

# Evaluating childsmile, Scotland's National Oral Health Improvement Programme for children

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## Abstract

In the early 2000s, a Scottish Government Oral Health Action Plan identified the need for a national programme to improve child oral health and reduce inequalities. 'Childsmile' aimed to improve child oral health in Scotland, reduce inequalities in outcomes and access to dental services, and to shift the balance of care from treatment to prevention through targeted and universal components in dental practice, community and educational settings. This paper describes how an embedded, theory-based research and evaluation arm with multi-disciplinary input helps determine priorities and provides important strategic direction. Programme theory is articulated in dedicated, dynamic logic models, and evaluation themes are as follows: population-level data linkage; trials and economic evaluations; investigations drawing from behavioural and implementation science; evidence reviews and updates; and applications of systems science. There is also a growing knowledge sharing network internationally. Collaborative working from all stakeholders is necessary to maintain gains and to address areas that may not be working as well, and never more so with the major disruptions to the programme from the COVID-19 pandemic and response. Conclusions are that evaluation and research are synergistic with a complex, dynamic programme like Childsmile. The evidence obtained allows for appraisal of the relative strengths of component interventions and the reach and impact of Childsmile to feed into national policy.

## KEYWORDS

childhood caries, dental public health, programme evaluation

## 1 | BACKGROUND

In the early 2000s, almost 60% of 5-year-olds in Scotland had obvious caries experience.<sup>1</sup> A Scottish Government Oral Health Action Plan<sup>2</sup> identified the need for a national programme to improve child

oral health and reduce inequalities. This has seen reduced prevalence of tooth decay, with less than a third (26%) of 5-year old children having obvious decay experience in their primary teeth in 2020.<sup>3</sup> However, a gradient based on socioeconomic circumstance persists<sup>4</sup> and children in the most deprived areas are still around

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three times more likely than those from the least socioeconomically deprived areas to experience decay by the time they start school.

## 1.1 | Childsmile

Initiated around 15 years ago, Childsmile aimed to improve child oral health in Scotland, reduce inequalities in outcomes and access to dental services, and to shift the balance of care from treatment to prevention (part of a national focus on supporting health from infancy) though targeted and universal components in various settings (Table 1).<sup>5</sup>

## 2 | EMBEDDED RESEARCH AND EVALUATION

### 2.1 | Theory-based approach

Childsmile is complemented by an embedded, theory-based research and evaluation arm. This is led by the University of Glasgow in partnership with NHS Scotland and has had core funding from the Scottish Government alongside further external grants (see [acknowledgements](#)).<sup>6</sup> The programme is conceptualized as a complex intervention<sup>7</sup> and programme theory is articulated in dedicated, dynamic logic models, first developed through document analysis, observation and facilitated workshops with all relevant stakeholders, including the following: programme directors, managers and coordinators; Dental Nurses; and dental health support workers. This provides an overview of assumptions underpinning programme delivery, risks to sustainability, and key areas for study via (a) a longitudinal process evaluation applying behavioural and implementation science and (b) dedicated studies assessing clinical outcomes and cost-effectiveness. This allows us to determine which components

of the intervention are most effective and what additional interventions might be beneficial.

### 2.2 | 'Big data' linkage studies

The research and evaluation programme benefits from access to a national data 'safe haven'.<sup>8</sup> Coordinated by Public Health Scotland, the safe haven is a secure supported environment whereby pseudonymized individual health (outcome) data (e.g. from the National Dental Inspection Programme for children) can be linked with other administrative service data (e.g. from educational settings or Practitioner Services Division, part of National Services Scotland) for analysis.

For example, we linked four Childsmile interventions (supervised toothbrushing and fluoride varnish application in the nursery/kindergarten setting, dental practice visits, and dental health support worker visits) to dental inspection data to form a longitudinal cohort of over 50 000 five-year-old children in 2014/15 (collected longitudinally from birth).<sup>9</sup> This innovative work allowed for assessment of the independent impact of each intervention on caries experience, adjusting for age, sex and deprivation (using the area-based Scottish Index of Multiple Deprivation; SIMD). Results showed that the universal interventions in terms of participating in supervised toothbrushing in the nursery/kindergarten setting (participating for >3 years, adjusted OR [aOR] = 0.60; 95% CI 0.55–0.66) and regular dental practice visits ( $\geq 6$  visits, aOR = 0.55; 95% CI 0.50–0.61) were independently and most strongly associated with reduced odds of caries experience, with the impact of supervised toothbrushing being greatest in areas of high socioeconomic deprivation. The findings were less clear for dental health support worker contacts (see Table 1), although these were found to support dental practice attendance.<sup>10</sup> Targeted fluoride varnish application in the nursery/kindergarten was not independently associated with caries experience

TABLE 1 Universal and targeted elements of Childsmile, Scotland's national oral health improvement programme for children

	Dental practice setting	Community setting	Education setting
Universal	Oral hygiene instruction and diet advice provided by an appropriately trained member of the dental team; Six-monthly fluoride varnish application from 2 to 12 years of age	Free dental pack containing toothbrush and fluoride toothpaste (1450ppmF) until age of five; Oral health advice from Health Visiting team	Distribution of dental packs and supervised toothbrushing in all nursery schools/ kindergartens (the main age range is 3–5 years but some 2-year-olds may attend); Policy input into regulations around healthy eating in schools
Targeted	Intensive programme of care delivered by an appropriately trained member of the dental team, incorporating dedicated oral health promotion sessions	Targeted support via referrals from health visitors (who provide a universal public health nurse home visiting programme for all children from birth to 5 years) to a Dental Health Support Worker service; this involves home visits and/ or telephone contact to support toothbrushing, facilitate child registration and attendance at dental practice, and link families to local community-based support organizations where appropriate.	Fluoride varnish applications to children's teeth twice a year in targeted nurseries and Primary Schools, years 1 and 2 (approximately 5–6 years old) Supervised toothbrushing in Primary Schools, years 1 and 2 (approximately 5–6 years old)

(supported by the trial results below). Further work is underway based on refreshing this linkage using data up to 2016/17 on dental extraction under general anaesthetic as an additional outcome measure.

This evidence allows for appraisal of the relative strengths of component interventions as part of national policy. We are also able to study the reach and impact of Childsmile interventions on the oral health of vulnerable groups such as care experienced children<sup>11</sup> and we are examining: the intersectional roles of ethnicity and additional educational support needs alongside socioeconomic factors in relation to dental health; and the relationship between childhood obesity and dental caries underpinned by the common risk factor of sugar consumption.

Finally, a new innovative study utilizing data from the 'Growing up in Scotland' cohort, a large-scale nationally representative prospective longitudinal cohort study of children born in 2002, 2004 and 2010 (collected longitudinally from birth to 5 years; ~11 000 children), will explore (via data linkage) early life child, family and community-level influences on caries experience and the impact of exposure to Childsmile interventions on behaviour change, improving oral health and reducing inequalities.

### 2.3 | Trial data

With the support of stakeholders, it has also been possible to embed a parallel group two-year randomized treatment-as-usual (TAU) controlled trial in the programme. This was undertaken to assess the effectiveness and cost-effectiveness of targeted fluoride varnish application in the nursery/kindergarten setting plus TAU (primarily supervised toothbrushing) versus treatment-as-usual alone. The primary endpoint for each individual child was whether or not there had been any occurrence of new caries lesions over the two-year period, as measured by any increase in d3mft at 2 years of follow-up compared with the d3mft at baseline (d3mft is dental decay as measured by the dmft scale in the dentine<sup>12</sup>). Overall, 26.9% ( $n = 155$ ) had worsened d3mft in the fluoride varnish application group, and 31.6% ( $n = 181$ ) in the control group, with an adjusted odds ratio (OR) of 0.80 (0.62–1.03),  $p = .078$ .<sup>13</sup>

### 2.4 | Economic evaluation

Cost analysis in 2015 comparing cost of providing the programme versus those for avoided dental treatments found promising results for supervised toothbrushing in the nursery/kindergarten setting, with savings in the eighth year of the programme of approximately £3.0 m GBP, and the largest decrease in modelled costs for the most deprived cohort of children.<sup>14</sup> An economic evaluation conducted alongside the trial of fluoride varnish application (over and above the daily supervised toothbrushing), however, calculated a cost of GBP

£686 to prevent a single worsening of d3mft and a Number Needed to Treat (NNT) of 21.<sup>15</sup> In terms of Quality Adjusted Life Years (QALYs), the probability that the intervention was cost-effective at the UK National Institute for Health and Care Excellence (NICE) threshold was 11.3%. This together with the trial results themselves raises important issues about the relative strengths of the interventions in this setting and implications for policy and resource allocation (see Section 3).

### 2.5 | Behavioural and implementation science

A behavioural and implementation science programme continually studies the barriers and facilitators to implementation of programme theory, while also appraising best practice to ensure interventions remain evidence-based.

Process evaluation shows fluoride varnish application in practice is variable, despite being designed as a universal aspect of the programme. A postal survey of General Dental Practitioners in 2011 ( $n = 1090$ , 53.6% response rate) based on the Theoretical Domains Framework (TDF) showed self-reported fluoride varnish application to be independently associated with GDPs knowledge of guidelines, perceiving application to be part of one's professional role, believing it to be something parents want for their children, and general motivation to apply.<sup>16</sup> After remuneration for CS activities was incorporated into the dental contract, (including a fee-per-item payment from 2011 for varnishing 2–5-year-olds' teeth) a follow-up survey of GDPs in 2013 ( $n = 709$ , 74% of eligible responders) found this increased the extent whereby dentists would view fluoride varnish application as part of their social/professional role and identity.<sup>17</sup>

With respect to the more holistic aspects of the family consultation in practice (incorporating fluoride varnish application, oral hygiene instruction and diet advice), a series of innovative video-based studies have examined the professional-child-carer interactions using a coding scheme for communicative aspects of this triadic interaction<sup>18–20</sup> and highlighted the importance of a team-based approach and of parent/carers facilitation in moderating child participation.

A number of ongoing studies are applying the Consolidated Framework for Implementation Research (CFIR<sup>21</sup>). Doctoral students are exploring barriers and facilitators for optimizing the toothbrushing programme in the nursery/kindergarten setting and how dental health support workers link families to community services for support. A third CFIR-driven study is exploring applicability of a home-toothbrushing support tool first developed in the practice-context in the Netherlands and based on social learning theory.<sup>22</sup> As with studies in dental practice, close engagement with the Childsmile programme managers and coordinators, and NHS Education for Scotland who support staff training, has been vital in securing successful recruitment of dental health support workers, nursery staff and parents as research partners/advisors and participants.

## 2.6 | Evidence reviews and updates

As well as monitoring programme fidelity and variation, assessing oral health and economic outcomes, and investigating mechanisms for improvement, we continue to collate, appraise and synthesize up-to-date data and knowledge with a view to ensuring the programme remains wedded to high quality scientific evidence and principles. We are currently working on a systematic overview of the effectiveness of fluoride-based interventions delivered in early educational settings to prevent early childhood caries.<sup>23</sup> This will feed into an international evidence review and consensus statement in this regard. Similar rigorous appraisal of evidence continues to feed into programme theory for the community visits. Young et al.<sup>24</sup> conducted a realist review to determine how, why and in what context UK-based lay health worker interventions are effective in improving child health parenting behaviours, and a parallel systematic review focused on how to 'tailor' interventions to family need.<sup>25</sup>

Similarly, we recently conducted the first systematic review to focus on interventions that link families with young children to community-based support organizations, finding active interventions to be more effective in linking families to community support than 'passive' signposting, despite variable quality of evidence.<sup>26</sup>

## 2.7 | Systems science

Finally, updated guidance on evaluation of complex interventions stresses the important of studying and modelling the systems into which they are to be implemented in order to increase the opportunities for uptake and sustainability.<sup>27</sup> We are working in dental practice to optimize programme aims and outcomes for staff and organizations alike. The employment of complex systems theory to examine the variable conditions affecting fluoride varnish application in practice<sup>28</sup> has allowed for innovative practice-based feasibility tests of systems improvement tools for preventive care (co-designed with dental team members).

## 2.8 | International collaboration and dissemination

We also collaborate with partners in the UK and abroad in carrying out evaluation and sharing experience, with Childsmile recognized as best practice by the European Commission in achieving prevention and treatment of non-communicable diseases, and promotion of health and wellbeing.<sup>29</sup> The University of Glasgow is supporting evaluation of Chile's child oral health improvement programme ('Sembrando Sonrisas'), which is based on Childsmile.<sup>30</sup> We have an ongoing collaboration with a number of countries in South Eastern Europe to benchmark programmatic efforts against the WHO implementation manual for the prevention of early childhood caries,<sup>31</sup> and joint working between the University of Glasgow, the University of Malawi, the WHO and the Malawi Ministry of Health is underway to develop a child oral health improvement strategy in Malawi.

## 3 | DISCUSSION

Programmes like Childsmile are complex and dynamic and its comprehensive evaluation has contributed to its success. There are several strengths of the evaluation and research including collaborative working involving all stakeholders which has been necessary to maintain gains and to address areas that may not be working as well, and never more so with the major disruptions to the programme from the COVID-19 pandemic and response. The research and evaluation efforts have also benefited from core Scottish Government funding, supplemented by additional grant support (see [acknowledgements](#)). The evaluation is also supported by Childsmile Programme Managers along with wider NHS and education staff. And it benefits from data linkage capability and multi-disciplinary input from public health, clinical, statistical, epidemiological, health economics, psychological and organizational systems perspectives.

The use of logic models as part of a theory-based approach, together with national monitoring data from routine administrative databases, helps determine evaluation strategies and priorities. Expertise in managing and analysing large datasets is increasingly important and mature mechanisms for timely and efficient data sharing and protection are essential. Population data-linkage projects like those described will provide important strategic direction, for example, on the relative merits of toothbrushing versus fluoride varnish application, or the importance of community-based approaches for addressing underlying inequalities.

The evaluation has some limitations including a lack of information on intermediate outcomes such as the impact on, for example, toothbrushing or dietary behaviours in the home. As with all population-level interventions, detailed understanding of practices on the ground (e.g. on the quality of advice-related interventions in dental practices or home visits, or the extent to which children participate every day in nursery/kindergarten toothbrushing) is also somewhat limited. The engagement of families with community (Non-Governmental Organization) activity and services is also vital, and our capture of that is a recognized gap which we are actively trying to fill.

## 4 | CONCLUSION

While delivering a full breadth evaluation as we have undertaken for Childsmile is not always going to be possible in different settings and with competing priorities and financial constraints, some important principles will likely be of interest.

Firstly, frameworks and theories for approaching implementation of complex interventions are now well-established, such as employing logic models to guide the development, implementation and evaluation of oral health improvement programmes. Research and evaluation questions require data collection at the appropriate level (e.g. individual/child level, nursery/kindergarten/school level, practice level, community level etc.). Often the issue is to decide whether stand-alone studies are essential, or whether integration

of data capture into existing routine administrative data systems is feasible. We would endorse a focus on capturing routine administrative data as a resource-efficient way of evaluating programmes, but it is likely that some detail at the individual level is offset to achieve population-level coverage. Funding remains essential and the case should be made of the importance of evaluation to the achievement of programme goals. Finally, close partnerships between programme and evaluation teams and policy makers are key to ensuring findings can be fed back into programme development in a way that maximizes impact.

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## DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

## REFERENCES

1. Committee, S.D.E.C.-o, *Scotland's National Dental Inspections Programme*, 2003, Dundee: Dental Health Services Research Unit, University of Dundee.
2. Executive, S.J.E.S.E, *An action plan for improving oral health and modernising NHS dental services in Scotland* 2005. 1.
3. Report of the 2020 Detailed Inspection Programme of Primary 1 Children and the Basic Inspection of Primary 1 and Primary 7 children, in *National Dental Inspection Programme*. 2020.
4. Levin KA, Davies CA, Topping GVA, Assaf AV, Pitts NB. Inequalities in dental caries of 5-year-old children in Scotland, 1993-2003. *Eur J Public Health*. 2009;19(3):337-342.
5. Macpherson LM, Ball GE, Brewster L, et al. Childsmile: the national child oral health improvement programme in Scotland. Part 1: Establishment and development. *Br Dent J*. 2010;209(2):73-78.
6. Eaves J, Gnich W. Can programme theory be used as a 'translational tool' to optimise health service delivery in a national early years' initiative in Scotland: a case study. *BMC Health Serv Res*. 2013;13:425.
7. Craig P, Dieppe P, Macintyre S, Michie S, Nazareth I, Petticrew M. Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ*. 2008;337(7676):979-983.
8. Pavis S, Morris AD. Unleashing the power of administrative health data: the Scottish model. *Public Health Res Pract*. 2015;25(4):e2541541.
9. Kidd JBR, McMahon AD, Sherriff A, et al. Evaluation of a national complex oral health improvement programme: a population data linkage cohort study in Scotland. *BMJ Open*. 2020;10(11):e038116.
10. Hodgins F, Sherriff A, Gnich W, Ross AJ, Macpherson LMD. The effectiveness of Dental Health Support Workers at linking families with primary care dental practices: a population-wide data linkage cohort study. *BMC Oral Health*. 2018;18:191.
11. McMahon AD, Elliott L, Macpherson LMD, et al. Inequalities in the dental health needs and access to dental services among looked after children in Scotland: a population data linkage study. *Arch Dis Child*. 2018;103(1):39-43.
12. Pitts NB, Evans DJ, Pine CM. British Association for the Study of Community Dentistry (BASCD) diagnostic criteria for caries prevalence surveys-1996/97. *Community Dent Health*. 1997;14(Suppl 1):6-9.
13. McMahon AD, Wright W, Anopa Y, et al. Fluoride Varnish in Nursery Schools: A Randomised Controlled Trial - Protecting Teeth @3. *Caries Res*. 2020;54(3):274-282.
14. Anopa Y, McMahon AD, Conway DI, Ball GE, McIntosh E, Macpherson LMD. Improving child oral health: cost analysis of a National nursery toothbrushing programme. *PLoS One*. 2015;10(8):e0136211.
15. Anopa Y, Macpherson LMD, McMahon AD, Wright W, Conway DI, McIntosh E. Economic evaluation of the protecting teeth @ 3 randomized controlled trial. *JDR Clin Trans Res*. 2022; 23800844221090444.
16. Gnich W, Bonetti D, Sherriff A, Sharma S, Conway DI, Macpherson LMD. Use of the theoretical domains framework to further understanding of what influences application of fluoride varnish to children's teeth: a national survey of general dental practitioners in Scotland. *Community Dent Oral Epidemiol*. 2015;43(3):272-281.
17. Gnich W, Sherriff A, Bonetti D, Conway DI, Macpherson LMD. The effect of introducing a financial incentive to promote application of fluoride varnish in dental practice in Scotland: a natural experiment. *Implement Sci*. 2018;13:95.
18. Yuan S, Humphris G, MacPherson L, Ross A, Freeman R. BMC Oral Health. *Development of an Interaction Coding Scheme (PaeD-TrICS) to record the triadic communication behaviours in preventive dental consultations with preschool child patients and families: a video-based observational study*. 2019;19:162.
19. Yuan S, Humphris G, Macpherson LMD, Ross A, Freeman R. Communication strategies to encourage child participation in an oral health promotion session: an exemplar video observational study. *Health Expect*. 2021;24(2):700-708.
20. Yuan, S., et al., *Moderating Parents: Exploring Child-Parent-Dental Professional Communication in Preventive Dental Visits*, in *96th General Session and Exhibition of the International Association of Dental Research (IADR 2018)*. IADR Alexandria, VA, USA; 2018.
21. Kirk MA, Kelley C, Yankey N, Birken SA, Abadie B, Damschroder L. A systematic review of the use of the Consolidated Framework for Implementation Research. *Implement Sci*. 2016;11:72.
22. de Jong-Lenters M, van Bussel J, Polak E, L'Hoir M, Duijster D. Feasibility of the 'Uitblinkers' intervention to improve toothbrushing among children: a pilot study. *Ned Tijdschr Tandheelkd*. 2020;127(3):189-198.
23. A. Blokland, A.R., D. Conway, *A systematic overview of fluoride-based interventions delivered in early educational settings to prevent early childhood caries*. PROSPERO 2021 CRD42021284641.
24. Young M, Ross A, Sheriff A, Deas L, Gnich W. Child health interventions delivered by lay health workers to parents: a realist review. *J Child Health Care*. 2021;5:628-646.
25. Hodgins F, Gnich W, Ross AJ, Sherriff A, Worlledge-Andrew H. How lay health workers tailor in effective health behaviour change interventions: a protocol for a systematic review. *Syst Rev*. 2016;5:102.
26. Burns J, Conway DI, Gnich W, Macpherson LMD. A systematic review of interventions to link families with preschool children from healthcare services to community-based support. *J Public Health*. 2021;43(2):e224-e235.

27. Skivington K, Matthews L, Simpson SA, et al. A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. *BMJ*. 2021;374:n2061.
28. Ross, A., et al., A Systems Analysis of Fluoride Varnish Application in General Dental Practice in Scotland using the Functional Resonance Analysis Method, 64th ORCA Congress 2017: Oslo. p. 366–366.
29. Platform for Better Oral Health in Europe. 2019; Available from: <http://www.oralhealthplatform.eu/news/Childsmile-recognised-as-best-practice-by-european-commission/>
30. Andrés Celis, et al. *Evaluation of the National Child Oral Health Improvement Programme for Chile*. in *European Association of Dental Public health (EADPH)*. 2021.
31. Ending Childhood Dental Caries. *WHO Implementation manual. Oral Health Program, Prevention of Non-communicable Diseases*; 2019.

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