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Children's oral health-related knowledge, attitudes and beliefs as predictors of success in caries control during a 3.4-year randomized clinical trial

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Abstract

Objectives. The aim of this study was to determine whether the baseline oral health-related knowledge, attitudes and beliefs of the participants in a randomized clinical trial (RCT) were associated with D_3MFS increment. Additionally, the aim was to study whether the association was mediated by the two baseline behaviors, i.e. brushing teeth and eating candies. ***Methods.*** Children in Pori, Finland ($n = 493$) aged 11–12 years, with active initial caries lesion(s) at baseline, were studied. The data were based on clinical examinations in 2001 and 2005 and on a questionnaire administered in 2001. Associations between success in caries control and baseline oral health-related knowledge, attitudes and the belief in keeping one's own teeth throughout life were evaluated using negative binomial regression analyses while considering the effects of the two baseline oral health behaviors. ***Results.*** The degree of concern about getting decay in one's own teeth was associated with caries increment. The less concerned the child was about new caries lesions, the more likely he/she was to develop new cavities. This association was not mediated by the two behaviors. Those children who did not know whether or not their mother had cavities were more likely to fail in caries control than were children who knew about their mother's cavities. ***Conclusions.*** It is important to determine child's level of concern about getting cavities because children who are concerned about developing cavities are likely to succeed in caries control while the opposite is true for those children who do not share this concern.

Key Words: *behavioral science, caries, child, prevention*

Introduction

Health behaviors among children include patterns, actions and habits related to the maintenance and improvement of health [1]. Habits are established during the years of growing up, therefore childhood is important for the future health of the individual [2] and good oral health practices are necessary from a young age to ensure positive long-term oral health. Knowledge, beliefs and attitudes have been suggested to precede health behaviors [3], which in turn are associated with oral health [4,5]. Health knowledge among children consists of cognitive understanding of health-related concepts and causality. Among children, health attitudes represent positive and negative evaluations and emotional feelings with respect to health [6,7]. To understand how children make decisions about their oral health behaviors we need to widen our knowledge on the role of oral health-related knowledge, beliefs and attitudes. This is especially important for the practicing dentists who are responsible for controlling dental caries among children. To make caries control more effective and to allocate resources rightly, information on predictors of caries increment beyond oral health behaviors are needed. Such predictors might help to identify both those children who are likely to need minimal attention and those who need extra attention.

In caries trials, where the experimental regimens most often comprise clinical procedures, the average

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number of new caries lesions in the experimental and control groups is usually compared. However, even in studies where the experimental regimen is clearly efficacious, some individuals develop new caries lesions and some succeed in avoiding them. This is true for both the experimental and the control groups. In Pori, Finland, a randomized clinical trial (RCT) was conducted during the years 2001–2005. The experimental caries control regimen included both a behavioral intervention and preventive procedures. Children in the experimental group had significantly smaller mean caries increment than had those in the control group [8]. In the experimental group, however, quite a few children developed several new caries lesions and in the control group a considerable number of children had no new caries lesions. We wanted to study the reason for this. Earlier secondary analysis carried out using the data of the RCT has indicated that the children who had established good oral health behaviors at baseline (brushing teeth with fluoride toothpaste at least twice a day and avoiding eating candies daily) were more likely to keep their teeth healthy [9].

There are only a few studies in which the associations between oral health-related knowledge, attitudes and beliefs and caries increment have been evaluated; and we found no studies focused on schoolchildren [10]. Our interest was to determine whether the influence of certain knowledge, attitudes and beliefs prior to the RCT were so strong that they forestalled the control of dental caries irrespective of the regimen. Especially, we wanted to learn whether even as intensified preventive care as given for the experimental group was unable to help those children with insufficient baseline oral health-related knowledge, unfavorable attitudes and/or beliefs, and, on the other hand, whether a certain baseline oral-health related knowledge, attitude or belief had helped children to manage without intensified preventive care. Therefore, we decided to continue the secondary analysis of the data obtained in our randomized clinical trial [8]. The aim was to ascertain whether self-reported knowledge, attitudes and beliefs at baseline were associated with D_3MFS increment among the participants of the RCT. Additionally, we aimed to study if those associations were mediated by the two baseline oral health behaviors, that had been shown to be associated with D_3MFS increment, i.e. brushing teeth and candy eating.

Materials and methods

For the present study data gathered for a randomized clinical trial conducted in Pori, Finland [8] were used. The data were obtained from clinical examinations performed in 2001 and 2005 and from a questionnaire survey conducted in 2001 concerning oral health-related behaviors, knowledge, attitudes and beliefs as well as background information for each child.

Study sample

The sampling frame for the randomized controlled trial consisted of all 5th and 6th graders in the town of Pori, except for mentally disabled and handicapped children attending special schools. The participants (n = 1691) were 11–12-year-old children who started the 2001–2002 school year in Pori. Ninety-three per cent of the children (n = 1575) attended the baseline appointment, at which they were screened for the presence or absence of active initial caries lesions. A total of 706 (45%) children had at least one active initial caries lesion. An informed consent was received from 577 of them. These children were randomized into two groups (experimental, control) using computer-generated random numbers and 497 of them completed the RCT. For numbers of children in the different phases of the study, see Hausen et al. [8]. The children in the experimental group (n = 250) were offered an individually designed patient-centered regimen for caries control. The children in the control group (n = 247) received the standard dental care, including caries prevention, offered in the public dental clinics in Pori [8]. Four of the 497 children were excluded from this study due to missing questionnaire data.

Regimen for the experimental group

The experimental regimen for caries control included counseling on oral hygiene and diet by dental hygienists, who had been trained by experts in patient- and empowerment-centered health counseling. The aim was to identify and eliminate the factors that had led to the presence of active initial caries lesions. An additional aim was to discuss with the child how he/she could reverse active initial lesions and prevent the onset of new lesions. The child was supported and encouraged to take responsibility for his/her own dental health. Dietary habits were discussed with the child and, if frequent snacking existed, the importance of regular meals was emphasized. Toothbrushes, fluoride toothpaste (1500 ppm, containing 10% xylitol) and fluoride and xylitol lozenges were distributed to the children. The roles of fluoride and xylitol in caries prevention were explained. Tooth surfaces with active initial caries lesions were pointed out using a mirror. The child practiced to clean those surfaces and all surfaces of erupting teeth with special care. Brushing twice a day with fluoride toothpaste was emphasized. The recommendation was not to rinse after brushing, only to spit out the remaining toothpaste. The surfaces of active initial caries lesions were cleaned professionally and fluoride and chlorhexidine varnish was applied on problem areas and to newly erupted fissures twice at an interval of 1–2 weeks. Non-invasive procedures were repeated until the initial lesion seemed to be reversed.

Community-level promotion of oral health

The randomized controlled trial was performed in a context where a continuous program of oral health promotion using a multilevel approach was targeted not only to the trial participants (experimental, control), but also to their peers, parents and others involved in the children's everyday life. The aim was to increase children's knowledge of oral health problems and their prevention and to improve their oral health-related behavior. A particular aim was to provide social support for the children in the experimental group. The children acquired information related to good oral health and presented their findings as projects that included videos, PowerPoint presentations, plays and posters. They learned to recognize possible oral health hazards in the school environment, and these were also discussed with the school nurses and parents. Themes related to oral health were also covered regularly in the local mass media. The details concerning the community-level promotion of oral health have been reported previously [11].

Measurements

One trained and calibrated public health dentist carried out the clinical dental examinations both at baseline and at the end of the trial. She did not participate in the dental care of the children. Caries status was registered clinically and radiographically. Each clinical examination was performed using the criteria of Nyvad et al. [12], with special emphasis on assessing the activity of initial caries lesions. Digital bitewing radiographs (Dixi 2; Planmeca, Helsinki, Finland) were taken for all children at baseline and at the end of the study. Included in the decayed, missing or filled surfaces (D_3MFS) score were surfaces with active or inactive caries lesions with cavitation (scores 5 and 6 according to Nyvad et al. [12]), those with a filling, those extracted as a result of caries and those with caries extending to the inner or middle third of the dentin or to the pulp, according to radiographs. The kappa values [13] for the intra-examiner reliability in assessing D_3MFS = 0 vs D_3MFS > 0 were 0.84 and 0.96, at baseline and at the end of the study, respectively. The average follow-up period was 3.4 years. Individual D_3MFS increment scores (ΔD_3MFS) were calculated as the differences between D_3MFS scores in 2005 and 2001 [8]. For details of the study arrangements, see Hausen et al. [8].

Questionnaires

Oral health personnel delivered the questionnaires to all 1691 pupils in the schools of Pori and the completed questionnaires were collected in sealed envelopes. The details of the questionnaire, its development and its administration have been described previously [14]. Oral health-related behaviors were measured using 7-point Likert-scale questions that had alternatives describing the frequency of the behavior. Of the oral health-related behaviors, information on brushing teeth with fluoride toothpaste and eating candies was used in this study. Oral health-related knowledge and attitudes were measured using 4-point Likert-scale statements (Table I) with alternatives 'strongly agree', 'partly agree', 'partly disagree' and 'strongly disagree'. The only belief that was included in the analyses was measured with the question 'I believe I can keep my own teeth throughout life'. Replies to that statement were 'yes', 'I don't know' and 'no'. The questionnaire included in this study was pilot-tested among 53 children of the same age in Seinäjoki, Finland and was found to be reliable [14] and valid [15].

Statistical analyses

The main outcome was the D_3MFS increment during the follow-up period 2001–2005. The independent variables were gender, treatment regimen (experimental or control), oral health-related knowledge and attitudes, the belief of keeping one's own teeth throughout life and tooth brushing and candy eating.

The percentages of the children who strongly agreed with the statements about oral health-related knowledge and attitudes and who believed in keeping one's own teeth throughout life at baseline were determined separately for the experimental and control groups. Statistical significances of the differences between the groups were evaluated with chi-squared tests. The percentages of children according to their responses were evaluated. The percentage distribution of children according to D_3MFS increment score was evaluated.

Since the variance of ΔD_3MFS score was larger than its mean, we decided to use negative binomial regression analyses for evaluating whether knowledge, attitudes and the belief in keeping teeth were associated with the ΔD_3MFS increment. Four negative ΔD_3MFS values were substituted with zeros. Children were categorized into three categories according to their responses concerning oral health-related attitudes, knowledge and the two behaviors (Table II). Bivariate negative binomial regression analyses were conducted to identify associations between independent variables and ΔD_3MFS, while considering the experimental group as a confounder. To study whether these associations were mediated by tooth brushing and candy eating, mediation analysis (negative binomial regression analyses) with four steps was conducted according to a method introduced by Baron and Kenny [16] (Figure 1). In mediation analyses the experimental group was considered as a confounder.

Table I. Percentages of 11–12-year-old children who strongly agreed with the statements about oral health-related knowledge, attitudes and the belief at baseline in Pori, Finland.

Statement (n = 493)	Experimental group (n = 250)	Control group (n = 243)
Knowledge		
A person has to brush his/her teeth twice a day	67	71
A person can prevent decay by using fluoride toothpaste	71	68
To assure sufficient fluoride supply, one has to brush teeth with fluoride toothpaste at least twice a day	50	56
A person can prevent decay by using xylitol products after meals	56	58
A person can reduce the risk of caries lesions by omitting one sweet snack daily	47	49
Attitude		
I would be concerned about decay in my		
Own teeth	24	23
Mother's teeth	7	6
Father's teeth	7	6
Friend's teeth	7	6
Brushing teeth is important for me when going to		
School	34	29
A dentist	81	80
Sports, hobbies, etc.	10	9
Meet my best friend	17	19
A disco	56	58
Meet my girl-/boyfriend	59	63
Brushing teeth is important for me because then		
I feel fresh	64	64
My parents are happy	46	57
My friends are happy	25	24
I will not get decay	85	86
My appearance is better	46	48
I avoid tooth discoloration	72	75
My breath is fresh	83	87
My gingiva is healthy	64	71
Belief		
I believe I can keep my own teeth for my whole life	43	50

Chi-squared tests were used to evaluate statistical significances of the differences between the groups.

The variables which were significantly associated with ΔD_3MFS were included for negative binomial regression analyses. Independent variables were the regimen, concern about getting decay in own teeth and a child's baseline knowledge about his/her mother's possible dental caries lesions. Furthermore, the two behaviors which had been found to be associated with caries increment were included [9]. Concern about getting caries lesions was categorized to very vs quite vs not at all, a little. Candy eating was categorized to once a week or less vs more than once a week but not daily vs at least once a day. Knowledge about mother's possible dental caries lesions was categorized to yes, no vs the child did not know. Treatment regimen was categorized to control vs experimental. For unadjusted models the number of observations ranged from 443–493 and for binomial regression analyses the number of observations was 427. We also conducted zero-inflated negative binomial regression analyses, but since the fit of these models was not better than that of the previous ones, the results are not reported. Statistical analyses were carried out using SPSS version 16.0 software (SPSS, Chicago, IL) and Stata version 8.0 (Stata Corporation, College Station, TX).

Table II. Percentages of children according to their responses concerning items included in the final model.

Variable	%
Concern about getting decay in own teeth	
Not at all, a little	43
Quite	34
Very	23
Does mother have cavities in her teeth	
Yes	27
No	22
Child does not know	51
Tooth brushing	
At least twice a day	57
Once a day	34
Three times a week or less	9
Candy eating	
Once a week or less	7
At least twice a week	68
At least once a day	25

Ethical aspects

The Ethics Committee of the Northern Ostrobothnia Hospital District and the Health Board of Pori gave permission for the study.

Results

At baseline the distributions of the children according to their replies to statements about oral health-related knowledge, attitudes and the belief in keeping teeth were similar in the experimental and control groups and no statistically significant differences between the groups were observed (Table I). No gender differences were observed in the associations between attitudes, knowledge and the belief in keeping teeth and caries increment. Figure 2 shows the percentage distribution of children according to D_3MFS increment score. A total of 100 children developed no new caries lesions and 382 developed at least one new caries lesion. The distributions of children according to their responses concerning items included to the final model are presented in Table II.

Concern about getting caries in own teeth was not associated with candy eating. Therefore, candy eating could not mediate the association between concern about getting caries and ΔD_3MFS. Tooth brushing did not mediate the association between concern about getting caries and ΔD_3MFS (Table III).

Negative binomial regression analyses revealed that when considering the effect of the regimen and the two behaviors, lack of concern about decay was associated with the onset of new caries lesions (Table IV). Additionally, those children who did not know whether or not their mother had decay were more likely to have new caries lesions than were children who knew about their mother's caries situation.

Discussion

Self-reported baseline concern about getting decay in one's own teeth indicated success in caries control while considering simultaneously the effects of the two baseline oral health behaviors. This is a novel finding. The association between concern about getting caries and D_3MFS increment was not mediated by the two behaviors. The children who were not concerned about cavities were more likely to have a high caries increment than those who were concerned. Even as intensified preventive care as that given was not able to help the majority of children who were not concerned. On the other hand, the children

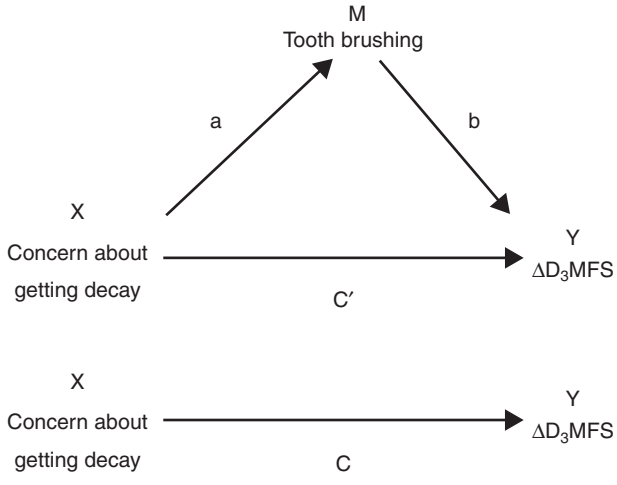

Figure 1. A path diagram of a causal chain. M is a mediator if (1) X affects to Y, (2) X affects to M, (3) M affects to Y and (4) path c' is zero or significantly reduced when M is controlled for. In all analyses the experimental group was considered as a confounder.

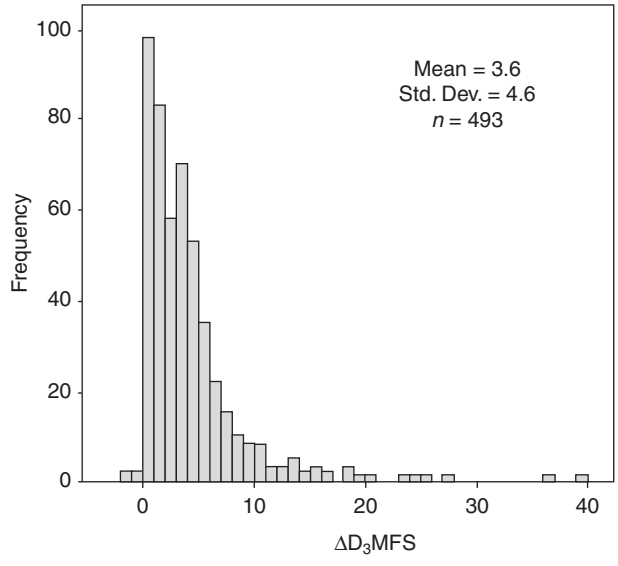

Figure 2. Percentage distribution of children according to D_3MFS increment score.

Table III. The four steps of mediation analysis (with negative binomial regression) while considering the experimental group as a confounder.

Model	Path	Model chain	B	SE	*p*-value	RR	95% CI
Direct effect	c	Concern about getting decay in own teeth (X) → ΔD_3MFS (Y)					
		Not at all, a little	0.50	0.14	< 0.001	1.7	1.26–2.16
		Quite	0.28	0.14	0.053	1.3	1.00–1.75
		Very	0			1	
Mediation analysis	a	Concern about getting decay in own teeth (X) → Tooth brushing (M)					
		Not at all, a little	0.65	0.21	0.003	1.9	1.25–2.90
		Quite	0.21	0.23	0.369	1.2	0.78–1.95
		Very	0			1	
	b	Tooth brushing (M) → ΔD_3MFS (Y)					
		Three times a week or less	0.51	0.18	0.005	1.7	1.17–2.39
		Once a day	−0.10	0.11	0.373	0.9	0.73–1.13
		At least twice a day	0			1	
	c'	Concern about getting decay in own teeth (X) → ΔD_3MFS (Y) when tooth brushing is controlled for.					
		Not at all, a little	0.47	0.14	0.001	1.6	1.22–2.09
		Quite	0.25	0.15	0.090	1.3	0.96–1.70
		Very	0			1	

B, regression coefficient; RR, rate ratio.

Table IV. Summary of the results of negative binomial regression analyses exploring predictors of ΔD_3MFS among 11–12-year-old children in the experimental and control groups while considering the experimental group as a confounder.

	Unadjusted					Binomial regression analyses				
Variable and coding	B	SE	*p*-value	RR	95% CI	B	SE	*p*-value	RR	95% CI
Concern about getting decay in my own teeth										
Not at all, a little	0.50	0.14	< 0.001	1.7	1.26–2.16	0.37	0.15	0.014	1.4	1.08–1.93
Quite	0.28	0.14	0.053	1.3	1.00–1.75	0.15	0.16	0.322	1.2	0.86–1.58
Very	0			1		0			1	
Does mother have cavities in her teeth										
Children did not know	1.33	0.09	< 0.001	1.4	1.16–1.74	0.30	0.12	0.010	1.4	1.07–1.69
Yes, no	0			1		0			1	
Tooth brushing										
Three times a week or less	0.51	0.18	0.005	1.7	1.17–2.39	0.44	0.20	0.029	1.6	1.04–2.29
Once a day	−0.10	0.11	0.373	0.9	0.73–1.13	−0.16	0.12	0.191	0.9	0.67–1.08
At least twice a day	0			1		0			1	
Candy eating										
At least once a day	0.57	0.23	0.014	1.8	1.12–2.81	0.53	0.25	0.033	1.7	1.05–2.78
At least twice a week	0.22	0.22	0.309	1.3	0.81–1.92	0.27	0.23	0.253	1.3	0.83–2.05
Once a week or less	0			1		0			1	
Treatment regimen										
Experimental group	−0.58	0.10	< 0.001	0.6	0.46–0.68	−0.57	0.11	< 0.001	0.6	0.45–0.70
Control group	0			1		0			1	

B, regression coefficient; RR, rate ratio.

who expressed concern about getting cavities were, in general, able to avoid new cavities. The level of concern about getting cavities may indicate the degree at which an individual values his/her teeth and the importance of having sound teeth. Expressed concern can be used to identify those children who are likely to take care of their teeth nearly all by themselves and who probably do not need so much of the available oral healthcare resources. Lack of concern, in turn, may indicate that a child is likely to have a caries problem. Poutanen et al. [17] found that children who did not believe in keeping their teeth throughout life were more likely to have initial caries at baseline and the probability was higher if the child was not concerned about getting caries [17]. The results of both the present and the previous study are in agreement; lack of concern was associated not only with initial caries lesions at baseline but also with an increment in the number of decayed, missing and filled surfaces over a period of 3.4-years. In the present study those children who were not concerned about getting caries in their own teeth also brushed their teeth insufficiently. The attitude was associated with the behavior which, in turn, was associated with D_3MFS increment, although true mediation did not exist. Therefore, children at this developmental stage could benefit from counseling focused on the reasons for lack of concern. Also other reasons than the health-related ones may influence tooth brushing habits. According to Macgregor et al. [18], tooth brushing once a day was associated with individual's lifestyle and social reasons, such as getting-up time, breakfast and time of going to bed.

At baseline, the children who did not know about their parent's possible dental caries lesions had more likely active initial caries lesions [17]. In the present study children who reported not knowing about their mother's possible tooth decay were more likely to develop cavities during the RCT than were children who knew about their mother's possible decay. Knowledge about mother's caries state probably indicates that oral health-related matters are discussed within the family. These discussions are important because they may contribute not only to absence of active initial caries lesions at baseline [17] but also to D_3MFS increment.

Children's self-reported baseline oral health-related knowledge was not associated with caries increment. A considerable number of children with poor oral health-related knowledge at baseline were able to avoid developing new cavities. Poor oral health-related knowledge may not be a barrier to good oral health. In oral health promotion oral health-related knowledge has been conventionally delivered, aiming to affect oral heath-related behavior. However, it seems difficult to change oral heath-related behavior [10,11]. Improved effectiveness in oral health promotion is needed. This may be achieved by affecting children's attitudes on getting decay.

All the children included in the present study had at least one active initial caries lesion. The participants of the RCT reported being somewhat less concerned about getting cavities than did children in the whole age cohort [14]. In addition, the participants believed they would be able to keep their own teeth for their entire life somewhat less often than the whole age cohort did [14]. Children who participated in the RCT were from all schools, except the special schools. All occupational groups were represented among the parents of the children.

In conclusion, a child's baseline concern about getting caries lesions and knowledge about his/her mother's possible dental caries lesions were indicative of success in caries control while considering simultaneously the effects of the two baseline oral health behaviors. By asking about these issues one might be able to identify some of the children that could benefit from special attention. It is especially important to determine a child's concern about getting cavities because the children who are concerned about the risk of developing cavities might be more likely to behave in a health-enhancing manner than those children who do not share this concern.

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