*Community Dental Health* (2024) **41,** 208–214
Received 20 May 2024; Accepted 23 July 2024; Online 6 August 2024

doi:10.1922/CDH_00107Kouassi07

# Effectiveness of preventive intervention programmes aiming to improve oral health in children who have undergone caries-related dental extractions: a rapid review

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***Objective***: To determine the effectiveness of preventive interventions in children who have undergone caries-related dental extractions. ***Methods***: Rapid review across five databases (CENTRAL, Ovid Medline, Embase, Web of Science and Scopus). Quality was assessed using the Risk of Bias 2 tool. ***Results***: Five studies were included, all randomised controlled trials involving pre-and/or post-extractions activity. Three studies involved oral health education (computer game, motivational interviewing, visual aids), one delivered clinical prevention (fissure sealants), and one an enhanced prevention programme combining additional health education and a clinical intervention (fluoride varnish). Retention was mixed (55%-80% in the intervention groups). Of the three studies measuring caries, all reported less caries development in the test group. However, only a study involving a dental nurse-delivered structured conversation, informed by motivational interviewing, showed an improvement in oral health. Two studies reporting on plaque and gingival bleeding had conflicting results. A study reporting on subsequent dental attendance did not demonstrate a clear improvement. ***Conclusion***: Few published studies have explored prevention-based interventions in high caries-risk children requiring dental extractions. Whilst evidence of clinical benefit of preventive interventions in this population is limited, the potential use of contemporary behaviour change techniques appears promising. There is an urgent need for more high-quality longer-term trials using contemporary methodologies.

**Keywords***: tooth extraction, general anaesthesia, preventive dentistry, dental health services, Dental caries, dental care for children*

## Introduction

Dental caries is the most prevalent non-communicable disease worldwide (WHO, 2022). Even in high-income countries (HICs) where there has been a decline in caries experience, this disease remains a challenge. The 2022 national survey of 5-year-old children in England (2022) suggested that almost one third (29.3%) had tooth decay experience with children in more deprived areas being more affected (OHID, 2023). Five-year-old children have been identified as having the highest rates of hospital admissions due to tooth decay (Kaddour *et al*., 2023). Specifically, children aged 4 to 9 years old accounted for 68.9% of total admissions in children from 1 to 19 years old, between 2015-16 and 2020-21.

Early childhood caries (ECC) is defined as the presence of one or more carious teeth in a child of preschool age (Vadiakas, 2008). Severe ECC, which refers to the presence of at least one smooth surface lesion in very young children (under the age of three years) or multiple lesions in older preschool children (Vadiakas, 2008; Ismail & Sohn, 1999), is the most common reason for children to be pre-compliant and require hospital admission for extractions under general anaesthetic (GA) (OHID, 2022).

Advanced tooth decay, at an early age generally leads to hospitalisation for dental extractions, most often involving care under GA, with local anaesthesia and sedation used in older children, where appropriate. In England, it is the most common hospital procedure in 6- to 10-year-olds, with 83.1% of hospital extractions in this age group being dental caries-related (OHID, 2022). Children often require removal of more than one tooth. A service evaluation exploring the views of parents whose children required extractions under GA found that 47% of parents reported a previous history of dental GA due to caries for their child or other children in the family (Olley *et al*., 2011). It also suggested that these children are members of a higher-risk family. Moreover, when treated under GA, many high-caries risk children repeatedly risk morbidity and mortality from a disease that is largely preventable. The cost of hospital admissions is appreciable; yet surgical treatment alone does not address the disease risk and burden. Further action is required to address modifiable risk factors including diet, oral hygiene, and dental attendance. The attendance of these children often at designated facilities for their extractions, allows opportunity for intervention. Whilst substantial evidence is available on the prevention of oral disease and guidance for dental teams, such as '*Delivering Better Oral Health*' (OHID, 2021), a review of the preventative advice and support provided to these high caries risk children undergoing dental extractions, and their families, has not been conducted.

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Thus, the aim of this study was to determine the effectiveness of preventive interventions to improve oral health in children who have undergone caries-related dental extractions. It aimed to answer the following questions to inform future research and action:

1. What preventative interventions have been delivered to children (and their families) who have undergone caries-related dental extractions?
2. What effects have these interventions had on oral health and behaviours?

## Methods

The review was conducted using Khangura's rapid review method (Khangura *et al*., 2012; Thomas *et al*., 2013). Published research reports were identified by searching databases including CENTRAL (Cochrane Central Register of Controlled Trials), Ovid Medline, Embase, Web of Science and Scopus. A citation search of the included articles identified further eligible studies. The search terms used were based on the PICO framework (Table 1), and adapted for each database in consultation with library services. Broad criteria were set for age and outcome as pilot searches suggested that few studies would be included in the review. The effects of interventions on proxy markers, such as plaque and gingival bleeding, were included due to the role of oral hygiene in caries formation and to include studies with short follow-up that could not measure caries incidence as a clinical parameter.

The search was conducted in November 2022; and updated in February 2024. Searches were limited to studies published between 2000-2024. Results from each database were imported into Endnote software and duplicates removed. Records were screened independently by two reviewers on Rayyan software by title and abstract. Where eligibility was not determined by title and abstract alone, the full article was obtained and screened in line with the inclusion criteria. Disagreements were resolved by the reviewers in discussion with senior academics in the research team.

**Table 1.** PICO framework, inclusion and exclusion criteria, search terms.

| | |
|---|---|
| Population | Children up to 17 years of age who have undergone or are being scheduled for dental extractions due to caries. |
| Intervention | Any oral health intervention aiming to improve oral health outcomes. |
| Comparator | Children who did not receive any oral health interventions. |
| Outcome | Effect on caries and gingival health.<br>Changes in oral health behaviours such as toothbrushing frequency, dental attendance, dietary changes. |
| Inclusion Criteria | • All studies including interventions to improve oral health in children who have undergone dental extractions or being scheduled for dental extractions in any setting including hospital, specialised clinics or general dental clinics.<br>• Children having at least one caries-related dental extraction.<br>• No restrictions will be made on the type of oral health intervention, outcome or child age.<br>• Any study design (such randomized control trials, non-randomized studies, observational studies, case-control, cross-sectional).<br>• Only English language full text publications will be included.<br>• Interventions aimed at children and/or their families. |
| Exclusion Criteria | • Papers that do not clearly involve children who have undergone dental extractions as the population.<br>• Conference abstracts, dissertations, letters to editors and any other non-scientific papers. |
| Key Search Terms (Example of search from Web of Science) | • (Child* or stepchild* or step-child* or kid or kids or girl* or boy or boys or teen* or youth* or youngster* or adolescen* or preschool* or pre-school* or kindergarten* or school* or juvenile* or minors or p*ediatric)<br>AND<br>• (remov* near/6 (teeth or tooth or dental or molar* or premolar* or pre-molar*)) OR (Extract* near/6 (teeth or tooth or dental or molar* or premolar* or pre-molar*))<br>AND<br>• ((teeth or tooth or dental) NEAR/3 (caries or carious or decay))<br>AND<br>• ((dent* or oral or mouth or teeth or tooth*) near/3 (instruct* or advice or advis* or educat* or teach* or train* or promot* or interven* or demonstrat* or supervi* or prevent*)) OR (toothbrush* or "tooth brush*" or tooth-brush) OR ((toothpaste* or tooth-paste* or "tooth paste*" or dentifice*)) OR ((mouthrinse* or mouthwash* or "mouth rinse*" or "mouth wash*" or mouth-rinse* or mouth-wash*)) OR (fluorid* near/3 (varnish or topical)) OR ((Fissure* near/3 seal*)) OR (Cariogenic diet) OR (dietary sugar*)) OR ((dental or oral) and health behavio*r*) OR (behav* and (change or therapy)) OR (Motivational interviewing) OR ((Caries or decay) near/2 (prevent* or reduc*)) OR (Oral hygiene) OR ((demonstrat* or supervis*) AND (toothbrush* or "tooth brush*" or tooth-brush*) ) |

One author extracted data from the included studies using a data collection form comprising: General study information, aim, population, details of intervention and control, follow-up, outcome, key findings, and authors' conclusions. Due to the heterogeneity among the studies, only a qualitative synthesis could be performed.

### *Risk of bias assessment*

The Cochrane risk-of-bias tool for randomised trials (RoB2) (McGuinness *et al*., 2020) was applied. Two authors assessed the quality of methodology for each study including randomisation process, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, completeness of outcome data and risk of selective reporting and other bias. Any disagreements were resolved through discussion with a third reviewer.

## Results

### *Study selection*

A total of 4,051 records were identified through database searches, which was reduced to 2,649 after removal of duplicates. Nine studies were assessed for eligibility but only three met the inclusion criteria (Alkilzy *et al*., 2022; Pine *et al*., 2020; Raja *et al*., 2020). Two other studies were identified through citation searching of the included papers (Aljafari *et al*., 2017; Picard *et al*., 2014). In total, five papers were included for qualitative synthesis (Figure 1).

### *Characteristics of included studies*

All included studies were randomised controlled trials (RCTs) from HICs and were published between 2014 and 2022: United Kingdom (n=3), United States of America (n=1) and Germany (n=1). The included studies assessed different interventions including motivational interviewing, the use of video games and visual aids. Four studies took place in dental teaching hospitals (Aljafari *et al*., 2017; Picard *et al*., 2014; Pine, *et al*., 2020; Raja *et al*., 2020) and one in specialised practices that offer dental GA (Alkilzy *et al*., 2022). The study by Raja et al., (2020) was a pilot RCT.

Four of the five studies involved dental extractions under GA (Aljafari *et al*., 2017; Alkilzy *et al*., 2022; Picard *et al*., 2014; Raja *et al*., 2020) and one included general and local anaesthesia, and inhalation sedation (Pine *et al.,* 2020). Participants were aged 1-15 years with 54 to 408 participants per study. Two studies had a 2-year follow up (Raja *et al*., 2020; Pine *et al.,* 2020), whilst the others had a follow up interval of two weeks (Picard *et al*., 2014), three months (Aljafari *et al*., 2017) and one year (Alkilzy *et al*., 2022). Four studies reported the socio-economic status of the participants. Most participants in the studies by Aljafari *et al*. (2017) and Raja *et al*. (2020) were from socio-economically disadvantaged

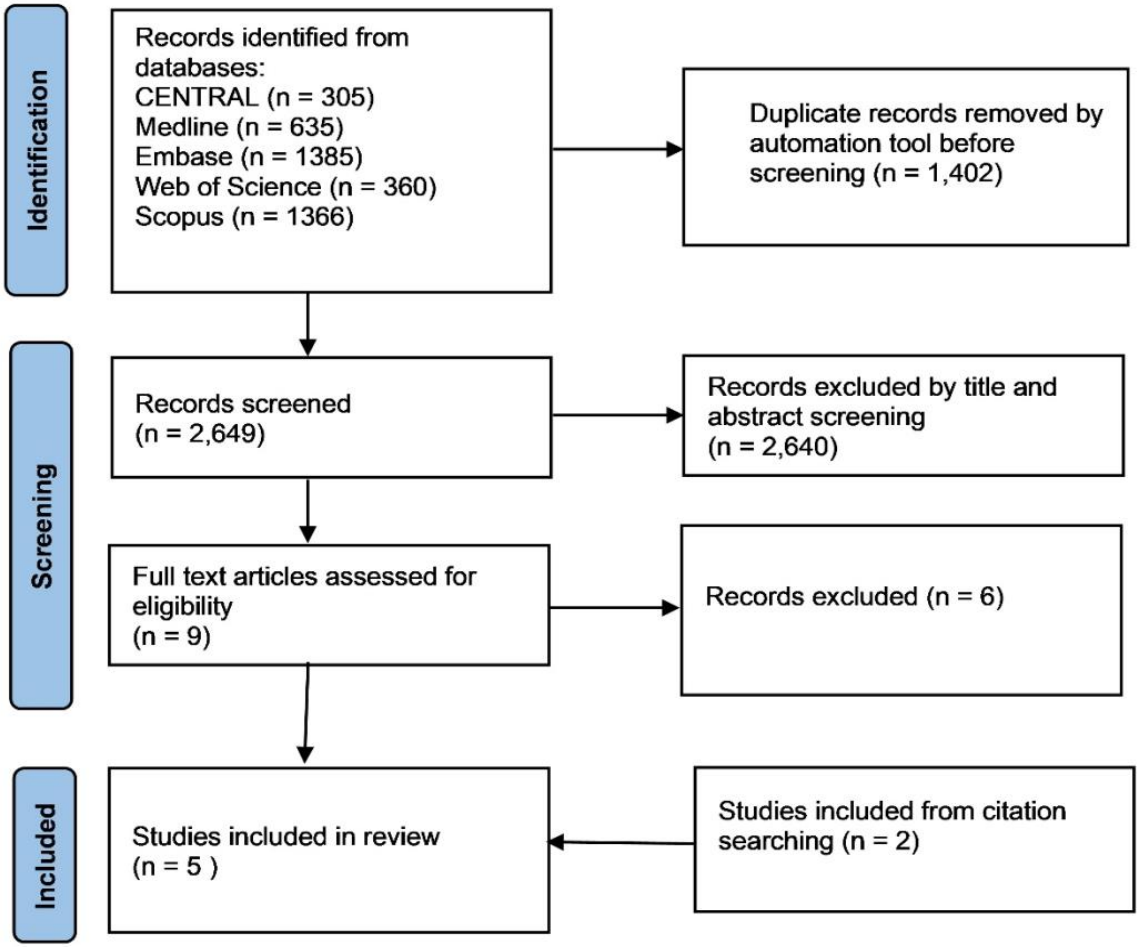


***Figure 1****. PRISMA Diagram (Page et al., 2021).*

groups; and in the studies by Picard *et al*. (2014) and Pine et al. (2020) participants were of mixed socio-economic status. Nevertheless, it is possible that whilst study participants were from a mixture of socioeconomic backgrounds, the lower socioeconomic group may have been larger. The characteristics of included studies are presented in Table 2.

Four studies delivered oral health education to patients and parents using different methods. For instance, Picard et al. (2014) used visual aids. Another provided two additional intensive prevention sessions to supplement the standard preventative programme offered within the German national health system (Alkilzy *et al*., 2022). Aljafari et al. (2017) used a video game to deliver oral health education whilst another (Pine *et al*., 2020) used nurse-assisted motivational interviewing. The fifth study provided a clinical intervention consisting of fissure sealants to caries-free permanent molars before dental extractions (Raja *et al*., 2020).

In four studies, the control was "standard prevention advice" although this varied in nature between studies. In the fifth study the control was a conversation about tooth development and parents were advised to attend their child's dental practice as normal; information about caries prevention was not given (Pine *et al.,* 2020).

Retention amongst the studies varied. In the study by Alkilzy *et al*., (2022), 80% of intervention and 71% of control participants returned for the 12-month follow-up. Pine et al. (2020) had similar retention rates with 74% of intervention and 84% of control participants attending the 24-month follow-up. Raja et al. (2020) had retention rates of 78% in the intervention group and 86% in the control group, albeit reversed with the control having higher retention. Picard et al. (2014) did not report retention rates by group but overall retention was 63%. The study by Aljafari et al. (2017) had the lowest retention rates with 50% of intervention participants completing the 3-month follow-up telephone call, compared with 57% of the control group.

### *Effects on oral health*

Three studies reported on the effects of the interventions on caries (Alkilzy *et al.,* 2022; Pine *et al.,* 2020; Raja *et al.,* 2020). However, there was variation in diagnostic criteria used and the dentition observed. Whilst all three studies reported fewer children with caries in the intervention than the control group, only one was significant (Pine *et al.,* 2020). Sixty-two per cent of children in the control group developed caries (dentine caries in either dentition) compared with 44% of intervention ($p$=0.021) and the odds of experiencing new dentine caries were reduced by 51% in the intervention compared with the control group. Raja et al. (2020) reported on caries prevalence at 24 months for all permanent teeth, permanent molars that were present and sound at baseline, and primary molars. For each outcome, fewer children in the intervention group had caries than in the control group: 41.9% of children in the control group had dentine caries experience in at least one permanent molar that was present and sound at baseline compared to none in the intervention group. Alkilzy et al. (2022), reported on caries experience in the primary dentition without (dmft/dmfs) and with (idmft/idmfs) initial carious lesions (ICDAS 1-3); dental caries incidence was lower for children in the intervention group than those in the control, albeit not significant.

Two studies also reported on plaque and gingival health to measure changes in oral hygiene. However, findings were inconsistent. Alkilzy et al. (2022) reported significantly greater improvement in both approximal plaque and sulcular bleeding in the intervention group than the control ($p$=0.003 and $p$=0.005 respectively). In the study by Picard et al. (2014), the intervention did not affect plaque (measured using the simplified oral hygiene index) or gingival health (measured using gingival index).

### *Effects on oral health behaviour*

One study compared return rates to general dental practice (Pine *et al.,* 2020). Interestingly, fewer children in the intervention group (61%) attended their dental practice in the two years after the extractions compared with the control (64%). However, there was a non-significant trend for intervention children to return sooner 3 to 4 months after extraction. Two studies reported on return rates but did not compare figures between groups (Aljafari *et al.,* 2017; Raja *et al.,* 2020).

One RCT assessed diet using a children's dietary questionnaire at baseline and at a telephone call 3 months after the intervention (Aljafari *et al.*, 2017). Parents of children in the intervention group reported a significant reduction in children's consumption of sweetened drinks from baseline, than the control group. However, a non-significant reduction in the consumption of non-core foods, from baseline, was observed in both groups. The method of education delivery did not change the children's self-reported snack selection.

Two studies explored toothbrushing frequency (Al-Jafari *et al.,* 2017; Picard *et al.*, 2014). Picard et al. *(2014)* found an overall increase in toothbrushing from baseline to follow-up unrelated to the type of education received. In the study by Aljafari et al. (2017), children reported brushing twice daily at baseline irrespective of the group. This study did not report on toothbrushing frequency at follow-up.

### *Risk of Bias*

Figure 2 presents the risk of bias for the outcomes of each study. Where available, study protocols were consulted (Aljafari *et al*., 2015; Pine *et al*., 2015). Only one study had an overall low risk of bias (Pine *et al.,* 2020). One study had a high risk (*Picard et al., 2014)* and the remaining three studies were deemed unclear (Aljafari *et al.,* 2017; Alkilzy *et al*. 2022; Raja *et al.,* 2020). Due to the nature of the interventions, all studies were defined as high risk in blinding of participants and personnel.

## Discussion

To our knowledge, this is the first review of the evidence on preventive interventions in children undergoing caries-related dental extractions. The evidence in this field is limited. By implementing broad criteria for the PICO framework, such as extending the age to include adolescents and exploring the effects of intervention on proxy markers of caries, two additional studies (Picard *et al*. 2014; Raja *et al*. 2020) were eligible for inclusion.

**Table 2**. Summary of included studies.

| *Author, Year, Country* | *Aim* | *Population* | *Intervention and control* | *Follow-up and retention* | *Outcome(s)* | *Key Findings* | *Authors' Conclusion* |
|---|---|---|---|---|---|---|---|
| Aljafari et al. 2017 UK | To compare an oral health education computer game to traditional one-to-one verbal oral health education, delivered by a trained dental nurse-educator. | Children aged 4-10 years referred to a dental hospital for dental extractions under general anaesthesia.<br>Test, n=55<br>Control, n=54<br>Mean age: 6.5 years | *Intervention*: Child and parent played a computer game comprising oral health messages at the pre-assessment clinic and given DVD to take home<br>*Control*: Child and parent received verbal oral health education by dental nurse | 3 months<br>Retention:<br>Intervention n=28, 51%<br>Control n=31, 57% | Parent and child satisfaction with education method*<br>Child's dietary knowledge<br>Changes in diet and toothbrushing<br>Dental attendance | Parents in intervention group reported a reduction in children's consumption of sweetened drinks.<br>Non-significant reduction in the children's consumption of non-core foods in both groups.<br>Improved children's dietary knowledge in both groups. | Children found using a computer game satisfactory.<br>Video game can improve dietary knowledge and help families to change diet.<br>Further research needed of long-term impact of video games to deliver oral health education. |
| Alkilzy et al. 2022 Germany | To investigate the effect of two individual intensive oral hygiene sessions (before and after GA) in high caries risk pre-school children. | Children aged 2-5 years due for dental treatment under GA in specialist practice.<br>Test n=201<br>Control n=205<br>Mean age: 4 years | *Intervention*: Children received two preventive sessions delivered by dentists in addition to baseline exam & standard prevention offered within German health system<br>*Control*: Standard preventive program | 1 year<br>Retention:<br>Intervention n=161, 80%<br>Control n=147, 71% | Carious, filled and missing teeth in the primary dentition<br>Approximal Plaque Index<br>Gingiva Sulcus Bleeding Index | Greater improvement from baseline in plaque and bleeding in the intervention group.<br>Caries incidence similar in both groups at follow up. | Additional preventive appointments in high caries risk children improved oral health parameters. |
| Picard et al. 2014 USA | To investigate using visual aids during parent education improves attendance, oral health outcomes, attitudes and satisfaction with dental GA. | Children aged 18 months-7 years undergoing dental general anaesthesia<br>Mean age: 3.19 years | *Intervention*: Post-operative instructions and oral health education was delivered with support from visual aids<br>*Control*: Verbal oral health education | 2 weeks<br>n=34<br>Retention:<br>Not specified | Plaque score<br>Gingival Health<br>Toothbrushing frequency<br>Attendance at follow-up<br>Parent satisfaction | Type of education used did not affect plaque score, gingival health, or behaviour.<br>Plaque scores improved at follow-up for all children.<br>Less educated parents less likely to bring children for follow-up visits. | Oral hygiene and brushing frequency better in all children.<br>Parents in the intervention group more likely to bring children for a follow-up visit.<br>Intervention group parents more satisfied and interested in communicating with dentist. |
| Pine et al. 2020 UK | Test efficacy of motivational interview, to prevent recurrence of caries in children who had primary tooth extracted 2 years previously. | Children aged 5-7 years scheduled to have a carious primary tooth extracted in 12 UK centres<br>Test n=119<br>Control n=122<br>Mean age: 6 years | *Intervention*: Parents received motivational interview with a trained dental nurse<br>*Control*: An educational conversation between a dental nurse and parents about tooth eruption | 2 years<br>Retention:<br>Intervention n=88, 74%<br>Control n=103, 84% | Caries on any tooth that was caries-free at baseline*<br>Use of services<br>Dental treatment in two years post-intervention | Fewer children in the intervention group developed caries than control group.<br>There was a non-significant trend for children in intervention group to return to their referring dental practice sooner than control.<br>Fewer children in the intervention group had a restoration placed 2-years post-intervention. | Motivational interview with a trained dental nurse reduced risk of new caries experience. |
| Raja et al. 2020 UK | Pilot RCT to assess feasibility of sealing sound permanent molars at pre-GA assessment in children needing caries-related extractions. | Children aged 5-15 years referred to a dental hospital for dental extractions under GA<br>Test n=50<br>Control n=50<br>Mean age: 7.7 years | *Intervention*: Children received fissure sealants on permanent molars on the day of pre-assessment<br>*Control*: Did not receive fissure sealants as part of the study. Received standard preventive care | 2 years<br>Retention:<br>Intervention n= 43, 86%<br>Control: n= 39, 78% | Dentine caries in primary teeth and permanent molars<br>Dental attendance<br>Retention of Fissure Sealant<br>Preventive dental treatment | More caries experience in control group and more untreated caries in permanent teeth than sealant group.<br>More intervention children visited a dentist in the 24 months compared with control. | Placing sealants at GA assessment is feasible, well received and may reduce caries incidence. |

*Primary Outcome

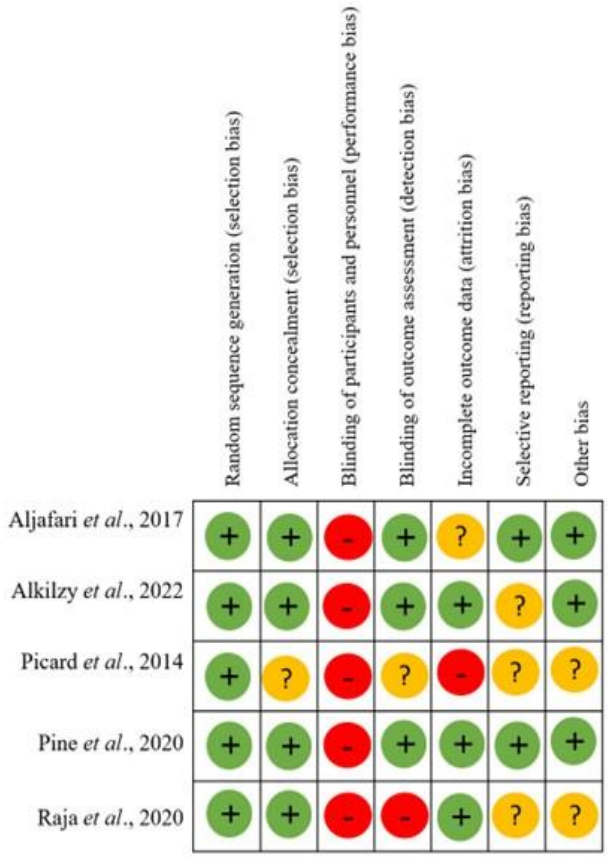


***Figure 2**. Risk of Bias summary (McGuinness et al., 2020).*

Most of the evidence comes from dedicated services. There is emerging evidence from one well-designed, multi-centre, high-quality trial. This study used contemporary behaviour change techniques, namely a 'brief negotiated interview for oral health', in the Dental RECUR Trial involving a Brief Negotiated Interview for Oral Health which linked the family back into their general dental practitioner for follow-up care, after hospital admission for dental extractions (Pine *et al*., 2020). The evidence from this study with a low risk of bias, may deliver better outcomes in relation to dental caries. Such interventions play a role in supporting a reduction in dental caries. They also offer valuable insights, indicating that parents value engaging in discussions with various members of the dental team.

Behavioural sciences increasingly enhance our understanding of health-related behaviour and how interventions can facilitate long-term behaviour change (PHE, 2021). Thus, the utilisation of a 'brief negotiated interview for oral health' by Pine et al. (2020) is an example of a supportive behaviour change technique delivered by dental nurses. It is based on motivational interviewing techniques used for other habitual behaviours such as smoking. The 30-minute intervention sets and agrees on goals that are tailored for each family. It was the only study that demonstrated benefits from the intervention to reduce caries experience at 2-year follow-up. However, for most individuals, providing information to increase knowledge will not result in behaviour change (PHE, 2021). Evidence suggests that it is more common in high-risk families who are likely to have several complex challenges which prevent behaviour change. Therefore, interventions that address broader determinants of health and incorporate behavioural sciences may be more effective than traditional health education such as that provided in the other studies.

Children requiring extractions suggest symptomatic dental attendance. All studies in this review included children under 6 years who had had ECC and thus were pre-compliant. Only one included study measured dental attendance (Pine *et al*., 2020). The nurse-assisted intervention urged parents to make an appointment with their child's general dental practitioner whereas children in the control group were advised to attend as usual. Despite this, more parents in the control group attended the dentist in the 24-month period following dental extractions.

Overall, there is a paucity of well-designed research in this field and little evidence of co-produced interventions, albeit the National Institute for Health and Care Research (NIHR) funded trial in the UK will likely have involved Patient/Parent Participation on Interventions (PPI) (Pine *et al.*, 2020). None of the studies reported on cost-effectiveness of the intervention. All but one study used single-session interventions which would make them more cost-effective than interventions requiring more sessions. In one RCT, the intervention was nurse-led (Pine *et al.,* 2020) whilst another was patient-led (participants played a video game with oral health messages) (Aljafari *et al.,* 2017). These interventions are likely to be more cost-effective than those that are dentist-led (Alkilzy *et al.,* 2022; Picard *et al.,* 2014; Raja *et al.,* 2020).

The limitations of the rapid review approach are outlined by Khangura et al. (2012), in relation to its single search, speed, scope, and language. In addition,

grey literature was not searched. The absence of the latter exaggerates the bias in the published literature whereby negative outcomes are less likely to be reported. However, every effort was made to identify relevant published papers through citation searching of the selected papers.

Further research is required in this field, and this aligns with the top priority identified in the UK by the James Lind Alliance (2018) for NIHR. Ultimately, for high-caries risk individuals, the aim of any intervention is to reduce caries risk, which requires a reduction in sugar (volume and frequency) and optimal use of fluoride (OHID, 2021). Interventions in future studies should promote regular dental attendance to facilitate holistic caries management, and measure attendance in study and control groups to assess effectiveness, as they will benefit from a long-term relationship with their dental practice to deliver regular evidence-based prevention (Office of Health Improvement and Disparities, 2021). Two studies had follow-up periods of less than one year, which is not sufficient for caries. Whilst other outcomes can be used as surrogates such as plaque and bleeding scores, and self-reported oral hygiene and diet, these are not reliable, particularly as they do not include any consideration of the major behavioural risk factor (sugar), and shorter studies raise the question as to whether any of the observed changes would be maintained and observed in the longer-term to reduce the incidence of dental caries. Measuring outcomes such as dental caries requires follow-up sufficient for its development and sustained behaviour change. Future studies should evaluate the longer-term impacts of interventions (ideally a minimum of 2-year follow-up) to assess their effectiveness. Finally, studies should be co-produced with participants to maximise retention.

In conclusion, there is limited evidence on preventive interventions from studies amongst children who have undergone dental extractions and their outcomes. The use of contemporary behaviour change approaches appears promising. More well-designed studies, with longer follow-up, are required to assess the long-term impacts on health and oral health behaviours. Dental caries incidence should be the primary outcome of such studies. Future trials should report on participant characteristics that can affect caries risk such as socioeconomic status to assess variations in the effects of interventions and study retention.

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