Economic evaluation of a risk-based caries prevention program in preschool children

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We have previously reported that, in young children, a risk-based caries prevention program compared with conventional prevention has a good caries-preventive effect. The present study aimed to assess the economic aspects of this program. We used the presence of mutans streptococci in plaque (Dentocult-SM®) and/or the presence of incipient carious lesions at 2 years of age for risk assessment, and measured the outcome of caries (yes/no) at the age of 5 years. Dental assistants carried out the screening and preventive work. The economic analysis included the actual running costs of the program during the 3-year follow-up based on the time spent on dental visits. The costs per child per 3 years were significantly lower in the risk-based group (54 €) than in the conventional prevention group (69 €) (Student's t test, $P = 0.004$). If a dentist with an assistant had done all the work, the costs would have been twice as high. Compared to conventional prevention, the results suggest that risk-based prevention can be effective in reducing both costs and dental caries in preschool children, provided that the screening and preventive measures are delegated to preventive dental assistants. ☐ *Costs; Mutans streptococci; paediatric dentistry; screening*

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Dental caries in children has fallen dramatically in most Western countries during the past 20 years (1–2). However, a small minority of children develop many cavities while the dentition of the majority remains intact (3). Caries continues to be a problem for individuals at high caries risk. This is true especially in young children, because restorative treatment of their teeth is often difficult and expensive.

In Finland, every child has been routinely examined at regular intervals for caries and other oral problems during the past 20–25 years. To improve cost-effectiveness, it would be desirable to target examinations and intensive prevention of individuals at high risk of caries, and exclude individuals at low risk.

We developed a risk-based caries prevention program for preschool children and compared it with conventional prevention in a neighboring health center. The developed program was based on earlier information about the strong association of early mutans streptococci colonization, incipient caries lesions, and development of early childhood caries (4–5). We divided the population into three caries risk categories, 'low', 'intermediate', and 'high'. The program aimed to control costs by delegating tasks to preventive dental assistants, and to maintain or improve the good dental health of children (6). Our results indicated that, in young children, risk-based management was more effective than conventional prevention of caries. Additionally, the accuracy of the target grouping was found to be acceptable (6). The good clinical results of the program needed to be accompanied by reasonable costs before it could be adopted in practice.

The present study was therefore aimed at assessing the time and costs of the risk-based prevention program presented above compared with conventional prevention.

Subjects and methods

Subjects

The study protocol was approved by the Ethics Committees of the Medical Faculty of Turku University and the Municipal Health Center in Vanha Korpilahti. The study was carried out in the Municipal Health Centers of Vanha Korpilahti and Saarijärvi, Finland, in 1989–1993. The risk-based prevention group in Vanha Korpilahti ($n = 299$) and the routine prevention group in Saarijärvi ($n = 226$) included all 2-year-old children born in 1987 or 1988, and they were followed up for 3 years.

At baseline, and at the final examination, a dentist examined the child, the dentist being blind to earlier examinations and information about mutans streptococci (MS). All restorative treatment and associated decisions were carried out by dentists. In the routine prevention group, the children received prevention and restorative treatment when the examining dentist considered it necessary on the basis of clinical information. The prevention was mostly delegated to dental hygienists, but also the dentists gave preventive treatment in connection with other treatment. In the risk-based prevention group, MS screening and all preventive measures were carried out by preventive dental assistants.

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In the risk-based prevention group, screening was carried out at the age of 2 years with two screening criteria: the presence of MS in proximal plaque (Dentocult-SM® Strip Mutans, Orion Diagnostica, Espoo, Finland) and/or the presence of incipient or other carious lesions. The MS-free and caries-free children were considered to be at low caries risk. They received annual basic preventive measures, which included health education for parents. MS-positive children with no caries or fillings were seen twice a year and treated with fluoride varnish. The children with signs of caries were considered to be at high caries risk and were treated with chlorhexidine and/or fluoride varnish every 3rd month (6). For every child, the actual amount of time used was recorded in minutes in the personal records within the health center during the 3-year follow-up. This was carried out in relation to visits to a dentist/assistant team, and separately to preventive dental assistants or hygienists.

Economic assessment

We used the actual running costs of the health center for the analyses. According to the annual report of Vanha Korpilahti Health Center 1993, the salary costs represented 77% of the total running costs of dental care, the material costs 9%, and other costs 14%. At the Vanha Korpilahti health center, a dentist did approximately 108 h/month of clinical work in 1993. The hourly costs of prevention and treatment were calculated by dividing the costs of dental care by the number of clinical working hours of the dentists and dental assistants. The time spent on health education was also counted as clinical work. The costs of one clinical working hour were 51 Euros (€), of which the material expenses were 5 €/hour and other expenses about 7 €/h. Thus, on average, costs other than salary were 12 €/h. This sum was added to the salary costs of each personnel group.

In each personnel group, the hourly costs of the clinical work were calculated by dividing the yearly salary of the group by their clinical working hours. The salary costs of a dentist's clinical work were 46 €/h, and for dental assistants 18 €/h. The salary costs included the social security costs (31% of the salary). Each dentist had one dental assistant, so total costs of the dentist/assistant team were 75 €/h (46 + 18 + 12). The equivalent costs of a preventive dental assistant were 30 €/h (18 + 12). The salary costs of the routine prevention group were calculated using the same figures as above in order to improve comparability of the groups.

The costs per child for the 3-year follow-up period were calculated by multiplying the time spent by the costs per hour of the required personnel. This was carried out for preventive dental assistants (examinations and prevention) and separately for a dentist/assistant team (mainly restorative treatment). The sum of these two costs represented total running costs. The time and costs related to treatment of traumas were not included in the present analyses.

In addition, the costs of the risk-based preventive program were estimated in two hypothetical situations: 1) when a dentist/dental assistant team had done all the work (including examinations and prevention); 2) when the children at low risk were only offered the examinations at the age of 2 and 5 years, plus the restorative treatment they actually received, but no other prevention and examinations during the 3-year follow-up.

Statistical analyses

Student's *t* test was used to evaluate the significance of differences in means between the groups, and *P* values <0.05 were considered statistically significant. The analyses were carried out using the SAS® statistical program (7).

Results

The total time spent on dental treatment was identical in the prevention groups during the 3-year follow-up (Table 1). In the risk-based group, however, the time spent by preventive dental assistants was significantly longer, and the time related to restorative treatment significantly shorter than in the routine prevention group (Table 1).

The actual running costs during the 3-year follow-up were lower in the risk-based group than in the routine prevention group ($P = 0.004$) (Table 2). If a dentist/dental assistant team, instead of preventive dental assistants, had done all the work, the running costs would have increased greatly, from 54 €/child to 134 €/child in the risk-based

Table 1. Mean time (min) per child (and standard deviation (*s*)) used on dental treatment during the 3-year follow-up for preventive dental assistants (prevention and examinations) and separately for a dentist/assistant team (mainly restorative treatment)

	Prevention group				
	Risk-based		Routine		
Time spent by	Min	*s*	Min	*s*	Significance of group difference *P*
Preventive dental assistants	104	43	85	32	<0.001
Dentist/assistant team	3	13	22	52	<0.001
Total time	107	48	107	72	0.96
No. of children	299		226		

Table 2. Mean running costs (€) per child (and standard deviation (*s*) during the 3-year follow-up. First, actual running costs, and second, estimated costs in two hypothetical situations*†

	Prevention group				
	Risk-based		Routine		
Costs	€	*s*	€	*s*	Significance of group difference *P*
Actual costs					
Preventive dental assistants	51	21	42	16	<0.001
Dentist/assistant team	3	16	28	66	<0.001
Total costs	54	29	69	74	0.004
Estimated costs					
Only dentist + assistant*	134	60	134	90	
Dental assistant†	23	16	47	66	
No. of children	299		226		

* Estimated costs if the screening and all the preventive and restorative work were done by a dentist with an assistant.
† Estimated costs if all the preventive work and examinations were done by a dental assistant, the low-risk children examined at a 3-year interval, and the restorative treatment done by a dentist.

group (Table 2). If the low-risk children had been excluded from prevention and annual examinations, the costs of the risk-based group would have been reduced to half the actual costs (from 54 to 23 €/child) (Table 2).

These costs were distributed unevenly among risk categories and treatment types (Fig. 1). Within the low-risk category, costs were low and did not, in practice, differ between the prevention groups (Fig. 1). For the intermediate-risk category, the costs of preventive dental assistants were comparable between the prevention groups. However, the costs of restorative treatment and, accordingly, also total costs, were significantly higher in the routine than in the risk-based prevention group ($P = 0.001$) (Fig. 1). For the high-risk children in the risk-based prevention group the costs of preventive dental assistants were higher ($P < 0.001$), and those of the dentist/assistant team lower ($P = 0.007$), compared to the routine prevention group. Within this high-risk category, the total costs were lower in the risk-based than in the routine prevention group ($P = 0.046$) (Fig. 1).

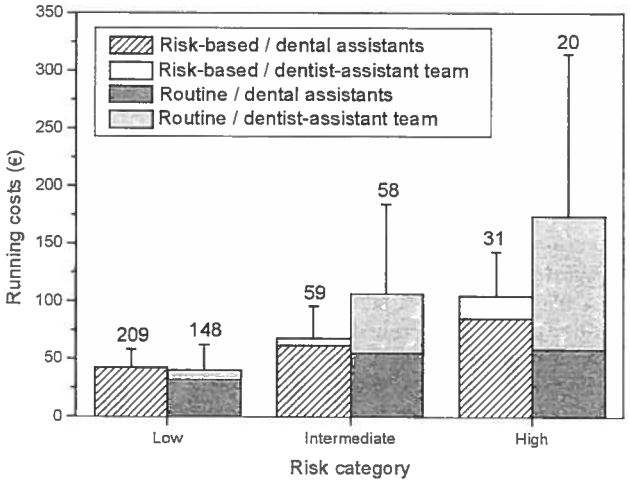

Fig. 1. Mean running costs (and standard deviation) in € during the 3-year follow-up in risk-based and routine prevention groups by risk categories estimated at 2 years of age: Low = no mutans streptococci detected, no signs of caries. Intermediate = mutans streptococci detected, no signs of caries. High = signs of caries detected. The figures above the columns refer to the number of subjects. Significant differences between the risk-based and routine prevention groups (Student's *t* test). Within intermediate category: Total costs, $P = 0.001$. Within the high-risk category: Total costs, $P = 0.046$.

Discussion

Our results indicate that, in preschool children, a risk-based prevention program can be effective in reducing both dental caries and running costs, provided that preventive dental assistants carry out the program. The time spent on prevention at this early age reduced the need for restorative treatment and, thus, the time of a dentist/assistant team. This is in line with earlier observations on early risk assessment and targeted prevention of caries (8). This strongly favours the adoption of risk-based prevention in the oral health care of preschool children. The superiority of the present program in both clinical and economic aspects makes selection possible without the need for further cost-effectiveness analysis. Interestingly, similar outcomes were also presented in a study in which an economic model was estimated on the basis of cross-sectional data and theoretical considerations (9).

Our results are not in line with those presented in schoolchildren and adolescents, probably due to the age difference of the subjects (10). Young age might be favourable for the prediction and prevention of dental caries; the first caries attack being easier and simpler to predict and control than the later processes.

The present measure of costs does not include the costs of restorative treatment of lesions found at the final examination. Their inclusion would most probably

increase the difference between the groups in favour of the risk-based prevention group.

Dental assistants or hygienists have also been used to economic advantage in dental examinations and prevention in many previous preventive programs (8, 11–17). It is clear that it would be possible to greatly reduce health-care costs without jeopardising the quality of the health care if risk assessment and prevention in preschool children were carried out by appropriate personnel using the right methods. However, changing the structure of the personnel often requires long-term planning and time. In fact, the hypothetical situation of a dentist and dental assistant team carrying out the program, and the associated high costs, corresponds rather well with the practice prior to the study in the present health centers. If the present program had been carried out by a team consisting of a dentist and a dental assistant, the costs would have been over five times as high as the least expensive option, i.e. using preventive dental assistants and having the children at low risk excluded from annual preventive visits. This kind of practical sensitivity analysis reveals how strongly costs depend on the dental personnel delivering care. However, the costs of a dental hygienist working alone and a preventive dental assistant working alone are comparable, the difference being about 2 €. The use of the higher salary cost of a hygienist for both prevention groups would not have changed the outcome.

The economic analysis was done from the perspective of a municipal health center. For this reason, the present costs are strongly related to the working time of the personnel. The costs related to parents and their children (e.g. travelling, working time lost, pain and suffering associated with restorative treatment, stress following a high-risk program) were not included. However, the time the parents spent on the program is closely related to the total treatment time, which was almost identical within the risk-based and routine prevention groups during the 3-year follow-up. The time spent within the risk-based group was dominated more by prevention than it was within the routine prevention group. Therefore, the addition of a family perspective would have had little or no effect on the results.

Nowadays, the majority of children have no cavities, while a small minority develop many. In the present study, we found that, at the age of 5 years, 3% of the children had 50% of all the caries lesions. The percentage was the same in both groups, although the number of lesions was different. Thus, it is advisable to use individualized recall intervals rather than to lengthen the recall intervals of whole age cohorts. This is in line with the national recommendations on oral health examination intervals in Finland (18). In preschool children, there is no need to examine the children at low risk every year, while the children at high caries risk benefit from frequent visits and intensive prevention. The present results are not applicable to school children or adolescents.

This study was carried out as a field study, in real life conditions, using the existing personnel and facilities. Almost all the population is included in the regular recall system of the health center, and the need for treatment is increasing due to an increasing and aging population in the catchment area. Our principal aim was to control running costs by delegating tasks to preventive dental assistants, while at the same time maintaining or improving the good level of dental health. The dentist and dental assistant pair would thus have time and opportunity for other tasks in the health center; in this case the dental treatment of adults and the elderly.

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