

Optimizing Oral Health

**Towards a tailored, effective and
cost-effective dental care**

Erik Vermaire

Optimizing Oral Health

Towards a tailored, effective and cost-effective dental care

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Chapter

1

Introduction



Introduction

Background

The main topic of this thesis is the prevention of dental caries in children. Caries can be regarded as the outcome of a demineralization process that occurs when commensal oral microorganisms ferment dietary carbohydrates to acid causing a pH drop in the dental plaque with subsequent demineralization of the enamel and dentine (Keyes & Jordan, 1963). Caries has been found in human ancestors already. First signs of caries have been found in Australopithecines (living about 10^6 years ago) and in Neanderthals (living about 10^5 years ago). The first distinct increase in caries prevalence started in medieval age, not coincidentally in the same period that the introduction of sugar cane in human diet took place. Approximately 10 carious teeth per 100 teeth was estimated for the Middle Ages (500-1500 A.D.) (Keene, 1980; Varrel, 1991; Caffel et al., 2004; Esclassan et al., 2008). The second distinct increase in caries prevalence occurred in the first two decades after World War II (1945-1965) mainly due to the increased availability to (sugary) foods and drinks. Approximately 25 carious teeth per 100 teeth was reported in modern age (data 2003; website WHO). The first signs of invasive caries treatment known so far (drilled occlusal surfaces of permanent molars), have been reported to originate from the Neolithic age (7,500-9,000 years ago) in Pakistan (Coppa et al., 2006), while the first proof of caries preventive activities (the use of a toothbrush) have been reported to originate from ancient China 1,600 years ago (Kumar, 2011).

Nowadays, caries is found to be one of the most prevalent diseases among children worldwide: 60-90% of all schoolchildren experience one or more carious lesions in their primary teeth. Caries is present, albeit unequally distributed, throughout all socioeconomic classes in both developing and developed countries (Bagramian et al., 2009; Petersen, 2003). An unhealthy mouth can result in reduced general health. The relationship between oral health and general health is increasingly recognized (Söder et al., 2012; Soto-Barreras et al., 2012). While the basis for maintaining a good oral health is laid in childhood (Thorstensson & Johansson, 2009), it is desirable to start caries preventive actions as early in life as possible.

Caries preventive measures

According to current standards, caries is a disease that can be prevented. The most effective measure for caries prevention nowadays is considered to be the daily use of fluoridated toothpaste (Marinho et al., 2003). Despite the fact that brushing one's teeth with fluoridated toothpaste twice daily should not be too difficult to achieve, still the mean number of decayed, missing and filled surfaces as a result of caries (DMFS) in 17-year-old children in the Netherlands is 5.2 (\pm 7.6) (Poorterman & Schuller, 2006). Behavioural aspects are considered to play a role in caries prevention, as do the prevailing attitudes individuals may have concerning caries preventive measures.

In the Netherlands, a common caries prevention programme consists of dental check-ups routinely twice a year, frequently followed by a professional fluoride application and sealing all fissures of newly erupting permanent molars. Still, the percentages of 5-, 11-, 17- and 23-year-old children with no caries experience (dmfs/DMFS = 0) are respectively 44%, 53%, 29% and 14% (Poorterman & Schuller, 2006), certainly leave room for improvement.

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Exploring the possibilities to achieve this improvement in a regular dental practice resulted in two different approaches. The first one was to intensify the professionally administered prevention component of the regular approach: a meta-analysis of 14 placebo-controlled trials concluded that a higher caries preventive fraction was shown with increased frequency and intensity of professional fluoride applications (Marinho et al., 2002). In this thesis, this approach is referred to as the Increased Professional Fluoride Application (IPFA) regime. The second one was to reduce these professionally administered preventive interventions and to intensify the parental home care component of the regular approach: implementing such a non-operative caries treatment and prevention strategy has shown good results in Denmark and Russia (Carvalho et al., 1992, Ekstrand et al., 2000, Ekstrand & Christiansen 2005). However, the performance of this strategy has not been evaluated in the Netherlands yet. This approach will be referred to as the Non-Operative Caries Treatment and Prevention (NOCTP) regime in this thesis. Because of the different kinds of the suggested interventions, a randomized controlled clinical trial seemed the most accurate way to compare effectiveness of both strategies, with the normal strategy as control group.

Health economic aspects

In spite of increasing health care expenditures – and dentistry expenditures do not form no exception – health care budgets ultimately remain limited and, hence, choices need to be made about how to spend available resources optimally. In that context, health care decision makers may favour cost-effective interventions and prevention regimes. By spending available resources on the most cost-effective interventions, population's (oral) health can be optimized. Those interventions that offer sufficient value for money can then be selected and implemented. Optimal prevention of caries may be an important goal in that context, also given that in 2010 60% of the total dentistry budget (being 1.8 billion Euros) was spent on caries (Slobbe et al., 2011). Therefore, prevention of the disease may induce important health gains. In this thesis, it is investigated whether it is possible to attain such health gains against reasonable costs. In theory, prevention of caries might even induce cost reductions (when saving later costly interventions), but this need not be the case to be economically attractive. For the latter it is merely important that benefits outweigh the costs. In this thesis, this is investigated for the two intervention strategies compared to the current treatment strategy, performing an economic evaluation (Drummond, 2005).

Behavioural aspects

One of the tested measures in this trial (NOCTP) is considered to draw on parents' preparedness to be more involved in the –individually assessed– caries preventive care for their child. It would be of value to know in advance to what extent they indeed are willing to invest in their child's healthy mouth. Attitudes are likely to play a role in general health and oral health behaviour (Skeie et al., 2006; Jerkovic et al., 2009; Mohebbi et al., 2008; Poutanen et al. 2007). Therefore, the identification of prevailing attitudes in general and individually can be considered vital information in designing strategies to deliver individualized preventive care.

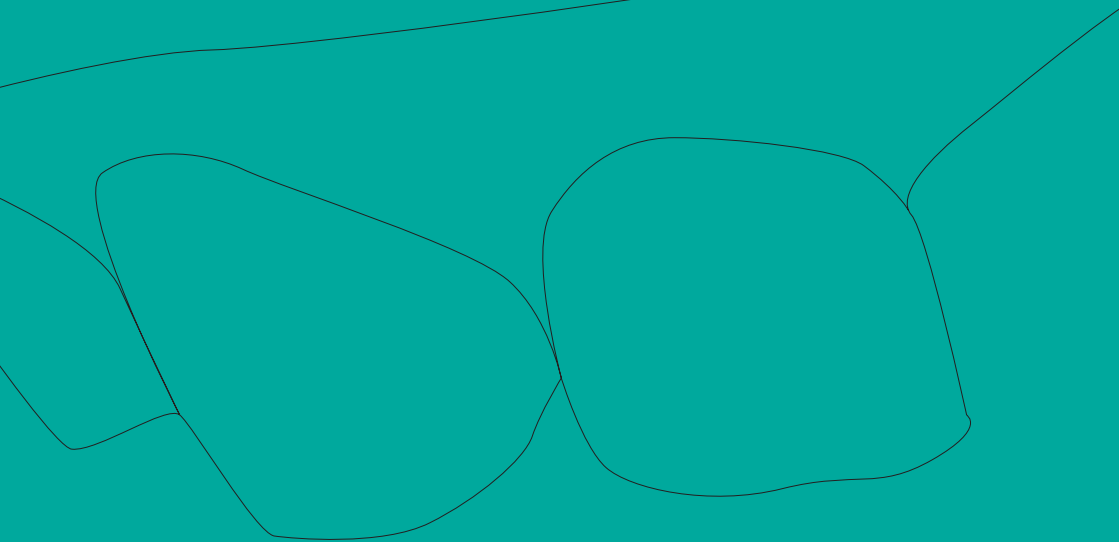
Aim of the thesis

The main aim of this thesis is threefold. Firstly, to test and describe a randomized clinical controlled trial testing the clinical performance of two different caries-prevention strategies compared with a regular approach (chapter 2). Secondly, to perform an economic evaluation of the applied strategies in this trial, thus investigating their 'value for money' (chapter 3). Thirdly, to explore parents' willingness to invest in oral health of their child, the prevailing parental attitudes towards prevention and attitude-dependent oral health behaviour (chapters 5, 6 and 7). These chapters are intermitted by a description of the sample of the children whose parents chose to participate in the RCT and the children whose parents chose not to do so (chapter 4). These studies jointly aim to test alternative possibilities for caries prevention in children in the Netherlands, explore the health economic aspects related to these measures and identify possible (implementation) pitfalls these measures could entail.

Chapter

2

**Three-year outcomes of
a randomized controlled
clinical trial in 6-year-old
children on caries-
prevention programs**



Three-year outcomes of a randomized controlled clinical trial in 6-year-old children on caries-prevention programs.

Introduction

According to current standards, the daily use of fluoridated toothpaste is the most effective measure for caries prevention (Marinho et al., 2003). Besides the use of occlusal sealants (Ahovuo-Saloranta et al., 2008), professional application of fluorides (gels, varnishes) is also considered to contribute largely to reduction of caries incidence (Marinho et al., 2002). A meta-analysis of 14 placebo-controlled trials concluded that a higher decayed, missing or filled surfaces (DMFS) prevented fraction was associated with increased frequency and intensity of application (Marinho et al., 2002). In the Netherlands, a frequently used approach of caries-prevention is to maintain a dental check-up interval of 6 months, apply 1.23% fluoride gel at these visits and routinely seal the occlusal surfaces of erupted permanent molars. Despite continuing efforts and concomitant expenses, a large number of children still experience caries. A study in 11-year-olds in the Netherlands reported an increase of decayed, missing or filled surfaces in permanent dentition (DMFS) from 1.4 (\pm 2.3) in 1999 to 1.7 (\pm 2.8) in 2005 (Poorterman & Schuller, 2006); this study also showed an increase in primary dentition (dmfs) in children aged 5: 4.0 (\pm 7.4) in 1999 vs. 4.6 (\pm 8.0) in 2005.

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An alternative strategy, implementing the concept of non-operative caries treatment and prevention (NOCTP), based on parental homecare, has been the subject of several studies. Although results to the contrary have been found (Arrow, 2000), most studies investigating delivering individualized preventive care report good efficacy and effectiveness (Carvalho et al., 1992; Ekstrand et al., 2000; Ekstrand & Christiansen, 2005; Hausen et al., 2007; Evans & Dennison, 2009).

Most studies on caries prevention strategies with NOCTP are performed in high-risk populations. But also for populations with relatively low caries prevalence rates it is important to identify the feasibility of these strategies and to determine which strategy is most effective in preventing caries. Therefore, it is of interest to investigate to what extent different caries preventive strategies are effective in daily practice in a mixed-SES population in a country with a relatively low caries incidence.

The aim of this study was to test the hypothesis that, compared to regular care (routinely twice a year a dental check-up with professional topical fluoride application and sealing newly erupting permanent molars) a larger caries-preventive effect can be achieved by following a non-operative caries treatment and prevention strategy (NOCTP) or by following the regular approach with an increased professional topical fluoride application frequency of 4 times a year (IPFA). All participants (from a mixed SES population) followed the respective programmes in the same general dental clinic in the Netherlands.

Material & Methods

Procedure

From September 2006 to September 2008, all parents of 6-year-old children (± 3 months) – all regular patients of a large dental clinic in 's-Hertogenbosch, the Netherlands – were asked to allow their child to participate in this trial. 's-Hertogenbosch is a city with approximately 150,000 inhabitants. This city can be considered, in terms of demographic indicators, to be representative of the Netherlands (Schuller, 2009). The study team sent a letter to inform the parents about the study and of the possibility of participation in the study, approximately two weeks prior to the planned dental check-up around the child's sixth birthday. After informed consent was obtained, parents were asked to fill out a questionnaire to provide information on socioeconomic variables, oral hygiene habits, dietary habits, and knowledge on dental topics. The questionnaire also asked parents to indicate the objections they might have of investing in preventive oral health treatments for their child. If the parent decided against participation, the reason for non-participation was recorded and the parent was still asked to fill out the same questionnaire.

Sample size estimation

The interventions aimed at the reduction of caries progression. Therefore, caries increment in permanent dentition (first three years after eruption) was considered the main outcome measure. Caries increment in primary dentition, the level of oral hygiene and the number of pit and fissure sealants were also recorded. A sample size of 181 was determined to be sufficient to observe a difference of 1 DMFS with 80% of power using a two sided test at $\alpha = 0.05$. An anticipated dropout percentage of 20% was taken into account. Therefore, a total of 230 children, aged 6.0 year (± 3 months) were included in this study. After inclusion, children were randomly assigned to one of three treatment groups using research randomizer: www.randomizer.org/form.htm.

Interventions

Children receiving the practice's regular caries treatment and prevention served as the control group. The regular protocol comprised preventive visits (dental check-ups) twice a year, professional 1.23% fluoride gel application twice a year, routinely sealing pits and fissures of newly erupted molars with a resin-based material and restoration of caries at the dentine-threshold (d3/D3-level).

In experimental group 1, the standard protocol was abandoned and replaced by a non-operative caries treatment and prevention protocol (NOCTP); an individual, tailored approach, which was copied from the protocol used in Nexø, Denmark (Ekstrand & Christiansen, 2005) and applied to the situation in this specific dental practice. The main difference was that all children in this study started the programme at the age of 6 years (and not already at 6 months). The dental personnel involved in this project followed a 1-day training course that was run by former staff of the Nexø-clinic. The protocol was based on the understanding caries being a localized process that can be prevented by tooth brushing with fluoride toothpaste. Recall intervals were individualized using the criteria described by Carvalho et al. (1992): the cooperation of the parents, the activity of caries lesions within the dentition, the eruption stage of permanent first molars, and caries activity in the occlusal surfaces of the first permanent molars. Each of these criteria was assigned either one (favourable) or two (unfavourable) points. With a maximum score, the recall interval was set at 1 month, with a minimum score at 9 months. Oral hygiene and dietary instructions were supported with written information, based on the leaflets used by the staff in the Nexø study. Professional fluoride applications were restricted to those situations where caries initiation or progression was recorded. Placement of pit and fissure sealants was also restricted to situations where intensified brushing with fluoride toothpaste and additional professional fluoride application were not able to inhibit caries progression. A checklist was completed by dental staff during each visit so that the dental staff could maintain accurate and up-to-date records of all preventive and restorative actions that were taken with each subject. Like in the control group, caries was restored at d3/D3-level in this group as well.

Children in experimental group 2 followed the same approach as the control group but the children in this second group had two additional visits where professional fluoride treatments were given (a total of 4 times / year). The rationale behind this was firstly the fact that professional fluoride gel applications gain effectiveness while increasing the frequency of applications (Marinho et al., 2002) and secondly to exclude the

possibility that extra visits by itself (disregarding the content of that visit) may have a positive effect on caries preventive effectiveness.

Questionnaires

Dental knowledge and perceived resistance to perform dental hygiene measures were scored using a dental knowledge questionnaire and a perceived dental hygiene burden questionnaire, respectively. Scores on the dental knowledge questionnaire varied from 0 to 5 with a higher score indicating higher dental knowledge. Scores on dental hygiene burden varied from 0 to 5 with higher scores indicating a higher perceived burden. A detailed description of these questionnaires is given elsewhere (Vermaire et al., 2012).

Caries scores

Clinical examinations were carried out by one experienced and trained dentist, blinded to the treatment groups. At baseline and after three years, 11% and 10%, respectively, of the children were re-examined by a second experienced and trained dentist. Inter-examiner agreement scores for dmfs/DMFS and plaque scores were $\kappa = 0.89$ and $\kappa = 0.74$ for the baseline measurements, and $\kappa = 0.91$ and $\kappa = 0.80$ after three years, respectively. Neither of these dentists participated in the dental healthcare programme for the children. Due to medical-ethical objections, no radiographs were taken for the purpose of this study; therefore, the incidence of caries was exclusively clinically assessed. The children's oral health condition was assessed clinically during a visit at the dental clinic using mirror, light, a blunt probe and compressed air. Oral hygiene was assessed using the simplified oral hygiene index (OHI-s) (Greene & Vermillion, 1964) and caries were assessed using the dmfs-/DMFS-index, with caries scored at the dentine-threshold (d3/D3) (WHO, 1979).

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics 20.0. The sample was characterized using descriptive statistics. Mean dmfs / DMFS scores were compared using independent samples t-tests. The significance level was set at $\alpha = 0.05$.

The study was approved by the Medical Ethical Committee of the VU University Amsterdam, the Netherlands. Protocol number NL13709.029.06.

Results

After three years, complete data for a total of 179 children was available for analysis. A flowchart of the attrition of participants in this study is presented in Figure 1. Some of the reasons for withdrawal were the following: inconvenience for the child (20 parents), burden of travelling to the clinic (20 parents), inconvenience for the parent (10 parents), and serious illness (1 child). In the IPFA group, 60% of the withdrawals were because of the perceived inconvenience by the child (especially gagging because of the use of fluoride gel filled trays), while in the NOCTP group, 46% of the withdrawals discontinued participation in the study because of the burden of travelling. Almost 25% of the withdrawals in the NOCTP group did so because these parents felt that they were preventing their child from receiving the regular care that they were used to.

Sample characteristics and non-clinical outcomes at 6 and 9 years of age are presented in Table 1. It was found that after three years, knowledge on dental topics was greatest in the NOCTP group. The NOCTP group also had the lowest scores on oral hygiene burden questions; however, this was also the case at the age of 6 and is therefore not to be attributed to the intervention.

Table 2 shows the outcomes of the clinical measurements at baseline and after three years for each experimental group. After three years, children in the NOCTP group had developed $0.15 (\pm 0.50)$ DMFS, while the children in the IPFA group and the control group developed $0.34 (\pm 0.87)$ and $0.47 (\pm 1.04)$ DMFS, respectively. Independent sample t-test showed that this mean difference between the NOCTP and control group was statistically significant ($t = 2.13$; $p = 0.02$).

Table 3 shows the percentages of caries-free children in both primary and permanent dentition for each experimental group. In the NOCTP group, 5.4% of the children who were caries-free at the age of 6 developed caries into dentin in their primary dentition in a period of three years. In the IPFA and control groups, this was 14.6% and 21.8%, respectively. For the permanent dentition, the percentages were the following: 9.4%, 24.6% and 25.5%, respectively. Children in the NOCTP group who developed caries did so less frequently than children in the other groups. However, these differences were not statistically significant ($t = -1.77$, $p = 0.09$, compared to control and $t = -1.67$, $p = 0.11$, compared to IPFA).

After three years, the total duration of the visits was comparable for the NOCTP group and control group. In the first year of the study, the average contact time with the dentist for the NOCTP group, IPFA group, and control group were 14.40 minutes (± 5.18), 13.61 minutes (± 4.57) and 8.70 minutes (± 2.87), respectively. In the third year of the study, no statistically significant difference was found (8.85 minutes (± 2.83) in the NOCTP group vs. 9.00 minutes (± 3.41) in the control group). The total cumulative difference in contact time between the NOCTP group and the control group after three years was approximately 7 minutes. After three years, the mean number of visits for NOCTP group, the IPFA group, and the control group were the following: 7.45 (± 1.44), 11.26 (± 1.33) and 6.28 (± 1.02), respectively. The higher values in the IPFA group may be attributed to the fact that the protocol in that group prescribed at least 4 sessions per year during which professional fluoride treatments were provided.

Table 4 presents an overview of all actions taken at every visit in the NOCTP group. The number of visits per year decreased during the three years of the experiment. The number of actions taken per visit also decreased over time. Furthermore, in this group, restoration placements were highest in the 3rd year, yet still lower than that in the IPFA and control groups.

Discussion

This study aimed to compare the caries-preventive effect of a non-operative caries treatment and prevention strategy (NOCTP) that is based on increased parental home care and includes an individually assessed recall interval, with two strategies that are based on different professional topical fluoride application frequencies (4/year (IPFA) and 2/year (control) in addition to routine twice-a-year dental check-ups and sealing all erupting permanent molars. The NOCTP program turned out to be an effective program for caries-prevention in this regular dental practice in the Netherlands. Children in this program had better oral hygiene, a lower mean DMFS and the biggest chance to be – clinically – caries-free at the age of 9 compared to children in the other two programs.

A mean difference of 0.32 Δ DMFS between children in the control group and NOCTP group after three years was found. Taking into account the low caries prevalence in the study group, the results can be regarded as clinically significant; only approximately 3 children had to follow the NOCTP program to prevent one extra DMFS. Following the IPFA regime, children had a statistically non-significant reduction of 0.13 DMFS compared to the control group, which would mean a number needed to treat of about 8 children to prevent 1 DMFS.

A larger number of children in the NOCTP group discontinued participation in the study compared to the other two groups. This was mainly because of travel-related reasons and this happened mostly in the first year of the trial. Apparently, the parents found that the investment that they had to make to follow the program did not outweigh the possible benefits for their child. Other parents indicated that they felt uncomfortable 'withholding' their children regular care, especially when the children had older brothers or sisters who had followed the standard approach in the past.

Most children in the IPFA group who discontinued participation in the study did so because of inconvenience; undergoing the professional fluoride application was regularly accompanied with gagging because of the fluoride gel-filled tray. This, together with the uncertain effectiveness, limits the usefulness of this caries prevention strategy: if a strategy works but compliance is limited, no long-lasting effects should be expected. This may be considered an established fact for all strategies.

Limiting the indication for placement of occlusal sealants in the NOCTP strategy resulted in a considerable decrease in the number of placed sealants (Table 2). Whether this decrease is a lasting result or only a postponement is still unknown. But, as is shown in Table 4, after an increase in the number of placements of sealants in the second year of the trial (2 sealants in the first year vs. 11 in the second year), the number of placements of sealants in the NOCTP group seems to have levelled off in the third year (4 sealants). Whether this trend is the same for the placement of restorations is highly relevant as well because, as Table 4 also shows, the number of restorations doubled in the third year of the trial (8 restorations), compared to the other two years (4 in the first year, 5 in the second year). Whether this will also level off or increase further in the fourth year and beyond will become evident when longer-term results become available 6 years after the start of the trial, at the age of 12.

The NOCTP program in the current study is copied from the original study in Nexø, Denmark, where the program ran from the age of 8 months until the age of 18 (Ekstrand & Christiansen, 2005). In 18-year-olds, the mean number of DMFS was 1.23 (\pm 2.26), while in the comparison groups in other parts of Denmark, DMFS varied between 2.73 (\pm 3.94) and 3.93 (\pm 3.77). It should be noted that the comparison groups were among of the best performing health-service clinics in Denmark, with very low caries rates. The percentage of caries-free children was 55% in Nexø compared to 24-39% in the comparison groups. In spite of obvious differences in the age groups between the current study and the Nexø study, the same trend in caries development can be seen: children following a non-operative caries treatment and prevention

strategy had lower DMFS scores and more children in this group have no caries experience. This was also the case in a study where the NOCTP strategy was applied in Moscow, Russia (Ekstrand & Christiansen, 2005). Although the opposite has also been reported (Arrow, 2000), most other studies using individually delivered caries prevention strategies have reported outcomes that are comparable to those of the current study (Warren et al., 2010; Hausen et al., 2007; Pienihäkkinen & Jokela, 2002). Considering all of the studies mentioned above, it is clear that individualizing caries prevention results in a net-positive gain in effect. It can be argued that the NOCTP approach used in the current study in the Netherlands is a feasible approach and an effective way to prevent caries in this sample of children.

A relevant issue that needs to be addressed is that of the costs involved in applying the followed strategies. The original study in Nexø reported that the mean costs of applying the NOCTP regime was approximately € 130 / year (converted from the original amount of 1172 DKK / year), which was among the lowest in Denmark (Ekstrand & Christiansen, 2005). The reported costs in that study were only included to monitor the effect of implementation of the NOCTP regime on the cost per child per year. In Nexø, these costs were significantly lower than before NOCTP had been implemented. It was emphasized that because the way healthcare (including dental health) is organized and financed is different throughout countries and therefore the reported statistics are inadequate for economic comparisons with preventive programmes that are tested outside Denmark. From an earlier study we know that in the population of the current study, the mean stated parental willingness to pay to keep their children's teeth healthy until the age of 18 years is € 32 / month (Vermaire et al., 2012). However, money is not the only investment needed in caries prevention: the investment in the number of preventive visits needed, the extra time parents have to invest travelling to the clinic and accompanying their children, and brushing their children's teeth themselves may even be of greater importance. Hence, economic evaluations are necessary to compare both strategies with the control group and to identify the necessary resources used to achieve the extra gain in caries prevention.

In light of the results of this study, we can conclude that a non-operative caries treatment and prevention strategy (NOCTP) like the one that was used in Nexø, Denmark can be regarded as clinically effective in a general dental clinic in the Netherlands. In the future, it may be useful to expand the implementation of this strategy, both in more dental clinics in more regions, as well as in more age groups, and to perform a health economic evaluation of the strategy to assess its cost-effectiveness.

Table 1: Non-clinical outcomes

Percentages of total divided by research groups n = 179

	NOCTP (n = 54)		IPFA (n = 62)		CONTROL (n = 63)	
SEX						
male	27 (50.0%)		29 (46.7%)		31 (49.2%)	
female	27 (50.0%)		33 (53.2%)		32 (50.8%)	
SES						
low	14 (25.9%)		21 (33.9%)		20 (31.8%)	
medium	17 (31.5%)		23 (37.1%)		23 (36.4%)	
high	23 (42.6%)		18 (29.0%)		20 (31.8%)	
	6 y	9 y	6 y	9 y	6 y	9 y
Oral hygiene habits						
only child brushes	17 (31.5%)	35 (64.8%)	15 (24.2%)	39 (62.9%)	15 (23.8%)	40 (63.5%)
only parent brushes	16 (29.6%)	4 (7.4%)	7 (11.3%)	3 (4.8%)	18 (28.6%)	2 (3.2%)
both child & parent	21 (38.9%)	15 (27.8%)	40 (64.5%)	20 (32.3%)	30 (47.6%)	21 (33.3%)
Fluoride in toothpaste?						
consciously no	3 (5.6%)	1 (1.8%)	2 (3.2%)	1 (1.6%)	3 (4.8%)	2 (3.2%)
yes, age specific toothpaste*	41 (75.9%)	41 (75.9%)	49 (79.0%)	42 (67.7%)	48 (76.2%)	36 (57.1%)
yes, adult's toothpaste*	4 (7.4%)	9 (16.7%)	6 (9.7%)	14 (22.6%)	4 (6.3%)	19 (30.2%)
I don't know	6 (11.1%)	3 (5.6%)	5 (8.1%)	5 (8.1%)	8 (12.7%)	6 (9.5%)
Dietary habits – regular meals						
breakfast	48 (90.5%)	47 (88.7%)	54 (88.9%)	54 (88.9%)	55 (89.5%)	56 (91.2%)
lunch	51 (96.2%)	48 (90.6%)	56 (93.3%)	58 (96.7%)	55 (89.5%)	57 (93.4%)
dinner	51 (96.2%)	52 (98.1%)	58 (96.7%)	59 (98.3%)	58 (95.1%)	60 (98.3%)
Dietary habits – between meal snacks						
not every day	2 (3.7%)	2 (3.7%)	2 (3.2%)	2 (3.2%)	4 (6.3%)	3 (4.8%)
1-5 / day	41 (75.9%)	45 (83.3%)	48 (77.4%)	45 (72.6%)	47 (74.6%)	46 (73.0%)
> 5 / day	11 (20.4%)	7 (13.0%)	12 (19.4%)	15 (24.2%)	12 (19.1%)	14 (22.2%)
Dental knowledge score (0-10)						
< 5	4 (7.4%)	2 (3.7%)	4 (6.5%)	9 (14.5%)	5 (7.9%)	9 (14.3%)
5-7	19(35.2%)	13 (24.1%)	23 (37.1%)	37 (59.7%)	24 (38.1%)	21 (33.3%)
> 7	31(57.4%)	39 (72.2%)	35 (56.4%)	16 (25.8%)	34 (54.0%)	33 (52.4%)
Dental hygiene burden score (0-5)						
< 2	21 (38.9%)	14 (27.7%)	17 (27.4%)	10 (16.1%)	15 (23.8%)	13 (20.6%)
2-4	21 (38.9%)	30 (55.6%)	19 (30.6%)	23 (37.1%)	25 (39.7%)	27 (42.9%)
> 4	12 (22.2%)	9 (16.7%)	26 (42.0%)	29 (46.8%)	23 (36.5%)	23 (36.5%)

NOCTP: Non-Operative Caries Treatment and Prevention;

IPFA: Increased Professional Fluoride Application.

Fl- in toothpastes: < 5 y: 500ppm, < 5y 1000-1500ppm

Table 2: Mean scores of clinical variables divided by experimental group

Clinical data at baseline (6-years-old) n = 179								
	NOCTP (n = 54)	controls (n = 63)	t	p	IPFA (n = 62)	controls (n = 63)	t	p
OHI-s (0-3)	0.85 (± 0.65)	0.90 (± 0.62)	-0.42	.68	0.82 (± 0.68)	0.90 (± 0.62)	-0.63	.53
Sealants	0.19 (± 0.81)	0.19 (± 0.85)	0.01	.31	0.48 (± 1.23)	0.19 (± 0.85)	1.58	.12
dmfs	4.55 (± 6.20)	6.88 (± 8.99)	-1.59	.11	5.00 (± 8.23)	6.88 (± 8.99)	-1.03	.31
DMFS	0.06 (± 0.31)	0.02 (± 0.13)	0.98	.33	0.05 (± 0.29)	0.02 (± 0.13)	0.84	.40
Clinical data after 3 years (9-year-old) n = 179								
	NOCTP (n = 54)	controls (n = 63)	t	p	IPFA (n = 62)	controls (n = 63)	t	p
OHI-s (0-3)	0.80 (± 0.51)	1.01 (± 0.56)	-2.15	.03	0.99 (± 0.59)	1.01 (± 0.56)	-0.21	.83
Sealants	1.45 (± 1.76)	3.89 (± 1.40)	-8.16	.00	3.45 (± 1.10)	3.89 (± 1.40)	-1.95	.05
dmfs	5.04 (± 6.19)	7.31 (± 7.10)	-1.85	.07	5.77 (± 6.44)	7.31 (± 7.10)	-1.28	.20
DMFS	0.21 (± 0.60)	0.48 (± 1.04)	-1.80	.08	0.39 (± 0.93)	0.48 (± 1.04)	-0.55	.58
Differences after 3 years n = 179								
	NOCTP (n = 54)	controls (n = 63)	t	p	IPFA (n = 62)	controls (n = 63)	t	p
Δ OHI-s	-0.05 (± 0.64)	0.14 (± 0.77)	-1.40	.16	0.17 (± 0.70)	0.14 (± 0.77)	0.19	.85
Δ sealants	1.26 (± 1.71)	3.70 (± 1.55)	-8.01	.00	2.97 (± 1.58)	3.70 (± 1.55)	-2.64	.01
Δ dmfs	0.49 (± 4.65)	0.44 (± 6.79)	0.05	.96	0.77 (± 6.18)	0.44 (± 6.79)	0.29	.77
Δ DMFS	0.15 (± 0.50)	0.47 (± 1.04)	-2.17	.03	0.34 (± 0.87)	0.47 (± 1.04)	-0.67	.45

NOCTP: Non-Operative Caries Treatment and Prevention;

IPFA: Increased Professional Fluoride Application;

OHI-s: Simplified Oral Hygiene Index

Table 3: Percentages of caries-free children and mean caries scores in primary (dmfs) and permanent (DMFS) dentition (only in those who did develop new caries).

	dmfs = 0		Δ dmfs > 0		DMFS = 0		ΔDMFS > 0	
	6 y	9 y	N	mean Δdmfs (sd)	6 y	9 y	N	mean ΔDMFS (sd)
NOCTP	39.6%	34.0%	25	3.52 (3.39)	96.2%	86.8%	7	1.57 (0.79)
IPFA	51.6%	40.3%	26	5.31 (4.58)	96.8%	82.2%	11	2.18 (0.98)
Controls	43.8%	25.0%	30	5.17 (3.82)	98.4%	76.6%	15	2.07 (1.16)
Total	45.3%	33.0%	81	4.70 (3.99)	97.1%	81.6%	33	2.00 (1.03)

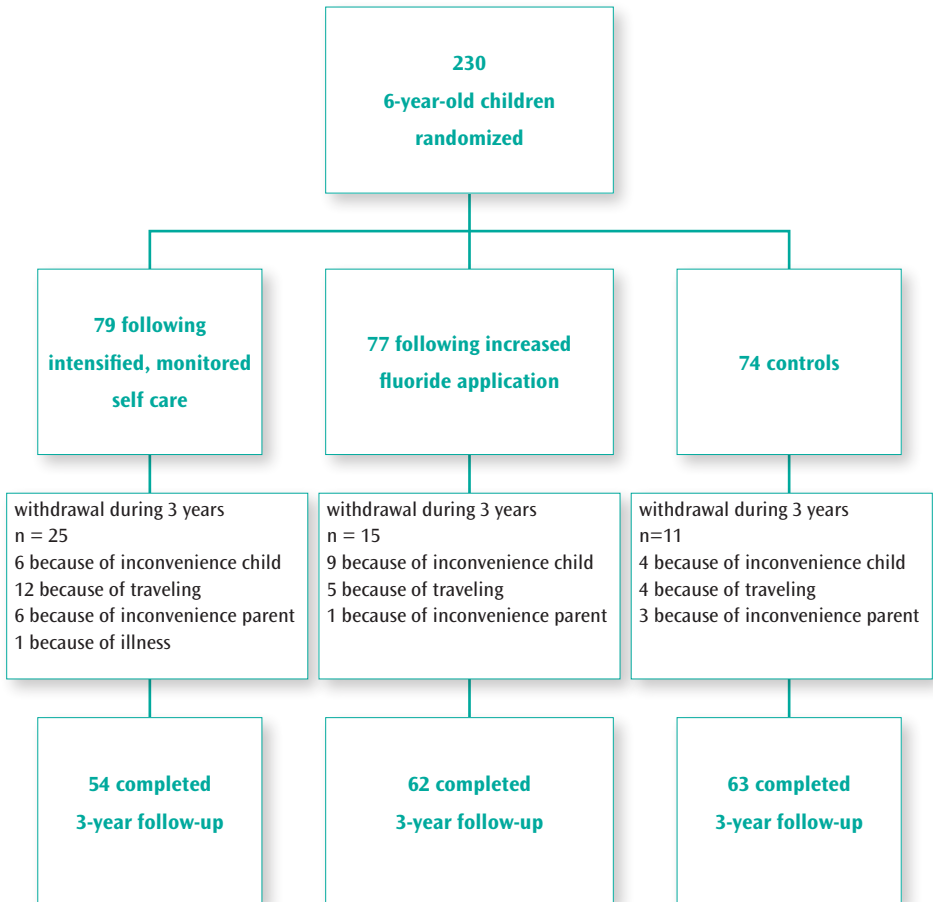
NOCTP: Non-Operative Caries Treatment and Prevention;

IPFA: Increased Professional Fluoride Application

Table 4: visit-specific content of recall sessions in NOCTP group (n = 54)

	Visit	Children	Reason for extra visit*				Intervention §					Missing
			oral hygiene	diet	eruption M1	unknown	disclosing plaque + instruction	tartar removal	fluoride appl.	sealing	restoration permanent dentition	
1st year	1	54	30	13	22	0	30	12	5	2	1	0
	2	49	27	5	35	0	31	9	3	0	2	2
	3	38	16	2	25	1	21	7	4	0	0	3
	4	37	14	0	7	1	5	3	2	0	0	2
	5	19	→ 5th visit was 1st visit of 2nd year									
2nd year	1	54	24	9	10	1	25	14	10	3	1	1
	2	35	16	1	2	1	15	9	7	5	2	6
	3	20	14	1	1	2	4	5	2	3	1	0
	4	18	→ 4th visit was 1st visit of 3rd year									
3rd year	1	54	17	3	0	1	7	6	2	1	3	2
	2	21	6	1	0	6	6	0	2	3	1	4
	3	13	1	0	0	5	1	1	0	0	0	4
	4	6	→ 4th visit was 1st visit of 4th year									

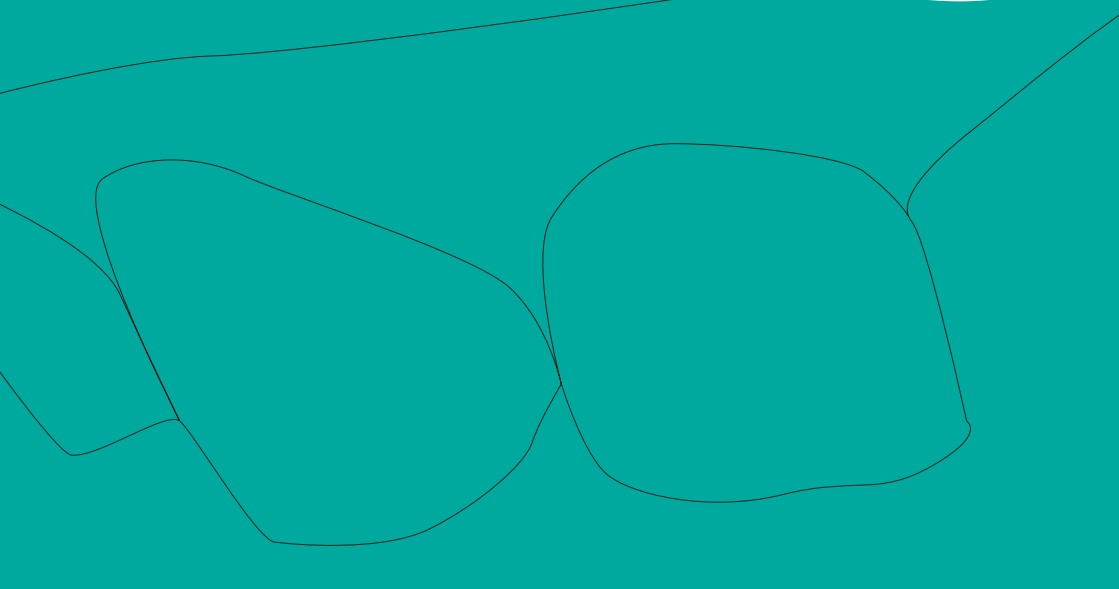
* double-counting possible when multiple reasons per child were recorded; § multiple interventions in same visit are possible



Chapter

3

**Non-participation in a
randomized controlled
trial: the effect on clinical
and non-clinical variables**



Non-participation in a randomized controlled trial: the effect on clinical and non-clinical variables

Introduction

Non-participation-studies reporting both clinical and non-clinical variables are scarce. A recent publication showed that non-participants of a study on a caries prevention program had lower scores of fluorosis and higher caries-levels in their permanent dentition than participants, but not in the primary dentition (Splieth et al. 2005). The authors suggested that these findings may be caused by a lower compliance of non-participating children with preventive measures and that they may be in greater need of caries prevention measures than responders of such a study do. Furthermore, the authors concluded that when the investigated preventive interventions were transferred to a broader group of children it is very likely that their efficiency will be significantly reduced as compared to the experimental results because the proportion of non-compliant people in the total group would be significantly greater than in the experimental group. Davies et al. (2007) concluded that as a result of non-participation only few benefits of a health intervention found in a deprived study population would be discernible at a population level. In their study, the non-participant children had higher dmft levels than the participating children. So non-participation bias may seriously affect the value of clinical trials and it generally is assumed that non-participation bias favors the benefits of preventive interventions. Non-participation may alter the external validity of a study. Strategies used for adjustment of non-participation bias may result in some degree of bias reduction (López et al. 2008). The simplest way is to use the method of inverse probability weights (Grimes and Schulz, 2002; Greenland, 2008). In this method, the participants are weighted by the inverse of the probability of participation. The probability of participation is based on the distributions of variables in eligible and, respectively participating and non-participating children.

The aim of this study is to identify and quantify clinical and non-clinical differences between eligible, participating and non-participating children of a randomized controlled trial (RCT) on caries-preventive strategies in young children and to establish whether the non-participants will have a considerable impact on the external validity of this RCT. A considerable amount of parents chose not to let their child participate in this trial. They were, however, willing to subject their child to the clinical baseline-

measurement and fill out the accompanying questionnaire themselves. This gave the opportunity to assess to what extent eligible, participating and non-participating children differ on both clinical and non-clinical variables.

Material and Methods

From October 2006 till October 2008 parents of all children, aged 6.0 years \pm 3 months, (n = 346) in three dental clinics in three of the larger cities in the Netherlands ('s-Hertogenbosch, The Hague and Utrecht) were approached to allow their child to participate in a randomized controlled trial on the effectiveness of strategies to prevent caries. Of this group 286 (83%) parents consented to participate and approved to (i) let their child be randomly assigned to an experimental or control group, (ii) let the oral health status of their child be recorded during a period of six years by means of clinical check-ups, (iii) let the clinical records and bitewing radiographs, taken by their dentist to be used for this study and (iv), fill out three times a set of questionnaires scoring demographic and socio-economic data, knowledge on dental issues and attitudinal and motivational related questions during the length of the trial.

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60 parents (17%) preferred not to let their child participate in this RCT. Reasons for this refusal were asked and recorded and parents were asked whether they would consent if participation would be limited to just one visit. Of these parents, 56 consented to participate on that condition. The remaining 4 persisted in their refusal and were not included.

Clinical

Of the participants (n = 286) and non-participants (n = 56) oral hygiene was scored applying the simplified Oral Hygiene Index (OHI-s); (Greene and Vermillion, 1964). Scores of this index vary from 0 (surface not covered with plaque) to 3 (incisal / occlusal 1/3 of the surface covered with plaque). No disclosing agent was used but the surfaces were gently explored using a blunt probe to detect dental plaque. Dental health was assessed using dmfs/DMFS-scores in respectively the primary and permanent dentition. Caries was scored at the dentine-threshold (d3), after drying with compressed air, using mirror, light and a blunt probe by a calibrated, experienced dentists. 35 of 342 children (10.2%) were re-examined by a second examiner. Inter-examiner agreement was high ($\kappa = 0.93$) for caries and satisfactory for plaque ($\kappa = 0.67$).

Questionnaire

Parents were asked to complete a questionnaire, scoring (i) ethnic background, (ii) education-level of both parents / care-givers, (iii) dietary and oral health habits of themselves and their children, (iv) knowledge on several dental health topics (oral hygiene, caries, fluoride, snacking, and prevention), (v) health insurance-matters and (vi) willingness to invest. Maternal education-level was used as a proxy for SES (Desai and Alva, 1998). Willingness to invest was assessed by asking parents to indicate the maximum price they were willing to spend to keep their child's teeth healthy in terms of (a) money (€ / month), (b) time (minutes brushing / day) and (c) effort (times visiting dental office / year). The rationale behind these questions is the presumed relation between these factors and caries experience (Ayo-Yusuf et al. 2009; Sbraraini et al. 2008).

Statistics

Differences in distribution of sample characteristics of both parents and children between participants and non-participants were tested with the Chi-square test. To quantify changes in the distribution of variables between eligible and participating or non-participating children the determinant-specific participation probability was calculated. The determinant-specific participation probability is the ratio of the participation probability in the participating or non-participating children divided by the participation probability in the eligible children. This method has been applied before by López et al. (2008) in their study on non-participation in a case-control study of periodontitis. Determinants with a participation probability < 1 are less likely to be present in the participant or non-participant group compared to the eligible population. For example 35.7% of the eligible children had low SES. The participation among parents of low SES was 32.9%. This yields a participation-ratio of $32.9 / 35.7 = 0.92$.

Since caries is a disease with a skewed distribution, describing characteristics (ds, ms, fs, dmfs, care-index) were tested by a non-parametric technique (Mann-Whitney) to analyze possible differences between participants and non-participants. Since all participating and non-participating children are also members of the eligible group, a one-sample t-test is preferable to test the differences between these groups respectively. For all tests, the level of significance was set at $\alpha = 0.05$.

Results

Reasons given for non-participation were mostly lack of time (46%), inconvenience for the child (18%), lack of interest (17%) of 'my child is no guinea pig (7%). The remaining 12% did not provide a reason. Parental characteristics of the eligible, participating and non-participating children are presented in Table 1 together with calculated determinant-specific participation probability ratios. Concerning non-participants, an over-representation of male accompanying parents, immigrants and parents with low SES was found with participation probabilities of 1.35, 1.68 and 1.40 respectively. Furthermore parents in the non-participation group are less likely, but statistically significantly, to eat all three regular meals themselves (participation probability: 0.88), to brush more than once a day (participation probability: 0.93), and to use interdental cleaning supplies (participation probability: 0.80), but more likely to use commercial mouth rinses (participation probability: 1.4). A lower level of knowledge was found in parents of non-participating children as well as a lower self-reported willingness to invest money, time and effort compared to participating children as well as the total eligible group. However, comparison between parents of participating and eligible children did not show statistically significant differences.

Characteristics of eligible, participating children and non-participating children are presented in Table 2 together with calculated determinant-specific participation probability ratios. The non-participating children were slightly less likely to hold on to regular meals (participation probability: 0.88). However, this was only statistically significant for eating all regular meals ($\chi^2 = 3.12$; $p = 0.05$) but not breakfast, lunch and dinner separately. The mean reported number of between-meal snacks did not differ between the three groups. Children of the non-participation group were more likely to be held responsible for brushing their own teeth (participation probability: 1.2) than children in the non-participation group (participation probability: 0.96). The OHI-s index was found to be higher in the non-participating children ($t = -2.91$; $p = 0.006$). However, dmfs-scores of non-participating children were (although not statistically significant) lower compared to all eligible children and participating children. Furthermore children of the non-participation group were found to have less extracted surfaces and less filled surfaces than non-participating children ($Z = -2.05$, $p = 0.04$; $Z = -1.80$, $p = 0.07$ respectively). Besides that, children of the non-participation-group had lower scores on their care-index (fs/ds+fs) ($Z = -2.72$, $p = 0.007$). When the clinical variables of the participating children were compared to all eligible children, differences were not statistically significant.

Discussion

Based on the findings of the present study, the assumption that non-participating children are unfavorable in all caries related variables beforehand cannot be held. Using the calculated participation-ratios it can easily be identified where the major differences can be expected. Despite less favorable socio-economic and dietary circumstances, the non-participating children did not appear to have more decayed, missing and filled surfaces than their participating peers or all eligible children. The group did show little more untreated carious surfaces but less extracted and filled surfaces, leaving a more positive dmfs than what was to be expected from earlier studies on non-participation in a caries prevention program (Splieth et al. 2005; Davies et al. 2007). Our results challenge the conclusions of studies that non-participation will bias the results of a study on preventive programs in favor of the intervention because firstly the non-participating children had lower dmfs, and secondly there were no statistically significant differences between participants and eligible children, suggesting that the external validity of the current RCT is not much affected, despite differences between the participants and non-participants, seen from the participation probability point of view. The largest differences were found in SES. Correcting for this covariate surprisingly polarized the initial results. Other factors than SES therefore must contribute to explain differences in dmfs-levels in the groups of children. One possible explanation is that non-participating children visit the dentist less regularly. The fact that the non-participating children had more untreated carious surfaces can support this suggestion: it is not unlikely that less dental visits will result in fewer surfaces treated (by either restoration or extraction). Another explanation for lower dmfs scores in our non-participant group may be related to more favorable health-attitudes and health-behaviour than the children in the participants-group. Parental attitudes were dealt with in various recent studies (Tickle et al., 2003; Skeie et al., 2006; Vermaire et al., 2010). The rationale behind this is that parents who are aware of their own 'power to prevent' may act differently than their counterparts who consider caries as an inevitable, hereditary disease or parents who are mainly focused on esthetics in their child or those who are too preoccupied with other things. Of course every possible way to minimize the effect of non-participation in clinical trial is welcomed. We therefore encourage further use of the proposed method of inversed probability weighting (López et al., 2008) to correct for possible overrepresentation of important variables. However, we also expect the impact of these corrections on the external validity to be modest in this RCT, considering the found participation probability ratios.

The first aim of this study was to identify and quantify differences between eligible participants and non-participants of an RCT on caries preventive strategies in young children. Differences in socioeconomic, behavioral and clinical variables were found between non-participants and participants but not between participants and the eligible group. The second aim was to establish whether the non-participants bias would have considerable impact on the external validity of an RCT. Seen from the participation probability point of view in this study (instead of the non-participants point of view) the impact was considered quite modest. Therefore, it is suggested that the external validity of an RCT on caries-preventive strategies is not necessarily affected by non-participation bias.

Table 1: Parent's characteristics accompanying participating and non-participating children.
Ratio indicates the determinant-specific participation probability divided by the overall participation probability

		eligible		participants		participation probability ratio	non-participants		non-participation probability ratio
		n	(%)	n	(%)		n	(%)	
All		342	(100)	286	(83.6)	1	56	(16.4)	1
Gender	Male	68	(19.9)	53	(18.5)	0.93	15	(26.8)*	1.35
	Female	274	(80.1)	233	(81.5)	1.02	41	(73.2)*	0.91
SES	Low	122	(35.7)	94	(32.9)	0.92	28	(50.0)*	1.40
	Medium	122	(35.7)	105	(36.7)	1.03	17	(30.4)*	0.85
	High	98	(28.6)	87	(30.4)	1.06	11	(19.6)*	0.68
Ethnicity	Autochthonous	235	(68.7)	208	(72.7)	1.06	27	(48.2)**	0.70
	Immigrant	105	(30.7)	76	(26.6)	0.87	29	(51.8)**	1.68
	Unknown	2	(0.6)	2	(0.70)	1.20	0	(0)	-
Family situation									
	Both parents	292	(85.4)	245	(85.7)	1.00	47	(83.9)	1.01
	Single parent	50	14.6	41	(14.3)	0.98	9	(16.1)	1.10
Dietary habits									
	Breakfast	311	(90.9)	264	(92.3)	1.02	47	(83.9)	0.92
	Lunch	321	(93.9)	271	(94.8)	1.00	50	(89.3)	0.95
	Dinner	330	(96.5)	277	(96.9)	1.00	53	(94.6)	0.98
	All regular meals	298	(87.1)	255	(89.2)	1.02	43	(76.8)	0.88
	Number of between-meal snacks	mean: 5.38 (± 2.51)		mean: 5.34 (± 2.50)			mean: 5.61 (± 2.54)		

		eligible		participants		participation probability ratio	non-participants		non-participation probability ratio
		n	(%)	n	(%)		n	(%)	
Oral hygiene habits									
Brushing frequency									
	Not every day	4	(1.2)	4	(1.40)	1.20	0	(0.0)	-
	Once a day	63	(18.4)	53	(18.5)	1.01	10	(17.9)	0.97
	More than once a day	265	(77.5)	229	(80.1)	1.03	46	(82.1)	0.93
Use of dental aids									
	Nothing	3	(0.9)	2	(0.70)	0.80	1	(1.80)	1.99
	Toothbrush/toothpaste	130	(38.0)	108	(37.8)	0.99	22	(39.3)	1.03
	+ Toothpicks/dental floss	151	(44.2)	132	(46.2)	1.05	19	(33.9)	0.80
	+ Commercial mouth rinse	60	(17.5)	46	(16.1)	0.92	14	(25.0)	1.42

	eligible		participants		t	p	non-participants		t	p
	mean	(± SD)	mean	(± SD)			mean	(SD)		
Knowledge										
Mean number of correct answers (of 10)	7.00	(1.88)	7.23	(1.83)	-1.71	0.09	5.87	(2.14)	10.36	0.000
Willingness to invest (maximum)										
Money (€ / month)	28.15	(29.18)	29.16	(21.74)	-0.60	0.55	22.18	(20.24)	3.54	0.000
Time (brushing mins/ day)	6.27	(3.84)	6.49	(3.85)	-1.01	0.31	4.90	(3.45)	6.15	0.000
Time (dental visits / year)	3.46	(1.80)	3.50	(1.79)	-0.34	0.74	3.26	(1.65)	1.97	0.050

* indicates p-level < 0.05

** indicates p-level < 0.01

Table 2: Child's characteristics of participating and non-participating children. Ratio indicates the determinant-specific participation probability divided by the overall participation probability

		eligible		participants		participation probability ratio		non-participants		non-participation probability ratio
		n	(%)	n	(%)			n	(%)	
All		342	(100)	286	(83.6)	1		56	(16.4)	
Gender	Male	169	(49.4)	140	(49.0)	0.99		29	(51.8)	1.05
	Female	173	(50.6)	146	(51.0)	1.01		27	(48.2)	0.95
Dietary habits										
	Breakfast	308	(90.0)	260	(90.9)	1.01		48	(85.7)	0.92
	Lunch	321	(93.9)	271	(94.8)	1.01		50	(89.3)	0.95
	Dinner	328	(95.9)	275	(96.2)	1.01		53	(94.6)	0.98
	All regular meals	297	(86.8)	254	(88.8)	1.02		43	(76.8)*	0.88
	Number of between-meal snacks (mean)	5.70 (± 2.63)		5.72 (± 2.66)				5.64 (± 2.48)		
Oral hygiene										
Tooth brushing										
	Mostly by child alone	102	(29.8)	82	(28.7)	0.96		20	(35.7)*	1.20
	By parent as well	240	(70.2)	204	(71.3)	1.02		36	(64.3)*	0.91
Brushing frequency										
	Not every day	73	(21.4)	59	(20.6)	0.97		14	(25.0)	1.17
	Once a day	115	(33.6)	97	(33.9)	1.01		18	(32.1)	0.96
	More than once a day	154	(45.0)	130	(45.5)	1.01		24	(42.9)	0.95

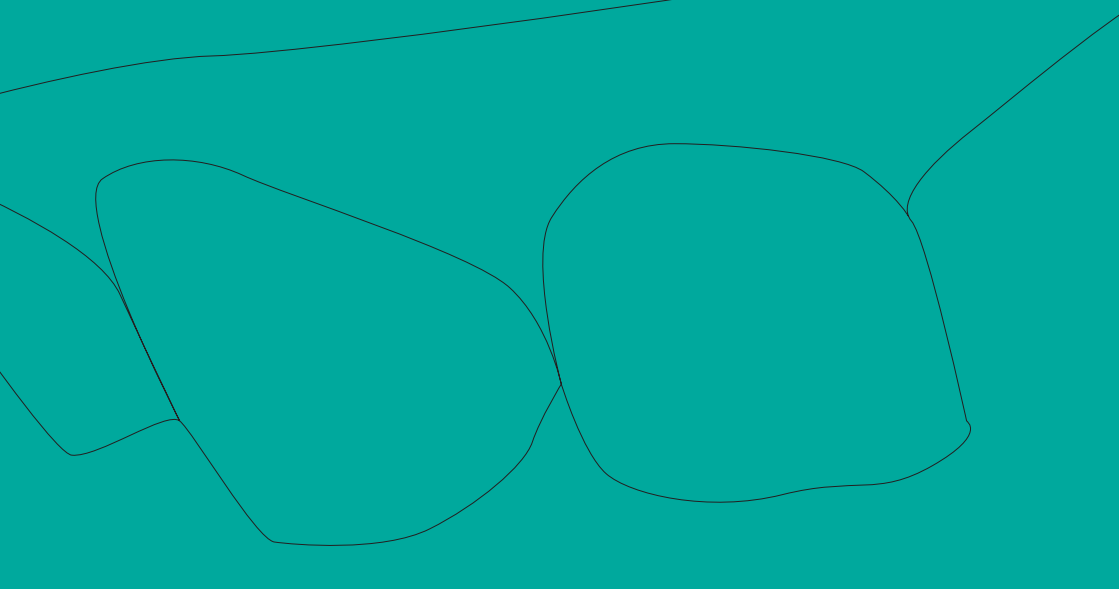
	eligible mean (± SD)		participants mean (± SD)		t	p	non-participants mean (SD)		t	p
Oral hygiene										
OHI-s (0-3)	0.95	(0.72)	0.88	(0.72)	26	21	1.25	(0.67)	2.91	0.006
Caries presence										
ds	1.69	(3.72)	1.58	(3.52)	-0.49	0.62	2.16	(4.48)	0.79	0.44
ms	2.79	(7.26)	3.12	(7.73)	0.67	0.50	1.32	(4.45)	-2.47	0.02
fs	2.02	(3.55)	2.20	(3.73)	0.75	0.45	1.21	(2.41)	-2.50	0.02
dmfs	5.93	(9.31)	6.28	(9.76)	0.56	0.58	4.43	(6.88)	-1.63	0.11
Care-index (fs/ds+fs)	0.55	(0.41)	0.59	(0.41)	1.00	0.32	0.37	(0.36)	-2.56	0.02

* indicates p-level < 0.05

Chapter

Value for money in preventive care: economic evaluation of two different caries prevention programmes compared with standard care in a randomized controlled trial in the Netherlands

4



Value for money in preventive care: economic evaluation of two different caries prevention programmes compared with standard care in a randomized controlled trial in the Netherlands

Introduction

Health care expenditures related to dental care have increased rapidly in recent years. For instance, in the Netherlands, the costs of dentistry increased by 10% between 2007 and 2010 (Poos et al., 2008; Slobbe et al., 2011). In many countries, increasingly high health care expenditures have raised questions about the amounts of money that should be spent on health care, as well as the justifications for these amounts. One prerequisite in the search for optimal allocation of scarce societal and health care resources is economic evaluation of health care interventions. In economic evaluations, the costs of an intervention are compared to the intervention's benefits, and expressed in some meaningful manner. Economic evaluations can be used to determine the relative efficiency of a new intervention compared with one or more alternatives.

Caries is one of the most prevalent diseases among children worldwide: 60-90% of all schoolchildren experience one or more carious lesions in their primary teeth. Caries is present, although unequally distributed, throughout all socioeconomic classes in both developing and developed countries (Bagramian et al., 2009; Petersen, 2003). As a result, a large proportion of the total dentistry budget is spent on treatment of dental caries; in the Netherlands, this share is 60% (Slobbe et al., 2011). In 2007, costs related to caries were 1.8 billion euros. This amount is equal to the costs related to coronary heart disease (Poos et al., 2008). Therefore, prevention of caries may realize considerable savings.

Many caries prevention programmes focus on professionally performed fluoride applications (Marinho et al., 2002). Some programmes focusing on intensified self-care have been developed during the past couple of decades (Carvalho et al., 1992; Ekstrand et al., 2000; Ekstrand and Christiansen, 2005; Hausen et al., 2007). Considering the allocation of scarce (health care) resources, it is important to have insight into both the costs and the effects of different prevention strategies and thus their relative cost-effectiveness. Such insight can help communities make best use of budgets for oral health. At this time, this kind of information is lacking.

This study aims to assess the cost-effectiveness of caries treatment and prevention strategies. This cost-effectiveness study was performed alongside a randomized controlled trial evaluating the effects of two caries prevention strategies compared with regular dental care among 6-year-olds. Based on earlier literature (Carvalho et al., 1992; Ekstrand and Christiansen, 2005; Marinho et al., 2002), this trial included a regular treatment and prevention approach (control group), an increased professional fluoride application approach (IPFA), and a non-operative caries treatment and prevention (NOCTP) approach. A full description of the evaluated strategies as well as the clinical results of this trial is reported in Chapter 2.

Methods

Interventions and participants

From September 2006 to September 2008, all parents of regular patients, aged 6.0 years (± 3 months) of a large dental clinic in 's-Hertogenbosch (a medium-large city in the Netherlands with some 150.000 inhabitants) were asked for consent to include their child in a randomized controlled trial on caries-preventive strategies. An anticipated dropout percentage of 20% was taken into account. A total of 230 children were included in this study and were randomly assigned to each of the following three groups:

1) Control group:

This group received standard dental care: dental check-ups twice a year, including professional fluoride gel applications (1.23% F-) and preventive pit and fissure sealants after eruption of the permanent molars, on a routine basis. The threshold for placing restorations was set at the dentine threshold (d3/D3-level).

2) Increased professional fluoride application (IPFA) group:

Like the control group, the IPFA group received standard dental care but the IPFA group had two additional professional fluoride gel applications. Children in this group therefore received a total of four professional fluoride applications per year.

3) Non-operative caries treatment and prevention (NOCTP) group:

The NOCTP protocol was copied from a study that Ekstrand and Christiansen performed in Nexø, Denmark (2005). Recall intervals were individualized using criteria described by Carvalho et al. (1992): caries activity, oral hygiene, eruption stage of permanent molars, and cooperation of child and parent. At each visit,

areas where plaque removal and fluoride toothpaste needed to be more effectively applied were identified. If, at the next visit, a progression of the caries process was recognized, fluoride varnish was applied locally. If, at the following visit, there was still no stabilisation or caries inhibition, the surface was sealed or restored.

The study was approved by the Medical Ethical Committee of the VU University Amsterdam, the Netherlands. Protocol number NL13709.029.06.

Time horizon

Data on time and resource use, and data on effectiveness were collected for a three-year time period.

Perspective

This study was conducted from both a health care and a societal perspective. Adopting a health care perspective, cost inclusion is limited to all medical costs: i.e. the costs of the treatment and prevention of caries. Adopting a societal perspective, all relevant societal costs are additionally included, such as out-of-pocket expenses (toothbrushes, toothpastes), travel costs to the clinic, travel time and time necessary to accompany the child, regardless of where these costs fall (Drummond et al., 2005).

Costs

Health care resource use and costs

Calculations were performed according to the recommendations in the Dutch manual for costing (Tan et al., 2012; Hakkaart-van Roijen et al., 2011). A bottom-up micro-costing approach was used to calculate medical costs. Instead of using fixed prices for each treatment strategy, cost-prices were determined per individual patient based on the number of minutes the dental professional spent on the patient.

At every visit to the dental clinic, the number of minutes that the dentist and/or the dental preventive nurse and/or dental hygienist spent on each patient was documented.

Since the Dutch manual for costing (Tan et al., 2012; Hakkaart-van Roijen et al., 2011) does not provide reference prices for dental professionals, cost prices in this study were based on the actual expenditures of the dental clinic. These cost prices were based on both gross incomes of the dental professionals and a share of the supplementary costs of the dental clinic (e.g., costs for materials, housing and management).

Gross incomes and all other expenditures of the dental clinic were divided by the number of ‘productive hours’ (hours spent on patient care) of the dental professionals (dentists, oral hygienists and dental nurses). It was assumed that 88.5% of working hours were spent on patient care and 11.5% on non-patient work, such as training, conference meetings and non-patient administrative work (Kalf et al., 2010). The dental clinic’s costs were divided among the various professionals based on their respective gross incomes. The cost price per minute was calculated to be € 2.60 for a dentist, € 0.78 for a dental hygienist and € 0.70 for a dental nurse. To calculate the medical costs, the calculated cost prices per minute were multiplied by the number of minutes that the dental professional spent on the particular patient.

Societal resource use and costs

At every visit to the dental clinic, data was collected on travel time and travel distance. Travel costs were calculated based on a price of € 0.20 per kilometre for both private (e.g., car) and public transportation) (Hakkaart-van Roijen et al., 2011). Time costs of the adult accompanying the child consisted of travel time, time with the dental professional and an estimated mean waiting time of 7 minutes (Nivell/Dutch Consumers’ association, 2002). Time costs were valued at € 12.50 per hour (Hakkaart-van Roijen et al., 2011).

To correct for the rise of general levels of prices of goods and services (inflation), prices were converted to 2011 euros.

Effects

Outcomes of the clinical trial were used to establish the effectiveness of the programs. Effectiveness was expressed as the number of prevented DMFS. DMFS scores were determined based on clinical examinations that were carried out by a dentist who was blinded to the treatment groups. Due to medical-ethical objections, no radiographs were taken for the purpose of this study. As a result, caries was only clinically assessed. Caries was scored at D3-level.

Discounting

In order to correct for time preferences, costs and effects occurring in the 2nd and 3rd year were discounted 4% and 1.5%, respectively, as prescribed in the Dutch pharmacoeconomic guidelines (College voor Zorgverzekeringen, 2006). For a background paper on discounting see Brouwer et al. (2005).

Cost-effectiveness

Incremental cost-effectiveness was expressed as the additional costs per prevented DMFS. The incremental cost-effectiveness ratio (ICER) was calculated by dividing the differences in costs between the experimental group and the control group by the differences in effects (Equation). Two ICERs were calculated: IPFA compared with regular care and NOCTP compared with regular care.

Equation

$$\text{ICER} = \frac{\text{Costs}_{\text{experimental group}} - \text{Costs}_{\text{control group}}}{\text{DMFS}_{\text{experimental group}} - \text{DMFS}_{\text{control group}}}$$

Sensitivity and scenario analyses

Univariate sensitivity analysis was conducted to assess the impact of labour costs on the study results. In the base case analyses, the salaries for a dentist, a dental hygienist, and a dental assistant were € 75,000, € 30,000, and € 25,000 per one full-time equivalent (FTE), respectively. Varying the dentists' salaries from € 45,000 to € 100,000, the dental hygienists' salaries from € 25,000 to € 45,000, and the dental assistants' salaries from € 20,000 to € 35,000 resulted in cost prices per minute of € 1.70 and € 3.03 for a dentist, € 0.67 and € 1.08 for a dental hygienist, and € 0.66 and € 0.95 for a dental assistant.

Since dentist salary turned out to be the most influential factor on the price per minute, sensitivity analyses were conducted with several hypothetical salaries, varying from € 45,000 a year per FTE (estimated starting salary of a newly graduated dentist) to € 100,000 a year per FTE (salary based on maximum norm-income of € 105,075 for an experienced dentist with full management responsibilities) (NZA 2011).

Task delegation and task reallocation have become increasingly relevant in both medicine and dentistry (Horrocks et al., 2002; Jerkovic et al., 2010). These changes would reduce the workload for dentists to restorative treatment, endodontic treatment, and provision of fixed and removable prosthetic care, and increase the workload of dental hygienists. For the cost-price calculations, an assumption was made that the workload for dental hygienists in the clinic would have increased from 4.0 to 5.3 FTE and dentists' workload would have decreased from 5.3 to 4.0 FTE. Therefore, the dental

clinic's costs and the allocation of these costs to the dental professionals would change, resulting in a cost price per minute increase from € 0.78 to € 0.81 for a dental hygienist and a cost-price per minute increase from € 2.60 to € 2.69 for a dentist.

Missing data

Children who dropped out of the study but remained patients of the clinic continued to receive regular care (n = 51). These subjects' study data were excluded from all data analyses.

Statistical analysis

Nonparametric bootstrapping (Campbell and Torgerson, 1999) was used to address the uncertainty associated with the fact that the data that were collected for the measures of incremental costs and effects were based on a sample of the population. To construct confidence intervals around the differences in mean costs and effects between the caries prevention strategies, 10,000 random samples were drawn from the data. The difference in costs and effects of these 10,000 samples were displayed in cost-effectiveness planes in scatterplots where each point in the cloud represents the outcomes of one of the randomly drawn samples. Moreover, the bootstrap results were presented in cost-effectiveness acceptability curves. The curves indicate the probability (placed on the y-axis) of the IPFA or the NOCTP strategy being cost-effective at different willingness-to-pay values (placed on the x-axis) for one prevented DMFS.

SPSS Statistical Software Package 20.0, Stata SE 12.1 and MS Excel 2010 were used to conduct the statistical analyses.

Results

Patients

A total of 179 children completed the three-year trial: 63 in the regular dental care programme, 62 in the IPFA programme and 54 in the NOCTP programme. Dropout rates were highest in the NOCTP group (32% vs. 22% in the IPFA group and 17% in the control group), resulting in a mean dropout rate of 22%. In the NOCTP group, the main reason for ending participation was the burden of travel; in the IPFA-group and control-group, the main reason was the inconvenience for the child. The baseline dmfs/DMFS of children dropping out of the study did not significantly differ from baseline dmfs/DMFS scores of children who did not drop out.

Costs

Resource use

Table 1 shows the direct medical and non-medical cost-related variables. In the first year, the contact time for children in the NOCTP group was twice that of children in the control group. By the third year of the trial, the difference in contact time between these two groups had disappeared. Similarly, in the first year, travel time was higher in the NOCTP group than in the control group, but in the third year, travel time levelled out. Contact time and accompanying time in the IPFA group was 50% higher than in the control group. Also, the mean number of visits and distance travelled (in kilometres) were higher in the IPFA group (45% and 60%) than in the regular care group.

In Table 2, both discounted and undiscounted cost outcomes are presented from a health care perspective and a societal perspective for the total period of 3 years. Mean total health care costs were € 106 for the control group, € 201 for the IPFA group and € 140 for the NOCTP group. The total societal costs (required parental investments, in terms of accompanying time, travel time and travel costs) were € 47, € 78 and € 48, respectively.

Effectiveness

The discounted and undiscounted caries increment scores of the three groups are presented in Table 3. Compared with the control group, the IPFA strategy had on average reduced the DMFS score by 0.13 ($t = -0.76$, $p = .44$) and the NOCTP strategy had reduced the DMFS score by 0.32 on average ($t = -2.17$, $p = .033$) three years after the start of the trial.

Incremental cost-effectiveness

From a health care perspective, the ICER of the IPFA group compared with regular care was € 733 per additional prevented DMFS, and from the societal perspective, the value was € 977 (Table 4). The ICERs of the NOCTP group compared with regular care were € 108 from the health care perspective and € 111 from the societal perspective.

Sensitivity and scenario analysis

In a scenario where a dental hygienist would have performed all of the preventive visits in both groups (assuming equal effectiveness between dentist and dental hygienist), the ICER would have been € 532 per prevented DMFS in for the IPFA programme and € 41 for the NOCTP programme (both from a societal perspective) (Table 5). Varying the salary of the dentist would result in larger differences in ICER values: between € 87 and

€ 274 per extra prevented DMFS in the NOCTP and between € 715 and € 1402 per extra prevented DMFS in the IPFA group.

Uncertainty

The results of bootstrapping (10,000 bootstraps) are presented separately for both experimental groups and for both the health care perspective and the societal perspective in Figure 1. For the NOCTP group, approximately 95% of the bootstrapped replications are on the east side of the cost-effectiveness plane, indicating an increase in prevented DMFS compared to that of the regular care group; for the IPFA group, this was approximately 70%. About half of the bootstrap replicates for the NOCTP group are above and about half are below the horizontal axis; this indicates that costs for the NOCTP group could either be lower or higher than the costs for the regular dental care. For the IPFA strategy, all bootstraps indicate an increase in costs compared to regular care.

The cost-effectiveness acceptability curves are presented in Figure 2. These curves indicate the probability of the IPFA approach or the NOCTP strategy being cost-effective at different willingness-to-pay values for a prevented DMFS. As Figure 2 shows, considering a societal willingness-to-pay of € 100 in 3 years for an additional prevented DMFS, the probability of the NOCTP strategy being cost-effective is approximately 95% and the probability of the IPFA strategy being cost-effective is approximately 2%.

Discussion

In this study, the non-operative caries treatment and prevention strategy, based on intensified and individualized self-care, was more effective but more costly than regular caries prevention comprising two dental preventive visits a year, professional fluoride application and preventive sealing of newly erupted permanent molars. The additional health care cost to prevent one DMFS was € 108. If the societal perspective was adopted (taking into account parental accompanying time and travel costs) the additional cost was € 111. An alternative approach comprising the control strategy with additional professional fluoride applications (IPFA) was slightly (but insignificantly) more effective than regular care and resulted in ICERs of € 733 (health care perspective) and € 977 (societal perspective) per prevented DMFS.

In NOCTP group, the largest investments were made in the first year of the trial (€ 64 in the first year, € 47 in the second year and € 35 in the third year) resembling the trend that was found in an economic evaluation of an individually designed patient-centred

regimen for caries control performed in Finland (Hietsalo et al., 2009). In both current study and Hietsalo et al.'s study (2009), the costs of the experimental group dropped below the costs of regular care in the third year. In Hietsalo et al.'s study (2009), the ICER was € 34 per prevented DMFS from a health care perspective, which is considerably lower than our findings. This difference may be explained by the differences in cost-prices and the fact that a major part of the regimen was conducted solely by dental hygienists. The results of the Finnish study closely resemble the ICERS of the scenario analysis in the current study; assuming prevention would be executed by dental hygienists, ICERs of the same magnitude were found (€ 37-€ 41).

This study had some limitations. For example, all calculations were based on the results of a relatively modest research population ($n = 179$). The dropout rate of 22% is comparable to those of other clinical trials in dentistry (Machiulskiene et al., 2002; Carvalho et al., 2010). Dropouts were not equally distributed among the treatment regimens. This may raise the question of whether the subjects who remained in the study were a selective group; the most engaged parents may have been more likely to follow through with the regimen. Since the initial mean dmfs-scores of these dropout children did not significantly differ at baseline, one can expect that this would not affect external validity (Vermaire et al., 2011). Note that reasons for withdrawal differed between groups: In the NOCTP group, the main reason was the burden of travelling, while in the IPFA group, the most reported reason was a perceived inconvenience for the child (e.g., tray with fluoride gel). This may indicate that the IPFA and the NOCTP programme are more burdensome than regular care. Compliance may be increased if parents and children are informed of all disadvantages and benefits in advance.

A second limitation of this study was that it only included data obtained in one (large) dental clinic. Nevertheless, the clinic can be considered to deliver dental care in a way that is comparable to that of many other practices in regular populations in the Netherlands. Further, there is no reason to believe that the NOCTP regimen cannot be introduced in other practices. Still, generalizability is dependent on the dental professional's attitude towards preventive dentistry.

A third limitation of this study was the rather short time period of the follow-up. In the study's three-year time period, the NOCTP strategy was more expensive than regular care. However, the NOCTP strategy may turn out to be cost-saving when it is applied over a longer period of time. After all, starting a restorative cycle is assumed to result in further investments during life.

Whether the findings of this study, based on a three-year time period imply that the NOCTP strategy can be considered cost-effective compared to regular care crucially depends on the societal willingness to pay for one extra prevented DMFS. If this exceeds about € 100, the probability of NOCTP being expected to be cost-effective exceeds 90% (Figure 2). To date, knowledge regarding the willingness to pay for dental care and oral health outcomes is limited. However, a recent study on willingness to invest among parents of 6-year-old children in the Netherlands reported an average total willingness to pay of € 31 per month to keep their children's teeth healthy until the age of 18 (Vermaire et al., 2012). Obviously, it is not completely clear how this translates into the value of one avoided DMFS. A time trade-off exercise may make these values tangible (Dolan et al., 1996). However, given that all three programs cost less than € 10 per month and the NOCTP strategy significantly reduces the DMFS score (thus giving the highest probability of improved oral health, at least up to the age of 9), the NOCTP strategy does appear to have the potential to be cost-effective.

In this study, dentists performed the intervention of the NOCTP group. However, it may also be suitable for this intervention to be partly performed by dental hygienists. So, we investigated what the impact on cost-outcomes would be if all preventive visits were to be performed by a dental hygienist, instead of the dentist, to make the results of this study comparable with earlier studies. The results of the scenario analysis imply that from a cost perspective, it may be favourable to have all preventive visits performed by a dental hygienist. However, we assumed that the effectiveness of the program would be equal to that of a case where a dentist performed the same work; whether this is true is uncertain. Many factors may influence efficacy and effectiveness of preventive efforts of dentists and dental hygienists, positively and negatively (Ohrn et al., 1996; Ohrn et al., 2008; Berndsen et al., 1993; Petersson and Brathall, 2000). However, prevention (both in periodontology and cariology) can be seen as a core business of the dental hygienist. It is not unlikely that a trend in differentiation within dental hygiene will develop. Several trials investigating caries prevention strategies were ones where interventions were performed partially or completely by oral hygienists and with good results (Hietsalo et al., 2009).

The NOCTP strategy indicated an increase in costs for the parents of (€ 47.81); the extra medical costs are covered by health insurance and therefore not directly paid for by the parent. Although the parental investment did not differ significantly in this study after the three years, there were notable differences in the first year. This may hamper follow-through on the NOCTP regime and hence broader implementation of the NOCTP

strategy. This is highlighted by the fact that a proportion of the parents indicated the burden of travelling/sacrificing spare time as a reason to quit participation. Therefore, if one wishes to implement the NOCTP strategy, it will be important to comprehensively introduce the protocol to parents and to emphasize that the increased demand on parents will, in most cases, be temporary. In the IPFA group, the main dropout reason was perceived inconvenience for the child of the application of fluoride gel in trays. Application of fluoride by means of varnish may have resulted in different dropout levels.

To date, little scientific attention has been paid to the cost-effectiveness of dental care, and economic evaluations in preventive dentistry are rare. We encourage further research in this area. It would be interesting to further investigate the effectiveness and cost-effectiveness of non-operative caries treatment and prevention in other dental clinics. It would also be worthwhile to examine the effects of having all preventive visits performed by dental hygienist. Further studies in dental care, including ones that use quality adjusted life years (QALYs) as a generic health outcome measure, would increase the comparability of the cost-effectiveness of dental care with other types of care. Moreover, more research on the willingness to pay for dental care (outcomes) is needed to enhance interpretations of cost-effectiveness outcomes in dental care.

Conclusion

The non-operative caries treatment and prevention (NOCTP) regime was more effective and more costly than regular dental care. However, the benefits are likely to outweigh the additional costs, implying that this is a cost-effective strategy. Increasing the number of professional fluoride applications did not result in a statistically significant caries reduction but it did at higher cost. If the results of this study are confirmed in future research, broadly implementing non-operative caries treatment and prevention should be considered.

Table 1: Direct medical and non-medical costs-related variables

	Year 1		Year 2		Year 3		Total
Mean contact time dentist in minutes (sd)							
NOCTP	14.40	(± 5.18)	11.07	(± 3.47)	8.85	(± 2.83)	34.32 (± 9.95)
IPFA	13.61	(± 4.57)	12.74	(± 4.15)	12.22	(± 4.78)	38.57 (± 12.91)
Control	8.70	(± 2.87)	9.71	(± 4.58)	9.00	(± 3.41)	27.41 (± 8.70)
Total	12.09	(± 4.95)	11.16	(± 4.30)	10.07	(± 4.09)	33.32 (± 11.71)
Mean additional contact time dental auxiliaries in minutes (sd)							
NOCTP	4.12	(± 1.85)	4.42	(± 1.97)	3.50	(± 1.65)	12.04 (± 2.81)
IPFA	13.82	(± 1.18)	13.06	(± 1.81)	12.41	(± 2.66)	39.64 (± 4.55)
Control	7.20	(± 2.11)	7.79	(± 2.39)	7.37	(± 2.00)	22.11 (± 4.05)
Total	9.84	(± 4.09)	9.72	(± 3.77)	9.61	(± 3.59)	26.46 (± 13.06)
Mean number of visits to dental clinic (sd)							
NOCTP	3.27	(± 0.87)	2.47	(± 0.54)	1.98	(± 0.42)	7.45 (± 1.44)
IPFA	3.94	(± 0.31)	3.71	(± 0.49)	3.55	(± 0.76)	11.26 (± 1.33)
Control	2.00	(± 0.53)	2.22	(± 0.57)	2.09	(± 0.56)	6.28 (± 1.02)
Total	3.05	(± 1.00)	2.81	(± 0.85)	2.56	(± 0.94)	8.35 (± 2.51)
Mean total travel distance to clinic in KMs (sd)							
NOCTP	21.1	(± 15.16)	16.4	(± 11.90)	12.9	(± 9.51)	50.4 (± 35.53)
IPFA	31.7	(± 36.69)	30.6	(± 36.98)	30.2	(± 37.34)	92.5 (± 110.93)
Control	18.2	(± 21.00)	21.1	(± 26.10)	18.1	(± 19.86)	57.4 (± 65.66)
Total	23.8	(± 26.91)	23.1	(± 28.10)	20.8	(± 26.47)	67.6 (± 80.58)
Mean total accompanying time in minutes (sd)							
Including travel time, contact time in clinic and waiting time (estimated at 7 minutes / visit)							
NOCTP	90.65	(± 37.98)	69.48	(± 27.63)	55.19	(± 20.67)	215.32 (± 77.97)
IPFA	109.68	(± 25.76)	103.54	(± 27.48)	99.09	(± 32.05)	312.32 (± 81.61)
Control	60.20	(± 24.27)	65.03	(± 26.15)	61.47	(± 22.68)	186.70 (± 64.87)
Total	86.74	(± 36.23)	78.89	(± 31.90)	71.25	(± 31.82)	236.88 (± 91.76)

NOCTP: Non Operative Caries Treatment and Prevention;

IPFA: Increased Professional Fluoride Application

Table 2: Discounted and not-discounted costs in year of participation and research group
Costs are converted to 2011 euros

	Year 1		Year 2		Year 3		Discount rate Year 2 & Year 3		Total
Mean costs in € (95% CI of mean)							0%	4%	
Health care costs									
NOCTP	61.64	(55.47-67.82)	47.46	(43.13-51.78)	35.89	(32.69-39.10)	144.99	(132.89-157.08)	140.46
IPFA	74.66	(69.72-79.60)	68.92	(64.40-73.43)	64.49	(59.12-69.87)	208.07	(194.04-222.10)	200.55
Control	35.64	(32.59-39.17)	39.93	(34.59-45.28)	35.32	(11.38-39.25)	110.89	(99.89-121.90)	106.69
Societal Costs									
Accompanying costs									
NOCTP	16.79	(14.05-18.18)	12.96	(11.13-14.12)	9.66	(8.54-10.60)	39.41	(34.09-42.54)	37.10
IPFA	22.10	(18.99-22.20)	20.60	(18.99-22.20)	19.42	(17.64-21.20)	62.12	(57.34-66.90)	59.86
Control	12.23	(10.58-13.34)	13.30	(11.46-14.40)	11.76	(10.55-13.03)	37.29	(33.01-40.36)	35.29
Travel costs									
NOCTP	4.60	(3.68-5.53)	3.53	(2.81-4.24)	2.70	(2.14-3.26)	10.84	(8.70-12.96)	10.49
IPFA	6.93	(4.89-8.96)	6.58	(4.56-8.60)	6.33	(4.34-8.32)	19.84	(13.80-25.88)	19.14
Control	3.97	(2.81-5.12)	4.55	(3.13-5.86)	3.79	(2.75-4.84)	12.31	(8.76-15.86)	11.85
Total Societal costs									
NOCTP	21.39	(18.07-23.63)	16.49	(14.20-18.23)	12.36	(10.85-13.72)	50.24	(43.54-55.17)	47.81
IPFA	29.03	(26.09-31.97)	27.18	(24.16-30.20)	25.75	(22.57-28.93)	81.96	(72.95-90.98)	78.97
Control	16.20	(13.68-18.35)	17.85	(14.88-20.28)	15.55	(13.59-17.65)	49.60	(42.57-55.85)	47.35
Total Costs									
NOCTP	83.03	(75.24-90.82)	63.95	(58.39-69.51)	48.25	(44.32-52.18)	195.23	(180.21-210.26)	189.13
IPFA	103.69	(97.70-109.68)	96.09	(90.15-102.04)	90.25	(82.95-97.55)	290.03	(271-76-308.30)	279.53
Control	51.84	(46.75-56.93)	57.78	(50.76-64.79)	50.87	(45.73-56.02)	160.49	(155.74-195.23)	154.43

NOCTP: Non Operative Caries Treatment and Prevention;
IPFA: Increased Professional Fluoride Application

Table 3: Discounted and not-discounted effect calculations compared with control group

Effects compared to Control Additional DMFS prevention after 3 years		Effect	
	Discount rate	0%	1.5%
Caries increment (ΔDMFS) (± sd)			
Control	0.47 (± 1.039)		
CI 95%	(0.209-0.728)		
NOCTP	0.15 (± 0.496)	0.32	0.31
CI 95%	(0.014-0.288)		
IPFA	0.34 (± 0.867)	0.13	0.13
CI 95%	(0.119-0.559)		

NOCTP: Non Operative Caries Treatment and Prevention;
IPFA: Increased Professional Fluoride Application

Table 4: Discounted and not-discounted ICER calculations for health care perspective and societal perspective

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		Health Care Perspective			Societal Perspective	
		Discounting			Discounting	
		0%	4% costs 1.5% effects		0%	4% costs 1.5% effects
NOCTP	Δ costs	34.10	33.77	Δ costs	34.74	34.70
	Δ effects	0.318	0.313	Δ effects	0.318	0.313
	ICER	107	108	ICER	109	111
IPFA	Δ costs	97.18	93.86	Δ costs	129.54	125.10
	Δ effects	0.130	0.128	Δ effects	0.130	0.128
	ICER	748	733	ICER	996	977

NOCTP: Non Operative Caries Treatment and Prevention;
IPFA: Increased Professional Fluoride Application;
ICER: Incremental Cost Effectiveness Ratio

Table 5: ICERs after sensitivity and scenario analyses

Intervention	Perspective	Salary dentist € 45.000	Salary dentist € 100.000	Intervention performed by dental hygienist
	Health care			
NOCTP		€ 71	€ 141	€ 37
IPFA		€ 469	€ 852	€ 211
	Societal			
NOCTP		€ 87	€ 274	€ 41
IPFA		€ 715	€ 1402	€ 532

ICER: Incremental Cost Effectiveness Ratio; NOCTP: Non Operative Caries Treatment and Prevention;
 IPFA: Increased Professional Fluoride Application

Figure 1: Cost Effectiveness Plane

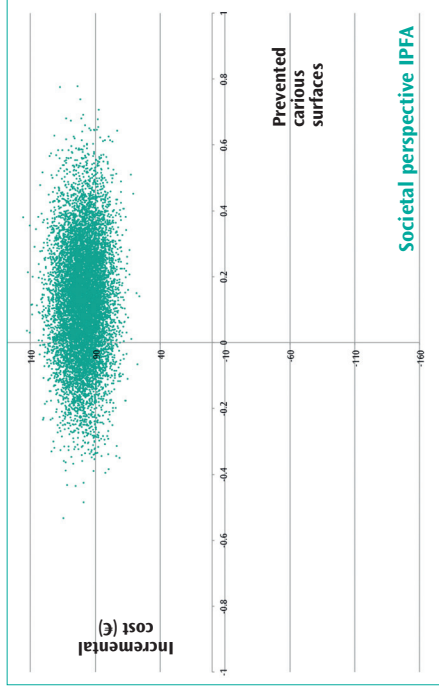
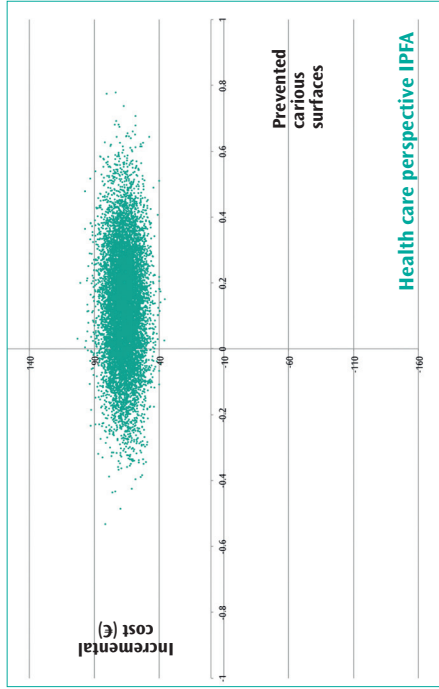
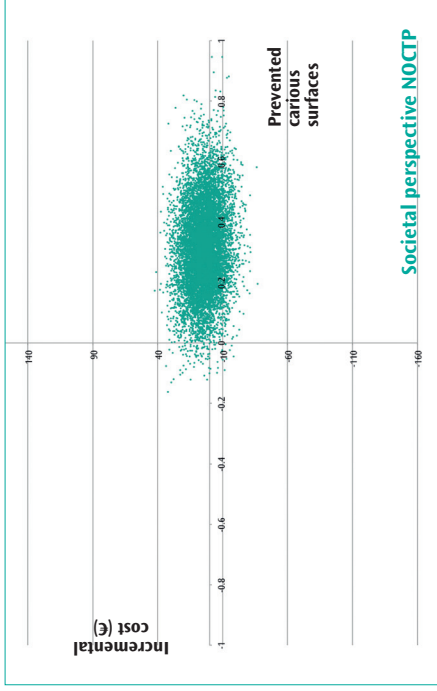
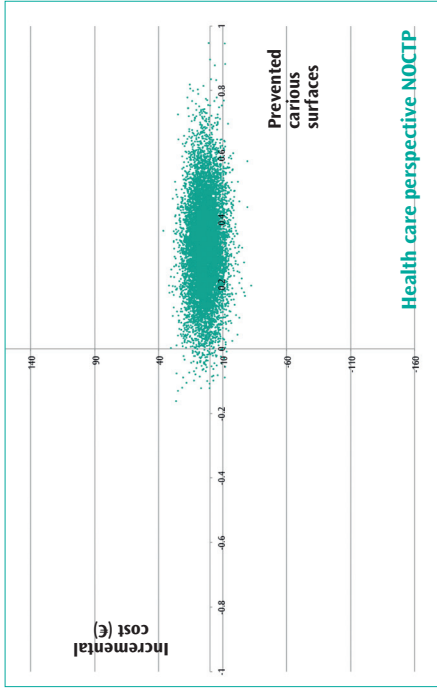
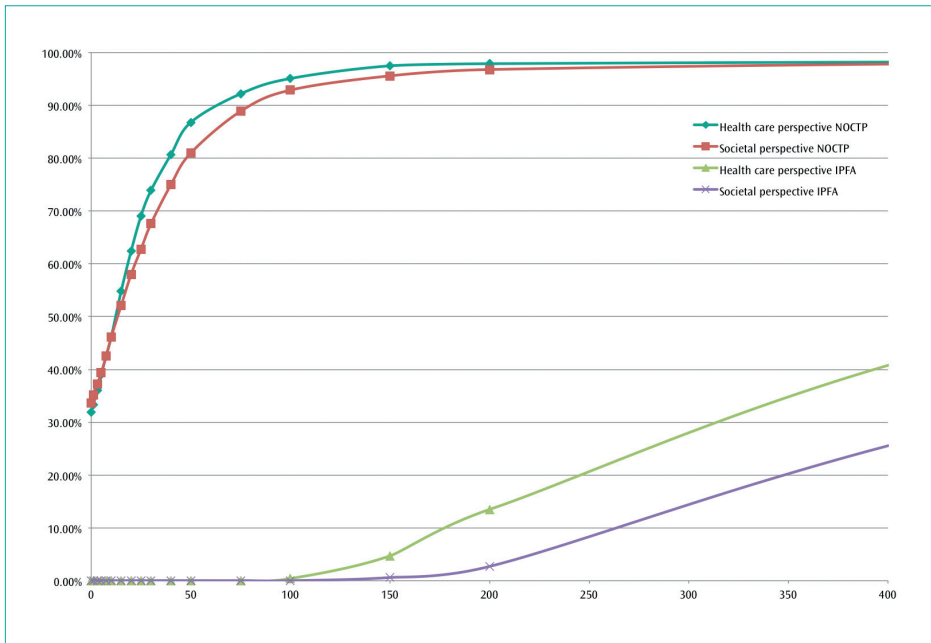


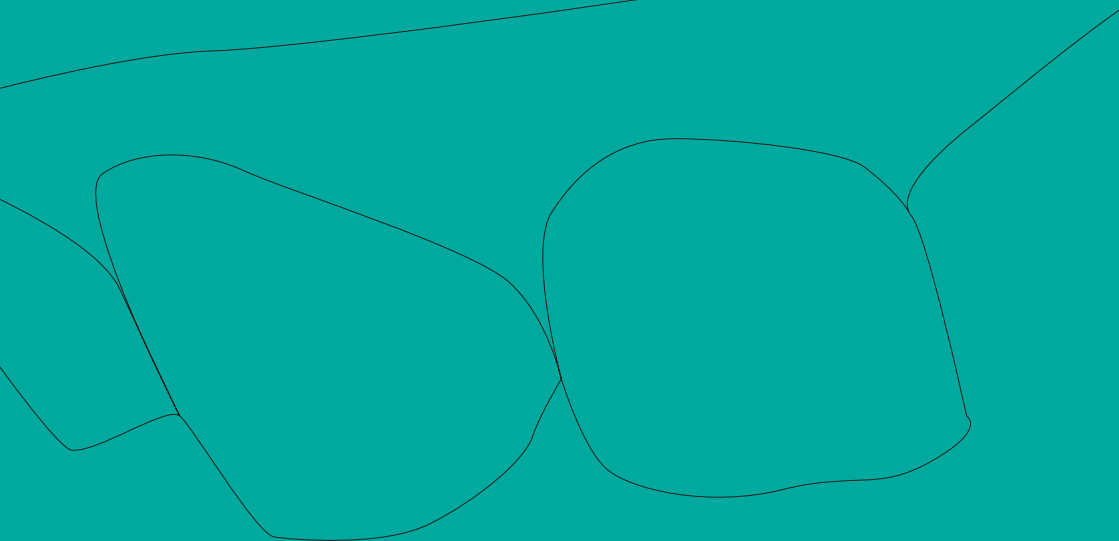
Figure 2: Acceptability curve: probability of number of bootstraps being cost-effective at different willingness to pay values (in €)



Chapter

5

**Putting your money where
your mouth is: parents'
valuation of good oral
health of their children**



Putting your money where your mouth is: parents' valuation of good oral health of their children

Introduction

Oral health is an important aspect of overall health. Not only given the intrinsic value of good oral health, but also given the increasingly recognized relationship between oral health and general health (e.g. Söder et al., 2012; Soto-Barerras et al., 2012): oral diseases and lack of oral hygiene can result in reduced general health. This stresses the importance of maintaining a good oral health. Importantly, the basis for this is laid in childhood and children's oral health can be regarded as the best predictor of oral health in adulthood (Thorstensson et al., 2009). To achieve a good oral health in children, parental investments are vital (Adair et al., 2004). Hence, it is crucial to study parents' knowledge of and willingness to invest in good oral health of their children.

Dental caries (tooth decay) is found to be one of the most prevalent infectious diseases among children and is caused by the activity of the common oral micro flora. Worldwide, 60-90% of all schoolchildren experience one or more carious lesions in their primary teeth and it is present, albeit unequally distributed, throughout all socioeconomic classes, in both developed and developing countries (Petersen, 2003; Bagramian 2009).

Considering current standards, caries is a disease that can largely be prevented by maintaining appropriate oral hygiene, adhering to a strict but simple fluoride-regime and limiting the intake of fermentable carbohydrates. Especially for children under the age of 10, parents can be considered the most important actor in caries prevention. Young children largely depend on their parents' help in maintaining their oral health. Hence, parents need to invest money, time and effort in their children's dental health. Their willingness to do so will depend, among other things, on their knowledge and attitude regarding the importance of preventing caries, their perceptions of the effectiveness of maintaining proper oral hygiene, and their preferences regarding such investments. Some previous studies investigated the association between dental knowledge and oral health. In adults, it has been shown that having more knowledge about dental topics is associated with a better oral health (Brennan et al., 2010; Zhu et al., 2005). In children, the relationship between knowledge of oral health and attitudes towards oral health behavior has been established as well (Tolvanen et al., 2010; Peng et al., 1997). If parents lack proper knowledge regarding how to preserve their children's oral health, do not

maintain effective oral hygiene habits or are not using fluoride toothpaste daily, and if they allow their children unhealthy dietary habits as well, this may result in a negative impact on the actual oral health status of their children (Daly et al., 2010). In children, however, providing a comprehensive oral health education program is not enough to improve dental health status, especially in a low SES-population (Moskovitz et al., 2009). It has been suggested that parental oral health behavior and attitudes should be considered in planning dental services for young children (Wigen & Wang, 2010). Regarding this, it should be recognized that different 'types of parents' exist. It has been shown that five different prevailing attitudes towards oral health exist among parents of children at the care-dependent-age of 6 years old (Vermaire et al., 2010).

It is still unknown how parents value oral health for their children and how this is related to their knowledge on the topic and their own oral health behavior. Caries preventive care has been valued before in 19-year-olds in Sweden in a contingent valuation study (Oscarsson et al., 2007). That study compared a high-caries risk group (DMFT > 8) with a low-risk group (DMFT = 0). The authors found that the high-risk group was willing to pay nearly € 7 more per month than the low-risk group (€ 32 vs. € 25; converted from original amounts in SEK) to receive oral health instructions and a professional fluoride application by a dental hygienist three times a year. It is not known whether this difference already existed beforehand or that it should be seen as a result of the suffered disease. Parents or caregivers of children can also be asked to provide an estimation of their willingness to pay for oral health benefits in their children, for example parents of Asthma patients who were prepared to pay \$6.00 per month for a hypothetical medicine for 20 episode-free days (Walzer & Zweifel, 2007). A study in Thailand, in which parents were asked to value both caries prevention (sealing occlusal surfaces) and cure (filling cavities), revealed that no difference in willingness to pay existed between prevention and cure. Furthermore, as expected, it was found that willingness to pay was positively affected by parent's income (Tianviwat et al., 2008).

However, money is not the only conceptualization of willingness to invest. Willingness to invest time can be regarded as a good and relevant alternative (van Helvoort-Postulart et al., 2009). This may be especially the case in preventive dentistry, where investing time (e.g. brushing children's teeth) can be considered as important as investing money (e.g. paying for toothpaste and toothbrushes or dental clinic visits). Moreover, differences in ability to pay between social-economic groups may translate in differences in willingness to pay, but need not necessarily translate into differences in willingness to invest time. A higher willingness to invest time may, in fact, compensate

for a lower willingness to pay when this is affected by limited ability to pay. The aim of the present study is to investigate the parental willingness to invest in the oral health of their child in terms of money and time and to relate this to oral health related knowledge and behavioral aspects.

Methods

290 children, aged 6.0 years (± 3 months), participating in a randomized clinical trial (RCT) on caries-preventive strategies were included in this study. Parents were asked to provide information on parental education, oral health habits, dietary habits, knowledge on dental topics, willingness to pay money and willingness to invest time as well as perceived resistance against investing in preventive oral health actions (for their child). Clinical data were retrieved from the baseline measurement of the RCT. The study was approved by the Medical Ethical Committee of the VU University Amsterdam, the Netherlands. Protocol number: 2006/156.

Procedure

Information was gathered using written questionnaires, completed by the accompanying parent, when the child visited a participating dental clinic in one of three large cities in the Netherlands ('s-Hertogenbosch, the Hague and Enschede). Parents were informed about the study and the possibility to participate in writing approximately two weeks prior to their child's planned visit to the dental clinic. After informed consent was obtained, their child was included and parents were asked to fill out the questionnaire. When the parent decided not to let their child participate, the reason of non-participation was recorded. The majority of the questionnaires (84%) were completed and returned at the same visit. When people indicated not to have enough time, they took it home and returned it within a week (14%) or after a reminder within one month (2%).

Instruments

Clinical

Children's oral health situation was assessed clinically during a visit at the dental clinic using a mirror, light, a blunt probe and compressed air. Oral hygiene was assessed using the simplified oral hygiene index (OHI-s) (Greene & Vermillion, 1964) and caries using the dmfs-index (decayed, missing and filled surfaces), with caries scored at the dentine-threshold (d3).

Dental hygiene knowledge

Parents were asked to complete the questionnaire and explicitly instructed to only consider the child who was involved in this trial in answering the questions, thus disregarding possible brothers and sisters in the same family. The questionnaire included a short dental hygiene knowledge test consisting of ten items. We used an existing questionnaire for this purpose (Kalsbeek et al., 1989). Each item was presented with three answer options, of which only one was correct, and the option “I don’t know”. (An example item is “Toothpaste often contains fluoride. This is to prevent...” with answer options “cavities”; “bad breath”; “tartar”; and “I don’t know”.)

Respondents’ answers were classified as correct (1) or wrong (0). Factor analysis and reliability analysis were conducted to analyse the responses to these ten questions, showing that five (of the ten) items formed a scale with satisfactory reliability ($\alpha = .73$). The score on dental hygiene knowledge scale was determined for each respondent by aggregating the number of correct answers to these five questions, thus ranging from 0 to 5 (with a higher score indicating a higher dental hygiene knowledge). A score between 0 and 2 was categorized as ‘poor’, a score of 3 or 4 as ‘fair’ and a score of 5 as ‘good’ dental hygiene knowledge. Parents also self-assessed their knowledge of dental hygiene as ‘sufficient’ or ‘insufficient’. Parents who assessed their knowledge to be sufficient scored higher on the dental hygiene knowledge scale than those who assessed their knowledge to be insufficient ($p < = 0.001$).

Dental hygiene burden

The questionnaire also included seven statements exploring the burden experienced by parents from undertaking activities to promote the dental hygiene of their child (an example item is “brushing my child’s teeth daily:...”). Respondents rated these statements using a Likert scale ranging from “not at all inconvenient” to “very inconvenient”. Following factor and reliability analysis all seven items were retained to form a scale with good reliability ($\alpha = .80$). The score on the dental hygiene burden scale was computed as the mean response to the seven statements, normalized to form a 0 to 5 score (with higher scores indicating higher burden). Dental hygiene burden scores were negatively associated with dental hygiene knowledge scores ($\rho = -.361$, $p = .002$). Parents who assessed their knowledge to be sufficient scored lower on the dental hygiene burden scale than those who assessed their knowledge to be insufficient ($p = .034$).

Measures of willingness to invest

Parents were asked to answer the following questions:

1. “How much are you willing to pay every month to keep your child’s mouth healthy, caries-free and pain-free until his or her 18th birthday?” Parents were able to choose one out of five options: € 0,-; € 1 to € 10,-; € 11 to € 25; € 26 to € 50; or more than € 50.
2. “How many minutes are you willing to brush your child’s teeth yourself every day to keep your child’s mouth healthy, caries-free and pain-free until his or her 18th birthday?” Parents were able to choose one out of five options: no time (0 minutes); 1 to 2 minutes; 3 to 4 minutes; 5 to 6 minutes; or more than 6 minutes a day.
3. “How many times are you prepared to visit a dental clinic every year for check-ups or oral hygiene counseling to keep your child’s mouth healthy, caries-free and pain-free until his or her 18th birthday?” Parents were able to choose one out of 5 options: no visits; 1 or 2 visits; 3 or 4 visits; 5 or 6 visits; or more than 6 visits per year.

Measures of oral health related behavior

Oral hygiene-habits and dietary habits of the parents and their children were also investigated. It was asked how many times the parents themselves brush their own teeth and their children’s teeth and how many times children brushed their own teeth. Parents had to indicate how difficult they perceived brushing their children’s teeth (on a VAS scale from 0 (not difficult at all) to 10 (extremely difficult)). Furthermore, fluoride-use as well as usual toothpaste type was asked. Concerning dietary behavior, parents were asked whether they and their child usually ate the common meals of breakfast, lunch and dinner (separately asked) as well as the usual number of in-between-meal snacks.

Analysis

Associations between the measures of willingness to invest were investigated by (i) inspecting cross-tabulation between willingness to invest time and willingness to pay measures (see Table 3) and (ii) bivariate and multivariate correlations between these measures (see Table 4). Because an ordinal regression model with willingness to pay as dependent variable did not pass the test of parallel lines, standardized linear

regression coefficients are presented in Table 4. Associations between measures of willingness to invest and measures of parental knowledge, assessment and perceptions of oral health and their oral health behaviour were investigated using bivariate correlations (see Table 5). The significance level was set at $\alpha = 0.05$.

Results

Initially, 346 parents were asked to complete the questionnaire and let their child participate in a randomized controlled trial on caries-preventive measures in children aged from 6 to 12 years old. 290 parents (84%) agreed to participate. Table 1 describes this sample.

Parents indicated to attach high importance to their child's general and oral health (VAS scale: mean scores 9.60 and 9.43, respectively). The differences between parents were much smaller for general health (range 6-10) than for oral health (range 2-10).

Table 2 describes oral health behaviour in this sample. The results indicate that every child brushed their own teeth or had them brushed by their parents on a regular basis although six children (2.1%) did not brush or were not brushed by their parents every day. All other children (284; 97.9%) brushed or were brushed at least once a day with fluoridated toothpaste.

It was also found that 9.7% of the children regularly skipped breakfast, 6.9% frequently skipped lunch and 4.1% did not have dinner on a regular basis. In total, 251 (86.6%) children usually ate all three main meals. The large majority of children (72.4%) ate 1 to 5 in-between-meal snacks per day, while 20.7% ate more than 5 per day.

Figure 1 shows the responses to the willingness to invest questions, indicating that 79.3% of the parents were willing to pay at least some amount of money in order to maintain good oral health for their child. Moreover, 83.4% of the parents were willing to spend more than two minutes per day on brushing and were willing to go to the dentist more than once a year (for a preventive visit) for this purpose. On average, parents were willing to invest a maximum of € 31.25 (± 30.96); median: 25.00 per month, 6.47 (± 4.17), median: 5.0 minutes of tooth brushing per day and 3.45 (± 1.72), median: 3.0 preventive visits to the dental clinic per year to maintain good oral health for their children. Combining the results presented in Figure 1 indicated that 11.7% of the parents was not willing either to invest any money, to brush more than 2 minutes

per day, or to go to the dentist more than once a year, in order to achieve good oral health for their child. Compared to other parents, these parents could be characterised by a lower level of education of mothers ($Z = -6.75, p = .000$) and fathers ($Z = -3.63, p = .000$); a lower socio-economic status ($Z = -5.92, p = .000$); attaching a lower importance to their children's general health ($Z = -1.46, p = .143$) and oral health ($Z = -1.33, p = .184$); having a lower dental hygiene knowledge ($Z = -11.20, p = .000$); and experiencing a higher dental hygiene burden ($Z = -9.17, p = .000$).

A statistically significant, negative correlation was found between the dental hygiene burden score and willingness to invest money ($\rho = -.22; p = .038$), brushing time ($\rho = -.29; p = .001$) and number of preventive visits ($\rho = -.28; p = .001$). Dental knowledge was correlated to socioeconomic status ($\rho = -.33; p = .001$) and oral hygiene ($\rho = -.21; p = .03$).

A weak negative correlation was found between willingness to pay and dmfs ($r = -0.164, p = .036$). No correlation was found between dmfs and outcomes of the willingness to invest questions.

Table 3 indicates how responses to the willingness to invest time questions were related to willingness to pay. On average, higher scores on one measure were associated with higher scores on the other measures. This was confirmed in the bivariate and multivariate association between the willingness to invest questions as shown in Table 4. Measures of willingness to invest were significantly, moderately and positively correlated: higher willingness to pay was associated with higher willingness to invest time (in terms of brushing and visits).

Table 5 shows the results of bivariate analyses, indicating how willingness to invest was associated with sample characteristics. These associations were all in the same directions and mostly statistically significant. For example, more knowledge regarding dental health and attaching a higher importance to children's oral health were associated with higher willingness to invest in terms of both money and time. The associations for the group of parents who were not willing to spend any money and only limited time (shown in the last column of Table 5) were consistently in the opposite direction.

Discussion

The purpose of this study was to investigate the parental willingness to invest in the oral health for their children in terms of money and time and to relate these outcomes to oral health-related knowledge and behavioral aspects. We found that, on average, parents valued their children's general health and oral health highly. Still, one fifth of the parents were unwilling to spend any money to maintain good oral health in their children. On the positive side, this implies that 80% of the parents were willing to spend at least some money and almost 10% of the parents were even willing to spend more than € 50 per month on maintaining a good oral health for their child. Besides this, clearly nearly all parents are willing to invest something on their children's oral health (by purchasing toothbrushes, spending some time brushing or going to the dentist for check-ups). The posed questions aimed to explore the maximum investments parents were willing to make. Parents valued oral health of their child very highly (9.47 on a scale from 0-10). It should be noted, however, that this valuation was not obtained using some trade-off technique (but simply on a 0 to 10 scale). The (very) high valuation does not reflect a real trade-off, and one may feel the subsequent indications of valuation (willingness to pay and willingness to invest) to be at variance with this high score. A positive relation between the investments in time and money indicates that parents with a higher financial willingness to invest also showed to be more willing to invest time.

Concerning the relationship between knowledge of and attitudes towards oral health behavior, the results of this study are in concordance with previous findings. Regarding the valuation of caries-preventive care, some notable differences compared to an earlier Swedish study were observed (Oscarsson et al., 2007). In that study, in adolescents, it was found that a high-risk group (having a DMFT > 8) valued preventive care higher than a low-risk group (having DMFT = 0). Here, in contrast, we found no difference between risk groups (based on dental hygiene, knowledge and burden-scores) concerning willingness to pay and, in fact, a lower willingness to invest in terms of time and number of preventive visits to the dental clinic among those parents in the high risk group. This may be because of the difference in defining high-risk as well as the differences in subjects (adolescents vs. parents of young children).

Before discussing the implications of our results, a few remarks should be made regarding the limitations of this study. The sample used was relatively small ($n = 290$) and not fully representative of the Dutch general population. The share of non-western

immigrants in our sample was almost 28%, while this share is just below 12% in the Dutch population (website Statistics Netherlands). This is explained by the fact that our data were collected in larger cities where the share of non-western immigrants mostly is higher. We found no statistically significant effect of ethnicity on the investigated relationships. Another issue that may have influenced our results is non-response. Some 16% of invited parents decided not to participate in this study, which is a non-negligible proportion. It needs noting, however, that a recent study on non-participation bias in the RCT on which this study is based showed that participants did not significantly differ from the total invited sample in terms of characteristics like age, gender, oral hygiene habits and dietary habits. Therefore, the external validity was not necessarily affected by non-participation bias (Vermaire et al., 2011). Furthermore, it should be noted that the results from a stated preference method may differ from revealed preferences. Still, it is common to use stated preference methods like the ones used here in valuing “goods” for which market prices do not exist or cannot be easily observed. Although parents were asked, when completing the questionnaire, to only consider the child who was in the trial, they obviously may have considered investments for possible brothers or sisters as well. This could lead to lower WTP and WTI estimates (all other things equal) when parents with more children aggregated investments across their children. However, the regression did not reveal an influence of the variable ‘only child’; hence the influence of having more children in the same household appears to be small.

As indicated before, in preventive dentistry the investment in terms of time of parents may be even more important than their willingness to pay. Because of the young age of the children included in this study (6 years), they are mostly dependent on their parents for maintaining proper oral hygiene. It was found that almost 25% of the respondents were willing to invest only a few minutes of their time to brush their children’s teeth. Moreover, parents who were unwilling invest time for good oral health in their children, often were also less willing to pay money. This positive correlation between willingness to pay (money) and willingness to give up time is in line with earlier research in the field of hypertension (van Helvoort-Postulart et al., 2009). It should be noted that in that study a larger share of respondents gave protest answers using willingness to pay questions compared to willingness to invest time (12% and 2% respectively).

A striking, and from a preventive point of view worrying, finding in this study was that almost 12% of the parents indicated to be unwilling to pay any money as well as unwilling to invest any time in brushing their children’s teeth. Moreover, they indicated

to be unwilling to visit the dentist for preventive measures more than once a year. The children of this group of parents certainly may be at higher risk of developing oral diseases because, besides the fact that their parents are unwilling to invest time and money in their oral health, they also appeared to have the worst oral hygiene habits (brushing frequency and quality) and dietary habits (least regular meals and most between-meal snacks). Also when dmfs was considered, an unfavorable outcome could be identified in children of parents with a lower willingness to pay. This trend was seen concerning and willingness to invest time as well, although not statistically significant.

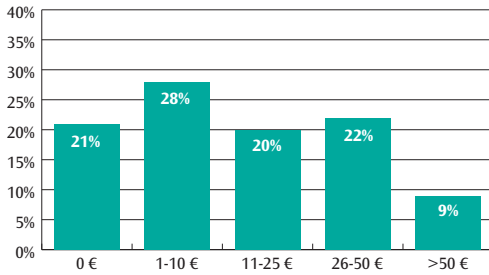
Our results indicate a clear challenge for oral health prevention: to reach those children whose parents are apparently unwilling to invest time, money and effort in their proper oral hygiene. A sometimes-proposed option would be to improve parental knowledge on dental health and risk factors (e.g. Garcia and Sohn, 2012), which, in turn, could then lead to improved willingness to invest in oral hygiene in children. A parallel can be drawn here with the impact of improvement of knowledge on the effects of vaccination on infant immunization rates (Owais et al., 2011). However, in our sample, the average level of knowledge was already at a relatively satisfactory level, which may invalidate the assumed chain of logic behind such interventions. Nevertheless, an increase in parents' knowledge on health and risk factors should be welcomed, although knowing how and why to maintain good oral health in their children seemingly does not 'automatically' translate into desired behavior. This resembles the situation for other lifestyle interventions, e.g. obesity and smoking habits, where the link between knowledge and behavior also is not as direct as sometimes hoped (Chapman and Ogden, 2009; Bledsoe, 2006). A study on parent's attitudes towards oral health in 6-year-olds children revealed 5 different "types" of parents (Vermaire et al., 2010). It would be interesting to see if different types of parents will also result in different type of risk-behavior, concerning oral health in their child. This may help identify the most effective strategy promoting oral health behavior. For example: a recent review on promoting health behaviors suggested that the technique of Motivational Interviewing can be a promising tool to establish behavioral change and is effective in numerous health domains, including oral health (Martins and McNeil, 2009), but also other ways to influence attitudes were considered recently. In a study on obesity, a strong and positive effect of peer pressure on adolescents' BMI was reported in several subgroups (Mora and Gil, 2012). Also in dentistry it was suggested that peer social networks and tooth brushing behavior are related (Dorri et al., 2010). Another approach may be to circumvent the investments required by parents completely, for instance through implementing school-based prevention programs. In the literature on such programs,

divergent operationalization of such programs and effectiveness results are reported (Divaris et al., 2012; Ersin et al., 2008; Sköld, 2005). One study interestingly compared parents' preferences on whether their child was to receive dental care in a hospital setting or in a mobile-clinic, reporting a preference for the latter (Tianviwat et al. 2009). Customizing caries-preventive care therefore may improve effectiveness. Also when cost-effectiveness is considered, it seems important to realize that targeted interventions (aimed specifically at those children at risk of oral health problems) are often to be preferred over more general interventions, which also target a large group of children who do not require such interventions (Stamm et al., 1984).

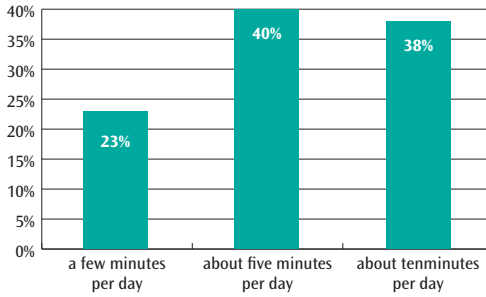
Concluding, this study revealed differences in parents' valuation of oral health in their children and the existence of a group of high-risk children, whose parents appear relatively unwilling to invest in oral health. Still, a significant share of our sample was willing to invest considerably both in terms of money and time. It may be of interest to identify the reasons for these – self reported – preferences. Information that parents are willing to invest in the oral health of their children can be useful for the dental professional in order to increase the effectiveness of their efforts to improve oral health in their pediatric patients. It would also be interesting to see to what extent stated and revealed preferences concerning this topic differ and to identify causes for such differences. Future research could investigate whether programs aimed at improving preventive dentistry could better target the children directly (e.g. through school-based prevention programs) or through parents (e.g. through motivational interviewing or using peer social networks). Perhaps differentiation in caries prevention is necessary, given the differences between parents reported in this study.

Figure 1: Frequencies of willingness to pay and willingness to invest time

willingness to pay



willingness to invest time in brushing teeth



willingness to invest time in visits to the dentist

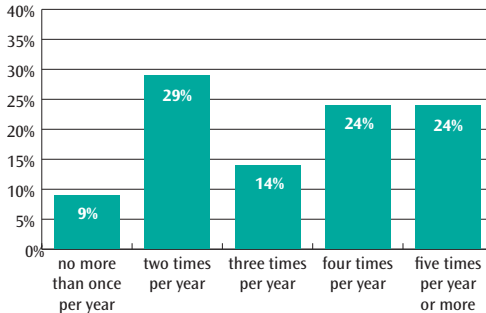


Table 1: Descriptive statistics (n = 290)

		N	(%)	mean	sd
Demographics child					
Sex	male	143	(49.3)		
	female	147	(50.7)		
Ethnicity	indigenous	207	(71.4)		
	non-western immigrant	83	(28.6)		
Only child	yes	51	(17.6)		
	no	239	(82.4)		
Is this child the oldest child?	yes	142	(49)		
	no	148	(51)		
Single parent family	yes	40	(13.8)		
	no	250	(86.2)		
Education mother	low	97	(33.4)		
	medium	109	(37.6)		
	high	84	(29.0)		
Education father	low	108	(37.2)		
	medium	88	(30.4)		
	high	94	(32.4)		
Oral health child					
Observed clinical scores ^a	ds			1.77	3.63
	ms			2.29	5.57
	fs			2.09	3.40
	dmfs			6.15	8.99
	OHI-s (0-3)			0.91	0.73
Parents' knowledge, assessment and perceptions					
Dental hygiene knowledge score (0-5)				4.05	1.33
Self-assessed knowledge	enough	247	(85.2)		
	not enough	43	(14.8)		
Dental hygiene burden score (0-5)				1.57	0.93
Importance of child's general health ^b				9.60	0.78
Importance of child's oral health ^b				9.43	1.04
Child's oral health assessed by parent ^c				7.08	1.85

Note:

^a ds: decayed surfaces, ms: missing surfaces, fs: filled surfaces, dmfs: decayed, missing and filled surfaces, OHI-s: simplified oral hygiene index (minimum score:0 [no surfaces covered with plaque]; maximum score: 3 [all surfaces covered with plaque])

^b rated on scale ranging from 0 (not at all important) to 10 (very important).

^c rated on scale ranging from 0 (could not be worse) to 10 (could not be better).

Table 2: Oral health behaviour

		N	(%)	mean	sd
How often does your child brush its' own teeth?	Never	12	4.1		
	Sometimes, not every day	50	17.2		
	Once a day	96	33.1		
	Twice a day (or more)	132	45.5		
How often do you brush your child's teeth?	Never	7	2.4		
	Sometimes, not every day	78	26.9		
	Once a day	115	39.7		
	Twice a day (or more)	90	31.0		
How often do you brush your teeth?	Never	0	0.0		
	Sometimes, not every day	3	1.0		
	Once a day	52	17.9		
	Twice a day (or more)	235	81.0		
What time of day are the child's teeth brushed?	In the morning	25	8.6		
	In the evening	58	20.0		
	Both	207	71.4		
What type of toothpaste is used?	Same as parent	28	9.7		
	Children's toothpaste	260	89.7		
	None / don't know	2	0.6		
How easy is it for you to brush your child's teeth? (0-10)				7.41	1.98
Which main meals does your child usually eat?	Breakfast (yes)	262	90.3		
	Lunch (yes)	270	93.1		
	Dinner (yes)	278	95.9		
How many in-betweens does your child usually eat?	Sometimes, not every day	20	6.9		
	One to five times a day	210	72.4		
	More than five times a day	60	20.7		
How many in-betweens do you usually eat?	Never	2	0.7		
	Sometimes, not every day	22	7.6		
	One to five times a day	203	70.0		
	More than five times a day	63	21.7		

Table 3: Cross-tabulations between willingness to pay and to invest time

Willingness to invest time		Willingness to pay				
		N	0 €	1-10 €	11-25 €	26-50 €
in visits to dentist						
- no more than once per year	27	55.6%	18.5%	14.8%	11.1%	-
- two times per year	84	26.2%	31.0%	16.7%	17.9%	8.3%
- three times per year	40	15.0%	50.0%	15.0%	20.0%	-
- four times per year	69	11.6%	24.6%	36.2%	21.7%	5.8%
- five times per year or more	70	12.9%	18.6%	12.9%	32.9%	22.9%
in time brushing						
- a few minutes per day	66	39.4%	30.3%	10.6%	16.7%	3.0%
- about five minutes per day	115	14.8%	40.9%	23.5%	16.5%	4.3%
- about ten minutes per day	109	15.6%	12.8%	22.0%	31.2%	18.3%

Note: rows add up to 100% for each variable separately; maximum % per row indicated in bold.

Table 4: Associations between willingness to pay and to invest time

	Bivariate ^a				Multivariate ^b		
	Willingness to pay		Willingness to invest time in brushing		Willingness to pay		
	ρ	p	ρ	p	Beta	t	p
Willingness to invest time in brushing	0.339	< 0.001			0.292	4.63	< 0.001
Willingness to invest time in visits to dentist	0.328	< 0.001	0.591	0.000	0.198	2.91	0.029

Note:

^a Spearman's correlation coefficient.

^b Standardized linear regression coefficients are presented (model with constant, statistically not significant).

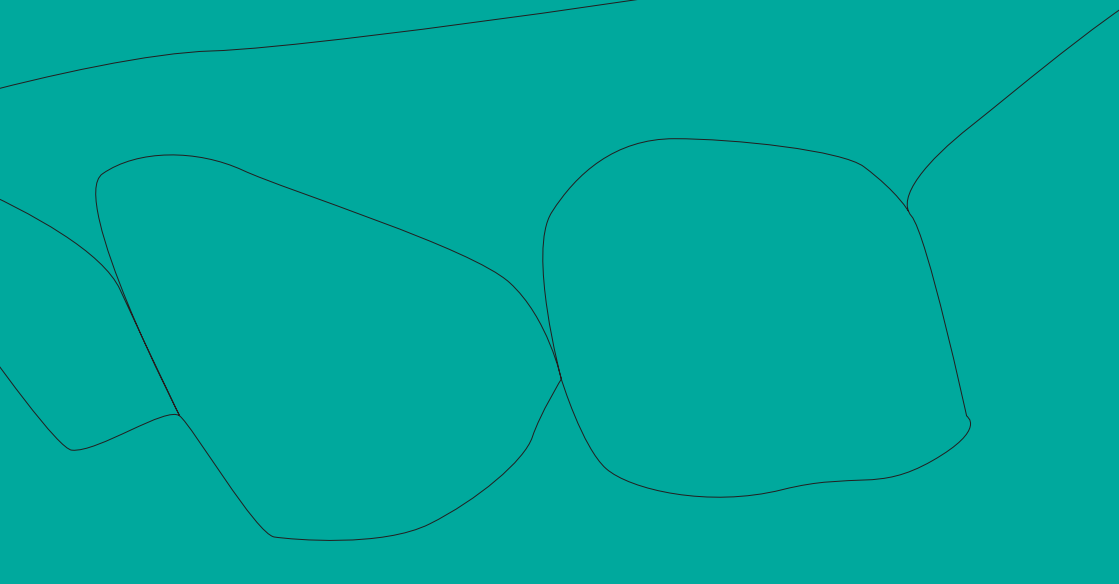
Table 5: Bivariate associations of willingness to pay and willingness to invest time with parents' knowledge, assessment, perceptions of oral health and their oral health behaviour (Spearman's correlation coefficients; only statistically significant correlations shown)

	Willingness to pay		Willingness to invest time in brushing		Willingness to invest time in visits to dentist		Not willing to invest any money and only limited time (n = 31 / 11.7%)	
	ρ	ρ	ρ	ρ	ρ	ρ	ρ	ρ
Socioeconomic status	-.195	.001	-.256	.000	-.163	.005	-.348	.000
Dental hygiene knowledge score (0-5)	0.172	.001	0.177	.000	0.098	.17	-0.661	.000
Dental hygiene burden score (0-5)	-0.201	.005	-0.274	.001	-0.331	.000	0.315	.001
Importance of child's oral health	0.254	.000	0.133	.021	0.107	.107	-0.094	.286
Importance of child's general health	0.142	.055	0.146	.051	0.120	.035	-0.137	.162
How often do you brush your child's teeth?	0.127	.058	0.053	.316	0.021	.759	-0.033	.579
How many main meals does your child usually eat?	0.209	.000	0.171	.001	0.151	.012	-0.493	.000
How many in-betweens does your child usually eat?	-0.093	.031	-0.245	.000	-0.201	.001	0.268	.000
How many in-betweens do you usually eat?	-0.091	.055	-0.130*	.051	-0.149*	.035	0.206	.000

Chapter

6

Attitudes towards oral health among parents of six-year-old children at risk of developing caries



Attitudes towards oral health among parents of six-year-old children at risk of developing caries

Introduction

Attitudes are widely considered a relevant construct for dental health behaviour and education research because of their effect on health perceptions and behaviour (Mohebbi et al., 2008; Poutanen et al., 2007; Skei et al., 2006; Kaye et al., 2005; Jerkovic et al., 2009). From the health care point of view, it is desirable to alter attitudes that obstruct effective behaviour. Successful smoking-cessation and oral health modification strategies in adults have already shown that different attitudes require different communication strategies (Doran et al., 2004; Stewart et al., 1996), but before attitudes can be changed, they need to be determined.

Common to most definitions of “attitude” is that they are subjective, that is, influenced by cognitive, emotional, and physical tendencies (Cross, 2005; Oppenheim, 1992). Questionnaires have traditionally been used to describe attitudes (Glanz et al., 2002) in a variety of areas, including dentistry (Kaye et al., 2005; Gussy et al., 2008; Poutanen et al., 2006; Tickle et al., 2003). The scoring of psychological constructs like attitudes is usually performed using Likert-type scales or semantic differential-based questionnaires. A drawback of these types of response formats is the possible introduction of an acquiescence bias, that is, a tendency to agree or indicate a positive connotation with the questions. Furthermore, attitudes usually grouped into one mean composite score. Parents, for example, will have either high, moderate, or low attitudes towards oral health (Peterson et al., 2000). Others have used VAS-scales for measuring cognitive, affective, and behavioural aspects of attitudes, also resulting in an overall score (Stenberg et al., 2000). This type of information can be useful for dental professionals, as it tells them what “type of parent” is rearing their paediatric patient. But it does not inform them of the antecedents of a parent’s attitude and therefore provides little support for developing individualised oral health education that will help parents alter their obstructive attitudes and adopt an effective preventive regime. This is especially relevant in the case of children at risk of developing caries.

The aim of this study is to explore the range and diversity of parents’ attitudes toward oral health in depth using Q-methodology, a research method that combines qualitative and quantitative methods and provides a scientific foundation for the systematic study

of subjectivity (Cross, 2005; Watts et al., 2005). Q-methodology originated in the 1930s (Stephenson, 1935)¹ and many of its studies have been published in the fields of social and political science. In health services and medicine it is still relatively novel, but has been increasingly used in the past decade (Kreuger et al., 2008; Tielen et al., 2008; van Exel et al., 2007; van Exel et al., 2006; Baker, 2006; Bryant et al., 2006; Ryan and Zerwic, 2004). In orthodontic research the method has recently been applied to the evaluation of smile aesthetics. Compared to the use of visual analogue scales, Q-methodology appeared to be a more reliable method (Schnabel et al., 2009).

Because the method is still rather unfamiliar in the dental research field, the procedure is presented in detail.

Material & Methods

In a Q-methodological study, purposively-selected respondents are presented with a sample of opinion statements representative of the subject of study. Respondents are asked to rank-order the statements from their individual point of view and according to instruction. By sorting the statements respondents give subjective meaning to the statement set and so reveal their subjective viewpoint (Smith, 2001). The individual Q-sorts are then correlated and subjected to by-person factor analysis to reveal similarities in viewpoint. If individuals were to have a different viewpoint, their Q-sorts would not correlate. If, however, significant clusters of correlations exist, they can be identified and described as common viewpoints and individuals can be measured to them. Q-methodology can thus be used to reveal and describe a population of *viewpoints* rather than a *population* of people (as in conventional factor analysis). Because the purpose is to identify the range and diversity of attitudes in a population and not the proportion of population that holds them, a small purposive sample of respondents is sufficient for a Q-study (Smith, 2001; Brown, 1980). In common survey analysis, a representative sample of the population is presented with a theoretical selection of measurement instruments, which are expected to provide answers that can be generalised to the larger population. In Q-methodology, a representative set of opinion statements about the subject of study is evaluated by a theoretical selection of respondents, who are expected to reveal the range of attitudes that can be generalised to the subject (and thus not the population sample).

¹ William Stephenson, the inventor of Q-methodology, served as the last assistant to Charles Spearman, the inventor of conventional factor analysis.

Our current Q-methodological study was conducted in four steps (described below): development of the statement set, selection of respondents, interviews, and analysis.

Development of the statement set

Relevant topics within parents' opinions regarding oral health habits and behaviour toward their children were identified on the basis of a literature search and interviews with three experts on health behaviour and oral health. Opinion statements on these topics were collected in the first half of 2007 using both popular and scientific literature and websites concerning parenting issues. To ensure coverage of all the relevant topics, an adapted version of the Health Belief Model (HBM) (Glanz et al., 2002; Rosenstock et al., 1988) was used. The HBM was chosen because it is well known as a general and comprehensive model. Although some have called for the development of a model specific to dental research because of the HBM's limitations (Ashford and Blinkhorn, 1999), it is here suitable for our purpose.

The collected opinion statements ($n = 78$) were categorised to the seven dimensions incorporated in the HBM: susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, self-efficacy, and perceived threats. Next, the sample of statements was reduced to a manageable, representative set. This process involved multiple sessions with members of the research team and consultation with a panel of 25 parents. The final 37 statements were text edited, randomly assigned a number, and printed on separate cards. Table I presents the full list of statements and their relation to the dimension of the HBM.

Subjects

The study was conducted among parents of 6-year-old children because at this age the eruption of the permanent dentition starts, the children are still dependent on parents' help for achieving adequate oral hygiene, and the children are at risk for caries development. Respondents were purposively selected according to socioeconomic status (low, middle, and high level of education) and oral health situation (good and otherwise), defining six target groups. In addition, a fair representation of indigenous and non-indigenous ethnic backgrounds was targeted in each of the six groups. This sampling structure was chosen because the factors are known to be the most relevant for prediction of caries distribution in the Netherlands. The resulting sample was therefore anticipated to represent the entire range and diversity of attitudes toward oral health.

From June to November 2007, parents visiting one of two dental clinics in a medium-sized and a large city in the Netherlands with their child for the regular semi-annual check-up were asked to participate in the study. Parents were approached consecutively until at least six respondents were recruited in each of the defined target groups. A total of 39 parents consented to participate. Eleven (28%) had a high level of education, sixteen (41%) medium, and twelve (31%) low. Oral hygiene levels were equally distributed among education levels. Twenty-five (64%) were female, fourteen (36%) male. Twenty-seven (69%) were indigenous to the Netherlands, six (15%) Moroccan, three (8%) Turkish, and three (8%) Surinamese/Netherlands Antilleans.

The study was judged and approved by the Medical Ethical Committee of the VU University Amsterdam, the Netherlands. Protocol number: 2006/156.

Procedure

74 Parents who agreed to participate did so while at the clinic. They were asked to read carefully through all 37 statements and divide them into three piles: a) statements with which they generally agreed, b) those with which they generally disagreed, and c) those about which they felt neutral or ambiguous. They were then instructed to read through the “agree” statements again, select the two they agreed with most, and place them in the two outermost spots at the right side of the score sheet (Figure I, column 9). Then they were asked to go through the remaining “agree” statements, select the three they agreed with most, and place them in the next column on the score sheet (column 8), and so forth, until all cards in the “agree” pile were placed on the score sheet. The procedure was repeated for the cards in the “disagree” pile, starting in column 1 of the score sheet and continuing from left to right. Last, the statements from the “neutral” pile were evaluated and placed in the remaining middle spots. In a follow-up interview (10-15 minutes) participants were asked to explain their Q-sorts. The interviews were recorded and transcribed literally to augment interpretation and description of the findings.

Statistical analysis

All 39 Q-sorts were entered and analysed in PQMethod 2.11 (Schmolk, 2002), dedicated software for Q-analysis. The aim of the analysis, which is entirely based on conventional correlation and factor analysis techniques, is to identify a limited number of coherent patterns in the rank-ordering of the statements. After determining the correlation

matrix between Q-sorts, it is factor-analysed to identify clusters of coherent Q-sorts (Brown, 1980; Rosenstock et al., 1988). For each resulting factor, a composite sort of the statements was computed based on the Q-sorts defining it ($p < .05$), using their factor loadings as relative weights. This idealised Q-sort represents how a person loading 100% on that factor would have sorted the statement set (Table II). Finally, each factor was interpreted and described as an attitude toward oral health using the composite sort, with emphasis on (1) the statements that distinguished the factor statistically significantly from others, and (2) relevant interview statements made by respondents defining the factor to explain their Q-sorts.

Results

By-person factor analysis (centroid factor extraction with varimax rotation) showed that the data supported a 5-factor solution (factors with Eigenvalue > 1 were retained). Adjacent factor solutions were also inspected, but the 5-factor solution provided the most clear and intelligible portrayal of attitudes of parents with six-year-olds toward oral health. These factors were defined by three to eight variables (i.e., Q-sorts), with a cumulative explained variance of 62%.

The five attitudes described below are illustrated by parents' interview statements (italicised). Relevant statement numbers are referred to in parentheses.

Attitude 1. Conscious and responsible

Parents emphasise the positive effects of their behaviour and minimise the effort it takes to maintain healthy teeth.

Compared to all other types of parents, these consider caries development in the primary and permanent dentition of children to be the biggest problem (Table 1, statements 1, 28): *"A cavity in your tooth means you'll have a weak spot in your mouth for the rest of your life and it will cause you lifelong trouble."* Healthy and fresh teeth are important, providing a good appearance and confidence (4, 27, 34, 37): *"I think it's a shame when you see some children hiding their mouths with their hands when they're laughing."* Parental responsibility for maintaining proper oral hygiene in their children is acknowledged (12): *"Let my son brush his teeth himself? I won't rely on that";* and (20): *"Maybe hereditary elements are involved in some way, but brushing my child's teeth myself prevents him from developing cavities."* The effort it takes to maintain oral health is not considered to be too great (7, 25, 31) and parents are familiar with the effect of

diet on caries development (22). They demonstrate an intention to closely monitor their child's dental health (5) and are convinced that parents can make a difference in their child's caries prevention (2, 20).

In sum, this type of parent is aware of the importance of proper oral hygiene and of their own responsibility in helping to achieve this in their children. They were thus categorised as 'conscious and responsible'.

Attitude 2: Trivialising and fatalistic

Parents prefer not to go to dentists themselves, consider their child's cavity a minor problem (if any), and state with conviction that caries are principally a genetic problem and therefore beyond control.

These parents point out with great certainty that developing caries is mainly a matter of bad luck (21), that there is not much they can do about it (20), and that it is determined genetically (24): *"The fact that my child has so many cavities is no surprise to me: both my grandmother and grandfather had all their teeth extracted and replaced by a prosthesis before they were 25 years old, my mother has no teeth left either and I've lost quite a few already."* The influence parents can have in preventing the development of caries in their children by brushing their teeth is estimated to be low (2, 19): *"So many people in my neighbourhood brush their own and their children's teeth quite a lot and they still get cavities. My sister never brushes my nephews' teeth and they don't have any holes in them."* Having dental decay is not considered a serious problem for either permanent or deciduous dentition (1, 28). Furthermore, their value of healthy teeth is remarkably lower than all other types of parents (4, 27). These parents prefer not to go to the dentist themselves, and take their children only when there are problems with their teeth (15). A yearly visit is considered sufficient (8). When they do go to the dentist, they dislike the criticism of the dental professional who finds fault with their brushing (35). *"I always have to listen to his speech about brushing better – like I don't have the ability to remember that from the last time!"* Finally, this type of parent is less critical about the brushing abilities of their child (12) and they wholly disagree with the statement that proper brushing is difficult (7). This attitude was thus called 'trivialising and fatalistic'.

Attitude 3: Appearance-driven and open-minded

Parents are mainly focused on the benefits healthy teeth have on looks and they are remarkably amenable to professional dental information.

These parents seem to endorse the importance of having good looking, clean, healthy teeth. They are convinced that this can provide their children with self-confidence and will save money in the long term. They also indicate the importance of brushing their children's teeth to obtain or retain a nice smile (27): "...good looks are very important nowadays and having nice-looking teeth can help achieve this goal"; and "Having ugly teeth can influence daily life enormously." A dental appointment is not at all inconvenient (6, 33); on the contrary, it can help them learn more about taking good care of their teeth (18): "Some things in life just need to be done and I think going to the dentist is one of those things. And you always get something useful out of it." A cavity is a matter of parental responsibility, not bad luck: "Parents are to be held responsible for taking good care of their children and taking good care of their teeth is a part of it." They do, however, strongly disagree with the statement that parents should be ashamed if their child develops caries (3). Finally, this type of parent claims to keep a close eye on their children's oral health (5): "Children are not capable of taking good care of themselves. It's the parent's duty to do so until they can." This attitude was thus called 'appearance driven and open minded'.

Attitude 4: Knowledgeable but defensive

Parents know what the ideal balance is to maintain adequate oral health but point out the barriers they encounter while trying to achieve it. The major one seems to be lack of time.

These parents are well aware of all the possible benefits of healthy oral habits (17, 19, 36) and all the disadvantages that may result from not conforming to them (2, 9, 26). They consider decay in a deciduous (or any) tooth very serious (1) but also consider the effort it takes to brush the child's teeth seriously difficult. Brushing is therefore not done as often as they know it should be (7, 25): "...it's just that she won't open her mouth when I try to brush her teeth at night. Most of the time I just leave it like that; I don't want to spoil the atmosphere"; and "We both work full-time and we don't want to fill the time we have with the children with a daily struggle. Besides that, it isn't everyday they don't want to." On the other hand this type of parent attends to dental check-ups frequently and eagerly (8, 15): "...if you have check-ups regularly, the dentist is able to find problems at an early stage and he can prevent them getting worse." It may be that this type of parent adheres to the idea of 'shared responsibility' with the dentist with respect to the oral health of the child, or that they assuage their own guilt by shifting the burden to the dentist whenever possible. This attitude was therefore called 'knowledgeable but defensive'.

Attitude 5: Conscious and concerned

Parents know what action should be taken for their children's best oral health but are concerned that their efforts in the end may have little effect.

These parents assign great value to all general aspects of healthy (oral) behaviour (15, 19, 28), including oral hygiene (25, 31, 32). They are the only group to emphasise the effect diet has on teeth (11, 22, 26, 29, 30). *"I know what all those fizzy drinks can do to your teeth; when I do the shopping those are not likely to end up in my cart."* The undertone of uncertainty is quite present (2, 9, 24): *"...even though I'm trying really hard there's always a risk of my child getting a cavity; you know, neither my husband nor I have strong teeth."* This type of parent also underlines the importance of getting the advice of a dental professional (16, 23, 32), is aware of the importance of keeping the permanent dentition in good health (28), but is surprisingly relaxed when it comes to decay in primary dentition (1): *"... milk teeth are temporary anyway; they'll be replaced in a few years. But when it comes to permanent teeth, it would be a shame if they were affected by caries."* Having healthy, permanent, teeth is, on its own, considered very important. Suggested benefits of having healthy teeth are less important (17, 27, 34, 36, 37). This attitude was called 'conscious and concerned'.

Discussion and recommendations

In this explorative study we found five distinct attitudes toward oral health among parents of six-year-old children: 1) conscious and responsible, 2) trivialising and fatalistic, 3) appearance driven and open minded, 4) knowledgeable but defensive and 5) conscious and concerned. That attitudes concerning oral health differ across parents perhaps does not come as a surprise, but how these differences were identified and characterised in this study is novel and insightful. Of course, claiming that this is the definitive range and variety of attitudes in the population investigated on the basis of one explorative study would be premature, especially for populations in countries with different dental health insurance policies. Replications would have to confirm this and are encouraged. But for the Netherlands, we consider these attitudes to be representative of the range and variety of attitudes operant among parents of six-year-olds, and they provide valuable information for dental professionals to develop and adapt their oral health education to specific groups of patients. For implementation of these results in daily practice, a self-report quick-scan measure is under consideration.

A few remarks should be made regarding this study. Because Q-studies use a relatively small sample of respondents, a frequent question is whether a different sample would have resulted in similar attitudes toward oral health. As explained previously, Q-methodology relies on a theoretical selection of respondents to explore a range and variety of attitudes. A different sample recruited on the basis of the same theoretical structure is therefore expected to reveal similar attitudes. Past studies have shown that the test-retest reliability of Q-studies generally is around .80 (Brown, 1993). A previous Q-study, investigating parental attitudes, reported a test-retest value of .72 (Pease et al., 1989). The current study, however, needs to be replicated before we can say more about the reliability of the results. The results will also depend in some part on the model used to develop and structure a representative statement set. Here we used a modified version of the Health Belief Model because it is widely considered to be generally applicative as well as comprehensive and therefore well-suited to our purpose. A number of alternative models could have been used, including a range of alternative beliefs potentially influencing oral health behaviour (Michie et al., 2005), and one might wonder whether the results would have been different in that case. Because the HBM was chosen for structuring the research instrument and no direct reference is made to its belief categories in the interpretation and description of the results, we believe the role of the belief categories as specified by the HBM is limited. Therefore, if a different model had been chosen, equally general but distinguishing other belief categories, a somewhat different statement set could have emerged, but the resulting attitudes would likely be very similar. It is of course difficult to be conclusive, making it an interesting hypothesis for a validation study. Furthermore, based on the current study, nothing can be said about the proportion of the population that holds these attitudes, or about associations of the attitudes with characteristics of parents, the family context, or other variables of interest. Q-methodology is not fit for this purpose (Brown, 1995). A traditional survey in which the five attitudes are presented to a representative sample of parents of six-year-olds could provide this type of information.

When comparing the results found in this study with those from other Q-studies of health attitudes (Tielen et al., 2008; van Exel, et al., 2007) some similarities appear. Despite the aspect of health studied, the revealed attitudes all distinguish degrees of involvement, control, concern, self-confidence, pliability, and motivation. These are important factors in understanding health behaviours, which are often studied more in-depth independently, but as shown in these Q-studies, are related and interact.

Comparing our results to those from a recent survey among African-Americans (Sohn et al., 2008), it can be said that while the fatalistic type of parent was found in both samples, the distinction between fatalistic and non-fatalistic can be further refined.

In this study, Q-methodology proved to be a feasible way to analyse parents' attitudes toward the oral health of their children. Respondents found it interesting to participate and were confident in ranking the statements according to the instructions and with the score sheet provided. Despite the fact that the ranking of the statements and the follow-up interview took a total of about 45 minutes, participants remained involved and talkative, resulting in much helpful information for interpreting and describing the statistical results. Taken together, we believe Q-methodology is a useful and welcome addition to the toolbox for future social and behavioural dental research.

To conclude, the results of this study can contribute to a better understanding among dentists of parents' attitudes toward their children's oral health. It is not intended as a means to label parents as 'good' or 'bad' in how they attend to their children's oral health. Revealing the parent's thinking on this topic can help to individualise the preventive strategy by, for example, applying individual education techniques like motivational interviewing or individually-assigned professional fluoride applications. Whether attitude-dependent prevention will result in more effective preventive strategies and oral health education is a matter for future research.

Psychological Model	Author	Sample size	Study design	Outcome measure	Results
Health belief model (HBM) Rosenstock 1966, 1974	Vanagas et al.* 2009 *similar to HLoC and TPB	397	Cross sectional	Understanding of importance of preventing tooth decay, importance of controlling (sugary) snacking and perceived seriousness of tooth decay	- Parental attitudes were significantly associated with oral health behaviour they apply to their children
	Pine et al. 2000	421	Randomized controlled trial	Caries increment / twice daily brushing	- Caries reduction 16% in intervention group - Parental belief influence the likelihood of brushing twice a day
	Durward et al. 1989	238	Cross sectional	Perceived value of preventive dental visits	- HBM provides little explanatory power in predicting preventive behaviors
Protection motivation theory Rogers 1975, 1983	Kegeles et al. 1984	> 1500	Before and after study	Behaviour changes in relation to beliefs	- No evidence that HBM can be helpful in either predicting or helping to explain behavior of adolescents
	Mohebbi et al. 2009	242	Randomized controlled trial	Increment of carious surfaces	- Oral health education, using given to mothers by general health staff is a valuable tool to prevent caries in infants and toddlers
	No studies found for cariology				

Psychological Model	Author	Sample size	Study design	Outcome measure	Results
Health locus of control (HLLoC) Wallston 1982	Vanagas et al. * 2009 * similar to HBM and TPB	397	Cross sectional	Understanding of importance of preventing tooth decay, importance of controlling (sugary) snacking and perceived seriousness of tooth decay	<ul style="list-style-type: none"> - Parental attitudes were significantly associated with oral health behaviour they apply to their children
	Brandão et al. 2006	110	Cross sectional	Prevalence of early childhood caries	<ul style="list-style-type: none"> - No statistically significant differences between the means for each health locus of control sub-scale and early childhood caries was found
	Chase et al. 2004	79	Cross sectional (cohort study)	Influence of all different loci of control on healthcare outcomes	<ul style="list-style-type: none"> - No meaningful difference existed between the Relapse versus Non-relapse groups with respect to each health locus of control parameter
	Lencová et al. 2008	285	Cross sectional	Level of untreated caries	<ul style="list-style-type: none"> - Parents who returned for follow-up care appeared to have an internal health locus of control while those who did not return had an external locus
	Syrjälä et al. 2004	149	Cross sectional	Proportions of variance explained by the linear regression model	<ul style="list-style-type: none"> - Higher internal parental LoC is associated with better control of both untreated caries and caries experience in their preschool children - A more internal LoC within the family is advantageous in the prevention of dental caries

Psychological Model	Author	Sample size	Study design	Outcome measure	Results
	Knecht et al. 1999	149	Cross sectional	Frequencies of tooth brushing and dental visiting, oral indexes, diabetes adherence, and HbA1c level	<ul style="list-style-type: none"> - Self-efficacy is the best overall determinant of various health behavior practices - The ability of psychological characteristics to explain oral health was limited. Improvement of self-efficacy therefore may have a positive effect on various aspects of health behaviors. - Locus of control beliefs are health behavior specific
Social cognitive theory (Social Learning Theory) Bandura 1986	Reisine et al. 1994	184	Longitudinal (1 year follow-up)	Increment of carious surfaces	<ul style="list-style-type: none"> - Children with higher dmfs, higher S. mutans, and whose parents reported more frequent brushing had more decay in the second year. - None of the other behavioral, cognitive, or demographic factors was significant
Theory of planned behavior (TPB) Azjen 1988	Vanagas et al. * 2009 * similar to HBM and HLoC	397	Cross sectional	Understanding of importance of preventing tooth decay, importance of controlling (sugary) snacking and perceived seriousness of tooth decay Changes in self-perceived sugar consumption	<ul style="list-style-type: none"> - Parental attitudes were significantly associated with oral health behaviour they apply to their children
	Astrøm et al. 2004	372	Cross sectional	Sugar intake of their children reported by parents	<ul style="list-style-type: none"> - TPB is a valid theory to predict intended and self-perceived sugar consumption prospectively
	Astrøm et al. 2006	589	Cross sectional		<ul style="list-style-type: none"> - TPB provided a significant prediction of intention with attitude

Psychological Model	Author	Sample size	Study design	Outcome measure	Results
Theory of reasoned action (TRA) Fishbein 1975, Azjen & Fishbein 1980	Freeman et al 1997	187	Randomized controlled trial	Preferences of sugar consumption	- Immediate pleasurable taste of sugar outweighed and deferred the recognition of dangers associated with its consumption. - Past dental health experiences, behaviours and education together with the role of parental figures acted as important influences
Implementation intentions Gollwitzer 1993	No studies found for cariology				
Trans theoretical model (Stages of Change) Prochaska 1984	Amin et al 2007	26	Qualitative research	Receptiveness to advice and willingness to change undesired behaviour	- Readiness to change is an important predictor of whether parents adopted and maintained preventive behaviors to improve their child's oral health
	Tillis et al. 2003	521	Cross sectional	Regular interdental cleaning	- Stages of change was shown to be a valid and reliable method to analyze the pros and cons involved in behavioural change-decision-making
Theory of interpersonal behaviour Triandis 1977, Godin & Sheppard 1990	No studies found for cariology				
Problem behaviour theory Jessor 1984	No studies found for cariology				
Model of personal investment Tappe 1992	No studies found for cariology				

Statements †		Factor				
		1	2	3	4	5
1	A cavity in a deciduous (baby) tooth isn't all that serious	-4*	3**	-1	-3	0**
2	If you brush well, you won't develop cavities	2	-4*	-2	1	-2
3	When your child develops a cavity, it is something that a parent should be ashamed of	-1	-3	-4	-1	-1
4	Healthy teeth are worth the world	4	0**	4	4	4
5	I keep a close eye on my child's oral health	3	-2**	3	2	2
6	I'd rather not go to the dentist for myself	0	3**	-3**	0	0
7	Brushing well is hard to achieve	-2	-4**	0	3**	0
8	Going to the dentist once a year is enough for me	-1	2	1	-4**	0
9	A restored tooth is as strong as a sound tooth	0	1*	-1	-2	-3
10	When your child has caries, parents are to be held responsible	1	-1	-1	0	1
11	Children shouldn't spend their pocket money on sweets	0	-1	-1	0	2
12	My child is quite capable of brushing his/her own teeth; there's no need for me to interfere	-3	1	-2	-3	0
13	In my social environment everyone takes their children to the dentist regularly	2	0	1	1	1
14	I know enough about oral hygiene to maintain proper oral health	1	1	1	1	1
15	I take my child to the dentist only when he/she is in pain	-2	2**	-4	-4	-4
16	I welcome every effort the dental professional makes in teaching me oral hygiene	1	0	3	1	3
17	Taking good care of your teeth saves a lot of money in the future	0	-2	3	3	0
18	I think a dental appointment is a lot of fuss	-1	2**	-2	-1	-1
19	Brushing my child's teeth myself can help prevent cavities	4	-3**	2	2	4
20	It's not the parent's fault if the child develops a cavity	-2**	4**	0	-1	-1
21	Getting cavities is a matter of bad luck	-1	3**	-2	-1	-1
22	When you don't watch your diet, you're just asking for cavities to develop	2	-2	-3	-1	2
23	If I want to know something about things inside my mouth, I'll ask or look it up	0	-1	2	2	2
24	Some families just happen to have bad teeth	-1	4**	1	0	1
25	It's hard to keep up with brushing my child's teeth twice a day	-3	0	0	4**	-2
26	It doesn't matter what you eat or drink as long as you just brush well afterwards	1	-1	1	-2	-2
27	Having healthy teeth gives my child confidence	3	-3	4	0	1
28	A cavity in a permanent tooth isn't all that serious	-4	1**	-3	-2	-4
29	When you eat and drink, you should be aware of its effect on your teeth	1	0	0	1	3*

Statements †		Factor				
		1	2	3	4	5
30	It's clear to me what's good for my teeth and what's not	-1	-1	0	0	3**
31	Brushing my child's teeth takes a lot of effort	-3	0	-1	0	-2
32	I usually forget the advice my dentist gives me	-2	0	0	-2	-3
33	Brushing your teeth is something you learn from the dentist	0	-2	2*	-3	-1
34	I brush my child's teeth for fresh breath	2	1	1	-1	-3**
35	I hate it when my dentist tells me I'm not brushing well	1	2	0	1	1
36	Brushing well now saves a lot of trouble when you're older	0	-1	-1	3**	-1
37	I brush my child's teeth so he/she will have a nice smile	3	1	2	2	0

Notes:

(*) significant at < .05;

(**) significant at < .01.

† The statements were related to the dimensions of the Health Belief Model as follows: 1, 9, 26 and 28 represent "perceived severity"; 2, 5, 14, 22, 27 and 29 "self-efficacy"; 3, 10, 15, 20, 21 and 24 "perceived susceptibility"; 4, 16, 17, 19, 36 and 37 "perceived benefits"; 6, 7, 8, 18 and 35 "perceived barriers"; 11, 25, 31 and 32 "perceived threats"; and 12, 13, 23, 30, 33 "cues to action".

Factor 1 – Conscious and Responsible

Disagree most	-4	-3	-2	-1	0	+1	+2	+3	Agree most
A cavity in a deciduous (baby) tooth isn't all that serious	My child is quite capable of brushing his/her own teeth; there's no need for me to interfere	Brushing well is hard to achieve	When your child develops a cavity, it is something that a parent should be ashamed of	I'd rather not go to the dentist for myself	When your child has cavities, parents are to be held responsible	If you brush well, you won't develop cavities	I keep a close eye on my child's oral health	Healthy teeth are worth the world	
A cavity in a permanent tooth isn't all that serious	It's hard to keep up with brushing my child's teeth twice a day	I take my child to the dentist only when he/she is in pain	Going to the dentist once a year is enough for me	A restored tooth is as strong as a sound tooth	I know enough about oral hygiene to maintain proper oral health	In my social environment everyone takes their children to the dentist regularly	Having healthy teeth gives my child confidence	Brushing my child's teeth myself can help prevent cavities	
	Brushing my child's teeth takes a lot of effort	It's not the parent's fault if the child develops a cavity	I think a dental appointment is a lot of fuss	Children shouldn't spend their pocket money on sweets	I welcome every effort the dental professional makes in teaching me oral hygiene	When you don't watch your diet, you're just asking for cavities to develop	I brush my child's teeth so he/she will have a nice smile		
		I usually forget the advice my dentist gives me	Getting cavities is a matter of bad luck	Taking good care of your teeth saves a lot of money in the future	It doesn't matter what you eat or drink as long as you just brush well afterwards	I brush my child's teeth for fresh breath			
		Some families just happen to have bad teeth		If I want to know something about things inside my mouth, I'll ask or look it up	When you eat and drink, you should be aware of its effect on your teeth				
		It's clear to me what's good for my teeth and what's not		Brushing your teeth is something you learn from the dentist	I hate it when my dentist tells me I'm not brushing well				
				Brushing well now saves a lot of trouble when you're older					

Note: distinguishing statements (see Table 1) shown in bold.

Factor 2 – Trivialising and Fatalistic

Disagree most		Agree most						
-4	-3	-2	-1	0	+1	+2	+3	+4
Brushing well is hard to achieve	When your child develops a cavity, it is something that a parent should be ashamed of	Taking good care of your teeth saves a lot of money in the future	It's clear to me what's good for my teeth and what's not	It's hard to keep up with brushing my child's teeth twice a day	A cavity in a permanent tooth isn't all that serious	I take my child to the dentist only when he/she is in pain	A cavity in a deciduous (baby) tooth isn't all that serious	It's not the parent's fault if the child develops a cavity
If you brush well, you won't develop cavities	Having healthy teeth gives my child confidence	Brushing your teeth is something you learn from the dentist	Children shouldn't spend their pocket money on sweets	Brushing my child's teeth takes a lot of effort	My child is quite capable of brushing his/his own teeth; there's no need for me to interfere	Going to the dentist once a year is enough for me	Getting cavities is a matter of bad luck	Some families just happen to have bad teeth
Brushing my child's teeth myself can help prevent cavities	When you don't watch your diet, you're just asking for cavities to develop	When you don't keep a close eye on my child's oral health	If I want to know something about things inside my mouth, I'll ask or look it up	I usually forget the advice my dentist gives me	A restored tooth is as strong as a sound tooth	I think a dental appointment is a lot of fuss	I'd rather not go to the dentist for myself	
			Brushing well now saves a lot of trouble when you're older	I welcome every effort the dental professional makes in teaching me oral hygiene	I know enough about oral hygiene to maintain proper oral health	I hate it when my dentist tells me I'm not brushing well		
			When your child has caries, parents are to be held responsible	When you eat and drink, you should be aware of its effect on your teeth	I brush my child's teeth for fresh breath			
			It doesn't matter what you eat or drink as long as you just brush well afterwards	In my social environment everyone takes their children to the dentist regularly	Brush my child's teeth so he/she will have a nice smile			
			Healthy teeth are worth the world					

Note: distinguishing statements (see Table 1) shown in bold.

Factor 3 – Appearance Driven and Open Minded

Disagree
most

-4	-3	-2	-1	0	+1	+2	+3	+4	Agree most
When your child develops a cavity, it is something that a parent should be ashamed of	When you don't watch your diet, you're just asking for cavities to develop	If you brush well, you won't develop cavities	Children shouldn't spend their pocket money on sweets	Brushing well is hard to achieve	It doesn't matter what you eat or drink as long as you just brush well afterwards	Brushing my child's teeth myself can help prevent cavities	Taking good care of your teeth saves a lot of money in the future	Having healthy teeth gives my child confidence	
I take my child to the dentist only when he/she is in pain	A cavity in a permanent tooth isn't all that serious	My child is quite capable of brushing his/her own teeth; there's no need for me to interfere	Brushing well now saves a lot of trouble when you're older	It's clear to me what's good for my teeth and what's not	In my social environment everyone takes their children to the dentist regularly	Brushing your teeth is something you learn from the dentist	I keep a close eye on my child's oral health	Healthy teeth are worth the world	
	I'd rather not go to the dentist for myself	I think a dental appointment is a lot of fuss	When your child has caries, parents are to be held responsible	It's hard to keep up with brushing my child's teeth twice a day	I know enough about oral hygiene to maintain proper oral health	If I want to know something about things inside my mouth, I'll ask or look it up	I welcome every effort the dental professional makes in teaching me oral hygiene		
		Getting cavities is a matter of bad luck	Brushing my child's teeth takes a lot of effort	I usually forget the advice my dentist gives me	I brush my child's teeth for fresh breath	I brush my child's teeth so he/she will have a nice smile			
		A restored tooth is as strong as a sound tooth		When you eat and drink, you should be aware of its effect on your teeth	Going to the dentist once a year is enough for me				
		A cavity in a deciduous (baby) tooth isn't all that serious		I hate it when my dentist tells me I'm not brushing well	Some families just happen to have bad teeth				
				It's not the parent's fault if the child develops a cavity					

Note: distinguishing statements (see Table 1) shown in bold.

Factor 4 – Knowledgeable but Defensive

Disagree most

-4

I take my child to the dentist only when he/she is in pain

-3

My child is quite capable of brushing his/her own teeth; there's no need for me to interfere

-2

A cavity in a permanent tooth isn't all that serious

-1

When your child develops a cavity, it is something that a parent should be ashamed of

0

I'd rather not go to the dentist for myself

+1

If you brush well, you won't develop cavities

+2

Brushing my child's teeth myself can help prevent cavities

+3

Brushing well now saves a lot of trouble when you're older

Agree most

+4

It's hard to keep up with brushing my child's teeth twice a day

Going to the dentist once a year is enough for me

A cavity in a deciduous (baby) tooth isn't all that serious

A restored tooth is as strong as a sound tooth

When you don't watch your diet, you're just asking for cavities to develop

Children shouldn't spend their pocket money on sweets

When you eat and drink, you should be aware of its effect on your teeth

If I want to know something about things inside my mouth, I'll ask or look it up

Brushing well is hard to achieve

Healthy teeth are worth the world

Brushing your teeth is something you learn from the dentist

I usually forget the advice my dentist gives me

I think a dental appointment is a lot of fuss

When your child has caries, parents are to be held responsible

I hate it when my dentist tells me I'm not brushing well

I brush my child's teeth so he/she will have a nice smile in the future

It doesn't matter what you eat or drink as long as you just brush well afterwards

Getting cavities is a matter of bad luck

Brushing my child's teeth takes a lot of effort

In my social environment everyone takes their children to the dentist regularly

I keep a close eye on my child's oral health

It's not the parent's fault if the child develops a cavity

It's clear to me what's good for my teeth and what's not

I know enough about oral hygiene to maintain proper oral health

I brush my child's teeth for fresh breath

Some families just happen to have bad teeth

Welcome every effort the dental professional makes in teaching me oral hygiene

Having healthy teeth gives my child confidence

Note: distinguishing statements (see Table 1) shown in bold.

Factor 5 – Conscious and Concerned

Disagree most		Agree most	
-4	I take my child to the dentist only when he/she is in pain	+4	Brushing my child's teeth myself can help prevent cavities
-3	A restored tooth is as strong as a sound tooth	+3	It's clear to me what's good for my teeth and what's not
-2	It doesn't matter what you eat or drink as long as you just brush well afterwards	+2	When you don't watch your diet, you're just asking for cavities to develop
-1	Brushing your teeth is something you learn from the dentist	+1	When your child has cavities, parents are to be held responsible
0	Going to the dentist once a year is enough for me	0	My child is quite capable of brushing his/her own teeth; there's no need for me to interfere
1	When your child develops a cavity, it is something that a parent should be ashamed of	1	Some families just happen to have bad teeth
2	Brushing my child's teeth takes a lot of effort	2	Children shouldn't spend their pocket money on sweets
3	If you brush well, you won't develop cavities	3	When you eat and drink, you should be aware of your effect on your teeth
4	I brush my child's teeth for fresh breath	4	I welcome every effort the dental professional makes in teaching me oral hygiene
	It's hard to keep up with brushing my child's teeth twice a day		If I want to know something about things inside my mouth, I'll ask or look it up
	Getting cavities is a matter of bad luck		I keep a close eye on my child's oral health
	It's not the parent's fault if the child develops a cavity		I hate it when my dentist tells me I'm not brushing well
	Brushing well now saves a lot of trouble when you're older		In my social environment everyone takes their children to the dentist regularly
	Taking good care of your teeth saves a lot of money in the future		I know enough about oral hygiene to maintain proper oral health
			I'd rather not go to the dentist for myself
			I brush my child's teeth so he/she will have a nice smile
			Brushing well is hard to achieve
			Having healthy teeth gives my child confidence
			A cavity in a deciduous (baby) tooth isn't all that serious
			I think a dental appointment is a lot of fuss
			I keep a close eye on my child's oral health

Note: distinguishing statements (see Table 1) shown in bold.

Chapter

7

**Parental attitudes towards
oral health and caries-risk
in their children**



Parental attitudes towards oral health and caries-risk in their children

Introduction

Life style interventions gain effectiveness when they are tailored for patients holding specific attitudes (Schwarzer et al., 2010). This probably also holds for caries preventive measures, but identifying attitudes on an individual patient level may be difficult or too time-consuming in daily dental practice. Attitudes are, by definition, subjective and difficult to catch using survey questionnaires (Cross, 2005). The importance of attitudes of parents towards oral health related behaviour of their child is well established (Daly et al, 2010; Wigen & Wang, 2010). In chapter 6 attitudes towards oral health among parents of 6-year-old children at risk of developing caries were explored using Q-methodology (Watts & Stenner, 2012), and identified five prevailing attitudes: conscious and responsible, i.e. parents who are aware of the need to care and willing to take responsibility; *trivializing and fatalistic*, i.e. parents who are convinced that dental disease is a genetic matter and not a major problem; *appearance-driven and open-minded*, i.e. parents who are convinced that having good-looking teeth is important and follow dental professional's advice to achieve this; *knowledgeable but defensive*, i.e. parents who are aware of why and how to apply healthy dental behaviour but report to be too busy to spout it into practice; *conscious and concerned*, i.e. parents who are afraid that all their efforts in maintaining a proper oral hygiene in the end will be futile (Vermaire et al., 2010).

Studies like the one performed in chapter 6 may give relevant information for daily dental practice, but conducting intensive interviews with each and every parent or patient is not likely to be considered feasible. When similar information could be collected with less time effort, it can be used in dental counsel-sessions or in planning caries prevention strategies. The aim of this study is to investigate whether, as an alternative, parents can be matched with aforementioned attitudes towards oral health by means of a short questionnaire. As an aside, this study gives insight in the distribution of these attitudes among a large sample of parents. Furthermore, this study aims to explore how the five attitudes associate with diet and oral hygiene habits and with clinical outcomes in children.

The parents of 179 9-year-old children (± 3 months) participating in a randomized controlled trial (RCT) on caries-preventive strategies (Chapter 2) were included in this study. As part of the 3-year follow-up measurement of the trial, data on oral hygiene habits, dietary habits, socioeconomic status, dental knowledge, perceived dental hygiene burden and willingness to invest in oral hygiene were collected, together with clinical data on caries experience and oral hygiene of the child. A more extensive description of how these data were collected is reported in Chapter 5.

Attitude measurement

A vignette sheet was developed based on the results of the Q-methodological study of chapter 6 (Figure 1). As described by Baker et al. (2010), abbreviated descriptions of the five attitudes were composed using the characterizing and distinguishing statements of each attitude. The readability of the abbreviated descriptions of the attitudes was assessed using a T-Scan interface (Kraf & Pander Maat, 2009). Each attitude description was tested on mean number of characters per word, the mean length of the words used, proportion of frequent words (i.e., how many words in the text are among the 9,600 most used words in the Dutch language), D-level of the text (i.e., scale of difficulty of the grammar used), mean distance between subject and verb, mean distance between object and verb, Lemma type-token ratio (i.e., a measure of word diversity), mean number of adjectives, mean number of nouns and the density of personal references. The T-scan showed no substantial differences in readability between the five descriptions. The description of attitude 5 was slightly more difficult to read, possibly making it less appealing to the reader, and the description of attitude 2 had a relatively higher density of personal references, potentially making it more appealing to the reader. Because the differences in readability were minor and no straightforward alternatives for improvement could be identified, no changes were made to the original descriptions. No considerable impact of readability is expected on matching parents with the attitudes.

As final question in a larger questionnaire, parents were instructed to read the vignette sheet containing the five abbreviated descriptions of oral health attitudes (Figure 1). Next, they were asked to indicate for each description how well it matched their attitude towards oral health, using a five-point rating scale with answer categories “not at all” (1), “not” (2), “neutral” (3), “a little” (4), or “very much” (5). These scores for each attitude are the main outcome measure in this study. Next, parents were asked to

indicate which one of the descriptions matched their attitude best. The answer to this question was used as a control question as well as to match parents to a single attitude in the event equal highest scores were given on more than one attitude and these needed to be untied. Finally, parents were asked which description did not match their attitude at all, again as a control question (see Figure 1).

Clinical measurements

Oral hygiene of the children was measured using the simplified oral hygiene index (OHI-s) (Greene & Vermillion, 1968). Caries was scored using dmfs/DMFS at the dentine threshold (d3/D3) (WHO, 1979).

Analysis

The match of parents with the five attitudes towards oral health behaviour was explored using descriptive statistics. To be able to give an indication of the distribution of attitudes among participating parents, they were matched to a single attitude using the following simple procedure: if a parent gave a maximum score of 4 or 5 to a single attitude, this attitude was selected as the best matching attitude. If a parent's maximum score of 4 or 5 tied between two or more attitude descriptions, the parent was matched to one of these tied attitudes based on the follow-up question in which they were asked to indicate which single description matched their attitude best. In all other cases, a parent was not matched to a specific attitude.

Bivariate associations between the 1 to 5 scores on the attitude questions and categorical variables (e.g., background characteristics, dietary and oral hygiene habits) were investigated using Chi-square test and with continuous variables (e.g., willingness to invest, clinical outcomes) using ANOVA. Multivariate associations were investigated using binary logistic regressions, with the scores on each attitude question dichotomized into 0 (for scores 1, 2 and 3) and 1 (for scores 4 and 5) as dependent variable. Given the size of the sample and the variety of potential explanatory variables in the data-set, these were tested using a forward conditional procedure (entry criterion $p < .10$; removal criterion $p < .15$). Analyses were conducted in SPSS version 19. The study was approved by the Medical Ethical Committee of the VU University Amsterdam, the Netherlands. Protocol number NL 13709.029.06.

Results

A total of 179 survey questionnaires were returned, of which 9 were excluded because the attitude questions were not answered completely or not at all. Therefore, 170 (95.0%) respondents remained for analysis. Most respondents ($n = 137$; 80.6%) were mothers accompanying their child to the dental clinic, 28 (16.5%) were fathers and 5 (2.9%) were other family members. Respondents were fairly equally distributed across low ($n = 50$; 29.4%), middle ($n = 62$; 36.5%) and high ($n = 58$; 34.1%) SES-categories. The large majority was of Dutch origin ($n = 141$; 82.9%), the remainder of immigrant origin ($n = 29$; 17.1%).

Figure 2 presents the response patterns to the attitude questions ($n = 170$), which shows that all possible scores were used for all attitudes. All respondents matched well (score 4) to very well (score 5) with at least one of the five attitudes. The maximum score on any attitude was 4 for 64 respondents (37.6%) and 5 for the remaining 106 respondents (62.4%). Eight respondents gave all five attitudes the same score (i.e., six respondents gave all a score 4 and two gave all a score 5). Table 1 shows that mean scores (and sd) were fairly similar for attitudes 1, 3, 4 and 5, and lower for attitude 2 (but sd higher). Correlations between attitude scores were low, indicating the attitudes are distinct. Higher SES was positively associated with attitude 1 ($p < .01$) and negatively with attitude 2 ($p < .001$); no significant associations were found with origin. Using the follow-up question for untying equal highest scores, 159 of the 170 respondents (93.5%) could be matched to a single best matching profile. Attitude 1 matched best for 9% of the sample, attitude 2 for 8%, attitude 3 for 31%, attitude 4 for 43% and attitude 5 for 9% of the sample (Figure 3).

Correlations with non-clinical outcomes are presented in Table 2. Parents scoring higher on attitude 1 ('Conscious and concerned') more often served all main courses on a daily basis, had a higher score on dental knowledge and a lower score on dental burden. Parents scoring higher on attitude 2 ('Trivializing and fatalistic') more often skipped breakfast and lunch on a regular basis, and thus did not serve all main courses on a daily basis, were less willing to invest money or time in the oral hygiene of their child, valued the general health of their child lower, had a lower score on dental knowledge and a higher score on dental burden. Parents with a higher score on attitude 3 ('Appearance-driven and open minded') more often served breakfast and lunch on a daily basis, and thus all main courses as well, were more willing to invest money in the oral hygiene of their child, and valued the general and oral health of their child higher.

Parents with a higher score on attitude 4 ('Knowledgeable but defensive') were less willing to visit the dentist and also had a higher score on dental burden. Parents scoring higher on attitude 5 ('Conscious and concerned') more often served breakfast and lunch, and thus all main courses, on a regular basis.

Table 3 presents correlations between the five profiles and clinical outcomes. Children of parents scoring higher on attitude 1 had lower ms and dmfs scores, those of parents scoring higher on attitude 2 had higher OHI-s and dmfs scores, and those of parents scoring higher on attitude 4 had a higher OHI-s score.

Multivariate analysis showed that matching best to attitude 1 (i.e., a score of 4 or 5 on profile 'Conscious and concerned') was associated with higher SES ($p = .06$), higher dental knowledge ($p = .05$), and valued the oral health of their child higher ($p = .05$). Matching best to attitude 2 was associated with lower SES ($p = .00$), serving breakfast less frequently ($p = .05$), the parent eating between meals snacks more often ($p = .10$) and valuing general health lower ($p = .06$). Matching best to attitude 3 was associated with eating lunch more regularly ($p = .008$), a lower number of between meal snacking by the parent ($p = .06$) and a higher value given to oral health ($p = .02$). Matching best to attitude 4 was associated with a lower SES ($p = .08$), a higher perceived dental hygiene burden ($p = .01$) and a higher dental knowledge ($p = .02$). Matching best to attitude 5 was associated with a lower SES ($p = .005$) and eating breakfast more frequently ($p = .002$). The overall percentages correct classification of the binary logistic regressions varied between (65.2 and 89.0).

Discussion

The aim of this study was to investigate whether parents can be matched with five main attitudes towards oral health found in a former study by means of a short questionnaire, making the use of such information in dental counsel-sessions or in planning caries prevention strategies more feasible. The results appear to be favourable. We found that respondents identified well to very well with at least one of the attitudes, and seemed to be able to differentiate well the extent to which they matched to the different attitudes. In addition, this study explored how the five parental attitudes associate with diet and oral hygiene habits and with clinical outcomes in their children. Various statistically significant associations were observed, and although most coefficients were small to moderate, the direction (i.e., sign) of the correlations was intuitively as expected. Finally, this study gave some insight in the

distribution of these attitudes among parents and showed that this varied between 8 and 43%, and that attitudes 3 and 4 represented almost 75% of the population in this study.

Before discussing the results, some potential limitations of this study should be addressed. First of all, this study was innovative in linking results of a Q-methodological study to those of a clinical study. The development, use and analysis of abbreviated descriptions of attitudes found using Q-methodology is still in an exploratory stage. Feasibility, reliability and validity of such an approach still need to be established. Our results appear encouraging, but further research and replication of this study is required. Furthermore, the Q-study that laid the foundation for this study was conducted in the Netherlands, and the abbreviated descriptions used in the questionnaire analysed here were aimed at the Dutch public. Replication of this study in other countries may therefore require replication of the Q-methodological study as well. Finally, the sample used in this study is selective and the order in which the attitude questions were presented to respondents was not randomized. Therefore, some precaution is warranted in the interpretation and generalization of the findings regarding the associations of attitudes with other characteristics of the sample, and the distribution of the attitudes in a wider population.

Despite these limitations, the results also showed some keystones for further research towards a more tailored caries preventive care. Differences in attitudes towards oral health related behaviour may result in necessary different approaches in caries prevention. In that context, it is noteworthy to stress out that – next to differences in associations between attitudes and clinical and non-clinical variables – some similarities were found as well. This implies that not every attitude may require its own strategy but several aspects of different attitudes may be applicable to one single parent. For example: concerning brushing habits, a large proportion of parents in both profiles 2 and 4 indicated that the child is held mainly responsible for their daily oral hygiene. Children of parents with profile 2 and profile 4 had also higher plaque scores than children of other parents. Results of the original Q-methodological study (chapter 6), provide more comprehensive information on the profiles.

Results from that study show that parents of Profile 2 are convinced that their child of 6 years old is quite capable of doing so itself, while the parents holding profile 4 know that they should brush their child themselves but they don't like the nuisance of arguing about it with their child. Therefore, although both clinical and non-clinical

outcomes are the same in different groups, the targeted intervention may be different. For example it may be suggested – in this specific situation – to emphasize on knowledge in the case a parent scores high on Profile 2 and on counselling to find a feasible moment in the daily routine for parents scoring high on Profile 4.

Parents scoring high on profile 2 can be considered to have the least desirable lifestyle pattern: eating less regular meals on a daily basis than the other groups, eating more than 5 between-meal snacks a day, being less willing to invest in the oral health of their child (in terms of money and brushing time) and having the lowest scores on dental knowledge. This may cause their children to run a higher risk to develop dental diseases.

Parents with profiles 2 and 4 may be less willing to invest in the oral health of their children, for various reasons. In that case, motivating these parents may be necessary to prevent dental decay in their children. If that fails, these children may benefit more from professionally applied caries preventive actions since their parents may be expected to be less involved in active participation in the oral care of their child.

It can be concluded that by using a self-assessed attitude tool, derived from the results of a Q-methodological study, it is possible to identify different groups of parents with different oral health-related risk factors. Of course it is hardly likely that people are 100% only 1 type of parent; parents can be considered to be a mix of different typologies. However, information on the composition of that mix may be helpful for the dental professional to estimate risks and to deliver a more tailored prevention strategy in children. The identification of parental attitudes using this self-reported questionnaire has the potential to provide this extra information. Whether attitude-dependent-applied caries prevention will show different success-rates is the next step in this development.

Table 1: Mean score and bivariate correlations between attitudes

	Score Mean (S.D.)	Conscious and Responsible (attitude 1)	Trivializing and Fatalistic (attitude 2)	Appearance- Driven and Open-Minded (attitude 3)	Knowledgeable but Defensive (attitude 4)	Conscious and Concerned (attitude 5)
Conscious and Responsible	3.7 (0.87)	1.00	-0.25**	0.21**	0.01	-0.05
Trivializing and Fatalistic	2.8 (1.20)		1.00	-0.24**	0.11	0.06
Appearance-Driven and Open-Minded	4.3 (0.80)			1.00	0.25**	0.19*
Knowledgeable but Defensive	4.1 (0.83)				1.00	0.32**
Conscious and Concerned	3.8 (0.79)					1.00

Note:

*** $p < 0.01$;* $p < 0.05$.

Table 2: Bivariate correlations between attitudes and non-clinical outcomes

	Statistic % or Mean (sd)	Conscious and Responsible (attitude 1)	Trivializing and Fatalistic (attitude 2)	Appearance-Driven and Open-Minded (attitude 3)	Knowledgeable but Defensive (attitude 4)	Conscious and Concerned (attitude 5)
Dietary habits (n = 156)						
Breakfast (% yes daily)	91.7	n.s.	-0.33**	0.18*	n.s.	0.24**
Lunch (% yes daily)	94.9	n.s.	-0.24**	0.29**	n.s.	0.19*
Dinner (% yes daily)	98.7	n.s.	n.s.	n.s.	n.s.	n.s.
All main courses (% yes daily)	90.4	0.16*	-0.34**	0.21**	n.s.	0.24**
Between meal snacking (% ≥5 / day)	17.3	n.s.	n.s.	n.s.	n.s.	n.s.
Oral hygiene habits (n = 156)						
Child brushes 2x / day (% yes)	43.6	n.s.	n.s.	n.s.	n.s.	n.s.
Parent brushes child 2x / day (% yes)	33.3	n.s.	n.s.	n.s.	n.s.	n.s.
Willingness to invest (n = 155)						
Money (€ / month)	31.6 (30.7)	n.s.	-0.22**	0.15*	n.s.	n.s.
Time (minutes brushing / day)	6.5 (4.2)	n.s.	-0.16*	n.s.	n.s.	n.s.
Time (visits to dentist / year)	3.5 (1.7)	n.s.	n.s.	n.s.	-0.23**	n.s.
Valuation general health (VAS 0-10)	9.6 (0.8)	n.s.	-0.15*	0.19**	n.s.	n.s.
Valuation oral health (VAS 0-10)	9.5 (1.0)	n.s.	n.s.	0.16*	n.s.	n.s.
Dental knowledge score (scores 0-10)	7.3 (1.8)	0.27**	-0.19**	n.s.	n.s.	n.s.
Dental burden score (scores 0-10)	3.0 (1.8)	-0.20**	0.14*	n.s.	0.16*	n.s.

Note:

*** p < 0.01;

* p < 0.05.

Table 3: Bivariate correlations between attitudes and clinical outcomes in children (n = 170)

	Statistic % or Mean (S.D.)	Conscious and Responsible (attitude 1)	Trivializing and Fatalistic (attitude 2)	Appearance-Driven and Open-Minded (attitude 3)	Knowledgeable but Defensive (attitude 4)	Conscious and Concerned (attitude 5)
OHI-s	0.83 (0.63)	n.s.	0.27**	n.s.	0.14*	n.s.
ds	1.45 (3.46)	n.s.	n.s.	n.s.	n.s.	n.s.
ms	1.57 (3.75)	-0.13*	n.s.	n.s.	n.s.	n.s.
fs	2.62 (3.92)	n.s.	n.s.	n.s.	n.s.	n.s.
dmfs	5.65 (8.16)	-0.18**	0.13*	n.s.	n.s.	n.s.

Note:

** $p < 0.01$;

* $p < 0.05$.

OHI-s: simplified oral hygiene index: minimum score 0 (no plaque) maximum score: 3 (plaque on upper third of tooth),

ds: decayed surfaces primary dentition,

ms: missing surfaces because of caries in primary dentition,

fs: filled carious surfaces in primary dentition,

dmfs/DMFS total decayed, missing and filled surfaces because of caries in primary/permanent dentition.

Figure 1: Attitudes question (translated from Dutch into English)

Instruction: Please read carefully the descriptions below and indicate by ticking the appropriate box how well each one matches your attitude towards oral hygiene.

I think it is a shame if my child would develop a cavity in his/her teeth. I consider a healthy mouth to be very important. To reach this goal a parent should watch carefully what his/her child eats and brushes their teeth very carefully. When your child develops a cavity, the parent is the one the most responsible for.

not at all not a little well very well

My child is quite capable to brush its teeth itself. The problem with cavities is that –as a parent- you are not able to do anything about it. Certainly when you mother, father, or grandparents have “weak teeth” as well. You can brush teeth like no other, but cavities are inevitable. Once a cavity is there, I believe the dentist is quite capable to restore it perfectly.

not at all not a little well very well

A healthy mouth is very important for me: it is the first thing other people will look at and a fresh, healthy looking mouth gives my child a lot of self-confidence. If you take good care of your teeth now, it can save you from a lot of trouble in the future. I’m eager to learn from the dental professional how to take the best care of my teeth as possible.

not at all not a little well very well

I consider healthy teeth to be of great importance so I do my best to keep it that way and I think I know what I should do. I do encounter some difficulties, though. I have a busy life and sometimes other things go first and I don’t like arguing with my child over tooth brushing. Therefore it is very important for my children to see the dentist regularly for checkups and treatment.

not at all not a little well very well

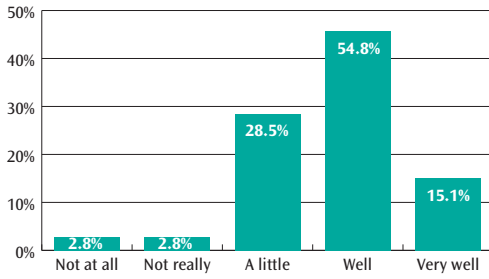
I know what to do to preserve my child’s dental health: I brush twice a day and watch what my child’s diet very closely. Still I’m afraid that it is possible that in some families you just cannot fully prevent caries. Of course it is worse to have a cavity in a permanent tooth than in a primary one.

not at all not a little well very well

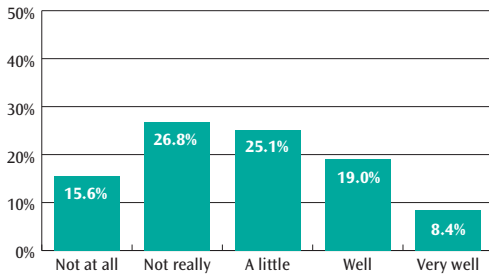
<p>Which of these descriptions matches your attitude best?</p> <p>not at all not a little well very well</p> <p><input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/></p> <p><input type="checkbox"/> No description matches best</p>	<p>Which of these descriptions does not match your attitude at all?</p> <p>not at all not a little well very well</p> <p><input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/></p> <p><input type="checkbox"/> No description does not match at all</p>
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Figure 2: Responses to attitudes questions

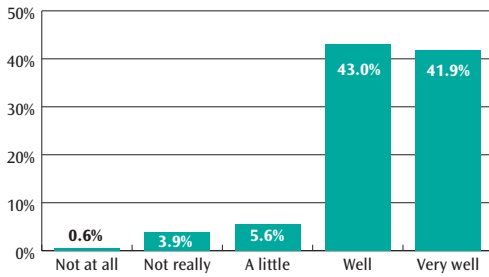
Conscious and Responsible



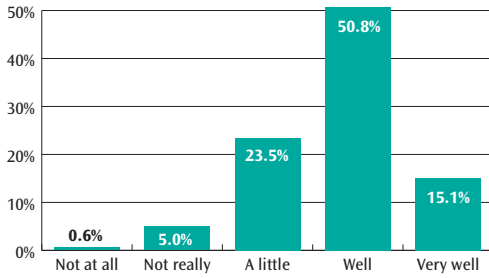
Trivializing and Fatalistic



Appearance-Driven and Open-Minded



Knowledgeable but Defensive



Conscious and Concerned

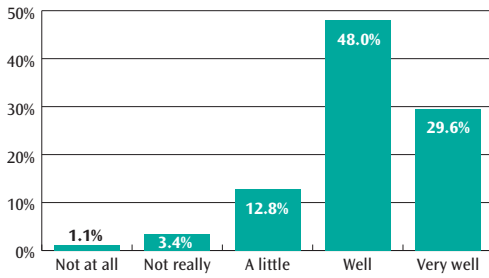
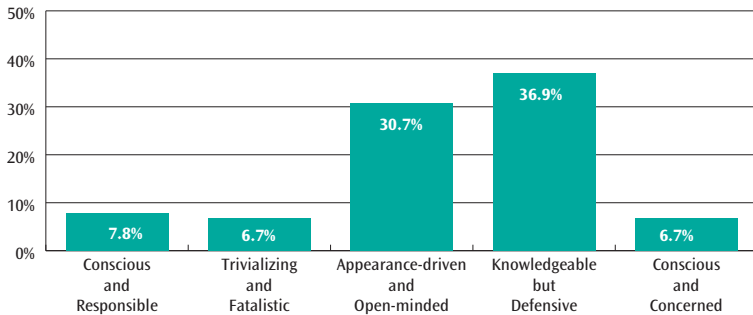


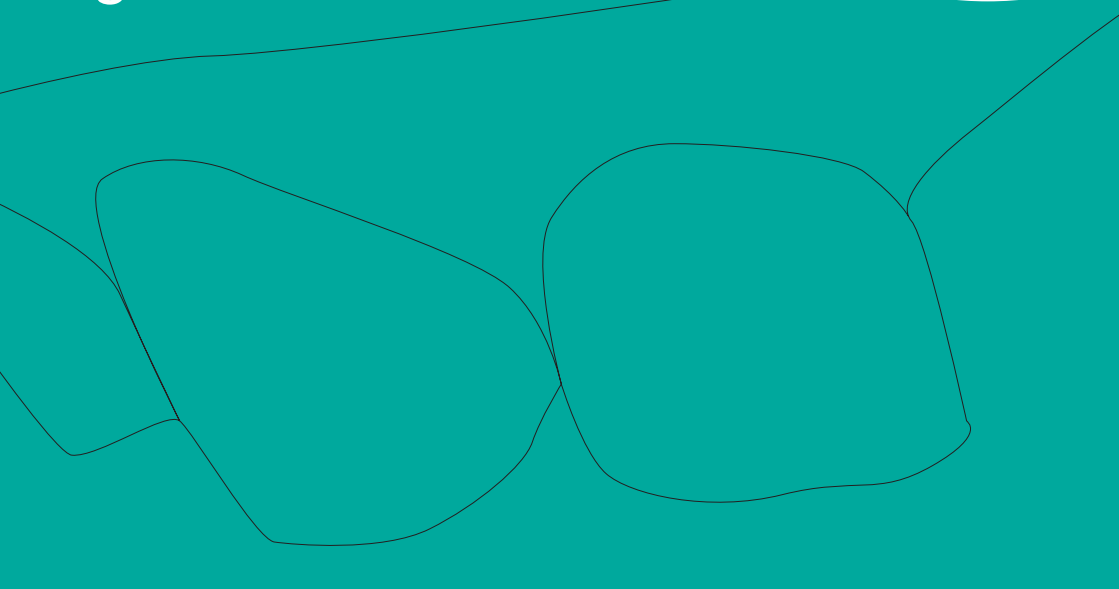
Figure 3: Distribution of attitudes based on single best matching attitude



Chapter

8

**Summary and
general discussion**



Summary and general discussion

This chapter first provides a summary of the findings of this thesis. Then, these findings are discussed. The chapter ends with recommendations in light of the findings of this thesis.

Summary

This thesis had three main aims. First to describe a randomized controlled clinical trial (RCT) on caries prevention strategies in 6- to 9-year-old children; this trial compared the clinical performance of two different caries-prevention strategies to that of a regular/standard approach; second to perform an economic evaluation of these strategies to determine their 'value for money' and third to explore parents' willingness to invest in the oral health of their child, the parents' prevailing attitudes towards prevention, and the relation between the attitudes and the reported behaviour to ensure oral health for their children.

Chapter 2 of this thesis described the RCT. A total of 179 6-year-old children were randomly assigned to one of two experimental groups or the control group. The control group received routine bi-annual check-up appointments additionally comprising professionally applied fluoride gel treatments and resin-based sealants in the occlusal surfaces of the first permanent molars upon eruption. One experimental group followed an Intensified Professional Fluoride Application (IPFA) program, which consisted of the regime of the control group plus two additional visits for professional fluoride treatment; thus, the children in the IPFA group received a total of four fluoride applications per year. The other experimental group followed a Non-Operative Caries Treatment and Prevention program (NOCTP) that was copied from an earlier study in Nexø, Denmark (Ekstrand & Christiansen, 2005). This strategy comprised an individually assessed recall interval for check-up appointments, based on risk factors including the cooperation of the parent, caries experience / development, the eruption stage of the first permanent molar, and caries experience / development and progression specifically in the occlusal surface of the first permanent molars. Besides this individually assessed recall interval, professional fluoride applications and placements of pit and fissure sealants were provided strictly on individual indication. The main outcome measure was the caries increment in permanent dentition. After three years of the trial, the caries increment in the control group, the IPFA group, and the NOCTP group were 0.47 (\pm

1.04), 0.34 (\pm 0.87) and 0.15 (\pm 0.50) DMFS, respectively. Based on the results of this study, it was concluded that following a NOCTP regime in this population resulted in three times less caries development than in the control condition.

Chapter 3 dealt with the effect of non-participation on the external validity of the outcomes of the randomized clinical trial described in chapter 2. Although many RCTs encounter the phenomenon of non-participation, studies reporting clinical and non-clinical parameters of participants and non-participants of trials are scarce. In the available studies, non-participants often showed less favorable outcomes than participants on both socioeconomic parameters as well as on caries experience. In this study, as part of baseline data collection, all children eligible to participate in the RCT, 346 parents of children of 6.0 years (\pm 3 months) of age were approached to let their child participate. Sixty parents refused, but 56 of them were willing to fill out the same set of questionnaires and allowed their child to be clinically examined once. The results showed that parents from participating children had higher socioeconomic status, were more often of autochthonous origin and scored better on knowledge questions than parents of non-participating children. Furthermore, parents of participating children reported a higher willingness to invest, both parents and children were more likely to have regular meals on a daily basis and their child had lower levels of plaque. Surprisingly, the participating children had higher dmfs scores than the non-participating children. Non-participating children had however a higher number of untreated carious lesions into dentin and therefore their care index (fs/ds + fs) was lower than that of participating children. Based on the findings of this study, the often-declared presumption that non-participating children will show less favorable clinical outcomes cannot be supported. Thus the external validity of a randomized controlled trial on caries-prevention strategies is not necessarily negatively affected by non-participation bias.

Chapter 4 described the results of an economic evaluation of the two experimental caries prevention strategies compared with the regular care strategy (control group). Information on resource use (like treatment time, travel time and distance and mode of transport) during the 3-year period of the trial was collected and documented by the dental nurses at every patient visit. Caries increment scores (at the D3MFS-level; caries into dentin) were used to assess effectiveness of the caries prevention programs. Cost calculations were performed using bottom-up micro costing; including all cost components that are believed to have a significant impact on the total costs. Incremental cost-effectiveness ratios (ICERs) were expressed as additional costs per prevented DMFS.

The ICERs compared with regular dental care from a health care perspective and societal perspective were € 733 and € 977 per prevented DMFS in the IPFA programme, and € 108 and € 111 in the NOCTP programme. The costs for the NOCTP group were highest in the first year of the study. Costs of the programme decreased in the second year of the study and equalled the costs of the control group in the third year. Given the findings of this study, the NOCTP programme may be considered preferred in the prevention of caries from both a medical and an economic point of view.

In Chapter 5, the willingness of the parents to invest in the oral health of their child was investigated. This willingness to invest was assessed in terms of money and time, and this was related to oral-health-related knowledge and reported behaviour of the parents. 290 parents of the 6-year-old children initially participating in this RCT on caries prevention strategies in the Netherlands were asked to provide information on education, oral health habits, dietary habits, knowledge on dental topics, willingness to pay in time and money and stated resistance to invest in preventive actions for the oral health of their children. Despite the fact that overall, parents highly valued their child's oral health, almost 12% of the parents were unwilling to spend any money or invest any time in brushing their child's teeth to maintain good oral health for their child. Additionally, these parents indicated that they were unwilling to visit the dentist for preventive measures more than once a year. Hence, the children of these parents may be considered at higher risk of developing oral diseases because worse oral hygiene habits and dietary habits were also found in this group. These results suggest that it may be necessary to differentiate caries-prevention programs to target parents in the most effective way, or even target these programs directly at the involved children (e.g., via school).

Chapter 6 described an effort to identify prevailing attitudes of parents regarding the oral health of their children. Parental attitudes are likely to play a role in achieving and maintaining a desired level of oral health in children. Q-methodology was used for this purpose. This method has been proven to be successful in identifying attitudes in a wide range of disciplines but in dentistry these Q-studies are scarce. In this study, 39 parents ranked 37 statements regarding dental health behaviour that parents may apply to their children. The parents later explained their rankings in a short interview. In Q-methodology, rather than reporting one average composed attitude and opinion, various (combinations of) opinions and attitudes are identified using by-person factor analysis of the ranking of the statements. Based on parents' beliefs, attitudes and cognitions, five profiles were identified: (1) conscious and responsible, (2) trivializing

and fatalistic, (3) appearance-driven and open-minded, (4) knowledgeable but defensive and (5) conscious and concerned. Q-methodology appeared to be a useful way to structure the complexity of parents' opinions and attitudes towards their children's dental health. Q-methodology also appeared to provide comprehensive clusters of individual attitudes, based on various levels of responses to a wide range of questions. The five identified profiles may be useful in developing tailor-made prevention strategies in caries prevention.

The first steps in that direction were made in Chapter 7. On the basis of the results of the study reported in chapter 6, five vignettes with textual descriptions of the profiles, described in that chapter, were made, using distinguishing and identifying statements. Parents were asked to indicate the extent to which they felt the vignettes applied to them. These results were compared with data on oral hygiene, preventive and dietary behaviour, willingness to invest and caries activity. Univariate and multivariate regression analyses revealed that SES, dietary behaviour, dental knowledge and the perceived importance of oral health and general health remained associated with different profiles. Parents belonging to profile 2 (Trivializing and fatalistic) were more likely than the other parents to indicate less desirable (oral health) behavior: i.e. eating less regular meals on a daily basis, being less prepared to invest in their child's oral health, valuing less their oral health and general health, scoring lower on dental knowledge and perceiving preventive measures as more burdensome than other parents. Moreover, differentiation in clinical outcomes was shown as well; children of parents with profiles 2 and 4 appeared to have less favourable outcomes in levels of oral hygiene and dmfs/DMFS. Beyond the vignette-tool's usefulness as an additional risk-assessment tool, it may also provide information that is useful in planning more targeted caries-prevention strategies. It may also be used in counseling sessions (e.g., using motivational interviewing) to, tailor-made, emphasize important issues for parents belonging to specific behavioural groups.

General discussion

Before addressing the implications of the findings of this thesis, some limitations of this study will be discussed.

Although the calculated, necessary number of 181 participants was almost reached, 179 participants may be considered a relatively small research sample. As in any clinical study, many factors influenced the successful inclusion and continuation of respondents

in this study; e.g., parents as well as their children should be willing to invest additional time in the programs, etc. The anticipated dropout percentage of 20% was slightly exceeded (22%). The highest dropout rates were found in the NOCTP group (31%). This may result in a selection bias because of the possibility that more children with less involved parents dropped out of the NOCTP programme.

The duration of the trial is another issue that needs noting. It was assumed beforehand that a 3-year follow up period would be sufficiently long to identify possible differences concerning the development of carious lesions. However, the longer the period during which results can be evaluated, the more evidence regarding long-term costs and effects can be gathered. On the one hand, the caries preventive effect of the NOCTP strategy may turn out to be even larger in the longer run, if the positive effects endure over time while the intensity of the programme decreases. On the other hand, the effectiveness may also diminish over time, for instance, if following a restrictive indication policy only would appear to have resulted in a postponement of dental problems, rather than avoiding them completely. However, no examples for these situations have been encountered during the length of this trial. A longer-term follow-up measurement is currently performed, but the results of that study are not available yet and fall outside the scope of this thesis.

The fact that the whole experiment took place in one single large dental clinic may reduce external validity. The city of 's-Hertogenbosch was chosen because it is demographically representative of the Netherlands (Schuller et al., 2009). What the effectiveness of the studied strategies will be in, for instance, more privileged or deprived parts of the country (with different socio economic status) but also on the basis of attitudes or travel distance (e.g., more in rural areas) cannot be concluded from the current study. More research on this matter is required and encouraged.

Despite these limitations, the results of this study have some important implications for dental care in the Netherlands. In order to address these, results of the separate studies in this thesis will be merged and discussed in a clinical perspective, a health economics perspective, a patient's perspective and a dental professional's perspective.

Chapters 2 and 4 investigated respectively effectiveness and cost-effectiveness of two different caries-prevention strategies compared to regular care. In the IPFA strategy, professional preventive interventions were intensified, while in the NOCTP strategy the efforts in improving parental homecare were strengthened. When a treatment strategy

gains more health benefits at lower costs, that strategy is considered to 'dominate' the alternative. In chapter 4 it was found that in the current RCT, IPFA was dominated by NOCTP. Therefore, the discussion will be further focussed on the NOCTP strategy.

Let us assume that the NOCTP programme was to be implemented nationwide. Given our findings and using caries prevalence numbers, the number of extra-prevented carious lesions in The Netherlands could be calculated. Unfortunately, no exact data on caries prevalence in the permanent dentition of 9-year-olds in the Netherlands is available. However, we do know that in 2005 the caries prevalence of 11-year-old children in the Netherlands was 1.7 (\pm 2.8) (Poorterman & Schuller, 2006). With approximately 204,000 11-year-old children living in the Netherlands (website Statistics Netherlands, 2013), 346,800 decayed, missing or filled surfaces because of caries in permanent dentition could be expected. If all of these children were to follow the NOCTP regime for three years and the same extra caries reduction would be achieved as found in our RCT, approximately 110,000 extra carious surfaces would be prevented in this age group after a three-year program. As described in Chapter 4, following this NOCTP regime does not only yield better oral health outcomes, but also entails additional costs. Using an economic evaluation, it was assessed that the incremental cost effectiveness ratios (ICERs) for the NOCTP program relative to standard care would be € 108 per prevented DMFS for the three year program from a health care perspective and € 111 per prevented DMFS for the three year program from a societal perspective. Whether this can be considered value for money depends on the societal value placed on preventing caries. If this is more than € 111 per prevented DMFS, than implementing NOCTP is welfare improving.

One should be aware of the fact that the calculated ICERs in Chapter 4 only pertain to the observed three-year period. To establish long-term cost-effectiveness, longer follow-up periods can be used (as currently done), but commonly decision analytic modelling is applied to cover very long time horizons (e.g., 30 year or life time). In such modelling exercises, assumptions have to be made on aspects like long term effectiveness of the NOCTP program, transition probabilities (e.g., the possibility that a carious lesion will progress or not progress, that a tooth will be restored, that a restoration will be replaced, that an endodontic treatment will be performed, or that the tooth will be extracted, etc.) and the costs in every stage of dental decay. Doing so can result in a more favourable or less favourable outcomes than reported here. In the United States, lifetime costs for having a carious tooth have been estimated at \$1811 (Anderson, 2001). In the current composition and execution of the NOCTP approach

€ 111 (societal perspective) for a prevented carious surface seems reasonably cost effective but further research, applying decision analytic modelling for caries prevention, is highly encouraged.

In the original Nexø study (Ekstrand & Christiansen, 2005), as well as in another non-invasive caries control study (Hausen et al., 2007), dental auxiliaries were actively involved in running the program. In the Netherlands, the process of task delegation and task reallocation in dentistry can be regarded as quite advanced. Dental hygienists and dental prevention nurses have become quite common. Since prevention is a core business for both types of professionals (the former partially self-employed and the latter under the responsibility of a dentist), the application of a NOCTP regime may be effectively applied by both. The ICER of the NOCTP strategy that was reported in Chapter 4 may be positively influenced by the deployment of these dental auxiliaries, provided this deployment has the same effectiveness. Further research seems necessary to identify the most optimal design of the NOCTP strategy.

In addition to being a health care professional, the general dental practitioner in the Netherlands is an entrepreneur. Considering the current reimbursement system in the Netherlands, implementing NOCTP – while perhaps cost-effective – may not be financially attractive for dentists. Currently, the dental professional in the Netherlands is paid for every procedure or activity that is performed. When tangible interventions – like restorations and routinely applying professionally fluoride or placing occlusal resin-based sealants – are more financially attractive than promoting self-care-based prevention activities, a ‘paradigm-shift’ towards more self-care-based, preventive strategies and thus a potential wider acceptance of the NOCTP strategy is hampered. Only very recently, a tariff has been introduced for every 5 minutes of time that dentists use for prevention visits. What the effect of this change will have on the dental professional’s behaviour is still unknown but considering the given tariff (€ 12.10 / 5 minutes), this possible financial obstacle to implement NOCTP in daily practice seems to have met. If one would aim at stimulating the broader implementation of NOCTP-like strategies, it is therefore important to equal profits for various treatments and preventive actions and, doing so, incentivise dentists in such a way that this paradigm shift is indeed feasible. In that context it is worth noting that ‘outcome-based financing’ or ‘pay-for-performance’ (P4P) are concepts that have not been introduced in dentistry yet but certainly may be considered to be suitable for oral care, as well (Jha, 2013; Tinanoff, 2012). Health insurers and policy makers also may be interested in supporting to implement the NOCTP programme on a larger scale. In the original Nexø-study, the

costs of running the dental service clinic with the NOCTP strategy was significantly lower than the costs before the NOCTP strategy had been implemented (Ekstrand & Christiansen, 2005). This cost calculation was not based on an economic evaluation and therefore cannot be compared one-on one to the results of the current study. However, also in this current study, it was also found that, in the short run, more resources were used, but that already after 3 years the costs of the NOCTP programme equalled the regular costs.

Another issue that may hamper the dental professional's willingness to adopt to the NOCTP approach is the fact that it may be perceived as a strategy of 'doing nothing' or 'supervised neglect', given its non-invasive, restraint and preventive nature. However, the way that the profession looks at caries and caries prevention nowadays appears to be changing (Fisher, 2012; Fejerskov, 2004), while evidence on the effectiveness of non-invasive caries treatment and prevention approaches accumulate (Thylstrup et al., 1997; Ekstrand et al., 2000; Ekstrand & Christiansen, 2005). Nevertheless, this does not alter the fact that a thorough monitoring of the development of the caries process can be regarded desirable.

A monitoring system that records caries activity at the dental visits is desirable for several reasons. It may give the dental professional an indication of whether he or she is on the right track with the chosen prevention strategy. It may also be helpful in communicating with other dental health professionals (task delegation). Furthermore it can justify presented invoices for health insurers (reimbursement) and finally it may be used for the communication with patients (and their parents). An index, comparable to the Dutch Periodontal Screenings Index (DPSI) that is used in the Netherlands (van der Velden, 2009), may be developed for this purpose.

Implementation of the NOCTP strategy may require adaptation of the organisational structure of the dental practice and the skills of dental professionals. Hence, successful implementation of NOCTP may require investments, perhaps not in terms of technologies, but in training, education, informing clients and reorganising practices. Perhaps, if NOCTP would play a more prominent role in dental education, implementation of the strategy will progress more easily. Dental professionals could be trained in delivering tailor-made caries preventive care, based on the individual's needs and their attitude towards a healthy mouth. This may require a shift in thinking, organizing and acting, which may well be part of their education.

Concerning the parents, it was found that a significant proportion was hesitant to consenting to participate or in continuing participation. The percentage of discontinuation was largest in the NOCTP group (Chapter 2 and Chapter 4). The most prevalent reason for non-consent or discontinuation was the parents' feeling of their child 'withholding care'. However, as described in Chapter 2, children in the NOCTP group developed 70% less carious surfaces than in the regular care group. It is therefore important and potentially possible to relieve the worry of these parents, for instance through better information on the favourable outcomes. Another argument for the parents of the NOCTP group to discontinue participation in the study had to do with the fact that extra efforts were required in terms of travel time and extra visits to the dental clinic. This can be nuanced as well based on results that are described in Chapter 4. It is true that initially extra investments had to be made by the parents, but over the three years of the trial this difference disappeared later. Moreover, in a NOCTP programme, parents themselves are, to a large extent, in control of the number of extra visits they have to make by adhering to the dental professional's instructions and advice.

Concerning successful implementation of the NOCTP strategy, it is essential to realize that parental involvement and investments are pivotal for success. Hence, when a caries prevention strategy is 'home-care based' and, therefore, largely dependent on the parental willingness to invest, it is important to know what can be expected in this respect from parents. In Chapter 6, five types of parental attitudes were distinguished based on a Q-methodological study. Moreover, in Chapter 7 we found that these different parental attitudes were associated with different self-reported dietary behaviour, oral hygiene behaviour and even differences in clinical outcomes like oral hygiene and caries prevalence. One should bear in mind that following the NOCTP strategy requires a clear investment by the parent in their child's oral health. Hence, it may not be the most effective or cost-effective strategy for children of the 11.5% of parents who indicated that they were not willing to invest any money or time (brushing their children themselves) and not willing to visit a dental clinic more than once a year for prevention visits. If these parents would nonetheless be confronted with a NOCTP regime, their compliance may be insufficient to make the programme effective. In fact, the programme may then be less effective than a currently conventional programme. Techniques like Motivational Interviewing may change the behaviour in the desired direction of some of these parents, but for those cases where success isn't forthcoming as yet, children of these parents may benefit more from a professionally directed approach, which, in some cases, may circumvent the active participation of parents. In such cases, directly targeting children, for instance through school dental services, may

be more effective and cost-effective. Future research should be aimed at further investigating the exact conditions under which NOCTP is an effective and cost-effective strategy and which alternatives could be offered best in cases where NOCTP is not the best option (e.g., because of low involvement of parents). Another approach is to attempt to motivate parents to participate actively. In that sense, the potential benefits of the NOCTP program and the fact that the additional efforts are limited in time (to especially the first year) and that parents themselves strongly influence the required efforts, may need emphasis in contact especially with more reluctant parents. This may be tailored by using information on parental attitudes.

Recommendations

On the basis of this dissertation, it can be concluded that a broader implementation of a Non-Operative Caries Treatment and Prevention strategy on a broader scale should be encouraged. Stepwise implementation is preferred because the following aspects of such an implementation process then could be monitored closely.

The design of the NOCTP strategy itself may be fine-tuned to gain effectiveness. It is suggested to evaluate the prescribed recall-interval, to upscale the indication of the program to a broader population (e.g., 0-18 years), to explore how to involve a larger part of the patient-population and how to best target dropouts.

The instruments for monitoring and registering the caries process should be further developed. Also, the application of attitude-dependent caries prevention (e.g., using vignettes) is an issue that requires further research. The incorporation of the NOCTP strategy in dental practices should be monitored closely. It is suggested that all possible barriers to implementation of the strategy are mapped in various populations and practise settings in order to make NOCTP a feasible strategy. Linked up closely to this, it is important to consider optimal reimbursement systems to facilitate the uptake of caries preventive measures and incentivise dental practices to do so. This may require a shift from 'fee for service' to outcome based financing or 'pay for performance' (P4P).

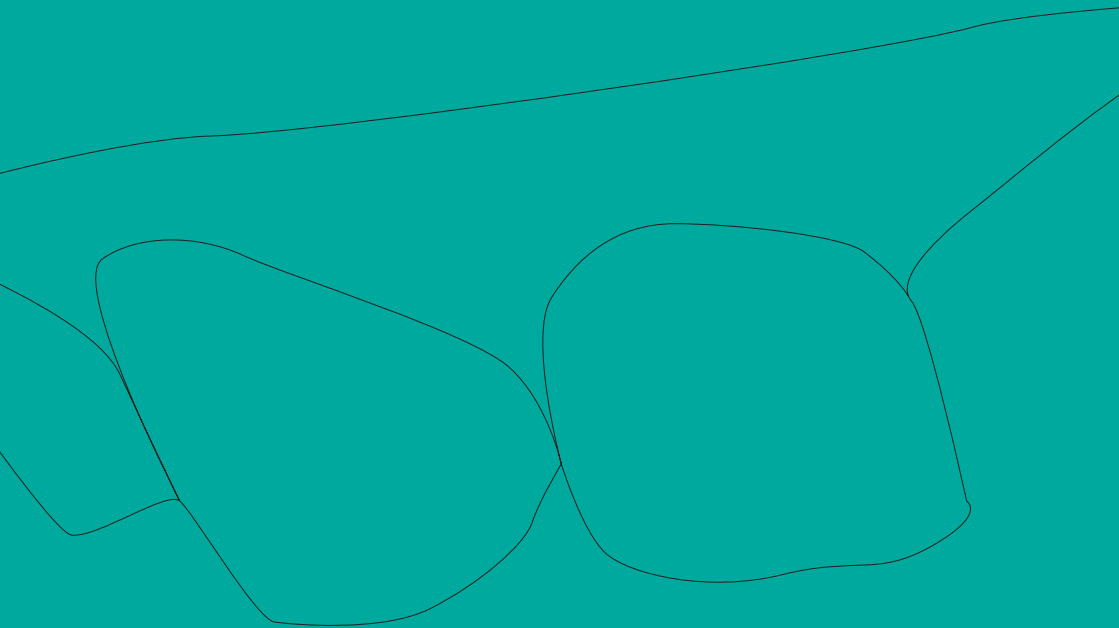
Furthermore, it is suggested to perform longer follow-up studies of the effectiveness and cost-effectiveness of NOCTP, as well as exploring its cost-effectiveness in decision analytic modelling. To that end, transition probabilities for various stages of caries progression and treatment need to be determined.

In addition, it is recommended – next to training manual skills – to continuously secure sufficient emphasis on the prevention of caries in dental education.

Concluding remark

This thesis has investigated several aspects of preventive measures in oral health. It hopes to have contributed to the understanding of effectiveness and cost-effectiveness of alternative approaches to maintain and restore oral health, as well as of attitudes of parents regarding their children's oral health. Ultimately, I hope this thesis will contribute to optimizing oral health – a worthwhile goal!

Samen- vutting



Samenvatting

Dit proefschrift bestaat uit een korte inleiding, een zestal deelonderzoeken die apart beschreven zijn in zes hoofdstukken, een samenvatting en een hoofdstuk met daarin een afsluitende discussie en enkele aanbevelingen.

De inleiding van dit proefschrift geeft in het kort inzicht in de ontwikkeling van cariës (tandbederf) in de geschiedenis van de mensheid. Uit de inleiding blijkt dat er – ook in Nederland – nog veel cariësprevalentiewinst te behalen valt als gekeken wordt naar de meest recente cariësprevalentiecijfers.

Het doel van dit promotieonderzoek was drieërlei. Het eerste doel was het vaststellen van de klinische effectiviteit van twee cariëspreventieve protocollen in vergelijking met een standaard preventief protocol dat uitgaat van twee keer per jaar een gebitscontrole, mondhygiëne-instructie, een professionele fluorideapplicatie en het routinematig sealen van doorgebroken blijvende kiezen. Het onderzoek werd uitgevoerd als een ‘randomized controlled trial’ (RCT). Het tweede doel van het onderzoek was een economische evaluatie van de gevolgde strategieën. Om richting te kunnen geven aan geïndividualiseerde preventie is het in kaart brengen van voorkomende attitudes van ouders als derde doel gesteld. Daarbij is onderzocht wat de relatie is met gebitsgezondheid gerelateerde variabelen.

Het onderzoek werd uitgevoerd in één praktijk van het Centrum voor Tandzorg in 's-Hertogenbosch. Hoofdstuk 2 beschrijft de RCT. In totaal werden 179 zesjarige kinderen willekeurig aan een van de drie onderzoeksgroepen toegewezen. Eén groep volgde een niet-operatieve cariësbehandeling- en preventiestrategie (NOCTP: Non-Operative Caries Treatment and Prevention) waarbij het interval tussen twee preventieve bezoeken individueel bepaald werd. Hiervoor werd gebruikgemaakt van een eerder in Nexø, Denemarken, toegepaste risico-inschatting. Deze was gebaseerd op het niveau van zelfzorg van de ouder (de mondhygiëne) dat de ouder bij het kind wist te bewerkstelligen), de doorbraakfase van blijvende gebitselementen en de cariësontwikkeling in het gebit in het algemeen en in de blijvende molaren in het bijzonder. De interventie was met name gericht op het verhogen van het niveau van zelfzorg. Naarmate het niveau van zelfzorg hoger was, werd dit ‘terugkom-interval’ groter. Indien er ondanks een goede mondhygiëne toch sprake was van cariësontwikkeling werd lokaal fluoride aangebracht. Als dit niet afdoende was, werd er

gebruikgemaakt van kunstharss fissuurlak. Indien cariës het d3/D3 niveau (in dentine) had bereikt, werd deze gerestaureerd. De tweede experimentele groep (IPFA: Intensified Professional Fluoride Application) en de controlegroep verschilden alleen in de frequentie van de te geven fluoride-applicaties. In de controlegroep was dit twee keer per jaar, in de IPFA groep vier keer. Verder kwamen de kinderen twee keer per jaar voor periodieke controle en werden de occlusale vlakken van de blijvende molaren geseald. Cariës werd gerestaureerd op d3/D3 niveau. Na drie jaar bleek de cariëstoename in de controlegroep, de IPFA groep en de NOCTP-groep respectievelijk 0,47 (\pm 1,04), 0,34 (\pm 0,87) en 0,15 (\pm 0,50). De resultaten van dit onderzoek geven aan dat de NOCTP-strategie driemaal effectiever is in het voorkomen van gaatjes in vergelijking met de controlegroep.

Hoofdstuk 3 beschrijft de verschillen in klinische en niet-klinische mondgezondheidsvariabelen van de ouders en kinderen die op voorhand aangegeven hadden niet mee te willen doen aan deze RCT en ouders en kinderen die dat wel wilden. Het betreft de in de hoofdstukken 2 en 4 beschreven kinderen uit de praktijk in 's-Hertogenbosch en kinderen uit praktijken in Utrecht en 's-Gravenhage die zich in eerste instantie ook als deelnemer aan de RCT konden aanmelden. Deze laatste twee praktijken zijn in een vroeg stadium (gedurende de periode van de nulmetingen) om organisatorische redenen afgehaakt en hebben dus geen deel uitgemaakt van de RCT en de economische evaluatie. Van alle 346 kinderen die voor dit onderzoek waren uitgenodigd, hebben zestig ouders aangegeven hun kind niet mee te willen laten doen omwille van de te verwachten belasting voor het kind of voor de ouder zelf. Op het verzoek of men toch eenmalig dezelfde vragenlijst zou willen invullen en of de tandarts-onderzoeker eenmaal het gebit van hun kind mocht onderzoeken, antwoordden 56 van hen bevestigend. Dit gaf de unieke gelegenheid om zowel klinische als niet-klinische variabelen van zowel participanten als non-participanten te vergelijken. Vaak wordt aangenomen dat non-participanten een minder gunstige Ausgangssituatie hebben, waardoor het effect van een interventie wordt overschat en de externe validiteit (in hoeverre de resultaten nog gelden voor de hele populatie wanneer de non-participanten uit de steekproef gehaald worden) wordt beïnvloed. In dit onderzoek is gebleken dat er inderdaad verschillen waren tussen participanten en non-participanten in deze RCT. De non-participantengroep had vaker een vader als begeleider, vaker een lage SES, vaker een allochtone afkomst en een lagere bereidheid tot investeren in het gebit van hun kind (wat betreft geld en tijd dat ze wilden tandenpoetsen bij hun kind). De groep als geheel was echter te klein om een statistisch significant verschil tussen de participanten en de totale groep te veroorzaken. Wat betreft de klinische uitkomsten

geldt hetzelfde: de groep non-participanten is te klein om een statistisch aantoonbaar verschil te maken. Echter, de richting van het verschil tussen non-participanten en participanten was anders dan op basis van voorgaande literatuur werd verwacht. Weliswaar gaven de ouders aan minder vaak elke dag ontbijt, lunch en diner te nuttigen en was ook de mondhygiëne slechter dan de participantengroep, de dmfs (de som van alle door cariës aangetaste, gerestaureerde en getrokken vlakken in het melkgebit) was lager in de non-participanten groep. Indien dit getal werd uitgesplitst naar onbehandeld, gerestaureerd en getrokken, bleek er sprake te zijn van een groter aantal vlakken dat onbehandeld carieus was en een kleiner gemiddeld aantal getrokken en gerestaureerde vlakken. Dit resulteerde in een lagere verzorgingsgraad van de non-participanten. Op basis van deze resultaten kan worden gesteld dat de externe validiteit van de resultaten van de RCT niet noodzakelijkerwijs werd beïnvloed door de non-participatie.

Om een uitspraak te kunnen doen over de kosteneffectiviteit van de twee experimentele groepen vergeleken met de controlegroep wordt in hoofdstuk 4 met de uitkomsten van hoofdstuk 2 verder gerekend. Want behalve de klinische prestatie is zeker ook van belang dat de extra tijd, geld en moeite die patiënten steken in het uitvoeren van deze methode niet buitenproportioneel is in vergelijking met de opbrengsten. Bij ieder bezoek aan de tandartspraktijk werd van elk deelnemend kind geregistreerd hoe lang deze bij de mondzorgverlener in de kamer was, hoe lang deze onderweg was om bij de praktijk te komen, door wie deze werd begeleid en hoe men naar de praktijk was gekomen. Een zogenoemde 'incrementele kosteneffectiviteitsratio' (IKER) werd berekend van elke strategie. Kort gezegd: wat heeft het volgen van de methode gekost om 1 extra DMFS te hebben voorkomen. Het bleek dat de IKER voor de NOCTP lag op € 108 en voor IPFA op € 977. Opgemerkt dient te worden dat de meeste kosten in de NOCTP-groep met name werden gemaakt in het eerste jaar. In het derde jaar bleek geen verschil in benodigde investeringen in tijd, geld en moeite. Op basis van dit onderzoek kan worden gesteld dat het volgen van een NOCTP-strategie te prefereren valt boven het volgen van een IPFA-strategie. Om de definitieve waarde van deze strategieën te bepalen is verder onderzoek naar de levenslange kosten van het hebben van 1 DMFT noodzakelijk. Op basis van de huidige kosten mag worden verondersteld dat deze vele malen hoger zullen zijn dan de nu gevonden € 108 van het volgen van de NOCTP-strategie.

In hoofdstuk 5 is een analyse gemaakt van de bereidheid van ouders om te investeren in een goede gebitsgezondheid van hun kind. Deze bereidheid tot investeren (of willingness to invest) werd uitgedrukt in geld en tijd. Deze uitkomsten zijn gerelateerd aan gegevens die werden verzameld met behulp van de door de ouders ingevulde vragenlijsten op het gebied van hun kennis, opleiding, gedrag, en de bereidheid en weerstand om te investeren in het gebit van hun kind. Ondanks het feit dat ouders over het algemeen zeker bereid waren in het gebit van hun kind te investeren, gaf toch een niet verwaarloosbaar deel van bijna 12 procent aan nauwelijks tot geen geld, tijd en moeite te willen steken in een goede gebitsgezondheid van hun kind. De kinderen van deze ouders lijken een verhoogd risico te hebben om gebitsziektes te ontwikkelen, omdat in deze groep ook minder gunstige mondhygiëne- en dieetgewoontes werden gerapporteerd. Wellicht is het noodzakelijk om voor deze groep een ander cariës-preventief programma te hanteren dat ofwel ouders weet te motiveren of de ouders omzeilt, bijvoorbeeld door interventies op scholen of in buurthuizen uit te voeren.

Hoofdstuk 6 beschrijft het proces van classificeren of typeren van de in de Nederlandse samenleving aanwezige attitudes van ouders van zes jaar oude kinderen ten opzichte van de gebitsgezondheid van hun kinderen. Hiervoor werd Q-methodologie gebruikt. Q-methodologie is een hybride onderzoeksmethode (deels kwalitatief, deels kwantitatief) waarbij proefpersonen op basis van stellingen over het onderzoeksgebied aangeven in hoeverre zij het eens zijn met de bewuste stelling. Dit gebeurt niet op een schaal, maar ten opzichte van de andere stellingen. Door middel van factoranalyse van alle proefpersonen worden clusters van stellingen gevormd. Hierdoor delen sommige proefpersonen bepaalde meningen waarover zij het eens zijn of oneens zijn. Op basis van een pilot met 78 stellingen werden 37 stellingen geselecteerd. In dit onderzoek werd een vijftal onderscheidende clusters (of attitudes) gevonden. Type 1: een bewust en verantwoordelijk type: deze ouder weet dat hij verantwoordelijk is voor het gebit van hun kind en handelt daar ook naar. Type 2: een bagatelliserend en fatalistisch type: deze ouder is van mening dat het niet zo heel erg is om een gaatje te krijgen. Er zit volgens hen ook een grote erfelijke component in het krijgen van gaatjes. Type 3: uiterlijk georiënteerd en open voor suggesties: deze ouder hecht veel waarde aan een goede esthetiek, het gebit is een soort visitekaartje. Als een mondzorg professional aanwijzingen geeft wordt daar goed naar geluisterd. Type 4: bewust maar druk: deze ouder is bewust van de nut en noodzaak van mondhygiëne maar geeft ook aan dat men in het gezin vaak te druk is om dit dagelijks goed vol te houden. Type 5: bewust maar bezorgd: deze ouder is vooral bang dat alle moeite die er wel ingestopt wordt wellicht niet altijd het juiste effect zal sorteren. Het zichtbaar maken van de attitudes van de

ouders kan de tandheekkundig professional helpen bij het individualiseren van de preventieve zorg. Verder onderzoek is hiervoor vereist.

Een aanzet hiertoe werd verder uitgediept in hoofdstuk 7. Op basis van de onderscheidende- en karakteriserende stellingen uit het Q-methodologische onderzoek, beschreven in hoofdstuk 6, werden 5 vignetten gemaakt. Deze tekstuele beschrijvingen werden aan de ouders voorgelegd en hen werd gevraagd in welke mate deze beschrijvingen op hen van toepassing waren. Deze resultaten werden vergeleken met hun uitkomsten op het gebied van mondhygiëne, preventief gedrag, dieetpatroon, bereidheid tot investeren in de gebitsgezondheid van hun kind en cariësactiviteit van hun kind. De ouders van de kinderen uit de RCT voelden zich het meest aangesproken door type 3 en type 4 (respectievelijk 31,6% en 43,7%). De rest van de ouders was ongeveer gelijk verdeeld over de resterende profielen. Ouders die type 2 als meest op hen van toepassing vonden aten minder regelmatig de reguliere maaltijden, waren minder bereid geld te investeren in het gebit van hun kind, waardeerden hun algemene gezondheid en hun mondgezondheid lager dan de ouders in de andere profielen. Tevens scoorden zij lager op de kennisvragen en hoger op de ervaren last van preventieve maatregelen. In de klinische variabelen werd gevonden dat hun kinderen een minder goede mondhygiëne hadden en meer onbehandelde carieuze vlakken dan de kinderen met ouders in de types 1, 3 en 5. Meer nog dan gebruikt te worden als extra risico-inschattingmiddel zou een verder ontwikkelde versie van het gebruikte screeningsinstrument kunnen bijdragen aan het verder individualiseren van de cariëspreventieve zorg. Dit kan dan door de ingezette interventie aan te passen in het profiel waartoe de ouder zich het meest toe aangetrokken voelt. Uiteraard dient dit nog gestaafd te worden door verder onderzoek.

Hoofdstuk 8 geeft eerst enkele beperkingen aan van de in dit proefschrift uitgevoerde onderzoeken. Daarna combineert het de uitkomsten en discussiepunten uit deze voorgaande hoofdstukken en belicht deze uitkomsten vanuit een klinisch-, een gezondheidseconomisch- en een patiëntenperspectief en vanuit het perspectief van de tandheekkundige professional.

Hoewel het tevoren berekende, benodigde aantal van 181 proefpersonen bijna werd gehaald, kan het zijn dat 179 proefpersonen als een bescheiden aantal wordt beschouwd. Zoals in elk klinisch onderzoek, wordt een succesvolle inclusie van proefpersonen, evenals hun bereidheid om mee te blijven doen, beïnvloedt door verschillende factoren (bijvoorbeeld door de bereidheid tot investeren in tijd en moeite

door zowel de kinderen als hun ouders). Het uitvalspercentage waar van tevoren rekening mee werd gehouden (20%) werd licht overschreden (22%). Deze uitval vond meer plaats in de NOCTP-groep (31%). Dit zou kunnen resulteren in selectie-bias vanwege de mogelijkheid dat meer niet-gemotiveerde ouders uit te NOCTP-onderzoeksgroep vallen.

De duur van het onderzoek is nog iets waarbij stilgestaan moet worden. Een periode van drie jaar werd geacht voldoende lang te zijn om mogelijke verschillen in cariësontwikkeling te registreren. Echter, hoe langer de periode is waarover de resultaten geëvolueerd kunnen worden, hoe krachtiger deze resultaten zullen zijn. Aan de ene kant zou het cariëspreventieve effect van de NOCTP-strategie groter kunnen blijken te zijn op de lange duur als de cariësontwikkeling geëxtrapoleerd zou worden; aan de andere kant kan het effect weer helemaal teniet zijn gedaan als zou blijken dat het volgen van een restrictief indicatiebeleid op het gebied van plaatsen van sealants alleen maar tot een uitstel van het plaatsen van deze sealants zou hebben geleid. In de afgelopen drie jaar zijn daar echter geen aanwijzingen voor gevonden. Een langere vervolgtijd is momenteel gaande maar de resultaten daarvan zijn nog niet beschikbaar en valt daarnaast buiten het doel van dit proefschrift.

Het feit dat het experiment plaatsvond in één grote tandartsenpraktijk kan leiden tot een verminderde externe validiteit. De stad 's-Hertogenbosch werd gekozen vanwege de demografische representativiteit voor Nederland (Schuller et al., 2009). Wat de resultaten zouden zijn wanneer het onderzoek zou zijn gehouden in gebieden met een hogere of een lagere socio-economische status, of met verschillende attitudes of verschillen in reistijd naar de praktijk (bij voorbeeld in meer landelijk gelegen gebieden) is niet uit de resultaten van dit onderzoek vast te stellen. Meer onderzoek hiernaar is noodzakelijk.

Ondanks deze beperkingen hebben de resultaten van dit onderzoek belangrijke implicaties voor de mondzorg in Nederland. Alles overziend lijkt invoering van de NOCTP-strategie op grotere schaal een logische vervolgstap. Het toepassen van een preventiestrategie zoals in deze studie in het NOCTP-regime is toegepast is niet nieuw. Waar in de laatste decennia de cariëspreventie een steeds meer professioneel uitgevoerde kant heeft gekregen, is het aanleren en stimuleren van zelfzorg door de ouder niet mee geëvolueerd. Resultaten uit de voorgaande hoofdstukken leert dat het adequaat leren omgaan met tandenborstel en fluoridetandpasta, mits goed begeleid, een krachtiger instrument is om cariës te voorkomen dan meer professioneel ingrijpen. Wellicht zal blijken dat de NOCTP-strategie niet bij elk kind (lees: elke ouder) zal

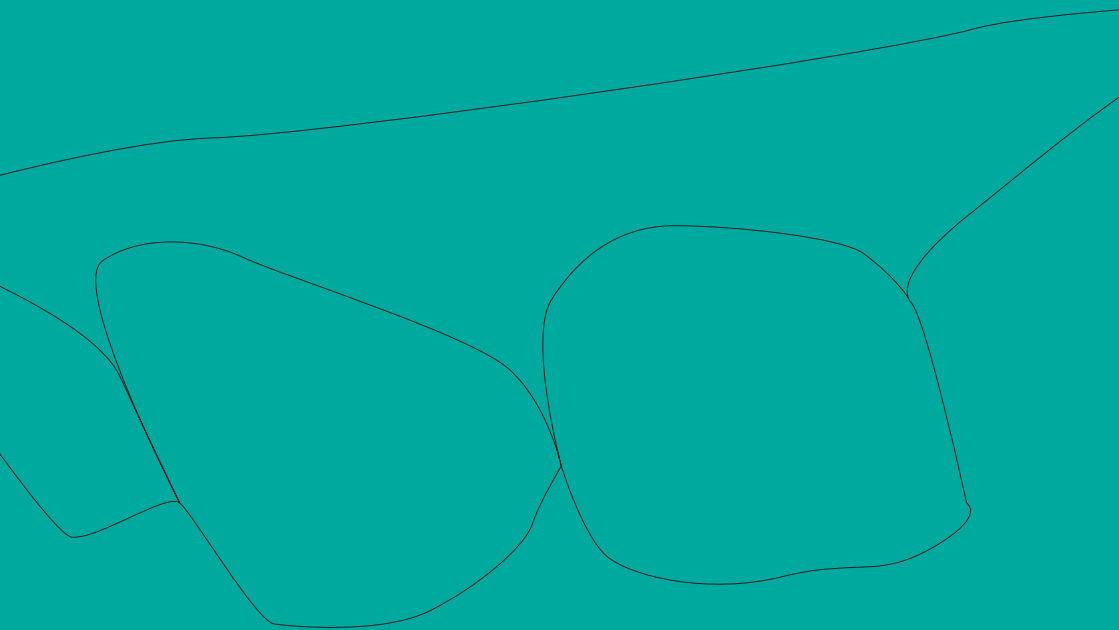
kunnen worden toegepast omdat de medewerking van de ouder, die van vitaal belang moet worden beschouwd, onvoldoende is. In hoofdstuk 5 is gerapporteerd dat ongeveer 11% van de ouders minimaal bereid is tot investeren in het gebit van hun kind. Kinderen van deze ouders zullen dus extra moeten worden gemonitord en bij hen zal een evenwicht gevonden moeten worden tussen het bevorderen van zelfzorg en toepassen van professioneel toegepaste cariëspreventieve middelen. Een mogelijke valkuil voor invoering van een NOCTP-strategie zou kunnen zijn dat ouders het een te grote belasting vinden om tijd, geld en moeite te investeren in het gebit van hun kind. Dit kan worden ondervangen door ouders voor te bereiden door aan te geven dat dit slechts bij risico-momenten noodzakelijk is en dat zij –behoudens doorbraak van de nieuwe elementen- zelf de regie hierover hebben door een adequate mondhygiëne bij hun kind toe te passen. Een andere groep ouders heeft wellicht een andere reden om af te haken: namelijk de gewenning aan het routinematig twee keer per jaar voor controle komen met de daarbij uitgevoerde professionele preventie. Aan de ene kant kunnen ouders er derhalve het nut en de noodzaak niet van inzien om misschien wel zes keer in een jaar voor een preventief bezoek naar de tandarts te gaan, en aan de andere kant kunnen zij het gevoel krijgen dat zij hun kinderen juist zorg onthouden door niet routinematig alle kauwvlakken te laten sealen of niet twee keer per jaar een fluorideapplicatie aan laten brengen in het gebit van hun kind. Educatie van de ouders – ook aan het begin van de preventiecyclus – is daarom te beschouwen als een must. Om in te schatten wat de attitude van de ouder is, kan een screeningsinstrument voor de mondzorgprofessional, waarvan een eerste aanzet toe in hoofdstuk 7 is gepresenteerd, een hulpmiddel zijn. Deze informatie kan gebruikt worden de te geven cariëspreventie adviezen af te stemmen op de individuele behoeften van het kind (en diens ouder). Zoals gezegd is een eerste aanzet hiertoe is beschreven in hoofdstuk 7 maar deze dient nog verder ontwikkeld en getoetst te worden.

Een ander aspect dat nader onderzoek behoeft is de delegatie van preventieve taken aan ondersteunend personeel (mondhygiënist, preventie-assistent). Een adequate training, bijvoorbeeld op het gebied van motivational interviewing, kan er mede voor zorgen dat de geleverde preventieve mondzorg meer individueel wordt afgestemd en in de toekomst aan effectiviteit kan winnen. Waarbij niet vergeten moet worden dat ook preventie niet alleen een zaak is van ondersteunend personeel maar dat de tandarts hierin ook zeker een coördinerende rol moet blijven vervullen als regisseur van de mondzorg van de individuele patiënt.

Ondanks het feit dat er geen grote investeringen noodzakelijk zijn om de NOCTP-strategie toe te passen, vraagt het wel de nodige aanpassingen in denken. De routine-matige aanpak die al enkele decennia gevolgd wordt, verschaft namelijk toch een soort van veiligheid. Toch is gebleken uit de stijgende kosten maar niet verder afnemende cariësprevalentiecijfers dat een grote stap in cariëspreventie gezet moet worden. Op basis van het onderzoek uit dit proefschrift lijkt de meest logische stap die in de richting van NOCTP. Invoering van de NOCTP-aanpak zal echter vragen om een verandering in hoe de diagnostiek en behandelingsplanning bedreven werd, maar ook het vergoedingensysteem voor de tandarts dient mee te evolueren van een tarief per verrichting naar een meer outcome-based vergoedingenstructuur, of Pay for Performance (P4P) waarbij de behandelaar wordt afgerekend op tevoren met de verzekeraar of overheid gemaakte afspraken. De tandheelkundig professional moet de invoering van een NOCTP-strategie in feite beschouwen al een nieuw product dat verkocht kan worden aan hun patiënt: op maat gemaakte cariëspreventie.

Dit proefschrift onderzocht verschillende aspecten van cariëspreventieve maatregelen. Het hoopt te hebben bijgedragen aan de kennis op het gebied van effectiviteit en kosteneffectiviteit van verschillende strategieën om een gezonde mond te behouden en inzicht te hebben gegeven in de attitudes van ouders ten opzichte van de gebitsgezondheid van hun kind. Uiteindelijk moet dit alles leiden tot het optimaliseren van de mondgezondheid; en dat is toch zeker de moeite waard!

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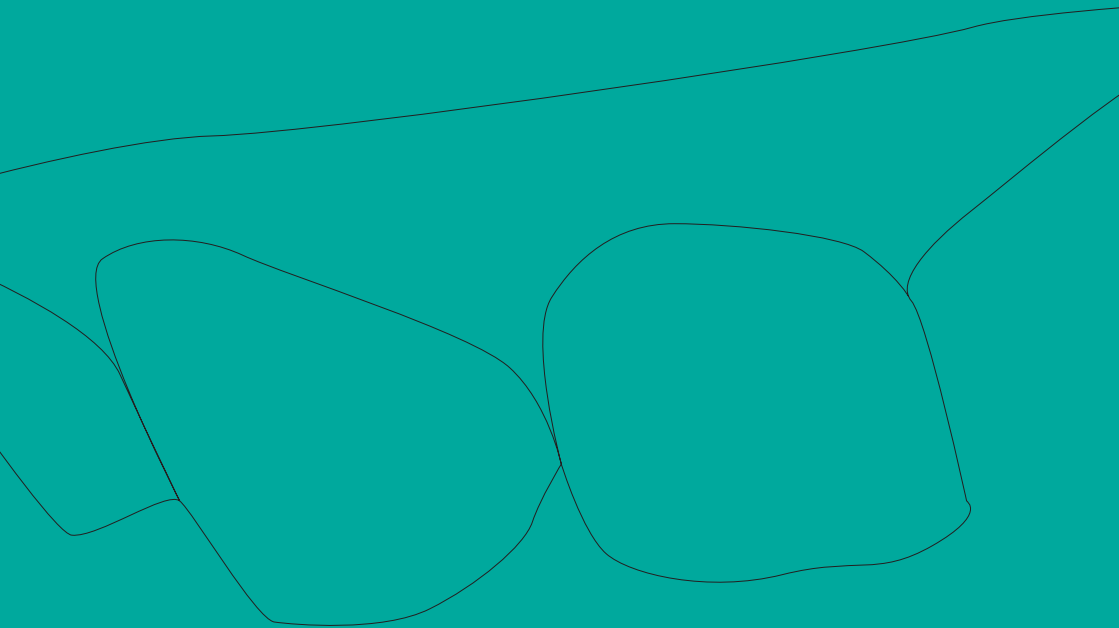
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List of publications



List of publications

Vermaire JH, van Exel NJ, van Loveren C, Brouwer WBF. Putting your money where your mouth is: parents' valuation of good oral health of their children.

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[chapter 5 in this thesis]

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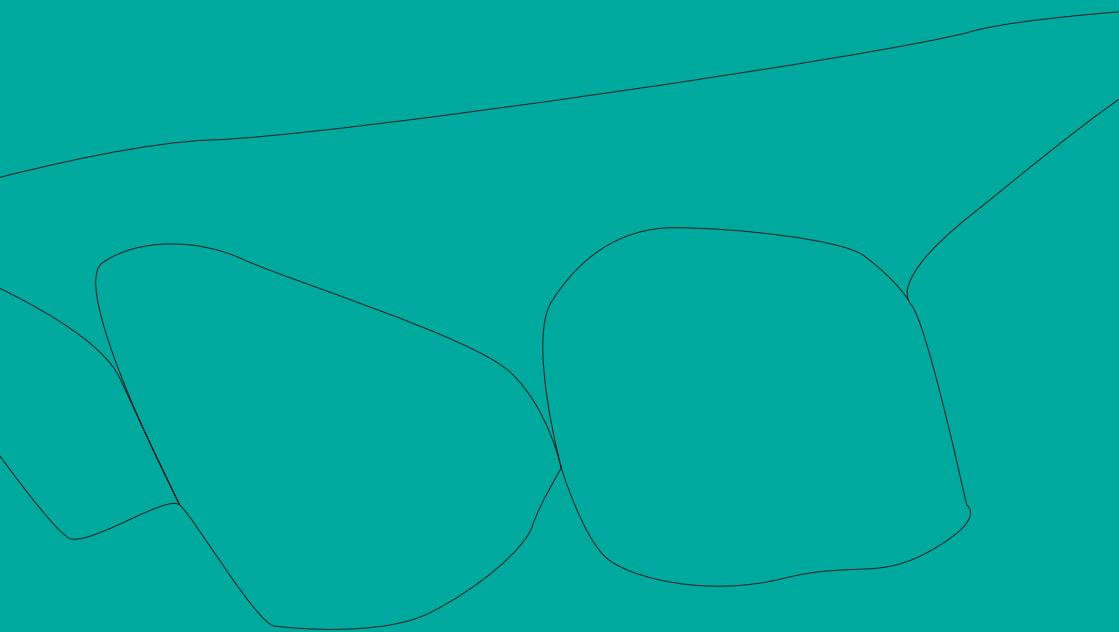
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Dankwoord



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positieve bijdrage aan kan leveren. Ik heb het dan ook als voorrecht ervaren jou als mede promotor te hebben gehad. Ook van jou hoop ik in de toekomst nog veel te kunnen blijven leren 😊.

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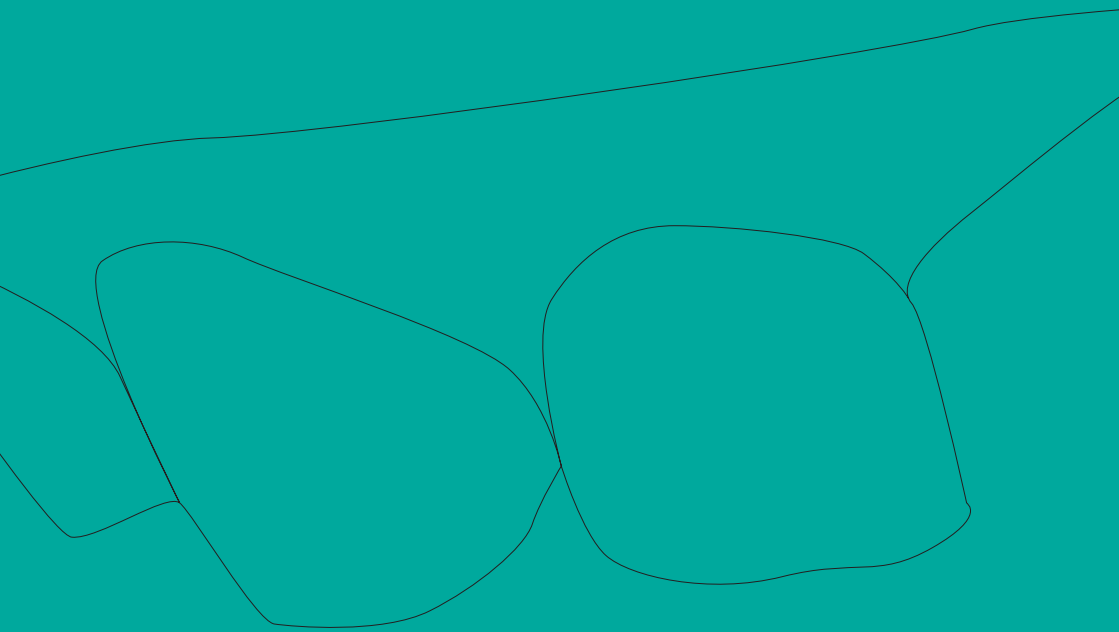
Mijn moeder wil ik ook bedanken voor haar onvoorwaardelijke steun bij mijn besluit om deze stap richting het onderzoek te zetten en voor haar interesse in alles wat ik doe. Evenals mijn vader. Pap, in het begin vond je het maar vreemd dat ik een goedlopende tandartspraktijk na vijf jaar al weer van de hand deed om onderzoek te gaan doen. Gaandeweg heb je gemerkt wat het doen van onderzoek nu eigenlijk inhoudt en wat het voor mij betekent. Ik vind het leuk dat je dat ook bent gaan zien. Mijn broer René en zijn vrouw Marjolijn, jullie ook bedankt voor alle interesse die jullie hebben gesteld in mijn onderzoek. Ook mijn schoonvader en zijn vrouw wil ik graag bedanken; Frank en Kiki: heel hartelijk bedankt voor jullie interesse en voor de gezelligheid.

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Curriculum Vitae



Curriculum Vitae

Jan Hendrik (Erik) Vermaire was born on October 6th 1973 in Vlissingen, the Netherlands. He finished secondary school at O.S.G. Huygenwaard in Heerhugowaard in 1993 and started to study dentistry at the Academic Centre for Dentistry Amsterdam (ACTA) in that same year. During these years his interest in dental research started by joining the department of Social Dentistry and Behavioural Sciences as a research assistant focussing on complaints against general dental practitioners. He graduated dental school in March 2000 and started a general dental practice shortly after.

In January 2003 he started a postgraduate education in Management of Dental Fear at the department of Social Dentistry and Behavioural Sciences of ACTA and the Special Dental Care clinic Amsterdam (SBT). This post-initial master course was completed in June 2006. As a part of this postgraduate program, he completed a clinical study on the effect of dental anxiety treatment on Quality of Life in patients with a pathological fear of dental treatment.

To be able to work half time on his PhD project at the department of Social Dentistry and Behavioural Sciences at ACTA, he handed over his general dental practice in January 2005 and continued working half time as a specially trained dentist treating extremely anxious, psychological and psychiatric compromised dental patients at the Centre for Special Care Dentistry of a general hospital in Alkmaar (Medisch Centrum Alkmaar), where he has been working from March 2002 up till now.

Since November 2012, he works halftime as a dental researcher at TNO (Life Style-Behavioural and Societal Sciences) in Leiden.

Erik lives together with his wife Puck van Meurs and their daughter Veerle (2004) and son Adne (2007) in Stompeteren, the Netherlands.

