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Oral health: local authority oral health improvement strategies

Evidence review 1: review of evidence of the effectiveness of community-based oral health improvement programmes and interventions.

Evidence review for the Centre for Public Health at NICE

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List of Abbreviations and glossary

ABC	Access Barriers to Care Index
ASD	Autism Spectrum Disorder
BASCD	The British Association for the Study of Community Dentistry
BBB	'Boosting Better Breaks' dietary health promotion programme
BDA	British Dental Association
Care Index	Filled teeth as a percentage of decayed, missing or filled teeth (ft/dmft x 100), used as a marker of dental service utilisation; see Restoration Index
Caries	Tooth decay or cavities
Caries increment	Change from baseline (or other defined timepoint) in the number of decayed, extracted/missing or filled teeth/surfaces in the primary or permanent dentition
Cariogenic	Producing or promoting the development of dental caries
Carvalho Index	Indicator of plaque accumulation (0: no visible plaque; 1: detectable plaque restricted to fossae and grooves; 2: surface partially or totally covered with heavy plaque accumulation)
CI	Confidence interval
CPI	Community Periodontal Index, 0 to 4 scale for periodontal disease (higher scores indicating worse periodontal health)
$d_1$mft/D_1MFT	Non-cavitated enamel decay, missing or filled deciduous/permanent teeth
$d_2$mft/D_2MFT	Cavitated enamel decay, missing or filled deciduous (indicated by lower case lettering) /PERMANENT (indicated by upper case lettering) teeth
D_{3cv}MT	Decay (cavitation and visual dentine caries) and missing permanent teeth
$d_3$mft/D_3MFT	Cavitated dentine decay, missing or filled deciduous/PERMANENT teeth
deft/DEFT	Decayed, extracted or filled deciduous/PERMANENT teeth
DepCat	Deprivation Category, a measure of community deprivation, higher scores indicate greater deprivation
DFS_a	Decay or filled approximal surface of the permanent dentition
DH	Department of Health
Dmfs/DMFS	Decayed, missing or filled deciduous/PERMANENT tooth surface;
Dmft/DMFT	Decayed, missing or filled deciduous/PERMANENT teeth
dt/DT	Decayed deciduous/PERMANENT teeth
ECC	Early childhood caries
et/ET	Extracted deciduous/PERMANENT teeth
F	Fluoride
F/DF	Filled teeth as a proportion of decayed and filled teeth; see Restoration Index
ft/dmft x 100	Filled teeth as a percentage of decayed, missing or filled teeth; see Care Index
FMR	Fluoride mouth rinse

FNR	Fluoridation [status of water] not reported
FOTI	Fibre optic transillumination
ft/FT	Filled deciduous/PERMANENT teeth
FW	Fluoridated water
GI	Loe and Silness Gingival index, indicator of gingival inflammation; scores range from 0 to 3, with higher scores indicating more severe inflammation
HEALTH	'Healthcare Empowerment Alliance for people living in Transitional Housing' project
HIV	Human immunodeficiency virus
ICDAS	International caries detection assessment system; scoring descriptions below
ICDAS d_0/D_0	Sound surface
ICDAS d_1/D_1	First visual change in enamel – early stage decay
ICDAS d_2/D_2	Distinct visual change in enamel – early stage decay
ICDAS d_3/D_3	Localised enamel breakdown – established decay
ICDAS d_4/D_4	Underlying dentine shadow – established decay
ICDAS d_5/D_5	Distinct cavity with visible dentine – severe decay
ICDAS d_6/D_6	Extensive cavity within visible dentine – severe decay
IST	Health Integrated Service Team
LF	Laser fluorescence, used to assess tooth mineralisation
Loe and Silness Gingival Index	See GI
mt/MT	Missing deciduous/PERMANENT teeth
NF	Non-fluoridated [water]
NIH	U.S. National Institutes of Health
NNT	Number needed to treat
NR	Not reported
NRT	Nicotine replacement therapy
NS	Not significant
OHAT	Oral health action team
OR	Odds Ratio
ORHIS	'Oral Health Information Seminars' programme
PF	Prevented Fraction (the difference in caries between the intervention and comparator group, as a percentage of caries in the comparator group)
PHE	Public Health England
PI	Silness and Loe Plaque Index; scores on a scale of 0 to 3, higher scores indicate more soft matter within the gingival pocket and/or the tooth and gingival margin
PMTC	Professional mechanical tooth cleaning
ppm	Parts per million
PR	Prevalence ratio
RC	Reviewer calculated

Restoration Index	Proportion of decayed or filled teeth that have been filled (i.e. restored), used as a marker of dental service utilisation; see Care Index
RR	Relative risk
s	Seconds
SD	Standard deviation
SE	Standard error
S-ECC	Severe early childhood caries
SEM	Standard error of the mean
SES	Socioeconomic status
SiC	Significant caries index – represents the mean dmft/DMFT for the top third of a population when ranked by DMFT
Silness and Loe Plaque Index	See PI
SBI	Sulcus Bleeding Index, indicator of periodontal status; scored on a scale of 0 to 5, with higher scores indicating greater gingival bleeding and inflammation
TB	Tuberculosis
THF	Transitional housing facility
vs	Versus
WHO	World Health Organization
WIC	'Women, Infants, and Children' programme

1 Executive Summary

1.1 Introduction

Oral health across the UK has been steadily improving over the past several decades. This improvement has been seen both in adults, more of whom are keeping their teeth throughout their lives, and children, who have seen a reduction in tooth decay compared to children in previous decades (DH 2005). The 2009/2010 Adult Dental Health Survey highlights a reduction in prevalence of some common oral health conditions between 1998 and 2009, including visible dental caries, although tooth wear and more severe forms of periodontal disease have shown increased prevalence (White 2012). The decline in dental caries has been contributed to by the widespread availability of fluoridated toothpaste since the 1970's (Macpherson 2013). During the same period, improvements were seen in oral hygiene behaviours as well, with frequent brushing among adults becoming more common (White 2012).

Despite this overall trend towards improvement at the population level, inequalities in oral health persist. The British Dental Association has recognised socioeconomic status (SES) as a key determinant of inequalities in oral health, and reports an association between SES and an array of oral health conditions, including gingival and periodontal disease and oral cancer (BDA 2013).

Several specific populations are considered to be at increased risk of poor oral health, including children under the age of five years, individuals with disabilities, older people and individuals in lower socioeconomic groups (BDA 2013, DH 2005).

1.2 Aims and objectives

This evidence review addresses the following questions:

1. What are the most effective community based programmes and interventions to promote, improve, and maintain the oral health of a local community? In particular, what are the most effective approaches for groups of people who are disadvantaged and at high risk of poor oral health?

The review includes evidence concerning the effectiveness of community based oral health improvement programmes that aim to reduce and prevent dental and periodontal diseases, oral cancer or other oral diseases and to promote oral health by:

- Increasing access to fluoride
- Improving oral health hygiene
- Improving diet
- Increasing attendance at general dental practices

1.3 Methods

Briefly, the steps in this review were:

- Identifying relevant studies by systematic searches of electronic literature databases, including grey literature and supplemental searches
- Selecting relevant studies relating to community based oral health promotion programmes or interventions that meet inclusion criteria
- Assessing the quality of the included studies
- Extracting data from the included studies
- Summarising findings and drafting evidence statements relating to the effectiveness of oral health promotion programmes among the target populations

1.4 Findings/evidence statements

The identified evidence has been generally organised using a life course approach, with further subgrouping by setting. The major categories and associated evidence statements were:

- Before and during pregnancy (No studies identified)
- Early years – babies and very young children
  - Nursery or pre-school settings (Evidence Statements 1 to 3)
  - Home or community settings (Evidence Statements 4 to 7)
- Children and young people of primary and secondary school age
  - School settings (Evidence Statements 8 to 17)
  - Community settings (Evidence Statement 18)

  - Home settings (Evidence Statement 19)
- Young adults (No studies identified)
- Adults
  - Workplace settings (Evidence Statement 20)
- Elderly
  - Community settings (Evidence Statement 21)

In addition to the life course approach, evidence for specific at risk populations was assessed:

- Homeless populations (Evidence Statement 22)
- Children with developmental or learning disorders (Evidence Statement 23)
- Indigenous populations – included following consultation with the committee for the potential to inform decisions regarding community based oral health programmes in disadvantaged or hard to reach populations in the UK (Evidence Statements 24 to 25)

The identified evidence for each of the populations is summarised in the Evidence Statements.

Evidence Statement 1: Effect of nursery based fluoridated milk programmes on the oral health of children under the age of five

Weak evidence from one cluster RCT (Sweden[1]) suggests that a nursery based daily fluoride milk programme may be effective at preventing tooth decay in the primary molars and canine teeth of younger nursery school children (caries free OR: 2.7, 95% CI 1.7 to 4.2; mean dmfs prevented fraction: 75%)[1].

[1] Stecksen-Blicks et al. 2009 [+]

Evidence Statement 2: Association between nursery based supervised tooth brushing programmes and dental caries at age 5

Weak evidence from one interrupted time series study (UK[1]) suggests that a national daily supervised tooth brushing programme in nurseries that includes provision of fluoride toothpaste for home use is associated with significant improvements in oral health of five year old children at a population level, with a difference in mean $d_3$mft of -0.99 (95% CI -1.08 to -0.90)[1] over the 12 years following programme implementation. This reduction follows a trend of increasing caries prevalence in the decade prior to programme implementation (data not reported).

Significant reductions in dental caries were seen amongst the most deprived communities (Deprivation Categories 6 and 7 difference in mean $d_3$mft: -1.71, 95% CI -1.93 to -1.49)[1] as well as in the least deprived communities (Deprivation categories 1 and 2 difference in mean $d_3$mft: -0.43, 95% CI -0.60 to -0.25)[1], suggesting that the programme may be effective at reducing absolute oral health inequalities in this age group.

[1] Macpherson et al. 2013 [++]

Evidence Statement 3: Association between nursery or school based oral health promotion and education programmes and dental decay among children under the age of five

Weak evidence from one cluster RCT (US[1]) and two before and after studies (France[2], Sweden[3]) suggests that nursery based oral health education and promotion programmes are not associated with improvements in oral hygiene, oral heatlh knowledge or dental decay status, but may prevent the worsening of caries amongst young children in deprived communities.

One study[1] found that a single, brief preschool based oral health education programme alone has no impact on the self-reported oral hygiene behaviours of five year old children (comparative statistics not reported)[1]. This study also found no programme effect on oral health knowledge, or attitudes toward oral hygiene, dentists or nutrition (comparative statistics not reported)[1].

Another study[2] found no significant difference in mean caries levels amongst children from deprived areas who participated in a school based oral health education and brushing programme (mean (SD) dmft - before 1.47 (2.75) vs. after 1.44 (2.78); reported as NS, 95% CI and p-value NR)[2], while children from non-participating schools in similarly deprived or semi-deprived areas had significant increases in mean dmft during the same time period (mean (SD) dmft – before 0.97 (2.42) vs. after 1.52 (2.83); 95% CI NR, p=0.04)[2], suggesting that the programme was associated with preventing a worsening of tooth decay.

The third study[3] found that the percentage of caries free three year olds increased from 35% in the early 1970's, prior to the kindergarten based oral health education programmes implementation, up to 97% twenty years after implementation; no statistical analysis or associations were reported[3].

[1] Grant et al. 2010 [-]
[2] Tubert-Jeannin et al. 2012 [+]
[3] Axelsson et al. 2005 [-]

Evidence Statement 4: Effect of multi-component, community based oral health promotion programmes on dental caries and dental service access in children under the age of five

Moderate evidence from two interrupted time series (UK[1,2]) describing similar programmes suggests that oral health promotion campaigns delivered through multiple venues and targeting several aspects of oral health may be associated with a reduced risk of dental decay in children under the age of five living in deprived communities.

In the most deprived communities, the programme was associated with a dmft prevented fraction of 46%[1] among three year old children, and 37%[1] among four year old children.

Evidence from one study[2] suggests that a multi-component community wide intervention implemented in at risk areas is associated with significantly lower odds

of experiencing tooth decay at age 5 in the most deprived areas (DepCat 7 $d_3$mft>0: OR 0.35, 95% CI 0.26 to 0.47; p<0.001)[2] and across the wider population (DepCats 1-7 $d_3$mft>0: OR 0.66, 95% CI 0.57 to 0.77; p<0.0001)[2].

Neither programme was associated with significant differences in dental service utilisation, assessed either using the Care Index amongst three year olds (before: 1.5%, after: 1.9%; 95% CI and p-value NR)[1] or four year olds (before: 3.2%, after: 3.8%; 95% CI and p-value NR)[1]. The second study assessed restorative care utilisation using survey data and found no difference in use amongst children from the most deprived communities before versus after the programme implementation (no values reported)[2].

[1] Blair et al. 2004 [+]
[2] Blair et al. 2006 [+]

Evidence Statement 5: Association between community based oral health promotion and education programmes and the oral health and hygiene of young, low-income children

Moderate evidence from one cohort study (US[1]) and one before and after study (Sweden[2]) suggests that community based oral health promotion and education programmes delivered to low-income mothers or parents of young children (aged 2) may be associated with preventing tooth decay over approximately one year.

One study [+][1] found that oral health education counselling of low income mothers of 2 year old children, plus assignment to a dental care organisation to improve service access, was associated with a 48% increased likelihood of three year old children being caries free (RR 1.48, 95% CI 1.13 to 1.93)[1], and a significantly lower mean (SD) dt (0.75 (2.5) vs. 1.6 (2.5); 95% CI NR, p=0.04)[1], significantly fewer children exhibiting bleeding gums (before: 49.3%; vs. after: 39.1%, 95% CI NR, p<0.01) but had no impact on visible plaque amongst three year olds (statistics NR)[1].

The second study [+][2] found that provision of five education sessions, a toothbrush and discounted fluoride toothpaste to low-income parents at a community based

outreach facility was associated with significantly increased likelihood of being caries free at age three (RR 2.5, 95% CI 1.8 to 3.4, NNT 4.6)[2], with a significantly lower mean (SD) deft at age 3 (programme: 3.0 (NR) vs. comparator: 4.4 (NR); 95% CI NR, p<0.01)[2], significant reductions in the percentage of parents reporting they did not brush their child's teeth daily (13.2% at age 2 to 5.6% at age 3, 95% CI NR, p<0.001; intervention vs. comparator at age 3 p<0.01)[2] and significant reductions in the percentage of parents reporting no use of fluoride toothpaste (7.5% at age 2 to 2.1% at age 3, 95% CI NR, p<0.001; intervention vs. comparator at age 3 not significant).

[1] Milgrom et al. 2010 [+]
[2] Wennhall et al. 2005 [+]

Evidence Statement 6: Effect of oral health promotion and education programmes provided by home health visitors on the oral health and access to dental services of very young children

Moderate evidence from one RCT (UK[1]), one non-randomised controlled trial (UK[2]) and one cohort study (UK[3]) suggests that oral health promotion and education programmes delivered by health visitors during early life home visits are no more effective than standard health visits at improving the oral health of children under the age of five, but may be associated with improvements in dental registration rates in deprived areas.

One study[1] found that an oral health education programme provided to parents during home health visits is no more effective than a usual health visitor programme (which also addressed oral health) at reducing caries amongst three year or five year olds (mean dmfs age 3: 2.03, 95% CI 1.39 to 2.67 vs. 2.19, 95% CI 1.41 to 2.97; age 5: 3.99, 95% CI 2.94 to 5.04 vs. 4.84, 95% CI 3.39 to 6.29)[1].

A second study[2] reported a significant increase in the proportion of children aged 0 to 2 years who were registered with a dentist after the home visitor programme. However, discrepancies in the reported effect size and significance (mean

difference: 4% (-8% to 0%), p<0.05)[2] undermines the certainty of interpretation. No significant differences were found at longer term follow-up (aged three to five).

One observational study[3] found that intensive home visits addressing general as well as oral health to be significantly associated with improved dental registration rates amongst young children in disadvantaged communities (adjusted OR 2.60, 95% CI NR; p<0.001)[3].

[1] Whittle et al. 2008 [+]
[2] Yuan et al. 2007 [+]
[3] Shute and Judge 2005 [-]

Evidence Statement 7: Effect of oral health promotion and education programmes delivered via post on the oral health and dental service access of children under the age of five

Inconsistent evidence was identified from four publications reporting on three RCTs (UK[1], Australia[2,3], USA[4]) regarding the effect of oral health promotion and education materials and supplies delivered via post on the tooth decay of young children; effectiveness may vary according to deprivation status and provision of fluoride toothpaste. Postal reminders of eligibility for dental services and fluoride varnish benefit programme may have no effect on dental registration or use of fluoride amongst low-income children.

One study[1] found that postal provision of educational literature plus high fluoride toothpaste was associated with reduced caries prevalence in both the most and least deprived areas, while low fluoride content toothpaste was associated with reduced prevalence in only the most deprived areas: (dmft>0 least deprived - high F: 40%, low F: 51%, comparator: 44%; difference across group reported as significant, 95% CI and p-values NR. dmft>0 most deprived - high F: 61%, low F: 59%, comparator: 68%; difference across group reported at significant; 95% CI and p-value NR)[1]. The high fluoride toothpaste intervention was effective at reducing mean caries in the least deprived group (mean (SD) dmft - 1.4 (2.5) vs. 1.9 (2.9), 95% CI NR, p<0.05)[1],

but not amongst children in the most deprived areas, despite a reduction in caries prevalence in this group.

Results from another trial[2] indicate a significant reduction in incident of severe caries of the upper incisors amongst 20 month old children (OR ([comparator vs. intervention] 6.8, 95% CI 2.1 to 21.9)[2]. These results were not maintained into later childhood (age 6 to 7 $d_3$mft>0 intervention: 31%, comparator: 30%; reported as NS, 95% CI and p-value NR)[3] or in mean $d_3$mft (intervention: 0.99 (SD 1.81), comparator: 1.29 (SD 2.66); reported as NS; 95% CI and p-value NR)[3].

The final RCT[4] suggests that an oral health promotion programme delivered as postal reminders is no more effective than usual care at increasing dental service utilisation or improving topical fluoride use (no effect size estimates reported)[4].

[1] Ellwood et al. 2004 [+]
[2] Plutzer and Spencer 2007 [-]
[3] Plutzer et al. 2012 [-]
[4] Cruz et al. 2012 [+]

Evidence Statement 8: Effectiveness of school based fluoride varnish interventions at preventing dental caries among primary and secondary school students

Moderate evidence from one RCT (Sweden[1]), two cluster RCTs (Germany[2], UK[3]) and one interrupted time series (Germany[4]) suggests that school based fluoride varnish programmes can be effective at preventing or reducing enamel caries amongst children in deprived or at risk communities, but are less effective amongst children in non-deprived or low risk areas.

One study[1] found that more frequent application schedules (once a month for 8 months during the school year) confers the largest benefit, with a prevented fraction of incident approximal caries in the permanent dentition of 76% across the general student population and 82% to 83% amongst students from low-medium income

communities with no access to fluoridated water, but not effective amongst children from high income communities with access to fluoridated water[1].

Evidence regarding biannual school based fluoride application programmes was inconsistent, with one study[1] suggesting that such a programme is effective at reducing incident caries of the approximal surfaces in secondary school students (prevented fraction 57%, significant at $p<0.001$)[1]. This study found differential effects of the biannual fluoride varnish schedule, with no significant impact seen amongst children from low risk communities, and a prevented fraction of 66% to 69% in low-medium income areas with no fluoridated water[1].

Two studies[2,3] found that biannual fluoride varnish application was not effective at reducing mean caries levels in the first permanent molars in an area with low caries prevalence (0.81 (SD 1.74) vs. 0.78 (SD 1.81); 95% CI and p-value NR) at reducing mean caries increment for more advanced lesions in the primary dentition (mean d_3fs increment difference: 0.01 (SE 0.18), 95% CI -0.34 to 0.37; mean d_2fs increment difference: 0.28 (SE 0.20); 95% CI -0.12 to 0.67)[3]. The third study[3] was effective at reducing the mean increment of d_1fs lesions (mean difference: 0.28 (SE 0.20); 95% CI -0.12 to 0.67, significant at $p=0.03$)[3].

The final study[4] found that four years after the addition of a biannual fluoride varnish programme to existing health promotion efforts, there was a 42% reduction in mean DMFT amongst nine year olds in an underprivileged community, and a 40.7% reduction in mean DMFT amongst 12 year olds, however, no significance tests were reported.[4]

[1] Moberg et al. 2005 [++]
[2] Splieth et al. 2011 [-]
[3] Hardman et al. 2007 [+]
[4] Dohnke-Hohrmann and Zimmer 2004 [-]

Evidence Statement 9: Effectiveness of school based fluoride milk interventions at preventing dental caries among primary and secondary school students

Inconsistent evidence regarding the association between school based fluoride milk schemes and dental caries was identified from one cohort study (UK[1]) and one cross sectional study (UK[2]).

One study found that students aged 7 to 9 years who received fluoridated milk each day at school had worse oral health than children attending non-programme schools when assessed at the tooth level (adjusted mean difference in 4 year dmft increment: 0.40, 95% CI 0.04 to 0.75, p-value NR)[1]. The difference was not significant at the surface level, however (adjusted mean difference in 4 year dmfs increment: 0.38, 95% CI -0.45 to 1.21, p-value NR)[1]. The fluoride milk programme was not associated with differences in caries of the permanent molars at either the tooth or surface level (adjusted mean difference DMFT: 0.00, 95% CI -0.15 to 0.14, p-value NR; adjusted mean difference DFS: -0.10, 95% CI -0.30 to 0.11, p-value NR)[1].

The second study[2] found that a similar daily fluoride milk programme was associated with a lower caries prevalence of the first permanent molars of 12 year olds (adjusted mean difference DMFT [comparator vs. programme]: 0.49 (SE 0.11), 95% CI 0.27 to 0.72, p<0.001)[2]. This difference was significant at the surface level as well (adjusted mean difference DFS [comparator vs. programme]: 0.74 (0.13), 95% CI 0.48 to 1.00, p<0.001)[2]. Children in the comparator group were significantly more likely to have any caries of the first permanent molars compared to children who had attended schools that provided fluoridated milk for seven years (adjusted OR: 1.71, 95% CI 1.32 to 2.23, p<0.001)[2].

[1] Ketley et al. 2003 [+]
[2] Riley et al. 2005 [++]

Evidence Statement 10: Effectiveness of school based fluoride mouth rinse interventions at preventing dental caries among primary and secondary school students

Moderate evidence from one cluster RCT (Sweden[1]), one cohort study (Japan[2]) and three cross sectional studies (1 UK[4], 2 Japan[3,5]) suggests that school based fluoride

mouth rinse (FMR) programmes can be effective at preventing or reducing dental decay of the permanent dentition amongst school aged children living in communities with no exposure to fluoridated water.

One study[1] found that regular rinsing throughout the school year is effective at reducing incident approximal caries amongst secondary school students, with a prevented fraction of 41% to 59%[1] depending on rinsing schedule. This effect varied according to baseline caries status, with students presenting with approximal caries at age 13 (mean incidence 1.47 (SD 2.11) vs. 2.46 (SD 2.93); 95% CI NR, p<0.01)[1], but had no significant effect amongst children who were caries free at that age (mean incidence 0.38 (SD 1.24) vs. 0.67 (SD 1.85); reported as NS, 95% CI and p-value NR)[1].

Another study[2] found that daily fluoride rinsing for five years was associated with a significantly lower one year mean DFT increment (0.05 (SD 0.36) vs. 0.59 (SD 1.21); 95% CI not reported, p<0.001)[2] and significantly lower mean DFT at age 9 to 10 years (0.12 (SD 0.43) vs. 1.67 (SD 1.69); 95% CI not reported, p<0.001)[2].

Another study[3] found that participation in a school based, daily FMR programme from nursery through junior high school (eleven years duration) was associated with long term reductions in caries prevalence and average caries amongst females in two age groups (aged between 20 and 29 years, compared to the control group: prevalence 76.9% vs. 96.8%, 95% CI NR, p<0.05; mean (SD) DMFT 3.2 (3.1) vs. 9.3 (5.2); 95% CI NR, p<0.001. Aged 30 to 39 years: prevalence 77.8% vs. 98.3%, 95% CI NR, p<0.05; mean (SD DMFT 4.6 (6.4) vs. 11.4 (5.3); 95% CI NR, p<0.001)[3].

Participating during elementary school only (shorter FMR programme duration) was not associated with long term reductions in DMFT prevalence or average decay in either age group (aged 20 to 29 years: 93.5% vs. 96.8%, 95% CI NR, p>0.05; mean (SD) DMFT 7.3 (4.9) vs. 9.3 (5.2); 95% CI NR, p>0.05. Aged 30 to 39 years: 100% vs. 98.3%, 95% CI NR, p>0.05; mean (SD) DMFT 8.8 (5.5) vs. 11.4 (5.3); 95% CI NR, p>0.05)[3.]

Another study[4] found that participation in a fortnightly FMR programme for five years was associated with significantly reduced likelihood of tooth decay (D_3MFT>0: OR

0.79, 95% CI 0.65 to 0.96)[4]; but found no significant association with average decay overall (mean D_3MFT: 1.17 (95% CI 1.06 to 1.28) vs. 1.17 (95% CI 1.04 to 1.30); p=0.997)[4], or amongst the most deprived students (mean D_3MFT DepCat 7: 2.16 (95% CI 1.50 to 2.81) vs. 2.47 (95% CI 1.45 to 3.49); p=0.618)[4], but was associated with a significant reduction in average caries levels amongst the least deprived children (mean D_3MFT DepCat 1: 0.33 (95% CI -0.02 to 0.69) vs. 0.83 (95% CI 0.55 to 1.11); p=0.036)[4].

The final study[5] reported that a weekly FMR programme delivered for six years was associated with a significantly lower caries prevalence at age 12 (DMFT 46.1% vs. 64.9%, 95% CI NR, p<0.05)[5] as well as with lower mean caries at both the tooth and surface level (mean (SD) DMFT: 1.28 (NR) vs. 2.02 (NR); 95% CI NR, p<0.05. DMFS: 2.05 (NR) vs. 3.69 (NR); 95% CI NR, p<0.05)[5].

[1] Moberg et al. 2005b [+]
[2] Kaneko et al. 2006 [+]
[3] Neko-Uwagawa et al. 2011 [-]
[4] Levin et al. 2009 [+]
[5] Komiyama et al. 2012 [+]

Evidence Statement 11: The effect of school based daily supervised tooth brushing on the oral health and hygiene of primary school children

There is moderate evidence from three cluster RCTs (2 UK[1,2] and 1 Australia[3]) to suggest that daily, school based, teacher supervised tooth brushing with 1,000 to 1,450ppm fluoride toothpaste may reduce dental decay among primary school children and weak evidence from one cluster RCT (The Netherlands[4]) to suggest that such programmes may improve oral hygiene in the short but not long term.

One study[1] using 1,450ppm fluoride toothpaste showed an overall reduction in incident dmfs/DMFS: mean difference -0.32, 10.9% reduction (95% CI NR, p<0.001)[1]. When disaggregated by dentition type, the reduced incidence was significant only in deciduous teeth (mean difference 0.33, % reduction NR); 95% CI NR, p<0.001)[1] while no significant difference was seen in the permanent dentition

(reported as non-significant, values NR)[1]. A greater effect was seen amongst children with caries at baseline (mean difference -1.39 (-30.0%); 95% CI NR; p<0.001)[1].

Another study[2] using 1,000ppm fluoride toothpaste found a reduction in D_3FS of the first permanent molars by 39% (95% CI NR; p=0.002)[2] among children in a relatively deprived area.

Another study[3] found that daily supervised tooth brushing with a low fluoride toothpaste (specific content not reported) had no significant effect on 3 year caries incidence (D_3MFS) in teeth that were caries free at age 5 (difference and 95% CI NR, p=0.256)[3].

One study[4] found significant improvements in mean brushing frequency during the course of the programme and immediately thereafter (effect size and 95% CI NR; p<0.001)[4], but this effect was not maintained one year after the end of the programme (effect size and 95% CI NR; p=0.45)[4]. The intervention had no effect on attitudes towards toothbrushing (one year effect size and 95% CI NR; p=0.59)[4].

[1] Jackson et al. 2005 [+]
[2] Pine et al. 2007 [+]
[3] Burnett et al. 2005 [-]
[4] Wind et al. 2005 [-]

Evidence Statement 12: The association between multi-component school based interventions and the oral health of primary school children

There is inconsistent evidence from one cohort study (US[1]) and two before and after studies (US[2], Sweden[3]) regarding the association between multi-component school based oral health programmes, which include the provision of preventive services (e.g. pit and fissure sealants) and dental caries in primary school students.

One cohort study[1] found that caries incidence was significantly higher in the comparator group vs. the programme group in both the primary and permanent dentition (dfs OR 2.00, 95% CI 1.31 to 3.06; DFS OR: 2.20, 95% CI 1.38 to 3.48)[1].

The greatest benefit was seen for the occlusal surfaces of the primary (OR: 2.46, 95% CI 1.58 to 3.82)[1] and permanent dentition (OR: 2.78, 95% CI 1.70 to 4.56)[1].

A second study[2] found that overall, the preventive programme was associated with a significantly higher mean percent of erupted first molars with decay (adjusted DMFT difference: 3.02% (1.24 to 4.80), $p<0.05$)[2] which may be attributable to low uptake of sealant services, as only 18% of eligible students received sealants. When assessed according to sealant status, there was a significantly lower percentage of decayed first molars amongst eligible children who had received sealants vs. those who did not (difference: -4.6%, 95% CI -7.9% to -1.3%; $p<0.05$)[2], suggesting that efforts should be made to ensure adequate uptake of school based pit and fissure sealant services if such programmes are to have an effect.

The third study[3] reported reductions in mean DFS and mean DS amongst 7, 12 and 19 years olds from the early 1970's, prior to programme implementation, to 1993; neither statistical analysis nor information on secular trends was reported[3].

[1] Niederman et al. 2008 [-]
[2] Bodner and Pulos. 2010 [++]
[3] Axelsson et al. 2005 [-]

Evidence Statement 13: The effect of health promotion programmes addressing common risk factors on the oral health and related behaviours of school children

Inconsistent evidence was identified from two cluster non-randomised trials (UK[1], Sweden[2]) and one ecological study (Canada[3]) regarding the effectiveness of school based programmes that address common risk factors on oral health outcomes.

One study[1] that focused on altering the school environment in order to promote healthy school based eating, resulted in no effect on tooth decay ($D_{3cv}MFT$) amongst school children (effect size not reported)[1]. When considering obvious dentine decay on its own ($D_{3cv}T$), there was a significant effect favouring the control group, with

attendance at non-programme schools associated with significantly lower levels of visibly cavitated teeth (β (SE): -0.31 (0.15); 95% CI NR, p<0.05)[1].

Another study[3], assessing of "Healthy Schools", which altered the school environment to promote general health, reported that voluntarily participating schools had a significantly lower mean percentage of children with two or more decayed deciduous or permanent teeth (effect size not reported, p=0.007)[3]; subgroup analysis revealed this relationship to be significant in low- but not high-income schools (data not reported)[3].

Another study[2] reported that a school based tobacco education programme delivered by dental professionals had no impact on the tobacco using behaviours of secondary school students, however, no statistical analysis was reported[2].

[1] Freeman and Oliver 2009 [-]
[2] Hedman et al. 2010 [-]
[3] Muirhead and Lawrence 2011 [+]

Evidence Statement 14: The effect of school based oral health education programmes on dental decay amongst school aged children

There is moderate evidence from one cluster RCT (Belgium[1]), one cross sectional study (Germany[3]), and one before and after study (The Netherlands[4]) to suggest that oral health education programmes may improve plaque and gingival health, and when combined with fluoride provision are associated with reduced tooth decay amongst primary school children.

One study[1] found that an oral health education programme resulted in no difference in the prevalence of decay (DMFT prevalence difference: 0.61%; 95% CI NR; p=0.76)[1] and had no effect on average decay levels (mean (SEM) DMFT: 0.92 (0.02) vs. 1.0 (0.06); 95% CI NR, p=0.49; mean (SEM) DMFS: 1.46 (0.04) vs. 1.59 (0.10), 95% CI NR, p=0.31)[1].

The study[1] also reported a significant reduction in the Plaque Index of the buccal surfaces (-0.05, 95% CI -0.007 to -0.09; p=0.02)[1], but no significant difference in the

Plaque Index of the occlusal surfaces (no comparative statistics reported)[1]. Significant improvement in gingival health also reported (mean (SEM) SBI scores: 0.21 (0.003) vs. 0.29 (0.02), 95% CI NR, p<0.001)[1]. However, significant differences between the groups already existed at the beginning of the study; whether these baseline differences were controlled for during analysis was not reported. Another study[2] found that a six year, intensive school oral health promotion programme, which included weekly fluoride varnish applications, was associated with significant increases in the proportion of children who were caries free at age 12 versus children from non-participating schools (73% vs. 41%; reported as significant, 95% CI and p-value)[2]. Significant reduction in average decay levels (mean (SD) ICDAS $D_{5,6}$MFT: 0.50 (NR) vs. 0.77 (NR); 95% CI NR, p=0.043)[2] and oral health inequalities (severity of caries index (SiC) score – programme: 0.96 (SD NR), comparator: 1.46 (SD NR); 95% CI NR, p<0.005)[2] were observed as well.

A third study[3] that included an educational packet focusing on oral health, school based teeth brushing lessons and weekly fluoride mouth rinsing was associated with significantly lower decay levels at age 12 (mean (SD) DMFS (0.5 (NR) vs. 2.0 (NR); reported as significant, 95% CI and p-value NR)[3].

[1] Vanobbergen et al. 2004 [-]
[2] Pieper et al. 2012 [+]
[3] Pieterse et al. 2006 [+]

Evidence Statement 15: The effect/association of school based oral health education programmes on oral hygiene amongst school aged children

Moderate evidence from two cluster RCTs (Belgium[1], Ireland and UK[2]) and two before and after studies (Israel[4], The Netherlands[7]) suggests that oral health education alone is insufficient to alter the tooth brushing behaviours of school children, but that the provision of oral hygiene supplies (e.g. toothbrushes, toothpaste) may be associated with improved oral hygiene.

One oral health education only programme[1] resulted in no significant difference in the proportion of students reported to not brush every day in intervention vs.

comparator groups (8.4% vs. 7.0%; 95% CI NR, p=0.27)[1], or in regular use of dental floss (6% vs. 7%; 95% CI NR, p=0.71)[1]. This study did find small but statistically significant differences in use of fluoride toothpaste, with intervention groups having higher use (88% vs. 86%, 95% CI NR, p<0.05)[1].

Another intervention study[2] found that children who received an oral health promotion and education programme without coinciding provision of toothbrush and fluoride toothpaste had significantly decreased salivary fluoride levels over the course of a year, with higher fluoride levels taken to be indicative of regular toothbrushing with fluoride toothpaste (values and 95% CI NR; p=0.0001)[2]. A separate arm in this trial that also provided free fluoridated toothpaste and toothbrush for a year was found to significantly improve tooth brushing behaviour, as measured by salivary fluoride levels (0.024 (SD NR) vs. 0.019 (SD NR); 95% CI NR; p<0.0001)[2].

Another study[3] reported significant increases in the percentage of children brushing twice a day after implementation of an oral health education programme plus provision of oral hygiene supplies and tutoring on oral hygiene skills (32.8% vs. 97.4%; 95% CI NR, p<0.0001)[3], as well as corresponding reductions in the percentage of children brushing once per day after programme implementation (67.2% vs. 12.6%; 95% CI NR, p<0.0001)[3].

Another study[4] included oral health education, fluoride mouth rinsing and oral hygiene demonstrations, and was associated with no difference in proportion of children who reported brushing their teeth at least twice per day before and after the intervention implementation (62% vs. 79%; reported as NS, 95% CI and p-value NR)[4] or between participating and non-participating schools after the programme's implementation (79% vs. 84%; reported as NS, 95% CI and p-value NR)[4].

[1] Vanobbergen et al. 2004 [-]
[2] Dental Health Foundation 2007 [+]
[3] Livny et al. 2008 [+]
[4] Pieterse et al. 2006 [+]

Evidence Statement 16: The effect/association of school based oral health education programmes on dental access, diet and oral health knowledge and attitudes among school aged children

Weak evidence from two cluster RCTs (Belgium[1], Ireland and UK[2]) and one before and after study (Israel[3]) suggests that school based oral health education programmes may be associated with improved access to restorative dental services, and improvements in oral health related diet and knowledge among school aged children.

One intervention study[1] found that an annual, one hour school based oral health education programme was effective at improving restorative dental service utilisation amongst school children, as assessed by the Restoration Index (mean (SEM) Restoration Index (F/DF): 0.80 (0.01) vs. 0.73 (0.02); 95% CI NR, $p<0.01$)[1], however, there was no difference in the proportion of students reporting that their last visit to the dentist was more than six months ago (intervention: 67.0%, comparator: 66.6%, 95% CI NR, $p=0.11$)[1]. The programme was also associated with significant reductions in the proportion of children eating more than 2 between-meal snacks, as reported by parents (29.9% vs. 36.9%, difference: -7%, 95% CI NR; $p<0.001$)[1].

Another study[3] reported no changes in the percentage of children bringing sandwiches with sweetened spreads to school (before: 37.7%, after: 33.2%; 95% CI NR, p=NS)[3], but was associated with a significant reduction in the percentage of students bringing sweetened soft drinks to school (before: 22.4%, after: 13.3%; 95% CI NR, $p=0.01$)[3].

Another study[2] found that an oral health education programme was effective at improving student knowledge of tooth brushing and toothpaste (group values and 95% CI NR; $p=0.02$)[2], total snack knowledge (group values and 95% CI NR; $p=0.009$)[2] and safer snack knowledge (group values and 95% CI NR; $p=0.004$)[2].

[1] Vanobbergen et al. 2004 [-]
[2] Dental Health Foundation 2007 [+]
[3] Livny et al. 2008 [+]

Evidence Statement 17: The effect/association of peer-to-peer oral health education programmes on oral hygiene and diet habits amongst school aged children

Weak evidence from one cluster RCT (UK[1]) and two before and after studies (Germany[2,3]) suggests that peer-to-peer oral health education programmes may be associated with improved oral health knowledge and hygiene behaviours, but is not associated with changes in dietary behaviours amongst primary school children.

One study[1] found that a peer-to-peer oral health education programme was not effective at improving the snacking habits of children aged 5 or 11, with no significant effect detected in cariogenic snacking score (higher scores indicate greater cariogenic effect (11 year olds: β 0.88 (SE 0.44), 95% CI -0.11 to 1.86; p=0.07; 5 year olds: β 0.61 (SE 0.31), 95% CI -0.75 to 0.68; p=0.08)[1].

The study reported conflicting results on oral health knowledge; intervention school students had significantly higher mean (95% CI) oral health knowledge scores than control school students (1.04 (0.93 to 1.26) vs. 0.83 (0.66 to 0.88); 95% CI and p-value NR, higher scores indicate better knowledge)[1]. However, regression analysis suggests that intervention school attendance was associated with negative effects on differences in dental health knowledge (β -0.43 (SE 0.15), 95% CI -0.69 to 0.17; p=0.005)[1], these results were reported as significant, despite a 95% confidence interval that included zero.

One study[2] reported significant improvements in oral hygiene amongst older fourth grade students, including mean (SD) time spent brushing (80.5s (46.4) vs. 117.0 (50.3); 95% CI NR, p=0.004)[2], use of taught tooth brushing technique (0% vs. 73.3%; 95% CI NR, p<0.001)[2], and taking a systematic approach to brushing (0% vs. 86.7%; 95% CI NR, p<0.001)[2]. The programme also resulted in significant improvements in oral health attitudes, with more 11 year olds reporting that they brushed their teeth for health reasons after programme implementation (40% vs. 86.7%; 95% CI NR, p<0.001)[2].

Another study[3] reported significant improvements amongst first graders in use of the recommended tooth brushing technique (26.3% vs. 78.9%; 95% CI NR, p=0.0001)[3],

and of the recommended systematic approach to brushing (0% vs. 68.4%; 95% CI NR, p=0.0001)[3]. No significant changes were seen in mean (SD) time spent brushing, however (87.1s (63) vs. 86.1s (42); reported as non-significant, 95% CI and p-value NR)[3].

[1] Freeman and Bunting 2003 [-]

[2] Reinhardt et al. 2009 [+]

[3] Reinhardt et al. 2009b [+]

Evidence Statement 18: The effect of community based oral health education programmes on plaque and gingival health of school aged children

Weak evidence from two before and after studies (US[1,2]) describing similar programmes suggests that community centre based oral health promotion and education programmes that include provision of oral hygiene supplies (e.g. toothbrush and fluoride toothpaste) may be associated with improvements in plaque scores, gingival health and oral health knowledge

The two studies[1,2] assessed the same programme delivered at community based children's clubs in two different cities and reported reductions in Plaque Index ranging from 0.09 units (-3%; 95% CI NR; p<0.044)[2] to 1.12 units (-29%; 95% CI NR; p<0.001)[1] after four weeks, with the higher percent reduction exhibited in the community with higher plaque levels at baseline.

Both programmes were associated with a significant reduction in Gingival Index scores, ranging from 0.044 units (-24%; 95% CI NR; p<0.001)[2] to 0.19 units (-51%; 95% CI NR; p<0.001)[1]; as with the Plaque Index, there were higher baseline Gingival Index values in the study with the higher percent reduction[1].

One of the studies[2] reported significant improvements in overall oral health and hygiene knowledge amongst school aged children, with significant increases in the proportion of children answering five oral health questions correctly after the programme (37% vs. 70%; 95% CI NR, p<0.001)[2].

The other study[1] reported mixed results, with no improvements in knowledge of plaque (82% vs. 85%, reported as NS)[1], recommended brushing frequency (82% vs. 85%, reported as NS)[1] or healthy foods (75% vs. 81%, reported as NS)[1], but significant improvements in knowledge of recommended brushing duration (51% vs. 69%; 95% CI NR, $p<0.05$)[1] and recommended dental visit frequency (64% vs. 81%; 95% CI NR; $p<0.05$)[1].

[1] Biesbrock et al. 2003 [+]
[2] Biesbrock et al. 2004 [+]

Evidence Statement 19: The effect of home visits to low income families by community based care coordinators or facilitators on dental service access amongst low income school children

There is weak evidence from one RCT (US[1]) and one before and after study (Canada[2]) to suggest that intensive home visits by care facilitators or coordinators may improve access to[2] and use of[1] dental services among low income children eligible for government funded dental care. No effect sizes were reported in either study.

[1] Binkley et al. 2010 [+]
[2] Harrison et al. 2003 [-]

Evidence Statement 20: The association between participation in work based oral health promotion programmes and oral health among adults

There is weak evidence based on a within group analysis of an RCT (Japan[1]) and a cross sectional study (Japan[2]) to suggest that work based oral health education and promotion programmes may be associated with improved oral health amongst employed adults.

The first study[1] reported significant improvements in periodontal and gingival inflammation in a group of employees participating in a web-based periodontal

education programme, measures on which the control group saw no improvement (no values reported)[1].

The second study[2] reported significant associations between attending three annual work based oral health education sessions and lower DMFT and improved periodontal health amongst both men and women (comparative statistics not reported)[2].

[1] Ojima et al. 2003 [-]
[2] Morishita et al. 2003 [+]

Evidence Statement 21: The effect of oral health interventions and promotion programmes on the oral health, oral hygiene and knowledge of elderly populations

Weak evidence from one RCT (UK[1]) and two cluster non-randomised controlled trials (Australia[2,3]) suggests that oral health interventions and education programmes may be effective at improving flossing behaviour, gingival health, dental attendance and knowledge amongst elderly individuals, but has no impact on tooth decay, brushing habits, or plaque levels in this population.

One study[1] found that a six month xylitol chewing gum intervention had no significant effect on tooth decay levels amongst individuals over the age of 60, but did lead to significant improvements in plaque levels and gingival health (effect sizes not reported, $p<0.001$ for both comparisons)[1].

One study[2] found that a community based health education and promotion programme delivered at social clubs amongst elderly migrant populations led to significant improvements in flossing, although effects varied with ethnicity (Greek clubs: OR 13.33, 95% CI 5.64 to 31.58; Italian clubs: OR 5.16, 95% CI 2.32 to 11.51)[2]. The programme had no effect on toothbrushing behaviours in either group.

In terms of dental access, the programme[2] had no significant effect on dental attendance amongst participants from Greek social clubs (OR 0.77, 95% CI and p-

value NR)[2], while significant increases in attendance were reported amongst older community dwelling Italian migrants (OR 1.82, 95% CI 1.01 to 3.35)[2]. Finally, the study reported significant improvements in caries knowledge (β 1.32 (SE 0.46); p<0.01), periodontal health knowledge (β 2.07 (SE 0.36); p<0.001) and oral cancer knowledge (β 5.47 (SE 0.69); p<0.001) amongst older Greek migrant populations, while significant associations were seen in periodontal (β 0.49 (SE 0.25); p<0.05) and oral cancer knowldedge (β 0.96 (SE 0.45); p<0.05) amongst older Italian migrant populations[2].

Another study[3] found that an oral health promotion and education programme at community based social clubs had no significant effect on plaque levels, but did lead to significant improvements in gingival health amongst elderly migrants in Australia (effect size not reported, p<0.01)[3]. The programme also had no significant effect on regular toothbrushing (values not reported)[3], but did find significant differences in daily flossing behaviour (values not reported)[3].

[1] Al-Haboubi et al. 2012 [+]
[2] Marino et al. 2004 [-]
[3] Marino et al. 2013 [-]

Evidence Statement 22: The effect of oral health interventions and promotion programmes on the oral health and dental service access of homeless or formerly homeless individuals

There is weak evidence from one RCT (US[1]) and one before and after study (US[2]) suggesting that oral health programmes amongst the homeless or formerly homeless may reduce perceived barriers to access of dental services, but may not improve utilisation of such services.

One shelter based study[2] found that a simple oral health programme that includes providing mothers with the contact information for local dentists as well as with access to a telephone in order to make an appointment for their children is

associated with significantly reduced perceived barriers to dental care (mean (SD) ABC scores: 45.00 (15.98) vs. 37.95 (12.60); 95% CI NR; p<0.001)[2].

A second study[1] found that a broad health promotion and provision programme amongst the formerly homeless had no significant effect on dental service utilisation after six months (adjusted OR 0.541, 95% CI 0.265 to 1.105; p=0.092)[1] or 18 months (adjusted OR 0.882, 95% CI 0.435 to 1.788, p=0.727)[1]. Nor was any effect seen in terms of dental decay after six months (values NR, p=0.36)[1] or 18 months (values NR, p=0.75)[1].

[1] Ciaranello et al. 2006 [+]
[2] DiMarco et al. 2010 [-]

Evidence Statement 23: The effect of a school based health promotion programme on the oral hygiene and dental service utilisation of children with Autism Spectrum Disorder

Weak evidence was identified from one before and after study (UK[1]) regarding the effect of a broad school based health promotion programme amongst children with Autism Spectrum Disorder. Due to the lack of descriptive or comparative statistics, no conclusions regarding programme effectiveness can be drawn[1].

[1] Mitton et al. 2012 [-]

Evidence Statement 24: The effect of community based oral health promotion and prevention programmes on dental decay and gingival health of Indigenous populations

Inconsistent evidence from one cluster RCT with results reported in three separate publications (Australia[1,2,3]), one non-randomised controlled trial (US[4]) and one before and after study (Canada[5]) was identified regarding the effect of community based oral health promotion programmes on the oral health of children in Indigenous communities.

One study[1] suggested that a multi-component oral health promotion programme that includes fluoride varnish applications may be effective at reducing tooth decay (adjusted $d_3$mfs increment: -3.5 (-5.1 to -1.9); prevented fraction 36%)[1].

Another publication[2] for the same study found a significant reduciton in two year $d_3$mfs cummulative incidence (RR 0.75, 95% CI 0.71 to 0.80)[2]; the reduction was significant among surfaces that were sound at the start of the study (RR: 0.73, 95% CI 0.69 to 0.79)[2] and those that were considered opaque at baseline (RR: 0.77, 95% CI 0.65 to 0.92)[2], but not among hypoplastic surfaces (RR: 0.90, 95% CI 0.75 to 1.08)[2] or precavitated surfaces (RR: 0.92, 95% CI 0.74 to 1.15)[2].

A third publication[3] found that the same programme had no effect on Gingival Index scores (0.48 (SD 1.15) vs. 0.54 (SD 1.22); 95% CI NR, p=0.56)[3].

Another study[4] of a 12 month community- and family-level nutrition programme focussing on breastfeeding and the consumption of sweetened beverages reported significant reductions in cavitated enamel (d_2) and incipient enamel (d_1) lesion prevalence in three communities after accounting for secular trends in similar communities; the association ranged from a reduction in d_2 lesions of 0.342 to 0.440 (significant at p≤0.032)[4], and 0.300 to 0.631 in d_1 lesions (significant at p≤0.059 and p=0.013, respectively)[4].

Another study[5] found no significant difference in the proportion of children who were caries free before and after the implementation of a three year, school based oral health education and promotion programme, which included the provision of fluoride (8%, after: 30%; reported as NS; 95% CI and p-value NR)[5]. The programme was associated with significant reductions in average decay levels in the permanent but not primary dentition (DMFT: 5.5 (SD 6.2) vs. 6.1 (8.5); 95% CI NR, p<0.05. dmft: 20.1 (SD 18.2) vs. 20.4 (SD 19.2); reported as NS, 95% CI and p-value NR)[5].

[1] Slade et al. 2011 [++]

[2] Divaris et al. 2013 [+]

[3] Roberts et al. 2010 [+]

[4] Maupome et al. 2012 [-]

[5] Macnab et al. 2007 [-]

Evidence Statement 25: The effect of community based oral health promotion and prevention programmes on oral hygiene and dietary behaviours, and dental service utilisation amongst children in Indigenous communities

Inconsistent evidence from one cluster RCT (Australia[1]) and one before and after study (Canada[2]) was identified regarding the effect of community based oral health promotion programmes on the oral health of children in Indigenous communities.

One study[1] reported that after two years of a multi-component oral health promotion programme, there was no difference in the percentage of children reported to have brushed their teeth on the previous day between programme and control communities (40.5% vs. 40.2%; 95% CI NR, p=1.00)[1], and was associated with a worsening of sugary drink consumption amongst children, compared to control group communities at the end of the two year programme (61.5% vs. 52.5%; 95% CI NR, p=0.03)[1].

Another study[2] reported that participation in a school based oral health education and promotion programme, which included a supervised toothbrushing component, was associated with a significant reduction in the percentage of children reported to brush their teeth at home each day (95% vs. 75%; 95% CI NR, p=0.01)[2] and associated with significantly higher percentage of children brushing their teeth each day at school (0% vs. 100%; 95% CI NR, p<0.0001)[2].

The programme was also associated with an increase in the proportion of children reported to eat confectionary fewer than three times per week (9% vs. 63%, 95% CI NR, p<0.0001)[2] and an increase in the percentage of children reported to consume sugary drinks fewer than three times per week after the programme implementation than before (19%, after: 58%; 95% CI NR, p=0.0002)[2].

The second study[2] also suggests that participation in a school based oral health promotion programme is associated with an increased percentage of children

reporting to have visited the dentist each year (76%, after: 100%; 95% CI NR, p=0.002)[2].

[1] Roberts et al. 2010 [+]

[2] Macnab et al. 2007 [-]

2 Introduction

Oral health across the UK has been steadily improving over the past several decades. This improvement has been seen both in adults, more of whom are keeping their teeth throughout their lives, and children, who have seen a reduction in tooth decay compared to children in previous decades (DH 2005). The 2009/2010 Adult Dental Health Survey highlights a reduction in prevalence of some common oral health conditions between 1998 and 2009, including visible dental caries, although tooth wear and more severe forms of periodontal disease have shown increased prevalence (White 2012). The decline in dental caries has been contributed to by the widespread availability of fluoridated toothpaste since the 1970's (Macpherson 2013). During the same period, improvements were seen in oral hygiene behaviours as well, with frequent toothbrushing among adults becoming more common (White 2012).

Good oral hygiene and dietary behaviours, appropriate use of fluorides, and access to effective professional dental care are essential in order to achieve good oral health (Kwan 2003). Oral diseases affect the hard and soft tissues of the mouth, including the teeth, bone, gums, lips, tongue and mucosa (PHE 2013). These conditions, i.e. tooth decay, tooth wear (including dental erosion), periodontal disease and oral cancer, are generally preventable and share common risk factors with other chronic non-communicable diseases. These risk factors include poor diet and nutrition, tobacco and alcohol use, and inadequate oral hygiene, and are associated with an increased risk for oral diseases (DH 2010, DH 2005). As such, a common risk factor approach to oral health promotion has been proposed in order to secure further improvements in the oral and general health of the population (DH 2005, Petersen 2008, Petersen 2004).

Oral health inequalities

Despite this overall trend towards improvement at the population level, inequalities in oral health persist. The British Dental Association (BDA) has recognised socioeconomic status as a key determinant of inequalities in oral health, and reports an association between SES and an array of oral health conditions, including

gingival and periodontal disease and oral cancer (BDA 2013). Recent secondary analysis of the 2009/2010 Adult Dental Health Survey suggests that there are strong associations between educational attainment and clusters of health compromising behaviours (which include smoking, tooth brushing frequency, dental visits and sugar consumption), with less educated groups being more likely to exhibit detrimental behaviour patterns (Singh 2013). Several specific populations are considered to be at increased risk of poor oral health (see Section 3.1), including children under the age of five years, individuals with disabilities, older people and individuals in lower socioeconomic groups (BDA 2013, DH 2005).

Evidence-based oral health promotion and disease prevention programmes are needed in order to achieve further improvements and to reduce the persistent inequalities in oral health.

Aims and objectives

This evidence review has two components. The first will assess the effectiveness of community based oral health improvement programmes that aim to reduce and prevent dental and periodontal diseases, oral cancer or other oral diseases and to promote oral health by:

- Increasing access to fluoride
- Improving oral health hygiene
- Improving diet
- Increasing attendance at general dental practices

The second component reviews the barriers and facilitators to implementing these programmes and is provided as a separate report.

Research questions

The review aims to address the following questions:

1. What are the most effective community based programmes and interventions to promote, improve, and maintain the oral health of a local community?

2. What are the most effective approaches for groups of people who are disadvantaged and at high risk of poor oral health?
3. What are the barriers to and facilitators of implementing oral health promotion programmes and interventions (including user and provider perspectives)?

Questions 1 and 2 are covered in this report, while question 3 is addressed in a qualitative review.

3 Methods

Briefly, the steps in this review were:

- Identifying relevant studies by systematic searches of electronic literature databases, including grey literature and supplemental searches
- Selecting relevant studies relating to community based oral health promotion programmes or interventions that meet inclusion criteria
- Assessing the quality of the included studies
- Extracting data from the included studies
- Summarising findings and drafting evidence statements relating to the effectiveness of oral health promotion programmes among the target populations

Further details are described in Sections 3.1 to 3.4.

3.1 Scope of the review

The evidence review covers community based oral health promotion programmes and interventions that aim to:

- Increase access to fluoride, for example, by providing children with free fluoride toothpaste, providing fluoridated milk and fluoride drops in schools, or by dental nurses offering fluoride varnish applications in schools.
- Improve oral hygiene, for example, by offering supervised tooth brushing with fluoride toothpaste at childcare sites and schools, or running information and education campaigns about tooth brushing.
- Improve diet, for example, by providing support to adopt a healthy diet or by offering nutritious food and drink in schools and workplaces.
- Increase access to dentists, for example through better coordination of dental health services with community health initiatives.

The review does not address activities related to water fluoridation; preventive information, advice or treatment provided by dental health practitioners to their patients; or oral health promotion and access to dental treatment programmes

provided in residential or care settings (e.g. nursing or residential care homes for children, young people, or adults).

The effectiveness of these programmes and interventions will be assessed in the local population, with an additional emphasis on those whose social circumstances or lifestyle place them at greater risk of poor oral health or make it difficult for them to access dental services. These at risk populations include, for example:

- Children aged 5 and under
- People on a low income
- Older people
- People who are homeless
- People who frequently change the location where they live (for example, traveller communities)
- People from some black and minority ethnic groups (for example, those of South Asian origin)
- People who chew tobacco
- People with mobility difficulties who live independently in the community
- People with a learning disability who live independently in the community

3.2 Systematic searches

A three stage search strategy was developed based on the 'Triple Plus' approach (Booth 2013), which involves:

1. Bibliographic database searching (including MEDLINE)
2. Grey literature searching (e.g. using specialist databases such as EPPI Database of Promoting Health Effectiveness Reviews)
3. Supplemental search techniques (such as searching for: related articles, cited articles in included studies, and articles which cite the included studies)

This approach was selected as Booth's research shows that it is more efficient at capturing the relevant research than exhaustive searching of a large number of databases.

3.2.1 Stage 1 Bibliographic database searching

The stage 1 search strategy was developed in MEDLINE. We worked closely with the CPH team at NICE, and used thorough testing to identify the optimal search (best balance between sensitivity and specificity) that was fit for purpose. The MEDLINE search strategy prioritised the use of key, broad, free text terms, as there is a risk that relevant records could be indexed in different ways with a wide variety of potential MeSH terms (or not indexed at all). We avoided limiting by population groups, programme names, interventions, settings, or study designs. However, we filtered out lower grades of evidence such as editorials and commentaries.

The following bibliographic databases were searched for articles published in English:

- MEDLINE and MEDLINE In Process (Ovid interface) Applied Social Science Index and Abstracts (Proquest interface)
- Social Policy & Practice Database (Ovid interface)
- HMIC (Ovid interface)
- Database of Abstracts of Reviews of Effects (Centre for Reviews and Dissemination interface)
- The EPPI Centre's public health effectiveness resource collection: includes both journal published and grey literature (Bibliomap + TRoPHI [Trials Register of Promoting Health Interventions] + DoPHER [Database of Promoting Health Effectiveness Reviews])

The MEDLINE search strategy (see Appendix A) was translated for the other databases, and adapted to take into account database size, coverage, available search facilities and available indexing terms. Search results were uploaded and managed in Reference Manager.

3.2.2 Stage 2 Grey literature searching

Reports produced by governments, academics, business and industry, theses or dissertations in electronic formats, but which are not controlled by commercial publishers/journals (i.e. where publishing is not the primary activity of the producing body) were considered to be grey literature. This literature was searched in order to identify studies meeting review inclusion criteria that were not identified in traditional databases and are 'non-journal' papers.

The following sources were searched as part of Stage 2:

- A specific search on Google focussing on full text pdf papers and programme evaluations on particular population groups, in non-journal papers,
- Browsing the key websites listed below and harvesting relevant records.
  - Centers for Disease Control http://www.cdc.gov/oralhealth/index.htm
  - World Health Organization http://www.who.int/oral_health/en/
  - British Society for Disability and Oral Health http://www.bsdh.org.uk/index.php
  - NICE Evidence Search http://www.evidence.nhs.uk/
  - Cochrane Oral Health Group http://onlinelibrary.wiley.com/o/cochrane/clabout/articles/ORAL/sect0-meta.html
  - Oral Health Services Research Centre, University Dental School, Cork http://ohsrc.ucc.ie/html/publications.html
  - State Government Victoria Evidence based oral health promotion resource http://docs.health.vic.gov.au/docs/doc/1A32DFB77FEFBE9CCA25789900125529/$FILE/Final%20Oral%20Health%20Resource%20May%202011%20web%20version.pdf

This list was selected from 40 key websites in the field as making potentially relevant documents freely available.

3.2.3 Stage 3 Supplemental searches

Supplemental search techniques were employed in order to gather further relevant evidence. Good quality and UK relevant papers were identified by the Research

Analyst during the sifting process as key references, and used during the supplemental searches. In total, ten citations were used for the effectiveness review supplemental searches (see Appendix B for a list of key references).

Related Articles search

Using PubMed, for each key paper up to 50 related references were ranked by relevance and scanned to gather new, relevant material.

Citation tracking of key studies (a prospective technique to capture research which refers to key studies)

For each key paper, Google Scholar was searched to identify unique research which cited the key reference. Full citation lists were harvested in Word or by screenshot, and relevant, unique records were entered into the Reference Manager database.

Reference harvesting of key studies (a retrospective technique to capture research listed by key studies)

For each key paper, the reference list was scanned for new relevant records, which were added to the Reference Manager database.

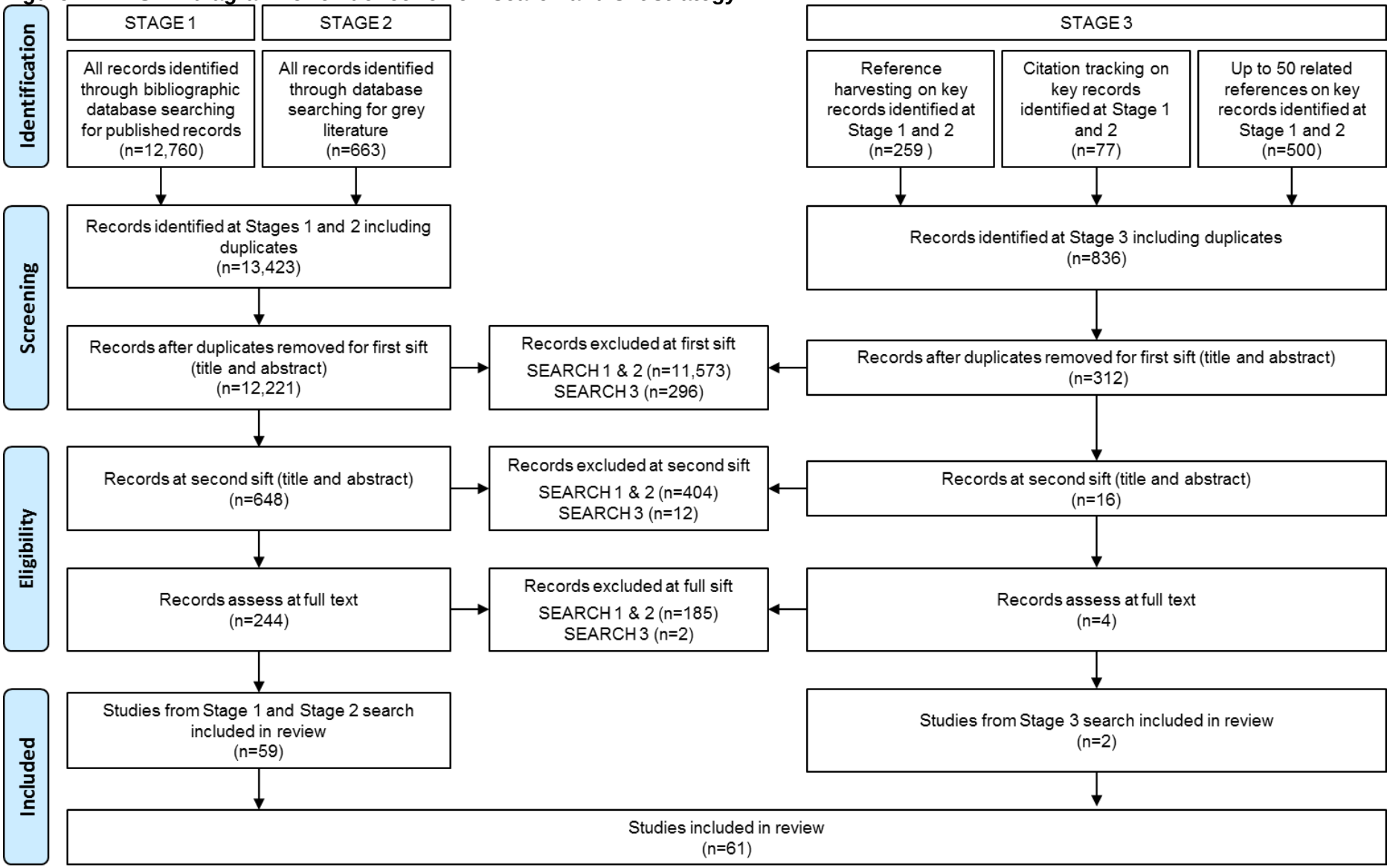
3.3 Selecting studies for inclusion

Studies were evaluated for inclusion against the criteria listed in sifting protocol (see Appendix C). Broadly, community based oral health promotion programmes that aimed to reduce or prevent dental and periodontal disease, oral cancer or other oral diseases and promote oral health among the general population or at risk groups, and which reported oral health, modifiable risk factor or determinant outcomes were considered to meet inclusion criteria. The main reasons for exclusion were:

- Wrong programme or intervention type
- Wrong population
- Wrong study type

In total, 12,221 studies were identified during the search, and 61 unique citations for 58 studies were included in the review. See Figure 1 for the flow of studies from search to inclusion.

Figure 1: PRISMA diagram for evidence review search and sift strategy



3.3.1 First pass appraisal

Evidence identified in the search was filtered at the title/abstract level by an Information Specialist to remove any clearly non-relevant material. Studies were excluded on the basis of the following:

- Clearly non-relevant topics or populations or information (e.g. letters, animal studies)
- Non-relevant programme/intervention type (e.g. not community based, no oral health promotion/disease prevention component)

A random sample of 300 citations was double sifted by a second Information Specialist. A kappa of 0.60 or greater was considered to reflect good inter-rater reliability.

The double sift at this stage resulted in agreement below the agreed kappa threshold (kappa=0.36). Further investigation revealed two main sources of disagreement:

1. Differences in the handling of records published between 1993 and 2002 - the protocol wording originally referred to these records as both ‘provisionally included’ and ‘excluded’, which led one Information Specialist to include pre-2003 records at first sift and the second Information Specialist to exclude at first sift. It was agreed that these records should be excluded, and the protocol language was clarified to reflect this.

2. Differences in the handling of risk association studies that do not include the evaluation of a programme or intervention – a large subset of records reported the results of cross sectional or case control studies that identified specific populations at increased risk for poor oral health. After discussion it was agreed that these studies should be excluded, and the protocol was updated to reflect this agreement.

When these two categories of disagreements were resolved, good inter-rater reliability was achieved (kappa=0.72). To ensure that the protocol adjustments sufficiently addressed the source of the disagreement, a further 100 random records were double sifted, which resulted in high percent agreement (91%), but a very low

kappa (0.15). This was found to be due to a phenomenon known as the kappa paradox (Feinstein 1990), whereby high levels of agreement are achieved yet low kappa values results; this is due to a very high or very low prevalence of a given response. Researchers have recommended reporting additional statistics when faced with this paradox, in order that the source of the low kappa can be objectively interpreted (Kundel 2003). Following this recommendation, the following statistics were calculated for this additional sift, which suggest that the low kappa (0.15) arose due to low prevalence of included studies and high agreement on excluded studies:

- Proportion of observed agreement: 0.91
- Proportion of expected agreement: 0.89
- Proportion of positive agreement: 0.18
- Proportion of negative agreement: 0.95
- Prevalence index: -0.89
- Bias index: 0.07

This stage of screening acted as a “coarse filter” and erred on the side of inclusion, to avoid exclusion of studies that might be relevant. The filtered references were tagged in a Reference Manager database and passed on to a Research Analyst for second pass appraisal.

3.3.2 Second pass appraisal

A Health Research Analyst conducted a more detailed assessment of the records tagged during the first sift. Relevant studies were selected for full text appraisal during this second title/abstract sift. The same exclusion criteria were applied as during the first sift, but to a more stringent level, and information regarding reason for exclusion was recorded in the Reference Manager database at this stage (see Appendix D for excluded study bibliography.

Any queries regarding inclusion/exclusion were resolved by discussion with a second analyst. If it was unclear whether a study met inclusion/exclusion criteria the full text was obtained. A 10% sample of citations were then double sifted by a second Health Research Analyst, which resulted in good inter-rater reliability (kappa=0.71). This stage of screening acted as a finer filter than the first pass appraisal, but again erred

on the side of inclusion if details are not included to allow decisions about the eligibility of the paper. Papers selected for full text appraisal were tagged in Reference Manager.

3.3.3 Full text appraisal

The full text papers were appraised by a Research Analyst. Information on reason for exclusion was recorded (see Appendix D for excluded study bibliography). A 10% sample of full texts were double screened at this stage, which resulted in good inter-rater reliability (kappa=0.83). Disagreements regarding inclusion/exclusion were resolved by discussion, with recourse to a third analyst if needed.

3.3.4 Provisional inclusion of studies

Studies published between 1993 and 2002 were provisionally excluded, pending review of research published within the past decade.

As the majority of studies were relevant to school children and children under five, studies published between 1993 and 2002 were searched and sifted for relevance to other disadvantaged or high risk populations, as limited evidence on these groups was identified during the first stage of the review. These populations included, for example:

- People on a low income
- Older people
- People who are homeless
- People who frequently change the location where they live (for example, traveller communities)
- People from some black and minority ethnic groups (for example, those of South Asian origin)
- People who chew tobacco
- People with mobility difficulties who live independently in the community
- People with a learning disability and who live independently in the community

3.4 Quality appraisal

Quality appraisal was carried out for all studies selected at full text using NICE quantitative study quality checklists. The ratings are as follows:

[++] All or most of the NICE checklist criteria have been fulfilled; where they have not been fulfilled the conclusions are very unlikely to alter.

[+] Some of the checklist criteria have been fulfilled, where they have not been fulfilled, or not adequately described, the conclusions are unlikely to alter.

[-] Few or no checklist criteria have been fulfilled and the conclusions are likely or very likely to alter.

A 10% sample of included studies was double quality appraised by a second analyst, with good inter-rater reliability (kappa=0.61); any disagreements were resolved by discussion.

4 Summary of findings

The identified evidence for each population of interest is reviewed in Sections 4.1 to 4.12. For each population, studies are subgrouped first by setting, then by intervention type where applicable. The water fluoridation status for each study is summarised at the end of the bolded identifying information:

- 'FW' indicates that the study population is exposed to fluoridated water
- 'NF' indicates no fluoridated water exposure
- 'FNR' indicates that the local water fluoridation status was not reported

Effect and association sizes (e.g. odds ratios, relative risks, prevented fraction and mean differences) are provided whenever reported in the original study.

4.1 Children aged under five In nursery or pre-school settings

4.1.1 Fluoridated milk programmes

One cluster RCT (Stecksen-Blicks et al. 2009 [+]) was identified that assessed the effectiveness of nursery based fluoridated milk programmes at preventing dental decay in children under the age of five years.

Stecksen-Blicks et al. 2009 (Cluster RCT [+], Sweden, n=27 centres and 248 participants, NF)

Preschool age children attending day care centres in northern Sweden received 150ml milk supplemented with 2.5mg F/L as well as the probiotic Lactobacillus rhamnosus each weekday at lunch for 21 months.

There were no baseline differences in caries experience between children from intervention and comparator centres (which received no fluoride/probiotic milk). At 21 months' follow-up children attending intervention schools were more likely to be caries free than those attending comparator schools (intervention: 77%, comparator: 56%; OR: 2.7, 95% CI 1.7 to 4.2) and had a lower mean dmfs of molars and canine teeth (intervention: 0.9 (SD 2.2), comparator: 2.2 (3.7); 95% CI NR, $p<0.05$). The mean dmfs increment was 0.3 (SD 1.8) in the intervention group and 1.6 (SD 3.1) in

the comparator group (95% CI NR, p<0.05), which represents a prevented fraction of 75%.

Due to study design limitations, these results may not be representative of older nursery school children. The study attrition rate was greater than 25% and children completing the study were, on average, younger than non-completers (mean age 42 vs. 60 months). This is due in part to difficulty with follow-up amongst older children who had left the day care centres. See Section 4.4.3 for evidence relating to the effectiveness of similar fluoride mouth rinse programmes amongst school aged children.

Evidence Statement 1: Effect of nursery based fluoridated milk programmes on the oral health of children under the age of five

Weak evidence from one cluster RCT (Sweden[1]) suggests that a nursery based daily fluoride milk programme may be effective at preventing tooth decay in the primary molars and canine teeth of younger nursery school children (caries free OR: 2.7, 95% CI 1.7 to 4.2; mean dmfs prevented fraction: 75%)[1].

[1] Stecksen-Blicks et al. 2009 [+]

4.1.2 Supervised toothbrushing programmes

One interrupted time series (Macpherson et al. 2013 [++]) was identified that assessed the association between a nursery based supervised toothbrushing programmes and dental decay of children under the age of five years.

Macpherson et al. 2013 (Interrupted time series [++], UK [Scotland], n=99,071, NF)

This study utilised dental survey data for children aged five years old in Scotland between 1987 and 2009 in order to evaluate the effect of the Childsmile daily supervised tooth brushing programme in nurseries (which included a distribution by nurseries of fluoride toothpaste for use at home). The toothbrushing programme was introduced gradually over this period, with funding for a national programme becoming available in 2001/2002. As year of introduction varied across

healthboards, all results presented cover the fifteen year period of 3 years pre- to 12 years post-programme implementation.

There was a significant reduction in mean (SD) $d_3$mft among five year old children 10 to 12 years after the programme compared to the three years prior to implementation (pre-programme: 3.06 (3.76), post-programme: 2.07 (3.16); difference: -0.99 (95% CI -1.08 to -0.90), p<0.001).

When analysed by deprivation category, there was a significant reduction in $d_3$mft amongst children in Deprivation Category 6-7, the most deprived children (pre-programme mean (SD): 4.48 (4.12), post-programme: 2.77 (3.59); difference: -1.71, 95% CI -1.93 to -1.49, p=NR). The reduction in $d_3$mft over the course of the study was also significant amongst children in deprivation Categories 1-2 , representing the least deprived communities (pre-programme: 1.52 (2.63), post-programme: 1.10 (2.29); difference: -0.43, 95% CI -0.60 to -0.25, p=NR). This represents a reduction in absolute caries inequalities between the most and least deprived communities.

Given the study design, conclusions can only be drawn regarding the association between the implementation of the nationwide nursery based supervised toothbrushing component of Childsmile and changes in tooth decay amongst five year old children. As a nationwide programme, the ability to assess whether the reduction seen during this time period is due to the programme itself, or whether it corresponds with a secular trend in caries reduction is restricted to assessment in caries in the decade prior to implementation. During this time period, the authors report that there was a secular trend of increasing levels of dental decay amongst five-year old children across Scotland (data NR).

Evidence Statement 2: Association between nursery based supervised tooth brushing programmes and dental caries at age 5

Weak evidence from one interrupted time series study (UK[1]) suggests that a national daily supervised tooth brushing programme in nurseries that includes provision of fluoride toothpaste for home use is associated with significant improvements in oral health of five year old children at a population level, with a difference in mean $d_3$mft of -0.99 (95% CI -1.08 to -0.90)[1] over the 12 years following programme

implementation. This reduction follows a trend of increasing caries prevalence in the decade prior to programme implementation (data not reported).

Significant reductions in dental caries were seen amongst the most deprived communities (Deprivation Categories 6 and 7 difference in mean $d_3$mft: -1.71, 95% CI -1.93 to -1.49)[1] as well as in the least deprived communities (Deprivation categories 1 and 2 difference in mean $d_3$mft: -0.43, 95% CI -0.60 to -0.25)[1], suggesting that the programme may be effective at reducing absolute oral health inequalities in this age group.

[1] Macpherson et al. 2013 [++]

4.1.3 Oral health promotion and education programmes

Three studies were identified that assessed the effectiveness of school or nursery based oral health promotion and education programmes on the oral health, oral hygiene and dental attendance of children aged less than five years:

- One cluster RCT (Grant et al. 2010 [-])
- Two before and after studies (Tubert-Jeannin et al. 2012 [+] and Axelsson et al. 2005 [-])

Grant et al. 2010 (Cluster RCT [-], USA, n=NR centres and 105 participants, FNR)

Low-income children aged 3 to 5 enrolled in Head Start programmes in Chapel Hill, North Carolina, USA participated in a brief oral health and nutrition educational intervention lasting 8 to 10 minutes. After adjusting for baseline scores, race, language of interview, and group allocation, there were no significant differences between the programme group and a comparator that received no intervention on child reported outcomes, including:

- Toothbrush, toothpaste and floss use (values NR, p=0.15)
- Knowledge of the benefits of brushing teeth (values NR, p=0.07)
- Oral health attitudes toward toothbrushing and dentists (values NR, p=0.18)

- Nutrition Attitudes (values NR, p=0.33)

Tubert-Jeannin et al. 2012 (Before and after [+], France, n=21 schools and 1,073 participants, FNR)

Five year old children attending public schools in deprived areas in Clermont-Ferrand, France and six randomly selected schools in non-deprived areas were assessed for dental caries in 2003. In 2005 a city-wide oral health promotion programme was implemented in schools with the highest caries risk (based on 2003 caries levels and area deprivation), and was provided to all children between the ages of 3 and 5. The programme was designed to promote a supportive school environment for deprived or semi-deprived children with high-to-moderate caries levels, and focused on improving tooth brushing habits and use of fluoridated toothpaste, educational activities directed at carers and school staff (guidelines regarding oral hygiene, nutrition and dental care). From 2006 to 2009 the programme was voluntarily implemented by schools. The intervention group for the current study included five-year old children (the oldest preschool children) in 2009. Caries outcomes (dmft or $d_3$mft) were assessed visually without the use of radiographs and categorised at the enamel or dentine level using ICDAS criteria and compared to those of five year old children attending the same Clermont-Ferrand schools in 2003, prior to programme implementation.

Of the programme cohort, 42.2% were in a deprived area (schools in deprived areas of the city which receive additional educational resources from the Ministry of Education), 28.0% in a semi-deprived area (schools in deprived areas of the city which receive municipal assistance) and 30.8% non-deprived area (no definition reported).

Statistical comparisons (95% CIs and p-values for differences before and after the programme) were not standardly reported. They are reported below following group mean (SD) values, where available. See Appendix E for pooled results across all schools, regardless of deprivation and programme status, before and after programme implementation were.

In a subgroup analysis by deprivation, there was a trend towards higher caries levels in areas of higher deprivation, both before and after the intervention (trend 2003: p<0.0001; trend 2009: p<0.0001), however, comparisons between time periods were not reported (see Table 1).

Table 1: Mean (SD) dmft by deprivation status

Deprivation level	2003	2009	Significance
Deprived	1.42 (2.88)	1.44 (2.73)	NR
Semi-deprived	0.97 (2.09)	1.52 (2.92)	NR
Non-deprived area	0.26 (0.94)	0.46 (1.90)	NR

Another subgroup analysis by deprivation and programme participation revealed that programme participation does not improve oral health in deprived or semi-deprived areas, but may keep decay from worsening, as seen in non-programme areas of similar SES (see Table 2).

Table 2: Mean (SD) dmft by deprivation level and programme participation status

Deprivation level	2003	2009	Significance
Deprived/semi-deprived programme	1.47 (2.75)	1.44 (2.78)	NS
Deprived/semi-deprived non-programme	0.97 (2.42)	1.52 (2.83)	p=0.04
Non-deprived area non-programme	0.26 (0.94)	0.46 (1.90)	NR

The study included a Multiple Factorial Analysis, however the results were unextractable as they were presented graphically only. The authors suggest that there was a school based cluster effect, with changes in dmft varying across schools with some decreasing over time and others increasing. Schools in non-deprived areas tended to have decreases in mean dmft after the programme was implemented, deprived schools tended to have increases in mean dmft after (despite) the programme's implementation.

Axelsson et al. 2005 (Before and after study [-], Sweden, n=NR, NF)

Prophy-dental clinics (prophylaxis clinics) were gradually introduced into elementary schools in Varmland county Sweden in 1975. Dental hygienists or dental assistants provided individualised, needs-related preventative dentistry starting in 1979. Programme contents varied according with age, with the kindergarten programme

serving children aged 3 to 5 years being delivered by dental assistants, hygienists and teachers. This portion of the programme included supervised tooth brushing with a fluoride toothpaste and oral health education games. Approximately 10% of the children were assessed as being at high risk, and received professional mechanical tooth cleaning (PMTC), and fluoride varnish treatments two to four times a year.

After 20 years, the effects of the programme were compared using descriptive statistics (no statistical analysis) to a group that received no intervention (the precise nature of caries prevention efforts before programme introduction were not reported).

Before the start of the programme, the percentage of three year olds free from caries was 35%; in 1993, this had increased to 97% (95% CI and p-value NR). No information was provided on secular trends in caries free three year olds in areas that did not implement the programme, which may confound the association between programme implementation and caries risk among preschool children. As no statistical analysis was conducted, the role of other potential confounding variables is not accounted for and conclusions regarding the effectiveness of the programme are limited.

Summary and Evidence Statement

The three identified programmes were delivered to children between the ages of three and five years.

Conclusions regarding programme effects and associations are restricted by study limitations in outcome assessment and statistical analysis. Overall, the studies suggest that nursery or school based oral health education programmes are not effective at improving the oral hygiene practices or oral health knowledge and have limited association with decay status of children under the age of five.

Evidence Statement 3: Association between nursery or school based oral health promotion and education programmes and dental decay among children under the age of five

Weak evidence from one cluster RCT (US[1]) and two before and after studies (France[2], Sweden[3]) suggests that nursery based oral health education and

promotion programmes are not associated with improvements in oral hygiene, oral heatlh knowledge or dental decay status, but may prevent the worsening of caries amongst young children in deprived communities.

One study[1] found that a single, brief preschool based oral health education programme alone has no impact on the self-reported oral hygiene behaviours of five year old children (comparative statistics not reported)[1]. This study also found no programme effect on oral health knowledge, or attitudes toward oral hygiene, dentists or nutrition (comparative statistics not reported)[1].

Another study[2] found no significant difference in mean caries levels amongst children from deprived areas who participated in a school based oral health education and brushing programme (mean (SD) dmft - before 1.47 (2.75) vs. after 1.44 (2.78); reported as NS, 95% CI and p-value NR)[2], while children from non-participating schools in similarly deprived or semi-deprived areas had significant increases in mean dmft during the same time period (mean (SD) dmft – before 0.97 (2.42) vs. after 1.52 (2.83); 95% CI NR, p=0.04)[2], suggesting that the programme was associated with preventing a worsening of tooth decay.

The third study[3] found that the percentage of caries free three year olds increased from 35% in the early 1970's, prior to the kindergarten based oral health education programmes implementation, up to 97% twenty years after implementation; no statistical analysis or associations were reported[3].

[1] Grant et al. 2010 [-]
[2] Tubert-Jeannin et al. 2012 [+]
[3] Axelsson et al. 2005 [-]

4.2 Children aged under five in community settings

4.2.1 Multi-component oral health promotion programmes

Two studies were identified that assessed the impact of multi-component oral health promotion programmes on early childhood caries:

- Two interrupted time series (Blair et al. 2004 [+], Blair et al. 2006 [+])

These programmes adderessed several risk factors, including oral hygiene, diet, and dental attendence and were implemented in multiple community settings.

Blair et al. 2004 (Interrupted time series [+], UK [Scotland], n=1,553, FNR)

Blair et al. 2004 described two pilot oral health promotion programmes in areas of Glasgow which were described as being particularly socioeconomically deprived and where a needs assessment revealed poor dental health among infants. Starting in 1996, the children residing in the G22 postcode were eligible for a programme that targeted early nutrition, regular oral hygiene, use of fluoride dentifrice (e.g. toothpaste), and "The Friendly Dentist Scheme".

The programme utilised multiple avenues in order to reach target individuals and groups, with campaigns including breakfast clubs in schools and community centres, annual community fairs, promotion of sugar free medicines in National Smile Week, snack and meal policies for schools, tooth brushing schemes (e.g. in nurseries), free toothbrush and fluoride dentifrice, fruit promotion in nurseries and schools, a child friendly dentist scheme, opportunistic primary care oral health promotion, parenting support baby club, baby bottle swap/cup provision, opportunistic oral health promotion by health visitor, and oral health related competitions.

In 1998 a similar area of the city (in terms of SES) initiated the programme. This area (the G33 postcode) was originally intended to serve as comparator in a controlled study, however, after the oral health improvements seen in G22 during the first two programme years, it was thought to be unethical to continue to withhold the programme from the comparator community. Results are presented here for the original programme community (G22); see Appendix E for G33 outcomes.

Within group comparisons for outcomes over time were adjusted for deprivation levels (DepCat). Outcomes were stratified for child age (36-47 months or 48-59 months), and are presented for baseline (1995/96) and four year follow-up (1999/00) only, as intermediary outcomes were only presented in graph form (see Appendix E for visual estimates of graphical values). Significant reductions in decay (mean dmft) were observed for both three and four year old children (see Table 3).

Table 3: Oral health outcomes for children aged 3 and 4 years old, before and after programme implementation

Outcome	3 year olds, before vs. after	Difference, p-value	4 year olds, before vs. after	Difference, p-value
dmft, mean (95% CI)	3.9 (2.8 to 5.1) vs. 2.1 (1.6 to 2.6)	-46%, p=NR§	5.9 (5.1 to 6.8) vs. 3.7 (3.1 to 4.3)	-37%, p=NR§
dmft=0, %	38% vs. 51%	NR, p=0.078	17% vs. 40%	NR, p<0.0001
dmft≥4, %	NR	NR, p=0.006	NR	p=0.001
dt>0, %	62.1% vs. 47.9%	NR	81.5% vs. 55.9%	NR
mt>0, %	13.6% vs. 4.1%	NR, p=0.025	34.1% vs. 14.7%	NR, p<0.001
Care Index (ft/dmft x 100)	1.5% vs. 1.9%	NS, values NR	3.2% vs. 3.8%	NS, values NR
§ Estimated as significantly different based on non-overlapping 95% CIs				

Blair et al. 2006 (Interrupted time series [+], UK [Scotland], n=6,828, FNR)

Children aged up to 5 years in Glasgow received the community based oral health promotion programme based on two pilot programmes described in Blair et al. 2004. Based on the results of these pilot programmes it was recommended that oral health action teams (OHATs) be established to implement the programme in other severely deprived communities in Glasgow. These teams were designed to include an oral health promoter, lead general dental practitioner, community dental officer, community pharmacist, liaison health visitor, public health practitioner, education sector staff, and community workers or volunteers. From 2000 the programme was delivered by OHATs as they became established, and by 2001 almost all remaining severely deprived communities were reported to have active programmes.

The activities were delivered in settings outside the dental surgery in order to gain access to the most 'at risk' children. Non-jargon literature was developed to reflect caries-risk behaviours and what can be done to modify these in the community.

The activities in one OHAT were described, and included the development of consultation groups and information leaflets, nursery staff education and training of volunteers from playgroups, healthy snack policies for nurseries, community oral health promotion events, parent workshops, free toothpaste and toothbrush distribution by health visitors as well as dentists and pharmacy outlets, a 'change to cup' scheme to encourage the transition from bottle feeding, dental registration

promotion schemes, 'get cooking' classes, perinatal oral health sessions, a weaning fair with subsidised utensils and food blenders, and a playbox resource.

Outcomes were compared in the most deprived areas of Glasgow (DepCat 7) before implementation of the OHATs (1995/96 to 1999/00), as well as between implementation communities and the less deprived areas (DepCat 1-6) of the city where there was no implementation of the community based oral health promotion programme during the study period (1995 to 2004).

Mean $d_3$mft score at age 5 was assessed as part of the routine surveys amongst primary school reception classes. When stratified by deprivation category, the odds ratio (95% CI) for 5 years olds having evidence of caries ($d_3$mft>0) after vs. before OHAT implementation (adjusted for age; 'all Glasgow' results adjusted for age and DepCat) was significant across the city and amongst the most deprived groups (see Table 4).

Table 4: Odds Ratio (OR) caries prevalence ($d_3$mft>0) by deprivation category

Deprivation Category	OR (95% CI)	p-value
All Glasgow (DepCat 1-7)	0.66 (0.57 to 0.77)	p<0.0001
DepCat 7	0.35 (0.26 to 0.47)	p<0.001
DepCat 6	1.03 (0.74 to 1.43)	p=0.88
DepCat 5	0.65 (0.37 to 1.13)	p=0.125
DepCat 4	0.98 (0.67 to 1.45)	p=0.94
DepCat 3	0.62 (0.39 to 0.98)	p=0.040
DepCat 2	0.66 (0.42 to 1.05)	p=0.08
DepCat 1	0.70 (0.40 to 1.12)	p=0.20

Programme implementation was associated with a significant increase in the proportion of children considered caries free, and a significant reduction in extracted teeth (missing due to caries, mt) in both the target areas and the city as a whole. Children from the most deprived communities also exhibited significant reductions in untreated decay (see Table 5).

Table 5: Oral health outcomes for children aged 5 in DepCat 7 and across Glasgow,

	Population	Before	After	p-value
Caries free ($d_3$mft=0), % children	DepCat7	20%	32%	p<0.001
	All Glasgow	34%	42%	p<0.001
et, % children	DepCat7	35%	22%	p<0.0001
	All Glasgow	21%	16%	p<0.001
Untreated decay, % children	DepCat7	75%	58%	p<0.0001
	All Glasgow	NR	NR	NR

Summary and Evidence Statement

The two identified studies (Blair et al. 2004 [+] and Blair et al. 2006 [+]) describe a similar multi-faceted community based health promotion programme targeting children under the age of five considered to be at risk for dental caries. Blair et al. 2004 [+] described the pilot study in two areas of Glasgow. Based on the results of the pilot programmes, the Oral Health Action Teams (OHATs) described in Blair et al. 2006 [+] were developed in order to deliver the programme in the most severely deprived areas of Glasgow.

Overall, both the pilot programme and the extended city wide programme were found to be associated with significant improvements in the oral health of young children, especially in the most deprived areas, including:

- A significant increase in the proportion of children found to be caries free
- A significant reduction in the proportion of young children with any missing or extracted teeth due to caries
- A significant reduction in the proportion of children with a high caries burden (four or more decayed, missing or filled teeth)

Blair et al. 2006 [+] reported that there was no background trend for improvement in infant dental health in Glasgow over more than a decade prior to introduction of OHATs (previous to the programme introduction, approaches to reducing caries were based on dental health education in nurseries, schools, and clinical dental settings). This suggests that the results seen over time were unlikely to be due to secular improvements in oral health alone.

While improvements in oral health were reported, neither study found significant associations between programme participation and access/use of dental services.

Evidence Statement 4: Effect of multi-component, community based oral health promotion programmes on dental caries and dental service access in children under the age of five

Moderate evidence from two interrupted time series (UK[1,2]) describing similar programmes suggests that oral health promotion campaigns delivered through multiple venues and targeting several aspects of oral health may be associated with a reduced risk of dental decay in children under the age of five living in deprived communities.

In the most deprived communities, the programme was associated with a dmft prevented fraction of 46%[1] among three year old children, and 37%[1] among four year old children.

Evidence from one study[2] suggests that a multi-component community wide intervention implemented in at risk areas is associated with significantly lower odds of experiencing tooth decay at age 5 in the most deprived areas (DepCat 7 $d_3$mft>0: OR 0.35, 95% CI 0.26 to 0.47; p<0.001)[2] and across the wider population (DepCats 1-7 $d_3$mft>0: OR 0.66, 95% CI 0.57 to 0.77; p<0.0001)[2].

Neither programme was associated with significant differences in dental service utilisation, assessed either using the Care Index amongst three year olds (before: 1.5%, after: 1.9%; 95% CI and p-value NR)[1] or four year olds (before: 3.2%, after: 3.8%; 95% CI and p-value NR)[1]. The second study assessed restorative care utilisation using survey data and found no difference in use amongst children from the most deprived communities before versus after the programme implementation (no values reported)[2].

[1] Blair et al. 2004 [+]
[2] Blair et al. 2006 [+]

4.2.2 Oral health promotion and education programmes

Two studies were identified that assessed the effectiveness of community based oral health education and promotion programmes on the oral health, oral hygiene and dental attendance of children aged less than five years:

- One cohort study (Milgrom et al. 2010 [+])
- One before and after study (Wennhall et al. 2005 [+])

Milgrom et al. 2010 (Cohort study [+], USA, n=169, NF)

Rural counties in Oregon, USA implemented a community based public health programme that provided women with educational materials promoting dental visits for offspring in the second year of life, home visits or counselling sessions at the local Women, Infants, and Children (WIC) programme centre, and assignment to a dental managed care programme.

Compared to children of women from neighbouring rural counties who were eligible for dental care as part of the standard Oregon Health Plan (OHP), children of women participating in the programme were more likely to be caries free (%) and had fewer decayed teeth (mean, SD) at follow-up approximately one year later. Information on the duration of programme participation was not reported, so it is unclear how long after the end of the intervention the follow-up measurements were taken.

- Caries free – 85% vs. 58.9%; 95% CI NR, p<0.0004; RR 1.48 (1.13 to 1.93)
- Decayed teeth – 0.75 vs. 1.6 (2.5); 95% CI NR; p=0.04

Children in the intervention group were significanly younger than those in the comparator group (age difference of 4 months, p<0.003). This was adjusted for during the analysis.

Wennhall et al. 2005 (Before and after study [+], Sweden, n=1,021, NF)

The parent/guardian of children born between July 1998 and June 2000 in suburban Rosengard, Malmo, Sweden (described as a “low socioeconomic area”; no SES

metrics reported) were provided with five sessions of an oral health promotion programme. The sessions were provided over the course of one year by dental assistants in a community based outreach facility in the suburban centre.

When the child was 24 months of age, the parent/guardian was given practical tooth brushing instruction; a toothbrush, a three month supply of free fluoride tablets and offered discounted fluoridated toothpaste. Dietary recommendations were given, focusing on avoiding night-time meals and sugary snacks. Subsequent sessions (at 27, 30, 33 and 36 months of age) reinforced the tooth brushing instruction, and focused on oral hygiene and diet problem solving.

After one year, oral health and dietary outcomes were compared between programme children and children from the same suburban area born between July and December 1997 (the year prior to programme start).

Programme participation was associated with a significantly lower mean deft at age 3, higher likelihood of being caries free (RR 2.5 (1.8 to 3.4); NNT 4.6), and lower likelihood of having cavitated lesions or bleeding gums after brushing. Initial enamel lesions and plaque scores were not different between the pre- and post-programme groups. Significant differences between intervention and comparator groups at age 3 were also seen in terms of consumption of sweets at night, daily toothbrushing and use of fluoridated toothpaste (see Table 6).

Table 1: Oral health, oral hygiene and dietary outcomes at age 3

Outcome	Intervention	Comparator	p-value
Mean (SD) deft	3.0 (NR)	4.4 (NR)	p<0.01
Caries free, %	37%	15%	p<0.001
$d_{1,}$ %	52%	29%	p=NS (value NR)
Cavitated lesions, %	29%	55%	p<0.001
Bleeding gums, %	39.1%	49.3%	p<0.01
Visible plaque, %	NR	NR	p=NS (value NR)
Sweets at night, %	14.8%	23.8%	p<0.001
No daily toothbrushing, %	5.6%‡	21.1%	p<0.01
No fluoride toothpaste use, %	2.1%	1.8%	p=NS (value NR)
‡ Significant reduction within group, age 2 vs. age 3			

Summary and Evidence Statement

The two community based oral health education programmes were provided to low income parents or families of children aged two to three years, but differed in their intensity, content and settings.

One programme (Milgrom et al. 2010 [+]) included oral health education efforts without the provision of fluoride. The programme also focused on improving access to dental services by providing a dental home to low-income pregnant women and their young children, and provided educational materials to mothers as well as flexible counselling sessions either at home or at local WIC centres.

The Wennhall et al. 2005 [+] programme included five oral health promotion sessions aimed at parents or caregivers, which included an both educational materials as well as oral hygiene supplies provided at a community based outreach centre in a low SES community, and included economic incentives in the form of discounted fluoride toothpaste. Results in this before and after study were compared to similarly aged children from the year prior to programme implementation.

Overall, these studies suggest that community based oral health promotion and education programmes provided to parents or carers of young low-income children may be associated with improved oral health and hygiene of three year old children, including:

- Significant increases in percentage of children who are free of dental caries
- Significant reductions in average decay levels
- Significant improvements in gingival health
- Significant improvements in parental toothbrushing activity

Significant improvements over time were also reported in fluoride toothpaste use amongst programme participants, however, there was no difference when compared to similarly aged children at the end of the study; it is unclear whether this within group reduction is associated with programme participation, or if parents are more inclined to use fluoride toothpaste in the oral hygiene routines of their children when they are older.

Evidence Statement 5: Association between community based oral health promotion and education programmes and the oral health and hygiene of young, low-income children

Moderate evidence from one cohort study (US[1]) and one before and after study (Sweden[2]) suggests that community based oral health promotion and education programmes delivered to low-income mothers or parents of young children (aged 2) may be associated with preventing tooth decay over approximately one year.

One study [+][1] found that oral health education counselling of low income mothers of 2 year old children, plus assignment to a dental care organisation to improve service access, was associated with a 48% increased likelihood of three year old children being caries free (RR 1.48, 95% CI 1.13 to 1.93)[1], and a significantly lower mean (SD) dt (0.75 (2.5) vs. 1.6 (2.5); 95% CI NR, p=0.04)[1], significantly fewer children exhibiting bleeding gums (before: 49.3%; vs. after: 39.1%, 95% CI NR, p<0.01) but had no impact on visible plaque amongst three year olds (statistics NR)[1].

The second study [+][2] found that provision of five education sessions, a toothbrush and discounted fluoride toothpaste to low-income parents at a community based outreach facility was associated with significantly increased likelihood of being caries free at age three (RR 2.5, 95% CI 1.8 to 3.4, NNT 4.6)[2], with a significantly lower mean (SD) deft at age 3 (programme: 3.0 (NR) vs. comparator: 4.4 (NR); 95% CI NR, p<0.01)[2], significant reductions in the percentage of parents reporting they did not brush their child's teeth daily (13.2% at age 2 to 5.6% at age 3, 95% CI NR, p<0.001; intervention vs. comparator at age 3 p<0.01)[2] and significant reductions in the percentage of parents reporting no use of fluoride toothpaste (7.5% at age 2 to 2.1% at age 3, 95% CI NR, p<0.001; intervention vs. comparator at age 3 not significant).

[1] Milgrom et al. 2010 [+]

[2] Wennhall et al. 2005 [+]

4.3 Children aged under five in home settings

4.3.1 Home visitor programmes

Three studies were identified that assessed the effectiveness of oral health education and promotion programmes on the oral health, oral hygiene and dental attendance of children aged less than five years:

- One RCT (Whittle et al. 2008 [+])
- One non-randomised controlled trial (Yuan et al. 2007 [+])
- One prospective cohort study (Shute and Judge, 2005 [-])

Whittle et al. 2008 (RCT [+], UK [England], n=501, FNR)

A health visitor, who was attached to the local community dental service, made a home visit to parents of 8 month old children in the Burnley, Pendle, and Rossendale areas of England, where dental health is known to be particularly poor. Dental health advice was provided, based on Health Education Authority recommendations. The health visitor made a second visit when the child was about 20 months to assess a diet record sheet sent to the parent in advance. They discussed what and when the child was eating and drinking based on the sheet responses. A toothbrush, low fluoride toothpaste and "Giving Teeth a Good Start" leaflet covering diet and tooth brushing advice were provided at both visits.

Oral health outcomes at ages 3 and 5 years were compared to children who received normal care provided by health visitors in the area (which included verbal advice about registering with a dentist; avoiding sugary drinks, sweets and medicine; and tooth brushing). There were no significant differences in oral health outcomes between the two groups at either age 3 or 5; all comparisons were reported as non-significant (95% CIs and p-values NR). Age 5 outcomes for children in the intervention group were also compared to results from a standard dental census at all area schools among five year old children. Mean dmfs at age 5 was reported as significantly lower in the intervention group than in the census group (see Table 7).

Table 7: Mean dmfs at age 3 and 5

Outcome	Intervention	Comparator	Age 5 census group
dmfs age 3, mean (95% CI)	2.03 (1.39 to 2.67)	2.19 (1.41 to 2.97)	NA
dmfs age 5, mean (95% CI)	3.99 (2.94 to 5.04)§	4.84 (3.39 to 6.29)	5.94, (5.55 to 6.33)§
§ Significant difference reported between groups; 95% CI and p-value NR			

Yuan et al. 2007 (Non-randomised controlled trial [+], UK [Northern Ireland], n=22 wards, participants NR, FNR)

Children residing in urban and rural wards in and around Belfast (within the top 10% most deprived communities in Northern Ireland) with the lowest dental registration rates were eligible for a dental registration programme. New mothers in programme wards received a dental registration intervention lasting two years, during which time health visitors (community based nurses) provided dental health education, feeding cups, toothbrushes and fluoride toothpaste, registration vouchers and a list of local participating dentists. The intervention was delivered during three routine health visits when the baby was aged 7 weeks, 8 months and 18 months. Using the voucher, mothers could register children with a dental practice, and were provided with one-on-one advice regarding how to reduce the need for pain-only dental appointments and about maintaining registration with the practice.

Six months before implementation and during the programme, the percentage (95% CI) of children aged 0 to 2 years who were registered with a dentist was similar in programme and comparator wards:

- Six months pre-programme (programme: 17% (15% to 20%), comparator: 21% (17% to 24%); mean difference: -3% (-8% to 1%), p=0.13).
- During the programme (programme: 25% (19% to 31%), comparator: 22% (19% to 24%), mean difference: 3% (-2% to 9%), p=0.21)

Five months post-programme, 26% (23% to 29%) of programme children were registered with a dental practice, while 22% (19% to 25%) of comparator children

were registered. This difference was reported as statistically significant (mean difference: 4% (-8% to 0%), p<0.05).

There were no significant differences between programme and comparator communities in the proportion of 3 to 5 year old children who were registered with a dental practice:

- 6 months pre-programme (programme: 52% (45% to 58%), comparator: 46% (41% to 51%), mean difference: 5% (-2% to 15%); p=0.14)
- During the programme (programme: 53% (46% to 60%), comparator: 48% (44% to 53%), mean difference: 4% (-3% to 12%), p=0.25)
- 5 months post-programme (programme: 54% (49% to 60%), comparator: 52% (46% to 57%), mean difference: 3% (-5% to 11%), p=0.48)

Shute and Judge, 2005 (Prospective cohort study [-], UK [Scotland], n=627, FNR)

Families of newborn children in disadvantaged areas of Glasgow, Scotland received a home visit by Start Well health visitors in 2002. The health promotion programme involved a team of health professionals and lay health workers who provided an intensive home-based service (in addition to routine services) addressing home safety, encouragement of playing, and a parenting skills programme. After controlling for several sociodemographic and confounding variables, Start Well children were significantly more likely to be registered with a dental practice at six months compared to children from communities where the programme had not been implemented (programme: 45.1%, comparator: 26%, difference: 19.1% (9% to 28.3%), p<0.001; adjusted OR 2.60, 95% CI NR; p<0.001).

Summary and Evidence Statement

All three programmes were implemented in areas of high deprivation, areas with poor oral health, or among low income families of very young children. The intensity and content of the programmes varied, as did the comparators selected for analysis. These differences may account for varying results seen across the studies.

Whittle et al. 2008 [+] included a home-based oral health promotion programme that provided dietary education and advice to parents during two home health visitor sessions, as well as a toothbrush, low fluoride toothpaste and educational leaflet that provided further diet and oral hygiene information. The comparator group received standard health visitor care, which included information on oral health.

Yuan et al. 2007 [+] describe a home health visitor programme designed to specifically address oral health of newborns and toddlers. The intervention included three visits during the first two years of life, and addressed diet, oral hygiene and registration with local dental services. The authors did not describe any usual care services provided to families in comparator wards in their study.

Finally, Shute and Judge, 2005 [-] describe an intensive home visit programme, involving multiple professionals and addressing several areas important for the general health and oral health of young children. Outcomes in this study were compared to a statutory health visitor programme in a demographically similar part of Glasgow.

One RCT (Whittle et al. 2008 [+] assessed oral health outcomes and found that the home health visitor programme was no more effective than usual care in terms of average tooth decay at age three or five years. The control group in this study received an established standard care health promotion programme delivered by health visitors, which included advice about registering with a dentist, oral hygiene practices and avoiding cariogenic drinks, foods and medicines; this informative usual care programme may account for the lack of significant difference in mean dental caries between intervention and control groups.

The two remaining studies assessed programme impact on dental access, assessed by dental registration rates. Both studies reported significant increases in the proportion of children registered with a dentist of very young. However, these results should be interpreted cautiously due to discrepancies in the reporting of statistical significance in Yuan et al 2007 [+] and low participation rates reported in Shute and Judge 2005 [-]. Approximately 50% of recruited families agreed to participate in the latter study, with the main reasons for non-participation being ‘too busy’ or ‘too tired’. Participation difference between programme and comparator groups, as well, with

61% of eligible programme families agreeing to participate vs. 39% of comparator group families. This may have resulted in the study population being more likely to register with dental practices.

Evidence Statement 6: Effect of oral health promotion and education programmes provided by home health visitors on the oral health and access to dental services of very young children

Moderate evidence from one RCT (UK[1]), one non-randomised controlled trial (UK[2]) and one cohort study (UK[3]) suggests that oral health promotion and education programmes delivered by health visitors during early life home visits are no more effective than standard health visits at improving the oral health of children under the age of five, but may be associated with improvements in dental registration rates in deprived areas.

One study[1] found that an oral health education programme provided to parents during home health visits is no more effective than a usual health visitor programme (which also addressed oral health) at reducing caries amongst three year or five year olds (mean dmfs age 3: 2.03, 95% CI 1.39 to 2.67 vs. 2.19, 95% CI 1.41 to 2.97; age 5: 3.99, 95% CI 2.94 to 5.04 vs. 4.84, 95% CI 3.39 to 6.29)[1].

A second study[2] reported a significant increase in the proportion of children aged 0 to 2 years who were registered with a dentist after the home visitor programme. However, discrepancies in the reported effect size and significance (mean difference: 4% (-8% to 0%), $p<0.05$)[2] undermines the certainty of interpretation. No significant differences were found at longer term follow-up (aged three to five).

One observational study[3] found that intensive home visits addressing general as well as oral health to be significantly associated with improved dental registration rates amongst young children in disadvantaged communities (adjusted OR 2.60, 95% CI NR; $p<0.001$)[3].

[1] Whittle et al. 2008 [+]

[2] Yuan et al. 2007 [+]

[3] Shute and Judge 2005 [-]

4.3.2 Postal delivery

Three studies were identified that assessed the impact of programmes delivered via post to families of children aged under five:

- 3 RCTs (Cruz et al. 2012 [+], Ellwood et al. 2004 [+], and Plutzer and Spencer 2007 [-], with longer term follow-up results reported in Plutzer et al. 2012 [-])

Cruz et al. 2012 (RCT [+], USA, n=6,041, FNR)

Families of low income children, aged 12 to 36 months, in 2002 residing in Yakima County, Washington and who were entitled to comprehensive oral health coverage under the state's Medicaid or Basic Health Plus programmes, participated in a postcard reminder programme that aimed to improved dental service access. Two interventions were assessed:

- Group 1 received mailed postcards (in both English and Spanish) with information on how to enrol in the “Mom and Me” programme,
- Group 2 received mailed postcards (in both English and Spanish) with the “Mom and Me” logo and two other postcards with information on the fluoride varnish benefit and early dental appointments for infants.

Use of topical fluoride and use of dental services over 18 months from the start of the programme were compared to a control group which received no postal mailings.

There were no significant difference across the three groups in the proportion of children with reported topical fluoride use (Group 1: 59%, Group 2: 60%, Group 3: 58%; Group 1 vs. Group 3: 95% CI= NR; p=0.27; Group 2 vs. Group 3: 95% CI= NR; p=0.16).

There was no significant differences in the proportion of children utilising any dental services over the course of the study, based on Medicaid claims during that time period (Group 1: 62%, Group 2: 63%, Group 3: 61%; Group 1 vs. Group 3: 95% CI= NR; p=0.35; Group 2 vs. Group 3: 95% CI= NR; p=0.15). When disaggregated into type of service, lack of significant differences remained (see Appendix E for outcome data on diagnostic, preventive and restorative dental service utilisation).

Ellwood et al. 2004 (RCT, [+], UK (England), n=7,422, NF)

Children who resided in one of nine health districts in north-west England with high levels of dental caries received, via post delivered to their families, health education literature, free toothpaste containing either 440ppm or 1450ppm fluoride every three months, and a toothbrush provided each year from age of 1 to 5.5 years. Families were asked not to give the children supplemental fluoride tablets during the study.

Analyses of oral health outcomes were against a comparator group which received no intervention (neither fluoride toothpaste nor educational materials). Analyses were stratified according to deprivation quartile (with higher quartiles indicating higher deprivation levels).

At age 5 to 6, children in the least deprived areas, those in the high fluoride toothpaste had the fewest caries, followed by children who did not receive the intervention; children in the low-fluoride toothpaste group had the highest mean dmft, 36% higher than the high fluoride group (95% CI NR, $p<0.05$); there was no difference in mean dmft between low fluoride and comparator groups (difference and 95% CI NR, $p>0.05$). See Table 8 for outcomes across deprivation quartiles and intervention groups.

Table 8: Oral health outcomes across intervention groups, stratified by deprivation levels

Deprivation Quartile	Literature plus high dose F toothpaste	Literature plus low dose F toothpaste	No intervention
Mean (SD) dmft			
1 (least)	1.4 (2.5)*	2.2 (3.0)	1.9 (2.9)
2	2.0 (2.9)	2.3 (3.0)	2.3 (2.9)
3	2.6 (3.3)	2.6 (3.1)	2.8 (3.1)
4 (most)	2.7 (3.0)	2.9 (3.6)	3.2 (3.4)
% dmft>0			
1 (least) §	40%	51%	44%
2 §	46%	58%	56%
3	56%	61%	53%
4 (most) §	61%	59%	68%
% dmft≥4			
1 (least)	16%^	27%^	22%
2	24%	28%	29%
3	32%	31%	36%
4 (most)	35%	35%	39%
% DMFT upper incisors			
1 (least)	6%	10%	9%
2	10%	9%	9%
3	11%	10%	12%
4 (most)	17%	17%	18%
% et/ET≥1			
1 (least)	9%	10%	10%
2	11%	14%	16%
3	15%	17%	21%
4 (most)	14%*	14%*	21%
* significant difference vs. comparator group at p<0.05; ^ significant differences between intervention groups; § significant differences reported, compared groups not specified			

Plutzer and Spencer, 2007 (RCT [-], Australia, n=649, FNR)

Two unique citations (Plutzer and Spencer 2007 [-] and Plutzer et al. 2012 [-]) reported results of an RCT amongst nulliparous pregnant women residing in Adelaide, Australia. Plutzer and Spencer 2007 [-] reported on programme content and short term outcomes, while Plutzer et al. 2012 reported longer term results. The women were randomised to a no intervention comparator group or an oral health

education programme delivered over 12 months and consisting of anticipatory guidance in order to support the establishment of healthy habits early (as opposed to changing behaviour after unhealthy habits were established). The women received three rounds of advice, one before their child was born, one when the child was aged 6 months, and the third when the children were 12 months old. In addition, a random sample of programme women received a structured telephone consultation on oral health of infants and any issues the women were facing. This was provided between the second and third rounds of education.

Six months post-intervention, Plutzer and Spencer 2007 [-] reported that programme participation led to a significant difference in percentage of 20 month old children experiencing incident severe early childhood caries (S-ECC) of the maxillary incisors (OR comparator vs. intervention: 6.8, 95% CI 2.1 to 21.9). There were no differences between the two intervention groups (three education sessions only vs. three education sessions plus a telephone consultation), although the statistics regarding this comparison were not reported.

Plutzer et al. 2012 report long term oral health results for 28.8% of the participant children who were available for follow-up at age 6 to 7 years. This study found no difference in the prevalence of dentine caries at the tooth level (d3mft>0) between intervention and comparator group children (intervention: 31%, comparator: 30%; reported as NS; 95% CI and p-value NR) or in mean d3mft (intervention: 0.99 (SD 1.81), comparator: 1.29 (SD 2.66); reported as NS; 95% CI and p-value NR). Similarly, no difference between intervention and comparator group children was found when dentine caries (mean d3mfs) were assessed at the surface level (intervention: 1.46 (SD 2.59), comparator: 2.45 (SD 6.65); reported as NS; 95% CI and p-value NR).

Finally, at age 6 to 7, there was no difference in mean significant caries index (SiC) scores, which assesses the average caries experience (dmft/DMFT) for the top 30% of a population when ranked by DMFT, that is, the mean caries amongst those with the worst caries (mean SiC intervention: 2.97 (SD 1.99), comparator: 3.90 (SD 3.38); reported as NS; 95% CI and p-value NR).

Summary and Evidence Statement

The home based oral health education programmes (delivered via post) varied according to participant age, socioeconomic status, as well as intervention content and intensity.

Ellwood et al. 2004 [+] compared the provision via post of either high- or low-dose fluoride toothpaste, a toothbrush and oral health education materials to the homes of children aged 1 to 5.5 years, and compared the effectiveness of these two interventions to a control group which received no materials. There were inconsistent results in terms of oral health outcomes, with Ellwood et al. 2004 [+] reporting that the effect varied according to fluoride content and participant deprivation status: the provision of health education materials and high fluoride toothpaste was effective at reducing caries burden amongst the least deprived children (fewer were found to have any caries, and the average caries level in the population was reduced). In the most deprived areas, both high and low fluoride toothpaste in addition to oral health education materials reduced the proportion of children with any decay, but had no impact on overall mean caries. This may have implications for increasing oral health inequalities.

The programme described in Plutzer and Spencer 2007 [-] (with long term results reported in Plutzer et al. 2012) described a dietary education programme for first time expectant mothers, with counselling provided antenatally and through the first year of the child's life. Outcomes in this study were compared to a control group that received no intervention. Overall, the results from these two publications suggest that providing first time mothers with written information on the oral health care of newborns may decrease the incidence of severe early childhood caries at 20 months of age, but may not have lasting benefits on dental decay of children at age 6 to 7 years.

However, there were substantial limitations to the study that should be considered. First, the women were notified of their group allocation prior to agreeing to participate in the study. Five of the women decided to change groups after this allocation notification (all five switched from the comparator to the intervention group). Second, attrition differed between the two groups on the basis of social variables; retention in

the intervention group was higher amongst women with lowest levels of education, while rentention in the comparator group was higher amongst women with highest levels of education. Finally, long term outcomes reported in Pluzter et al. 2012 were available for only 29% of the original participants, and the lack of significant difference between the groups may be due to either selection bias or lack of statistical power introduced by the low follow-up rate.

Cruz et al. 2012 [+] compared fluoride use and dental service outcomes to a comparator group that received no intervention postcards, but continued to receive standard leaflets and information regarding Medicaid dental benefits. This study resulted in no significant difference in reported topical fluoride use or in dental service use across the two intervention groups. The children in the study were selected based on eligibility for dental benefits, regardless of previous use of dental services. It is unclear if the postcard reminder and advice programme would have differential effects if it targeted a group of Medicaid eligible families with no previous dental benefit claims, as was done in a similar study among older Medicaid eligible children (see Blinkley et al. 2010 [+], Section 4.6.1).

Evidence Statement 7: Effect of oral health promotion and education programmes delivered via post on the oral health and dental service access of children under the age of five

Inconsistent evidence was identified from four publications reporting on three RCTs (UK[1], Australia[2,3], USA[4]) regarding the effect of oral health promotion and education materials and supplies delivered via post on the tooth decay of young children; effectiveness may vary according to deprivation status and provision of fluoride toothpaste. Postal reminders of eligibility for dental services and fluoride varnish benefit programme may have no effect on dental registration or use of fluoride amongst low-income children.

One study[1] found that postal provision of educational literature plus high fluoride toothpaste was associated with reduced caries prevalence in both the most and least deprived areas, while low fluoride content toothpaste was associated with reduced prevalence in only the most deprived areas: (dmft>0 least deprived - high F: 40%,

low F: 51%, comparator: 44%; difference across group reported as significant, 95% CI and p-values NR. dmft>0 most deprived - high F: 61%, low F: 59%, comparator: 68%; difference across group reported at significant; 95% CI and p-value NR)[1]. The high fluoride toothpaste intervention was effective at reducing mean caries in the least deprived group (mean (SD) dmft - 1.4 (2.5) vs. 1.9 (2.9), 95% CI NR, $p<0.05$)[1], but not amongst children in the most deprived areas, despite a reduction in caries prevalence in this group.

Results from another trial[2] indicate a significant reduction in incident of severe caries of the upper incisors amongst 20 month old children (OR ([comparator vs. intervention] 6.8, 95% CI 2.1 to 21.9)[2]. These results were not maintained into later childhood (age 6 to 7 $d_3$mft>0 intervention: 31%, comparator: 30%; reported as NS, 95% CI and p-value NR)[3] or in mean $d_3$mft (intervention: 0.99 (SD 1.81), comparator: 1.29 (SD 2.66); reported as NS; 95% CI and p-value NR)[3].

The final RCT[4] suggests that an oral health promotion programme delivered as postal reminders is no more effective than usual care at increasing dental service utilisation or improving topical fluoride use (no effect size estimates reported)[4].

[1] Ellwood et al. 2004 [+]
[2] Plutzer and Spencer 2007 [-]
[3] Plutzer et al. 2012 [-]
[4] Cruz et al. 2012 [+]

4.4 Children and young people of primary or secondary school age in school settings

4.4.1 Programmes to improve access to fluoride: fluoride varnish

Four studies were identified that assessed the impact of school based fluoride varnish programmes on the caries status of school children:

- One RCT (Moberg et al. 2005 [++])
- Two cluster RCTs (Splieth et al. 2011 [-], Hardman et al.2007 [+])
- One interrupted time series (Dohnke-Hohrmann and Zimmer 2004 [-])

Moberg et al. 2005 (RCT [++], Sweden, n=854, F and NF)

A fluoride varnish intervention was delivered to Swedish secondary school students aged 13 years in three different communities with varying caries risk (classified according to a combination of local water fluoridation status and socioeconomic variables):

- The low risk community had the highest SES and fluoridated water;
- The medium risk community had an intermediate SES and non-fluoridated water;
- The high risk community was an area of high social deprivation and non-fluoridated water.

Fluoride varnish was applied by a dental nurse to the approximal surfaces of the teeth on three different schedules. A school in each community was randomised to:

- Group 1, which received varnish applications twice a year at six month intervals, for 6 applications in 3 years;
- Group 2, which received varnish applications three times per year within one week, for 9 times in 3 years;
- Group 3, which received varnish applications 8 times per year during the school year at one month intervals, for 24 times in 3 years;
- Group 4, the comparator group which received no school based fluoride varnish applications

Students continued to receive standard care (attending dental clinics for regular check-ups, and receiving prophylactic treatment depending on their individual caries risk), with 95% of the children receiving a fluoride varnish application once a year outside of that provided at school via the programme.

Overall, there was a significant reduction in mean (SD) approximal caries (DFS_a) incidence over three years in intervention groups vs. comparator. There was, however, no significant difference in approximal caries incidence among low risk

students (high SES and fluoridated water) regardless of group allocation (see Table 9).

In non-fluoridated, medium SES areas (medium risk groups), the significance of the effect varied according to varnish application schedule, with significant differences seen between Group 1 and Group 4, and Group 3 and Group 4.

Fluoride varnish programmes delivered to students living in areas of high deprivation with no access to fluoridated water were effective at reducing caries incidence (all intervention groups vs. comparator: 95% CI NR, p<0.001).

Table 9: Approximal caries incidence of the permanent dentition amongst 16 year old participants according to fluoride varnish application schedule and caries risk

Population	Group 1	Group 2	Group 3	Group 4
Overall incidence DFS_a, mean (SD); Prevented fraction (%)				
Overall	0.79 (1.67)‡; 57%	0.98 (2.16)‡, 47%	0.45 (1.28)‡, 76%	1.85 (2.89)
Low risk	1.09 (1.87)	0.43 (1.22)	0.68 (1.81)	1.36 (2.76)
Medium risk	0.54 (1.51)‡; 66%	1.09 (2.60)	0.27 (0.79)‡; 83%	1.59 (2.61)
High risk	0.95 (1.67)‡; 69%	1.40 (1.89)‡; 54%	0.54 (1.26)‡; 82%	3.05 (3.37)
‡ Significant difference vs. Group 4 at p<0.001				

Among students with approximal enamel lesions at baseline (age 13), fluoride varnish programmes were effective at inhibiting caries progression over three years for all application schedules. Similar to caries incidence, there was a differential effect depending on caries risk, with no significant differences seen among high SES students with access to fluoridated water (reported as non-significant; 95% CIs and p-values NR. See Table 10).

No significant differences in caries progression were seen amongst adolescents of medium SES with no fluoridated water access (reported as non-significant; 95% CIs and p-values NR). However, in an area of high social deprivation and no systemic fluoride access, school based fluoride varnish applications were effective at preventing caries progression (95% CIs NR, p<0.003 for all comparisons).

Table 2: Caries progression amongst participants with approximal caries lesions at age 13

Population	Group 1	Group 2	Group 3	Group 4
Overall	0.10 (0.35)‡	0.21 (0.79)‡	0.22 (0.95)‡	0.40 (0.92)‡
Low risk	0.07 (0.26)	0.08 (0.27)	0.15 (0.74)	0.26 (0.87)
Medium risk	0.08 (0.34)	0.24 (0.88)	0.20 (1.06)	0.27 (0.71)
High risk	0.18 (0.45)‡	0.30 (0.96)‡	0.37 (0.93)‡	0.90 (1.24)‡
‡ Significant difference vs. Group 4 at p<0.003				

Splieth et al. 2011 (Cluster RCT [-], Germany, n=NR schools and 776 participants, FNR)

All first and second grade schoolchildren (aged 6 to 8 years) received a standard health promotion programme twice a year, which covered topics including caries aetiology and advice regarding oral hygiene, diet and fluoride. The intervention group further received a twice yearly topical fluoride varnish; both components were delivered by a dental hygienist.

The population had a low caries risk at baseline (mean DMFS 0.32), but high variation within the groups (SD >1.00 for both groups). The twice yearly fluoride varnish application programme had no significant effect on mean (SD) caries incidence in the first permanent molars at age 10 (intervention: 0.81 (1.74) vs. comparator: 0.78 (1.81); 95% CI and p-value NR). As at baseline, high variability in caries risk was seen at follow-up, with 69% of the intervention group and 72% of the comparator group experiencing no new caries (no statistical comparison reported).

The authors suggest that, given the observed polarisation in caries at both the beginning and end of the study, a few children in the population experience a considerable caries burden, and that twice yearly fluoride varnish applications do not appear to further reduce caries at a population level or among those with low existing caries risk, and may be insufficient to reduce the experience of caries amoung a high risk group. However, no subgroup analysis by baseline caries risk was reported.

Hardman et al. 2007 (Cluster RCT [+], UK [England], n=48 classes and 914 participants, NF)

A twice yearly school based fluoride varnish programme among primary school children in relatively deprived communities (further definition not reported) had no significant impact cavitated lesions in the primary molars at age 9:

- Mean d_3fs increment – intervention: 1.52 (SD NR), comparator: 1.49 (SD NR); mean difference 0.01 (SE 0.18); 95% CI -0.34 to 0.37, p=0.94;
- Mean d_2fs increment – intervention: 0.72 (SD NR), comparator: 0.97 (SD NR), mean difference: 0.28 (SE 0.20); 95% CI -0.12 to 0.67, p=0.17).

However, comparator students had a significantly higher mean d_1fs increment versus those receiving fluoride varnish (intervention: 0.71 (SD NR), comparator: 1.12 (SD NR), mean difference: 0.48 (SE 0.22); 95% CI 0.048 to 0.91, p=0.03).

There was no difference in the proportion of comparator group students experiencing a positive caries increment in the permanent molars when compared to those participating in the programme, regardless of severity:

- D_3FS – intervention: 0.16, comparator 0.19; adjusted difference: 0.25 (SE 0.21); 95% CI -0.15 to 0.65, p=0.22;
- D_2FS – intervention: 0.27, comparator: 0.31, adjusted difference: 0.22 (SE 0.17); 95% CI -0.11 to 0.55, p=0.20;
- D_1FS – intervention: 0.45, comparator: 0.48, adjusted difference: 0.05 (SE 0.15); 95% CI -0.24 to 0.35, p=0.36.

Dohnke-Hohrmann and Zimmer, 2004 (Interrupted time series [-], Germany, n=80,589 exams, FNR)

Primary school children in the Neukoln district of Berlin, a multicultural under-priveleged area of the city, received a pre-existing prevention programme (which addressed toothbrushing and nutrition, and was provided three to four times each school year) plus biannual application of fluoride varnish. Compared to before the programme implementation (1995/1996), 9 year old and 12 year old students in 1999/2000 (who had participated in the programme) had reductions in mean DMFT:

- 9 year olds - before:1.09 (SD NR), 4 years after introduction: 0.63 (SD NR), reduction 42% (signficance, 95% CI and p-value NR)
- 12 year olds – before: 2.77 (SD NR), 4 years after introduction: 1.64 (SD NR), reduction 40.7% (signficance, 95% CI and p-value NR)

Visual examination of graphs suggest a trend towards caries reduction over time (timepoints reported for five years) for children aged 6 to 12, however, Reductions for other age groups were not reported.

Summary and Evidence Statement

Overall, evidence suggests that school based fluoride varnish programmes may be effective at preventing new enamel lesions or inhibiting the progression of existing lesions in communities with high caries risk.

The four studies assessing school based fluoride varnish interventions differed in several key areas, including participant age, caries risk, fluoride application schedule, comparator group and outcomes assessed:

- Moberg et al. 2005 [++] included older children, aged 13 to 16, from communities of varying risk, and assessed several different fluoride varnish schedules on incident caries in the permanent dentition compared to children who received no intervention.
- Splieth et al. 2011 [-] included primary school children aged 6 to 8 years with low caries risk, and investigated the effect of biannual varnish applications on incident caries of the permanent molars at age 10 compared to a group that received an established school wide oral health promotion programme.
- Hardman et al. 2007 [+] included primary school children (aged 7) from relatively deprived communities, and assessed the effect of a biannual varnish schedule on caries of the primary and permanent molars at age 9, compared to a control group that received a toothbrush and fluoride toothpaste.
- Dohnke-Hohrmann and Zimmer 2004 [-] included primary school children aged 5 to 12, and assessed the association between a biannual fluoride varnish

programme and caries of the permanent dentition amongst 9 and 12 years olds before and after the programmes introduction.

The results of Moberg et al. 2005 [++] suggest that fluoride varnish applications can significantly reduce the caries incidence among 13 to 16 years old compared to no fluoride varnish, although the majority (>90%) of incident caries were enamel lesions (D_{1-2}), suggesting that the intervention is most effective at preventing less severe caries. The interventions reduced incident caries in the population overall, with the greatest effects seen amongst those students in deprived communities without access to fluoridated water, suggesting that this intervention may have implications for reducing oral health inequalities. The effect was most pronounced with most frequent application schedule (monthly throughout the school year), followed by twice a year, and with the least effective schedule being three applications in one week at the beginning of the school year.

The evidence regarding twice yearly fluoride varnish programmes was inconsistent. Splieth et al. 2011 [-], Hardman et al. 2007 [+] and Dohnke-Hohrmann and Zimmer 2004 [-]) assessed such programmes. Two of these studies (Splieth et al. 2011 [-], Hardman et al. 2007 [+]) suggested that school based, biannual fluoride varnish programmes are no more effective at reducing dental caries than providing a toothbrush and fluoride toothpaste or standard oral health promotion or education programmes in primary school children. These programmes may reduce the risk of the least severe caries in the primary molars ($d_1$fs), but had no impact on more severe lesions.

The non-significant results seen in these studies compared to the significant results in Group 1 of Moberg et al. 2005 [++], which received a similar biannual application schedule, may be due to the different comparator groups across the studies, or the different baseline risks of the included populations.

The children recruited into the Splieth et al. 2011 [-] study had low baseline caries prevalence, and the children who completed the study and were included in the analysis had significantly lower mean caries level than children who were lost to follow-up. While this lack of an intention to treat analysis limits the conclusions that

can be drawn from the study, the results do support the differential effect seen in Moberg et al. 2005, whereby fluoride varnish treatments had no significant impact on children with low caries risk.

Poor quality evidence from an interrupted time series (Dohnke-Hohrmann and Zimmer 2004 [-]) suggests that a biannual fluoride varnish programme can lead to a reduction in mean DMFT among 9 and 12 year old children in underprivileged communities with a high caries prevalence, however, the significance of this reduction was not reported. No data from similar communities is reported, which could be used to assess whether similar trends in caries prevalence occurred in communities that did not participate in the fluoride varnish programme. Due to limitations inherent in the study design and quality, the absence of data on secular trends and lack of reported statistical analysis, conclusions based on this study are limited.

Evidence Statement 8: Effectiveness of school based fluoride varnish interventions at preventing dental caries among primary and secondary school students

Moderate evidence from one RCT (Sweden[1]), two cluster RCTs (Germany[2], UK[3]) and one interrupted time series (Germany[4]) suggests that school based fluoride varnish programmes can be effective at preventing or reducing enamel caries amongst children in deprived or at risk communities, but are less effective amongst children in non-deprived or low risk areas.

One study[1] found that more frequent application schedules (once a month for 8 months during the school year) confers the largest benefit, with a prevented fraction of incident approximal caries in the permanent dentition of 76% across the general student population and 82% to 83% amongst students from low-medium income communities with no access to fluoridated water, but not effective amongst children from high income communities with access to fluoridated water[1].

Evidence regarding biannual school based fluoride application programmes was inconsistent, with one study[1] suggesting that such a programme is effective at reducing incident caries of the approximal surfaces in secondary school students

(prevented fraction 57%, significant at p<0.001)[1]. This study found differential effects of the biannual fluoride varnish schedule, with no significant impact seen amongst children from low risk communities, and a prevented fraction of 66% to 69% in low-medium income areas with no fluoridated water[1].

Two studies[2,3] found that biannual fluoride varnish application was not effective at reducing mean caries levels in the first permanent molars in an area with low caries prevalence (0.81 (SD 1.74) vs. 0.78 (SD 1.81); 95% CI and p-value NR) at reducing mean caries increment for more advanced lesions in the primary dentition (mean $d_3$fs increment difference: 0.01 (SE 0.18), 95% CI -0.34 to 0.37; mean $d_2$fs increment difference: 0.28 (SE 0.20); 95% CI -0.12 to 0.67)[3]. The third study[3] was effective at reducing the mean increment of $d_1$fs lesions (mean difference: 0.28 (SE 0.20); 95% CI -0.12 to 0.67, significant at p=0.03)[3].

The final study[4] found that four years after the addition of a biannual fluoride varnish programme to existing health promotion efforts, there was a 42% reduction in mean DMFT amongst nine year olds in an underprivileged community, and a 40.7% reduction in mean DMFT amongst 12 year olds, however, no significance tests were reported.[4]

[1] Moberg et al. 2005 [++]
[2] Splieth et al. 2011 [-]
[3] Hardman et al. 2007 [+]
[4] Dohnke-Hohrmann and Zimmer 2004 [-]

4.4.2 Programmes to improve access to fluoride: fluoridated milk

Two UK based observational studies were identified regarding the effectiveness of similar daily fluoridated milk programmes at nursery and primary schools:

- One prospective cohort study (Ketley et al. 2003 [+])
- One cross sectional study (Riley et al. 2005 [++])

Ketley et al. 2003 (Prospective cohort [+], UK [England], n=11 schools and 874 participants, NF)

Nursery and primary school students in areas of “substantial deprivation” in the UK received fluoridated milk at school five days per week, beginning in 1997. Compared to students from similar communities that did not participate, programme students at age 7 to 9 had a higher adjusted 4 year dmft increment (worse decay over time) in the primary molars (2.31 (SE 0.12) vs. 1.91 (SE 0.14); mean difference: 0.40, 95% CI 0.04 to 0.75; p-value not reported). The difference was not significant when assessed at the surface level (4.50 (SE 0.27) vs. 4.11 (SE 0.32), mean difference: 0.38, 95% CI -0.45 to 1.21; p-value not reported).

There was no significant difference between the two groups in terms of caries of the permanent molars at age 7 to 9 years at either the tooth or surface level:

- Mean DMFT – intervention: 0.40 (SD 0.85), comparator: 0.40 (SD 0.87), adjusted difference: 0.00; 95% CI -0.15 to 0.14; p-value not reported
- Mean DFS – intervention: 0.45 (1.12), comparator: 0.55 (1.35); mean difference: -0.10, 95% CI -0.30 to 0.11, p-value not reported).

Riley et al. 2005 (Cross sectional study [++], UK [England], n=42 schools and 2,825 participants, NF)

Children attending nursery and primary schools in an area of considerable deprivation participated in a school based fluoride milk programme. At age 12, children attending schools in a comparator community (which did not participate in the programme) had a significantly higher caries prevalence in the first permanent molars on a variety of measures:

- Mean (SD) DMFT – intervention: 1.01 (1.30), 95% CI 0.91 to 1.10, comparator: 1.46 (1.48), 95% CI 1.40 to 1.53; adjusted mean difference (SE): 0.49 (0.11), 95% CI 0.27 to 0.72, p<0.001
- Mean (SD) DT – intervention: 0.59 (0.98), 95% CI 0.51 to 0.66; comparator: 1.02 (1.24), 0.96 to 1.08; adjusted mean difference (SE): 0.43 (0.09) 95% CI 0.26 to 0.61, p<0.001

- Mean (SD) DFS – intervention: 1.20 (1.86); 95% CI 1.06 to 1.34; comparator: 1.89 (2.41); 95% CI 1.78 to 2.00; adjusted mean difference (SE): 0.74 (0.13), 95% CI 0.48 to 1.00, p<0.001).

Overall, children in the comaprator group were significantly more likely to have any caries (DMFT of first permanent molars >0) compared to children who had received fluoridated milk at school (intervention: 48% (44% to 52%), comparator: 61% (59% to 63%); adjusted OR: 1.71, 95% CI 1.32 to 2.23, p<0.001).

Summary and Evidence Statement

Inconsistent associations were seen between UK fluoride milk programmes and Ketley et al. 2003 [+] found no significant difference between programme and comparator schools on most caries outcomes of both the primary and permanent dentition, save for a significantly higher 4-year mean caries increment at the tooth level (dmft) in the primary molars among children aged 7 to 9 who had received fluoridated milk; the difference was non-significant at the surface level (dmfs). The study authors suggest that the lack of significant effect in the permanent dentition may be due in part to the low caries prevalence in the programme communities. Furthermore, both participating and non-participating students in the intervention schools were included in the analyses, which may have attenuated the results. Analysis of a similar programme by Riley et al. 2005 [++] found a significant reduction in caries at the tooth level (DMFT) and the surface level (DFS) in the first permanent molars at age 12 versus comparator schools.

The two programmes were similar in design; whether the differences in effectiveness of these programmes on caries of the permanent dentition are due to the age or other demographic characteristics of the participants, or implementation of the fluoridated milk scheme is difficult to determine based on the limited studies.

However, differences in programme implementation and design were described. Riley et al. 2005 [++] reported that there were few issues in enacting the supplemented milk programme, with high up take in programme schools, while Ketley et al. 2003 [+] reported that failures within the milk delivery system were

reported, but were unable to determine the precise level of disruption in the evaluated community. Furthermore, the duration of the fluoride milk programmes differed as well, with the scheme described in Riley et al. 2005 [++] providing fluoridated milk for seven years (up to age 11), while the children described in Ketley et al. 2003 were provided supplemented milk for four years. The inconsistent results between these two studies could therefore be due to these differences in programme duration or adherence.

Evidence Statement 9: Effectiveness of school based fluoride milk interventions at preventing dental caries among primary and secondary school students

Inconsistent evidence regarding the association between school based fluoride milk schemes and dental caries was identified from one cohort study (UK[1]) and one cross sectional study (UK[2]).

One study found that students aged 7 to 9 years who received fluoridated milk each day at school had worse oral health than children attending non-programme schools when assessed at the tooth level (adjusted mean difference in 4 year dmft increment: 0.40, 95% CI 0.04 to 0.75, p-value NR)[1]. The difference was not significant at the surface level, however (adjusted mean difference in 4 year dmfs increment: 0.38, 95% CI -0.45 to 1.21, p-value NR)[1]. The fluoride milk programme was not associated with differences in caries of the permanent molars at either the tooth or surface level (adjusted mean difference DMFT: 0.00, 95% CI -0.15 to 0.14, p-value NR; adjusted mean difference DFS: -0.10, 95% CI -0.30 to 0.11, p-value NR)[1].

The second study[2] found that a similar daily fluoride milk programme was associated with a lower caries prevalence of the first permanent molars of 12 year olds (adjusted mean difference DMFT [comparator vs. programme]: 0.49 (SE 0.11), 95% CI 0.27 to 0.72, p<0.001)[2]. This difference was significant at the surface level as well (adjusted mean difference DFS [comparator vs. programme]: 0.74 (0.13), 95% CI 0.48 to 1.00, p<0.001)[2]. Children in the comparator group were significantly more likely to have any caries of the first permanent molars compared to children who had

attended schools that provided fluoridated milk for seven years (adjusted OR: 1.71, 95% CI 1.32 to 2.23, p<0.001)[2].

[1] Ketley et al. 2003 [+]
[2] Riley et al. 2005 [++]

4.4.3 Programmes to improve access to fluoride: fluoride mouth rinse

Five studies were identified that assessed the impact of school based fluoride mouth rinse programmes on the oral health of children and young people in primary or secondary school children:

- One cluster RCT (Moberg et al. 2005b [+])
- One prospective cohort study (Kaneko et al. 2006 [+])
- Three cross sectional studies (Neko-Uwagawa et al. 2011 [-], Levin et al. 2009 [+], Komiyama et al. 2012 [+])

Moberg et al. 2005b (cluster RCT [+], Sweden, n=NR classes and 788 participants, NF)

School based, dental nurse supervised fluoride mouth rinse programmes were introduced in five secondary schools in an area of low to moderate caries risk (based on moderate to high socioeconomic status) in Sweden. The programmes varied in the frequency and timing of their rinsing schedules, and lasted for three years. Students rinsed for one minute per session on varying schedules:

- Group 1 rinsed the first three schooldays of each semester, 6 times per year for a total of 18 rinses in 3 years;
- Group 2 rinsed the first and last three schooldays per semester, 12 times a year for a total of 36 times in 3 years;
- Group 3 rinsed on 3 consecutive days once per month during the school year, 27 rinses a year for a total of 81 rinses in 3 years;
- Group 4 rinsed fortnightly during the schoolyear, 20 rinses per year for 60 rinses in 3 years;

- Group 5 served as the comparator group, and did not participate in the rinsing programme.

All students continued to receive standard care (attending dental clinics for regular check-ups, and receiving prophylactic treatment depending on their individual caries risk).

The low fluoride dose regimen (Group 1) had no significant difference in mean approximal caries incidence versus the comparator group (mean incidence (SD): 1.12 (2.10) vs. 1.59 (2.61), 95% CI and p-value not reported).

The higher dose regimens (groups 2, 3 and 4) all saw significant reductions in mean approximal surface caries incidence versus the non-rinsing comparator group:

- Group 2: 0.65 (1.57); 95% CI NR, p<0.01, prevented fraction 59%
- Group 3: 0.84 (1.62); 95% CI NR, p<0.01, prevented fraction 47%
- Group 4: 0.94 (1.81); 95% CI NR, p<0.01, prevented fraction 41%

There was, however, no difference in caries approximal caries incidence between the three higher dose groups.

Subgroup analysis by baseline caries status revealed that the FMR programmes were effective at reducing approximal caries incidence amongst those with any lesions at age 13, but resulted in no significant difference amongst students who were caries free at the start of the study:

- Baseline caries >0 – Groups 1-4 pooled:1.47 (2.11) vs. Group 5: 2.46 (2.93); 95% CI NR, p<0.01
- Baseline caries=0 – Groups 1-4 pooled: 0.38 (1.24) vs. Group 5: 0.67 (1.85); reported as NS, 95% CI and p-value NR

Among students with enamel lesions at baseline, there was no significant difference in caries progression among those participating in the rinsing programmes and the non-rinsing comparator group (groups 1-4 pooled: 0.16 (0.79) vs. group 5: 0.27 (0.71); non-significant, 95% CI and p-value not reported).

Kaneko et al. 2006 (Prospective cohort [+], Japan, n=215, NF)

A teacher supervised daily fluoride mouth rinse (FMR) plus standard care was carried out among nursery school students for two years (aged 5-6 years) and continued among elementary school students (from age 7). Oral health outcomes were compared to a comprehensive standard oral health education programme, which included yearly dental health education from a dental hygienist, routine education regarding tooth brushing instructions and advice to limit sweets consumption from the school nurse, teachers and school dentist.

There was a significant reduction in DFT at age 9 to 10 (mean DFT intervention: 0.12 (0.43), comparator: 1.67 (1.69); 95% CI not reported; p<0.001). Programme students also had a significantly lower mean DFT increment over one year (intervention: 0.05 (0.36), comparator: 0.59 (1.21); 95% CI not reported; p<0.001).

Neko-Uwagawa et al. 2011 (cross sectional study [-], Japan, n=637, NF)

The study assessed the long term effects of a fluoride mouth rinsing programme among women aged 20 years or older residing in cities, towns and villages in the Niigata Prefecture. The oral health status was compared among three groups:

- Group 1 – women who had participated in 11 years of a school based daily fluoride mouth rinse (FMR) programme from nursery school through junior high school.
- Group 2 – women who had participated in a school based FMR programme during elementary school only (duration not reported)
- Group 3 – women who had not participated in the school based FMR programme as children.

Participation in the daily FMR programme throughout school (Group 1) was associated with significantly better oral health when compared to the non-rinsing comparator group. This association was seen across multiple age groups and outcomes:

- Mean (SD) DMFT among 20 to 29 year olds (Group 1: 3.2 (3.1), Group 3: 9.3 (5.2); 95% CI NR, p<0.001)
- Mean DMFT (SD) among 30 to 39 year olds (Group 1: 4.6 (6.4), Group 3: 11.4 (5.3); 95% CI NR, p<0.001)
- Prevalence (%) DMFT among 20 to 29 year olds (Group 1: 76.9%, Group 3: 96.8%; 95% CI NR, p<0.05)
- Prevalence (%) DMFT among 30 to 39 year olds (Group 1: 77.8%, Group 3: 98.3%; 95% CI NR, p<0.05)

There was, however, no significant differences in oral health outcomes among women who had participated in the FMR programme for elementary school only:

- Mean (SD) DMFT among 20 to 29 year olds (Group 2: 7.3 (4.9), Group 3: 9.3 (5.2); 95% CI NR, p>0.05)
- Mean DMFT (SD) among 30 to 39 year olds (Group 2: 8.8 (5.5), Group 3: 11.4 (5.3); 95% CI NR, p>0.05
- Prevalence (%) DMFT among 20 to 29 year olds (Group 2: 93.5%, Group 3: 96.8%; 95% CI NR, p>0.05)
- Prevalence (%) DMFT among 30 to 39 year olds (Group 2: 100%, Group 3: 98.3%; 95% CI NR, p>0.05)

Levin et al. 2009 (Cross sectional study [+], UK [Scotland], n=1,333, NF)

A school based fluoride mouth rinsing programme in state run primary schools involved fortnightly supervised rinsing for children aged 6 to 11 rinse. The programme was targeted at schools with higher prevalence of D_3MFT, and started in 1967. Tooth decay status (D_3MFT) was compared between children aged 11 who had participated in the FMR programme, and those who had no recorded parental consent to take part. Children were from the full range of Carstairs Deprivation Categories, DepCat 1 (most affluent) to 7 (most deprived).

Over the whole population, there was no significant difference in the proportion of caries free children between rinsers and non-rinsers. When stratified by deprivation

category, only rinsers in the least deprived category were significantly more likely to be caries free compared to their non-rinsing peers (95% CIs not reported):

- DepCat 1 (least deprived) – rinsers: 81%, non-rinsers: 59%; p=0.048
- DepCat 2 – rinsers: 76%, non-rinsers: 70%; p=0.530
- DepCat 3 – rinsers: 60%, non-rinsers: 49%; p=0.070
- DepCat 4 – rinsers: 49%, non-rinsers: 55%; p=0.192
- DepCat 5 – rinsers: 49%, non-rinsers: 49%; p=0.978
- DepCat 6 – rinsers: 53%, non-rinsers: 55%; p=0.864
- DepCat 7 – rinsers: 31%, non-rinsers: 33%; p=0.846
- Total – rinsers: 52%, non-rinsers: 57%; p=0.077

Similar results were seen in terms of mean D_3MFT. Across the general population of 11 year olds, there was no significant difference in mean tooth decay between rinsers and non-rinsers. When stratified by deprivation category, only rinsers in the least deprived categories had significantly different mean D_3MFT scores compared to their non-rinsing peers (95% CIs NR for comparisons):

- DepCat 1 – rinsers: 0.33 (-0.02 to 0.69), non-rinsers: 0.83 (0.55 to 1.11); p=0.036
- DepCat 2 – rinsers: 0.43 (0.05 to 0.81), non-rinsers: 0.66 (0.50 to 0.83); p=0.269
- DepCat 3 – rinsers: 0.69 (0.49 to 0.90), non-rinsers: 1.38 (1.11 to 1.65); p=0.000
- DepCat 4 – rinsers: 1.32 (1.15 to 1.49), non-rinsers: 1.42 (1.02 to 1.82); p=0.633
- DepCat 5 – rinsers: 1.14 (0.87 to 1.42), non-rinsers: 1.31 (0.98 to 1.63); p=0.458
- DepCat 6 – rinsers: 1.13 (0.84 to 1.42), non-rinsers: 1.00 (0.52 to 1.48); p=0.648
- DepCat 7 – rinsers: 2.16 (1.50 to 2.81), non-rinsers: 2.47 (1.45 to 3.49); p=0.618
- Total – rinsers: 1.17 (1.06 to 1.28), non-rinsers: 1.17 (1.04 to 1.30); p=0.997

A multivariable logistic regression found that participation in the rinsing programme was associated with significantly lower odds of having any D_3MFT, while older age and higher deprivation category (compared to the least deprived category), were significantly associated with increased odds of decay:

- Rinsing: OR 0.79, 95% CI 0.65 to 0.96

- Age: OR 1.31, 95% CI 1.04 to 1.65
- DepCat 3 (vs. DepCat 1): OR 1.58, 95% CI 1.03 to 2.40
- DepCat 4 (vs. DepCat 1): OR 2.08, 95% CI 1.39 to 3.11
- DepCat 5 (vs. DepCat 1): OR 1.68, 95% CI 1.08 to 2.60
- DepCat 7 (vs. DepCat 1): OR 3.11, 95% CI 1.84 to 5.26

The other factors included in the model did not have a significant impact (gender, DepCat 2 and 6), and the regression analysis found no significant interaction between the effects of rinsing and deprivation i.e. its effects do not vary in individuals of different DepCat levels.

Komiyama et al. 2012 (Cross sectional study [+], Japan, n=881, NF)

Ten elementary schools participated in a weekly six year school based fluoride mouth rinse (FMR) programme. Nine elementary schools introduced the FMR programme during the 2005 school year; children who had attended these schools were exposed to FMR for less than one year (the last year of elementary school), and were included as the comparator group. During the first year of junior high school, six years of FMR exposure was associated with better oral health on multiple measures:

- Proportion with DMFT – FMR: 46.1%, comparator: 64.9%; 95% CI NR, $p<0.05$.
- Mean (SD) DMFT – FMR : 1.28 (NR), comparator: 2.02 (NR); 95% CI NR, $p<0.05$
- Mean (SD) DMFS – FMR: 2.05 (NR), comparator: 3.69 (NR); 95% CI NR, $p<0.05$

Summary and Evidence Statement

These studies varied not only in their design and quality, but also in their population and programme characteristics. While all studies assessed decay outcomes in the permanent dentition and were conducted in communities with no exposure to fluoridated water, the participants' age at assessment varied from 10 years in Neko-Uwagawa et al. 2011 [-], 11 years in Levin et al. 2009 [+], 12 years in Komiyama et al. 2012 [+], 16 years in Moberg et al. 2005b [+] and 20 to 39 years in Kaneko et al. 2006 [+].

The frequency and duration of exposure to the FMR programmes varied across the studies as well:

- Moberg et al. 2005b [+] included four different rinsing schedules during a 3 year programme (3 days at the semesters' start for 6 times/year, 3 days at the start and end of each semester for 12 times/year, 3 days at the start of each month for 27 times per year, fortnightly for 20 times/year)
- Kaneko et al. 2006 [+] and Neko-Uwagawa et al. 2011 [-] included daily rinsing, the former programme lasted for five years and the latter for up to 11 years
- Komiyama et al. 2012 [+] included a weekly rinsing programme lasting six years
- Levin et al. 2009 [+] described a fortnightly programme for children aged 6 to 11 (rinsers had five years of fluoride exposure through the FMR programme)

Overall, school based fluoride mouth rinse programmes were associated with significant reductions in caries of the permanent dentition. The impact on oral health inequalities was inconsistent, however. The results of two studies have implications for inequalities:

All participants in Moberg et al. 2005b [++] were from areas considered to have 'low to medium caries risk', a subgroup analysis by baseline caries score (caries free or approximal caries>0) was conducted as a proxy for individual risk. This analysis pooled the results from all four FMR schedules, and found that the programme was effective at reducing the caries incidence amongst students with any lesions at baseline, but that there was no significant effect amongst students who were caries free at age 13. This suggests that supervised FMR programmes may be effective at preventing caries among students at higher risk for dental decay, but not among those at lower risk (based on their caries prevalence at age 13), and thus could reduce oral health inequalities.

Results from Levin et al. 2001 [-] suggest that across the general population of 11 year olds, there was no significant difference in mean tooth decay between rinsers and non-rinsers. When stratified by deprivation category, only rinsers in the least deprived categories were significantly more likely to be caries free compared to their non-rinsing peers. This differential effect may be due to reduced uptake of the FMR

programme across Deprivation Categories, with the lowest uptake seen in DepCat 7 (80% uptake).

Evidence Statement 10: Effectiveness of school based fluoride mouth rinse interventions at preventing dental caries among primary and secondary school students

Moderate evidence from one cluster RCT (Sweden[1]), one cohort study (Japan[2]) and three cross sectional studies (1 UK[4], 2 Japan[3,5]) suggests that school based fluoride mouth rinse (FMR) programmes can be effective at preventing or reducing dental decay of the permanent dentition amongst school aged children living in communities with no exposure to fluoridated water.

One study[1] found that regular rinsing throughout the school year is effective at reducing incident approximal caries amongst secondary school students, with a prevented fraction of 41% to 59%[1] depending on rinsing schedule. This effect varied according to baseline caries status, with students presenting with approximal caries at age 13 (mean incidence 1.47 (SD 2.11) vs. 2.46 (SD 2.93); 95% CI NR, $p<0.01$)[1], but had no significant effect amongst children who were caries free at that age (mean incidence 0.38 (SD 1.24) vs. 0.67 (SD 1.85); reported as NS, 95% CI and p-value NR)[1].

Another study[2] found that daily fluoride rinsing for five years was associated with a significantly lower one year mean DFT increment (0.05 (SD 0.36) vs. 0.59 (SD 1.21); 95% CI not reported, $p<0.001$)[2] and significantly lower mean DFT at age 9 to 10 years (0.12 (SD 0.43) vs. 1.67 (SD 1.69); 95% CI not reported, $p<0.001$)[2].

Another study[3] found that participation in a school based, daily FMR programme from nursery through junior high school (eleven years duration) was associated with long term reductions in caries prevalence and average caries amongst females in two age groups (aged between 20 and 29 years, compared to the control group: prevalence 76.9% vs. 96.8%, 95% CI NR, $p<0.05$; mean (SD) DMFT 3.2 (3.1) vs. 9.3 (5.2); 95% CI NR, $p<0.001$. Aged 30 to 39 years: prevalence 77.8% vs. 98.3%, 95% CI NR, $p<0.05$; mean (SD DMFT 4.6 (6.4) vs. 11.4 (5.3); 95% CI NR, $p<0.001$)[3].

Participating during elementary school only (shorter FMR programme duration) was not associated with long term reductions in DMFT prevalence or average decay in either age group (aged 20 to 29 years: 93.5% vs. 96.8%, 95% CI NR, p>0.05; mean (SD) DMFT 7.3 (4.9) vs. 9.3 (5.2); 95% CI NR, p>0.05. Aged 30 to 39 years: 100% vs. 98.3%, 95% CI NR, p>0.05; mean (SD) DMFT 8.8 (5.5) vs. 11.4 (5.3); 95% CI NR, p>0.05)[3.]

Another study[4] found that participation in a fortnightly FMR programme for five years was associated with significantly reduced likelihood of tooth decay (D_3MFT>0: OR 0.79, 95% CI 0.65 to 0.96)[4]; but found no significant association with average decay overall (mean D_3MFT: 1.17 (95% CI 1.06 to 1.28) vs. 1.17 (95% CI 1.04 to 1.30); p=0.997)[4], or amongst the most deprived students (mean D_3MFT DepCat 7: 2.16 (95% CI 1.50 to 2.81) vs. 2.47 (95% CI 1.45 to 3.49); p=0.618)[4], but was associated with a significant reduction in average caries levels amongst the least deprived children (mean D_3MFT DepCat 1: 0.33 (95% CI -0.02 to 0.69) vs. 0.83 (95% CI 0.55 to 1.11); p=0.036)[4].

The final study[5] reported that a weekly FMR programme delivered for six years was associated with a significantly lower caries prevalence at age 12 (DMFT 46.1% vs. 64.9%, 95% CI NR, p<0.05)[5] as well as with lower mean caries at both the tooth and surface level (mean (SD) DMFT: 1.28 (NR) vs. 2.02 (NR); 95% CI NR, p<0.05. DMFS: 2.05 (NR) vs. 3.69 (NR); 95% CI NR, p<0.05)[5].

[1] Moberg et al. 2005b [+]
[2] Kaneko et al. 2006 [+]
[3] Neko-Uwagawa et al. 2011 [-]
[4] Levin et al. 2009 [+]
[5] Komiyama et al. 2012 [+]

4.4.4 Supervised toothbrushing with fluoride toothpaste

Four studies were identified that assessed the effectiveness of school based programmes that combine oral hygiene and fluoride interventions (e.g. supervised toothbrushing with fluoride toothpaste):

- Four cluster RCTs (Jackson et al. 2005 [+], Pine et al. 2007 [+], Burnett et al. 2005 [-], Wind et al. 2005 [-])

Jackson et al. 2005 (Cluster RCT [+], UK [England], n=NR schools and 517 participants, NF)

Children in their first year of primary school in Kensington, Chelsea and Westminster, London, UK were allocated by school to a school based, teacher supervised daily toothbrushing (with 1,450ppm fluoride toothpaste) programme or a comparator group which received no supervised tooth brushing. School catchment areas served neighbourhoods of social deprivation, however, no measures were reported.

Dental caries (dmfs and DMFS) were measured by visual assessment only using BASCD criteria and a portable lamp for illumination. After adjusting for baseline caries differences, the mean caries increment (dmfs and DMFS) over 21 months was:

- 10.9% lower in the intervention than the comparator group (intervention: 2.60 (1.84 to 3.36), comparator: 2.92 (2.18 to 3.66); difference: 0.32 (10.9% difference or prevented fraction); 95% CI NR, p<0.001).
- This total difference was accounted for by significant reductions in the deciduous teeth (dmfs) (intervention: 2.43 (1.67 to 3.20), comparator: 2.76 (2.02 to 3.51), difference: 0.33 (% NR); 95% CI NR, p<0.001).
- There was no difference in adjusted DMFS increment (intervention: 0.16 (0.04 to 0.27), comparator: 0.15 (0.04 to 0.26, difference: reported as not significant; 95% CI and p-value NR).

When considered by specific surface, there was:

- A significant difference in adjusted dmfs and DMFS increment of the proximal surfaces (intervention: 0.78 (0.45 to 1.11), comparator: 1.03 (0.71 to 1.34), difference: NR, 95% CI NR; p<0.01)

- No significant difference in caries increment of the occlusal surfaces (intervention: 1.11 (0.91 to 1.31), comparator: 1.03 (0.83 to 1.23); difference, 95% CI and p-value NR)
- No significant difference in caries increment of the smooth surfaces (intervention: 0.73 (0.37 to 1.09), comparator: 0.83 (0.48 to 1.18); difference, 95% CI and p-value NR).

In a subgroup analysis including only those children who had caries at baseline, there was a significant difference in:

- Total adjusted caries increment (dmfs and DMFS intervention: 3.30 (2.17 to 4.44), comparator: 4.58 (3.35 to 5.82), difference: 1.39 (30.0%); 95% CI NR; p<0.001)
- Proximal surface caries increment (intervention: 0.99 (0.49 to 1.48), comparator: 1.59 (1.05 to 2.12), difference: 0.60 (37.7%); 95% CI NR; p<0.01)
- Smooth surface caries increment (intervention: 0.98 (0.42 to 1.55), comparator: 1.47 (0.86 to 2.08), difference: 0.49 (33.3%); 95% CI NR; p=0.001).

There was no significant difference in caries increment of the occlusal surfaces of either the primary or permanent dentition (intervention: 1.37 (1.11 to 1.62), comparator: 1.49 (1.22 to 1.76), difference: NS; 95% CI and p-value NR).

Pine et al. 2007 (Cluster RCT [+], UK [England], n=24 classes (12 schools) and 595 participants, FNR)

Children in their first year of primary school from a "relatively deprived area" (no additional information reported) in Tayside participated in a school based daily supervised tooth brushing programme with 1,000ppm fluoridated toothpaste. At the beginning of school holidays a home support programme also advised parents on twice daily tooth brushing, and provided a toothbrush, toothpaste and a brushing chart to track twice daily brushing. Overall, the programme lasted for 30 months.

Enamel and dentine level caries (D_1FS and D_3FS) of first permanent molars was assessed visually during a school based clinical examination, with approximal and occlusal surfaces examined with fibre optic transillumination as well.

Compared to children in comparator classes in the same school, between baseline and 84 months follow-up, intervention children had:

- A 30% reduction in enamel lesions (D_1FS increment) of the first permanent molars (intervention: 2.75 (2.80), comparator: 3.95 (3.78); difference: 30%, 95% CI NR; p=0.001).
- A greater reduction in more severe caries, displaying a 39% reduction in dentine caries (D_3FS increment) of the first permanent molars versus the comparator group (intervention: 1.62 (2.51), comparator: 2.65 (3.62); difference: 39%, 95% CI NR; p=0.002).

Burnett et al. 2005 (Cluster RCT [-], Australia, n=NR schools and 803 participants, NF)

Year 1 children attending schools in the Bayside District, Queensland, Australia participated in a school based, teacher supervised daily tooth brushing programme using low dose fluoride toothpaste (concentration not reported) for three years. Approximately 30% of the participants included in the analysis (completers) were considered disadvantaged based on their families having health care card (HCC) access). Caries prevalence (method of assessment not reported) was grouped into three categories:

- 0 $d_3$mfs/D_3MFS (caries free)
- 1 to 4 $d_3$mfs/D_3MFS
- ≥5 $d_3$mfs/D_3MFS

At the beginning of the study, 53% of the toothbrushing group and 54% of the comparator group were caries free. At the end of the intervention these figures were 32% for the intervention and 34% for the comparator group. At baseline 19% of the intervention group and 21% of the comparator group were found to have between 1 and 4 $d_3$mfs/D_3MFS; at the end of the intervention these percentages were 30% intervention and 29% comparator.

In terms of proportion of children with five or more d_3mfs/D_3MFS, 28% of the intervention group and 25% of the comparator group were classified as such at baseline, increasing to 38% of intervention and 36% comparator at the end of the study.

For all three measures of severe caries prevalence in the deciduous or permanent dentition, this was reported as neither clinically nor significantly different between intervention and comparator groups (95% CIs and p-values not reported).

There was no significant difference in the odds of d_3mfs/D_3MFS between the intervention and comparator groups (OR 1.05 (0.82 to 1.35); p=0.687). These ORs were adjusted for father's education and frequency of adult brushing.

When assessing caries incidence in permanent teeth (the proportion of children in whom a sound surface at baseline becomes cavitated over the course of the study), there was no significant difference between the intervention and comparator group (intervention: 7%, comparator: 10%; 95% CI NR, p=0.256).

A subgroup analysis according to social disadvantage found that 40% of disadvantaged intervention children experienced five or more severe caries over the course of the study (95% CI 30% to 50%), while 34% of the comparator group (95% CI 23% to 45%) experienced the same level of severe caries; this difference was not significant (95% CI NR; p=0.293).

Wind et al. 2005 (Cluster RCT [-], The Netherlands, n=7 schools and 296 participants, FNR)

Children between the ages of 7 and 10 years attending elementary schools in the Netherlands in May 1998 participated in a daily school based supervised tooth brushing (use of fluoridated toothpaste not reported), at the same time each day, for 3 years. Compared to children who received no intervention, there was no significant difference in mean daily tooth brushing at home and at school at baseline, assessed via parent completed questionnaire, with higher scores indicating more frequent brushing (intervention: 2.21 (0.57), comparator: 2.14 (0.64), 95% CI NR; p=0.32). However, children in intervention schools brushed significantly more frequently 1.5

years after the programme's start (intervention: 2.85 (0.62), comparator: 1.91 (0.53), 95% CI NR; p<0.001) and immediately post-intervention (intervention: 2.80 (0.58), comparator: 1.91 (0.55), 95% CI NR; p<0.001). The difference was lost by 1 year post-intervention, however (intervention: 2.02 (0.71), comparator: 2.00 (0.67), 95% CI NR; p=0.45).

Attitudes towards tooth brushing were assessed via student completed questionnaire, with lower scores indicating poorer attitudes. At 1 year post-intervention there was no significant difference in toothbrushing attitudes between the groups (intervention: 6.02 (4.47), comparator: 6.49 (4.00), 95% CI NR; p=0.59).

Summary and Evidence Statement

Overall, in areas with non-fluoridated water, daily supervised toothbrushing with 1,000ppm (Pine et al. 2007 [+]) to 1,450ppm (Jackson et al. 2005 [+]) fluoride toothpaste was found to be effective at improving the oral health of children with no access to fluoridated water. These two studies found reductions of 10.9% overall, and 30.0% to 39.0% amongst children at increased caries risk (i.e. those with caries at baseline or from relatively deprived communities).

Burnett et al. 2005 [-] found that a supervised toothbrushing with low fluoride toothpaste (ppm not reported) was ineffective at reducing severe caries in either the general school aged population or the disadvantaged children with no access to fluoridated water.

Differences in the effect of supervised toothbrushing programmes on dentine caries in primary school children may be accounted for by differences across the studies in terms of:

- Fluoride dose of the toothpaste: Jackson et al. 2005 [+] used 1,450ppm, Pine et al. 2007 [+] used 1,000ppm while Burnett et al. 2005 [-] reported using low fluoride toothpaste without specifying the dose.
- Brushing duration and setting: while all three programmes were school based daily brushing, Pine et al. 2007 [+] provided a toothbrush, fluoride toothpaste and a brushing tracking chart in order to encourage continued brushing at home during

school holidays. Jackson et al. 2005 [+] and Burnett et al. 2005 [-] did not report providing supplies so that the programme could be continued over holidays.

- Teeth assessed in outcome measurements: Jackson et al. 2005 [+] and Burnett et al. 2005 [-] assessed all teeth, while Pine et al. 2007 [+] included only the first permanent molars.

Oral hygiene behaviours and attitudes

One study (Wind et al. 2005 [-]) assessed the effect of a daily supervised tooth brushing programme (fluoride status of toothpaste not reported) on oral hygiene behaviours, and found that children in the intervention group brushed more frequently each day than those in the comparator group during the intervention and immediately post-intervention, but that habits were similar one year later.

No other studies assessed the impact of school based supervised toothbrushing programmes on student oral hygiene behaviours or attitudes.

Evidence Statement 11: The effect of school based daily supervised tooth brushing on the oral health and hygiene of primary school children

There is moderate evidence from three cluster RCTs (2 UK[1,2] and 1 Australia[3]) to suggest that daily, school based, teacher supervised tooth brushing with 1,000 to 1,450ppm fluoride toothpaste may reduce dental decay among primary school children and weak evidence from one cluster RCT (The Netherlands[4]) to suggest that such programmes may improve oral hygiene in the short but not long term.

One study[1] using 1,450ppm fluoride toothpaste showed an overall reduction in incident dmfs/DMFS: mean difference -0.32, 10.9% reduction (95% CI NR, $p<0.001$)[1]. When disaggregated by dentition type, the reduced incidence was significant only in deciduous teeth (mean difference 0.33, % reduction NR); 95% CI NR, $p<0.001$)[1] while no significant difference was seen in the permanent dentition (reported as non-significant, values NR)[1]. A greater effect was seen amongst children with caries at baseline (mean difference -1.39 (-30.0%); 95% CI NR; $p<0.001$)[1].

Another study[2] using 1,000ppm fluoride toothpaste found a reduction in D_3FS of the first permanent molars by 39% (95% CI NR; p=0.002)[2] among children in a relatively deprived area.

Another study[3] found that daily supervised tooth brushing with a low fluoride toothpaste (specific content not reported) had no significant effect on 3 year caries incidence (D_3MFS) in teeth that were caries free at age 5 (difference and 95% CI NR, p=0.256)[3].

One study[4] found significant improvements in mean brushing frequency during the course of the programme and immediately thereafter (effect size and 95% CI NR; p<0.001)[4], but this effect was not maintained one year after the end of the programme (effect size and 95% CI NR; p=0.45)[4]. The intervention had no effect on attitudes towards toothbrushing (one year effect size and 95% CI NR; p=0.59)[4].

[1] Jackson et al. 2005 [+]
[2] Pine et al. 2007 [+]
[3] Burnett et al. 2005 [-]
[4] Wind et al. 2005 [-]

4.4.5 Multi-component oral health promotion interventions

Three studies were identified that assessed the effectiveness of multi-component school based oral health promotion and prevention programmes:

- One prospective cohort study (Niederman et al. 2008 [-])
- Two before & after studies (Bodner and Pulos 2010 [++], Axelsson et al. 2005 [-])

Niederman et al. 2008 (Cohort study [-], USA, n=6 schools and 635 participants, WF and NF)

Students in grades 1 through 3 attending rural, suburban and urban elementary schools in Massachusetts with a high proportion of low-income children (86.4% participated in Federal Free and Reduce Cost Meals Programme, eligibility requirements at or below 185% of the Federal Poverty Line) received a school based

oral health intervention. Children who provided informed consent received oral examinations at six month intervals. Based on the results of these examinations, dental hygienists provided preventive services twice per year, which included prophylaxis and oral hygiene instruction, provision of toothbrushes and fluoride toothpaste, placement of glass ionomer sealants and temporary restorations in carious teeth, and fluoride varnish. Written reports of the examination and treatment were sent home to parents, and referral letters to local collaborating dentists or community health centres were provided.

Dental caries incidence (proportion of new dfs or DFS accounting for lesion reversals) was measured as the number of decayed or filled primary or permanent teeth as a proportion of total primary or permanent teeth and assessed by a dentist using visual tactile methods (dry field and explorer). Outcomes were compared to children from the same schools who were eligible for but missed the preventive intervention appointment.

Participation in the programme was associated with a 25.4% reduction in incident caries of all surfaces of the primary teeth and a 53.2% reduction of all surfaces of the permanent teeth; see Table 11 for surface specific results.

Table 3: Incident caries at the surface level of the primary and permanent dentition, as a percent of total surfaces

Outcome	Intervention	Comparator	Difference p-value,	OR (95%CI)
Incident dfs, %	30.3%	40.6%	-25.4%, p=0.001	2.00 (1.31 to 3.06)
Occlusal, %	25.3%	39.5%	-35.9% p=0.0001	2.46 (1.58 to 3.82)
Proximal %	25.3%	32.7%	-22.6%, p=0.003	1.96 (1.25 to 3.08)
Smooth, %	18.6%	24.3%	-23.5%, p=0.03	1.71 (1.04 to 2.78)
Incident DFS, %	14.4%	30.8%	-53.2%, p=0.0008	2.20 (1.38 to 3.48)
Occlusal, %	11.3%	29.3%	-61.4%, p<0.0001	2.78 (1.70 to 4.56)
Proximal %	2.5%	7.7%	-67.5%, p=0.08	2.24 (0.92 to 5.48)
Smooth, %	8.8%	18.8%	-53.2%, p=0.004	2.27 (1.29 to 3.99)

Bodner and Pulos, 2010 (Before and after study [++], USA, n=5,808, FNR)

Second and fourth grade students attending public elementary schools in Pierce County, Washington, USA during the 2006/07 to 2008/09 school years participated in a school based oral health programme. Based on receipt of Free or Reduced Price Meals (185% of the Federal Poverty Line), 18.0% to 93.1% of students in selected schools were considered low-income.

Dental hygienists and assistants conducted oral health exams and determined caries and sealant status with a penlight and dental mirror, and children were referred to local dentists and community clinics for further examination or treatment if indicated by the exam. Second grade students with one or more fully erupted first molars without a sealant, decay or filling were eligible school based preventive treatment, consisting of fluoride releasing pit and fissure sealants. All second grade students were eligible for fluoride varnish application. Dental decay (DMFT) of first permanent molars (calculated as % of fully erupted first permanent molars with decay), history of decay in the primary and permanent teeth, untreated and treated caries were compared before and after the programme implementation. Measurements for 2006/07 were taken before the provision of any interventions, and served as the comparator group.

Among all second grade students in 2008/09 (who were eligible to receive referrals, fluoride varnish and pit and fissure sealants) had significantly higher proportion of erupted permanent molars with decay compared to second grade students from 2006/07.

See Table 12 for details on oral health and treatment outcomes in both age groups.

Table 4: Mean % molars dmft/DMFT and decay prevalence amongst 2nd and 4th grade students

	Before	After	Adjusted difference (95% CI)	Adjusted PR (95% CI)
2nd graders				
DMFT first molars, % teeth	7.9%	10.81%	3.02 (1.24 to 4.80)‡	-
History of dmft, % participants	56.96%	59.48%	-	1.04 (0.98 to 1.10)
History of DMFT, % participants	11.94%	16.20%	-	1.37 (1.14 to 1.63)‡
Untreated caries, % participants	22.10%	26.10%	-	1.18 (1.04 to 1.34)‡
Treated caries, % participants	46.93%	49.38%	-	1.04 (0.97 to 1.12)‡
4th graders				
DMFT first molars, % teeth	12.80%	14.80%	2.46 (0.21 to 4.72)‡	-
History of dmft, % participants	50.9%	50.3%	-	0.96 (0.90 to 1.04)
History of DMFT, % participants	22.3%	27.4%	-	1.23 (1.08 to 1.40)‡
Untreated caries, % participants	18.10%	20.31%	-	1.12 (0.96 to 1.30)
Treated caries, % participants	50.7%	49.3%	-	0.96 (0.89 to 1.03)
‡ Significant at p<0.05; PR prevalence ratio				

Axelsson et al. 2005 (Before and after study [-], Sweden, n=NR, NF)

Prophy-dental clinics (prophylaxis clinics) were gradually introduced into elementary schools in Varmland county Sweden in 1975. Dental hygienists or dental assistants provided individualised, needs-related preventative dentistry in 1979. Programme contents varied according with age, with the programme targeting children aged 5.5 to 7.5 years focusing on the maintaining of caries free fissures of the first permanent molars. Emphasis was placed on twice daily brushing by parents using a special technique and fluoride toothpaste. At risk children received supplemental professional mechanical tooth cleaning (PMTC), use of fluoride and chlorhexidine varnishes and fissure sealants.

Children aged 8 to 11.5 years were considered a low risk group and received education regarding daily teeth cleaning from dental assistants and hygienists in

school based prevention clinics. Ten percent of children were selected as high risk at received supplemental caries prevention treatment from a professional.

From the age of 12 to 14 years children were considered to be at high risk and received hygienist and assistant led lessons on preventative dentistry and self-care education regarding cleaning fissures of second molars and use of fluoride dentifrice. High risk students were taught to clean teeth before each meal and use fluoride chewing gum after each meal. High risk students were offered supplementary caries preventive measures (PMTC, topical fluoride varnish, chlorhexidine varnish, fissure sealants) provided by dental hygienists or assistants.

The oldest age group, those between 15 and 19 years old, were considered a low risk group, and attention focused on maintaining oral hygiene as third molars emerge, as well as on a healthy lifestyle (e.g. dietary habits).

After 20 years, the effects of the programme were compared using descriptive statistics (no statistical analysis) to a group that received no intervention (the precise nature of caries prevention efforts before programme introduction not reported).

Summary and Evidence Statement

One cohort study (Niederman et al. 2008 [-]) and two before and after studies (Bodner and Pulos 2010 [++], Axelsson et al. 2005 [-]) assessed the impact of multi-component school based oral health programmes

All three school based programmes involved an oral health education or promotion component, and children were eligible to receive prophylactic interventions if required (e.g. fluoride varnish, pit and fissure sealants). The ages children in the studies were similar: Niederman et al. 2008 [-] included first through third grade students, Bodner and Pulos 2010 [++] enrolled second and fourth graders and Axelsson et al. 2005 [-] reported results for 7 year old children.

The Niederman et al. 2008 [-] and Bodner and Pulos 2010 [++] studies were conducted in mixed SES populations, with approximately 85% of the Niederman cohort and between 18% and 93% (depending on the school) of the Bodner and Pulos groups being considered from families of low SES (annual income <185% of

the US Federal Poverty Line). Socioeconomic status was not reported in Axelsson et al. 2005 [-].

Comparator groups varied considerably across the studies. Niederman et al. 2008 [-] included eligible children who did not receive treatment due to programme design (phased programme introduction) or who missed their preventive intervention appointment as the comparator group, a selection that may have introduced considerable bias as it led to a comparator group that was older than the intervention group.

Bodner and Pulos 2010 [++] and Axelsson et al. 2005 [-] both included historical cohorts as the comparator group. The former study covered a three year period, while the latter study covered 20 years, and did not describe or account for any secular trends in dental decay over the considerable follow-up period. A widespread weekly or fortnightly fluoride mouth rinse programme was recommended nationally during the period covered by the study; this likely affected the oral health status of school children above the school based prophylactic intervention described by the study.

Inconsistent results were seen across the trials. One trial (Niederman et al. 2008 [-]) found that the programme was associated with lower likelihood of incident caries. Bodner and Pulos, 2010 [++] found no significant difference in caries prevalence of the primary dentition, and a significant worsening of caries in the first permanent molars. Given the study design and lack of information on population wide changes in caries prevalence over time, it is not possible to say whether this significant increase is attributable to the programme itself. The authors suggest that poor uptake of school based preventive services could account for the lack of programme effect (only 18% of eligible students received sealants). A subgroup analysis by sealant status to assess treatment effects revealed that those students who had received sealants had a significantly lower proportion of decayed first permanent molars compared to students who were eligible but did not receive sealants.

Axelsson et al. 2005 [-] reported reductions in average decay levels amongst 7 year old students over the twenty years since programme introduction, however, no

statistical comparisons were reported, and no information on secular oral health trends during the two decade period was provided.

Evidence Statement 12: The association between multi-component school based interventions and the oral health of primary school children

There is inconsistent evidence from one cohort study (US[1]) and two before and after studies (US[2], Sweden[3]) regarding the association between multi-component school based oral health programmes, which include the provision of preventive services (e.g. pit and fissure sealants) and dental caries in primary school students.

One cohort study[1] found that caries incidence was significantly higher in the comparator group vs. the programme group in both the primary and permanent dentition (dfs OR 2.00, 95% CI 1.31 to 3.06; DFS OR: 2.20, 95% CI 1.38 to 3.48)[1]. The greatest benefit was seen for the occlusal surfaces of the primary (OR: 2.46, 95% CI 1.58 to 3.82)[1] and permanent dentition (OR: 2.78, 95% CI 1.70 to 4.56)[1].

A second study[2] found that overall, the preventive programme was associated with a significantly higher mean percent of erupted first molars with decay (adjusted DMFT difference: 3.02% (1.24 to 4.80), $p<0.05$)[2] which may be attributable to low uptake of sealant services, as only 18% of eligible students received sealants. When assessed according to sealant status, there was a significantly lower percentage of decayed first molars amongst eligible children who had received sealants vs. those who did not (difference: -4.6%, 95% CI -7.9% to -1.3%; $p<0.05$)[2], suggesting that efforts should be made to ensure adequate uptake of school based pit and fissure sealant services if such programmes are to have an effect.

The third study[3] reported reductions in mean DFS and mean DS amongst 7, 12 and 19 years olds from the early 1970's, prior to programme implementation, to 1993; neither statistical analysis nor information on secular trends was reported[3].

[1] Niederman et al. 2008 [-]
[2] Bodner and Pulos. 2010 [++]
[3] Axelsson et al. 2005 [-]

4.4.6 Programmes targeting common risk factors

Three studies were identified that assessed the effectiveness of school based programmes targeting common risk factors for both oral and general health:

- Two cluster non-randomised trials (Freeman and Oliver 2009 [-], Hedman et al. 2010 [-])
- One correlation study (Muirhead and Lawrence 2011 [+])

Freeman and Oliver, 2009 (Cluster non-randomised controlled trial [-], UK [Northern Ireland], n=schools NR and 345 participants, FNR)

Fifth year children (9 years old) attending primary schools in Northern Ireland in areas of varied socioeconomic status participated in the 'Boosting Better Breaks' (BBB) dietary health promotion programme, which was designed to promote healthy eating in general and prevent dental caries. The programme included the introduction of school milk, water and fruit during school breaks; the closing of tuck shops; removal of confectionary, cakes, biscuits or soft-drinks as teacher provided rewards or prizes. Schools participating in the programme were matched according to SES and urban vs. rural setting to schools with no previous participation in BBB.

Consumption of sugary snacks was assessed using the rubbish bag method, and evaluated using a summary score (higher score indicates higher daily consumptions of sugary snacks).

Muirhead and Lawrence, 2011 (correlation study [+], Canada, n=242 schools, FNR)

York Region District and York Region Catholic elementary schools in Ontario, Canada participated in the voluntary "Healthy Schools" recognition programme to promote health-related activities between 2007 and 2008. The programme targeted several health related topics areas including healthy eating, physical activity, bullying prevention, personal safety, injury prevention, substance use and misuse, healthy growth and development and mental health activities. The impact of programme participation on tooth decay was assessed and oral health outcomes were compared

to regional schools that did not participate in the "Healthy Schools" recognition programme during 2007/2008.

Decayed teeth were assessed by a dental hygienist during school dental screenings using a standardised protocol. Deciduous and permanent teeth were considered decayed if they had a visible cavity, a lost temporary filling or a partial filling that required treatment. Comparisons were completed for all schools pooled as well as by school SES, with schools in neighbourhoods with greater than the national average (16.5%) of low income families classified as low-income neighbourhoods, and those with fewer than 16.5% of families considered high income.

Hedman et al. 2010 (Cluster non-randomised controlled trial [-], Sweden, n=198, FNR)

Students between the ages of 12 and 15 years, born in Uppsala County in 1989 and 1992 were assessed as being at high risk for oral diseases were eligible to participate in a health education programme targeting tobacco use. A dental hygienist and a dental nurse delivered a 40 minute interactive lecture at the schools addressing oral health and tobacco use. The lecture addressed the content of tobacco, its effect on the body, addiction, cost of use, risks of passive smoking and environmental consequences. Attitude and value training addressed reasons to use or not use tobacco, peer pressure, legislation and attitudes towards users.

Descriptive statistics were provided regarding the proportion of students in each group who reported engaging in a variety of tobacco related behaviours. No comparative statistical analysis was reported either within or between intervention and comparator groups in the percentage of participants reporting smoking tobacco:

- Intervention – before: 4%, after: 5%
- Comparator – before: 8%, after: 7%

Or the percentage of participants that reported using snuff:

- Intervention – before: 6%, after: 5%
- Comparator – before: 5%, after: 7%

Similarly, descriptive statistics regarding attitudes towards tobacco were reported. There were reportedly no significant differences in questionnaire responses between the intervention and comparator groups regarding attitudes towards tobacco use, however, no comparative statistics were provided.

Summary and Evidence Statement

Inconsistent results were seen between the two school based programmes addressing healthy diet, with one study reporting beneficial associations between the programme and dental caries, and results from another study indicating that programme participation may be harmful in terms of both the consumption of cariogenic foods as well as dental decay.

Muirhead and Lawrence 2011 [+] found that schools voluntarily participating in a general health promotion programme had a significantly lower mean percentage of children with two or more decay deciduous or permanent teeth; this may have been influenced by the voluntary nature of the programme. Examination of the results by socioeconomic subgroup suggested that the programme is associated with significant improvements in low income areas but not high income neighbourhoods. This suggests that general health programmes that target the school environment may have a differential effect on oral health depending on neighbourhood socioeconomic status, and may offer a mechanism by which to reduce inequalities in oral health.

The Boosting Better Breaks programme (Freeman and Oliver 2009 [-]) resulted in a significant increase in obvious decay, missing and filled teeth at two years follow-up. While no statistical analysis was reported for sugar consumption, evaluation of mean scores and their associated confidence intervals suggests that the programme resulted in no difference in sugar consumption over time. Authors suggest that restriction of sugary snacks at school may have influenced out-of-school consumption patterns (for instance, from local shops). However, given the low baseline scores, there may have been little room for improvement at programme schools. Combined, these results suggest that the ‘Boosting Better Breaks' (BBB) dietary health promotion programme was not effective at altering the consumption of cariogenic foods at school, and that consideration should be given to knock on

effects when school based food choices are restricted, as this could lead to increased consumption of sugary snacks from other outlets.

Evidence Statement 13: The effect of health promotion programmes addressing common risk factors on the oral health and related behaviours of school children

Inconsistent evidence was identified from two cluster non-randomised trials (UK[1], Sweden[2]) and one ecological study (Canada[3]) regarding the effectiveness of school based programmes that address common risk factors on oral health outcomes.

One study[1] that focused on altering the school environment in order to promote healthy school based eating, resulted in no effect on tooth decay ($D_{3cv}MFT$) amongst school children (effect size not reported)[1]. When considering obvious dentine decay on its own ($D_{3cv}T$), there was a significant effect favouring the control group, with attendance at non-programme schools associated with significantly lower levels of visibly cavitated teeth (β (SE): -0.31 (0.15); 95% CI NR, $p<0.05$)[1].

Another study[3], assessing "Healthy Schools", which altered the school environment to promote general health, reported that voluntarily participating schools had a significantly lower mean percentage of children with two or more decayed deciduous or permanent teeth (effect size not reported, $p=0.007$)[3]; subgroup analysis revealed this relationship to be significant in low- but not high-income schools (data not reported)[3].

Another study[2] reported that a school based tobacco education programme delivered by dental professionals had no impact on the tobacco using behaviours of secondary school students, however, no statistical analysis was reported[2].

[1] Freeman and Oliver 2009 [-]
[2] Hedman et al. 2010 [-]
[3] Muirhead and Lawrence 2011 [+]

4.4.7 Oral health education programmes

Five studies were identified that assessed the effectiveness of school based oral health education programmes, with and without the additional provision of fluoride, at improving the oral health, oral hygiene and knowledge of school aged children:

- Two cluster RCTs (Vanobbergen et al. 2004 [-], Dental Health Foundation 2007 [+])
- One cross sectional study (Pieper et al. 2012 [+])
- Two before and after studies (Livny et al. 2008 [+], Pieterse et al. 2006 [+])

Vanobbergen et al. 2004 (Cluster RCT [-], Belgium, n=NR schools and 5,268 participants, FNR)

Children born in 1989 in Flanders, in an area with low population wide caries levels, attending private, public and municipal schools participated in a yearly, one-hour oral health education programme delivered to both students and teachers, which included information on oral hygiene, use of fluorides, dietary habits and dental attendance. Brushing with fluoride toothpaste three times per day was advised. Dietary counselling focused on the cariogenic effect of frequent between-meal sugary snacks and beverages. The educational material was designed specifically for each age group. An oral health examination was conducted each year, and advice and a referral letter regarding the oral health status and treatment needs were provided to parents and School Health Care Centres following the examinations. Children attending comparator schools received a standard oral health promotion programme (details not reported) and an oral health examination at baseline and six years follow-up; advice and a referral letter regarding the oral health status and treatment needs was provided to parents and School Health Care Centres following the examinations.

At six years' follow-up, dental caries of the permanent dentition at both the tooth and surface level was assessed using a mirror and probe (no radiographs) against BASCD criteria. No significant differences in follow-up caries were found between the intervention and comparator groups at either the tooth level or at the surface level (mean (SEM) DMFT intervention: 0.92 (0.02), comparator: 1.0 (0.06), 95% CI

NR, p=0.49; DMFT prevalence intervention: 40.7% (38.9% to 42.3%), comparator: 41.3% (37.5% to 44.9%), difference: 0.61%; 95% CI NR; p=0.76; (mean (SEM) DMFS intervention: 1.46 (0.04), comparator: 1.59 (0.10), 95% CI NR, p=0.31).

The Restoration Index of the permanent dentition (filled teeth as a proportion of decayed and filled teeth: F/DF) served as a proxy measure for dental service utilisation. The mean (SEM) Restoration Index was significantly higher in the intervention vs. comparator group (intervention: 0.80 (0.01), comparator: 0.73 (0.02); 95% CI NR, p<0.01).

Plaque accumulation on the buccal surfaces was scored using the Index of Silness and Loe (PI) and on the occlusal surfaces of first permanent molars using a simplified version of the Carvalho Index (0: no visible plaque; 1: detectable plaque restricted to fossae and grooves; 2: surface partially or totally covered with heavy plaque accumulation). Students in intervention schools had a significantly lower PI on the buccal surfaces vs. the comparator schools' students (Intervention: 0.35 (0.008), comparator: 0.40 (0.02), difference: -0.05, 95% CI -0.007 to -0.09; p=0.02). No significant difference was seen on occlusal surfaces (intervention: 0.06 (0.003), comparator: 0.06 (0.007); 95% CI NR, p=0.30).

Gingival health status, assessed using the Sulcus Bleeding Index (SBI), was significantly better in the intervention vs. comparator groups (intervention: 0.21 (0.003), comparator: 0.29 (0.02), 95% CI NR, p<0.001).

Several oral hygiene outcomes were assess via parent completed questionnaire. Researchers found no significant difference in the proportion of students reported to not brush everyday (intervention: 8.4%, comparator: 7.0%, 95% CI NR, p=0.27), to regularly use dental floss (intervention: 6%, comparator: 7%, 95% CI NR, p=0.71), and to have their last visit to the dentist be more than six months previous (intervention: 67.0%, comparator: 66.6%, 95% CI NR, p=0.11). Significant increases were seen in use of fluoride toothpaste (intervention: 88%, comparator: 86%, 95% CI NR, p<0.05) and significant reductions were reported in the proportion of children reported to eat more than 2 between-meal snacks (intervention: 29.9%, comparator: 36.9%, difference: 7%, 95% CI NR; p<0.001).

Dental Health Foundation, 2007 (Cluster RCT [+], Ireland and UK [Northern Ireland], n=7 schools and 308 participants, Belfast NF and Dublin WF)

Children in their fourth year of primary school in areas of socioeconomic deprivation (no further definition reported) in Dublin and Belfast participated in a six week, school based oral health promotion programme called 'Winning Smiles', which included:

- Classroom visits by community dental staff, as well as homework and classroom worksheets to be completed between visits, and awards for participating children.
- During the oral health promotion programme children were taught to brush their teeth with fluoride toothpaste in order to remove plaque. The programme included a degree of competition, with scoring of plaque levels at baseline and 4 weeks. Children received awards at the end of the programme, and classes and schools compete against each other for awards/recognition.
- In the Dublin schools, children also received fluoridated toothpaste and a toothbrush at the first school visit and every three months by post.

Each city also included comparator schools which did not participate in the programme. The main outcome measure, tooth brushing compliance, was measured using equilibrium salivary fluoride levels in the morning and afternoon at school, approximately 14 and 18 hours post brushing.

In Dublin, where children are exposed to fluoridated water, there was no significant difference in mean salivary fluoride levels (mg/L) between children attending intervention vs. comparator schools at either baseline (intervention: 0.019 (SD NR), comparator: 0.020 (SD NR); 95% CI NR; p=0.0704) or 6 month follow-up (intervention: 0.023 (SD), comparator: 0.025 (SD NR); 95% CI NR; p=0.1218). However, at 12 months' follow-up, the intervention group had significantly higher levels (intervention: 0.024 (SD NR), comparator: 0.019 (SD NR); 95% CI NR; p<0.0001). When assessed over time, the Dublin intervention group demonstrated a significant increase in salivary fluoride levels between baseline and 6 month follow-up (values and 95% CI NR; p<0.0001), and between baseline and 12 month follow-up (mean values and 95% CI NR; p<0.0001). The Dublin comparator group had a significant increase in salivary fluoride levels between baseline and 6 months (values

and 95% CI NR; p=0.0003), but no significant change over the course of a year (mean values and 95% CI NR; p=0.0667).

In Belfast, where children were not exposed to fluoridated water, those who received the oral health promotion programme were similar at baseline to children from comparator schools in terms of salivary fluoride levels (intervention: 0.017 (SD NR), comparator: 0.016 (SD NR); 95% CI NR; p=0.2952). At six months' follow-up, the intervention group had a significantly higher fluoride level than the comparator group, but the actual difference in levels was small (intervention: 0.020 (SD NR), comparator: 0.018 (SD NR); 95% CI NR; p=0.0047). This increase was not maintained, with no significant difference seen at 12 months between intervention and comparator groups (intervention: 0.014 (SD NR), comparator: 0.014 (SD NR); 95% CI NR; p=0.8859).

Within the Belfast intervention group there was a significant increase in salivary fluoride levels between baseline and 6 months (values and 95% CI NR; p<0.0001), and a significant decrease between both 6 months to 12 months (values and 95% CI NR; p<0.0001) and baseline to 12 months (values and 95% CI NR; p=0.0001). Similarly, the Belfast comparator group had a significant increase between baseline and 6 months (values and 95% CI NR; p<0.0001), and a significant decrease between both 6 months to 12 months (values and 95% CI NR; p<0.0001) and baseline to 12 months (values and 95% CI NR; p=0.0012).

The study also assessed oral health related knowledge and attitudes (via a yes/no questionnaire, with higher scores indicating better knowledge or greater sense of importance or satisfaction), and found that the intervention groups (Dublin and Belfast combined) scored better than comparator groups at 12 months follow-up on measures of:

- Toothbrushing and toothpaste knowledge (group values and 95% CI NR; p=0.02)
- Total snack knowledge (group values and 95% CI NR; p=0.009)
- Safer snack knowledge (group values and 95% CI NR; p=0.004)
- Attitude towards importance of oral care (group values and 95% CI NR)

Pieper et al. 2012 (Cross sectional study [+], Germany, n=19 schools and 925 participants, NF)

A selective intensified programme was offered at kindergartens and primary schools in underprivileged districts (no other information reported) of Marburg County. The programme included enhanced oral health education, oral hygiene instructions (four times per year) and fluoride varnish applications (four times per year). Children attending schools in similarly underprivileged communities that did not receive the intervention served as a comparator group, and were matched on gender, age, mother's education and ethnicity.

All outcomes were assessed using International caries detection assessment system (ICDAS-II) criteria. Except for the least severe category (D1), children attending intervention schools exhibited lower mean caries than their comparator school counterparts (see Appendix E for detailed information on mean caries across ICDAS-II classification levels).

Attending a programme school was associated with lower overall caries ($ICDAS_{D1-6}MFT$), with programme participants exhibiting 2.44 (SD NR) caries on average, compared to 3.37 (SD NR) amongst comparator school children (95% CI NR, significant at p<0.00 [p-value reported to two decimal places only]). When outcomes were restricted to established and severe decay (ICDAS D_{3-6}), programme participation was still associated with lower mean caries experience at the tooth and surface level (mean ICDAS $D_{3-6}MFT$ programme: 0.88 (SD NR), comparator: 1.73 (SD NR); 95% CI NR, p<0.005; ICDAS $D_{3-6}FS$ programme: 0.95, comparator: 1.94; 95% CI NR, p<0.005).

The study authors reported that an ICDAS-II score of D_3 corresponds to a dentine lesion, and advised using results for $D_{5,6}MFT$ when comparing to other studies as it is closest to WHO criteria. On this outcome, differences in mean ICDAS $D_{5,6}MFT$ were found (programme: 0.50 (SD NR), comparator: 0.77 (SD NR); 95% CI NR, p=0.043).

The programme was originally implemented in response to the polarised nature of caries distribution in the population, despite overall declines in caries. In order to

assess the effect of the programme at addressing this polarisation, the authors utilised the severity of caries index (SiC), and found that programme participation was associated with a lower mean SiC score (programme: 0.96 (SD NR), comparator: 1.46 (SD NR); 95% CI NR, p<0.005). This suggests that the intensive programme may reduce the severity of caries inequalities in the targeted schools.

Livny et al. 2008 (Before and after study [+], Israel, n=227, FNR)

First grade school children of medium-low SES (metrics not reported) from five primary schools in Jerusalem participating in a municipal health education programme were given a toothbrush and toothpaste as part of the standard health education programme followed by dental health education sessions once a week for three weeks provided by a dental hygienist, with an emphasis on manual tooth brushing skills and technique. The programme included individual training, supervised brushing and verification of proper brushing technique. Health education regarding the use of fluoridated toothpaste and healthy dietary habits was also provided. After four months, there were significant changes to oral health behaviours, assessed via interviewing the students, including:

- Significant reductions in the percentage of children brushing once per day (before: 67.2%, after: 12.6%; 95% CI NR, p<0.0001)
- Significant increases in the percentage of children brushing twice a day (before: 32.8%, after: 97.4%; 95% CI NR, p<0.0001
- The mean number of mouth sections brushed of eight (before: 2.86 (SD 1.82), after: 5.76 (2.21); difference: 2.90 (95% CI 2.59 to 3.20), p<0.0001)

In terms of dietary behaviours related to sugary foods, there were no significant differences in the percentage of children bringing sandwiches with sweetened spreads to school (before: 37.7%, after: 33.2%; 95% CI NR, p=NS). There was, however, a significant reduction in the percentage of students bringing sweetened soft drinks to school (before: 22.4%, after: 13.3%; 95% CI NR, p=0.01).

Pieterse et al. 2006 (Before and after study [+], The Netherlands, n=7 schools and 249 participants, FNR)

Children in group 3 to 8 (aged 6 to 12 years) from primary schools in the village of Woudenberg, The Netherlands participated in a school based weekly fluoride mouth rinse rinsing and received school based tooth brushing lessons in groups 4 to 8 (aged 7 to 12 years). An educational packet focusing on oral health was also provided. Post programme outcomes were collected for group 8 students (mainly aged 12 years) in 2004 and compared to children attending local schools before programme implementation in 1995/1996, as well as post-programme (2004) values from non-participating schools.

DMFS and the proportion of children with sound teeth were assessed by a dental hygienist and assistant at school using a mirror, probe and hobby lamp. Among participating schools, mean caries levels were significantly lower after the school based programme than those seen before the programme was introduced (1995/96 2.5 (SD NR), 2004: 0.5 (SD NR); reported as significant, 95% CI and p-value NR). There was no significant difference in caries between 1995/96 and 2004 in children attending schools that did not participate in the programme (1995/96: 2.9 (SD NR), 2004: 2.0 (SD NR), reported as non-significant (95% CI and p-value NR). Comparing mean caries in 2004 between rinsing and non-rinsing schools revealed a significantly lower caries level among children attending programme schools (rinsing: 0.5 (SD NR), non-rinsing: 2.0 (SD NR), reported as significant, 95% CI and p-value NR).

A significantly higher percentage of children in programme schools were found to be caries free at age 8 compared to children the same schools before the programme was introduced (1995/96: 40%, 2004: 73%; reported as significant, 95% CI and p-value NR). There was no significant difference between children in non-rinsing schools in 2004 and children in 1995/96 (1995/96: 34%, 2004: 41%; reported as non-significant, 95% CI and p-value NR). The difference in percentage of children rated as being caries free at 8 years old in 2004 was significantly higher in the participating schools compared to non-participating schools (rinsing: 73%, non-rinsing: 41%; reported as significant, 95% CI and p-value).

There was no difference in self-reported oral hygiene practices (% of children who reported brushing their teeth at least twice per day) between the groups (rinsing

schools 1995/96: 62%, rinsing schools 2004: 79%. Non-rinsing schools 1995/96: 66%, 2004: 84%. All reported as non-significant, 95% CI and p-value NR).

Summary and evidence statements

Two cluster RCTs (Vanobbergen et al. 2004 [-], Dental Health Foundation 2007 [+]), one cross sectional study (Pieper et al. 2012 [+]), and one before and after study (Pieterse et al. 2006 [+]) examined the effect of community based oral health education programmes (with and without the provision of fluoride) on the oral health of school aged children.

The programmes differed in terms on content, with some programmes including oral health education only (Vanobbergen et al. 2004 [-], Belfast group of Dental Health Foundation 2007 [+],) while others also provided fluoride varnish (Pieper et al. 2012 [+]), oral hygiene equipment (Dublin group of Dental Health Foundation 2007 [+], Livny et al. 2008 [+]) or involved hands-on practice of tooth brushing as part of the programme (Pieterse et al. 2006 [+]).

Methods of assessing outcomes also differed. Self-report or parent-report behaviours were used to establish programme effect on oral hygiene in three studies (Vanobbergen et al. 2004 [-], Pieterse et al. 2006 [+], Livny et al. 2008 [+]). The Dental Health Foundation 2007 [+] study used salivary fluoride levels to assess compliance with the tooth brushing component of the study.

Oral health outcomes

Overall, these studies suggest that school based oral health education programmes that include the provision of fluoride or oral hygiene supplies (e.g. toothbrushes) may be effective at improving the oral health of school aged children.

One intervention study (Vanobbergen et al. 2004 [-]) found that the addition of annual oral health education (with no fluoride component) to the standard school based health promotion efforts had no effect on caries prevalence or mean level of dental decay. The programme was reported to have a significant impact on both plaque and gingival health, however, there were significant baseline differences

between the two groups on these measures, and this was not reported as controlled for in the statistical analyses.

Pieterse et al. 2006 [+] describe an oral health education plus fluoride provision programme. The school based programme included an educational packet focusing on oral health, school based teeth brushing lessons and weekly fluoride mouth rinsing. The study found significantly lower average decay levels, and results suggest that the association is not due to an overall reduction of caries in this age group over time. The programme was not associated with changes in toothbrushing behaviour, however.

Pieper et al. 2012 [+] reported that an intensive oral health education and promotion programme which included fluoride varnish applications was associated with lower average decay levels, as well as a reduction in caries inequalities in the targeted schools.

Evidence Statement 14: The effect of school based oral health education programmes on dental decay amongst school aged children

There is moderate evidence from one cluster RCT (Belgium[1]), one cross sectional study (Germany[3]), and one before and after study (The Netherlands[4]) to suggest that oral health education programmes may improve plaque and gingival health, and when combined with fluoride provision are associated with reduced tooth decay amongst primary school children.

One study[1] found that an oral health education programme resulted in no difference in the prevalence of decay (DMFT prevalence difference: 0.61%; 95% CI NR; p=0.76)[1] and had no effect on average decay levels (mean (SEM) DMFT: 0.92 (0.02) vs. 1.0 (0.06); 95% CI NR, p=0.49; mean (SEM) DMFS: 1.46 (0.04) vs. 1.59 (0.10), 95% CI NR, p=0.31)[1].

The study[1] also reported a significant reduction in the Plaque Index of the buccal surfaces (-0.05, 95% CI -0.007 to -0.09; p=0.02)[1], but no significant difference in the Plaque Index of occlusal surfaces (no comparative statistics reported)[1]. Significant improvement in gingival health also reported (mean (SEM) SBI scores: 0.21 (0.003)

vs. 0.29 (0.02), 95% CI NR, p<0.001)[1]. However, significant differences between the groups already existed at the beginning of the study; whether these baseline differences were controlled for during analysis was not reported. Another study[2] found that a six year, intensive school oral health promotion programme, which included weekly fluoride varnish applications, was associated with significant increases in the proportion of children who were caries free at age 12 versus children from non-participating schools (73% vs. 41%; reported as significant, 95% CI and p-value)[2]. Significant reduction in average decay levels (mean (SD) ICDAS $D_{5,6}$MFT: 0.50 (NR) vs. 0.77 (NR); 95% CI NR, p=0.043)[2] and oral health inequalities (severity of caries index (SiC) score – programme: 0.96 (SD NR), comparator: 1.46 (SD NR); 95% CI NR, p<0.005)[2] were observed as well.

A third study[3] that included an educational packet focusing on oral health, school based teeth brushing lessons and weekly fluoride mouth rinsing was associated with significantly lower decay levels at age 12 (mean (SD) DMFS (0.5 (NR) vs. 2.0 (NR); reported as significant, 95% CI and p-value NR)[3].

[1] Vanobbergen et al. 2004 [-]
[2] Pieper et al. 2012 [+]
[3] Pieterse et al. 2006 [+]

Oral Hygiene

Similar to the oral health results, evidence suggested that oral health education programmes on their own may not improve oral hygiene practices, but that combining education programmes with provision of toothbrushes and toothpaste, or practicing the taught techniques at school may significantly improve tooth brushing in school children.

- Two cluster RCTs (Vanobbergen et al. 2004 [-]) found no significant difference in the proportion of students reported to not brush every day, or in regular use of dental floss. Small but statistically significant differences were seen in terms of self-reported use of fluoride toothpaste.
- Another cluster RCT (Dental Health Foundation 2007 [+]) found that children in the Belfast group who received an oral health promotion and education

programme without coinciding provision of toothbrush and fluoride toothpaste had significantly decreased toothbrushing compliance.

Inconsistent results were seen in tooth brushing among children who received an oral health education programme that included the provision of a toothbrush and fluoride toothpaste or practicing of tooth brushing techniques:

- Dental Health Foundation 2007 [+] Dublin Group: oral health promotion and education programme plus free fluoridated toothpaste and toothbrush for a year was found to significantly improve tooth brushing compliance.
- Livny et al. 2008 [+]: significant reductions in the percentage of children brushing once per day accompanied by significant increases in the percentage of children brushing twice a day.
- Pieterse et al. 2006 [+]: non-significant increase in the proportion of children who reported brushing their teeth at least twice per day at age 12. The lack of significance may be attributed to the small sample size (n=45 before the programme vs. n=48 after the programme).

Evidence Statement 15: The effect/association of school based oral health education programmes on oral hygiene amongst school aged children

Moderate evidence from two cluster RCTs (Belgium[1], Ireland and UK[2]) and two before and after studies (Israel[4], The Netherlands[7]) suggests that oral health education alone is insufficient to alter the tooth brushing behaviours of school children, but that the provision of oral hygiene supplies (e.g. toothbrushes, toothpaste) may be associated with improved oral hygiene.

One oral health education only programme[1] resulted in no significant difference in the proportion of students reported to not brush every day in intervention vs. comparator groups (8.4% vs. 7.0%; 95% CI NR, p=0.27)[1], or in regular use of dental floss (6% vs. 7%; 95% CI NR, p=0.71)[1]. This study did find small but statistically significant differences in use of fluoride toothpaste, with intervention groups having higher use (88% vs. 86%, 95% CI NR, p<0.05)[1].

Another intervention study[2] found that children who received an oral health promotion and education programme without coinciding provision of toothbrush and fluoride toothpaste had significantly decreased salivary fluoride levels over the course of a year, with higher fluoride levels taken to be indicative of regular toothbrushing with fluoride toothpaste (values and 95% CI NR; p=0.0001)[2]. A separate arm in this trial that also provided free fluoridated toothpaste and toothbrush for a year was found to significantly improve tooth brushing behaviour, as measured by salivary fluoride levels (0.024 (SD NR) vs. 0.019 (SD NR); 95% CI NR; p<0.0001)[2].

Another study[3] reported significant increases in the percentage of children brushing twice a day after implementation of an oral health education programme plus provision of oral hygiene supplies and tutoring on oral hygiene skills (32.8% vs. 97.4%; 95% CI NR, p<0.0001)[3], as well as corresponding reductions in the percentage of children brushing once per day after programme implementation (67.2% vs. 12.6%; 95% CI NR, p<0.0001)[3].

Another study[4] included oral health education, fluoride mouth rinsing and oral hygiene demonstrations, and was associated with no difference in proportion of children who reported brushing their teeth at least twice per day before and after the intervention implementation (62% vs. 79%; reported as NS, 95% CI and p-value NR)[4] or between participating and non-participating schools after the programme's implementation (79% vs. 84%; reported as NS, 95% CI and p-value NR)[4].

[1] Vanobbergen et al. 2004 [-]
[2] Dental Health Foundation 2007 [+]
[3] Livny et al. 2008 [+]
[4] Pieterse et al. 2006 [+]

Dental Attendance

One study (Vanobbergen et al. 2004 [-]) assessed the effect of an oral health education programme on dental service access/utilisation. The programme resulted in a significantly higher proportion of decayed or filled teeth being filled (80% in the intervention group vs. 73% in the comparator group, indicating a significant impact

on use of restorative services. This may not provide a complete estimate the programme's effect on dental service access or utilisation, as it does not capture routine or preventive services. As a second measure, Vanobbergen et al. 2004 [-] also assessed student reported dental attendance, with no significant differences.

Diet

Dietary behaviours of children participating in oral health education programmes at school were assessed in two studies. Vanobbergen et al. 2004 [-] found significant reductions in the proportion of children reported to eat more than 2 between-meal snacks; the study relied on parent reports of the children's behaviours.

One before and after study (Livny et al. 2008 [+]) found no significant differences in the percentage of children who reported bringing sandwiches with sweetened spreads to school, but did find a significant reduction in the percentage of students bringing sweetened soft drinks to school.

The varying methods of collecting dietary outcome data and different outcomes assessed (sugary items [Livny et al. 2008 [+] vs. frequency of snacking [Vanobbergen et al. 2004 [-]) obscures conclusions regarding the effectiveness of school based oral health education programmes on children's dietary behaviours.

Knowledge

The Dental Health Foundation 2007 [+] study assessed oral health related knowledge amongst intervention groups from both Dublin and Belfast (combined). These groups scored better than comparator groups at 12 months follow-up on measures of tooth brushing and toothpaste knowledge (group values and 95% CI NR; p=0.02), total snack knowledge (group values and 95% CI NR; p=0.009) and safer snack knowledge (group values and 95% CI NR; p=0.004). While knowledge outcomes were combined across study sites, oral hygiene outcomes were reported separately; this makes establishing a link between changes in oral health knowledge and oral health behaviours difficult to assess.

Evidence Statement 16: The effect/association of school based oral health education programmes on dental access, diet and oral health knowledge and attitudes among school aged children

Weak evidence from two cluster RCTs (Belgium[1], Ireland and UK[2]) and one before and after study (Israel[3]) suggests that school based oral health education programmes may be associated with improved access to restorative dental services, and improvements in oral health related diet and knowledge among school aged children.

One intervention study[1] found that an annual, one hour school based oral health education programme was effective at improving restorative dental service utilisation amongst school children, as assessed by the Restoration Index (mean (SEM) Restoration Index (F/DF): 0.80 (0.01) vs. 0.73 (0.02); 95% CI NR, $p<0.01$)[1], however, there was no difference in the proportion of students reporting that their last visit to the dentist was more than six months ago (intervention: 67.0%, comparator: 66.6%, 95% CI NR, $p=0.11$)[1]. The programme was also associated with significant reductions in the proportion of children eating more than 2 between-meal snacks, as reported by parents (29.9% vs. 36.9%, difference: -7%, 95% CI NR; $p<0.001$)[1].

Another study[3] reported no changes in the percentage of children bringing sandwiches with sweetened spreads to school (before: 37.7%, after: 33.2%; 95% CI NR, p=NS)[3], but was associated with a significant reduction in the percentage of students bringing sweetened soft drinks to school (before: 22.4%, after: 13.3%; 95% CI NR, $p=0.01$)[3].

Another study[2] found that an oral health education programme was effective at improving student knowledge of tooth brushing and toothpaste (group values and 95% CI NR; $p=0.02$)[2], total snack knowledge (group values and 95% CI NR; $p=0.009$)[2] and safer snack knowledge (group values and 95% CI NR; $p=0.004$)[2].

[1] Vanobbergen et al. 2004 [-]
[2] Dental Health Foundation 2007 [+]
[3] Livny et al. 2008 [+]

4.4.8 Peer-to-peer oral health education programmes

Three studies were identified that assessed the effectiveness of school based, peer-to-peer oral health education programmes:

- One cluster RCT (Freeman and Bunting 2003 [-])
- Two before and after studies (Reinhardt et al. 2009 [+], Reinhardt et al. 2009b [+])

Freeman and Bunting, 2003 (Cluster RCT [-], UK [Northern Ireland], n=10 schools and 482 participants, FNR)

Children aged 5 and 11 years attending primary schools in North and West Belfast in areas of high social deprivation (SES definition not reported) participated in a three stage child-to-child oral health education intervention:

- Stage 1 – a healthy snacking education programme was delivered to older children over four weeks and addressed the importance of healthy teeth, the effect of different snacks on tooth health and oral hygiene practices.
- Stage 2 – over the course of a week the older children design a healthy snacking educational programme to be provided to their younger peers.
- Stage 3 – a one-hour child-to-child oral health education session was delivered by the 11 year olds to the 5 year olds.

Dietary behaviour at school break time was assessed at six weeks' follow-up and evaluated as a cariogenic snacking score (range 0-25, higher scores indicate consumption of more cariogenic/sugar containing snacks) and calculated using 'rubbish bag' collection.

Based on comparison of 95% confidence intervals, there was no significant difference in the baseline to follow-up change in cariogenic snacking score amongst older children (intervention: -0.93 (-1.40 to -0.46), comparator: -0.19 (-0.53 to -0.16); 95% CI and p-value NR). Regression analysis, adjusting for SES, gender and intervention status, suggests no significant effect of attending an intervention school

in terms of mean change in cariogenic snack scores of 11 year olds (β 0.88 (SE 0.44), 95% CI -0.11 to 1.86; p=0.07).

Similarly, there was no significant difference in cariogenic snacking change scores amongst younger children (intervention: -0.26 (-0.67 to 0.14), comparator: 0.07 (-0.33 to 0.45); 95% CI and p-value NR) and regression analysis revealed no effect associated with intervention school attendance (β 0.61 (SE 0.31), 95% CI -0.75 to 0.68; p=0.08).

The dental health knowledge of older children was evaluated using a 4 item questionnaire regarding the content, timing a frequency of snacking behaviour for healthy teeth. Scores were on a 4 point scale (0 to 3), with higher scores reflect better dental health knowledge. Scores were assessed There was no difference in dental health knowledge change scores between the intervention and comparator groups at baseline (intervention: 0.84 (0.71 to 0.98), comparator: 0.96 (0.81 to 1.13); 95% CI and p-value NR). However, children intervention schools had higher knowledge scores at follow-up vs. those in comparator schools (intervention: 1.04 (0.93 to 1.26), comparator: 0.83 (0.66 to 0.88); 95% CI and p-value NR). Regression analysis suggests conflicting results regarding the effect of intervention school attendance on difference in dental health knowledge (β -0.43 (SE 0.15), 95% CI -0.69 to 0.17; p=0.005; unclear if upper bound of 95% CI is correct; p-value and reported significance in text suggest a significant association).

Reinhardt et al. 2009 (Before and after [+], Germany, n=30, FNR)

Fourth graders and first graders from a primary school in a “deprived area” with a large migrant community in Cologne, Germany participated in a peer-to-peer oral health tutoring programme. The intervention involved first training the fourth graders about caries and tooth brushing, and then supporting them to train first graders. The fourth graders were taught about diet and nutrition relating to caries, as well as caries pathogenesis and prevention, and the Fones tooth brushing technique in theory and practice over 5 school hours. This took a project-like format, and included experiments on the effects of acid on the enamel, and calculation of the amount of sugar in different foods and drinks. The Fones method was taught on denture models by a trained teacher in groups of four. The fourth graders then brushed their

teeth in class each day after breakfast for a week supervised by a teacher. Errors were corrected mainly by classmates and if needed by a teacher. An animal sticker chart was used to incentivise morning and evening brushing over the week, and a completed sticker chart could be exchanged for a small reward at the end of the week (a balloon, sticker, or poster).

The fourth graders then planned over 4 hours how they would teach the Fones tooth brushing method to first graders first in pairs, then in groups of four and then as a class. A pilot manual was developed based on these discussions and then improved on in groups by videoing a simulation of the teaching, watching and correcting, and then repeating the simulation. The pilot manuals were re-evaluated and finalised, before practising in groups of three. Fourth graders who could use the manual correctly were given a 'dental teacher sticker' to reward them and to identify them to first graders.

The first graders were trained in tooth brushing for 2 hours. The introductory part was done by the teacher, followed by fourth graders instructing the first graders one-on-one in theory and practice. The fourth graders used the denture models to demonstrate the Fones tooth brushing method, and then asked the first graders to practise themselves. The fourth graders then demonstrated Fones tooth brushing on themselves and asked the first graders to follow their example and corrected when necessary.

The fourth graders were videoed brushing their teeth and interviewed about their oral hygiene habits both before the programme started and 7 days after teaching the first graders. Significant improvements across several dimensions of oral hygiene practice were observed:

- The time taken by fourth graders to brush their teeth increased from before to after the intervention (before 80.5s [SD 46.4] vs. after 117.0 [SD 50.3]; 95% CI NR, p=0.004).
- More of the fourth graders used a clock to check their tooth brushing time after the intervention (before 13/30 [43.3%] vs. after 22/30 [73.3%]; 95% CI NR, p=0.004).

- After the intervention, more of the fourth graders used a circular tooth brushing technique (before 0/30 [0%] vs. after 22/30 [73.3%]; 95% CI NR, p<0.001).
- More of the fourth graders used a systematic approach to brushing their teeth (masticatory, outer and inner) as recommended by German dental organisations after the intervention (before 0/30 [0%] vs. after 26/30 [86.7%]; p<0.001).

Attitudes and motivation towards tooth brushing also improved, with more of the fourth graders reporting that they brushed their teeth for dental health reasons after the intervention (before 12/30 [40%] vs. after 26/30 [86.7%]; p<0.001).

Results for first graders were published separately (see Reinhardt et al. 2009b [+]).

Reinhardt et al. 2009b (Before and after [+], Germany, n=38 first graders and n=30 fourth graders, FNR)

Fourth graders and first graders from a primary school in a “deprived area” with a large migrant community in Cologne, Germany participated a peer-to-peer oral health tutoring programme (described above in Reinhardt et al. 2009 [+]).

First graders were taught oral hygiene practices by their older peers over the course of two hours. The younger students were videoed brushing their teeth and interviewed about their oral hygiene habits and dental history both before and one week after the educational session.

Significant improvements in two dimensions of oral hygiene practice were observed:

- The proportion of first graders using a circular tooth brushing technique increased significantly from before to after the intervention (before 10/38 [26.3%] vs. after 30/38 [78.9%]; 95% CI NR, p=0.0001).
- The proportion of first graders using a systematic approach to tooth brushing (masticatory, outer and inner surface) as recommended by German dental organisations increased significantly from before to after the intervention (before 0/38 [0%] vs. after 26/38 [68.4%]; 95% CI NR, p=0.0001).

Mean recorded tooth brushing time before the intervention was 87.1 seconds (SD 63s; range 11s to 279s). Post-intervention first grade students had a mean recorded tooth brushing time of 86.1 seconds (SD 42s; range 35s to 196s); no statistical comparison of before and after times was reported.

Summary evidence statements

Two before and after studies (Reinhardt et al. 2009 [+], Reinhardt et al. 2009b [+]) assessed the effect of peer-to-peer oral health education programmes on the oral hygiene habits of school children. Overall the intervention, which involved hands-on practice of tooth brushing as part of the programme, and used video recording to assess outcomes, was more effective at improving the brushing habits and technique of older children who re-taught the programme (grade 4) than their younger peers (grade 1). Attitudes and motivation towards tooth brushing also reportedly improved amongst the older children.

Dietary behaviours of children participating in oral a peer-to-peer programme were assessed in one study (Freeman and Bunting 2003 [-]), this limited evidence suggests that the programme had no significant effect on cariogenic snacking amongst either older children or younger children. Children at comparator schools did receive standard oral health education, although the content of the comparator programme was not described. The study also assessed oral health knowledge, but there were discrepancies in the reporting. The authors report that intervention school attendance had a significant effect on differences in dental health knowledge (β -0.43 (SE 0.15), 95% CI -0.69 to 0.17; p=0.005), it is unclear if upper bound of 95% CI is correct (p-value and reported significance in text suggest a significant association, 95% CI suggest no significant association).

Evidence Statement 17: The effect/association of peer-to-peer oral health education programmes on oral hygiene and diet habits amongst school aged children

Weak evidence from one cluster RCT (UK[1]) and two before and after studies (Germany[2,3]) suggests that peer-to-peer oral health education programmes may be

associated with improved oral health knowledge and hygiene behaviours, but is not associated with changes in dietary behaviours amongst primary school children.

One study[1] found that a peer-to-peer oral health education programme was not effective at improving the snacking habits of children aged 5 or 11, with no significant effect detected in cariogenic snacking score (higher scores indicate greater cariogenic effect (11 year olds: β 0.88 (SE 0.44), 95% CI -0.11 to 1.86; p=0.07; 5 year olds: β 0.61 (SE 0.31), 95% CI -0.75 to 0.68; p=0.08)[1].

The study reported conflicting results on oral health knowledge; intervention school students had significantly higher mean (95% CI) oral health knowledge scores than control school students (1.04 (0.93 to 1.26) vs. 0.83 (0.66 to 0.88); 95% CI and p-value NR, higher scores indicate better knowledge)[1]. However, regression analysis suggests that intervention school attendance was associated with negative effects on differences in dental health knowledge (β -0.43 (SE 0.15), 95% CI -0.69 to 0.17; p=0.005)[1], these results were reported as significant, despite a 95% confidence interval that included zero.

One study[2] reported significant improvements in oral hygiene amongst older fourth grade students, including mean (SD) time spent brushing (80.5s (46.4) vs. 117.0 (50.3); 95% CI NR, p=0.004)[2], use of taught tooth brushing technique (0% vs. 73.3%; 95% CI NR, p<0.001)[2], and taking a systematic approach to brushing (0% vs. 86.7%; 95% CI NR, p<0.001)[2]. The programme also resulted in significant improvements in oral health attitudes, with more 11 year olds reporting that they brushed their teeth for health reasons after programme implementation (40% vs. 86.7%; 95% CI NR, p<0.001)[2].

Another study[3] reported significant improvements amongst first graders in use of the recommended tooth brushing technique (26.3% vs. 78.9%; 95% CI NR, p=0.0001)[3], and of the recommended systematic approach to brushing (0% vs. 68.4%; 95% CI NR, p=0.0001)[3]. No significant changes were seen in mean (SD) time spent brushing, however (87.1s (63) vs. 86.1s (42); reported as non-significant, 95% CI and p-value NR)[3].

[1] Freeman and Bunting 2003 [-]

[2] Reinhardt et al. 2009 [+]

[3] Reinhardt et al. 2009b [+]

4.5 Children and young people of primary or secondary school age in community settings

4.5.1 Oral health education programmes

Two studies were identified that assessed the effectiveness of oral health education programmes amongst school children (with and without the additional provision of fluoride):

- Two before and after studies (Biesbrock et al. 2003 [+], Biesbrock et al. 2004 [+])

Biesbrock et al. 2004 (Before and after [+], USA, n=106, FNR)

Children between the ages of 6 and 15 years who were members of a Boys and Girls Club of America in Chicago, Illinois, USA participated in an oral health promotion and education programme called the 'Crest Cavity Free Zone Program'. The programme consisted of three modules dependent upon participant age: Modules were taught as eight separate one-hour sessions, twice a week for four weeks. The educational programme utilised games, explorations and exercises and participants were provided with a toothbrush, a tube of toothpaste (fluoride content not specified), dental floss (for those aged 10 to 15 years) and disclosing tablets for the identification of plaque. Topics covered included developing good oral hygiene techniques (brushing and flossing), anatomy of teeth and gums, developing a positive attitude towards dentists and dental visits, and education concerning nutrition.

Oral health outcomes included the Loe-Silness Gingival Index (GI), assessed during clinical examination with a probe and measured on six surfaces per tooth, excluding the third molars, Plaque Index (PI), which was assessed during clinical exam using the Turesky Modification of the Quigley-Hein Index. A red-disclosing agent was used and the score was derived based on the buccal and lingual surfaces of all teeth, except the third molars.

There was a significant reduction in mean Plaque Index over the four week follow-up period (baseline: 3.06 (0.58), follow-up: 2.97 (0.56), difference: -0.09 units, -3%; 95% CI NR; p<0.044) and in mean Gingival Index (baseline: 0.184 (0.146), follow-up: 0.140 (0.117), difference: -0.044 units, -24%; 95% CI NR; p<0.001).

Assessment of oral health hygiene knowledge via a child completed five-item questionnaire suggested a significant increase in knowledge over the follow-up period, with an increased number of participants answering all five questions correctly (baseline: 33 (37%), follow-up: 62 (70%); 95% CI NR; p<0.001).

Biesbrock et al. 2003 (Before and after [+], USA, n=99, FNR)

Children between the ages of 5 and 15 years who were members of a Boys and Girls Club of America in urban Kentucky, USA participated in a similar programme to that described in Beisbrock et al. 2004 [+]. The Crest Cavity Free Zone Program included an oral health education programme, provision of a toothbrush, toothpaste, dental floss and plaque disclosing tablets. Topics covered included developing good oral hygiene techniques (brushing and flossing), anatomy of teeth and gums, developing a positive attitude towards dentists and dental visits, and education concerning nutrition.

Oral health outcomes included the Loe-Silness Gingival Index (GI) assessed during clinical examination with a probe and measured on six surfaces per tooth (excluding the third molars) and Plaque Index (PI) assessed during clinical exam using the Turesky Modification of the Quigley-Hein Index. A red-disclosing agent was used and the score was derived based on the buccal and lingual surfaces of all teeth, except the third molars.

After four weeks' follow-up there was a significant reduction in mean Gingival Index scores (baseline: 0.37 (0.21), follow-up: 0.18 (0.13); difference: -0.19 units, -51%; 95% CI NR; p<0.001), and in mean Plaque Index scores (baseline: 3.80 (0.49), follow-up: 2.68 (0.46), difference: -1.12 units, -29%; 95% CI NR; p<0.001).

Oral health hygiene knowledge, assessed using a child completed five-item questionnaire was no different between baseline and follow-up in terms of plaque,

recommended brushing frequency or healthy foods knowledge (plaque baseline: 60 (82%), follow-up: 63 (85%); recommended brushing frequency baseline: 60 (82%), follow-up: 64 (88%); healthy foods baseline: 46 (75%), follow-up: 61 (81%); reported as non-significant, 95% CIs and p-values NR). There were significant increases in the proportion of participants correctly answering questions regarding recommended brushing duration (baseline: 38 (51%), follow-up: 52 (69%), 95% CI NR; $p<0.05$) and recommended dental visit frequency (baseline: 48 (64%), follow-up: 61 (81%), 95% CI NR; $p<0.05$).

Summary and Evidence Statements

Overall, the oral health promotion and education programme provided by Boys and Girls Clubs of America in Chicago (Biesbrock et al. 2004 [+]) and Kentucky (Biesbrock et al. 2003 [+]) was associated with significant improvements in plaque, gingival health and oral health knowledge over a four week follow-up period. Greater improvements were seen amongst children in with worse plaque and gingival health at baseline assessment.

Evidence Statement 18: The effect of community based oral health education programmes on plaque and gingival health of school aged children

Weak evidence from two before and after studies (US[1,2]) describing similar programmes suggests that community centre based oral health promotion and education programmes that include provision of oral hygiene supplies (e.g. toothbrush and fluoride toothpaste) may be associated with improvements in plaque scores, gingival health and oral health knowledge

The two studies[1,2] assessed the same programme delivered at community based children's clubs in two different cities and reported reductions in Plaque Index ranging from 0.09 units (-3%; 95% CI NR; $p<0.044$)[2] to 1.12 units (-29%; 95% CI NR; $p<0.001$)[1] after four weeks, with the higher percent reduction exhibited in the community with higher plaque levels at baseline.

Both programmes were associated with a significant reduction in Gingival Index scores, ranging from 0.044 units (-24%; 95% CI NR; $p<0.001$)[2] to 0.19 units (-51%;

95% CI NR; p<0.001)[1]; as with the Plaque Index, there were higher baseline Gingival Index values in the study with the higher percent reduction[1].

One of the studies[2] reported significant improvements in overall oral health and hygiene knowledge amongst school aged children, with significant increases in the proportion of children answering five oral health questions correctly after the programme (37% vs. 70%; 95% CI NR, p<0.001)[2].

The other study[1] reported mixed results, with no improvements in knowledge of plaque (82% vs. 85%, reported as NS)[1], recommended brushing frequency (82% vs. 85%, reported as NS)[1] or healthy foods (75% vs. 81%, reported as NS)[1], but significant improvements in knowledge of recommended brushing duration (51% vs. 69%; 95% CI NR, p<0.05)[1] and recommended dental visit frequency (64% vs. 81%; 95% CI NR; p<0.05)[1].

[1] Biesbrock et al. 2003 [+]
[2] Biesbrock et al. 2004 [+]

4.6 Children and young people of primary or secondary school age in home settings

4.6.1 Programmes to improve dental service access

Two studies were identified that assessed the effectiveness of home visits on dental services access:

- One RCT (Binkley et al. 2010 [+])
- One before and after study (Harrison et al. 2003 [-])

Binkley et al. 2010 (RCT [+], USA, n=226, FNR)

Children aged 4 to 15 living in Louisville, Kentucky USA and enrolled in Medicaid but who had not accessed a dentist through the programme in at least two years were eligible to participate in a dental care coordinator programme. During a 45-60 minute home visit with the child's caregiver, the dental care coordinator discussed personal barriers to dental care access (including lack of knowledge of Medicaid and the

importance of oral health), provided information regarding available Medicaid services and providers, and the association between oral and general health. This information was supplemented with pamphlets by the American Dental Association. Toothbrushes, tooth paste and mouth-rinse were also provided. During home visits the care coordinator also provided the child with oral hygiene instructions. Caregivers who refused a home visit were provided with similar information over the phone, and products were mailed to the home.

To address structural barriers, the coordinator provided assistance in finding a dentist if the child did not have one and with scheduling dental appointments. Bus vouchers were provided in order to assist with transportation if this was identified as a barrier to access and weekly follow-up phone calls were made in order to continually assist with obtaining dental care.

One year after the start of the programme, routine or preventive dental service utilisation (assessed using Medicaid service claim files) was compared between programme families and a comparator group that received Routine Medicaid benefit up-dates and newsletters.

There was a significant difference in the use of routine and preventive dental services, with 43% of the intervention group having Medicaid claims during the follow-up period, compared to 26.5% of the comparator group (95% CI NR, p=0.047). There was a differential effect based on family income, with a significant difference in utilisation amongst lower income (<$15,000/year) children (intervention: 43%, comparator: 20%; 95% CI NR, p=0.014) but not amongst children from families with an annual income >$15,000/year (intervention: 59%, comparator: 59%, 95% CI NR, p=1.00).

Harrison et al. 2003 (Before and after study [-], Canada, n=128, FNR)

Children in grade 2 and above living in an urban, low-income neighbourhood with a large migrant population in Vancouver, Canada were included in a dental service facilitator programme. In the area, 68% of families are considered low-income (no definition reported). In order to increase access to dental services, three community based facilitators sent letters to parents (in their language spoken at home) and

attended community events in order to inform families of their role in facilitating access to publicly funded dental services (the Healthy Kids programme). Facilitators assessed individual family eligibility to publicly funded programmes, worked with financial assistance workers, assisted parents in completing application forms, and worked with the Ministry of Health to expedite the process. Once Healthy Kids funding was obtained, facilitators recommended several dentists to each family (taking into consideration language spoken, transportation issues and office hours) and advised parents on booking an appointment. Facilitators occasionally escorted the child to the appointment (if parents signed a release form) and managed cases if children had special treatment needs.

At one year follow-up more families were receiving Healthy Kids benefits compared to before programme implementation (before: 17.2%, after: 55.5%, difference (received benefits as result of project): 32.8%; 95% CI and p-value NR).

Summary and evidence statements

One RCT (Binkley et al. 2010 [+]) and one before and after study (Harrison et al. 2003 [-]) assessed the effect of home visits by community based facilitators or dental care coordinators on dental service access among primary school children from low income families.

Both studies reported that home visits by community based care facilitators improved access to dental services; only one study, however (Binkley et al. 2010 [+]) reported a statistical comparison of this outcome.

Harrison et al. 2003 [-] included low income participants from a migrant neighbourhood in Vancouver, Canada, and provided services in the family's language as spoken at home. In Binkley et al. 2010 [+] school children who were enrolled in Medicaid but had not accessed a dentist through the programme in at least two years were eligible to participate in a dental care coordinator programme. While all children in the study were from low income families (as they were all eligible for Medicaid), the benefit was greatest for those from the lowest income families. This may be due to the selection of outcome measure (Medicaid claims), which may not completely capture dental service utilisation, as it excludes any services from

providers who do not accept Medicaid. Very low income families may be less likely to utilise such out of pocket payment services. Alternatively, very low income families may face higher barriers to access that were lessened by the care coordinators. This study had quite low follow-up (60.2% follow-up) and no information was provided on differences between those who completed the programme vs. those who dropped out.

Both programmes were fairly intensive, involving home-visits, assessing barriers to access, coordination with local dental services, government and administrative bodies, advising parents or caregivers on the logistics of booking an appointment, facilitating transportation to the appointments, and in the case of the community based facilitator in the Harrison et al. 2003 [-] programme, accompanying the children to appointments.

Evidence Statement 19: The effect of home visits to low income families by community based care coordinators or facilitators on dental service access amongst low income school children

There is weak evidence from one RCT (US[1]) and one before and after study (Canada[2]) to suggest that intensive home visits by care facilitators or coordinators may improve access to[2] and use of[1] dental services among low income children eligible for government funded dental care. No effect sizes were reported in either study.

[1] Binkley et al. 2010 [+]
[2] Harrison et al. 2003 [-]

4.7 Adults in work or eligible for benefits

Two studies assessing the impact of work based interventions for dental and periodontal health were identified:

- One RCT (Ojima et al. 2003 [-])
- One cross sectional study (Morishita et al. 2003 [+])

Ojima et al. 2003 (RCT [-], Japan, n=13, FNR)

Workers at a company in Japan were randomised to an experimental group that received access to a web-based periodontal health system. The participants had an initial visit from dental hygienists in the workplace for 15-20 minutes. This involved cleaning of teeth and gums with toothbrushes and plaque disclosure. During the face-to-face visits information, images and video for populating the web-based system was collected.

There was a second dental hygienist visit at the workplace three weeks later. They revised and confirmed the tooth brushing instructions given in the first session.Two months after the initial visit the dental hygienist telephone the workers to encourage them. After this the workers were given access to the web-based system which stored and displayed personalised oral health records, including a text files, an image file, and videos. The text file contained patient-specific advice. The image file showed the participant's tooth alignment and indicated areas where they should use greater caution. The video file showed a dental professional illustrating toothbrush use in the participant's own mouth in areas that are difficult to clean during the workplace examination. Participants could log into their records from home and the workplace at any time and review the advice, images, and videos.

Individuals randomised to the comparator group received the same dental hygienist visits and follow up as the experimental group, but were not given access to the web-based system.

There were significant reductions in all outcomes from baseline to 3 months in the experimental group (Group E):

- Plaque accumulation: p=0.027 (figures displayed graphically only)
- Oral hygiene index: p=0.028 (figures displayed graphically only)
- Periodontal inflammation: p=0.046 (figures displayed graphically only)
- Gingival inflammation: p=0.028 (figures displayed graphically only)

There were significant reductions in only two outcomes from baseline to 3 months in the control group (Group C):

- Plaque accumulation: p=0.026 (figures displayed graphically only)

- Oral hygiene index: p=0.018 (figures displayed graphically only)
- Periodontal inflammation: NS (figures displayed graphically, p-value NR)
- Gingival inflammation: NS (figures displayed graphically; p-value NR)

While this was a randomised controlled trial, all analyses are restricted to before and after comparisons within the allocated groups; no statistical between group comparisons were reported (95% CIs or p-values).

Morishita et al. 2003 (Cross sectional study [+], Japan, n=629, FNR)

Employees of 43 companies in Japan participated in an oral health promotion programme in 1995. The workplace programme included a clinical examination and dental health education was provided on an annual basis in the workplace free of cost to employees. The study analysed those who had attended once, twice, or three times or more, and compared their oral health outcomes to employees who had not taken part in the programme.

Clinical examinations were carried out by three dental hygienists, and confirmed by a dentist. After the clinical examinations each participant was given oral hygiene instructions by the hygienist. This included using a disclosing solution to show plaque on lower anterior teeth. A tooth brushing method suitable for each participant was demonstrated using a toothbrush and a mirror, with interdental bushes and/or flosses used when necessary. After this oral prophylaxis of the anterior lower teeth was performed (not further described). A written notice of oral health was given, and workers with decayed teeth and or Community Periodontal Index score of 2 or more advise to consult their family dentist. The procedure took 20 minutes per employee.

Mean DMFT was lower in those who attended the programme three or more times than in other subgroups among both men and women (see Table 13 for detailed results).

Table 5: Oral health outcomes by frequency of attendance and gender

Outcome	Non-participants	Once	Twice	Three or more
Men				
DMFT, mean (SD)	12.66 (5.29)‡	13.26 (6.01)†	12.30 (5.63)	10.90 (5.14)
DT, mean (SD)	1.07 (1.67)‡	0.60 (0.96)	1.14 (1.84)†	0.44 (0.77)
MT, mean (SD)	0.85 (1.27)	1.12 (1.90)‡	0.82 (1.22)	0.56 (1.05)
FT, mean (SD)	10.74 (5.15)	11.53 (5.47)‡	10.34 (5.51)	9.90 (5.05)
CPI of 3 or 4, %	25.3%‡	25.7%†	20.0%	19.0%
Women				
DMFT, mean (SD)	12.29 (4.87)	12.60 (5.09)‡	12.24 (4.57)	11.01 (4.86)
DT, mean (SD)	0.60 (0.95)‡	0.54 (0.78)‡	0.41 (0.83)	0.30 (0.07)
MT, mean (SD)	0.74 (1.45)‡	0.30 (0.81)	0.39 (0.96)	0.39 (0.86)
FT, mean (SD)	10.95 (4.82)	11.75 (4.93)	11.44 (4.24)	10.33 (4.74)
CPI of 3 or 4, %	5.7%‡	2.7%	3.4%	2.9%
‡ $p<0.05$ vs. three times or more; † $p<0.01$ vs. three times or more				

Summary and Evidence Statement

These studies suggest that short, workplace interventions delivered by a dental hygienist once or twice for fifteen to twenty minutes can be effective at improving periodontal health and may be associated with reductions in dental decay. However, given limitations regarding the study designs and statistical analyses, overall the strength of the evidence is weak.

Evidence Statement 20: The association between participation in work based oral health promotion programmes and oral health among adults

There is weak evidence based on a within group analysis of an RCT (Japan[1]) and a cross sectional study (Japan[2]) to suggest that work based oral health education and promotion programmes may be associated with improved oral health amongst employed adults.

The first study[1] reported significant improvements in periodontal and gingival inflammation in a group of employees participating in a web-based periodontal education programme, measures on which the control group saw no improvement (no values reported)[1].

The second study[2] reported significant associations between attending three annual work based oral health education sessions and lower DMFT and improved periodontal health amongst both men and women (comparative statistics not reported)[2].

[1] Ojima et al. 2003 [-]
[2] Morishita et al. 2003 [+]

4.8 Elderly populations

Three studies assessing the impact of oral health programmes and interventions amongst elderly populations:

- One RCT (Al-Haboubi et al. 2012 [+])
- Two cluster non-randomised controlled trials (Marino et al. 2004 [-], Marino et al. 2013 [-])

Al-Haboubi et al. 2012 (RCT [+], UK [England], n=186, FNR)

Community dwelling older people (aged 60 years and older) who had 6 or more teeth and were not regular chewers of gum were recruited from primary care clinics. Programme participants were prescribed and provided with six months' supply of chewing gum (100% xylitol) to use twice a day for 15 minutes each time along with instructions of how and when to use the gum. The intervention lasted 6 months. Participants were instructed to continue their regular oral hygiene practices and dental attendance. Participants randomised to the comparator group did not receive any xylitol chewing gum, but were instructed to continue their regular oral hygiene practices and dental attendance (see Table 14).

There were no significant differences in mean number of missing teeth, mean missing coronal surfaces, mean decayed root surfaces or mean filled root surfaces over time in either group, or between the two groups at follow-up.

Participants in the intervention group saw significant reductions in mean decayed coronal surfaces over the course of the study. There was no significant difference in the comparator group over time, or between the two groups at six month follow-up.

Both intervention and comparator groups had significant differences in mean DMFS, mean DFS and mean filled coronal surfaces over the course of the study. There was no difference between the groups at the end of the study.

Significant reductions in Plaque Index scores and Gingival Index scores were seen in the intervention but not comparator groups over the course of the study; the differences between the two groups was significant at follow-up. There were no significant differences between the two groups in terms of frequency of tooth brushing or use of additional oral hygiene products (data NR).

Table 6: Oral health outcomes within groups (baseline to follow-up) and between groups at follow-up

Outcome mean (SD)	Intervention baseline vs. follow-up	Comparator baseline vs. follow-up	p-value between group
DMFS	85.6 (28.1) vs. 88.7 (26.8)§	83.8 (24.1) vs. 86.7 (23.3)§	p=0.627
DFS	32.7 (21.2) vs. 35.1 (20.5)§	34.9 (19.5) vs. 37.2 (20.3)§	p=0.542
MT	20.9 (6.5) vs. 20.8 (6.4)	21.8 (5.0) vs. 21.7 (5.8)	p=0.426
DS coronal	1.2 (2.6) vs. 0.8 (2.6)§	1.3 (3.3) vs. 1.1 (3.5)	p=0.522
MS coronal	52.9 (30.5) vs. 53.6 (29.7)	48.9 (26.9) vs. 49.5 (27.1)	p=0.386
FS coronal	31.6 (30.0) vs. 34.4 (20.2)§	33.6 (19.9) vs. 36.1 (20.9)§	p=0.610
DS root	0.3 (0.7) vs. 0.4 (0.9)	0.2 (0.5) vs. 0.2 (0.6)	p=0.154
FS root	0.6 (1.4) vs. 0.8 (1.6)	0.7 (1.6) vs. 0.6 (1.4)	p=0.570
Plaque Index	0.6 (0.7) vs. 0.3 (0.3)§	0.6 (0.4) vs. 0.6 (0.5)	p<0.001
Gingival Index	0.9 (0.3) vs. 0.7 (0.3)§	1.0 (0.3) vs. 0.9 (0.3) §	p<0.001
§ within group difference significant at p<0.05			

Marino et al. 2004 (Cluster non-randomised controlled trial [-], Australia, n=38 social clubs and 734 participants, FNR)

Ambulant adults over the age of 55 years attending Greek and Italian community social clubs in Melbourne, Australia were eligible to participate in a six-month oral

health promotion programme called Oral Health Information Seminars (ORHIS). The programme included three main components:

- Nine oral health group-based seminars, offered forthnightly at the social clubs by bilingual research assistants.
- Provision of oral care products, related to the content of each seminar session.
- Provision of oral health information sheets to reinforce seminar topic content.

The group-based seminars lasted 20-25 minutes, and addressed nine topics: expected oral changes associated with growing older; oral disease, dental caries periodontal disease; what to do with remaining teeth; oral cancer; dentures care; dry mouth; receiving oral care; oral health and diet; the relationship between oral and general health.

Both intervention and comparator participants received a minimal intervention following baseline assessment (oral health advice and education, referal to a dentist if needed, brochures with public dental clinic addresses, and a written statement regarding oral health treatment needs).

Two to 4 months after the intervention, oral hygiene behaviours and dental service utilisation were assessed via questionnaire. Participants from programme clubs were significantly more likely to report flossing than individuals from comparator clubs:

- Greek clubs: OR 13.33 (5.64 to 31.58)
- Italian clubs: OR 5.16 (2.32 to 11.51)

There was no effect on self reported toothbrushing behaviour in either Greek or Italian clubs (reported as non-significant; ORs, 95% CIs and p-values NR).

The programme had no effect on the use of dental services amongst individuals attending Greek social clubs (OR 0.77; reported as non-significant, 95% CI and p-value NR). Individuals from Italian programme clubs were significantly more likely to have reported using dental services than those from comparator clubs (OR 1.82, 95% CI 1.01 to 3.35, $p<0.05$).

Oral health knowledge was assessed via a 38 item questionnaire regarding symptoms, risk factors and causes of oral diseases, with higher scores indicating better knowledge.

Multivariate analysis (adjusted for clustering at the club level, age, sex, education and pre-test score for relevant variable) results (see Table 15) suggests that ORHIS participation was associated with significant positive effects in periodontal and oral health knowledge in both Greek and Italian clubs, and significant improvements in caries knowledge amongst Greek clubs. The programme had no significant effect on the caries knowledge of Italian club members.

Table 7: Intervention effect on oral health knowledge amongst elderly members of Greek and Italian social clubs

Knowledge outcome	Greek clubs β (SE)	Italian clubs β (SE)
Caries	1.32 (0.46)†	-0.44 (0.38)
Periodontal health	2.07 (0.36)‡	0.49 (0.25)§
Oral cancer	5.47 (0.69)‡	0.96 (SE 0.45)§
§ Significant at p<0.05, † significant at p<0.01, ‡ significant at p<0.001		

Marino et al. 2013 (Cluster non-randomised controlled trial [-], Australia, n=10 clubs and 144 participants, FNR)

Elderly people living independently in the community were recruited from 10 Italian social clubs by a research assistant who spoke Italian. Participants received an oral health programme that lasted 16 weeks. The Oral Health Information Seminars/Sheets (ORHIS) consisted of four components:

- Ten oral health seminars of 20 minutes each on oral hygiene and oral health education; oral health information sheets
- Four one-to-one oral hygiene sessions (including review of brushing technique, use of disclosing tablets, instructions on dental flossing techniques and dental cleaning)
- Provision of relevant oral health products (toothbrushes, toothpaste, dental floss, prosthesis brushes - one aid introduced each session).

Seminar sessions were delivered by a trained research assistant who had no professional oral health background. No direct professional oral health input or periodontal treatment was provided during the intervention period. Sessions were held at social clubs in groups of 6 to 8 single sex participants. Comparison group participants received no oral health program (and no special information on oral health during the course of the study).

No significant differences were seen within or between groups in terms of mean Plaque Index scores. Significant reductions in mean Gingival Index scores were seen within the intervention group over the course of the study. Both outcomes are scored on a scale of 0 to 3, with higher scores indicating more plaque or gingival inflammation (see Table 16 for results).

Table 8: Within and between group differences in oral health outcomes

Outcome	Intervention Mean (SD)	Comparator Mean (SD)	Intervention vs. comparator, p-value
Plaque Index			
Before	1.04 (0.73)	1.21 (0.88)	p=0.20
After	1.31 (0.65)	1.47 (0.80)	p=0.38
Gingival Index			
Before	0.44 (0.50) ‡	0.55 (0.62)	p=0.55
After	0.11 (0.25)‡	0.31 (0.48)	p=0.01
‡ Within group difference over time significant at p<0.001			

In terms of oral hygiene outcomes, the likelihood of flossing daily was significantly higher in the intervention vs. comparator groups, although values were not reported. There were no significant differences in the percentage of participants reporting regular tooth brushing:

- Intervention – before: 100%, after: NR; reported as non-significant, 95% CI and p-value NR
- Comparator – before: 99.3%, after: NR; reported as non-significant, 95% CI and p-value NR.

Summary and Evidence Statement

Overall, the evidence regarding oral health interventions and programmes amongst eldery populations is weak, but the three studies suggest that programmes may have a particular impact on flossing and gingival health amongst elderly populations. Based on the limited evidence identified, no effect was seen in terms of tooth decay or toothbrushing in this age group.

Evidence Statement 21: The effect of oral health interventions and promotion programmes on the oral health, oral hygiene and knowledge of elderly populations

Weak evidence from one RCT (UK[1]) and two cluster non-randomised controlled trials (Australia[2,3]) suggests that oral health interventions and education programmes may be effective at improving flossing behaviour, gingival health, dental attendance and knowledge amongst elderly individuals, but has no impact on tooth decay, brushing habits, or plaque levels in this population.

One study[1] found that a six month xylitol chewing gum intervention had no significant effect on tooth decay levels amongst individuals over the age of 60, but did lead to significant improvements in plaque levels and gingival health (effect sizes not reported, $p<0.001$ for both comparisons)[1].

One study[2] found that a community based health education and promotion programme delivered at social clubs amongst elderly migrant populations led to significant improvements in flossing, although effects varied with ethnicity (Greek clubs: OR 13.33, 95% CI 5.64 to 31.58; Italian clubs: OR 5.16, 95% CI 2.32 to 11.51)[2]. The programme had no effect on toothbrushing behaviours in either group.

In terms of dental access, the programme[2] had no significant effect on dental attendance amongst participants from Greek social clubs (OR 0.77, 95% CI and p-value NR)[2], while significant increases in attendance were reported amongst older community dwelling Italian migrants (OR 1.82, 95% CI 1.01 to 3.35)[2]. Finally, the study reported significant improvements in caries knowledge (β 1.32 (SE 0.46); $p<0.01$), periodontal health knowledge (β 2.07 (SE 0.36); $p<0.001$) and oral cancer knowledge (β 5.47 (SE 0.69); $p<0.001$) amongst older Greek migrant populations,

while significant associations were seen in periodontal (β 0.49 (SE 0.25); p<0.05) and oral cancer knowldedge (β 0.96 (SE 0.45); p<0.05) amongst older Italian migrant populations[2].

Another study[3] found that an oral health promotion and education programme at community based social clubs had no significant effect on plaque levels, but did lead to significant improvements in gingival health amongst elderly migrants in Australia (effect size not reported, p<0.01)[3]. The programme also had no significant effect on regular toothbrushing (values not reported)[3], but did find significant differences in daily flossing behaviour (values not reported)[3].

[1] Al-Haboubi et al. 2012 [+]
[2] Marino et al. 2004 [-]
[3] Marino et al. 2013 [-]

4.9 Homeless populations

Two studies were identified which assessed the impact of oral health programmes for homeless or formerly homeless populations:

- One non-randomised controlled trial (Ciaranello et al. 2006 [+])
- One before and after study (DiMarco et al. 2010 [-])

Ciaranello et al. 2006 (Non-randomised controlled trial [+], USA, n=6 sites and 609 participants, FNR)

Formerly homeless single adults living in four transitional housing facilities (THFs) in the Sacramento area of California participated in a programme entitled Healthcare Empowerment Alliance for people living in Transitional Housing (HEALTH) project.

The interventions were targeted towards previously identified barriers to accessing healthcare for homeless people. The Health Integrated Service Team (IST) included a medical director, a nurse practitioner, a medical clerk, and a social worker. The IST made weekly visits to the sites and provided comprehensive health assessments;

follow up care, social work services including counselling, health education and referrals to dental and other services. An advice nurse was available by telephone 24 hours a day. Additional clinics were provided for specific services (e.g. HIV and TB testing).

The HEALTH project aimed to provide direct dental, medical, and social services; referral for diagnostic testing and specialty care; and health education.

Comparisons were made over 18 months to two non-equivalent THFs not taking part in the HEALTH project. One of these was a male only site. The mean number of teeth with obvious decay among participants at the four intervention sites and two comparator sites were:

- Intervention – baseline: 2.9 (4.7), 6 month follow-up: 2.7 (5.1), 18 month follow-up: 1.8 (3.6)
- Comparator – baseline: 2.0 (2.5), 6 month follow-up: 1.9 (2.9), 18 month follow-up: 1.7 (2.2)

Regression analysis (adjusted for baseline values and gender) revealed that the intervention did not have a significant effect on decay at 6 months (values NR, p=0.36) or 18 months (values NR, p=0.75).

The proportion of participants who reported being able to access necessary dental specialist sometimes or always was:

- Intervention – baseline: 32%, 6 months: 29%, 18 months: 46%
- Comparator – baseline: 46%, 6 months: 45%, 18 months: 51%

Regression analysis (using baseline adjustment for main effects of THF site) found that the intervention did not have a significant effect on dental specialist access at 6 months (adjusted OR 0.541, 95% CI 0.265 to 1.105; p=0.092) or 18 months (adjusted OR 0.882, 95% CI 0.435 to 1.788, p=0.727).

DiMarco et al. 2010 (Before and after study [-], USA, n=120 mothers/families and 236 children, FNR)

Mothers and their children living in homeless shelters in the Midwestern United States were eligible for a nurse-managed shelter-based dental care and referral programme. Children received an oral exam, referrals to local dental providers who agreed to see children and accepted Medicaid, and mothers were provided access to a telephone in order to make an appointment.

After one month follow-up, access to care was assessed as the ability of the client to make an appointment and get to the appointment, measured via the Access Barriers to Care Index (ABC); scores range from 25 to 125, with lower scores indicating better access to care.

Of the families not lost to follow-up (89 of the original 120), there was a significant reduction in perceived barriers to care (mean ABC index score baseline: 45.00 (15.98), follow-up: 37.95 (12.60); 95% CI NR; $p<0.001$).

Summary and Evidence Statement

Limited evidence was identified regarding aimed at improving dental access among homeless or recently homeless individuals. The two identified studies had several weaknesses, including poorly reported analysis and short follow-up time.

Results indicate that a health promotion programme addressing several areas of health (e.g. medical, dental, social) is not effective at improving the oral health or access to specialist services amongst formerly homeless individuals.

A shelter-based oral health assessment, provision of contact information for local dentists, and facilitating the ability to make a dental appointment, may lead to homeless women perceiving fewer barriers to accessing dental services for her family. The long term effect of such programmes on access and attendance cannot be evaluated based on the current evidence.

Evidence Statement 22: The effect of oral health interventions and promotion programmes on the oral health and dental service access of homeless or formerly homeless individuals

There is weak evidence from one RCT (US[1]) and one before and after study (US[2]) suggesting that oral health programmes amongst the homeless or formerly homeless may reduce perceived barriers to access of dental services, but may not improve utilisation of such services.

One shelter based study[2] found that a simple oral health programme that includes providing mothers with the contact information for local dentists as well as with access to a telephone in order to make an appointment for their children is associated with significantly reduced perceived barriers to dental care (mean (SD) ABC scores: 45.00 (15.98) vs. 37.95 (12.60); 95% CI NR; p<0.001)[2].

A second study[1] found that a broad health promotion and provision programme amongst the formerly homeless had no significant effect on dental service utilisation after six months (adjusted OR 0.541, 95% CI 0.265 to 1.105; p=0.092)[1] or 18 months (adjusted OR 0.882, 95% CI 0.435 to 1.788, p=0.727)[1]. Nor was any effect seen in terms of dental decay after six months (values NR, p=0.36)[1] or 18 months (values NR, p=0.75)[1].

[1] Ciaranello et al. 2006 [+]
[2] DiMarco et al. 2010 [-]

4.10 Children with Autism Spectrum Disorders

One study was identified assessing the association between a school based health support programme and the oral health behaviours and access to dentists amongst children with special needs.

- One before and after study (Mitton et al. 2012 [-])

Mitton et al. 2012 (Before and after study [-], UK [England], n=23, FNR)

The 'Working Together for Health' Project was implemented in a specialist support primary school in Greater Manchester, England in order to improve the health (including the dental health) of children with autism spectrum disorders (ASD). The programme included a core team of a school nurse, a special education needs

teacher, a clinical psychologist, a dental therapist and two parents of children with ASD.

The activities were targeted to focus on the individual child's needs, likes, and dislikes, and the dental activities focused on desensitisation. Children were supported in brushing their teeth on a daily basis in school. The dental therapist assessed children reluctant to brush their teeth and gave advice to parents and staff on techniques and specialist brushes. They also worked with children with specific phobias. The dental therapist gave talks at new parents evenings, sports days, and at a food festival that was part of the programme. The children were also engaged in dental-related play involving pretending to be and dressing up as dentists. There was a drop in dental clinic, and a local policy was developed about treatment of children with ASD in the dental surgery. Links were developed between the school and local specialist dental services to reduce non-attendance, with the school reminding parents of appointments.

The diet part of the programme was aimed at raising awareness of the problems that children with ASD face, and techniques to introduce new foods and textures.

No statistical comparisons were reported (p-values or CI) for outcomes before and after the programme implementation.

In terms of behavioural outcomes, after programme implementation, 100% of children in school were brushing their teeth on a daily basis, whereas only 10 children were before (denominator not clear). Some parents reported improvement in brushing at home.

In terms of improving access to dentists, there were 11 new referrals to a specialist dental service for children with special needs and for children who had not been able to go to their family's dentist. Seven children who had previously missed two dental appointments were supported by their school nurse to attend their appointments. Four of the children also attended subsequent appointments for treatment.

Summary and Evidence Statement

Based on the identified evidence, no conclusions can be drawn regarding the effectiveness of school based health promotion programmes for children with Austism Spectrum Disorder. The single identified study provided very few quantitative results and provided no statistical comparisons by which to estimate programme impact.

Evidence Statement 23: The effect of a school based health promotion programme on the oral hygiene and dental service utilisation of children with Autism Spectrum Disorder

Weak evidence was identified from one before and after study (UK[1]) regarding the effect of a broad school based health promotion programme amongst children with Autism Spectrum Disorder. Due to the lack of descriptive or comparative statistics, no conclusions regarding programme effectiveness can be drawn[1].

[1] Mitton et al. 2012 [-]

4.11 Indigenous populations

Three studies (described in five publications) were identified that assessed the impact of oral health promotion programmes amongst children from Indigenous communities.

- One cluster RCT (Slade et al. 2011 [++], with additional results reported in Divaris et al. 2013 [+] and Roberts et al. 2010 [+])
- One non-randomised controlled trial (Maupome et al. 2012 [-])
- One before and after study (Macnab et al. 2007 [-])

Slade et al. 2011 (Cluster RCT [++], Australia, n=30 communities and 666 participants, FW and NF)

Three citations (Slade et al. 2011 [++], Divaris et al. 2013 [+] and Roberts et al. 2010 [+]) reported results for a programme amongst children aged two to four years residing in remote Aboriginal communities in Australia's Northern Territory who were

eligible to participate in a twice yearly multi-component oral health promotion intervention:

- Fluoride varnish application, twice a year for a total of five applications
- Oral health education/caries prevention advice for parents on sugar consumption, use of fluoride toothpaste and proper toothbrushing; parents also received a low-fluoride toothpaste for use at home
- Community health promotion, which consisted of engaging store owners, parents, community leaders and health centre workers

The water fluoridation status varied across the included communities, with some areas having access to fluoridated water and others having no access; all analyses in oral health analyses controlled for community area and size as well as water fluoride concentration.

Slade et al. 2011 [++] also found that at two years follow-up, the mean adjusted $d_3$mfs increment in the 15 intervention vs. 15 comparator communities was 6.2 (95% CI 5.0 to 7.4) vs. 9.7 (8.5 to 10.9). This reduction of 3.5 (-5.1 to -1.9) represents a prevented fraction of 36%.

Divaris et al. 2007 [+] reported that there was a significant reduction in 2 year cumulative incidence of cavities ($d_3$mfs) in the intervention vs. comparator communities, after adjusting for community water fluoridation (RR: 0.75, 95% CI 0.71 to 0.80). This effect varied according to surface, with significant reductions seen amongst surfaces that were sound at baseline assessment (RR: 0.73, 95% CI 0.69 to 0.79) and those that were considered opaque at baseline (RR: 0.77, 95% CI 0.65 to 0.92). No difference in risk was seen amongst surfaces found to be hypoplastic at the beginning of the study (RR: 0.90, 95% CI 0.75 to 1.08) or in precavitated surfaces (RR: 0.92, 95% CI 0.74 to 1.15).

Roberts et al. 2010 [+] reported that the programme had no impact on mean change in Gingival Index scores over the course of the study (intervention: 0.48 (SD 1.15) vs. comparator: 0.54 (SD 1.22); 95% CI NR, p=0.56), or the percentage of children

reported to have cleaned teeth on the previous day (intervention: 40.5% vs. comparator: 40.2%; 95% CI NR, p=1.00).

In terms of diet, Roberts et al. 2010 [+] reported that there was no difference in the percentage of intervention group children who reportedly consumed sugary drinks the day before vs. comparator group children at baseline (intervention baseline: 65.8%, follow-up: 63.0%; 95% CI NR, p=0.54). There was, however, a lower percentage of children from the comparator communities with parent reported sugary drink consumption at follow-up, compared to the percentage in the intervention communities (intervention: 61.5%, comparator: 52.5%; 95% CI NR, p=0.03).

Maupome et al. 2012 (Non-randomised controlled trial [-], USA, n=252, FNR)

Newborn children and their families, residing in four geographically separated American Indian communities in the Pacific Northwest of the United States, participated in a 12 month nutrition programme, which was intended to encourage breastfeeding and reduce the consumption of sweetened beverages, and used both community-wide media programmes as well as family level interventions. Three communities participated in the programme, and one comparator community did not.

Intervention effects reflect the change over time in the programme community (post- minus pre- caries) less the change over time in the comparator community, adjusting for age. All three intervention communities exhibited a reduction in the proportion of children with caries compared to the comparator community. This association ranged from a reduction of 0.342 to 0.440 (significant at p≤0.032) for cavitated enamel lesions (d2), and 0.300 to 0.631 (significant at p≤0.059 and p=0.013, respectively) for incipient lesions (d1).

Macnab et al. 2007 (Before and after study [-], Canada, n=98, FNR)

School-aged children attending kindergarten through grade 10 in a remote First Nations community participated in a three year school based oral health education and promotion programme. The programme consisted of daily supervised toothbrushing, weekly fluoride mouth rinse, and fluoride varnish application every four months (for children under the age of nine years). Paediatric residents

presented oral health education information in the classroom by paediatric residents, and provided dental health guidance to parents/family during well-baby and well-child visits.

There were discrepancies in outcome reporting within the study. The methods section of the paper reported primary outcomes as surface level decay and caries (dmfs/DMFS), however, the results section refers to these outcomes at the tooth level (dmft/DMFT). It is unclear which of the measures was used, and all data presented in this report refers to the outcome as reported in the publication's results section.

The authors reported that there were no significant differences in the proportion of children found to be caries free (before: 8%, after: 30%; reported as NS; 95% CI and p-value NR), nor in average levels of tooth decay, either overall (dmft) or when broken down to component outcomes (ds, ms, fs). Mean (SD) dmft levels were 20.1 (18.2) before the intervention, versus 20.4 (19.2) after implementation (differences reported as NS; 95% CI and p-value NR). See Appendix E for mean values in deciduous tooth decay outcomes before and after the study. The programme was associated with reduced decay of the permanent dentition, both overall (DMFT before: 5.5 (SD 6.2), after: 6.1 (8.5); 95% CI NR, $p<0.05$) and when considered in the component measures (see Appendix E for component results).

The percentage of children who reported brushing their teeth daily at home was significantly lower after the intervention's implementation than before (before: 95%, after: 75%; 95% CI NR, $p=0.01$), while the percentage of children reported to brush daily at school was higher after programme implementation (before: 0%, after: 100%; 95% CI NR, $p<0.0001$).

There were improvements in dietary outcomes, with a greater percentage of children reported to eat confectionary and consume sugary drinks fewer than three times per week after the programme implementation (confectionary before: 9%, after: 63%; 95% CI NR, $p<0.0001$; sugar sweetened drinks before: 19%, after: 58%; 95% CI NR, $p=0.0002$). Significant improvements were seen in dental attendance as well, with a higher proportion of children with a reported dentist visit each year after programme implementation than before (before: 76%, after: 100%; 95% CI NR, $p=0.002$).

Summary and Evidence Statements

The evidence concerning the impact of oral health promotion programmes amongst children from Indigenous communities is summarised by outcome below.

Oral Health

Overall, evidence suggests that community based interventions may be effective at reducing dental decay in young children from Indigenous communities.

Results from Slade et al. 2011 [++] and Divaris et al. 2007 [+] suggest that the programme may be effective at preventing new caries in young children, but not at arresting or reversing existing lesions. No impact was seen in gingival health in Roberts et al. 2010 [+].

Maupome et al. 2012 [-] found that over the course of the two year study there were significant secular trends in d_1t and d_2t caries in the comparator community, which were accounted for in the analyses. Improvement in reversible tooth decay was seen in all three communities receiving the nutritional health promotion programme when compared to the increase in caries experience seen in the comparator community.

Macnab et al. 2007 [-] reported no difference in terms of the percentage of children found to be caries free before and after a school based programme. The study may not, however, have been sufficiently powered to detect such an effect. There were differences in the proportion of the eligible population with available outcome data. Due to resource constraints, a convenience sample of twenty-six children (45% of children in the community) was assessed prior to the intervention, while all 40 children in the community were assessed at follow-up. Thirteen children had data both pre- and post-intervention. No information was provided on differences between children included in the baseline evaluation and those not assessed, and no information on sampling techniques was reported.

Evidence Statement 24: The effect of community based oral health promotion and prevention programmes on dental decay and gingival health of Indigenous populations

Inconsistent evidence from one cluster RCT with results reported in three separate publications (Australia[1,2,3]), one non-randomised controlled trial (US[4]) and one before and after study (Canada[5]) was identified regarding the effect of community based oral health promotion programmes on the oral health of children in Indigenous communities.

One study[1] suggested that a multi-component oral health promotion programme that includes fluoride varnish applications may be effective at reducing tooth decay (adjusted $d_3$mfs increment: -3.5 (-5.1 to -1.9); prevented fraction 36%)[1].

Another publication[2] for the same study found a significant reduciton in two year $d_3$mfs cummulative incidence (RR 0.75, 95% CI 0.71 to 0.80)[2]; the reduction was significant among surfaces that were sound at the start of the study (RR: 0.73, 95% CI 0.69 to 0.79)[2] and those that were considered opaque at baseline (RR: 0.77, 95% CI 0.65 to 0.92)[2], but not among hypoplastic surfaces (RR: 0.90, 95% CI 0.75 to 1.08)[2] or precavitated surfaces (RR: 0.92, 95% CI 0.74 to 1.15)[2].

A third publication[3] found that the same programme had no effect on Gingival Index scores (0.48 (SD 1.15) vs. 0.54 (SD 1.22); 95% CI NR, p=0.56)[3].

Another study[4] of a 12 month community- and family-level nutrition programme focussing on breastfeeding and the consumption of sweetened beverages reported significant reductions in cavitated enamel (d_2) and incipient enamel (d_1) lesion prevalence in three communities after accounting for secular trends in similar communities; the association ranged from a reduction in d_2 lesions of 0.342 to 0.440 (significant at p≤0.032)[4], and 0.300 to 0.631 in d_1 lesions (significant at p≤0.059 and p=0.013, respectively)[4].

Another study[5] found no significant difference in the proportion of children who were caries free before and after the implementation of a three year, school based oral health education and promotion programme, which included the provision of fluoride (8%, after: 30%; reported as NS; 95% CI and p-value NR)[5]. The programme was associated with significant reductions in average decay levels in the permanent but not primary dentition (DMFT: 5.5 (SD 6.2) vs. 6.1 (8.5); 95% CI NR, p<0.05. dmft: 20.1 (SD 18.2) vs. 20.4 (SD 19.2); reported as NS, 95% CI and p-value NR)[5].

[1] Slade et al. 2011 [++]

[2] Divaris et al. 2013 [+]

[3] Roberts et al. 2010 [+]

[4] Maupome et al. 2012 [-]

[5] Macnab et al. 2007 [-]

Oral hygiene

Overall, the oral health programmes identified had no effect on oral hygiene or were associated with harmful effects. Roberts et al. 2010 [+] found that a community wide health promotion programme had no effect on the percentage of children reported to have cleaned teeth on the previous day; there were no significant differences between programme and comparator communities either at baseline (16.6% vs. 15.1%; 95% CI NR, p=0.64) or at 2 year follow-up assessments (40.5% vs. 40.2%; 95% CI NR, p=1.00).

Results from Macnab et al. 2007 [-] suggest that introduction of the school based oral health programme may have had unintended consequences in terms of home-based oral hygiene practices, and the study authors suggest that the observed reduction daily home-based brushing may be due in part to increased brushing at school.

Diet

Inconsistent results were seen in the consumption of cariogenic foods and drinks. Roberts et al. 2010 [+] reports that there was no difference in the percentage of intervention group children who reportedly consumed sugary drinks the day before assessment. When assessing parent reported outcomes, signficantly fewer children in the comparator group were reported to consume sugary drinks at home. This difference arose due to a reduction in consumption in the comparator group, which was not seen among programme participants.

Macnab et al. 2007 [-] reported that improvement was seen across dietary outcomes, including confectionary and sugary drink consumption.

Dental service utilisation

Limited evidence was identified regard associations between oral health programmes and dental access. Macnab et al. 2007 [-] reported improvements in the proportion of children who visited a dentist each year after programme implementation.

Evidence Statement 25: The effect of community based oral health promotion and prevention programmes on oral hygiene and dietary behaviours, and dental service utilisation amongst children in Indigenous communities

Inconsistent evidence from one cluster RCT (Australia[1]) and one before and after study (Canada[2]) was identified regarding the effect of community based oral health promotion programmes on the oral health of children in Indigenous communities.

One study[1] reported that after two years of a multi-component oral health promotion programme, there was no difference in the percentage of children reported to have brushed their teeth on the previous day between programme and control communities (40.5% vs. 40.2%; 95% CI NR, p=1.00)[1], and was associated with a worsening of sugary drink consumption amongst children, compared to control group communities at the end of the two year programme (61.5% vs. 52.5%; 95% CI NR, p=0.03)[1].

Another study[2] reported that participation in a school based oral health education and promotion programme, which included a supervised toothbrushing component, was associated with a significant reduction in the percentage of children reported to brush their teeth at home each day (95% vs. 75%; 95% CI NR, p=0.01)[2] and associated with significantly higher percentage of children brushing their teeth each day at school (0% vs. 100%; 95% CI NR, p<0.0001)[2].

The programme was also associated with an increase in the proportion of children reported to eat confectionary fewer than three times per week (9% vs. 63%, 95% CI NR, p<0.0001)[2] and an increase in the percentage of children reported to consume sugary drinks fewer than three times per week after the programme implementation than before (19%, after: 58%; 95% CI NR, p=0.0002)[2].

The second study[2] also suggests that participation in a school based oral health promotion programme is associated with an increased percentage of children reporting to have visited the dentist each year (76%, after: 100%; 95% CI NR, p=0.002)[2].

[1] Roberts et al. 2010 [+]
[2] Macnab et al. 2007 [-]

5 Discussion and conclusions

There is wide variation in the quality of research methods and reporting across the included studies. Many provide descriptive statistics only, with no estimates of effect size or association; this limits the ability to draw conclusions on the effectiveness of the interventions and programmes identified. Several studies only provide descriptions of the significance comparisons, further complicating evidence synthesis and limiting the strength of any conclusions.

Overall, the ability of the review to support conclusions on the effectiveness of community based oral health interventions or programmes is limited by the inclusion of non-experimental study designs. Ideally, the review would have included RCTs or cluster RCTs only, however, this was impractical given that many programmes of interest are currently being implemented, and evaluation reports on such programmes were thought to form a critical portion of the evidence base. As such, many included studies are either interrupted time series, before and after studies, or in some cases, cross sectional in nature, and thus are only able to suggest areas where interventions or programmes may be associated with oral health of target populations.

The vast majority of identified studies (49 of 61, 80%) targeted young- or school aged children. Children under five are a particular risk for poor oral health, the impact of which can have life-long consequences. Efforts tend to focus education of carers, improving oral hygiene practices and improving early access to dental services in order to instil lifelong healthy behaviours and prevent onset of caries and other oral health problems. Identified programs were implemented in a mix of school or nursery, community and home settings.

Older children in England have a good standard of oral health compared to the rest of Europe, but challenges persist in terms of oral health inequalities across socioeconomic status (DH 2005). School settings were the focus of many oral health programmes in this age group. This approach has several potential benefits, although there was variation in effect across interventions. Potential benefits of school based programmes may include:

- Schools provide a 'captive audience' allowing for a high level of programme participation and may be suitable for population wide oral health promotion efforts.
- The settings may provide a natural clustering of children at higher risk for poor oral health (e.g. by socioeconomic status), and can be suitable for more targeted programmes amongst at risk children.
- Addressing oral health early in life may allow for instilling healthy habits, and aid in the prevention rather than treatment of tooth decay and other oral health issues.

Children – under five years and school aged

Fluoride interventions

Interventions that aimed to improve access to fluoride via school or nursery based programmes were generally found to be effective at reducing early childhood caries and dental decay. The evidence regarding the effectiveness of these programmes in nursery/preschool settings was limited, but of good quality (see Section 4.1).

Programmes that provided fluoride regularly throughout the school year (either via varnish applications, mouth rinse or fluoridated milk) tended to be more effective than those that provide access on a one-off or less regular schedule (see Section 4.4.2). However, fluoridated milk programmes may be prone to implementation difficulties.

Fluoride varnish

The evidence identified regarding the effectiveness of fluoride varnish application programmes was mixed, with significant effects seen in a programme aimed at preventing approximal caries among secondary school students with varying caries risk, and no effect seen among twice yearly programmes among primary school children. Overall, such programmes tended to be most effective in low-income/high-risk communities, while effects in lower risk communities tended to be non-significant.

A systematic review and meta-analysis of randomised or quasi-randomised controlled trials on the effectiveness of fluoride varnish suggested that such interventions can have a significant caries preventive effect in both permanent (prevented fraction 43%) and deciduous teeth (prevented fraction 37%), although there was moderate to substantial heterogeneity (Marinho et al. 2013). The review did not detect any association between prevented fractions and frequency of varnish application. There was overlap between the current review and the Marinho et al. 2013 review; Moberg et al. 2005 [++] and Hardman et al. 2007 [+] were included in both reviews. The trials in the Marinho review used a placebo or non-treatment control group, whereas two of the three studies included in the current review included a comparator group that received an established health promotion programme addressing oral hygiene and other oral health topics. The review also included studies conducted in clinics, and was not restricted to schools or other community-based settings. Differences in setting, study design and comparator may account for variation in results between this evidence review and the Marinho et al. 2013 systematic review.

Fluoride milk

Inconsistent evidence was identified from two UK based observational studies (Riley et al. 2005 [++], Ketley et al. 2003 [+]) and one cluster RCT conducted in Sweden (Stecksen-Blicks et al. 2009 [+]) regarding the effectiveness of a daily fluoridated milk programme at nursery and primary schools.

The prospective study (Ketley et al. 2003 [+]) reported that there was little to no difference in caries of the permanent dentition, and a significant worsening in the primary dentition compared to non-participating schools; the significance of the association in the primary teeth varied according to the level at which caries were assessed (tooth vs. surface level), and was non-significant at the surface level. The cross sectional study (Riley et al. 2005 [++]) observed a significant benefit to programme participation.

The two programmes were similar in content. It is notable that the significant results were detected by the cross sectional study only, however, there were

other differences between the two studies that may also account for the variation in observed association. Whether the differences in effectiveness are due to the age or other demographic characteristics of the participants, the outcomes assessed, or implementation of the fluoridated milk scheme cannot be determined.

A systematic review of RCTs (Yeung et al. 2005) concluded that there were an insufficient number of good quality studies on the effectiveness of fluoridated milk programmes at preventing dental caries. Based on the two identified trials included in the review, the evidence suggested that fluoridated milk could be beneficial to school aged children, especially in permanent dentition, a pattern that was seen in the two studies amongst primary school children (Riley et al. 2005 [++], Ketley et al. 2003 [+]). The cluster RCT included younger nursery aged children (Stecksen-Blicks et al. 2009 [+]) amongst whom changes in the permanent dentition would not be assessable. Given the conflicting results amongst the identified studies, additional high quality investigations into differences or difficulties in programme implementation could elucidate factors underlying a successful fluoridated milk scheme.

Fluoride mouth rinse

Overall, the identified evidence suggests that school based supervised mouth rinse programmes delivered over two to three years can significantly reduce caries incidence in the permanent dentition of both primary and secondary school children. Similarly, a systematic review and meta-analysis of randomised and quasi-randomised trials (Marinho et al. 2009) found that regular use of fluoride mouth rinse can reduce caries of the permanent dentition, regardless of other fluoride sources (including fluoridated water and toothpaste).

The inconsistent evidence regarding the potential effects of school based FMR programmes on oral health inequalities deserves particular consideration. Results from a cluster RCT reported in Moberg et al. 2005b [+] suggest that fluoride mouth rinse programmes have an overall beneficial effect on caries incidence in low to medium risk communities, and may be beneficial in terms of reducing

inequalities via their differential impact on groups with existing decay, with greater magnitude of effect seen with higher baseline decay. This suggests that benefits to be gained may vary according to an individual community's existing caries level. On the other hand, results from the a cross sectional study (Levin et al. 2009 [+]) suggest that weekly FMR programmes may serve to increase oral health inequalities, as the programme assessed had no significant association with mean caries either in the population as a whole or amongst the most deprived children, but was associated with significantly lower mean caries levels amongst the least deprived children. Whether the difference seen in the cross sectional study represents a true programme impact, or is attributable to confounding factors cannot conclusively be determined based on the available data. However, the association may be due in part to the low participation by children in the highest deprivation categories, and suggests that implementation efforts will need to focus on ensuring adequate uptake of school based fluoride mouth rinse interventions in the most deprived communities in order to ensure that local programmes do not exacerbate oral health inequalities.

Supervised toothbrushing

National scale, nursery based supervised toothbrushing programmes in Scotland were found to be associated with significant reductions in dental caries amongst five year olds (Macpherson et al. 2013 [++]) equivalent to a 32.3% reduction over the course of 15 years [reviewer calculated, RC]). The reduction amongst the most deprived categories (38.2% [RC]) was greater than that seen amongst the least deprived children (28.3% [RC]), suggesting that such programmes may be effective at reducing inequalities in oral health. Supervised toothbrushing with low fluoride toothpaste was found be associated with no significant difference in caries amongst primary school children (Burnett et al. 2005 [-]); however, two good quality cluster RCTs (Jackson et al. 2005 [+], Pine et al. 2007 [+]) found daily supervised brushing with higher fluoride toothpaste (1,000ppm to 1,450ppm) to have a significant effect in terms of reducing incident dental decay in this age group.

These results largely align with the direction and significance of effect reported in a systematic review and meta-analysis on the effectiveness of brushing with

fluoride toothpaste in terms of caries prevention amongst children and adolescents, which found that brushing with fluoride vs. non-fluoride toothpaste was associated with a prevented fraction of 24%, with 1.6 children required to brush with fluoridated toothpaste in order to prevent one DMFS in populations with caries increment of 2.6 DMFS/year (Marinho et al. 2003).

It should be noted that this review assessed the impact of fluoridated toothpaste in general, and was not specifically focused on the impact of school based supervised toothbrushing with fluoridated toothpaste. Only 12 of the 76 included studies were related to school based supervised toothbrushing with fluoridated toothpaste. Additionally, the majority of studies included in the Marinho et al. 2003 review were conducted in the 1960s and 1970s (2 of the 74 included studies were post-1970s, one in 1989 and another in 1994). The magnitude of effect seen in the review should not be assumed to apply to current UK populations given the overall reduction in dental caries over the past 30 years.

Oral health education

The effectiveness of oral health promotion and education programmes has been found to vary by outcome, with such programmes proving effective at altering oral health knowledge and attitudes, having varying effect on plaque accumulation and gingival health, and generally having limited impact in terms of caries reduction (Kay and Locker, 1996).

Such variation in effect was seen in the current review, with consistent improvements or effects on knowledge and attitude outcomes amongst school children (Reinhardt et al. 2009 [+], The Dental Health Foundation 2007 [+], Biesbrock et al. 2003 [+], Biesbrock et al. 2004 [+], and Freeman and Bunting 2003 [-]). Variable effects were found in terms of periodontal outcomes, including plaque accumulation and gingival health reported by Vanobbergen et al. 2004 [-], Biesbrock et al. 2003 [+], Biesbrock et al. 2004 [+] and Wennhall et al. 2005 [+].

Finally, in terms of effect of caries experience, studies that included the provision or use of fluoride tended to be associated with improvement in caries as opposed

to programmes with no fluoride component; the consistency of caries outcomes varied across studies, however.

Oral health education programmes among school children varied considerably in content, intensity and target population. Those programmes that provided education only tended to not impact oral hygiene behaviours such as toothbrushing, while programmes that included provision of oral hygiene supplies (e.g. toothbrushes, toothpaste) tended towards improved behaviours. The strongest evidence (in terms of study design) for this pattern of effectiveness comes from two cluster RCTs. Both Vanobbergen et al. 2004 [-] and the education only arm of the Dental Health Foundation 2007 [+] trial reported no significant differences in toothbrushing, either based on parent report (Vanobbergen et al. 2004 [-]) or more objective measures (Dental Health Foundation 2007 [+]). The remaining arm of the Dental Health Foundation 2007 [+] trial provided oral health education plus toothbrush and fluoride toothpaste, and resulted in significant improvements in objectively measured toothbrushing (with fluoride toothpaste). An important caveat of this two arm study is that schools in the education only arm lived in communities with no access to fluoridated water, while the education plus schools were in fluoridated areas. Evidence from these two cluster RCTs is bolstered by lower strength evidence from cross sectional and before and after studies, which generally support the pattern of associations.

Oral health education programmes targeting the prevention of early childhood caries (for those under the age of 5) may be most effective when aimed at mothers/parents/carers in non-school environments. These programmes may also impact oral hygiene practices, and suggest that providing information on the importance of good diet and oral hygiene (via health education and counselling) as well the means to act on that knowledge (via the provision of oral hygiene supplies and fluoride) can be effective at preventing early childhood caries. The evidence for programmes in these community settings is based on two studies, however, both of which targeted low-income families. As such, the findings should not be generalised to population-wide programs.

Adult populations

Only two studies were identified that assessed the effectiveness of work based oral health education programmes or interventions among adults, both of which were workplace interventions conducted in Japan, and neither of which had a study design suitable to determine the effectiveness of the interventions (one was a within group analysis of an RCT, the other a cross sectional study). Both studies narratively reported significant improvements in oral health outcomes (e.g. periodontal and gingival health, DMFT). However, neither study provided data on the strength of the association or significance. These weaknesses in quantity, quality, study design and reporting limit the ability to draw conclusions on the effectiveness of such interventions.

Elderly populations

The improvements in oral health over the past several decades extend to elderly populations as well, with more people over 65 keeping their teeth throughout life today than in previous decades. However, this presents new challenges in terms of increased tooth decay in elderly populations. The identified evidence in this population tended to be of low quality, and indicated that in depth health education programmes may be effective at changing some oral hygiene behaviours and their associated oral health outcomes (e.g. flossing frequency and gingival health), but that minimal gains are attainable in terms of toothbrushing, which was already high in the communities assessed, and associated improvements in terms of tooth decay.

Evidence gaps

There were several evidence gaps evident after the systematic search and sifting of studies.

Populations

There were considerable gaps in the evidence concerning key groups considered at risk for poor dental health (e.g. pregnant women, homeless, traveller communities, those with mobility difficulties and learning disabilities). The lack of

evidence may be due to underlying difficulties in delivering programmes in these populations, or due to difficulties in long term assessment in these groups. For instance, one identified study (DiMarco et al. 2010 [-]) conducted in homeless shelters was only able to assess short term outcomes due to limitations on time spent in the shelter. While the study found improvement in perceived barriers to accessing dental services, circumstantial limitations prevented assessment of whether the programme actually improved access to dentists in the high risk group.

In other populations, this evidence gap is due to specific scoping considerations. For instance, the majority of studies among pregnant women that were identified in the search were incorporated into individual patient care, and thus excluded from the current review.

Several studies were identified that assessed the effectiveness of community based programmes on the oral health amongst Indigenous populations. Poor health among indigenous communities is attributed to risk behaviours such as tobacco, alcohol and substance misuse, and broader social determinants including health care organisation and housing quality, geographic isolation/remoteness and lower SES. While not directly applicable to UK populations, these communities shared risk factors that may be informative when designing pilot investigations in populations considered difficult to reach with health promotion programmes, as the groups may share key characteristics that inform their oral health status. However, given the lack of direct applicability to the UK of studies in Indigenous Australian, American or Canadian communities, any conclusions drawn should be considered for hypothesis generation only. As with the studies identified throughout the review, the studies in indigenous populations were largely focused on children (see Sections 4.4.6 and 4.12), further reducing their applicability to at risk adult populations in the UK.

Interventions/Programmes

The UK Department of Health suggests that local authorities integrate oral health promotion into their policies and practice by taking a common risk factor

approach, for example, by providing healthy snack foods in school tuck shops and vending machines (DH 2005).

A limited number of studies were identified which assessed the integration of oral health promotion into broader health promotion programmes and environments, or explicitly addressed a behaviour (i.e. tobacco use, diet) that is a common risk factor for both oral diseases and other chronic conditions. Two school based programmes that addressed environmental and policy changes to promote oral and general health reported conflicting results, with oral health seen to improve in one correlation study (Muirhead and Lawrence 2011 [+]) and, depending on the outcome assessed, either decline or not change in another study (Freeman and Oliver 2009 [-]).

Outcomes

In terms of clinical outcomes, there was a particular lack of data on periodontal health, permitting few conclusions to be drawn, despite the prevalence of poor periodontal health in the UK. No evidence was identified regarding programme effect on oral cancer. Similarly, limited studies were identified on the common risk factor approach. Two main targets of a common risk factor programme (i.e. smoking, alcohol consumption) are linked to oral cancer risk (Bagnardi 2001).

Another key evidence gap identified was in regards to systematic reporting of side effects, specifically dental fluorosis (enamel defects arising from chronic exposure to too much fluoride during tooth development [Marinho et al. 2003]) in studies aiming to improve access to fluoride through nursery or school based programmes. This may be due in part to study protocols calling for use of low dose fluoride amongst children under the age of five (see Whittle et al. 2008 [+], Ellwood et al. 2004 [+], and Burnett et al. 2005 [-]).

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