent studies among children, however, high intake of sucrose increases the risk of developing caries lesions even in contemporary populations[4]. In Finland, during 1970–1990, the mean DMFT score among 12-year-olds decreased strongly and in 1991 was 1.2. Since then, no

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favourable trend in DMFT has been seen[5]. At the same time, the frequency of tooth brushing among Finnish adolescents has remained among the lowest in Europe[6].

Visual monitoring of the onset and progress of caries lesions requires years; but according to some recent studies, changes in the enamel can be detected more quickly using laser fluorescence (LF). In a study in which the effects of toothpastes with 1450 and 5000 ppm fluoride on initial caries lesions were compared, LF values decreased in both groups during the test period of 2 weeks; but for the group using toothpaste containing 5000 ppm fluoride the decrease was significantly larger than that with lower fluoride concentration[7]. In another study, the regression of incipient carious lesions during fluoride varnish therapy was monitored visually and using LF[8]. In the 5th and 9th weeks of treatment, the LF values had decreased significantly, which was in agreement with the results of visual inspection, showing lowered activity of the lesions.

In addition to reduced intake of fermentable carbohydrates, the removal of plaque from areas of teeth where limited functional attrition would otherwise allow the plaque to develop has been shown to be important for caries control. Meticulous plaque control in newly erupted teeth has been shown to reduce the development of caries lesions in these teeth significantly[9–11].

Our main aim was to study the effect of a dietary intervention lasting one academic year on schoolchildren's eating habits and consequently on the LF values of their teeth. A further aim was to compare the association of LF values of the teeth of those children who were in the group that had dietary intervention only with those who were in the dietary intervention group and received oral hygiene instruction (OHI) and with those in the control group.

Material and methods

Selection of the participating schools

Cities in different parts of the country with a sufficient number of secondary schools were considered as candidates for the nutrition and well-being project. Of the six cities that seemed most suitable, the two northernmost were omitted for practical reasons. In the remaining four cities, 23 schools in which the total number of seventh grade pupils exceeded 90 were invited to the study schools. An informed consent form was sent to the chief school officer of each town and to the headmaster of each of these schools. Consent from both quarters was obtained for 12 schools in three towns. These schools had a total of 1469 pupils in the seventh grade. As the next step, an information meeting for the parents and another for the seventh-grade pupils were arranged at every school. An informed consent form was then mailed home or given to the pupils to be taken home for the parents' signature. Consent from the pupil and his/her parent/guardian was obtained for 769 pupils (52%). The 12 schools were randomly assigned to intervention and control schools, six schools in each category; there was at least one dietary intervention and control school in each city. All these procedures were performed by the managers of the nutrition and well-being project.

The aim of the oral health subproject was to evaluate the oral health-related effects of the main nutrition and well-being project. In addition, a small-scale oral hygiene intervention was conducted. For this experiment, two of the intervention schools were randomly assigned to receive OHI. The remaining four intervention schools received NOHI (no oral hygiene intervention).

Baseline oral survey in 2007

In the study schools, all seventh-grade pupils for whom a positive consent was obtained were invited to participate in the baseline oral survey, which included a computer-assisted questionnaire and LF measurement of the teeth. Before the actual fieldwork, four teams, each consisting of a dental hygienist and a dental nurse, were trained by the authors for all procedures. A total of 739 pupils (96% of those with consent) attended the baseline oral survey, which was performed at school on the same day as the baseline measurements and

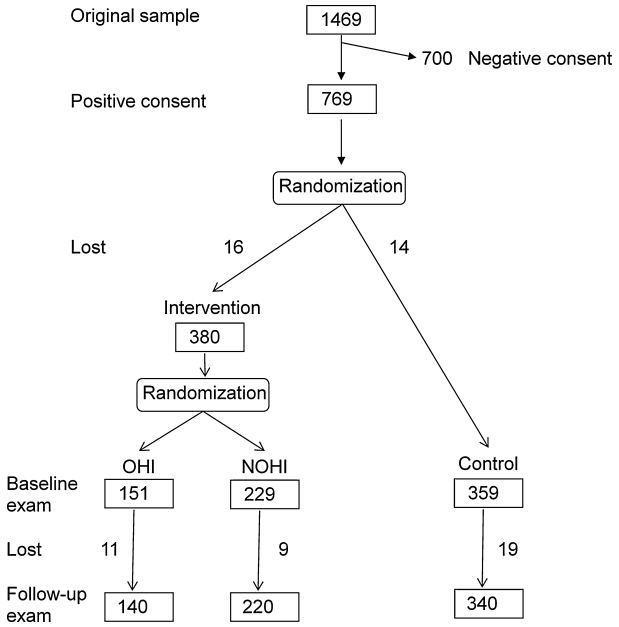

Fig. 1. Study design and numbers of subjects in each phase of the study.

dietary interviews for the main nutrition and well-being project. All procedures were conducted on school premises. For numbers of subjects in different phases of the study, see Fig. 1.

In the oral survey, the participants first answered a computer-assisted questionnaire under the supervision of a dental nurse. The questions covered dietary habits during school and leisure time as well as the amount of money spent on snacks and the social context of snacking. For questions concerning dietary and oral health habits, the reply alternatives were 'never or hardly ever' followed by 'every day or almost every day' and 'occasionally during the week'.

Before the dental examination, the pupil brushed his/her teeth using a toothbrush and water and then lay on an examination table. Posterior teeth were dried using a portable blow-dryer. The dental hygienist, wearing a medical forehead lamp, scanned the occlusal surfaces of molars and premolars using a DIAGNOdent® pen device (KaVo, Biberach, Germany). The device was calibrated individually for each pupil according to the manufacturer's instructions. The highest digit of each occlusal surface was recorded for premolars and molars.

Oral hygiene intervention

The aim of the oral hygiene intervention carried out by a dental hygienist in the OHI schools was to improve the quality of toothbrushing. Before the intervention in autumn 2007, two dental hygienists who were not participating in the oral inspections received a 2-day training session for the Nexø method, which emphasizes the importance of removing plaque from the occlusal surfaces of newly erupted molars[11]. One of the trained hygienists, however, dropped out after the training session and a third dental hygienist had to be trained. The OHI intervention had three phases: introduction of the background and aims in a school class, individual counselling, and a follow-up visit 2 months after the counselling session. During the individual counselling session, the dental hygienist trained the pupil to remove plaque from the occlusal surfaces of second molars. During the follow-up visit, she checked how the pupil had managed to clean his/her teeth and motivated him/her for continuing careful brushing.

Oral survey in 2008

The oral survey was repeated in 2008, 1 year after the baseline survey. The pupils answered the same questionnaire, and the occlusal tooth surfaces were scanned with LF following the protocol of the baseline survey. Before the field work, training for LF examination was repeated for all dental hygienists and nurses. As only one of the original teams remained unchanged, most of the team members were trained for the first time.

Statistical methods

The respondents answered a total of 19 questions concerning their dietary and oral hygiene habits. The answers were scored as −2 to 2, depending on the presumed effect of the habit on caries risk according to Anttonen *et al.*[12]. On the basis of the answers, a dietary score was calculated for each respondent. The lowest score was −71 and the highest +18. To avoid negative values, the scores calculated in this

manner were scaled using the formula 100 × (dietary score + 71)/89(%). The respondent with the least favourable dietary habits received a score of 100, and the respondent with the most favourable habits received a score of 0.

Dietary scores and answers to dietary questions in the intervention and control schools were compared. The dietary scores before and after the intervention were presented graphically using box plots. The differences in the change in answers to individual questions in 2007 and 2008 were analysed within the same type of school and between intervention and control schools in 2008 using the analysis of variance. To analyse questions on brushing frequency, the answers were recoded into two categories: those brushing at least two times a day and the rest. The statistical significance of the differences between the three groups was evaluated using chi-square tests. Mean LF values were calculated separately for premolars and molars, and the differences in the LF values between the groups were studied with the analysis of variance.

Ethical aspects

The Ethics Committee of the Hospital District of Helsinki and Uusimaa gave its approval for the study. Written consent was obtained from all participants and their parents.

Results

In 2007, 80–90% of the children in both the intervention and control schools ate breakfast, lunch, and dinner sitting down at a table; evening meal was clearly eaten less frequently (Table 1). Breakfast, school lunch and dinner were eaten by >50% of the respondents. There were no significant differences between the intervention and control schools. The percentages of those eating meals tended to decrease between 2007 and 2008, with the exception of school lunch and supper in the intervention schools. For school lunch, the difference in trends between the intervention and the control schools was statistically significant ($P < 0.001$). The percentage of those eating breakfast, school lunch, and dinner remained fairly stable ($P = 0.700$) in the intervention schools but decreased significantly ($P = 0.004$) in the control schools (Table 1).

Table 1. Percentages of pupils in dietary intervention and control schools eating different meals every day or almost every day sitting at a table.

Meal	Group	2007	2008
Breakfast	Dietary intervention	83.3	78.4
	Control	85.2	80.2
School lunch	Dietary intervention	87.9	91.0
	Control	88.8	82.0
Dinner	Dietary intervention	89.9	85.2
	Control	88.5	85.1
Supper	Dietary intervention	21.6	24.4
	Control	25.4	23.2
Breakfast, school lunch and dinner	Dietary intervention	63.6	62.2
	Control	66.5	55.6

Table 2. Percentages of pupils in dietary intervention and control schools who ate different parts of the school lunch every day or almost every day.

Part of school lunch	Group	2007	2008
Warm course	Dietary intervention	85.3	88.5
	Control	84.8	78.9
Salad and raw vegetables	Dietary intervention	61.5	58.3
	Control	53.8	51.7
Bread	Dietary intervention	38.5	54.3
	Control	36.5	42.4

In both the intervention and the control schools, in 2007, the warm course was the most frequently eaten part of the school lunch (eaten every day or almost every day by >80%), followed by salad and raw vegetables, and bread (Table 2). Salad and raw vegetables were eaten significantly more frequently in intervention schools than in control schools ($P = 0.043$). In 2008, the warm course was eaten more frequently in intervention schools and less frequently in control schools than in 2007 ($P = 0.024$). Salad and raw vegetables tended to be eaten by fewer pupils in 2008 than in 2007 (n.s.). Bread was reported to be eaten by more respondents at the end of the intervention period; the change was significant in intervention schools ($P < 0.001$), where fresh bread was available during the school lunch (Table 2).

At baseline, >60% of pupils in both intervention and control schools reported usually

Table 3. Selected dietary habits (%) among pupils in dietary intervention and control schools.

Habit	Group	2007	2008
Generally water for quenching thirst at school	Dietary intervention	62.6	69.5
	Control	69.4	62.5
Generally juice or fizzy drinks for quenching thirst at school	Dietary intervention	21.3	18.2
	Control	17.0	25.4
Generally water for quenching thirst at home	Dietary intervention	30.5	28.6
	Control	35.0	29.7
Generally juice or fizzy drinks for quenching thirst at home	Dietary intervention	54.3	56.3
	Control	48.0	53.3
Sweets every day or almost every day	Dietary intervention	6.3	1.7
	Control	5.1	5.3
Xylitol lozenges every day or almost every day	Dietary intervention	26.4	65.8
	Control	21.1	25.4
Xylitol chewing gum every day or almost every day	Dietary intervention	55.2	63.0
	Control	52.9	59.8

drinking water, and about 20% drank juice/soft drink for quenching thirst at school (Table 3). Between 2007 and 2008, the popularity of water increased in the intervention schools but decreased in the control schools ($P = 0.005$). The opposite was true for juice/-soft drink ($P = 0.004$). At home, juice/soft drink was the most popular thirst quencher, followed by water; for pupils of both intervention and control schools, the popularity of juice/soft drink tended to increase and that of water to decrease between 2007 and 2008 (n.s.) (Table 3).

Of the pupils, 5–6% reported eating sweets every day or almost every day in 2007. During the follow-up, this percentage decreased in intervention schools but increased in control schools ($P = 0.051$; Table 3). In 2007, about 20% of the respondents reported using xylitol lozenges every day or almost every day. Between 2007 and 2008, the popularity of these lozenges increased significantly ($P < 0.001$) in intervention schools, where they were distributed to all pupils. In 2007, xylitol chewing gum was used regularly by about half of the children. The percentage of those chewing xylitol gum increased in both groups of schools ($P = 0.038$ for intervention schools; Table 3). Pupils in the intervention schools reported spending €2.7 weekly on sweets, soft drinks, and other comfort-eating items in 2007 and €2.5 in 2008. The respective figures for children in the control schools were €2.5 and €2.9 (data not shown).

In 2007, 64–69% of the respondents reported brushing their teeth at least twice a day. In the two dietary and oral hygiene intervention schools, this percentage tended to decrease between 2007 and 2008 (n.s.). In the other schools, no change was observed (Table 4). Overall, the percentage of boys brushing their teeth twice a day was smaller than that of girls. Boys also reported more often than girls that they did not brush their teeth when they were tired or did not feel like it (data not shown).

Table 4. Percentages of pupils in schools with dietary intervention only, dietary and oral hygiene intervention, and control schools who brushed their teeth ≥2 times/day.

Group	2007	2008
Dietary intervention only	69.2	69.6
Dietary and oral hygiene intervention	63.6	58.6
Control	66.6	66.6

According to the answers to the computer-based questionnaire, a dietary score for 2007 and 2008 was calculated for each respondent. On average, the score tended to decrease between 2007 and 2008 in both intervention and control schools (n.s.), thus reflecting a tendency for the overall improvement of dietary habits (Fig. 2). The trend was clearly more favourable ($P = 0.022$) for schools with dietary and oral hygiene intervention than for the two other groups of schools (data not shown).

Mean values for LF of premolars and molars in 2007 and 2008 are shown (Table 5) separately for schools with dietary intervention only, schools with dietary and oral hygiene intervention, and for control schools. For premolars, there were no differences between years. In schools with dietary intervention

Table 5. Mean laser fluorescence values (SD) of premolars and molars among pupils in schools with dietary intervention only, dietary and oral hygiene intervention, and control schools.

Group	Tooth	2007	2008
Dietary intervention only	Premolar	8.0 (7.4)	7.6 (5.5)
	Molar	29.2 (17.4)	27.2 (16.1)
Dietary and oral hygiene intervention	Premolar	6.7 (3.3)	6.9 (4.2)
	Molar	26.2 (14.6)	28.8 (15.9)
Control	Premolar	6.7 (4.7)	6.6 (4.9)
	Molar	25.9 (17.4)	25.6 (15.2)

only, the mean values for molars decreased ($P = 0.024$), whereas in schools with dietary and oral hygiene intervention they tended to increase (n.s.). The distributions of subjects according to changes of values for molars are shown in Fig. 3. The most common category was no change. The tails for the two types of intervention schools clearly went in opposite directions, which shows up as a negative mean difference (indicating remineralization) for schools with dietary intervention only and a positive difference (demineralization) for control schools and for the schools with dietary and oral hygiene intervention (Fig. 3).

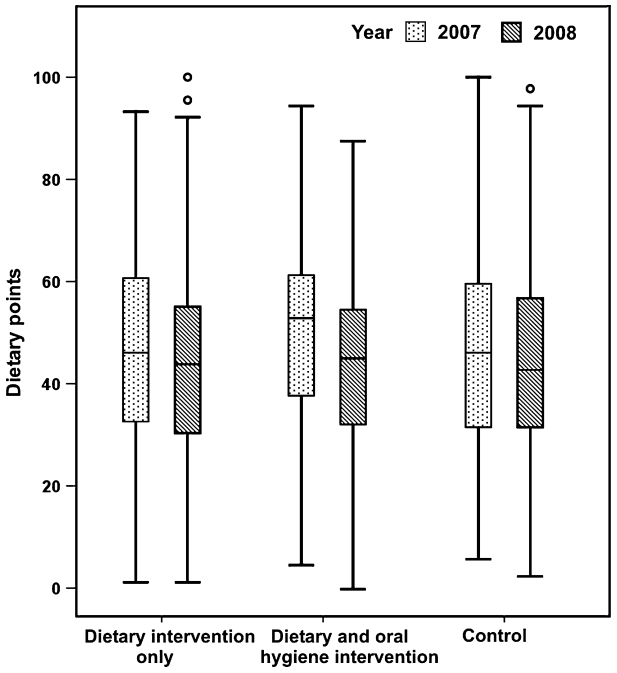

Fig. 2. Dietary scores among pupils in schools with dietary and oral hygiene intervention and control schools. A score of 0 represents the most favourable and 100 the least favourable dietary habits.

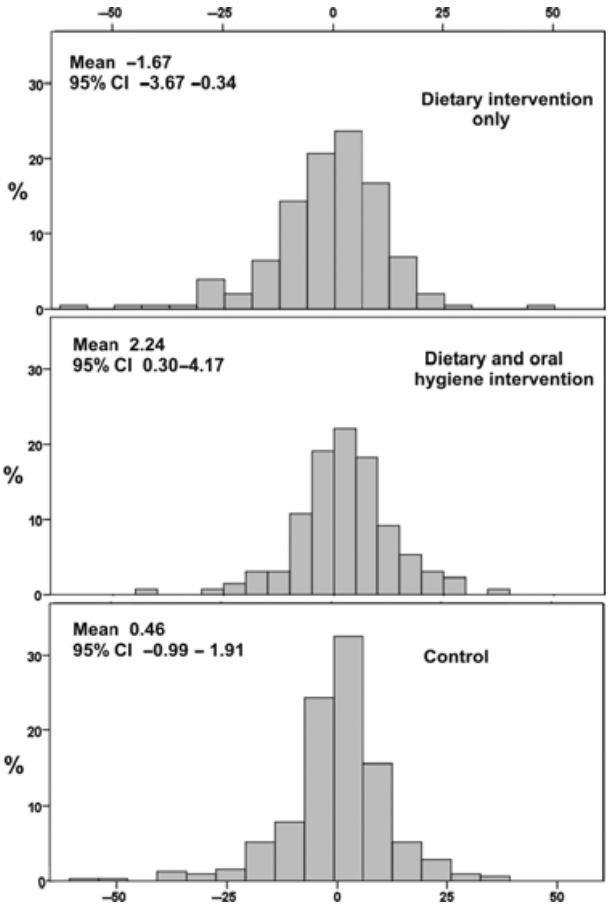

Fig. 3. Percentage distribution of pupils according to difference in laser fluorescence values between 2007 and 2008 in schools with dietary intervention only, dietary and oral hygiene intervention, and control schools.

Discussion

Neither the dietary nor the oral hygiene intervention had a clear effect on the mineralization of teeth as measured by LF, although some remineralization was seen in the teeth of children attending schools with dietary intervention only. The dietary intervention did, however, have favourable effects on certain eating habits of the pupils. The most notable improvements were increased consumption of water instead of juice/soft drink for quenching thirst at school and decreased consumption of sweets. The mean dietary score also decreased more in the intervention schools than in the control schools. In the intervention schools, the consumption of xylitol lozenges increased sharply, but this increase was probably due to their free delivery to children in the intervention schools,

and thus may not be permanent. Although the immediate effects of improved eating habits on dental health were small, they may result in detectable effects in the long run.

In two schools, OHIs were given in addition to the dietary intervention. The aim was to teach pupils to clean the occlusal surfaces of their newly erupted second molars regularly and properly. Unfortunately this aim was not reached. On the contrary, in the OHI schools, the percentage of children brushing twice a day decreased during the follow-up, whereas it remained the same in the other two groups of schools. Moreover, the LF values indicated no benefit to the teeth of children in the OHI schools, which was to be expected on the basis of the results of brushing frequency. The fact that brushing frequency was lowest in the OHI group already at baseline may partly explain the failure of the oral hygiene intervention.

The schools participating in the study were not selected by probability sampling. In spite of this, the results most likely describe the situation in Finnish secondary schools, as different types of communities and schools were involved in the study. The randomization of schools instead of randomizing individuals caused some imbalances at baseline between the groups of schools that were compared. This was especially true for toothbrushing frequency and dietary habits that were least favourable in the schools with dietary and oral hygiene intervention in 2007. Finding schools that are completely the same and then randomizing them is impossible in practise.

Only half of the pupils in the study schools agreed to participate in the study. One of the reasons might have been that consent was required from both the pupil and his/her caretaker. The low rate of participation is in agreement with experiences from some regularly repeated studies among Finnish adolescents where participation rates have decreased markedly during recent years[13]. The children who agreed to participate probably had better general and oral health than those who refused to participate. Consequently, caution is needed when the year-specific results are generalized. On the other hand, low participation at baseline does not influence comparisons between groups of schools and study years.

The fieldwork related to the evaluation of the effects of the interventions was performed by four teams, each consisting of a dental hygienist and dental nurse. Before the baseline assessments the members of the teams were thoroughly trained. Due to other commitments, only one of the four original teams remained exactly the same throughout the whole follow-up period. It is unlikely; however, that replacement of some team members had any decisive effect on the results, as all members were trained the same way before the assessments in 2008. In this training, special emphasis was placed on the use of the LF device.

The computer-based questionnaire used here had proved valid and reliable in previous studies by Kasila *et al.*[14], Anttonen *et al.*[12], and Lukkari *et al.*[15]. The same was true for this study where it captured important differences between the groups of schools in a number of eating habits related to dental health.

In a study among young adolescents, Anttonen *et al.*[16] found that mean values for LF of teeth increased during a 1-year follow-up. In this study, the mean values for LF remained the same or decreased slightly, more so in the schools with dietary intervention only, which indicates remineralization of initial lesions.

In conclusion, some positive dietary changes were seen in pupils attending schools with dietary intervention, and indications of remineralization were seen in the molar teeth of pupils in schools of dietary intervention only.

What this paper adds

- These results show that favourable changes in dietary habits can be achieved by a dietary intervention at schools.

Why this paper is important for paediatric dentists

- Laser fluorescence can be used for monitoring demineralization and remineralization of the occlusal surfaces of molars.
- A computer-assisted questionnaire is useful for evaluating dietary changes among schoolchildren.

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