PREVENTION OF EARLY CHILDHOOD CARIES: A SYSTEMATIC REVIEW

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Glossary and List of Abbreviations

ECC	Early Childhood Caries
MS	Mutans Streptococci
RCT	Randomised Controlled Trial
CCT	Controlled Clinical Trial
HE	Health Education
CHX	Chlorhexidine
dmfs/t	Decayed, missing, filled surface/teeth in milk teeth
DMFS/T	Decayed, missing, filled surface/teeth in permanent teeth
defs/t	Decayed, marked for extraction, filled surface/teeth in milk teeth
DEFS/T	Decayed, marked for extraction, filled surface/teeth in permanent teeth
NaF	Sodium Fluoride
SDF	Silver Diamine Fluoride
PNF	Pre natal fluoridation
GMA	Bisphenol A Glycidyl Methacrylate
FOTI	Fibre Optic Transillumination
DEPCAT	Deprivation Categories
ppmF	Parts per million Fluoride
ANOVA	Analysis of variance
SD	Standard Deviation
SE	Standard Error
NR	Not Reported
DP	Dental Programme
PDP	Preventive Dental Programme
CI	Confidence Interval
NS	Non Significant
CRD	Centre for Reviews and Dissemination, University of York, UK

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Executive Summary

Background

Early Childhood Caries can be defined as the occurrence of any sign of dental caries on any tooth surface in infants, toddlers and pre-school age children.

Dental caries is an infectious and transmissible disease. It is the result of an ecologic imbalance in the oral cavity resulting in the damage of the tooth structure. It usually occurs in children and young adults but can affect any age group. Dental caries in infants and young children exhibits a particular pattern of affecting the primary anterior teeth initially, which is followed by caries in upper first primary molars, upper secondary molars and canines. This characteristic pattern is related to the emergence sequence of the teeth and the tongue position during feeding. Dental caries in young children has been recognised for a long time but has been referred to by various names such as nursing bottle syndrome and baby bottle tooth decay. The common theme in these terms is a perceived central role of the inappropriate use of the baby bottle in the aetiology of this condition. However, the use of the baby bottle may not be the only, and most important factor in developing caries in young children. Because of the uncertainty of the role of the baby bottle in caries among young children, the Centre for Disease Control and Prevention suggested that the term for this clinical syndrome be replaced with Early Childhood Caries (ECC). ECC can destroy the primary dentition of toddlers and pre school children and there is a wide variation in their case definition and diagnostic criteria.

In the past three decades the average level of dental caries has significantly decreased, mainly because of the increased levels of oral hygiene and the availability of fluoride products in the community. However, despite this substantial decline, dental caries still remains one of the most common diseases affecting a substantial number of children. It now appears that caries prevalence has plateaued and is even increasing in younger age groups of children. The 2003 Children's Dental Health Survey commissioned by the Department of Health, the Welsh Assembly Health Department, the Scottish Executive Health Department and the Department of Health and Personal Social Services in Northern Ireland reported that 43% of five year olds had obvious decay experience in the primary teeth [1]. The report also showed that the proportion of five years olds with obvious tooth decay was higher in deprived primary schools (60%) than in non-deprived schools (40%) [2]. These findings are consistent with those of a previous survey carried out in a deprived urban community in Scotland (1999[3]), which showed that 64% of the three and half year olds included presented with dental caries.

An action plan for improving oral health and modernising NHS dental services in Scotland[4] reported that 55% of Scottish 5 year olds showed some signs of dental decay. According to the surveys co-ordinated by the British Association for the Study of Community Dentistry conducted in 2002/03, there has been a deterioration in the overall mean caries experience in 5-year-old

children in Scotland; with a value of 2.76 compared to 2.55 reported in 1999.[5] The frequency of ECC affecting younger children is also increasing. Recent studies[6-8]published in the last three years have reported increasing levels of ECC with a prevalence of up to 19% in high-income countries and as high as 85% in low socio-economic and disadvantaged groups compared to studies published in the mid 90's which reported 1-12% in developed countries and 70% in deprived communities within the developed countries. The action plan for Scotland[4] has identified a clear need for a robust and overarching strategy for children's oral health focused on prevention.

The Remit of this Review

The SIGN 47 guideline of 2000 [9] on "Preventing dental caries in children at high caries risk" dealt with the targeted prevention of caries in the permanent teeth of 6-16 year old children and the new SIGN 83 guideline[10] published in November 2005 focused on the individual pre-school child. SIGN 83 deals with a wider range of issues including epidemiology, the prediction of risk, and practice based management and intervention. The action plan for Scotland aims to achieve a target of 60% of 5-year-old Scottish children with no sign of dental disease by 2010. The identification and implementation of effective population-based interventions in this specific age group is crucial for achieving this target.

This review was commissioned by NHS Health Scotland in 2003 and although completed at the same time as the SIGN 83, has its focus on the effectiveness of community-based interventions; providing detailed scientific evidence underlying population based interventions and focusing on the prevention of dental caries rather than on the management of caries in young children. Taken together with SIGN 83, this should inform strategies of intervention aimed at whole populations and should identify future research priorities. This review is being updated and the results will be made available as soon as it is completed.

Aims

The aim was to conduct a systematic review to determine the effectiveness of population-based interventions for the prevention of caries in children of 0-5 years of age.

Methods

A comprehensive search strategy was developed to identify studies published between 1966 and 2003. Four major electronic databases were searched: Medline, Embase, Cinahl and the Cochrane library. Non-randomised studies were included only if they covered interventions, which were not addressed by the existing randomised clinical trials. Two reviewers independently selected

studies, assessed their methodological quality, and extracted the relevant data.

Outcome measures included: the incidence of caries, the status of caries, tooth loss, the percentage of caries-free teeth, the rate of restorations, and pain/discomfort episodes.

The quality of the papers was assessed on the basis of the following criteria: quality of randomisation, outcome assessors blinding to the intervention, the number of dropouts and withdrawals, the reporting of validated outcome measure and an intention to treat analysis.

In the absence of a previously published systematic review the results of this review provides a critical appraisal of the available evidence to date for effective measures to prevent Early Childhood Caries.

Results

The search strategy identified 12,224 citations: Forty-two reports of randomised controlled trials met the inclusion criteria. In addition, four non-randomised clinical trials on milk and salt fluoridation and five cross-sectional surveys on water fluoridation were judged eligible for inclusion.

The strength of this review is the systematic search of randomised controlled trials to identify effective interventions to prevent caries specifically in children under five years of age. However, some methodological limitations should be noted. Firstly, the included studies differed in relation to the target population, the type of intervention and the outcome measures. It was therefore impossible to statistically combine the results of the studies (i.e. through meta analysis), making it difficult to assess and compare the effectiveness of interventions. Secondly, the search of the literature was extensive but probably not exhaustive as journals were not hand searched and the authors were not contacted for additional information.

It is worth noting that overall the methodological quality of the studies was modest and as most of the conclusions drawn from this review are based on a very limited number of studies for each intervention they should therefore be interpreted with caution.

Results from randomised controlled trials

- **Health education**: Health education seemed to be effective when information was delivered in person via home visits compared with information provided by leaflets sent by post. The percentage of caries-free teeth was 69% for health education by home visits compared with 54% for health education by post based on one study, which was moderate in quality. Another moderate quality study indicated that the training of general nurses to promote dental health education might be as

effective as health education provided by dental hygienists and dental professionals.

Interactive games seemed to have a greater impact than verbal instructions on improving dental health knowledge in children. However, as this result was based on one weak quality study, the extent to which games would positively change children's behaviour in favour of better oral hygiene needs further investigation. There is some evidence that reduced sugar intake in nursery diets might help prevent caries in children, irrespective of their sugar intake at home. The results of a cluster randomised trial, which was moderate in quality, demonstrated that two thirds of children (65%) attending nurseries that adopted specific guidelines on reduced sugar intake did not develop any new caries compared to 38% of children at nurseries without such guidelines.

- **Topical fluoride**: Fluoride toothpastes proved to be effective in reducing dental caries. It was not possible to calculate the summary estimate of the treatment effect because of the nature of the various outcome measures reported. The results relating to the use of fluoride varnish were inconsistent across the trials. Only one of the four studies, that was moderate in quality, indicated some effectiveness. Children in the control group developed more new caries surfaces compared to the varnish groups (1.58 in the control group compared to 0.47 in the varnish group).

- **Systemic fluorides**: Fluoride drops might be effective in preventing early childhood caries even though their effects seem to be time-dependent, indicating greater benefits with the increased length of product usage. However, results were based on only two trials of weak methodological quality. There was no conclusive evidence on the effects of fluoridation tablets usage in pregnant women.

- **Antimicrobial agents**: The topical application of chlorhexidine and/or iodine, seemed to be effective when applied directly to children's teeth, but not when used on the mothers' dentition. A single moderate quality trial showed that 49% of children treated with chlorhexidine did not develop any new caries lesions compared with 29% of children who received a placebo gel and 26% of children in the non-intervention group. In another trial, applications of 10% iodine solution on children's teeth produced a 91% disease free survival compared with 54% in children who had received a placebo solution. A single strong quality study about the use of xylitol chewing gum in mothers showed that dmf (decayed, missing and filled teeth) values were significantly lower in the chewing gum group (0.83) compared with the chlorhexidine group (3.22) and the varnish group (2.87).

- **Sealants:** Pit and fissure sealants proved to be effective in preventing occlusal caries in children. The effectiveness was related to the retention rate of sealants. Two of the three studies of sealants were moderate to strong and one study was weak in quality. However, because of the different outcome measures reported in the three identified randomised

trials it was not possible to calculate a summary estimate of the treatment effect.

- Multiple components interventions were effective in preventing dental caries in children but it proved impossible to identify the contribution of each individual component. Interventions with multiple components included dietary counselling, antimicrobial mouth rinsing, professional tooth cleaning and fluoride treatment.

- There was a suggestion from a strong quality study that probiotic bacterium in milk might be effective in reducing the risk of caries in children.

Results from controlled clinical trials

- Results from controlled clinical trials indicated that milk and salt used as vehicles for fluoridation and invert sugar used to replace sucrose in the diet were effective measures in preventing dental caries in children. Eight years after salt fluoridation, there was a 56% difference in dmft values between intervention and control communities in favour of the intervention group. These results should however, be interpreted with caution because of the potential biases related to the adoption of a non-randomised study design and the fact that the methodological quality of the controlled clinical trials was not assessed in this review.

- Results from cross sectional surveys on random children samples selected from fluoridated and non-fluoridated areas indicated that water fluoridation was associated with a lower prevalence of caries.

Conclusions based on Randomised Controlled Trials:

- Early Childhood Caries is still a significant health problem.

- This review identified a range of possible effective interventions, some of which have been assessed in deprived groups. In deprived areas, guidelines relating to reduced sugar intake in the diet that were adopted by nurseries showed a statistically significant improvement based on a moderate quality study. Another moderate quality study showed that counselling mothers about oral hygiene and their children's diet, via home visits once a year, showed a statistically significant improvement in the dental health of children in deprived areas.

  The use of fluoride toothpastes was effective in the prevention of caries in children living in deprived areas, (based on three strong quality studies).

- Fluoride toothpastes, pit/fissure sealants and the topical application of anti-microbial agents together with health education by personal contact

seemed to be effective measures for preventing dental caries in children under five years of age.

Recommendations for research:

Most of the studies in this review compared topical and systemic fluoride interventions with the use of placebos or with no treatment. More studies are needed that compare one topical fluoride against another and/or a combination of topical fluorides. Studies are also needed to compare the use of a systemic fluoride to topical fluoride in this age group.

This review identified sealants as one of the effective methods to prevent caries but did not look into the costs of neither the sealants nor the training costs in relation to the effective application of the sealant. A review should be undertaken to establish both the cost and the feasibility of using sealants.

Studies have shown that training general nurses and/or health visitors to deliver dental health education is as effective as health education provided by dental health professionals. However, no studies have explored the impact of training nursery nurses and teachers who come into contact with children every day in delivering dental health education. Good quality studies are therefore needed to investigate these issues.

In spite of acknowledging the excessive intake of sugar and acid erosion as important causes of caries in children under five years of age relatively few intervention studies looking at the effectiveness of reduced sugar intake on the prevention of dental caries were identified. Good quality randomised controlled trials are needed to investigate this more fully.

References

1. Pitts NB & Harker R. (2004) *Obvious decay experience- Survey of children's dental health in the United Kingdom 2003 1-48* Office of National Statistics, London.

2. Steele J & Lader D (2004) *Social factors and oral health in children - Survey of children's dental health in the United Kingdom 2003 1-28* Office of National Statistics, London.

3. Sweeney PC; Gelbier S (1999) The dental health of pre-school children in a deprived urban community in Glasgow. *Community Dental Health*; 16: 22-5.

4. Scottish Executive (2005) *An action plan for improving oral health and modernising NHS dental services in Scotland* 1-41 Scottish Executive, Edinburgh.

5. Pitts NB; Boyles J; Nugent ZJ; Thomas N; Pine CM; British Association for the Study of Community Dentistry *et al*. The dental caries experience of 5-year-old children in England and Wales (2003/4) and in Scotland (2002/3). Surveys co-ordinated by the British Association for the Study of Community Dentistry. *Community Dental Health* 2005; 22:46-56.

6. Ferro R; Besostri A; Meneghetti B; Beghetto M; Ferro R; Besostri A *et al (2004)* Comparison of data on Early Childhood Caries (ECC) with previous data for Baby Bottle Tooth Decay (BBTD) in an Italian kindergarten population. *European Journal of Paediatr.Dent*;5:71-5.

7. Wennhall I; Matsson L; Schroder U; Twetman S; Wennhall I; Matsson L *et al* (2002) Caries prevalence in 3-year-old children living in a low socio-economic multicultural urban area in southern Sweden. *Swed.Dent.J.*;26:167-72.

8. Siegal MD; Yeager MS; Davis AM; Siegal MD; Yeager MS; Davis AM (2004) Oral health status and access to dental care for Ohio head start children. *Paediatr.Dent.*;**26**:519-25.

9. SIGN (2002) *Preventing dental caries in children at high caries risk*. Scottish Intercollegiate Guidelines Network, Edinburgh.

10. SIGN 83 (2005) *Prevention and management of dental decay in the pre-school child*. Scottish Executive, Edinburgh.

1 Introduction

1.1 Aetiology of Dental Caries

Dental caries is an infectious and transmissible disease. It is the result of an ecologic imbalance in the oral cavity[1] resulting in the damage of the tooth structure. It usually occurs in children and young adults but can affect any age group.

Dental caries is a local, but multifactorial disease. There is evidence that important causative factors for caries in children include socio-economic status, poor oral hygiene, hypoplasia, consumption of high sugar containing foods and oral colonisation of Mutans Streptococci (MS)[2]. Bacterial infection by *S.mutans* and *S.sorbinus*,[3-6] diets which are rich in sugars [5;7] host immunity and socio-cultural factors such as parental education and socio-economic status[1] play an important role in the aetiology of dental caries.

Studies have shown that the presence of cariogenic bacteria such as the *Streptococcus Mutans* and *Streptococcus Sorbinus* are one of the important predictors for the development of dental caries [5;8]. The first step in the aetiology of caries is primary infection by cariogenic bacteria. In infancy, the development of caries is attributed to frequent, prolonged oral exposure to cariogenic substrates such as carbohydrates in bottled drinks such as sweetened water or fruit juice. This facilitates the initial establishment of cariogenic bacteria in plaque and the prolonged exposure to carbohydrates enhances the further accumulation of bacteria to pathogenic levels.[1] Decreased salivary flow that occurs during sleep or because of a congenital defect of the salivary glands[9] makes the teeth more susceptible to the acid production of plaque bacteria[10]. The acids produced by bacteria in dental plaque play an important aetiological role in erosion and tooth destruction.

Demographic variables such as race/ethnicity and immigrant status play a very important role in the aetiology of dental caries. Studies of Native American populations and aboriginal populations in Canada and Australia demonstrate a high prevalence of dental caries in pre-school children [11;12]. Studies from Europe and the USA [5;13;14] that have analysed the risk of caries among immigrant populations showed that children from immigrant backgrounds have higher levels of dental caries. In Sweden, children who had immigrant backgrounds were three times more likely to have dental caries than non immigrant children, even after controlling for *mutans streptococci*, sugar consumption and social class [5]. These differences could be associated with cultural norms concerning oral health, care of primary teeth and child rearing practices [15]. Low socio-economic status is strongly associated with high levels of dental caries as reported by studies conducted among children in deprived communities [12;16]. Ethnic minorities may also experience significant barriers to dental care, including the cost of care. The provision of dental care within a region and access to dental care are also contributory factors to dental caries [17;18].

1.2 Pathogenesis of Dental caries

The initial process is that the cariogenic bacteria acts upon the fermentable sugars in the mouth to produce acids. Presence of teeth or other non-desquamating surfaces are a prerequisite for stable colonization of *mutans streptococci* and so the infants acquire them after their teeth emerge. As mothers usually enjoy frequent and intimate contact with their infants in the early years of life, the bacteria are generally transmitted vertically from mother to child unlike other infectious diseases where the infection is transmitted horizontally from an infected to a non-infected person [19]. A study by Li [20] in 1995 using a DNA fingerprinting technique reported that genotypes of *mutans streptococci* isolated from infants at the time of the initial acquisition, were homologous to those isolated from the mother's saliva in 71% of the mother-infant pairs, thus strongly suggesting that mothers are the major source of transmission of *mutans streptococci* to their infants. This study also hypothesized that mothers may transfer to their infants not only maternal immunoglobulins *via* the placenta and colostrums, but also a complementary set of indigenous bacteria capable of co-existing with these maternally derived immunity factors. The acquisition of bacteria might also have a role in the pathogenesis of dental caries. High counts of cariogenic bacteria in mothers are associated with the early colonisation in infants [21;22] .

Diet has an important role by providing the substrate for bacterial metabolism producing acids that lower the oral pH. The critical pH of the dental enamel is approximately 5.5 and any solution with a lower pH causes dental erosion, particularly if the attack is of long duration and is repeated over time [23]. Saliva counteracts the acid attacks, but if the challenge is severe saliva can no longer buffer the acid. After the pH decreases to less than 5.5 a process of demineralisation begins [7]. The acids produced by micro organisms in dental plaque dissolve the mineral matrix of dentin, leading to white spot lesions. If minerals continue to be lost because of acid challenge, the surface is eventually broken and cavities are formed [24].

1.3 Definition of Early Childhood Caries

Dental caries in infants and young children, exhibits a particular pattern of affecting the primary anterior teeth, which is followed by caries in the upper first primary molars, upper secondary molars and canines [24]. The characteristic pattern is related to the emergence sequence of the teeth and the tongue position during feeding. Dental caries in infants and young children has been recognised for a long time but was referred to by various names such as nursing caries, nursing bottle syndrome, night mouth bottle, infant feeding caries, baby bottle syndrome and baby bottle tooth decay. The common theme in these terms is a perceived central role of the inappropriate use of the baby bottle in the aetiology of this condition. However, the use of the baby bottle may not be the only, and most important factor in developing caries in young children [25]. Because of the uncertainty of the role of the baby bottle in caries among young children, the Centre for Disease Control and

Prevention suggested that the term for this clinical syndrome be replaced with Early Childhood Caries (ECC). Early Childhood Caries can destroy the primary dentition of toddlers and pre-school children [26].

There is wide variation in the case definition and diagnostic criteria of Early Childhood Caries [27;28]. However, ECC can be defined as the occurrence of any sign of dental caries on any tooth surface in infants, toddlers and pre-school age children [1;15].

1.4 Prevalence of Early Childhood Caries (ECC)

In the past three decades the average level of dental caries has significantly decreased mainly because of the general improvement of oral hygiene levels and the availability of fluoride products in the community. However, despite a substantial decline, dental caries still remains one of the most common diseases affecting children around the world. In the 1970s improvements in caries levels started to become apparent and continued during the 1980s. It now appears that caries prevalence has reached a plateau and may be increasing in younger age groups of children in countries that experienced the most pronounced decline early on [29]. A study from Northern Sweden reported that the number of children with caries had declined from 87% in 1967 to 42% in 1987 and then the decline levelled out. In 2002, 46% of the children had caries [30]. This increase could be partly attributed to poor dietary habits comprising of frequent sugar intake, poor oral hygiene [1] and in some cases the inability to access dental services.

The 2003 Children's Dental Health Survey commissioned by the Department of Health, the Welsh Assembly Health Department, the Scottish Executive Health Department and the Department of Health and Personal Social Services in Northern Ireland reported that 43% of five year olds had obvious decay experience in the primary teeth [31]; with 55% of Scottish 5 year olds showing some signs of dental decay [32]. The report also showed that the proportion of five years olds with obvious tooth decay was higher in deprived primary schools (60%) than in non-deprived schools (40%) [33]. These findings are consistent with those of a previous survey carried out in a deprived urban community in Scotland in 1999, which showed that 64% of the three and half year olds included presented with dental caries [34]. According to the surveys co-ordinated by the British Association for the Study of Community Dentistry conducted in 2002/03, there has been a deterioration in the overall mean caries experience in Scotland, with a value of 2.76 compared to 2.55 reported in 1999 [35].

Dental caries in infants and young children has long been recognised as a clinical syndrome and the frequency of Early Childhood Caries (ECC), defined as caries in children less than three years of age, appears to be increasing. Recent studies published in the last three years reported increasing levels of ECC with a prevalence of 19% in developed countries[36] and as high as 85% in low socio-economic and disadvantaged groups [37;38] compared to studies published in the mid 90's which reported 1-12% in developed countries and

70% in deprived communities within the developed countries.[39] Davies et al [40] reported that in the United Kingdom 19% of children, aged three years, suffered from "nursing caries", (i.e. caries affecting their upper incisors). A whole population study carried out in Sweden showed that the incidence of Early Childhood Caries to be 0.5% at 12 months of age, increasing to 8% at 24 months and 28% at 36 months of age [41].

Children who live in poverty are at higher risk of developing ECC because of poor nutrition, reduced emphasis on establishing healthy behaviours, and insufficient access to health care/education [26;37;42]. Children enrolled in Head Start, a federally funded programme in the United States for pre-school children living in poverty, consistently showed a higher prevalence of ECC, ranging from 38% to 73% [38;43;44].

Race and ethnicity play an important part in the occurrence of ECC. Studies published from Saudi Arabia and Thailand reported a prevalence of 73% and 82.8% among children less than three years old.[45,46]. Other recent publications have reported a higher prevalence of ECC among Hispanic, African American and Native American children [26;47;48].

1.5 Consequences of Early Childhood Caries

The premature loss of a tooth due to ECC may have significant effects on a child's facial growth and speech development [1;49;50]. The treatment of tooth decay by simple direct restorations (fillings) alone costs the NHS in England and Wales £173 million per year [51].

Caries prevalence in primary teeth has a positive predictive value for caries susceptibility in permanent teeth [52-54]. Hence, the preventive process of ECC should begin early in life to ensure a successful outcome [42;55]. A scoping exercise that was undertaken identified one systematic review which looked at data on the prevention of caries in pre-school children [56]. However, this review was carried out on only two databases and was of a poor quality with an inadequate search strategy. Fifteen narrative reviews that were identified by the scoping exercise emphasised the importance of intervention strategies for the prevention of caries in pre-school children [1;50;57]. These narrative reviews identified only limited information about effective interventions for the prevention of caries in pre-school children [58;59].

1.6 Remit of this review

The action plan for Scotland [32] identified a clear need for a robust and overarching strategy for children's oral health focused on prevention. The SIGN 47 guideline of 2000 [60] on "Preventing dental caries in children at high caries risk" dealt with the targeted prevention of caries in the permanent teeth of 6-16 year old children and the new SIGN 83 guideline [61], published in November 2005 focused on the prevention and management of dental decay in the individual pre-school child. SIGN 83 deals with a wider range of issues

including epidemiology, the prediction of risk, practice based management and intervention. The action plan for Scotland aims to achieve a target of 60% of 5-year-old Scottish children with no sign of dental disease by 2010. Identification of effective population-based interventions in relation to this specific age group and implementing them from early childhood is crucial for achieving this target.

The current review was commissioned by the NHS Health Scotland in 2003 and although completed at the same time as SIGN 83, it has its focus on the effectiveness of community-based interventions, providing detailed scientific evidence that support population-based interventions and focus on the prevention of dental caries rather on than the management of caries in young children. Taken together with SIGN 83 this should inform strategies aimed at whole populations and in identifying future research priorities. This review is being updated and the results will be available as soon as it is completed.

1.7 Aims of the review

The aim of this review was to carry out a systematic review to identify the effects of population-based interventions for the prevention of caries in children of 0-5 years of age.

2 Methodology

2.1 Inclusion criteria

2.1.1 Types of studies

The studies included were Randomised Controlled Trials and quasi-randomised trials in which at least 80% of the participants were children under five years of age. In the original protocol, Controlled Clinical Trials were also to be included in the review however, the search identified adequate numbers of randomised and quasi-randomised trials in the literature and so in view of adequate numbers of high-grade studies (RCTs) and time constraints, the Controlled Clinical Trials were excluded from the review. Controlled Clinical Trials, that assessed interventions that were not evaluated by Randomised Controlled Trials, were included in the review and the results are presented separately. Trials in which randomisation was not reported were grouped as Controlled Clinical Trials.

Water fluoridation is believed to be one of the effective methods to reduce caries. Randomised Controlled Trials are often considered as not being feasible for assessing the effects of water fluoridation on large population samples because of ethical reasons and other study designs are therefore usually adopted. No specific search strategy was applied to identify other study designs in this review. However, a few cross sectional surveys with random samples that assessed the effectiveness of water fluoridation were identified by the search strategy. Despite the lack of a separate robust search strategy to identify these studies, they were included and the results are presented separately.

2.1.2 Definition of ECC

There is a wide variation in the case definition of Early Childhood Caries. All definitions were accepted and any consideration of dental caries in children under five years of age was included in this review.

2.1.3 Types of participants

The participants were children of 0-5 years of age and the target populations of the interventions included parents, teachers, health visitors and other health care professionals. However, the only outcomes considered in this review were those that were measured in children of 0-5 years of age.

2.1.4 Types of interventions

The following interventions were assessed: dental health education, counselling, dietary interventions, fluorides and contact with health care personnel (e.g. dentists, dental hygienists, health visitors). In addition, a few other interventions that were not specified in the protocol were identified

during the search and, after the screening of the abstracts, were deemed suitable for inclusion. These included the use of Chlorhexidine gel and varnish, sealants, topical iodine, chewing gum by mothers and probiotic bacterium in milk. Both single and multi-component interventions were considered and these were compared to standard care or no intervention.

2.1.5 Outcome measures

The incidence of caries, the status of caries, tooth loss, the percentage of caries-free teeth, the rate of restorations and pain/discomfort episodes were the outcomes measured.

Measures of the prevalence of dental caries were based either on the number of decayed, missing and filled teeth (dmft), or on the number of decayed, missing and filled tooth surfaces (dmfs). Filled teeth are defined as those in which caries have been filled, and decayed teeth are those with untreated caries present deft/s, a variant of dmft/s, where 'e' indicating 'teeth marked for extraction' was also used to measure caries. A child's permanent teeth were denoted with uppercase letters: DMFT/DMFS.

Another indicator used in groups of children is the 'percentage of children who are caries-free', defined as those children whose teeth show no evidence of dental caries, treated or untreated [62]. Outcomes were measured either by clinical examination or by the use of additional diagnostic measures such as bitewing radiography and Fibre-optic transillumination.

2.2 Exclusion criteria

Studies that focused on indirect measures of the prevention of caries, such as the decreased levels of *S.mutans* bacteria and plaque index as the only outcome measures were excluded from the review. Studies in which participants had specific medical conditions were also excluded.

2.3 Systematic literature search

The electronic databases MEDLINE, EMBASE, CINAHL, Cochrane Library (Cochrane DSR, DARE, CENTRAL and ACP Journal Club), were searched systematically from 1966 to May 2003. No language restrictions were applied. The Medical Subject Headings (MESH) terms were combined with text words to identify all relevant studies. The search terms were then combined with the Cochrane Collaboration strategy for identifying 'Randomised Controlled Trials'. The MEDLINE search strategy was adopted for other databases that were searched. Full details of the search are described in appendix A. Reference lists of all included articles and review articles were checked to identify any other relevant studies. Any relevant study was retrieved and included in the review.

2.4 Method of review

2.4.1 Management of potentially eligible studies

All potentially eligible studies were entered into a bibliographic database (Reference Manager 9). Two reviewers independently assessed the first two hundred abstracts and any disagreement was resolved by discussion. One reviewer assessed the remaining abstracts because of time constraints, however queries about inclusion were discussed with the other reviewer.

2.4.2 Quality assessment of the studies

The methodological quality of most of the identified studies was assessed independently by two reviewers using a standard form (appendix B). Differences were resolved by discussion or referred to the third reviewer. Reviewers were not blind to the authors, institutions nor journals.

2.4.3 Data extraction and analysis

Two reviewers independently extracted data from identified studies. Discrepancies were resolved by consensus or arbitration. A data extraction form was developed and piloted for the purposes of this review (appendix B). Data was recorded regarding the following: the year of publication and author(s), the study design, the method of randomisation and allocation of concealment, the characteristics of participants, the details of the intervention, the outcomes, assessment and follow-up.

Data was entered into an Access database. As there were many outcome measurements and target populations, the results could not be easily combined by a meta-analysis and therefore comparisons across studies were only made “qualitatively”.

The presented results are summarised according to the type of intervention.

3 Results of the Literature Search

In total 12,224 titles and abstracts were identified by the search strategy (table 3:1).

Table 3:1: Total number of possible studies identified by systematic search

Source/Database	Years searched	No of abstracts
MEDLINE	1996 – October 2003	7055
EMBASE	1980 – October 2003	2282
CINAHL	1982 – October 2003	1039
COCHRANE LIBRARY	Updated April 2003	1848
TOTAL		**12,224**

617 publications were considered as being potentially eligible for inclusion and full-text articles were obtained. Forty-two randomised controlled trial reports met the final inclusion criteria. These are summarised according to the type of intervention and are listed in table 3:2.

Table 3:2: Summary of the randomised and quasi-randomised studies for each intervention identified

Author	Country	Year	Intervention
Sgan-Cohan et al [63]	Israel	2001	Health Education
Holt et al[64]	UK	1985	Health Education
Kowash et al[65]	UK	2000	Health Education
Ekman et al[66]	Sweden	1990	Health Education
Feldman et al[67]	USA	1988	Health Education
Makuch & Reschke[68]	Germany	2001	Health Education
Rodrigues et al[69]	Brazil	1999	Health Education/Promotion
Autio-Gold & Courts[70]	USA	2001	Topical Fl Varnish
Holm [71]	Sweden	1979	Topical Fl Varnish
Chu et al [72]	Hong Kong	2002	Topical Fl Varnish
Frostell et al [73]	Sweden	1991	Topical Fl Varnish
You et al [74]	China	2002	Fl Tooth paste
Winter et al [75]	UK	1989	Fl tooth paste
Holt et al [76]	UK	1994	Fl tooth paste
Davies et al [77]	UK	2001	Fl tooth paste
Hargreaves & Chester [78]	UK	1973	Fl tooth paste
Englander et al [79]	USA	1978	Topical Fluoride Gel
Lincir & Rosin-Grget [80]	Croatia	1993	Topical Fluoride solution
Schutz et al [81]	USA	1974	Topical Fluoride paste
Horowitz et al [82]	USA	1971	Fluoride mouth rinse
Hennon et al [83]	USA	1966	Systemic Fluoride drops
Hamberg [84]	Sweden	1971	Systemic Fluoride drops
Glenn et al [85]	USA	1982	Systemic Fluoride tablets
Leverett et al [86]	USA	1997	Systemic Fluoride tablets
Poulsen et al [87]	Denmark	1979	Sealant
Horowitz et al [88]	USA	1977	Sealant
Mertz-Fairhurst et al [89]	USA	1984	Sealant
Gisselsson et al [90]	Sweden	1994	Topical Chlorhexidine
Tenovuo et al [91]	Sweden	1992	Topical Chlorhexidine
Dasanayake et al [92]	USA	2002	Topical Chlorhexidine
Lopez et al [93]	Puerto Rico	2002	Topical Iodine
Dasanayake [94]	USA	1993	Topical Iodine
Pine et al [95]	UK	2000	Tooth brushing techniques
Curnow et al[96]	UK	2002	Tooth brushing techniques
Sjogren et al[97]	Sweden	1995	Tooth brushing techniques
Nase et al[98]	Finland	2001	Probiotic bacterium
Isokangas et al [99]	Finland	2000	Xylitol chewing gum
Olson et al [100]	USA	1981	Personal contact
Heifetz et al [101]	USA	1987	Combinations of interventions
Driscoll et al [102]	USA	1990	Combinations of interventions
Driscoll et al [103]	USA	1992	Combinations of interventions
Petersson et al [104]	Sweden	1985	Combinations of interventions
Lalloo & Solanki[105]	South Africa	1993	Combinations of interventions
Bagramian et al [106]	USA	1978	Combinations of interventions
Gomez & Weber[107]	Chile	2001	Combinations of interventions
Gomez et al[108]	Chile	2001	Combinations of interventions
Kohler et al [109]	Sweden	1984	Combinations of interventions
Kohler & Andreen[110]	Sweden	1994	Combinations of interventions

Thirty controlled clinical trials (CCT) were also identified by the search. Twenty-six controlled clinical trials considered interventions that were already assessed by randomised trials and were consequently excluded from the review. However, four studies (6 papers) that considered interventions that were not assessed by randomised trials were included (table 3:3a).

Water fluoridation is believed to be one of the important interventions in reducing caries in the community. No RCT's were identified in this area. However, five cross-sectional surveys of random samples of children in fluoridated areas and compared with children from non-fluoridated geographical areas were identified. These studies were included in this review (table 3:3b).

Table 3:3 a: Interventions assessed by Controlled Clinical Trials

Author	Country	Year	Intervention	Quality
Toth [111]	Hungary	1976	Salt fluoridation	Moderate
Toth [112]	Hungary	1978	Salt fluoridation	Moderate
Stephen [113]	UK	1981	Milk fluoridation	Moderate
Stephen et al[114]	UK	1984	Milk fluoridation	Moderate
Marino et al[115]	Chile	2001	Milk fluoridation	Moderate
Frostell et al[116]	Sweden	1981	Decreased sugar intake	Weak

Table 3:3 b: Cross-sectional surveys on water fluoridation

Author	Country	Year
Jackson et al[117]	UK	1985
Thomas et al[118]	UK	1995
O'Mullane et al[119]	Ireland	1988
Rugg-Gunn et al[120]	UK	1977
Evans et al[121]	UK	1995

4 Results of the Review

The results of this review are presented according to the type of interventions.

4.1 Randomised Controlled Trials

4.1.1 Health Education Interventions

Seven out of the 42 included studies looked at health education (HE) interventions. Four studies targeted the mothers [63-66] and three targeted the children.[67-69]

Quality: Five studies were moderate in quality and two studies were weak. (See tables 4:4a and 4:4b)

Summary: In general, educating mothers was effective in improving the dental caries status in children provided that there was contact with health personnel. Using more than one component of health education seemed to be the most effective type of HE intervention. The findings suggest that general nurses or health visitors, who come into contact with children and mothers most often, could be trained to deliver dental health education to mothers.

The education of children in nurseries by means of games and puppet shows about dental health was more effective than giving only verbal instructions. Reducing sugar content in nursery diets could also prove effective in reducing early childhood caries in children.

The study by Sgan-cohan et al[63] (table 4:4a (i)) reported that the group that received both health education and tooth paste/a tooth brush (TP/TB) showed a significant improvement in tooth brushing compared to the groups who either received only one of the components or no intervention at all.

The study by Holt et al,[64] compared health education intervention, either by home visits or by post to no contact and results are presented in table 4:4a(i). The results from χ^2 tests showed a significant association for group1 who received health education via home visits, as having a higher percentage of caries-free teeth (69% for HE by home visits vs. 54% for HE by post). However, comparison of means of defs/deft did not show any statistically significant difference.

The study by Kowash et al[65] was conducted with mothers from low socio-economic status. The study randomised the participants to five groups: four groups had health education in relation to diet only or oral hygiene only or a combination of diet and oral hygiene that was delivered either three times a year or once a year. The fifth group did not receive any intervention. The results presented in table 4:4a (i) showed a statistically significant difference between the groups by performing a non-parametric comparison of group means. Health education provided to mothers in their own homes about both

diet and oral hygiene was successful in preventing new caries in children. However, no dmfs values were reported for group B (oral hygiene only - 3/12) and it was not clear whether the Kruskal-Wallis test was performed for number of caries or dmfs. It also appeared that there was no statistically significant difference between home visits to provide health education made every 3 months or only once a year with respect to the percentage of caries. In addition, this study discussed interventions provided by a pediatric nurse and a dental health educator. However, the paper did not report these results in the publication.

The one remaining parental study by Ekman et al [66] considered the parents of immigrant populations by comparing health education given in their mother tongue and other languages. The intervention was carried out in two Swedish counties – Norrboton and Stockholm. The study randomised participants to four groups; in group FF, health education was given to Finnish parents in Finnish on three occasions; in group FS, HE was given to Finnish parents in Swedish, also thrice; in group FC, health education was given to Finnish parents in Swedish but the frequency was only twice and in the fourth group, SC, health education was given to Swedish parents in Swedish on two occasions. Every pair group comparison was done and the results are presented in table 4:4a (ii and iii). The best results for caries-free teeth and dmfs were observed when health education was given in the mother tongue, with no difference observed if HE was provided in Finnish or in Swedish. These findings were common to both counties.

When HE was provided in a *different* language, there was a statistically significant difference between HE that was given on two or on three occasions. This indicated that when health education was delivered in a different language, the impact of the intervention intensified with the increased frequency of provision. However, this difference was only observed in Norrboton County and not in Stockholm County. This could be attributed to the higher educational status and greater fluency in many languages among people living in Stockholm city.

Three studies targeted children in schools and nurseries. The results of these interventions are presented in table 4:4b. There were no dental health professionals involved and only teachers or nursery staff delivered the interventions.

The study by Feldman et al[67] looked at dental HE that was incorporated into regular academic subjects compared to dental HE that was given annually. These groups were further allocated depending on the provision of school-based treatments given by dentists in school-based mobile vans, or community treatment provided by participating GP's.

Assignment to the school based treatment intervention or community-based treatment group demonstrated no statistically significant association with DMFS seven years after the completion of the programme (table 4:4b). However, the authors claimed that the children who had been assigned to the school-based treatment programme and who also attended a school with the

enhanced health education, tended to use dental services on a more regular basis.

The study by Makuch & Reschke, [68] compared puppet shows that explained to children 'WHY' before 'WHAT', or games that explained 'WHAT' before 'WHY', with only verbal instructions to children. The study reported statistically significant differences between the groups that either had puppet shows or games compared to the group that had only verbal instructions. Statistically significant differences were only observed in relation to general dental knowledge between the experimental groups in favour of puppet shows. However, whether this increase in dental knowledge would ultimately decrease the prevalence of dental caries is debatable.

The study by Rodrigues et al[69] conducted a cluster randomisation trial with 12 nurseries that adopted guidelines on reduced sugar intake in their diet and 17 nurseries, which adopted no such guidelines. The results showed statistically significant differences in high caries increment between the nurseries that adopted the guidelines and those that did not. Children attending nurseries that *did not* use the guidelines had a higher caries risk, (with an odds ratio of 4.87), compared to those attending nurseries with guidelines. Furthermore, two thirds of children who attended nurseries using guidelines *did not* develop any new caries (approx. 65%), compared to approximately only 38% of children at nurseries without guidelines.

Three studies were carried out with parents and children from low socio-economic status [65;66;69]. The use of guidelines, with reduced sugar intake in the diet adopted by nurseries resulted in a statistically significant improvement in early dental health [69]. The counselling of mothers via home visits once a year about oral hygiene and diet resulted in a statistically significant improvement in the dental health of children in deprived areas.[65]

Table 4:4a (i): Results of the studies of Health Education Interventions targeting the mothers/parents of the children

Author (Yr), Study Type & Quality	Intervention	Sample Size & Age at start	Delivered by & length of follow-up	Outcome measure	Results
Sgan-Cohan et al (2001) Israel [63] Quasi RCT Quality: Weak	HE with/without tooth paste and tooth brush Vs no HE with/without TB and TP (4 groups: 2 study and 2 controls)	883 children 6-12 months mothers NR	General nurses 6 months	-percentage improvement in tooth brushing	**HE with TB/TP(P1)** / **HE without TB/TP (P2)** / **No HE with TB/TP(C1)** / **No HE and NoTB/TP (C2)** **Sample size**: **268** / **187** / **133** / **139** % improved in tooth brushing: 60.4% / 43.7% / 45.1% / 32.5% **P values** P1 vs P2: P=0.004 — P2 vs. C1: P=0.83(NS) P1 vs C1: P=0.02 — P2 vs. C2: P=0.11(NS) P1 vs C2: P=0.00004 — C1 vs. C2: P=0.09 (NS)
Holt et al (1985) UK [64] Quasi RCT Quality: Moderate	HE by home visits vs HE by post Vs no contact	1321 children 0-18 months Mothers NR	Dental health educator 5 years	-defs -deft -% caries-free teeth	**HE by Home visits** / **HE by post** / **No contact** / **p values** **Sample size**: **123** / **99** / **80** Mean defs(SD): 1.81 (4.56) / 2.36(4.50) / 3.19(8.21) / NS Mean deft(SD): 1.12(2.28) / 1.60 (2.51) / 1.73(3.33) / NS % caries-free teeth: 69%* / 69%* / 58% / <0.05 * significantly more than in group 2 (χ^2 , Yates= 5.01, p<0.05)

Author (Yr), Study Type & Quality	Intervention	Sample Size & Age at start	Delivered by & length of follow-up	Outcome measure	Results
*Kowash et al (2000) UK [65] RCT Quality: Moderate	Counseling on oral hygiene and/or diet by home visits vs no HE (5groups: 4 study and I control)	228 children mean 11.4 months Mothers 29years	Dental hygienist and paediatric. Nurse Study ended after 3yrs No follow-up	-dmfs -% with caries	**A: (D) (3/12)** / **B: (OH) (3/12)** / **C:D+OH (3/12)** / **D:D+OH (once a yr)** / **E: No HE** **Sample size** 45 / 47 / 51 / 36 / 55 % with caries 4%(n=2) / 0% / 0% / 0% / 33%(n=18) dmfs(SD) 0.29(1.64) / 0 / 0 / 0 / 1.75(5.09) † P= <0.001 tested by Kruskal-Wallis comparison of means (unclear if the test was done for number of caries or dmfs)

TB= Tooth brushing; TP= Tooth paste; D= Diet; OH= Oral hygiene; HE=Health Education;

Table 4:4a (ii): Health Education intervention targeting parents of immigrant populations

Author (Yr), Study Type & Quality	Intervention	Sample size& Age at start	Delivered by & length of follow-up	Outcome measure	Results				
*Ekman & Persson (1990) Sweden [66] RCT Quality: Moderate	HE in mother tongue vs HE in other languages	175 Children 6 –27 months parents NR	Dental hygienists and chair side assistants 9 months	-dfs -%caries-free teeth	**Parents** **HE** **HE(times)**	**Finnish (FF)** **Finnish** **Thrice**	**Finnish (FS)** **Swedish** **Thrice**	**Finnish(FC)** **Swedish** **Twice**	**Swedish(SC)** **Swedish** **Twice**
					Sample size				
					Norrbortan	31	30	30	80
					Stockholm	21	19	19	51
					% caries-free				
					Norrbortan	71%	53%	30%	80%
					Stockholm	71%	58%	32%	82%
					Dfs(SD)				
					Norrbortan	1.73(3.0)	2.7(4.5)	6.0(5.3)	0.9(2.1)
					Stockholm	1.2(2.2)	2.1(3.2)	4.6(4.6)	0.7(1.8)

Table 4:4a (iii): Significance when comparing different groups- Wilcoxon's rank sum test for dfs values and Chi-square for difference in proportions

% Caries-free / DFS		FF (HE in Finnish to Finnish parents) **3** times	FS (HE in Swedish to Finnish parents) **3** times	FC(HE in Swedish to Finnish parents) **2** times	SC (HE in Swedish to Swedish parents) **2** times
FF: (HE in Finnish to Finnish parents) **3** times	**Nor** *Stock*		**NS** ***NS***	**</** *NS*	**NS** *NS*
FS: (HE in Swedish to Finnish parents) **3** times ***Stock***	**Nor**	**NS** *NS*		**</** *NS*	*</* *</*
FC: (HE in Swedish to Finnish parents) **2** times	**Nor** ***Stock***	**NS** **</**	**</** *NS*		***</*** ***</***
SC: (HE in Swedish to Swedish parents) **2** times	**Nor** ***Stock***	**NS** ***NS***	*</* *</*	***</*** ***</***	

Bold –Norrbotten county *Italics* - Stockholm county * p<0.05 ** p<0.01 *** p<0.001

Table 4:4b Results of the studies of Health Education Interventions targeting children

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age	Delivered by & lengh of follow-up	Outcome measure	Results
Feldman et al (1988) USA[67] RCT Quality - Moderate	Dental HE incorporated into regular academic subjects vs annual session on dental HE	725 5 years	Teachers 7 years	-DMFS	**School based treatment** / **Community based** / **p value** ***Regular DHP*** / ***enhanced DHP*** / ***Regular DHP*** / ***enhanced DHP*** ***Sample size*** 280 (134/146) 126 (61/65) DMFS 6.808 8.458 8.178 7.398 >0.05 † DMFS (collapsed to assignment) 7.598 7.800 **† Two way Anova**
Makuch & Reschke (2001) Germany[68] RCT Quality - Weak	Verbal instruction vs. puppet show and games 3 groups: 2 study and 1 control Puppet show explained 'WHY' before 'WHAT' Games explained 'WHAT' before 'WHY'	90 3 - 4.4 years	Teachers and trained instructors 5 weeks	Assessed by 3-point Likert scale	**End of study** / **After 5 weeks** **Puppet 1st** / **verbal(C)** / **Puppet 1st** / **verbal(C)** ***Sample size*** 30 in puppet, 30 in games and 30 in control group ***Mean (SD)*** GHK 18(7.4) 8.8(4.02)* 16.3(6.7) 7.4(2.9)* TBS 3.8(0.8) 1.86(0.89)* 4(0) 2.2(0.92)* CRK 11.4(5.6) 4.5(2.2)* 10.6(5.1) 3.8 (1.9)* KSF 6.6(2.3) 4.3(2.4)* 5.7(1.9) 3.6(1.9)* **Games 1st** / **verbal(C)** / **Games 1st** / **verbal(C)** GHK 15(4.05) 8.8(4.02)* 12.9(4.9)† 7.4(2.8)* TBS 3.8(3.4) 1.8(0.89)* 4(0) 2.23(0.92)* CRK 9.56(3.3) 4.5(2.2)* 8.5(3.4) 3.8(1.9)* KSF 5.5(1.7) 4.3(2.4) 4.39(2.0) 2.6(1.9) **P values** * Between the control and intervention groups p=<0.01 (ANOVA) † Between the puppet and games groups significant differences only in general dental health knowledge in favor of puppet show p<0.01

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age	Delivered by & lengh of follow-up	Outcome measure	Results
*Rodrigues et al (1999)-Brazil[69] Cluster RCT Quality - Moderate	Dietary guidelines with reduced sugars in diet vs not adopting guidelines	650-29 nurseries 3 years	Nursery staff Study ended after a year No follow-up	-Caries increment Adjusted Odds ratio	**Guidelines on sugar** / ***12 nurseries(n=245)*** / **No guidelines** / ***17 nurseries (n=265)*** Lower caries increment: 86% / 63% High caries increment: 14% / 37% P value=<0.001 Adjusted odds ratios (95% CI) 4.87 (1.99 – 11.92) Adjusted for family income, baseline age, gender, household size, dmfs at baseline, daily frequency of sugar intake at home

GHK General health knowledge; TBS Tooth brushing skills; CRK Complex reasoning knowledge; KSF Knowledge of separated facts; DHP Dental Health Programme

4.1.2 Fluoride Interventions

Sixteen studies were identified which looked at fluoride interventions. Twelve studies considered topical fluorides and four studies looked at systemic fluorides.

4.1.2aTopical Fluorides

Out of the 12 topical fluoride interventions, four examined fluoride varnishes,[70-73] four (five papers) looked at fluoride tooth pastes [74-78], one study considered fluoride gel [79], one looked at the topical application of a fluoride solution [80], one considered the topical application of fluoride paste [81] and the final study examined the effectiveness of a mouth rinse [82].

Quality: Three out of four fluoride varnish studies, were of moderate quality and one study was strong (see table 4.1.2a). Four out of five papers on toothpastes were strong in quality and one was moderate (see table 4.1.2b). Studies of fluoride gel and fluoride paste were weak and the studies of the fluoride solution and fluoride mouth rinse were moderate in quality (see tables 4.1.2c and 4.1.2d).

Summary: Of all the topical fluoride interventions that were conducted with children under 5 years of age, the use of tooth pastes with fluorides seemed to reduce the caries in children. Studies on the topical application of varnish showed inconsistent results and revealed methodological flaws in one of the studies. The frequent application of the fluoride solution had a positive effect in reducing caries, but this was based on one study only.

4.1.2b Fluoride varnishes

The results of the four varnish studies are presented in table 4:1.2a.

The study by Autio-Gold & Courts[70] compared the use of varnish with no varnish and observed a slight increase in caries prevalence in the control group when compared to the varnish group at the end of the 9 month study. However, as the Mann Whitney U was used throughout the analysis instead of a non-parametric paired comparison, the interpretation of results should be viewed cautiously as the statistical significance would be even greater. The mean dmfs value was significantly higher in the control group at nine months than it at the baseline. The Dmfs were also significantly raised, for the treated group. The mean dmft between baseline and 9 months was statistically significantly raised for the control group (2.07±2.44 vs. 2.57±2.28), but the treated group showed no such significant differences (1.63±2.24 vs. 1.68±2.27). The mean ds value in the varnish group was significantly lower, at nine months compared with their baseline value, whereas it was significantly higher in the control group.

The transition from active to inactive lesions showed that, in the varnish group, 81.2% of active enamel lesions were inactive after nine months compared with 37.9% of active lesions in the control group. This was found to be statistically significant. The lesions that remained active also differed

significantly. In the control group, 36.9% of all active lesions were still active compared to only 8.2% of active lesions in the varnish group.

The study by Holm[71] compared the application of varnish with no varnish. The authors discuss parametric tests but suggest that because of the "skewness" of the data their use would be inappropriate. Assuming the skewness of all results, only the non-parametric median tests were relevant here. The results showed no statistical difference in median ds, defs and caries increment between the two groups. The only statistically significant median differences was for caries increment in occlusal surfaces in the treatment group (0.87±1.45) compared to the control group (1.74±2.03). The authors also reported that 43% of children in the varnish group and 29% of children in the control group did not develop caries lesions during the experimental period.

The study by Chu et al[72] compared the 38% Silver Diamine Fluoride solution (SDF), applied every 12 months, to the application of the 5% Sodium Fluoride varnish (NaF) applied every 3 months, with or without excavation of soft dentine caries lesions to no varnish. The results showed that children in the control group developed more new caries lesions compared to the children receiving SDF (0.47 in SDF group and 1.58 in the control group). The NaF varnish group also had fewer new caries surfaces compared with the control group (0.70 in NaF group and 1.58 in control group). These differences were statistically significant. While there was no significant difference between new caries between the NaF with excavation group compared to the control group, there was a significant difference in arrested caries lesions in SDF group compared to both the NaF group and the control group. Although not tabulated in the paper, the authors claimed that there was no significant difference in the mean number of arrested carious tooth surfaces found after 30 months between children who had caries excavated prior to SDF application and those who did not, (95% CI = 0.75 to 1.42). The finding for NaF was similar (95% CI = 0.04 – 2.12).

The study by Frostell et al [73] had two parts to the study. In the first part, there were four groups. The first group used sucrose (S) as part of their diet, and second group had fluoride varnish applied twice in addition to using sucrose (SD). In the third group the sugar was substituted by invert sugar (I) and in group four, this was combined with fluoride varnish that was applied twice a year (ID).

The results of the first part showed statistically significant differences at the end of the second year of intervention but only when the groups were looked at together (S+SD vs I+ID). The authors mention the Kruskal-Wallis test in the text of the paper, that may have been used as a non-parametric one way analysis, equivalent of testing pair wise comparisons, (although the labelling was confused in the paper). This indicated that, although the mean dmfs and dmft values were larger for the sucrose groups it did not reach statistical significance. This could be because of small sample sizes. In the second part, different children were included, who did not participate in the sugar group.

There were two groups that received either fluoride varnish or no varnish. The results indicated that children treated with the varnish showed a significant difference for $dmfs_1$ values between the groups during the two-year study period in favour of the varnish. However, the differences were not statistically significant at the end of the two years. Neither were the results statistically significant for $dmfs_2$ and $dmft_1$.

In summary, out of the four varnish studies, only one study by Chu et al [72] showed a statistically significant result in developing new caries surfaces in favour of NaF varnish compared to no varnish. The three remaining studies either showed only marginally significant improvement or no statistically significant improvement in the long-term with fluoride varnish.

Table 4.1.2a: Topical Fluorides Varnish Interventions

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
*Autio-Gold & Courts (2001) USA [70] RCT Quality – Strong	Topical application of fluoride varnish with 5% NaF (duraphat) vs. No fluoride application	183 3-5 years	Dentists 5 months	-dmfs -dmft	**(mean ±SD)** **Varnish** / **No varnish** / **p** / **Varnish** / **No varnish** / **†p value** **Sample size** 59 / 83 / ‡59 / ‡83 **Caries prevalence** dmfs 2.51±4.02 / 2.58±3.27 / NS / 3.05±4.25* / 4.05±4.40*** / <0.05 dmft 1.63±2.24 / 2.07±2.44 / NS / 1.68±2.27 / 2.57±2.28** / <0.01 ds 1.98±3.60 / 2.00±2.76 / NS / 0.76±1.64*** / 1.44±2.19** / <0.05 ‡ Mann-Whitney U test conducted between baseline and after 9 months * p<0.05 **p<0.001 ***p<0.0001 † Mann-Whitney U test between control and varnish group at 9 months **Activity of lesions – number (%)** / **Varnish** / **No varnish** / **p value** Active →Inactive 207(81.2%) / 85(37.8%) / <0.0001 Active→Active 21(8.2%) / 83 (36.9%) / <0.0001
Holm (1979) Sweden [71] Quasi RCT Quality - Moderate	Fluoride varnish (Duraphat) applied every 6 months vs. no Varnish	250 Mean 3 years	Dentists Study ended after 2 years No follow-up	-ds -defs -defs caries increment -caries-free teeth	**mean (SD)** / **Varnish** / **No varnish** / **p value** / **Median test** ***Sample size*** / ***112*** / ***113*** Baseline ds / NS Caries-free **After 2 years** ds 1.63(2.32) / 2.43(3.60) / NS defs 3.15(4.12) / 4.47(5.29) / NS defs caries increment 2.10(2.75) / 3.74(4.62) / NS occlusal surface incre 0.87(1.45) / 1.74(2.03) / <0.05 Buccal+lingual incre 0.12(0.44) / 0.18(0.72) / NS Caries-free teeth 38% / 27% Median differences tested by median test

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
Chu et al (2002) Hong Kong[72] Quasi RCT Quality-Moderate	38% SDF solution every 12 months vs. NaF (Duraphat) every months with or without removal of soft dentine lesions vs. no varnish (5 groups)	375 Mean 4 years	Dentists Study ended after 30 months No Follow-up	-new caries surfaces -arrested caries surfaces -% arrested caries, identified by black areas on the teeth	**Mean (SE)** SDF+exc (12mths) | SDF (12mths) | NaF+ exc (3mths) | NaF (3mths) | No varnish(C) | p value ***Sample size*** ***61*** | ***62*** | ***62*** | ***61*** | ***62*** New caries surfaces 0.26(0.09)[b] | 0.47(0.11)[b] | 0.89(0.20) | 0.70(0.12)[b] | 1.58(0.25)[a] | <0.001 Arrested caries surfaces 2.49(0.27)[c] | 2.82(0.30)[c] | 1.45(0.19)[d] | 1.54(0.27)[d] | 1.27(0.19)[d] | <0.001 Tests done: Arrested caries and new caries lesions-ANOVA Multiple comparisons using Scheffe's procedure: a > b; c> d
Frostell et al (1991) Sweden[73] RCT Quality-Moderate	1.Substitution of invert sugar for sucrose in combination with fluoride varnish (4 groups) 2. Varnish vs. No varnish	393 Mean 4 years 187 206	Dentists Study ended after 2 years No Follow-up	-dmfs -dmft	**Mean values of Caries incidence** **S** | **SD** | **I** | **ID** | **S+SD** | **I+ID** ***Sample size*** ***26*** | ***37*** | ***18*** | ***33*** | ***63*** | ***51*** **During 2 years** $dmfs_2$ 3.27 | 4.27 | 1.89 | 3.78 | 3.86 | 3.12 $dmft_1$ 1.62 | 1.65 | 0.39 | 1.43 | 1.64 | 1.06 **Only 2nd year** $dmfs_2$ 1.27 | 2.24 | -0.95 | 1.53 | 1.84* | 0.67* $dmft_1$ 0.85 | 0.84 | -0.50 | 0.52 | 0.84* | 0.16* **Varnish (Duraphat)** | **No Varnish** | **p value** ***Sample size*** **†** ***93*** | ***113***

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results		
					During 2 years (increase from baseline)		
					$dmfs_1$	2.26**	3.60	<0.01
					$dmfs_2$	2.86	4.10	
					$dmft_1$	1.09	1.32	
					Only 2nd year		
					$dmfs_1$	1.09	2.04	
					$dmfs_2$	1.33	2.06	
					$dmft_1$	0.55	0.58	
					† Student's t test was employed to compare groups at the end of the study			

SDF 38% Silver diamine fluoride solution
NaF 5% Sodium Fluoride varnish
Exc Excavation of soft dentine caries lesions

S Sucrose; **SD** Sucrose+Varnish; **I** Invert sugar; **ID** Invert sugar+varnish
$dmfs_2$ surfaces with all types of caries
$dmft_1$ / $dmfs_1$ Surfaces/teeth with macroscopic caries only

4.1.2c Fluoride Toothpaste studies

The results of the four fluoride toothpaste studies are presented in table 4:1.2c.

The study by You et al[74] looked at brushing twice daily with Sodium Fluoride (NaF) tooth paste (1100 ppm fluoride ion) for one minute while at school and under the supervision of teachers. Health education was also given every two weeks to teachers and children via video, audio-tapes and pictures. The control group was given toothbrushes with a placebo paste for ad libitum use at home. These children did not receive the school health education programme nor did they participate in classroom brushing. The results showed that in the subset of completed subjects, the treatment group had a statistically significant reduction in dmfs compared to the placebo group when assessed by both examiners (20.7% and 22.1% reduction). The overall results for the 'All subjects' similar to Intention to Treat analysis, showed two year increment data that was generally consistent with the final subject subset results, although the size of the effect was not as strong, as expected. There was a statistically significant reduction of dmfs in the treatment group of 14.4% when assessed by the first examiner and a 16.1% reduction when assessed by the second examiner. This indicates that fluoride in conjunction with an increase in dental health awareness can lead to a reduction in caries in children.

The studies by Winter et al and Holt et al compared the use of toothpaste with a lower fluoride level (550ppm) as a test paste, to a control paste with a standard fluoride content (1055ppm). Results at the end of 3 year study period, in a paper by Winter et al[75] showed that there was a marginal, statistically significant difference in the percentage of caries-free levels; with 63% having caries-free teeth in the higher fluoride group compared to 58% caries-free teeth in the lower fluoride group. No statistically significant differences were seen for the dmft and dmfs values. After a follow up of four and half years, in a paper by Holt et al,[76] there was no statistically significant differences between the groups in relation to either caries-free teeth or the dmft values in both primary teeth and erupted permanent teeth.

The study also looked at the differences in mean dmfs in relation to social class at the end of 3-year study period. Within the social class groupings, there did not appear to be any statistically significant difference in the cariostatic effect of the pastes. In addition, although significance levels were not reported, highest values for the dmfs and the lowest proportions of caries-free teeth were seen in the manual classes (IIIM-V).

The study by Davies et al[77] had three groups: The first group received fluoride toothpaste with 1450ppm of fluoride and the second group had a lower fluoride toothpaste (440ppm), compared to the control group who did not receive free toothpaste. The initial analysis involved children who had been examined and who had remained in the study. Using ANOVA, there were statistically significant differences in the mean dmft values and the prevalence of caries experience between the groups. Pair-wise comparisons revealed that children who received 1450ppmF toothpaste had statistically significant

lower mean dmft (2.15±2.96) than those who received either 440 ppmF toothpaste (dmft 2.49±3.16) or the control group (dmft 2.57±3.16). There was no statistically significant difference between the lower fluoride group and the control group. Using the χ^2 test, there was a statistically significant difference between the groups for caries prevalence for dmft>0; ranging from 50% in 1450ppmF group to 58% in the 440ppmF group and 58% in the control group. In the intention to treat analysis, statistically significant differences in the mean dmft were still found between those allocated to 1450ppmF and the control group and between the higher and the lower fluoride groups. Once again no statistically significant difference was seen between the 440 ppmF and the control group. The provision of free toothpaste containing 1450ppmF significantly reduced the mean dmft, when compared with the control group as well as with those receiving 440ppm fluoride toothpaste.

The authors also included results (mean and SD) from the control group of children who were not examined at follow up. These are likely to be conservative estimates and to reduce the effect, especially of the higher fluoride toothpaste. Nonetheless, the results showed group A (the high fluoride group) to be significantly better than group C (the control group), although statistically, A was not significantly different to group B (the low fluoride group).

The study by Hargreaves & Chester[78] compared a 2% sodium monofluorophosphate with placebo toothpaste and the results showed a statistically significant reduction in the caries on tooth surfaces - D(M)FS and also for erupted teeth in the mouth during the study period. However, no statistically significant difference was seen between the D(M)FT values.

In summary, all the four studies showed statistically significant results in favour of using a fluoride toothpaste compared to non-fluoride toothpaste. Two studies that compared the fluoride levels in the toothpastes showed inconsistent results. However, a recent good quality study by Davies et al [77] reported a decrease in caries experience with the use of a higher fluoride level toothpaste.

Table 4.1.2bTopical Fluoride Toothpaste interventions

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
You et al (2002) China [74] RCT Quality - Strong	Sodium Fluoride tooth paste with school dental prevention programme compared to placebo with no education programme	1334 Mean 3 years	Teachers Study ended after 2 years No Follow-up	dmfs	**2 year results** / ***Sample size*** / ***dmfs increment ± SE (completed subject subset)** 1st examiner: NaFwith DP 3.81(0.26); placebo/ No DP 4.81(0.24); % reduction 20.7%; p value 0.004 2nd examiner: 3.67(0.31); 4.71(0.29); 22.1%; 0.014 ***dmfs increment ± SE- All subjects** 1st examiner: 4.21 (0.23); 4.92(0.24); 14.4%; 0.034 2nd examiner: 4.07(0.27); 4.85(0.29); 16.1%; 0.046 *Adjusted mean dmfs increment score from analysis of covariance adjusted for gender, treatment group, county, age and baseline dmfs score
*Winter et al (1989) UK [75] Quasi RCT Quality - Strong	Tooth paste with 550ppmF brushed twice a day vs tooth paste with 1055 ppm F brushed twice a day	2177 Mean 2 years	Parents supervised 4½ years	-% caries-free teeth -dmft and - DMFT	**End of study (3years)** / ***Sample size*** / Number (%caries-free teeth) / Mean dmft± SD / Mean DMF±SD Intervention(550ppm): *1104*; 645(58%); 1.48; 2.45 Control(1055ppm): *1073*; 676(63%); 1.29; 2.21 95% CI (mean diff b/w groups): (-8.82%)-(0.48%); (-0.03)-(0.41); (-0.21)-(0.69) p value: <0.05; NS; NS **After 4½ years** / ***Sample size*** / Number (%caries free teeth) / Mean dmft± SD / Mean DMF±SD Intervention(550ppm): *517*; 247(48%); 1.69±2.29; 0.27±0.77 Control(1055ppm): *490*; 290(59%); 1.24±1.99; 0.22±0.65 p value: NS; NS; NS Comparison between the two groups were made using t tests

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
*Holt et al (1994) – UK [76] Quasi RCT Quality - Strong		After 4 and half years – n=1007			**Mean dmfs in relation to social class - End of study (3 years)** ***I-IIIN*** Number (%caries free teeth) 112(61%) 111(69%) dmfs 1.63 1.68 (-0.90)-(0.78) NS ***IIIM-V*** Number (%caries free teeth) 99(44%) 110(52%) dmfs 3.06 2.46 (-0.32)-(1.52) NS

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & Duration of follow-up	Outcome measure	Results
*Davies et al (2002) UK [77] RCT Quality-Strong	Free tooth paste either of 440ppm fluoride or 1450ppm fluoride compared to no free tooth paste (3 groups)	7422 Mean 12 months	Parents Study ended after 5½ years No Follow-up	-%caries experience -dmft	1450ppm **(A)** / 440ppm **(B)** / control **(C)** / **p value** **ANOVA pair wise comp** **Sample size** 1186 / 1176 / 1369 **Mean dmft(SD)** 2.15(2.96) / 2.49(3.16) / 2.57(3.16) **ANOVA p=0.002** A vs C 0.002 A vs B 0.020 B vs C 1.0 **Caries experience** dmft=0 n(%) 588(50%) / 498(42%) / 580(42%) NS dmft>0 n(%) 598(50%) / 678(58%) / 789(58%) χ^2_2=17;p= <0.001 ***Comparison of mean dmft between groups for all children examined (intention to treat) and imputing mean and SD from control group for children not examined*** **All children** 1696 / 1677 / 1655 **ANOVA p=0.001** Mean dmft(SD) 2.21(2.99) / 2.47(3.18) / 2.60(3.20) A vs C 0.001 A vs B 0.049 B vs C 0.71 **Imputed data** 2488 / 2472 / 2462 Mean dmft(SD) 2.33(3.06) / 2.51(3.19) / 2.60(3.20) **ANOVA p=0.009** A vs C 0.009 A vs B 0.13 B vs C 0.96
Hargreaves & Chester (1973) UK [78] RCT Quality-Moderate	2% sodium monofluorophosphate vs. placebo tooth paste	316 Mean 5.4 years	Parents Study ended after 3 years No follow-up	-DFT -DMFT -DFS -DMFS	**Test paste** / **Placebo tooth paste** ***Sample size*** ***163*** / ***140*** *No baseline differences between groups for D(M)FS and D(M)FT values* **Reduction in increment** / **(% reduction in increment)** DFT 0.25 (11%) DMFT 0.28 (11%) DFS 1.0*** (21%)*** DMFS 1.32** (23%)** ** p<0.01 *** p<0.001 statistical significance by students t test – comparing difference in increment between control and the test groups

4.1.2d Fluoride gel

One study out of 12 studies on topical fluorides by Englander et al [79] looked at the topical application of fluoride gel drops, the results of which are presented in table 4.1.2c. Englander et al compared the self-application of acidified gel drops containing fluoride to placebo gel-drops. The self-application for 3 minutes was assisted by dental hygienists or parents and was carried out three times a week during the 8-month study period. There was no statistically significant difference in the mean DEFT and DEFS increments between the test and the placebo group at the end of the study or after a follow-up of 20 months. It is assumed that an independent t-test was conducted. The authors claim that 70% of children were caries-free at the beginning of the study and out of these, 81% in the treatment group and 65% in the placebo did not develop new caries.

4.1.2e Fluoride solution

Another study, out of the 12 topical fluoride studies, by Lincir & Rosin-Grget[80] looked at the topical application of fluoride solution. The results are presented in table 4.1.2c. This study had three treatment groups and a control group. The first group (A) received topical applications of conventional amine fluoride solution with 1% fluoride five times a year. The second group (B) received applications of half strength fluoride solution (0.5% F) five times a year. The third group (C) received 0.5% fluoride solution, but the frequency was increased to ten times a year and the fourth group (D) was treated with a placebo solution. The results showed that the lowest dmft and dmfs caries increment was found in group C that received 0.5% F solution/10 times a year and the highest dmft and dmfs caries increment was found in the placebo group. Comparison of differences in mean increments between the groups showed statistically significant differences for dmft caries increments between groups C and D. For dmfs, both groups A and C showed benefits and were significantly different, to group D (placebo). Group C experienced 30.8% fewer new dmf teeth and 34.4% fewer new dmf surfaces than the placebo group D. Group A experienced 23.1% fewer instances of new decay and 31.3% fewer new dmfs than the placebo group D.

More frequent topical applications of low fluoride solutions (0.5%F /10 times a year) or the less frequent application of high fluoride solution (1%F /5 times a year) produced statistically significant differences in caries experience compared to the placebo group. However, there were no statistically significant differences observed between the groups that used the high and the low concentration of fluoride solution.

Table 4.1.2c Topical gel-drops/solution interventions

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
Englander et al (1978) USA[79] RCT Quality-Weak	Topical application of 1.1% fluoride gel/drops vs. placebo	231 Mean 4.8 years	Self application assisted by dental hygienists 20 months	-DEFT -DEFS	**End of study (8 months)** ***Sample size*** ***119*** ***112*** Mean (SE) DEFT increment 0.54(0.10) 0.33(0.07) NS DEFS increment 1.03(0.18) 0.87(0.18) NS **After 28 months** ***Sample size*** ***46*** ***44*** Mean DEFS increment 1.79 2.11 NS † Assume independent t test
Lincir & Rosin-Grget (1993) Croatia [80] RCT Quality-Moderate	Topical fluoride solution (1% F) and (0.5%F) vs. placebo	234 3-4 years	Dentists Study ended after 2 years No follow-up	-dmft -dmfs -% caries reduction	**1% F (A) 5times/yr** **0.5%F (B) 5 times/yr** **0.5%F(C) 10 times/year** **Placebo(D) 5 times/yr** ***Sample size*** ***55*** ***53*** ***61*** ***30*** No statistical difference between the four groups at baseline Mean (SD) **dmft increment** **4.0(3.3)** **4.8(3.6)** **3.6(2.8)[a]** **5.2(3.6)[b]** **dmfs increment** **9.0(8.9)[a]** **9.8(7.4)** **8.6(8.5)[a]** **13.1(11.5)[b]** Non-parametric Kruskal Wallis analysis and analysis of variance **Dunnett's one tailed t-test used to determine which group differed from others – a < b at 5% level**

4.1.2f Fluoride paste

One study out of 12 studies on topical fluorides, by Schutz et al[81] compared the topical application of acidulated paste with 1.2% fluoride to a placebo paste with no fluoride and the results are shown in table 4.1.2d. At the end of 2-year study period no statistically significant differences were observed between the test and the placebo groups.

4.1.2g Fluoride mouth rinse

Another study, out of 12 studies on topical fluorides, by Horowitz et al[82] compared the effect of a mouth rinse to a placebo. The treatment group rinsed with a 0.2% Sodium Fluoride (NaF) solution containing approximately 0.1% fluoride ion once a week at school and the placebo group rinsed once every month with a placebo solution containing sodium chloride at school. The results presented in table 4.1.2d show that the differences in means between the treatment and the control group were not statistically significant, neither at 12 nor 20 months. The treatment group developed 34% fewer Dmf teeth and 30% fewer Dmf surfaces than children in the control group. However, these results were not significantly different. After 20 months, the differences dropped to 25% and 16% respectively, again not statistically significant. When mean Dmfs increments were compared between the groups according to the status of tooth eruption, no statistically significant difference was observed between the teeth that were present at baseline and those that erupted during the study. The authors go on to claim that the percentage difference in Dmf surfaces between the groups, in favour of test group, was greater in the teeth that erupted during the study than those present at baseline (42% vs. 9.7%). However, this is difficult to verify from the presented data and, given the statistically non-significance of results between the groups, this comparison seems inappropriate.

Table 4.1.2d Topical paste/mouth rinse interventions

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
Schutz et al (1974) USA[81] Quasi RCT Quality - Weak	Topical application of paste with 1.2% fluoride vs. placebo paste	97 3-5 years	Dental hygienist Study ended after 2 years No Follow-up	-defs -% reduction	No significant baselines differences between the groups **After one year of study** — **fluoride paste** — **placebo** — **p value†** ***Sample size*** — ***51*** — ***46*** Mean defs increment — 1.43 — 1.57 — 0.50 (NS) **End of 2 years of study** — **fluoride paste** — **placebo** — **p value†** ***Sample size*** — ***20*** — ***20*** Mean defs increment — 4.65 — 4.04 — 0.10(NS) † student two tailed t-test was used - comparing groups
Horowitz et al (1971) USA [82] RCT Quality - Moderate	Mouth rinse using 10ml solution with 0.1% fluoride ion vs placebo solution	493 5 years	Self but supervised by teachers Study ended after 20 months No follow-up	-dmft -% difference	No significant baselines differences between the groups **Mouth rinse** — **Placebo** — **% diff** — **p value** ***Sample size*** — ***133*** — ***123*** **After 12 mths of study– Mean (SE)** DMFT increment — 0.35(0.08) — 0.53(0.08) — 34% — 0.12 DMFS increment — 0.69(0.14) — 0.98(0.14) — 29.6% — 0.14 **End of 20 months of study –Mean (SE)** DMFT increment — 0.54(0.10) — 0.72(0.09) — 25% — 0.17 DMFS increment — 1.08(0.17) — 1.29(0.17) — 16.3% — 0.40 **Mean DMFS increments after 20 months according to the status of tooth eruption** **Mouth rinse** — **No mouth rinse** — **% diff** — **p value** **Teeth present at baseline** DMFS increment — 0.93 — 1.03 — 9.7% — 0.66 **Teeth erupted during study** DMFS increment — 0.15 — 0.26 — 42.3% — 0.20

4.1.3 Systemic Fluorides

Out of 4 studies that looked at systemic fluoride interventions, two examined fluoride drops [83;84] and two examined fluoride tablets [85;86].

Quality: Both the studies of fluoride drops were weak in quality (see table 4.1.3a) and of the two studies considering fluoride tablets, one was weak in quality and one was strong (see table 4.1.3b).

Summary: Of the systemic fluorides, fluoride drops seemed to be effective and have time-related benefits. Prenatal fluoridation with fluoride tablets was effective in one study, while in the other, the ethical obligations of the study to give postnatal fluoridation to the babies involved may have had a confounding effect on the outcome.

4.1.3a Fluoride drops

The study by Hennon et al [83] had two groups. The treatment group received a fluoride-vitamin supplement containing Vitamin A, C and 0.5mg fluoride. The control group received identical vitamin drops without fluoride. The children were newborns to five years of age. The results are presented in table 4.1.3a and show a statistically significant difference in dmft and dmfs between the treatment and the control groups after 16 months use of fluoride drops ($p<0.02$) but not after 6 months. However, as the impact of the use of fluoride drops increased, to become highly significant ($p<0.001$) after 36 months, this indicates that greater benefits may result from the increased length of product use. After 36 months of use there were no statistically significant differences in the DMFTand DMFS values for permanent teeth between the control and treated group. This could be because of the very small number of children who had permanent teeth during the study period (4 children with 6 months exposure to fluoride drops and 40 children with 36 months of exposure).

The study by Hamberg [84] also compared the use of vitamin drops with and without fluoride, starting when the children were 2 to 3 weeks old. The results presented in Table 4.1.3a showed that there was no statistically significant difference between the treatment and the control group for the initial two years of the use of drops. At the age of three, the children in the treatment group had a 57% lower incidence of caries compared to the children in the control group who did not receive fluoride. In 5 year olds the incidence was decreased by 50% and in six year olds by 49%. However, statistical significance was not reported in the paper and measures of variability were not available. The authors also reported that few children were followed up when they were 10 years of age but no results of the 10-year follow-up were presented in the paper.

In summary, fluoride drops given to children as young as newborns, reduced the development of caries, although the effect was increased and became statistically more significant with their prolonged usage.

Table 4.1.3a Systemic fluoride drops interventions

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
Hennon et al (1966) USA[83] RCT Quality-Weak	Fluoride- vitamin supplement drops with 0.5 mg of fluoride vs identical vitamin supplement without fluoride (placebo)	436 0-5 years	Not stated Not clear	-deft -defs -% difference	No significant differences between groups at baseline Mean(SD) **Fl drops** **No Fl drops** **% diff** **p value** ***Sample size*** ***224*** ***212*** **After 6±2mths usage** deft 3.50(0.85) 4.50(0.61) 22.2 NS defs 5.18(1.46) 6.35(1.18) 19.8 NS **After 16±2mths usage** deft 3.72(0.66) 5.94(0.63) 37.4 <0.02 defs 5.84(1.18) 9.92(1.35) 41.1 <0.05 **After 35±3 mths usage** deft 3.04(0.40) 6.81(0.54) 55.4 <0.001 defs 4.56(0.77) 12.38(1.32) 63.2 <0.001 **After 6±2mths usage** ***n=2*** ***n=2*** DEFT 0.00 1.00 100 NS DEFS 0.00 1.00 100 NS **After 35±3 mths usage** ***n=17*** ***n=23*** DEFT 1.65(0.41) 2.57(0.38) 35.8 NS DEFS 2.47(0.70) 4.30(0.72) 42.6 NS
Hamberg (1971) Sweden [84] RCT Quality-Weak	Drops containing Vitamin A and D with 0.5mgs of fluoride/10 drops daily vs vitamin drops without fluoride	705 2-3 weeks	Nurses and parents 3 years	-mean number of decayed teeth -% reduction	**Mean number of decayed teeth showing cumulative frequency at age of 1 to 6 years** ***Sample size*** ***342*** ***363*** **Age in yrs** **Fluoride drops** **No fluoride drops** **% reduction*** 1 0.0 0.0 - 2 0.1 0.1 - 3 0.6 1.4 57% 4 1.6 3.4 54% 5 2.2 4.4 50% 6 2.7 5.2 49% * control group - fluoride group / control group x 100

4.1.3b Fluoride tablets

Two studies [85;86] considered systemic fluoride tablets. The results are presented in table 4.1.3b. The study by Glenn et al[85], compared the supplementation of sodium fluoride tablets with 1mg of fluoride in pregnant mothers from the 3rd to the 9th month of pregnancy, with no prenatal fluoride (PNF) supplementation. The children were followed up to 9 years of age. There were four groups: Group I was a control sibling group, in which the mothers did not receive prenatal fluoridation; Group II was a fluoride sibling group in which the mothers received fluoride tablet supplementation for one pregnancy, but not during another; Group III was an only child group, who received PNF and Group IV were mothers who were carrying twins who received PNF. They reported only on results comparing Group I (control group) with Group II siblings who received PNF. Statistically significant differences were found between the control group and PNF siblings for both DFS and the percentage of caries-free teeth.

Then, the PNF sub groups were later grouped to their own group-matched non-PNF sub groups. However, these sub groups were randomly selected. In the other group matched comparisons, although the PNF groups had lower DFS values and more caries-free teeth, statistical significance levels were not reported in the paper.

The comparison of all children together was then considered, with and without prenatal fluoridation supplementation, which showed a statistically significance difference in both the dfs values (0.17± 0.07 in treatment group and 8.7 ± 0.6 in control group) and the percentage of caries-free teeth (97% in the treatment group and 15% in the control group).

The study by Leverett et al[86] also compared prenatal fluoride supplementation, using tablets with 1mg fluoride ion with placebo tablets. Mothers were given one tablet daily from the 4th month to the 9th month of pregnancy. The results (table 4.1.3b) showed no statistically significant difference in the dfs values in the children at 3 years and at five years of age. However, because of ethical obligations postnatal fluoride drops were given to all the children, irrespective of the study group of the mothers. This could explain the statistically non-significant differences that were observed between groups.

Two studies were identified which looked at combinations of topical and systemic fluorides and these results are presented in section 4.1.11 where the combination interventions are considered.

Table 4.1.3b Systemic fluoride tablet interventions

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
Glenn et al (1982) USA[85] RCT Quality-Weak	Prenatal Fluoride (PNF) tablet supplementation with 1mg Fluoride ion during pregnancy vs. no fluoride tablets	492 Mothers age not reported	Self administered 9 years follow-up in children	-DFS -% caries-free teeth	See nested table below
Leverett et al (1997) USA [86] RCT Quality-Strong	Pre natal fluoride (PNF) tablet supplementation with 1mg fluoride ion during pregnancy vs. placebo with no fluoride	1175 Mothers-mean age 31.1 yrs	Self administered 5 years follow-up in children	-dfs -risk ratio	See nested table below

	Control(I)	Sibling(II)		only child (III)		Twins (IV)		p value
	No PNF	**No PNF**	**PNF**	**No PNF**	**PNF**	**No PNF**	**PNF**	
Sample size	***210***	***98***	***95***	***47***	***10***	***20***	***12***	
DFS	8.2[b]	11.1[c]	0.2[a]	5.7	0	9.2	0	<0.001*
% caries-free teeth	19%	0%	97%	19%	100%	25%	100%	<0.001*

*Group I (control) compared to Group II PNF; and Group II (PNF) vs (Non PNF) :a < b and a < c at 0.001

All children	**With PNF**	**Without PNF**	**p value**
Sample size	***117***	***375***	
DFS (SD)	0.17(0.07)	8.7(0.6)	<0.0001
% caries-free teeth	97%	15%	<0.001

At 3 years	**PNF**	**No PNF**	**Risk ratio(95%CI)**	**p value**
Sample size	***464***	***474***		
dfs (SD)	0.24(1.59)	0.12(0.94)		NS†
dfs per 1000 surfaces	2.7	1.3	2.07(0.82-5.24)	NS‡
At 5 years	**PNF**	**No PNF**	**Risk ratio(95%CI)**	**p value**
Sample size	***398***	***400***		
dfs (SD)	0.45(2.55)	0.50(2.83)		NS†
dfs per 1000 surfaces	5.2	5.7	0.90(0.41-1.97)	NS‡

† Assuming two-sample t test

‡Risk ratios derived from poisson regression using generalised estimating equations adjusted for sex

4.1.4 Sealants

Three studies [87-89] looked at sealant interventions in children under five years of age.

Quality: One study was strong in quality, one was moderate and the other was weak (see table 4.1.4).

Summary: Sealants if retained, could be effective in preventing caries in sealed tooth surfaces in children under five years of age.

The study by Poulsen et al[87] compared the effect of bis GMA (Bisphenol A Glycidyl Methacrylate) type fissure sealant with Consise Enamel Bond System to no sealant on all permanent teeth. The results are presented in table 4.1.4,. Using a 3 way factor association (Initial dmfs, group and caries increment), the results showed no statistically significant differences in dmfs values between the groups. There was a statistically significant difference between the groups in the number of new fillings placed during the study period (46.1 in the treatment group and 54.1 in the control group). In this study more than half of the intended sites were already erupted and about two thirds of these were already diagnosed as carious or restored. Therefore, the sealant could only be provided on less than half of the non-erupted sites and on one third of the erupted sites. The effect of the sealant appeared to be greater on the newly erupted teeth. At the end of 2 years, out of the number of sites sealed, sealants were completely retained in 58.2%, partially lost in 14.5% and completely lost in 27.3%.

The study by Horowitz et al[88] used half mouth design so that each child served as his or her own control. Occlusal surfaces in sound pairs of permanent teeth in one half of the mouth were treated with the sealant while the contralaterally matched teeth served as an unsealed control. The side of the mouth to be treated was determined by random assignment. Results in table 4.1.4 show that the sealant was 30% effective in preventing occlusal caries after 5 years (the formula used by the authors to calculate the effectiveness is given in table 4.1.4). In 27 pairs the treated occlusal surfaces remained sound and caries developed in untreated occlusal surfaces. By contrast, in only 6 instances did caries develop in a sealed tooth, while its matching control tooth remained sound. Eighty percent of occlusal surfaces of control teeth had decayed after five years, while only 56% of sealed teeth had decayed. However, statistical significance levels were not reported in the paper.

The authors reported that 42% of the initially sealed, paired sites still retained sealant, 14% had sealant partially missing and 44% had no visibly retained sealant. 62% of 106 sites, from which the sealant had been entirely lost, were classified as decayed, missing or filled (dmf) compared to 82% in the unsealed sites. Out of 21 sites, where the sealant was partially missing 10% were carious after 5 years compared to 71% in the unsealed site. Out of 10 sites in which sealant was all present 10% were carious compared to 80% in the unsealed site. This study appeared to show that if the sealant is retained it could be effective in preventing caries in sealed tooth surfaces.

The study by Mertz-Fairhurst et al[89] again used a half mouth design. This study compared the use of a sealant with no sealant. In addition, two types of sealants were compared (Delton and Nuva-Seal). The side of the mouth that received the sealant and the type of sealant was randomly determined. Children were followed up 7 years after a single application of sealant. There is some dubiety about the results presented in table 4.1.4. Statistically significant differences were observed in caries experience between the treated teeth, with complete sealant retention, and the contralateral control teeth (A versus B; p=0.005). However, the authors state that there was no statistically significant differences in caries experience between the treated teeth and the contralateral control teeth, with partial retention or complete loss of sealant (C versus D; p=0.010). The P value quoted is in fact statistically significant, but may be an error in the transcript. Taking the authors interpretation, the effectiveness of sealants depends on the retention of sealant. This is emphasised by the comparisons of caries experience between the treated teeth, with complete retention, and treated teeth with partial retention (A versus D; p=0.005). However, there was also a statistically significant difference in the carious control teeth if there was complete sealant retention or loss of sealant in the contralateral treated tooth (B versus C; p=0.005). There was 59% carious control teeth with complete retention vs. 85% carious teeth with the loss of sealant.

The study also looked at the effectiveness of different kinds of sealants and showed that seven years after a single application of a sealant, there was 55% effectiveness for Delton compared to 12% effectiveness in Nuva-Seal. In addition, the retention rate was statistically significantly better for the Delton sealant.

Table 4.1.4 Sealant Interventions

Author (Year), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
Poulsen et al (1979) Denmark [87] RCT Quality- Moderate	Sealant application vs. no sealant	256 Kindergarten	Dentists and dental hygienists Study ended after 2 years No Follow-up	-DMFS -FS	**Averaged over 3 factors: Initial dmfs, group and caries increment** **End of 2 years- DMFS** — **Sealant** — **n** — **No sealant** — **n** — **p value** ***Sample size*** — ***89*** — ***98*** 0 — 20.2 — 18 — 15.3 — 15 1 — 16.9 — 15 — 17.4 — 17 2 — 18.0 — 16 — 14.3 — 14 3 — 14.6 — 13 — 11.2 — 11 ≥4 — 30.3 — 27 — 41.8 — 41 — NS (G=26.998;22df) **FS (n)-new fillings** 0 — 22.5(20) — 23.5(23) 1 — 10.1(9) — 6.1(6) 2 — 12.4(11) — 9.2(9) 3 — 9.0(8) — 7.1(7) ≥4 — 46.1(41) — 54.1(53) — <0.01 (G=42.358;22df) association between 3 factors-Initial dmfs, group, caries increment using G statistic tested against the χ^2 – distribution

Author (Year), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	**Results**
Horowitz et al (1977) USA[88] RCT Quality- Strong	Sealant vs. no sealant	128 5-8 years	Dentists 5 years	-% difference - occlusal DMF score	**Occlusal caries status of tooth pairs** *Treated Sound/ Control DMF* | *Treated DMF/ Control sound* | *Treated DMF/ Control DMF* | *Treated Sound/ Control sound* | % diff* **4 yrs (n=78)** 34 | 8 | 44 | 18 | 33% **5 yrs(n=66)** 27 | 6 | 44 | 12 | 30% * No of pairs with DMF control teeth – no. of pairs with DMF treated teeth ÷ no. of pairs with DMF control teeth **Occlusal DMF score per 100 teeth** | **Sealant** | **No sealant (control)** At 4 yrs | 50.0 | 75.0 At 5 yrs | 56 | 80 **Dental caries status of paired sties according to the retention status of sealant** *Sealant status* | *All missing* Classified D,M,F Treated / Control | *Partially missing* Classified D,M,F Treated / Control | *All present* Classified D,M,F Treated / Control At 5 years | 62% / 82% | 10% / 71% | 10% / 80%

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
Mertz-Fairhurst et al (1984) USA [89] RCT Quality-Weak	Sealant vs. no sealant	382 5 years	Dentists and dental assistants 7 years after single application	% effectiveness of sealant	**7 years after single application (n=140)** — **% carious teeth** **A** Carious treated teeth with complete sealant retention — 10% **B** Carious control teeth with complete sealant retention — 59% **C** Carious control teeth with partial or complete loss of sealant on contra lateral treated tooth — 85% **D** Carious treated teeth with partial or complete loss of sealant — 90% **Group comparisons** — **χ^2** — **p value** A vs B — 58 — 0.005 D vs C — 1.0 — 0.010 (authors state NS) A vs D — 141 — 0.005 B vs C — 21 — 0.005 **7 years after single application** **Delton** — **Nuva-Seal** — **p value** ***Sample size*** — ***67*** — ***73*** % effectiveness — 55% — 12% ***% effectiveness = net gain = (success – failures) x 100/total no. carious control teeth.*** **% Retention** Complete retention — 66% — 31% Partial retention — 14% — 19% No retention — 20% — 50% — χ^2=130;<0.005

4.1.5 Chlorohexidine Interventions

Three studies [90-92] looked at chlorhexidine interventions. In one study the target population was the children, while in the other two studies it was the mothers.

Quality: The study conducted with children was moderate in quality. Out of two studies conducted with mothers, one was of moderate quality and one was weak (see table 4.1.5).

Summary: Chlorhexidine gel applied to children's teeth had a positive effect in reducing the frequency of caries in children. This was based on one study. However, chlorhexidine applied to the mother's teeth did not have the effect in either reducing the number of bacterium in children nor in decreasing the prevalence of caries in children.

In one Study by Gisselsson et al, [90] the target population was children. The study had three groups that compared chlorhexidine (CHX) gel with either a placebo gel or a control group that did not receive any gel treatment. The chlorhexidine gel group received 1% chlorhexidine every third month from the age of 4 years for a 3-year period. The placebo group received an identical gel, but without chlorhexidine. The results are presented in table 4.1.5 and show that the group that received chlorhexidine gel developed statistically significantly fewer defs (Incidence of 2.59), compared to the placebo group (incidence of 4.53) and no gel group (incidence of 4.20) during the 3-year study period. At the end of the study period, the deft, defs and fs values were statistically significantly lower, in the CHX group compared to the placebo and the control group.

The authors report in the text that the number of children who *did not* develop any caries lesions in the three-year study period was significantly higher in the chlorhexidine group (49.2%) compared to the placebo (29.3%) and the control group (25.9%). They also report that in the chlorhexidine group, more of the children (51.9%) who were without caries or fillings at baseline remained caries-free during the 3-year period, than in the placebo group (30.4%) and in the control group (28.6%).

In the other two studies the target population was mothers. In the study by Tenovuo et al,[91] at the age of 1 year, the child-mother pairs were divided into three groups on the basis of the levels of Mutans Streptococci (MS) in maternal saliva. The mothers who had higher MS levels were randomised into two groups. The treatment group was given chlorhexidine (1%)-sodium fluoride (0.2%) gel treatment twice a year, for 3 years (group A). In the control group, the mothers also had high levels of MS, but no gel was given (group B). Furthermore, a second control group was randomly selected from the mothers who had low levels of Mutans Streptococci (MS). In this second control group, no chlorhexidine gel was given (group C). However, the statistical analysis was only carried out on data from group A and group B. When the caries prevalence (mean dft) in children whose mothers who had high initial MS counts were analysed the results show that, those children

whose mothers had received chlorhexidine gel (group A) had fewer caries, both at 3 and 4 years of age than those whose mothers who had not had the gel (group B) although, these differences were not statistically significant. Lower caries incidence was reported by the authors for children in group C (in which the mothers had the lowest salivary MS), however, no statistical analysis was performed on the data from this third group.

The study also looked at the MS positive samples in the children at various ages in the different study groups. At the end of the study, although the highest colonisation rate was found in the children whose mothers had high MS counts but who had received no gel (group B) and the lowest rate found in group A, these results were not statistically significant. The authors also report that only 4/70 (5.7%) of MS negative children developed caries during the study period compared to 23/81 (28%) of the MS colonised children. The association of MS in children with the subsequent development of caries was statistically significant ($\chi^2 = 11.668$; $p < 0.001$), although this particular result was not tabulated in the paper. The results also showed that the earlier the colonisation by MS, the higher the number of decayed teeth at 4 years of age (table 4.1.5).

This study emphasises that the earlier the colonisation by MS in children, the higher the number of decayed teeth. However, it does not show any statistically significant difference in the MS levels in children between the mother treatment groups in that no significant benefit was observed in applying chlorhexidine (CHX) gel to mothers with high MS levels to prevent caries in children.

The study by Dasanyake et al[92] compared the application of 10% chlorhexidine varnish in mothers to a placebo varnish. The CHX varnish was first applied to the mothers when their babies were about 6 months old, (which was the approximate time of first tooth eruption) with four weekly applications at 6- monthly intervals for 3 years. The mother-child pair was followed up until the child's fourth birthday. The results showed that there was no statistically significant difference in the caries increment either among mothers or among children between the study groups. There were also no statistically significant differences in the percentage of children with detectable levels of *Streptococcus Mutans* during the study period between the treated and the control groups. However, the authors reported that in mothers, there was a considerable reduction in the levels of *Streptococcus Mutans* in the treatment group compared to the control group. The statistical significance levels were not reported.

Table 4.1.5 Chlorhexidine gel/varnish Interventions

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & Dura follow-up	Outcome measure	Results
Gisselsson et al (1994) [90] Sweden RCT Quality-Moderate	Chlorhexidine gel vs. placebo gel vs. control with no gel	291 4 years	Trained dental nurse Study ended after 3 years No Follow-up	-defs -deft -fs	See below

	CHX (A)	Placebo gel (B)	No gel (C)	p value
Sample size	***59***	***58***	***116***	
Mean defs				
Baseline	0.19	0.03	0.40	NS
Incidence (3yrs)	2.59	4.53	4.20	A vs B <0.01† A vs C <0.01†

End of 3 yrs of study - Mean (SD)

	CHX (A)	Placebo gel (B)	No gel (C)	p value
deft	1.98(2.57)	2.43(2.80)	3.03(3.51)	A vs C<0.05†
defs	2.78(3.27)	4.57(4.04)	4.60(4.86)	A vs B<0.01† A vs C<0.05†
fs	0.33(0.74)	1.04(1.62)	0.80(1.53)	A vs B<0.01† A vs C<0.05†
Children who did not get any caries lesions	49.2%	29.3%	25.9%	A vs B <0.05‡ A vs C <0.01‡
Children with caries-free teeth and remained caries-free	51.9%	30.4%	28.6%	A vs B <0.01‡ A vs C <0.01‡

†ANOVA used to test differences between means in subgroups
‡ Mann-Whitney U - test

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & Dura follow-up	Outcome measure	Results
Tenovuo et al (1992) Sweden [91] RCT Quality- Weak	Chlorhexidine 1% -NaF 0.2% vs no gel (three groups)	202 Mother-child pairs Children were one year old Mothers age NR	Not mentioned Study ended after 3 years No Follow-up	-dft	**High MS/ CHX gel (A)** / **High MS/ No gel(B)** / **Low MS/ No gel (C)** / **p value** ***Sample size*** ***56*** / ***50*** / ***45*** Mean dft At 3 yrs 0.10 / 0.46 / 0.02 / A vs B – NS‡ At 4 yrs 0.59 / 0.68 / 0.18 / A vs B – NS‡ **No of MS-positive samples in children at various ages- Number (%)** At 2 years 11 (20%) / 5 (10%) / 8 (18%) / NS† At 3 years 20 (36%) / 24 (48%) / 19 (42%) / NS† At 4 years 28 (50%) / 29 (58%) / 24 (53%) / NS† **Number of children with new caries and dft at 4 years of age in relation to time of colonisation by MS in whole study population** *Time of Colonisation years* / *number of children with caries* / *Mean dft* 2 / 8 / 3.13 / ANOVA 3 / 10 / 3.80 / F=4.23 4 / 5 / 1.40 / p <0.01 not colonised / 4 / 1.25 † χ^2 test – difference in colonisation ‡ ANOVA

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & Dura follow-up	Outcome measure	Results
Dasanayake et al (2002) USA [92] RCT Quality-Moderate	10% chlorhexidine varnish vs. placebo varnish	75 Mean mothers age 20.1years	Dental hygienist One year	-dft -dfs	No baseline diff in mothers DMFT/DMFS or children's characteristics **CHX varnish** / **Placebo varnish** / **p value** ***Sample size*** ***33*** ***33*** Caries Increment (SD) **Mother** DMFT 2.3 (3.9) 2.6 (2.4) NS† DMFS 4.6 (8.5) 3.5 (4.5) NS† **Child** dft 2.5 (3.7) 2.1 (2.4) NS† dfs 2.5 (3.7) 3.8 (7.8) NS† % Children colonised with MS 36.1% 40.5% NS‡ † presume t-test; ‡ presume chi-square test - both mentioned in text

4.1.6 Topical Iodine Interventions

Two studies [93;94] out of 42 studies, looked at the efficacy of antimicrobial therapy in the prevention of caries in children.

Quality: Both the studies were moderate in quality (see table 4.1.6).

Summary: The results show that the application of topical iodine to children's teeth appeared to be effective in preventing caries in children, but topical iodine application to mothers' dentition at the time of the first tooth eruption in children did not seem to have any effect on their children.

The study by Lopez et al[93] compared the topical application of 10% povidine iodine to a placebo. Children were 12-19 months of age and had *Streptococcus Mutans* positive cultures from the teeth plaque. A 10% Iodine solution was applied to the teeth every 2 months for 12 months. The results are presented in table 4.1.6. White spot lesions on the teeth were observed in 8% of the children in the treatment group compared to 32% in the placebo group. Using a log-rank test, the results showed that the hazard of treatment failure was statistically significantly higher in the placebo group than in the treatment group.

The study by Dasanayake[94] evaluated the effect of Iodine-NaF applied to the mothers' dentition compared to a placebo. The mothers had high *Streptococcus Mutans* levels and the topical iodine was applied to the mothers' dentition when the child was about 7 months old (i.e. at the time of first tooth emergence). The results did not reveal a significant difference in the percentage of children with caries between the treatment and the control group (table 4.1.6).

Table 4.1.6 Topical Iodine Interventions

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
Lopez et al (2002) Puerto Rico[93] RCT Quality-Moderate	10% topical Iodine vs. placebo	83 Mean 15.6 months (range 12-19 months)	Not mentioned Not reported	White spot lesions	**End of study (12mths)** / **Topical Iodine** / **Placebo** / **p value** ***Sample size*** / ***39*** / ***44*** White spot lesion / 8% / 32% Disease free survival % (±SES) / 91±5%† / 54±9%† / 0.0013‡ † Kaplan-Meier procedure ‡Log-rank test - statistic
Dasanayake (1993) USA[94] RCT Quality-Moderate	Iodine –NaF solution applied to mothers dentition vs. placebo	62 Mothers age 22-24 years	Dental hygienists 3 years in children	% teeth with caries	No significant baseline differences in DMFT and DMFS in mothers **I^2 – NaF** / **Placebo** / **p value** ***Sample size*** / ***23*** / ***25*** % with caries At 2 years / 17.4 / 4 / 0.18 (NS) † At 3 years / 30.4 / 16 / 0.24 (NS) † †Student t test was used

4.1.7 Tooth Brushing Techniques

The studies presented in this section were primarily focused on tooth brushing techniques rather than the use of fluoride toothpastes. The concomitant use of fluoride toothpaste was considered as a potentially confounding factor in these studies, and hence its use is presented separately. Two studies published in three papers,[95-97] looked at tooth brushing techniques in the prevention of caries in children under five years of age. However, two of these papers were based on one study, with each paper presenting slightly different aspects of the intervention. The paper by Pine et al [95] concentrated more on the qualitative aspects, with the presentation of few quantitative results, while the paper by Curnow et al [96] reported the quantitative results in detail.

Quality: All the three papers were moderate in quality (see table 4.1.7).

Summary: The supervision of tooth brushing on school days and the encouragement at home of regular tooth brushing with fluoridated toothpaste can lead to a significant reduction in caries in high risk communities (e.g. deprived areas). Modified toothpaste techniques were more effective in preventing caries in pre-school children than non-specified methods of using toothpaste.

For the study reported by Pine et al in 2000 [95] and Curnow et al in 2002, [96] supervised tooth brushing in school at lunch time combined with a home incentive scheme to brush twice daily during holidays with fluoride toothpaste was compared with no intervention. The results are presented in table 4.1.7 and show a statistically significant difference in the D_3FS increment between the treatment and the control group. At the end of the study when the mean caries value was compared by group, according to the children's brushing frequency at home, there was a statistically significant 64% difference in the caries experience of the control group, between brushing once a day or less and brushing twice a day or more; with brushing more frequently being beneficial. For the treatment group, this resulted only in a 16% non-significant difference. This indicates that although, supervised tooth brushing in schools, combined with home brushing was effective in reducing caries, children who brushed twice daily at home, irrespective of a supervised school regime, had fewer caries compared to children who brushed on one occasion. This study also included a survey of the participants who were from a deprived area, with a DEPCAT of 5 and 6. This revealed that the cost of toothbrushes and toothpaste were potential barriers to regular tooth brushing, while parental feelings, that there was no time to check their children's tooth brushing constituted an additional important barrier.

The same authors reported upon extended results in 2002. [96] In their previous report the researchers excluded 21 children, whose permanent molars had not erupted, from the analysis of caries increment. However, in this paper they reported the DFS caries increment of the first permanent molars including those 21 children, by examining them both clinically and by fibre-optic illumination. They also reported the caries increment 12 months after the eruption of the first permanent molars. The results in table 4.1.7 (Curnow et al

2002) show that there were statistically significant differences in the caries increment between the treatment and the control group at the end of the study. The authors report in the text that when clinical FOTI results were compared, the children in the intervention group had 32% fewer D_1 lesions (95% CI 4-60%) and 56% fewer D_3 lesion (95% CI 13-100%) in their permanent molars than children in the non-intervention group. The results remained statistically significant at the D_3 levels (and at D_1 level only on clinical data) when data were stratified by dental immaturity.

The study also included an analysis of the caries increment 12 months after the eruption of the first permanent molars; which also remained significantly different. The supervision of tooth brushing on school days and the encouragement of the regular use of fluoridated toothpaste at home can lead to a statistically significant reduction in caries in deprived communities.

Another study by Sjogren et al[97] was conducted to evaluate the caries reducing effect of a modified technique involving toothpaste use. This study had four groups –The intervention group used a modified technique using toothpaste, and in turn was divided into two groups; one using toothpaste A (group I) and the other using toothpaste B (group II).

The control group used the conventional 'bass method' of using toothpaste, and was in turn divided into two groups; one using toothpaste A (group III) and the other using toothpaste B (group IV). The conventional 'bass method' was designed to remove plaque from the gingival margins. The bristles are placed at a 45° angle to the gingivae. While the brush head is kept in contact with the gingivae and tooth, the bristles are moved in small circular motions.

The modified technique included the following steps:

1. The toothpaste was squeezed over a distance of 1 cm on a wet toothbrush and was evenly spread on the teeth, which were then brushed for approximately 2 minutes.

The children were instructed;

2. Not to spit out more than necessary during brushing.
3. The remaining dentifrice foam, together with sip of water (approximately 10 ml), was used as a mouth rinse that was filtered in the dentition by active cheek movement for 1 minute before being carefully spat out.
4. No further water rinsing was recommended afterwards and no eating or drinking was allowed for 2 hrs after brushing.

The authors reported in the figures the mean dfs_{E+D} for the four original groups, probably using a two way ANOVA. There was no statistically significant difference between the four treatment groups for either the caries indices at the end of the study and at follow-up, or caries increment at the end of the study. They compared the use of toothpaste A with toothpaste B, having combined the test and the control group, and found no difference, although statistical significance levels were not reported. They also reported that the caries increment was higher in the control groups than in the treatment groups, irrespective of dentifrice used. However, no quantitative

results were reported. Ignoring the toothpaste effects, the analysis of the combined test and control groups are presented in table 4.1.7. The results show that there was a statistically significant difference between the test and the control group in dfs values which included dentine and enamel lesions, fs and new caries. The number of caries-free children was not statistically significantly different, between the groups (50% in the treatment group and 41% in the control group).

Table 4.1.7 Tooth brushing technique interventions

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
*Pine et al (2000) UK[95] Cluster RCT Quality-Moderate	Supervised tooth brushing and home incentives to brush twice vs no intervention	545 from 12 Schools 5 years	Supervised by mothers with training Study ended after 2 years No Follow-up	-D_1MFS -D_3FS	**Tooth brushing** **control** **p value** ***Sample size*** ***227*** ***213*** D_3FS increment 0.22 0.50 0.007† † Exact permutation test - distributional free equivalent of a t-test ***Mean caries experience according to the children's brushing frequency at home after 2 years of study*** **Mean D_1MFS (sd)** 1 a day (or less) ***n*** 2 a day (or more) ***n*** % drop Tooth brushing 0.75(1.42) 48 0.63(1.21) 155 16% Control 1.84(2.85) 45 0.66 (1.41)* 129 64%* *p = 0.001

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
*Curnow et al (2002) UK [96] Cluster RCT Quality-Moderate	Supervised tooth brushing and home incentives to brush twice vs no intervention	534 from 12 Schools 5 years	Supervised by mothers with training Study ended after 2 years No Follow-up	-D_1FS -D_3FS	No baseline differences between the groups **D_1FS and D_3FS increment of first permanent molars after 24 months** **Tooth brushing** **control** **p value[a]** ***Sample size*** ***239*** ***222*** *Clinical* D_1FS 0.669 1.104 0.006; 0.038[b] D_3FS 0.192 0.455 0.008; 0.019[b] *Clinical + FOTI* D_1FS 0.808 1.194 0.023; 0.108[b] D_3FS 0.205 0.477 0.007; 0.015[b] **Clinical D_1FS and D_3FS increment 12 months after eruption of first permanent molars** **Tooth brushing** **control** **p value[a]** ***Sample size*** ***208*** 193 *Clinical* D_1FS 0.466 0.736 0.03 D_3FS 0.105 0.264 0.04 *Clinical + FOTI* D_1FS 0.524 0.788 0.05 D_3FS 0.111 0.280 0.03 [a] Exact p values from two sample permutation test [b] p values after stratification by dental maturity

D_3FS Dentine lesions only; D_1MFS All carious lesion both in enamel and dentine FOTI Fibre-optic transillumination

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
Sjogren et al (1995) Sweden [97] RCT Quality-Moderate	Special tooth brushing technique compared with bass method. Each in turn had 2 groups (4 groups)	369 4 years	Dental hygienists Study ended after 3 years No follow-up	dfs_{E+D} dfs_D fs	**Groups**: I (test) Mod tech/ Tooth paste A; II (test) Mod tech/ Tooth paste B; III (control) No mod tech/ Tooth paste A; IV (control) No mod tech/ Tooth paste B ***Sample size***: ***66***; ***65***; ***80***; ***70*** **The results presented below are for test and control groups with combined tooth paste groups**

Mean (SE)	**Test (mod tech)**	**Control**	**p value†**
Sample Size	***131***	***150***	
Baseline value			
dfs_{E+D}	0.36(0.08)	0.46 (0.08)	0.37
Caries-free children	82%	77%	NS
End of study (after 3 years)			
dfs_{E+D}	1.50(0.18)	2.01 (0.18)	0.04
dfs_D	0.49 (0.09)	0.70 (0.11)	0.06
fs	0.11 (0.04)	0.23 (0.07)	0.02
new dfs_{E+D}	1.14 (0.15)	1.55 (0.15)	0.04
Caries-free children	50%	41%	NS

† Presumably t-tests having combined tooth paste

$_{E+D}$ – Both enamel and dentine carious lesions
$_D$ – Dentine carious lesions
Mod tech – Modified technique

4.1.8 Probiotic Bacterium in Milk

Quality: Strong (see table 4.1.8)

The study by Nase et al[98] compared the beneficial effects of milk containing the probiotic bacteria - Lactobacillus rhamnoses GG, ATCC (LGG) to milk without LGG in reducing dental caries in children. The children in the test group drank milk with LGG five days a week for seven months. The authors reported in the text that in the whole study population, there were no statistically significant differences between the groups. The odds ratios (OR) adjusted for caries status at baseline were - for dt/DT >0: OR= 0.80 (95% CI 0.42-1.52); for dmft/DMFT>0: OR = 0.77(0.40 – 1.46). The results of the age-stratified analysis are presented in table 4.1.8. Statistically non-significant differences were observed in all the age groups, although the results for the 3-4 year old age group were marginal and may have shown benefits with slightly larger sample sizes. However, the authors do report that LGG significantly reduced caries. At this point it is not clear which outcomes were included in the statistical analysis. They could be reporting on all measures, including occlusal, approximal and smooth surface caries. The results quoted are the baseline-adjusted odds ratio, which was 0.56 (95% CI 0.36 – 0.88, p=0.01) and when it was controlled for age and gender, the corresponding odds ratio was 0.512 (95% CI 0.32 – 0.81, p=0.004). However, the interpretation of this positive finding is questionable since the authors are not transparent about their model.

4.1.9 Xylitol Chewing Gum

Quality: Strong (see table 4.1.9)

One study by Isokangas et al[99] compared the maternal use of habitual xylitol chewing gum to fluoride and chlorihexidine varnishes. The mothers started using xylitol chewing gum three months after the birth of their baby and the use of the gum was discontinued 24 months after delivery. The mothers in the chlorhexidine and the fluoride varnish groups received three varnishes at 6, 12 and 18 months after the delivery of their baby. All the mothers were Mutans Streptococci (MS) positive before they received the intervention. The only statistically significant results were those for the dmf values at the age of 5 years in favour of the xylitol group (0.83±1.63), compared with the chlorhexidine (3.22±4.10) and the fluoride varnish groups (2.87±3.48) (see table 4.1.9). The difference between the CHX and the fluoride group was not statistically significant. In addition, the authors reported in the text that the risk ratio between the children colonised and those who were not colonised with MS at the age of two years was 3.60 (95% CI, 1.99-6.49); thereby indicating increased caries among children who were MS positive, irrespective of the mothers treatment group.

4.1.10 Personal Contact

Quality: Moderate (see table 4.1.10)

The study by Olson et al[100] assessed the benefits of personal contact compared to a standard treatment. In this study, children with a definite dental problem from two schools were randomised, either to receive a standard letter with advice to the parents for the child to be seen by a dentist (i.e. the control group), or to receive an individualised letter with a personal contact (i.e. the experimental group). In the experimental group, in addition to the standard form of letter, the parents were sent an individualised letter that explained the susceptibility and severity of the problem and the net benefit of action. A personal contact was made within three weeks. Structured personal contact was made through a standardised phone call by trained personnel, or via a home visit if the family did not have a phone. The results showed that there were statistically significant differences in the dental problems experienced between the groups for both schools. In school 1, approximately 54% of children in the treatment group had dental problems compared to 85% in the control group. In school 2, approximately 42% in treatment group had dental problems compared to 90% in the control group (see table 4.1.10). The children who received personal attention experienced statistically significantly fewer dental problems, although there were still around 50% of the children who had enjoyed personal contact who had problems of some sort and it is not clear in the paper if there was any difference in the severity of the problems experienced between those who were in receipt of or who did not receive personal contact.

Tables 4.1.8 & 4.1.9 Probiotic bacterium/chewing gum

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
Nase et al (2001) Finland [98] RCT Quality-Strong	Milk with Lactobacillus rhamnosus (LGG) vs. milk without LGG	594 Mean 4.4-4.6 years	Personnel at the care centres Study ended after 7 months No follow-up	-dt/DT -dmft/DMFT	**1-2yr old children** | **LGG in milk** | **No LGG** | **OR (CI)** | **p value** ***Sample Size*** | ***31*** | ***38*** | dt/DT>0 | 6.5% | 2.6% | NM | 0.45 dmft/DMFT>0 | 6.5% | 2.6% | NM | 0.45 **3-4 yr old children** ***Sample Size*** | ***83*** | ***81*** | dt/DT>0 | 7.2% | 17% | 0.34 (0.11-1.04) | 0.06 dmft/DMFT>0 | 9.6% | 23% | 0.34 (0.12-1.03) | 0.06 **5-6 yr old children** ***Sample Size*** | ***117*** | ***101*** | dt/DT>0 | 15% | 5% | NM | 0.71 dmft/DMFT>0 | 21% | 22% | NM | 0.76
Isokangas et al (2000) Finland [99] RCT Quality-Strong	Xylitol chewing gum in mothers vs. either fluoride or chlorhexidine varnishes (3 groups)	195 Mothers age not reprted	Dentists for the application of the varnishes 3 years	-dmf	**End of study (2years)** **Mean dmf (SD)** **Xylitol Ch gum** | **n** | **CHX Varnish** | **n** | **Fl. Varnish** | **n** All | 0.02(0.20) | 103 | 0.21(0.83) | 28 | 0.21(0.70) | 33 MS+ | 0.20(0.63) | 10 | 0.75(1.49) | 8 | 0.44(0.96) | 16 MS- | 0.00(0.00) | 93 | 0.00(0.00) | 20 | 0.00(0.00) | 17 **End of 5 years (after 3 yrs follow-up)** **Mean dmf (SD)** **Xylitol Ch gum** | **n** | **CHX Varnish** | **n** | **Fl. Varnish** | **n** All | 0.83(1.63)* | 90 | 3.22(4.10) | 23 | 2.87(3.48) | 30 MS+ | 2.22(1.99) | 9 | 6.13(4.79) | 8 | 4.40(4.08) | 15 MS- | 0.68(1.52) | 81 | 1.67(2.74) | 15 | 1.33(1.84) | 15 * The group differed significantly from chlorhexidine and fluoride groups, p=<0.001

Table 4.1.10: Personal contact

-Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results			
Olson et al (1981) USA[100] RCT Quality-Moderate	Standard letter vs. individualised letter with personnel contact	170 5 years	Trained personnel 2 months	-problems with teeth	**School 1**			
						Letter with contact	**Standard letter**	
					Sample size	***26***	***27***	
					Number (%)			
					No Problem	12 (46.2)	4 (14.8)	χ^2 = 6.17;df =1
					Problem	14 (53.8)	23 (85.2)	p=0.01
					School 2			
						Letter with contact	**Standard letter**	
					Sample size	***40***	***31***	
					Number (%)			
					No Problem	23 (57.5)	3 (9.7)	χ^2 = 17.21;df =1
					Problem	17 (42.5)	28 (90.3)	p=0.001

4.1.11 Combinations of Interventions

Six studies published in ten papers looked at combinations of interventions. Two studies, published in four papers [101-104] focused on children as the target population and considered the combination of topical and systemic fluorides. Two other studies with children, [105;106] looked at dental prevention programmes with multiple components and the remaining two studies, published in four papers, [107-110] focused on mothers as the target population and examined dental programmes with multiple components.

Quality: Two studies were strong in quality, five studies were moderate and three studies were weak (see tables 4.1.11 and 4.1.12).

Summary: Combinations of interventions are effective in preventing caries in young children, although the effective component of the combined interventions is difficult to single out.

4.1.12 Combination of topical and systemic fluorides

Two studies, published in four papers, looked at the combination of topical and systemic fluorides on children. The study by Driscoll et al (1992) [103] looked at the use of a fluoride rinse vs. fluoride tablets vs. a combination of both the rinse and tablets. The children in Group A rinsed once a week in school with a 0.2% NaF solution; the children in Group B chewed daily in school, (and then swallowed) a neutral 2.2mg NaF tablet and Group C carried out both procedures. This study had a follow-up of eight years and reported their interim results in 1987, after 2 years[101] and in 1990 after 5 years.[102] The interim results are incorporated into the results and are presented in table 4.1.11.

At the end of two years, compared to the rinse group, children in the combination group developed 33% fewer new dmfs. When findings in the tablet group were considered as a comparative standard, children in the combination group showed a smaller benefit of about 19% reduction in new decay. When the effects of the single procedures were compared, children in the tablet group experienced a caries increment that was 17.6% lower than the rinse group. Although the combined group experienced fewer caries, the statistical analysis of the incremental score among the three treatment groups, using one-way ANOVA fell short of statistically demonstrating ($p = 0.06$) the additive effectiveness of fluoride tablets and rinsing.

At the end of 5 years, the study by Driscoll et al,[102] showed that compared to the rinse group, children in the combination group developed 31% fewer new dmfs. When compared with the tablet group, the combination group developed 16.5% less new decay. When the effects of the single procedures were compared, children in the tablet group experienced a caries increment that was 17.8% lower than the rinse group. A statistical comparison of the incremental caries score using Scheff's procedure, indicated that only the difference in scores between the combined fluoride procedure and the fluoride rinse were statistically significant ($p<0.05$). There were no statistically significant differences between the tablet and the combination group nor between the rinse and the tablet group.

At the end of eight years, children in the combination group had 32% fewer dmfs compared to the rinse group and 15% fewer caries compared to the tablet group. When the tablet and the rinse group were compared, the tablet group had 20% fewer dmfs values than the rinse group. Using the Scheffe's procedure, statistical differences were only found between the fluoride mouth rinse and the combined fluoride procedure, (95% CI 0.32, 2.03). There were no statistically significant differences found between the tablet and the combination groups (95% CI -0.45, 1.33), nor between the rinse and the tablet groups (95% CI-0.13, 1.61). The mean incremental dmf scores were also compared for early erupting tooth (incisors and first molars) and for late erupting teeth (pre molars and second molars). In both eruption categories, caries increment was lower in both combination group and tablet group compared to the rinse group. Only the difference in scores between the combination and the rinse groups for early erupting teeth reached statistical significance.

Overall, the results over the eight years follow-up showed that the combination group showed a statistically significant benefit over the rinse group alone but did not show any additional benefits over the tablet group alone. There were no statistically significant differences between the tablet and the rinse groups although children in the tablet group had fewer caries compared to children in the rinse group.

The study by Petersson et al[104] had four experimental groups who were exposed to different combinations of preventive programmes for a period of 2 years. Group I received fluoride tablets for sucking twice a day plus a placebo dentifrice free of fluoride, while group II was given a fluoride dentifrice containing 0.025% fluoride. Group III was given a placebo dentifrice plus fluoride varnish (Duraphat), twice a year. Group IV received fluoride dentifrice and a fluoride varnish twice a year. The results are presented in table 4.1.11. Presuming ANOVA, the results show no statistically significant differences between the groups.

4.1.13 Multi-component interventions with children

Two studies looked at the impact on children of dental preventive programme with multiple components. The study by Lalloo & Solanki [105] evaluated a comprehensive oral health programme in a cluster-randomised trial. This study was conducted in five schools in an area of a low socio-economic status. The systematic preventive programme in the experimental group involved dental health education, scaling and polishing, fissure sealants for molar teeth and the restoration and extraction of decayed teeth. In addition, daily tooth-brushing, supervised by teachers, using 1000ppm fluoride toothpaste was implemented in these schools. The control schools did not receive any of the components of the preventive programme. The results showed that statistically, the children in the experimental group had significantly lower mean dmfs values (1.94 in the treatment group vs. 6.12 in the control group) and had a higher number of caries-free subjects compared

to the control group (62.5% in treatment group vs. 37.5% in the control group) (see table 4.1.11).

The study by Bagramian et al[106] compared a combination of five preventive methods to an oral hygiene only programme. The combination consisted of the delivery of an oral hygiene programme in classrooms, which included supervised tooth brushing and counselling; dental examination with prophylaxis; the application of sealant every six months if necessary; the topical application of fluoride every 6 months and all necessary restorative care. The results are presented in table 4.1.11. The results show that statistically, the dmfs and dmft increment was significantly lower in the combination group compared to the oral hygiene only group.

4.1.14 Multi-component interventions with mothers

The two remaining studies published in 4 papers in this section considers the combination of interventions in which mothers were the target population.

Two papers by Gomez and others[107;108] were from the same study. This study evaluated the preventive dental programme (PDP) compared to no preventive dental programme. The target population were mothers in the 4th month of their pregnancy and continued after the birth of their children. The programme included health education about oral hygiene and diet, ultrasonic tartar removal, professional tooth cleaning with fluoride toothpaste, the chemical control of plaque by daily home antimicrobial mouth rinsing, tooth brushing at home twice daily and the restoration of frank carious lesions. The results are presented in table 4.1.12. In the first paper[107], the outcomes were measured in children when they were between 1 and 3.5 years. In children aged 1-2 years there were no statistically significant differences either in the dft values or caries-free children between the groups. In the two older age groups and considering all ages together, the dft scores were statistically significantly lower and the percentage of caries-free children was significantly higher in the PDP group compared to the control group.

In the second paper, [108] the outcomes were measured in children when they were five years of age. The results showed that, statistically, the children in the preventive programme showed significantly fewer decayed teeth, lower dft values and fewer caries-free teeth compared to the control group (the dft was 0.4 ± 1.4 in the treatment group and 1.3±1.7 in the control group). The percentage of caries-free children in the PDP group was 87% compared with 50% in the control group. There were no statistically significant differences in the filled teeth between the groups.

Two papers by Kohler and others [109;110] were again from the same study. This study looked at the prophylactic programme in mothers, beginning when the children were 3-8 months of age. The programme was repeated every 2-4 months and when necessary until the children were 3 years old. The preventive programme consisted of dietary counselling, professional tooth cleaning, oral hygiene instructions, fluoride treatment and the excavation of large cavities. The results are presented in table 4.1.12 and show that for the

37 children examined at the age of 3 years, 16% in the treatment group had carious teeth compared to 43% in the control group. This difference was statistically significant. At the age of 3 years, 41% in the treatment group and 70% in the control group were infected with the *S.Mutans*; a cariogenic bacteria. This difference was also statistically significant. The authors also reported that 51% of children who carried *S.Mutans* had caries, while only 3% of children with no detectable *S.Mutans* bacteria had caries.

In the second paper,[110] at 7 years of age and after 4 years of follow-up, there was statistically significantly lower defs values and a higher number of children who were caries-free in the prevention group. The mean defs was 5.2±5.0 in the treatment group compared to 8.6±5.6 in the control group. Twenty-three percent of children were caries-free in the treatment group compared to 9% in the control group. The results also showed that, statistically, the levels of cariogenic bacteria were significantly lower in the treatment group children compared to the control group. All the children who were colonised with *S.Mutans* bacteria before 2 years of age had significantly higher values of defs and a higher percentage of caries, irrespective of the group to which their mothers belonged (see table 4.1.12). This study suggests that those whose teeth were colonised earlier with cariogenic bacteria had high levels of caries and would therefore benefit from early preventive measures. Treatment of mothers when children were young seems to prevent the colonisation of bacteria in children and in turn reduces the number of caries in children.

Table 4.1.11 Combination of interventions with Children as target population

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
Heifetz et al (1987) USA[101] RCT Driscoll et al (1990) USA[102] RCT Driscoll et al (1992) USA[103] RCT Quality-Moderate for all 3 papers	Fl. Rinse vs. Fl. Tablet vs. Fl. Tablet + rinse	1640 5 years 789 640	Dental hygienists and trained dental students Study ended after 8 years No follow-up	dmfs	No significant baseline differences between the groups **dmfs(SD) F Rinse(A) F Tablet(B) F Tab + Rinse(C) % diff** **End of 2 years** ***Sample size* 345 331 369** Mean dmfs Incre 2.50(4.90) 2.06(4.79) 1.67(4.26) C vs A=33.2%; C vs B=18.9%; B vs A=17.6%; ANOVA p=0.06 **After 5 years of study** ***Sample size* 275 255 259** Mean DMFS Incre (SD) 2.14(2.58) 1.76(2.44) 1.47(2.15) C vs A=31.3%*; C vs B=16.5%; B vs A=17.8% **After 8 years of study** ***Sample size* 229 199 212** Mean DMFS Incre (SD) 3.57(4.03) 2.83(3.63) 2.40(3.28) C vs A=32.8%*; C vs B=15.2%; B vs A=20.7% **Mean DMFS increment for early and late erupting teeth after 8 years** Early erupting teeth 2.54 2.16 1.66 C vs A=34.6%*; B vs A=15% Late erupting teeth 1.03 0.67 0.74 C vs A=28.2%; B vs A=35% * ANOVA Scheffe's procedure p<0.05

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
Pettersson et al (1985) Sweden[104] Quasi RCT Quality-Strong	Fl Tablet vs. Fl dentifrice vs. Fl varnish vs. Fl varnish + Fl dentifrice	376 3 years	Dentists for varnish and parents for dentifrice and tablets Study ended after 2 years No follow-up	-dfs	No significant baseline differences between the groups **Group I (Fl.Tabl) / Group II (Fl. Paste) / Group III (Fl var+Fl paste) / Group IV / P value** ***Sample size*** ***91*** ***89*** ***104*** ***92*** **New carious surfaces (Mean)** 1st year 0.6 0.8 0.9 0.7 NS 2nd year 1.2 1.1 1.2 1.0 NS 1st-2nd year 1.8 2.0 2.1 1.7 NS
*Lalloo & Solanki (1994) South Africa [105] Cluster RCT Quality-Weak	Dental preventive programme vs no dental programme	212 (5 schools) 4-5 years	HE by oral hygienists, tooth brushing supervised by teachers Study ended after 7 years Not clear about follow-up	-DMFS	**After 7 years** / **Dental programme** / **non programme** / ***p value**** Sample size: 110 (3 schools) / 102 (2 schools) Mean DMFS: 1.94 / 6.12 / <0.001 DMFS≥15: 0.9% / 12.8% / not reported Caries-free subjects: 62.5% / 37.5% / <0.01 * Wilcoxon Two-Sample Test
Bagramian et al (1978) USA[106] RCT Quality-Moderate	Five preventive methods vs only oral hygiene programme	496 5 years	HE by dental hygienist,treatments by dentists and auxillaries Study ended after 3 years No follow-up	-DMFT -DMFS	No statistically significant differences between the groups at baseline **End of three years of study** **Combination group** / **Only oral hygiene** / **p value*** ***Sample size*** ***242*** ***254*** **Mean (SD)** DMFT Increment 0.44(0.80) 1.28(1.44) <0.01 DMFS Increment 0.62(1.34) 1.85(2.33) <0.01 *Student t-test was used

Table 4.1.12 Combination of Interventions with Mothers as target population

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
Gomez & Weber (2001) Chile[107] RCT	Dental prevention programme(PDP) vs. no PDP	360 Mother's age not reported	Not specified	-dft -% caries - free	**At 1-2 yrs of age** **PDP** **No PDP(C)** **p value** ***Sample size*** ***50*** ***50*** dft (Mean ±sd) 0.16±1.13 0.14±0.70 NS† % caries-free 98% 96% NS‡ **At 2-3 yrs of age** ***Sample size*** ***80*** ***80*** dft (Mean ±sd) 0.01±0.11 0.51±1.24 <0.05† % caries-free 99% 76% <0.05‡ **At 3-3.5yrs of age** ***Sample size*** ***50*** ***50*** dft (Mean ±sd) 0.20±0.95 1.40±2.22 <0.05† % caries-free 94% 58% <0.05‡ **All ages** ***Sample size*** dft (Mean ±sd) 0.11±0.78 0.66±1.55 <0.05† % caries-free 97% 77% <0.05‡
Gomez et al (2001) Chile[108] RCT Quality-Both papers were weak		60	5 years in children	-decayed teeth -filled teeth -dft	**At 5 yrs of age** **PDP** **No PDP(C)** **p value** ***Sample size*** ***30*** ***30*** Decayed teeth 0.0±0.0 1.0±1.6 <0.001† Filled teeth 0.4±1.4 1.3±1.7 NS dft (Mean ±sd) 0.4±1.4 1.3±1.7 <0.01† % caries-free 86.7% 50% <0.05‡ †Non parametric Mann-Whitney U-test ‡ Chi-square test

Author & year and Type	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
Kohler et al (1984) Sweden[109] Quasi RCT Quality-Moderate	Basic preventive programme with counselling, professional tooth cleaning and fluoride treatment	77 Mothers age not mentioned but children were 3-8months old	Dentists and specially trained nurses	-caries teeth	**End of study (at 3yrs)** / **Preventive prog** / **No prog** / **p value** ***Sample size*** / ***37*** / ***40*** With caries- n (%) / 6 (16%) / 17(43%) / <0.02† Infected with Strep.mutans / 15(41%) / 28(70%) / <0.01† ***No of children with caries according to the bacterial infection*** **Infected with Bacteria** / **non-infected** / **p value** ***Sample size*** / ***43*** / ***34*** With caries (%) / 22 (51%) / 1(3%) / not reported **After 4 yrs of follow-up (at 7 years)** ***Sample size*** / ***26*** / ***33*** defs Mean (SD) / 5.2±5.0 / 8.6±5.6 / <0.05‡ % caries-free (n / 23% (n=6) / 9% (n=3) / <0.01*
Kohler & Andreen (1994) Sweden[110] Quasi RCT Quality-Strong	Same intervention as above	59	4 years	-defs -%caries-free children	Infected with Strep.mutans: Mean (SD) / 3.21 (1.90) / 5.11(1.33) / <0.05‡ **Caries experience in the deciduous teeth at 7 years of age related to the time of Mutans streptococci detection** **Time of detection (age in yrs)** / **% with caries** / **mean defs (SD)** / **p value** >1-2 / 100% / 9.4 (4.9) / <0.05‡ >2-3 / 86% / 7.5 (5.7) / (>1-2 vs ND) >3 / 83% / 4.6 (4.5) Not detected (ND) / 44% / 2.3 (3.1) † Chi-square test ‡ One way analysis of variance * z-test

4.2 Controlled Clinical Trials

This review also considered Controlled Clinical Trials (CCTs), which looked at the effectiveness of interventions that were not assessed by Randomised Controlled Trials. Four studies were identified. One study published in two papers [111; 112] looked at salt fluoridation, two studies published in 3 papers [113-115] looked at milk fluoridation and one study looked at the role of sugar restriction [116] in the reduction of caries in children under five years of age. These studies had a comparison group but were not randomised.

Summary: Out of three interventions assessed by the Controlled Clinical Trials, there is evidence that milk and salt can be used as an effective vehicle for fluoridation. The substitution of invert sugars to sucrose seems to reduce caries in only one index. However, as these samples were very selective the results of the CCT's should be interpreted with caution.

4.2.1 Salt Fluoridation

In the studies by Toth [111;112] an experimental village used fluoridated salt for all purposes and was compared to a matched control village that did not use fluoridated salt, (the results are presented in table 4.2.1). In the first paper,[111] the results showed that after 8 years the mean dmft values in the treatment village were lower (mean dmft=2.43) compared to the control village (mean dmft 5.54), with a 56% difference between the villages. This difference, calculated from values included in the paper, was found to be statistically significant. After 8 years in the village with salt fluoridation, the number of children with caries-free teeth increased from 23% at the start of the study to 60.6%, with the authors reporting that there was no statistically significant change in the control village.

The second paper by the same author [112], now at 10 years after salt fluoridation reported similar results, however, the results showed a statistically significant difference in the dmft values in the 2-6 years old children between the treatment and the control village. The paper also reported values for 4-6 year old children and showed that the mean dmft value was lower and the number of caries-free children was higher in the salt fluoridated village than in the control village. The significance levels for this age group were not reported nor were precisions given to enable this inference.

4.2.2 Milk Fluoridation

Three papers from two studies [113-115] looked at milk fluoridation. The study by Stephen[113] was conducted in an area of low socio-economic status. The children in the treatment group drank 200ml of milk with 7ppmF 200 days per annum and the control group had milk with no fluoride in it. The results from the first paper in 1981, presented in table 4.2.2 showed that 3 years after the study, there were no statistically significant differences between the groups in mean def and defs values. When the mean DMF and DMFS for permanent teeth that were erupted and non-erupted at baseline were analysed, no

statistically significant differences were seen until the fourth year of the study for both erupted and non-erupted teeth.

The second paper (by the same author and others in 1984) [114] reported on the same study with the 5 year results. This showed that there were statistically significant differences in the DMFT and DMFS values between the treatment and the control groups. The results remained statistically significant when the teeth already erupted at baseline were excluded. This study showed that milk fluoridation was effective in reducing caries and the analysis of erupted and non-erupted teeth at baseline indicated that the effect was time related.

The study by Marino et al[115] compared the use of fluoridated milk powder and milk cereal with non-fluoridated milk powder. Children from one community received fluoridated milk and the other received milk without fluoride. After 4 years of the milk-fluoridation scheme, a 'Convenience sample of children' between 3 and 6 years of age were chosen from two communities for the study. Baseline measurements were recorded before the intervention and cross-sectional surveys were conducted on independent sample in these communities every year. The results are presented in table 4.2.2 and show that after 4 years of milk fluoridation there were statistically significant differences between the test and the control communities in both dmfs values and the percentage of caries-free children. Additionally, for the treatment community, statistically significant differences in the dmfs values and the percentage of caries-free children were seen between the start and the end of the study. The dmfs value decreased from 11.78± 13.63 at the start of the study to 3.35±5.68 at the end of the study. In the treatment community the proportion of caries-free children increased from 22% at the beginning to 48.4% at the end of the study. Similar results for the control community did not indicate such statistically significant differences.

4.2.3 Sugar Restriction

The study by Frostell et al[116] was conducted in an industrial town near Stockholm. The parents of children in the experimental group bought products in which sucrose was substituted by invert sugar from the local participating super-market. The control group bought normal products with sucrose. The results (table 4.2.3) showed that in the 1st year, no statistically significant differences between the invert sugar and the sucrose groups were seen. However, in the second year, there were statistically significant differences in both the dmfs and dmft values, albeit when both macroscopic and microscopic lesions were included. Over the 2 years, the only statistically significant difference was observed in the $dmfs_1$ values when macroscopic and microscopic lesions values were included.

Table 4.2.1 Controlled clinical trials: Salt fluoridation

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results				
Toth (1976) Hungary[111] CCT Quality-Moderate Toth (1978) Hungary[112] CCT Quality-Moderate	Salt fluoridation vs. no salt fluoridation	174 561 4 years	-public health intervention Study ended after 10 years No Follow-up	-dmft % caries-free children		**Salt Fl**	**No salt Fl**	**% diff**	**p value**
					2-6 yr olds				
					At start of study				
					Sample size	***82***	***92***		
					dmft±SE	4.18±0.38	5.19±0.46		
					Caries-free children	23%	17.3%		
					At the end of 8 yrs				
					Sample size	***127***	***537***		
					dmft±SE	2.43±0.35	5.54±0.21	56%	<0.05*†
					Caries-free children	60.6%	27.3%		
					At the end of 10 years				
					Sample size	***137***	***424***		
					dmft (2-6 yr olds)	1.43	4.56		<0.05†
					For 4-6 yr olds				
					dmft	2.80	5.98	53%	
					Caries-free children	46.75%	13.82%		
					† t-test used * calculated for this review				

Table 4.2.2 Controlled clinical trials: Milk fluoridation

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
Stephen (1981) UK[113] CCT Quality-Moderate	Milk fluoridation vs. no fluoride in milk	187 4½-5½ years	Milk distribution assistant	-def -defs -DMF -DMFS	No significant baseline differences between the groups **After 3 years** / **Milk with fluoride** / **Placebo** / **p value** ***Sample size*** / ***72*** / ***71*** Mean def: 6.3 / 6.0 / NS Mean defs: 22.1 / 22.1 / NS **Mean DMF, DMFS & % diff between groups for erupted permanent Molars at baseline** No significant baseline differences between the groups (23 in each group erupted) **After 1 year** / **Milk with fluoride** / **Placebo** / **% diff** / **p value** ***Sample (n teeth)*** / ***174*** / ***163*** Mean DMF: 0.33 / 0.35 / 5.7% / NS Mean DMFS: 0.35 / 0.36 / 2.8% / NS **After 3 years** ***Sample (n teeth)*** / ***288*** / ***284*** Mean DMF: 1.54 / 1.83 / 15.9% / NS Mean DMFS: 3.08 / 3.06 / -0.7% / NS **After 4 years** ***Sample (n teeth)*** / ***196*** / ***236*** Mean DMF: 1.65 / 2.39 / 31% / <0.01* Mean DMFS: 2.94 / 4.80 / 38.8% / <0.01* **Mean DMF, DMFS & % diff between groups for unerupted permanent Molars at baseline** **After 3 years** ***Sample (n teeth)*** / ***265*** / ***259*** Mean DMF: 1.33 / 1.63 / 18.4% / <0.01* Mean DMFS: 2.93 / 2.88 / -1.7% / <0.01* **After 4 years** ***Sample (n teeth)*** / ***183*** / ***218*** Mean DMF: 1.47 / 2.22 / 33.8% / <0.01* Mean DMFS: 2.94 / 4.53 / 35.1% / <0.01* * Wilcoxon Rank Sum Test

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & length of follow-up	Outcome measure	Results
Stephen et al (1984) UK[114] CCT Quality-Moderate	Milk fluoridation vs. no fluoride in milk	187	Milk distribution assistant Study ended after 5 years No Follow-up	-DMFT -DMFS	**Milk with fluoride** / **Placebo** / **% diff** / **p value** ***Sample (n teeth)*** ***838*** / ***918*** Mean DMFT 2.14 / 3.11 / 31.2% / <0.05* Mean DMFS 3.76 / 6.61 / 43.1% / <0.01* **Mean DMFT, DMFS & % diff between groups for permanent teeth excluding permanent first molars which erupted at baseline** **Milk with fluoride** / **Placebo** / **% diff** / **p value** ***Sample (n teeth)*** ***823*** / ***904*** Mean DMFT 1.94 / 3.02 / 35.8% / <0.05* Mean DMFS 3.29 / 6.33 / 48.0% / <0.01* * Wilcoxon Rank Sum Test
Marino et al (2001) Chile[115] CCT Quality-Moderate	Fluoridated powdered milk and milk cereal vs. no fluoridated milk powder	366 0-6 years	Milk distribution by nutritionists Study ended after 4 years No Follow-up	-dmfs -% caries-free children	**Fl. Milk powder** / **Placebo** / **% reduce** / **p value** **(After 4 yrs)** **Sample size** **252** / **240** dmfs (SD) 3.35(5.68) / 5.65(7.08) / 41% / <0.01† Caries-free children 48.4% / 29.6% / <0.01‡ **Fl. Milk powder (test community)** **Start** / **End** / **% reduce** / **p value** dmfs (SD) 11.78(13.69) / 3.35(5.68) / 72% / <0.01† Caries-free children 22% / 48.4% / <0.01‡ **Control community** Caries-free children 28% / 29.6% / NS ‡ † Mann-Whitney test ‡ Chi square test

Table 4.2.3 Controlled clinical trials: Invert sugar consumption

Author (Yr), Study Type & Quality	Intervention	Sample Size /Age at start	Delivered by & Dura follow-up	Outcome measure	Results				
Frostell et al (1981) Sweden[116] CCT Quality-Weak	Invert sugar products vs. sucrose sugar	170 3 year olds	Trained personnel supervised them Study ended after 2 years No Follow-up	-dmfs -dmft	**Increment(±SE)**	**Invert sugar**	**control (sucrose)**	**% reduc**	**p value**
					1st year				
					Sample size	***56***	*89*		
					$dmfs_1$	3.38±0.59	4.34±0.52	22.1%	NS
					$dmfs_2$	2.96±0.49	3.60±0.48	17.8%	NS
					$dmft_1$	2.09±0.33	2.08±0.28	0.5 %	NS
					$dmft_2$	1.84±0.29	1.93±0.24	4.7%	NS
					2nd year				
					Sample size	***56***	*67*		
					$dmfs_1$	1.95±0.59	4.39±0.54	55.6%	<0.005
					$dmfs_2$	1.54±0.40	2.37±0.35	35%	NS
					$dmft_1$	0.82±0.31	1.78±0.26	53.9%	<0.02
					$dmft_2$	0.93±0.25	1.08±0.19	13.9%	NS
					Over 2 years				
					Sample size	**56**	**67**		
					$dmfs_1$	5.39±0.80	8.31±0.76	35.1%	<0.01
					$dmfs_2$	4.48±0.60	6.19±0.81	27.6%	NS
					$dmft_1$	2.91±0.40	3.51±0.36	17.1%	NS
					$dmft_2$	2.77±0.36	3.03±0.33	8.6%	NS

$dmfs_{1\ and}$ $dmft_1$ - Caries surfaces and teeth without macroscopic defects included (macroscopic and microscopic lesions)
$dmfs_2$ and $dmft_2$ - Caries surfaces and teeth without macroscopic lesions excluded (Only macroscopic lesions)

4.3 Cross-sectional Studies

Water fluoridation is believed to be one of the effective methods of reducing caries. A recent systematic review of water fluoridation [122] published in 2000 by the NHS Centre for Reviews and Dissemination at York University reported that water fluoridation was associated with an increased proportion of children who were without caries. However, the CRD review was not conducted specifically with children, below five years of age. While this review did not identify any trials assessing the effectiveness of fluoridation of water in children under five, a few cross-sectional studies were identified. Studies were only considered here in this review if the samples were randomly selected and compared to a random sample from non-fluoridated areas. Consequently, five papers [117-121] were identified that assessed the effectiveness of water fluoridation in random samples of children under five years of age.

Summary: Water fluoridation produces considerable reductions in the dental caries in five-year old children. These were cross-sectional surveys from random samples taken from the fluoridated and non-fluoridated areas. Although careful measures have been taken to reduce bias in these surveys, such results do not have the quality often achievable by properly controlled randomised trials.

Jackson et al[117] conducted a cross-sectional survey in 1983 investigating dental caries levels on the Island of Anglesey in North Wales that has been fully fluoridated since 1964. This area was compared to the mainland where water was not fluoridated. A random sample was chosen from each community and the caries status was measured. The results are presented in table 4.3 and show that the mean dmf values were 1.58±0.17 for the fluoridated area compared to 3.55±0.33 in the non-fluoridated mainland; a difference of 55%. When the dmf values were compared over nine years of fluoridation (between 1974 and 1983), the decrease in caries was 44% in the fluoridated area compared to 22% in the non-fluoridated area. The restorative index increased in the fluoridated area but remained the same in the non-fluoridated area. However, the statistical significances of these results were not reported in the paper.

Thomas et al [118] also conducted a survey in Anglesey in the same area of the previous study. This area was fully fluoridated until 1987/88, after which fluoridation became intermittent and was terminated in 1991. The survey carried out in 1993, compared caries levels over the time in Anglesey described in the previous surveys, along with survey data from a non-fluoridated area. The results are presented in table 4.3. The results show a progressive increase in the dmft values in the fluoridated area over the period of decreasing exposure to fluoridation from 1987-93. This study also looked at the dmft values according to the exposure to fluorides in the water. Children who were exposed to fluorides for an average of 35% of their lives had 21% lower dmft values of 1.81±2.86 compared to children who had exposure for less than 10% of their lives, with dmft of 2.28±3.48. The authors reported that other sources of fluoridation were considered in the analysis. However, no

details of the analysis nor of measures of statistical significances were reported in the paper.

The study by O'Mullane et al[119] looked at the effectiveness of water fluoridation in the prevention of dental caries in Irish children. Between 1964 and 1972 most of the larger public piped water supplies in the Republic of Ireland were fluoridated and by 1986, 65% of the population lived in fluoridated areas. A baseline pre-fluoridation study had been conducted in the years 1961-63. The O'Mullane et al study conducted a post-fluoridation survey in 1984, comparing the caries prevalence in fluoridated and non-fluoridated areas and also compared these with the pre-fluoridation study. The results reported in table 4.3 show that there was a statistically significant difference in the dmfs and dmft values between the fluoridated and the non-fluoridated areas. There were proportionally more caries-free children in the fluoridated areas (52%) compared to in the non-fluoridated areas (38%), however the statistical significance of the values for these proportions were not reported. When compared to the pre-fluoridation study, the caries prevalence had declined by 68% (dmft 5.6 vs. 1.8) in the fluoridated area and by 46% (dmft 5.6 vs. 3.0) in the non-fluoridated area.

The study by Rugg-Gunn et al[120] surveyed children to investigate the effect of water fluoridation in Newcastle-upon-Tyne (i.e. a fluoridated area) and Northumberland (i.e. a non-fluoridated area). Thirty schools were randomly selected from fluoridated and non-fluoridated areas and children from both urban and rural fluoridated and non-fluoridated areas were examined. The study had four groups: fluoridated urban (F-urban); fluoridated rural (F-Rural); non-fluoridated urban (NF Urban) and non-fluoridated rural (NF-rural). The fluoridated urban (F-urban) areas were further divided into children from social priority areas (Low SES) and non-priority areas. The results are presented in table 4.3. The results show that there were statistically significant differences in the deft and defs values between the fluoridated and the non-fluoridated areas. With regard to deft values, children in the fluoridated areas had 57% fewer caries in the urban –low SES areas (deft 2.6±2.85) and 67% fewer in rural areas (deft 2.0±2.47) compared to the non-fluoridated areas (deft 6.1±4.03 in urban and 6.1±4.3 in rural). Similarly, for defs values, children in the fluoridated areas had 61% fewer caries in urban – low SES areas (defs 4.5±6.38) and had 74% fewer in rural areas (defs 3.1±5.32) compared to the non-fluoridated areas (11.6±9.54 in urban and 11.7±10.64 in rural). The number of toothache episodes assessed by a survey showed that there was a statistically significant difference in the percentage of children with toothache episodes between the fluoridated (45%) and the non-fluoridated areas (55%).

Evans et al[121] compared the effects of water fluoridation between a fluoridated Newcastle area with a non-fluoridated Northumberland area as in the previous study in 1995. The same schools as in the previous study were used as the sampling units. The results are shown in table 4.3. The results show that, statistically, the mean dmft, dmfs and dfs values were significantly less in the fluoridated area compared to the non-fluoridated areas. The dmft was 45% less in the fluoridated area while the corresponding dmfs values was 52% less in the fluoridated area compared to children in non-fluoridated area. The

percentage of children who had experienced toothache was 17% in the non-fluoridated area compared to only 9% in the fluoridated area. Over the years, from 1976 to 1994 the rate of caries experience had declined in both fluoridated and non-fluoridated areas. However, the rate of decline appeared to be less in the fluoridated area, although no statistical results were available.

Table 4.3 Cross-sectional surveys –Water Fluoridation

Author (Yr), Study Type & Quality	Sample size and age of participants	Outcome measure	Results
Jackson et al (1985) UK[117] Survey Quality- Not assessed	347 5 years	-dmf -Restorative index	**Year** / ***dmf ±SE*** / ***Sample size(1983)*** / 1974 / 1983 (present study) / Diff. 1974-1983 **Fluoridated**: ***219*** / 2.83 / 1.58±0.17 / 44% **†RI**: 21% / 31% **Non fluori area**: ***128*** / 4.58 / 3.55±0.33 / 22% **†RI**: 28% / 28% **% diff**: 55% **†RI Restorative Index: f / f + d%**
Thomas et al (1995) UK[118] Survey Quality- Not assessed	725 in 1993 Mean age 5.5 years	-dmft	**Status of Fluoridation** / **Year** / **Fluoridated** / **Non fluoridated area** / **% diff** ***Mean dmft(SD)*** Fully fluoridated / 1987/88 / 0.80(1.43) / 2.26(3.17) / 65% Intermittent / 1989/90 / 1.26 / 2.27 / 44% Terminated / 1991/92 / 1.44 / 2.41 / 40% **Present survey** / **1993** / **2.01(3.27)** **Mean dmft according to exposure to fluorides** **Exposure to FI** / **Sample size** / **dmft(SD)** 35% of their lives / 230 / 1.81(2.86) <10% of their lives / 268 / 2.28(3.48)
O'Mullane et al (1988) Ireland[119] Quality- Not assessed	1705 in 1984 Average age 4.7 years	-dmft -dmfs -%caries-free children	**Pre Fluoridation - 1961-63 with sample size of 9753 five year old children** dmft 5.6 / % children with no caries % Caries-free children 15% / caries in permanent teeth 34% **Post fluoridation - 1984** **Fluoridated** / **Non fluoridated area** / **% diff** / **p value** ***Sample size(1984)*** ***869*** / ***836*** dmft±?SD 1.8±2.8 / 3.0±3.7 / 40% / <0.001 dmfs 3.6 / 6.2 / 42% / <0.001 % caries-free children 52% / 38% caries in permanent teeth 69% / 56%

Author (Yr), Study Type & Quality	Sample size	Outcome measure	Results
Rugg-Gunn et al (1977) UK[120] Survey Quality- Not assessed	771children from 30 schools 5 years	-deft -defs -% caries-free children -% children with tooth ache	**Mean (SD)** / **Fluoridated** / **Non-fluoridated** / **% diff** / **†p value** **FU –Low SES** / **FU-Ordi** / **F Rural** / **NF Urban** / **NF Rural** / **U** / **R** ***Sample size*** ***226*** ***212*** ***93*** ***132*** ***108*** deft 2.6(2.85) 2.4(2.73) 2.0(2.47) 6.1(4.03) 6.1(4.30) 57% 67% <0.001 defs 4.5(6.38) 3.6(4.98) 3.1(5.32) 11.6(9.54) 11.7(10.64) 61% 74% <0.001 % caries-free children 29.2% 36.3% 34.4% 10.6% 12.0% % children with tooth ache 22% 17% 17% 40% 38% 45%(F) 55%(NF) <0.01 † Chi-square test for deft / defs values and % with tooth ache between F and NF areas
Evans et al (1995) UK[121] Survey Quality- Not assessed	932 children from 28 schools Mean age 5.5 years	-dmft -dmfs -dfs -% with tooth ache -no of sound teeth	**Fluoridated** / **Non-fluoridated** / **†diff** / **% diff** / **p value** ***Sample size*** ***496*** ***436*** dmft 1.33 2.41 1.08 45% <0.001 dmfs 2.80 5.77 2.97 52% <0.001 dfs 1.73 3.44 1.71 50% <0.001 no of sound teeth 18.21 17.06 +1.15 +6% <0.001 % children with tooth ache 9% 17% <0.05 † Chi-squared and Mann-Whitney U tests **Year** / **Fluoridated** / **Non-fluoridated(dmft)** / **% diff** 1976 2.6 6.1 57% 1981 1.5 3.8 60% 1987 1.8 3.9 54% 1994 1.3 2.4 44%

5 Discussion

This review explored the effects of various interventions to prevent dental caries in children under five years of age. The review identified the majority of the Randomised Controlled Trial interventions in the area of fluorides (topical and systemic), health education and a combination of interventions. The effectiveness of the interventions was widely varied, but most of them were effective in at least some aspects.

5.1 Strengths and weaknesses of the review

The strength of this review is the systematic search of Randomised Controlled Trials to identify effective interventions to prevent caries specifically in children under five years of age. The action plan for Scotland[32] has identified a clear need for a robust and overarching strategy for children's oral health focused on prevention and aims to achieve a target of 60% of 5-year-old Scottish children with no sign of dental disease by 2010. This review will help to identify the effective interventions relevant to this specific age group in trying to meet this target.

Some methodological limitations should be noted. Firstly, the included studies differed in terms of their target populations, the type of intervention and the outcomes measured. It was impossible to statistically combine the results of the studies via meta-analysis, thereby making it difficult to assess and compare the effectiveness of interventions. Secondly, the search of the literature was extensive but probably not exhaustive. Journals were not hand searched and the authors were not contacted for additional information. It is also worth noting that most of the conclusions drawn from this review are based on only one or two single studies of moderate quality and should therefore be interpreted with caution.

5.2 Health Education interventions

Overall, health education appears to be effective when there is a personal contact with the parents. A study by Holt et al[64] that compared health education (HE) by post versus home visiting reported an improvement in the dental condition of children who had home visiting, thereby emphasising the importance of personal contact. The percentage of caries-free teeth was 69% for health education by home visits compared with 54% for health education by postal leaflet. However, the disappointing outcome for health education by postal leaflet might be partly because of a tendency to ignore information by post, or in some cases to the poor literacy of mothers. One study [65] that looked at health education provided by dental health professionals and general nurses found no difference in the outcomes. Therefore it may be reasonable to suggest that health visitors and general practice nurses, who come into contact with mothers and children as part of health surveillance programmes, could be trained to deliver dental health education to mothers. While health education studies that considered the training of general nurses/health visitors compared to that of dental professionals for delivering dental health education, reported positive results, no studies were identified

that looked at the training of teachers and compared it with that of health care professionals. Given the frequency of teacher's contact with children, their potential role in dental health education needs to be further investigated.

Hands on games and puppet shows seemed to be more effective in improving child knowledge and in turn might positively change their behaviour in favour of better oral hygiene although this would need further replication. A cluster randomisation trial showed that reducing sugar content in nursery diets was effective, irrespective of the sugar intake at home. Two thirds of children attending nurseries, that adopted specific guidelines on reduced sugar intake, did not develop any new caries compared to approximately 38% of children at nurseries without such guidelines. However, these findings cannot be generalised to include children who did not attend nurseries for the whole day and do not take account of the attitudes, beliefs and subsequent motivation of mothers/carers who might not be sufficiently engaged to reduce sugar intake at home.

5.3 Topical Fluorides

Toothpastes showed consistent effectiveness in reducing caries. This is in comparison with the findings of a recent review conducted and updated by Marino et al, that showed that fluoride toothpastes were efficacious in preventing caries in children and adolescents.[123; 124] One of the four studies looking at fluoride varnish, which was moderate in quality, indicated some effectiveness. Children in the control group developed more new caries surfaces compared to the varnish groups (0.47 in the varnish group compared to 1.58 in the control group). Another study considering the frequent topical application of a fluoride solution by dentists showed that such applications appeared to have some effect in reducing caries, regardless of the strength of the solution. This could be equally attributed to the positive effect of increased contact with the dentist or to the actual treatment itself or to the appropriate application of the fluoride solution.

A series of Cochrane systematic reviews conducted by Marinho, comparing one topical fluoride against another[125] and a combination of topical fluorides against one topical fluoride[126], reported that fluoride toothpastes in comparison to mouth rinses and gels appeared to have a similar degree of effectiveness. Topical mouth rinse, gel and varnish used in addition to toothpaste showed a modest reduction in caries. These reviews were conducted with children, who were between 2 and 16 years of age, and were not specific to children under five years. Most of the studies identified by this review looked at topical fluorides compared to a placebo or no treatment. Only two studies [103;104] were identified that compared a combination of topical and/or systemic fluorides to a single topical or systemic fluorides. A study by Driscoll et al[103] had a long follow-up of eight years and compared fluoride tablets (systemic) with fluoride rinse (topical) and the combination of both. This study showed that a combination was better than using the rinse only, but not better than using tablets. Although there were no statistically significant differences between the tablet and rinse groups there appeared to be a trend towards fewer caries in the tablet group. Additionally, tablets were considered as the best option, as they were reported as being easier to

administer than the rinse by the teachers who supervised the programme. Very few studies were identified in this age group that compared one topical fluoride against another or that compared the effectiveness of combinations over one topical fluoride.

5.4 Systemic fluorides

Fluoride drops given systemically to children, appeared to be effective and had time-related benefits although both studies were weak in quality and conducted in the early seventies. Two studies assessed giving fluoride tablets to mothers in the prenatal period at the time of intra uterine tooth formation. The results were inconsistent and there was no reliable evidence about the effects of fluoridation tablets in pregnant women. Although these systemic fluoride studies compared the use of fluoride drops/tablets with a placebo, studies that compare the use of topical fluoride and systemic fluoride in this age group are lacking.

5.5 Sealants

Pit and fissure sealants proved to be effective in preventing occlusal caries in children depending on the retention of the sealants. Retention could depend on the type of sealant and the method of application. One study that compared two types of sealant at a follow-up of seven years showed that Delton (i.e. type of sealant) had a better retention rate, and that the effective application of the sealant might require training. This review, however, did not look into the cost of sealants nor the cost of training to enhance their effective application.

5.6 Antimicrobial agents

Chlorhexidine is an anti-microbial agent that is believed to suppress the caries causative bacteria in the oral cavity and thereby reducing the risk of dental caries.

Infants are thought to be infected with the bacteria from their mothers by vertical transmission during a period called the 'window of infectivity,' estimated to be around 19-31 months of age. Studies have therefore tried using chlorhexidine in children and in mother's dentition to prevent the transmission of bacteria to children. The results from one moderate quality study show that 49% of children treated with chlorhexidine gel did not develop any new caries lesions compared with 29% of children who received a placebo gel and 26% of children in the non-intervention group. The results from two studies with CHX, applied to mothers' teeth showed that it was ineffective in reducing both the bacteria and the prevalence of caries in children. Earlier colonisation by bacteria is a causative factor for developing caries in children however, the number of bacteria in children did not seem to be affected by interventions for treating the bacterial level in their mothers. Consequently, using CHX in children only but not their mothers might be effective in the prevention of caries. The same results were shown in the topical application of iodine interventions. Iodine is another anti-microbial

agent used to reduce the bacterial levels in the oral cavity. The results from these studies also showed that, while iodine applied to children's teeth produced 91% disease free survival compared with 54% in children who received a placebo solution, it was ineffective if applied to the mothers' teeth.

5.7 Tooth brushing

The supervision of tooth brushing on school days and the encouragement of regular tooth brushing at home appeared to reduce caries especially when a modified brushing technique, advocated by one moderate quality study was used. However, this same study conducted in a deprived area showed that, irrespective of school brushing, if their children regularly brushed twice daily at home, with the supervision of their parents, the children had fewer caries. A survey of parents in deprived areas from this study highlighted the fact the parents who felt that there was no time to check if children had brushed their teeth was an important barrier. This emphasises the fact that the mothers' motivation to ensure that their children brush at home can be very effective in the prevention of caries. The studies of health education showed that personal contact by nurses with home visits can be effective in motivating mothers to promote the care of their children's teeth. This was again emphasised by another study by Olson et al (1981) that demonstrated that personal attention given to parents, via a phone call or a home visit had a considerable effect in reducing caries in their child.

5.8 Multiple component interventions

The combination of interventions, with multiple components to their programmes showed significant benefits compared to programmes with one component or to no programme at all. In addition, the composition of the multi-component interventions varied extensively, making it difficult to draw conclusions about the effectiveness of this specific category of interventions or to identify the contribution of each individual component to the programme's success. Two such studies assessed preventive programmes in mothers, with one beginning during pregnancy and one when the children were as young as 3 months. The components were counselling and oral hygiene instructions, professional tooth cleaning, and fluoride treatment, with the result that the children showed benefits when they were 5-7 years of age. Another multi component study by Kohler and others also demonstrated that the earlier the colonisation of bacteria the greater the caries in children. However, the issue of whether treating mothers leads directly to a reduction of bacteria in children remains doubtful as shown by other studies. [91;92] The multiple component studies here showed benefits in children, but these benefits could be equally as a result of educating the mothers about the oral care of their children rather than as a result of the fluoride treatment of the mothers themselves. Therefore, further investigation is required to address these issues.

A single study that looked at probiotic bacterium in milk appeared to be effective in preventing caries but was difficult to interpret because of uncertainty about the model presented in the paper by the authors. Although a

single strong quality study conducted recently using Xylitol chewing gum in mothers, showed that dmf values were significantly lower in the chewing gum group (0.83) compared with the chlorhexidine group (3.22) and the varnish group (2.87), this issue merits further investigation.

Studies have suggested that the frequent and prolonged intake of sugars is a more important determinant in the aetiology of early childhood caries [1;15;127]. In spite of this recognition, only two RCT's [69; 73] and one CCT [116] were identified that looked at interventions of reduced sugar intake. Thus, more high quality randomised controlled trials are needed to investigate this still further.

Although there were sufficient numbers of randomised trials looking at the prevention of caries in children under five, this review also considered Controlled Clinical Trials of interventions that were not addressed by the randomised trials. Three interventions involving the use of salt, milk fluoridation and the substitution of sucrose with invert sugar were identified. Two CCT's showed that milk and salt could be used as a vehicle for fluoridation and proved to be effective. However, because of the potential for selection bias in CCT's, these results should be interpreted with caution. Indeed, perhaps these interventions should now be tested using good quality randomised controlled trials.

Cross-sectional surveys of random samples from water fluoridated areas with comparison groups in non-fluoridated areas also showed that water fluoridation was effective in preventing caries in under five year olds.

Fluoride toothpastes, pit/fissure sealants and the topical application of anti-microbial agents in children along with health education by personal contact seem to be effective in the prevention of caries. The percentage of caries-free teeth was observed to be a common outcome reported in the majority of these papers. While a direct comparison of this outcome measure between the effective interventions was attempted, as only one study had fully reported this outcome direct comparison proved unsatisfactory. The effectiveness of the various interventions is tabulated in table 5a and table 5b.

Table 5a: Effectiveness of Interventions by Randomised Controlled Trials

Type of Intervention	Number of studies	Result	Quality of the studies
Health Education	Total =7	Effective with multiple concepts and with personnel contact	5-Moderate; 2-Weak
Topical fluorides	Total=12		
-Fluoride Varnishes	4	Inconsistent	3-Moderate; 1-Strong
-Fluoride Tooth pastes	4 (5 papers)	Effective	4-Strong; 1- Moderate
-Fluoride gel	1	Not effective	Weak
-Fluoride solution	1	Effective	Moderate
-Fluoride paste	1	Not effective	Weak
-Fluoride mouth rinse	1	Not effective	Moderate
Systemic Fluorides	Total=4		
-Fluoride drops	2	Effective	2- Weak
-Fluoride Tablets-Prenatal	2	Inconsistent	1- Weak; 1- Strong
Sealants	Total=3	Effective, depends on retention	1-Strong; 1-Moderate; 1- Weak
Topical Chlorhexidine	Total=3		
-In children	1	Effective when used on children	1 in children -Moderate
-In mothers	2	Not effective when used on mothers dentition	1 in mothers – Weak 1 in mothers - Moderate
Topical Iodine	Total=2		
-In children	1	Effective when used on children	1- Moderate
-In mothers	1	Not effective when used on mothers dentition	1-Moderate
Tooth brushing Techniques	Total=2 (3 papers)	Supervised tooth brushing and modified technique is effective	3- Moderate
Probiotic bacterium in Milk	Total=1	Effective but not prescriptive of the model	Strong
Xylitol chewing gum in mothers	Total=1	Effective	Strong
Personal Contact	Total=1	Effective	Moderate
Combination of interventions	Total=6 (10 papers)	Effective but difficult to identify the effective component	2- Strong; 5- Moderate; 3- Weak

Table 5b: Effectiveness on interventions by controlled clinical trials and Cross sectional surveys

Type of Intervention	Number of studies	Result
Controlled clinical trials		
-Salt Fluoridation	1 (2 papers)	Effective
-Milk Fluoridation	2 (3 papers)	Effective
-Decrease sugar intake	1	Effective
Cross sectional Surveys on Water fluoridation with random samples	5	Effective

6 Conclusion

6.1 Implications for practice

Fluoride toothpastes, pit/fissure sealants and the topical application of anti-microbial agents in children together with health education by personal contact seem to be effective in preventing dental caries in children under five.

Health education is effective when personal contact is established with parents by home visits compared to leaflets sent by post. The training of general nurses to promote dental health education also seemed to be effective. Hands on games and puppet shows seemed to be more effective in improving child knowledge and in turn might positively change their behaviour in favour of better oral hygiene, although this would require further investigation. Reduced sugar intake in nursery diets appeared to prevent caries in children, irrespective of their sugar intake at home.

Pit and fissure sealants proved to be effective although their effectiveness is related to their retention rate. Among the topical fluorides, only toothpastes showed consistent effectiveness.

Chlorhexidine and iodine seemed to be effective when applied to children's teeth, however no effects were observed when these were used on mother's dentition.

6.2 Recommendations for research

Most of the studies in this review compared topical and systemic fluoride interventions with placebo or no treatment. More studies are needed that compare a systemic fluoride to a topical fluoride in this age group. Further research is also needed to compare one topical fluoride against another and to compare the combination of topical fluorides with a single topical fluoride.

This review identified sealants as one of the effective methods to prevent caries but did not investigate the costs of either sealants nor the training for to enhance their effective application. It is recommended that a review should be conducted to establish these costs.

Studies have shown that training general nurses and/or health visitors to deliver dental health education is as effective as health education delivered by dental health professionals. However, no studies have explored the impact of training upon nursery nurses and teachers who come into daily contact with children in delivering dental health education to children. Good quality studies are needed to investigate these issues.

In spite of recognising the excessive intake of sugar as an important cause of caries in children who are under five years of age, relatively few intervention studies in this area were identified. Randomised controlled trials are needed to examine the effectiveness of reduced sugar intake in the prevention of early childhood caries.

7 References

1. Twetman S, Garcia-Godoy F, Goepferd SJ. (2000) Infant oral health. [Review] [75 refs]. *Dent.Clin.North Am.*;**44**:487-505.

2. Milgrom P, Riedy CA, Weinstein P, Tanner AC, Manibusan L, Bruss J. (2000) Dental caries and its relationship to bacterial infection, hypoplasia, diet, and oral hygiene in 6- to 36-month-old children. *Community Dent.Oral Epidemiol.*;**28**:295-306.

3. Brown JP, Junner C, Liew V. (1985) A study of Streptococcus mutans levels in both infants with bottle caries and their mothers. *Aust.Dent.J.*;**30**:96-8.

4. Caufield PW, Cutter GR, Dasanayake AP. (1993) Initial acquisition of mutans streptococci by infants: evidence for a discrete window of infectivity. *J.Dent.Res.*;**72**:37-45.

5. Grindefjord M, Dahllof G, Ekstrom G, Hojer B, Modeer T. (1993) Caries prevalence in 2.5-year-old children. *Caries Res.*;**27**:505-10.

6. Aaltonen AS, Suhonen JT, Tenovuo J, Inkila-Saari I. (2000) Efficacy of a slow-release device containing fluoride, xylitol and sorbitol in preventing infant caries. *Acta Odontol.Scand.*;**58**:285-92.

7. Nowak AJ,.Warren JJ. (2000) Infant oral health and oral habits. [Review] [100 refs]. *Pediatr.Clin.North Am.*;**47**:1043-66.

8. Marsh PD, Nyvad B. (2003) The oral microflora and biofilms on teeth. In Ole Fejerskow, Edwina Kidd, eds. (2003) *Dental caries: The disease and its clinical Management*, pp 29-48. Blackwell Munksgaard,

9. Gelbier MJ, Winter GB, Gelbier MJ, Winter GB. (1995) Absence of salivary glands in children with rampant dental caries: report of seven cases. *Int.J.Paediatr.Dent.*;**5**:253-7.

10. McDermott RJ. (1985) Nursing caries syndrome: A critical educational challenge for pediatric health personnel. *Patient Educ.Couns.*;**. 7: 21-23**

11. Endean C, Roberts-Thomson K, Wooley S, Endean C, Roberts-Thomson K, Wooley S. Anangu (2004) Oral health: the status of the Indigenous population of the Anangu Pitjantjatjara lands. *Aust.J.Rural Health*;**12**:99-103.

12. Vargas CM, Crall JJ, Schneider DA, Vargas CM, Crall JJ, Schneider DA. (1998) Sociodemographic distribution of pediatric dental caries: NHANES III, 1988-1994.[see comment]. *J.Am.Dent.Assoc.*;**129**:1229-38.

13. Silver DH,.Silver DH. (1992) A comparison of 3-year-olds' caries experience in 1973, 1981 and 1989 in a Hertfordshire town, related to family behaviour and social class. *Br.Dent.J.* ;**172**:191-7.

14. Verrips GH, Kalsbeek H, Van Woerkum CM, Koelen M, Kok-Weimar TL, Verrips GH *et al*. (1994) Correlates of toothbrushing in preschool children by their parents in four ethnic groups in The Netherlands. *Community Dent.Health*;**11**:233-9.

15. Hallett KB. (2000) Early childhood caries--a new name for an old problem. *Ann.R.Australas.Coll.Dent.Surg.*;**15**:268-75.

16. Winter GB,.Winter GB. (1990) Epidemiology of dental caries. [Review] [87 refs]. *Arch.Oral Biol.*;**35 Suppl**:1S-7S.

17. Vargas CM, Ronzio CR, Hayes KL, Vargas CM, Ronzio CR, Hayes KL. (2003) Oral health status of children and adolescents by rural residence, United States. *J.Rural Health*;**19**:260-8.

18. Vargas CM, Monajemy N, Khurana P, Tinanoff N, Vargas CM, Monajemy N *et al*. (2002) Oral health status of preschool children attending Head Start in Maryland, 2000. *Pediatr.Dent.*;**24**:257-63.

19. Caufield PW, Cutter GR, Dasanayake AP, Caufield PW, Cutter GR, Dasanayake AP. (1993) Initial acquisition of mutans streptococci by infants: evidence for a discrete window of infectivity. *J.Dent.Res.*;**72**:37-45.

20. Li Y, Wang W, Caufield PW, Li Y, Wang W, Caufield PW. (2000) The fidelity of mutans streptococci transmission and caries status correlate with breast-feeding experience among Chinese families. *Caries Res.*;**34**:123-32.

21. Berkowitz RJ, Turner J, Green P. (1981) Maternal salivary levels of Streptococcus mutans and primary oral infection of infants. *Arch.Oral Biol.*;**26**:147-9.

22. Kohler B, Andreen I, Jonsson B. (1988) The earlier the colonization by mutans streptococci, the higher the caries prevalence at 4 years of age. *Oral Microbiol.Immunol.*;**3**:14-7.

23. Meurman JH, ten Cate JM, Meurman JH, ten Cate JM. (1996) Pathogenesis and modifying factors of dental erosion. [Review] [71 refs]. *Eur.J Oral Sci.*;**104**:199-206.

24. Caufield PW,.Griffen AL. (2000) Dental caries. An infectious and transmissible disease. [Review] [42 refs]. *Pediatr.Clin.North Am.*;**47**:1001-19.

25. Mohan A, Morse DE, O'Sullivan DM, Tinanoff N. (1998) The relationship between bottle usage/content, age, and number of teeth

with mutans streptococci colonization in 6-24-month-old children. *Community Dent.Oral Epidemiol.*;**26**:12-20.

26. Berkowitz RJ,.Berkowitz RJ. (2003) Causes, treatment and prevention of early childhood caries: a microbiologic perspective. *J.Can.Dent.Assoc.*;**69**:304-7.

27. De Grauwe A, Aps JK, Martens LC, De Grauwe A, Aps JK, Martens LC. (2004) Early Childhood Caries (ECC): what's in a name?. [Review] [40 refs]. *Eur.J.Paediatr.Dent.*;**5**:62-70.

28. Ismail AI,.Sohn W. (1999) A systematic review of clinical diagnostic criteria of early childhood caries. *J.Public Health Dent.* 9;**59**:171-91.

29. Pitts N.B, O.Fejerskov and F.R.Von der Fehr. (2003) Caries Epidemiology, with special emphasis on diagnostic standards. pp 141-64. Blackwell Munksgaard,

30. Stecksen-Blicks C, Sunnegardh K, Borssen E, Stecksen-Blicks C, Sunnegardh K, Borssen E. (2004) Caries experience and background factors in 4-year-old children: time trends 1967-2002. *Caries Res.*;**38**:149-55.

31. Nigel Pitts and Rachael Harker. (2004) Obvious decay experience-Survey of children's dental Health in the United Kingdom 2003. *Children's dental health in the United Kingdom 2003.* 1-48. Office of National Statistics, London.

32. Scottish Executive (2005) *An action plan for improving oral health and modernising NHS dental services in Scotland*. 1-41. Scottish Executive, Edinburgh.

33. Steele J & Lader D (2004) *Social factors and oral health in children - Survey of children's dental health in the United Kingdom 2003*. 1-28. Office of National Statistics, London,.

34. Sweeney PC, Gelbier S. (1999) The dental health of pre-school children in a deprived urban community in Glasgow. *Community Dent.Health*;**16**:22-5.

35. Pitts NB, Boyles J, Nugent ZJ, Thomas N, Pine CM, British Association for the Study of Community Dentistry. *et al*. (2005) The dental caries experience of 5-year-old children in England and Wales (2003/4) and in Scotland (2002/3). Surveys co-ordinated by the British Association for the Study of Community Dentistry. *Community Dent.Health*;**22**:46-56.

36. Ferro R, Besostri A, Meneghetti B, Beghetto M, Ferro R, Besostri A *et al*. (2004) Comparison of data on Early Childhood Caries (ECC) with

previous data for Baby Bottle Tooth Decay (BBTD) in an Italian kindergarten population. *Eur.J.Paediatr.Dent.*;**5**:71-5.

37. Wennhall I, Matsson L, Schroder U, Twetman S, Wennhall I, Matsson L *et al*. (2002) Caries prevalence in 3-year-old children living in a low socio-economic multicultural urban area in southern Sweden. *Swed.Dent.J.*;**26**:167-72.

38. Siegal MD, Yeager MS, Davis AM, Siegal MD, Yeager MS, Davis AM. (2004) Oral health status and access to dental care for ohio head start children. *Pediatr.Dent.*;**26**:519-25.

39. Milnes AR. (1996) Description and epidemiology of nursing caries. [Review] [59 refs]. *Journal of Public Health Dentistry.*;**56**:38-50.

40. Davies GM, Blinkhorn FA, Duxbury JT. (2001) Caries among 3-year-olds in greater Manchester. *Br.Dent.J.*;**190**:381-4.

41. Wendt LK,.Wendt LK. (1995) On oral health in infants and toddlers. [Review] [115 refs]. *Swed.Dent.J.Suppl*;**106**:1-62.

42. Tinanoff N,.Palmer CA. (2000) Dietary determinants of dental caries and dietary recommendations for preschool children. *J.Public Health Dent.*;**60**:197-206.

43. Autio-Gold JT, Tomar SL, Autio-Gold JT, Tomar SL. (2005) Prevalence of noncavitated and cavitated carious lesions in 5-year-old head start schoolchildren in Alachua County, Florida. *Pediatr.Dent.*;**27**:54-60.

44. Montero MJ, Douglass JM, Mathieu GM, Montero MJ, Douglass JM, Mathieu GM. (2003) Prevalence of dental caries and enamel defects in Connecticut Head Start children. *Pediatr.Dent.*;**25**:235-9.

45. Vachirarojpisan T, Shinada K, Kawaguchi Y, Laungwechakan P, Somkote T, Detsomboonrat P *et al*. (2004) Early childhood caries in children aged 6-19 months. *Community Dent.Oral Epidemiol.*;**32**:133-42.

46. Al Malik MI, Holt RD, Bedi R. (2003) Prevalence and patterns of caries, rampant caries, and oral health in two- to five-year-old children in Saudi Arabia. *J.Dent.Child (Chic.)*, **70**:235-42.

47. Albert DA, Park K, Findley S, Mitchell DA, McManus JM, Albert DA *et al*. (2002) Dental caries among disadvantaged 3- to 4-year-old children in northern Manhattan. *Pediatr.Dent.*;**24**:229-33.

48. Shiboski CH, Gansky SA, Ramos-Gomez F, Ngo L, Isman R, Pollick HF *et al*. (2003) The association of early childhood caries and race/ethnicity among California preschool children.[erratum appears in J Public Health Dent. 2003 Fall;63(4):264]. *J.Public Health Dent.*;**63**:38-46.

49. Brice DM, Blum JR, Steinberg BJ. (1996) The etiology, treatment, and prevention of nursing caries. [Review] [25 refs]. *Compend.Contin.Educ.Dent.*;**17**:92-8.

50. Davies GN. Early childhood caries--a synopsis. (1998) [Review] [60 refs]. *Community Dent.Oral Epidemiol.*;**26**:106-16.

51. Center for Reviews and Dissemination Reviewers. Dental restoration: what type of filling? *Database of Abstracts of Reviews of Effectiveness* 2002;Issue 4, December 2002.

52. Tinanoff N,.O'Sullivan DM. (1997) Early childhood caries: overview and recent findings. [Review] [53 refs]. *Pediatr.Dent.* 1997;**19**:12-6.

53. Weinstein P. (1998) Public health issues in early childhood caries. [see comments.]. [Review] [61 refs]. *Community Dent.Oral Epidemiol.*;**26**:84-90.

54. Raadal M,.Espelid I. (1992) Caries prevalence in primary teeth as a predictor of early fissure caries in permanent first molars. *Community Dent.Oral Epidemiol.*;**20**:30-4.

55. Schafer TE,.Adair SM. (2000) Prevention of dental disease. The role of the pediatrician. [Review] [68 refs]. *Pediatr.Clin.North Am.*;**47**:1021-42.

56. Ismail AI. (1998) Prevention of early childhood caries. [Review] [96 refs]. *Community Dent.Oral Epidemiol.*;**26**:49-61.

57. Locker D. (2000) Deprivation and oral health: a review. [Review] [53 refs]. *Community Dent.Oral Epidemiol.*;**28**:161-9.

58. Tinanoff N. (1995) Dental caries risk assessment and prevention. [Review] [36 refs]. *Dent.Clin.North Am.*;**39**:709-19.

59. Weintraub JA. (1998) Prevention of early childhood caries: a public health perspective. [Review] [23 refs]. *Community Dent.Oral Epidemiol.*;**26**:62-6.

60. SIGN (2002). *Preventing dental caries in children at high caries risk.* Scottish Intercollegiate Guidelines Network, Edinburgh.

61. SIGN 83 (2005). *Prevention and management of dental decay in the pre-school child.* Scottish Executive, Edinburgh.

62. Lewit EM, Kerrebrock N. (1998) Child Indicators: Dental Health. *Protecting Children from Abuse and Neglect*;**8**:133-42.

63. Sgan-Cohen HD, Mansbach IK, Haver D, Gofin R. (2001) Community-oriented oral health promotion for infants in Jerusalem: evaluation of a program trial. *J.Public Health Dent.*;**61**:107-13.

64. Holt RD, Winter GB, Fox B, Askew R. (1985) Effects of dental health education for mothers with young children in London. *Community Dentistry & Oral Epidemiology.*;**13**:148-51.

65. Kowash MB, Pinfield A, Smith J, Curzon ME. (2000) Effectiveness on oral health of a long-term health education programme for mothers with young children. *Br.Dent.J.*;**188**:201-5.

66. Ekman A, Persson B. (1990) Effect of early dental health education for Finnish immigrant families. *Swed.Dent.J.*;**14**:143-51.

67. Feldman CA, Bentley JM, Oler J. (1988) The Rural Dental Health Program: long-term impact of two dental delivery systems on children's oral health. *Journal of Public Health Dentistry.*;**48**:201-7.

68. Makuch A, Reschke K. (2001) Playing games in promoting childhood dental health. *Patient Educ.Couns.*;**43**:105-10.

69. Rodrigues CS, Watt RG, Sheiham A. (1999) Effects of dietary guidelines on sugar intake and dental caries in 3-year-olds attending nurseries in Brazil. *Health Promotion International*;**14**:329-35.

70. Autio-Gold JT, Courts F. (2001) Assessing the effect of fluoride varnish on early enamel carious lesions in the primary dentition. *J.Am.Dent.Assoc.*;**132**:1247-53.

71. Holm AK. (1979) Effect of fluoride varnish (Duraphat) in preschool children. *Community Dent.Oral Epidemiol.*;**7**:241-5.

72. Chu CH, Lo EC, Lin HC. (2002) Effectiveness of silver diamine fluoride and sodium fluoride varnish in arresting dentin caries in Chinese pre-school children. *J.Dent.Res.*; **81**:767-70.

73. Frostell G, Birkhed D, Edwardsson S, Goldberg P, Petersson LG, Priwe C *et al*. (1991) Effect of partial substitution of invert sugar for sucrose in combination with Duraphat treatment on caries development in preschool children: the Malmo Study. *Caries Research.*;**25**:304-10.

74. You BJ, Jian WW, Sheng RW, Jun Q, Wa WC, Bartizek RD *et al*. (2002) Caries prevention in Chinese children with sodium fluoride dentifrice delivered through a kindergarten-based oral health program in China. *J.Clin.Dent.*;**13**:179-84.

75. Winter GB, Holt RD, Williams BF. (1989) Clinical trial of a low-fluoride toothpaste for young children. *International Dental Journal.*;**39**:227-35.

76. Holt RD, Morris CE, Winter GB, Downer MC. (1994) Enamel opacities and dental caries in children who used a low fluoride toothpaste between 2 and 5 years of age. *International Dental Journal.*;**44**:331-41.

77. Davies GM, Worthington HV, Ellwood RP, Bentley EM, Blinkhorn AS, Taylor GO *et al*. (2002) A randomised controlled trial of the

effectiveness of providing free fluoride toothpaste from the age of 12 months on reducing caries in 54-year old children. *Community Dent.Health*;**19**:131-6.

78. Hargreaves JA,.Chester CG. (1973) Clinical trial among Scottish children of an anti-caries dentifrice containing 2 percent sodium monofluorophosphate. *Community Dentistry & Oral Epidemiology.*;**1**:47-57.

79. Englander HR, Mellberg JR, Engler WO. (1978) Observations on dental caries in primary teeth after frequent fluoride toplications in a program involving other preventives. *Journal of Dental Research.*;**57**:855-60.

80. Lincir I, Rosin-Grget K. (1993) Caries-preventive effect of two different topical fluoride concentrations with two different frequencies of application in preschool children. *Caries Research.*;**27**:484-7.

81. Schutze HJ, Jr., Forrester DJ, Balis SB. (1974) Evaluation of a fluoride prophylaxis paste in a fluoridated community. *Journal of the Canadian Dental Association.*;**40**:675-83.

82. Horowitz HS, Creighton WE, McClendon BJ. (1971) The effect on human dental caries of weekly oral rinsing with a sodium fluoride mouthwash: a final report. *Archives of Oral Biology.*;**16**:609-16.

83. Hennon DK, Stookey GK, Muhler JC. (1966) The clinical anticariogenic effectiveness of supplementary fluoride-vitamin preparations. Results at the end of three years. *Journal of Dentistry for Children.*;**33**:3-12.

84. Hamberg L. (1971) Controlled trial of fluoride in vitamin drops for prevention of caries in children. *Lancet.*;**1**:441-2.

85. Glenn FB, Glenn WD, III, Duncan RC. (1982) Fluoride tablet supplementation during pregnancy for caries immunity: a study of the offspring produced. *Am.J.Obstet.Gynecol.*;**143**:560-4.

86. Leverett DH, Adair SM, Vaughan BW, Proskin HM, Moss ME. (1997) Randomized clinical trial of the effect of prenatal fluoride supplements in preventing dental caries. *Caries Res.*;**31**:174-9.

87. Poulsen S, Thylstrup A, Christensen PF, Ishoy. (1979) Evaluation of a pit- and fissure-sealing program in a public dental health service after 2 years. *Community Dent.Oral Epidemiol.*;**7**:154-7.

88. Horowitz HS, Heifetz SB, Poulsen S. (1977) Retention and effectiveness of a single application of an adhesive sealant in preventing occlusal caries: final report after five years of a study in Kalispell, Montana. *J.Am.Dent.Assoc.*;**95**:1133-9.

89. Mertz-Fairhurst EJ, Fairhurst CW, Williams JE, Della-Giustina VE, Brooks JD. (1984) A comparative clinical study of two pit and fissure sealants: 7-year results in Augusta, GA. *J.Am.Dent.Assoc.*;**109**:252-5.

90. Gisselsson H, Birkhed D, Bjorn AL. Effect of a 3-year professional flossing program with chlorhexidine gel on approximal caries and cost of treatment in preschool children. *Caries Research.* 1994;**28**:394-9.

91. Tenovuo J, Hakkinen P, Paunio P, Emilson CG. (1992) Effects of chlorhexidine-fluoride gel treatments in mothers on the establishment of mutans streptococci in primary teeth and the development of dental caries in children. *Caries Res.*;**26**:275-80.

92. Dasanayake AP, Wiener HW, Li Y, Vermund SV, Caufield PW. (2002) Lack of effect of chlorhexidine varnish on Streptococcus mutans transmission and caries in mothers and children. *Caries Res.*;**36**:288-93.

93. Lopez L, Berkowitz R, Spiekerman C, Weinstein P. (2002) Topical antimicrobial therapy in the prevention of early childhood caries: a follow-up report. *Pediatr.Dent.*;**24**:204-6.

94. Dasanayake AP (1993) CPCGSH. Transmission of mutans streptococci to infants following short term application of an iodine-NaF solution to mothers' dentition. *Community Dent.Oral Epidemiol.*;**21**:136-42.

95. Pine CM, McGoldrick PM, Burnside G, Curnow MM, Chesters RK, Nicholson J *et al*. (2000) An intervention programme to establish regular toothbrushing: understanding parents' beliefs and motivating children. *Int.Dent.J.*;Suppl Creating A Successful :312-23.

96. Curnow MM, Pine CM, Burnside G, Nicholson JA, Chesters RK, Huntington E. (2002) A randomised controlled trial of the efficacy of supervised toothbrushing in high-caries-risk children. *Caries Res.*;**36**:294-300.

97. Sjogren K, Birkhed D, Rangmar B. (1995) Effect of a modified toothpaste technique on approximal caries in preschool children. *Caries Research.*;**29**:435-41.

98. Nase L, Hatakka K, Savilahti E, Saxelin M, Ponka A, Poussa T *et al*. (2001) Effect of long-term consumption of a probiotic bacterium, Lactobacillus rhamnosus GG, in milk on dental caries and caries risk in children. *Caries Res.*;**35**:412-20.

99. Isokangas P, Soderling E, Pienihakkinen K, Alanen P. (2000) Occurrence of dental decay in children after maternal consumption of xylitol chewing gum, a follow-up from 0 to 5 years of age.[comment]. *J.Dent.Res.*;**79**:1885-9.

100. Olson DG, Levy RL, Evans CA, Jr., Olson SK. (1981) Enhancement of high risk children's utilization of dental services. *American Journal of Public Health.*;**71**:631-4.

101. Heifetz SB, Horowitz HS, Meyers RJ, Li SH. (1987) Evaluation of the comparative effectiveness of fluoride mouthrinsing, fluoride tablets, and both procedures in combination: interim findings after two years. *Pediatr.Dent.*;**9**:121-5.

102. Driscoll WS, Nowjack-Raymer R, Heifetz SB, Li SH, Selwitz RH. (1990) Evaluation of the comparative effectiveness of fluoride mouthrinsing, fluoride tablets, and both procedures in combination: interim findings after five years. *Journal of Public Health Dentistry.*;**50**:13-7.

103. Driscoll WS, Nowjack-Raymer R, Selwitz RH, Li SH, Heifetz SB. (1992) A comparison of the caries-preventive effects of fluoride mouthrinsing, fluoride tablets, and both procedures combined: final results after eight years. *Journal of Public Health Dentistry.*;**52**:111-6.

104. Petersson LG, Koch G, Rasmusson CG, Stanke H. (1985) Effect on caries of different fluoride prophylactic programs in preschool children. A two year clinical study. *Swedish Dental Journal.*;**9**:97-104.

105. Lalloo R & Solanki GS. (1994) An evaluation of a school-based comprehensive public oral health care programme. *Community Dental Health.*;**11**:152-5.

106. Bagramian RA, Graves RC, Srivastava S. (1978) A combined approach to preventing dental caries in schoolchildren : caries reductions after 3 years. *Community Dent.Oral Epidemiol.* ;**6**:166-71.

107. Gomez SS, Weber AA. (2001) Effectiveness of a caries preventive program in pregnant women and new mothers on their offspring. *Int.J.Paediatr.Dent.*;**11**:117-22.

108. Gomez SS, Weber AA, Emilson CG. (2001) A prospective study of a caries prevention program in pregnant women and their children five and six years of age. *J.Dent.Child*;**68**:191-5.

109. Kohler B, Andreen I, Jonsson B. (1984) The effect of caries-preventive measures in mothers on dental caries and the oral presence of the bacteria Streptococcus mutans and lactobacilli in their children. *Arch.Oral Biol.*;**29**:879-83.

110. Kohler B, Andreen I. (1994) Influence of caries-preventive measures in mothers on cariogenic bacteria and caries experience in their children. *Archives of Oral Biology.*;**39**:907-11.

111. Toth K. (1976) A study of 8 years' domestic salt fluoridation for prevention of caries. *Community Dent.Oral Epidemiol.*;**4**:106-10.

112. Toth K. (1978) Ten years domestic salt fluoridation in Hungary. *Acta Paediatr.Acad.Sci.Hung.*;**19**:319-27.

113. Stephen KW. (1981) A 4-year double-blind fluoridated school milk study in a vitamin-D deficient area. *Br.Dent.J.*;**151**:287-92.

114. Stephen KW, Boyle IT, Campbell D, McNee S, Boyle P. (1984) Five-year double-blind fluoridated milk study in Scotland. *Community Dentistry & Oral Epidemiology.*;**12**:223-9.

115. Marino R, Villa A, Guerrero S. (2001) A community trial of fluoridated powdered milk in Chile. *Community Dent.Oral Epidemiol.*;**29**:435-42.

116. Frostell G, Blomqvist T, Bruner P. (1981) Reduction of caries in pre-school children by sucrose restriction and substitution with invert sugar. The Gustavsberg study. *Acta Odontologica Scandinavica,* Vol 39(6) (pp 333-347),

117. Jackson D, James PM, Thomas FD. (1985) Fluoridation in Anglesey 1983: a clinical study of dental caries. *Br.Dent.J.*;**158**:45-9.

118. Thomas FD, Kassab JY, Jones BM. (1995) Fluoridation in Anglesey 1993: a clinical study of dental caries in 5-year-old children who had experienced sub-optimal fluoridation.[comment]. *British Dental Journal.*;**178**:55-9.

119. O'Mullane DM, Clarkson J, Holland T, O'Hickey S, Whelton H. (1988) Effectiveness of water fluoridation in the prevention of dental caries in Irish children. *Community Dental Health.*;**5**:331-44.

120. Rugg-Gunn AJ, Carmichael CL, French AD, Furness JA. (1977) Fluoridation in Newcastle and Northumberland. A clinical study of 5-year-old children. *Br.Dent.J.*;**142**:395-402.

121. Evans DJ, Rugg-Gunn AJ, Tabari ED. (1995) The effect of 25 years of water fluoridation in Newcastle assessed in four surveys of 5-year-old children over an 18-year period. *British Dental Journal.*;**178**:60-4.

122. McDonagh MS, Whiting PF, Wilson PM, Sutton AJ, Chestnutt I, Cooper J *et al*. (2000) Systematic review of water fluoridation.[see comment]. [Review] [6 refs]. *BMJ*;**321**:855-9.

123. Marinho VC, Higgins JP, Sheiham A, Logan S. (2003) Fluoride toothpastes for preventing dental caries in children and adolescents. [Review] [164 refs]. *Cochrane Database Syst.Rev.*;CD002278.

124. Marinho VC, Higgins JP, Logan S, Sheiham A. (2002) Fluoride varnishes for preventing dental caries in children and adolescents. [Review] [92 refs]. *Cochrane Database Syst.Rev.*;CD002279.

125. Marinho VC, Higgins JP, Sheiham A, Logan S. (2004) One topical fluoride (toothpastes, or mouth rinses, or gels, or varnishes) versus another for preventing dental caries in children and adolescents. [Review] [58 refs]. *Cochrane Database Syst.Rev.*;CD002780.

126. Marinho VC, Higgins JP, Sheiham A, Logan S. (2004) Combinations of topical fluoride (toothpastes, mouth rinses, gels, varnishes) versus single topical fluoride for preventing dental caries in children and

adolescents.[see comment]. [Review] [46 refs]. *Cochrane Database Syst.Rev.*;CD002781.

127. Winter GB, Rule DC, Mailer GP, James PM, Gordon PH. (1971) The prevalence of dental caries in pre-school children aged 1 to 4 years. *Br.Dent.J.*;**130**:434-6.

Appendix A: Search Strategy

In MEDLINE the following specific search strategy was used

1. (child$ and caries).tw.
2. (nurs$ and caries).tw.
3. (nurs$ and bottle).tw.
4. (bottle$ and syndrom$).tw.
5. (bottle$ and caries).tw.
6. (bab$ and bottle$).tw.
7. (infant$ and caries).tw.
8. (feed$ and caries).tw.
9. ((tooth or teeth$) and decay).tw.
10. BBTD.tw.
11. exp Tooth, Deciduous/
12. (tooth and deciduous).tw.
13. (night$ and bottle$).tw.
14. exp bottle feeding/
15. exp infant nutrition/
16. exp oral health/
17. exp dental caries/
18. exp dentition, primary/
19. (oral and health).tw.
20. (dental and (carie$ or carious)).tw.
21. exp oral hygiene/
22. (oral and hygien$).tw.
23. exp dental care/
24. (dental and care).tw.
25. (caries and preven$).tw.
26. (milk adj1 teeth).tw.
27. or/1-26
28. exp child/
29. (child$ or pediatric or paediatric).tw.
30. (toddler$ or infant$ or baby or babies).tw.
31. (preschool or pre-school or pre school).tw.
32. (new adj1 born).tw.
33. or/28-32
34. exp Randomized Controlled Trials/
35. randomized controlled trial.pt.
36. exp Random Allocation/
37. (random$ or alloc$ or assign$).ti,ab.
38. controlled clinical trial.pt.
39. exp Double-Blind Method/
40. exp Single-Blind Method/
41. or/34-40
42. clinical trial.pt.
43. exp Clinical Trials/
44. exp Cross-Over Studies/
45. ((cross-over or crossover) adj5 (stud$ or trial$ or design$)).tw.
46. (clin$ adj25 trial$).ti,ab.

47. ((singl$ or doubl$ or trebl$ or tripl$) adj5 (blind$ or mask$)).ti,ab.
48. placebos.sh.
49. placebo$.ti,ab.
50. random$.ti,ab.
51. research design.sh.
52. exp placebos/
53. or/42-52
54. 53 not 41
55. Comparative Study/
56. exp Evaluation Studies/
57. exp Follow-Up Studies/
58. exp Prospective Studies/
59. (control$ or prospectiv$ or volunteer$).ti,ab.
60. or/55-59
61. 41 or 54
62. 60 not (60 and 61)
63. 27 and 33 and 41
64. 27 and 33 and 54
65. 27 and 33 and 62

The MEDLINE search strategy was adapted for use with the other databases.

Appendix B: Data Extraction Form

Bibliographic Details

Authors

_____

Journal

_____

Title

_____

_____

Year Volume Issue Pages

Country of origin _____

Reviewer1 _____ Reviewer 2 _____

Database _____ Ref ID _____

Medline Embase Cochrane Library Cinahl

Others (e.g. reference checking, PhD)

Details_____

_____

Eligibility check

	Yes	No	Unclear or others with details
Randomised Controlled Trial or Controlled Clinical Trial			
Age ≤ 5 years			
Prevention of caries as outcome			

Yes ☐ No ☐

References ☐ Interesting ☐

Study Characteristics

Study design	RCT	Quasi Randomised trial	
Method of randomisation			

Study population baseline characteristics

	Control	Intervention	Intervention 2:	Intervention 3:	Intervention 4:
Number of participants					
Sex					
Age of participants					
Social Class					
Ethnic group					
Setting					

Details of interventions

	Control	Intervention	Intervention 2:	Intervention 3:	Intervention 4:
Description of intervention					
Target population					
Who delivered intervention					
Duration of intervention					
Health professional involvement					

Outcomes and assessment

Outcome measured	Incidence of caries Status of caries Tooth loss % of caries-free teeth Rate of restorations Pain/discomfort episodes	Details:
Outcome Evaluation: Measurement used		
Measurement of intervention effect:	Odds ratio (95% CI) Mean differences (95% CI) Others:	Details:

Follow-up

% Drop out at the end of the study		Details:
Duration of follow-up		Details:
Number of follow-ups		
Loss to follow up %		
Are Losses to follow-up described?	Yes/No	Details:
Any other issues arising:		

Appendix C: Quality Assessment Form

Method of randomisation			
Quality of randomisation	A=adequate concealment of allocation	B=uncertain if adequately concealed	C=not adequately concealed
Outcome assessors blind to intervention	A=Blinding stated	B=Not mentioned or unclear	C=Not blinded
Number of withdrawals and dropouts	A=States numbers and reasons for withdrawals	B=States withdrawal only States withdrawals but no numbers	C=Not mentioned
Validated outcome measures used	Yes	No	
Intention to treat Analysis	Yes	No	

Strong ☐ Moderate ☐ Weak ☐

Conclusions:

Appendix D: Overall Methodological Quality of the Study

Forty-eight papers from 42 randomised controlled trials that were included in the review were assessed for methodological quality.

The quality of the studies were assessed on: method of randomisation; quality of randomisation; outcome assessors blinding to the intervention; number of dropouts and withdrawals; reporting of validated outcome measure and Intention to Treat analysis. Each of these criteria was graded from either A-C or yes/no according to the strength of compliance.

Each study was subsequently classified as strong, moderate or weak on the basis of the minimum grade obtained within each criterion.

The follow-up and appropriateness of statistical methods used was also considered in assessing the quality of the study.

Half of the papers (25 papers out of 48) were of moderate quality. Eleven studies were strong and 12 studies were weak in the methodological quality.

These studies were assessed on the information that was published in the paper. Because of time constraints authors were not contacted for further information. (Studies might have scored higher if authors were contacted for the details to assess the study). Studies that were conducted in the 1990's were mostly moderate to strong in quality and the weak studies were usually carried out in the 1960's and the 1970's.

The quality of the studies are summarised in the main report.