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ABSTRACT

We aimed to assess the association between the roll-out of the national nursery toothbrushing program and a reduction in dental decay in five-year-old children in a Scotland-wide population study. The intervention was supervised toothbrushing in nurseries and distribution of fluoride toothpaste and toothbrushes for home use, measured as the percentage of nurseries participating in each health service administrative board area. The endpoint was mean d_3mft in 99,071 five-year-old children, covering 7% to 25% of the relevant population (in various years), who participated in multiple cross-sectional dental epidemiology surveys in 1987 to 2009. The slope of the uptake in toothbrushing was correlated with the slope in the reduction of d_3mft . The mean d_3mft in Years -2 to 0 (relative to that in start-up Year 0) was 3.06, reducing to 2.07 in Years 10 to 12 (difference = -0.99; 95% CI -1.08, -0.90; $p < 0.001$). The uptake of toothbrushing correlated with the decline in d_3mft (correlation = -0.64; -0.86, -0.16; $p = 0.011$). The result improved when one outlying Health Board was excluded (correlation = -0.90; -0.97, -0.70; $p < 0.0001$). An improvement in the dental health of five-year-olds was detected and is associated with the uptake of nursery toothbrushing.

KEY WORDS: dental caries, fluorides, child health, public health dentistry, oral health, epidemiology.

National Supervised Toothbrushing Program and Dental Decay in Scotland

INTRODUCTION

Oral health has been identified as an objective measure of child health (The Scottish Office, 1999). From the late 1980s and through the 1990s, some Health Boards in Scotland introduced local nursery toothbrushing programs, with various proportions of nurseries in each area being involved. In 2001-2002, funding became available at the national level for a standardized nursery toothbrushing program to be introduced across Scotland. Around this time, a national consultation on child oral health ended any thoughts that fluoridation of the public water supply would be introduced in Scotland (Scottish Executive, 2002), and an Action Plan for oral health improvement was developed (Scottish Executive, 2005). Subsequently, supervised toothbrushing became a main component of the *Childsmile* program, which developed as the national child oral health improvement program in 2006 (Scottish Executive, 2005; Macpherson *et al.*, 2010).

In the last 30 years of the 20th century, the prevalence of dental decay across the world was reported to be almost universally declining, attributed to the introduction and widespread use of fluoride toothpaste during this period (Downer, 1998; Marthaler, 2004; Bagramian *et al.*, 2009). United Kingdom trends in children's dental caries had declined rapidly from the 1970s to the late 1980s (Todd and Dodd, 1985; Downer, 1998); however, by the 1990s, these improvements had begun to slow in Scotland, with children here having among the worst rates of dental decay in the UK (O'Brien, 1994) and Europe (WHO, 2012). Inequalities in dental decay were also emerging, with those from the lowest socio-economic groups bearing the greatest burden (Marthaler, 2004).

Cochrane reviews have demonstrated the effectiveness of brushing with fluoridated toothpaste for preventing caries in children (Marinho *et al.*, 2003; Walsh *et al.*, 2010). An earlier systematic review of school-based oral health education programs concluded that they could change behavior but had limited effect in preventing decay (Kay and Locker, 1996). These programs are also often singled out as evidence that education-based approaches can widen health inequalities (Schou and Wight, 1994; The Stationery Office, 2009). Since then, there has been some limited work assessing the effectiveness of toothbrushing programs in schools and nurseries (Cumow *et al.*, 2002; Rong *et al.*, 2003; Jackson *et al.*, 2005); however, no formal evaluation of such programs has been undertaken on a country-wide scale.

Our aims were to test the hypothesis that the national nursery toothbrushing program roll-out would be associated with a reduction in caries in five-year-old children across Scotland and to assess any changes over time in the inequality in the distribution of dental caries.

DISCUSSION

Results from the National Dental Inspection Program have shown a dramatic decline in caries in five-year-old children in Scotland in the past decade, during a time when nursery toothbrushing programs were being developed and rolled out in every Health Board across Scotland. Moreover, a corresponding

reduction in absolute inequalities between dental caries rates in the most compared with the least deprived communities was observed. This is the first study to demonstrate the association between a supervised nursery toothbrushing program and a reduction in dental caries at a community- and country-wide level. This association is strengthened by the fact that prior to the commencement of the initiative, the secular trend was of increasing levels of dental decay in the five-year-old population.

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Some Health Boards showed an increase in dental decay immediately after the introduction of the toothbrushing program. This can be explained by the fact that the effectiveness of the program in decreasing tooth decay in children was not immediate. We found a sharper decrease in decay levels when toothbrushing intensity reached around 50% (*i.e.*, when half of all nursery schools in a Health Board were participating in the program).

The improvement in dental decay levels in Scotland is unlikely to have been part of a secular change. No such trend was observed for England and Wales. The explanation is also unlikely to be due to other sources of fluoride: Fluoride supplement use in Scotland is not recommended (SDCEP, 2010), and fluoride varnish programs did not commence until 2009, apart from a small pilot area (Turner *et al.*, 2010). Moreover, despite numerous child health initiatives in Scotland over the past decade, no improvement in child health measures – such as the proportion of overweight five-year-old children and hospital admission figures (excluding dental) for zero- to five-year-olds – has occurred over the same period (Appendix Figs. 2 and 3). In contrast, the proportion of Scottish five-year-old children with obvious decay experience decreased over time. The lack of improvement in body mass index data and the recognized major challenges associated with achieving behavioral changes related to diet would suggest that increasing the provision of regular use of fluoridated toothpaste at nurseries and in the home has been the important factor associated with this health improvement.

The main limitation of this study was a lack of individual school- and child-level data relating to participation in the toothbrushing program. Nevertheless, one of the major strengths of the nursery brushing initiative is the fact that it is a national program, with uptake now reaching almost all nurseries in all Health Board areas. The development of national standards for this intervention and the regular monitoring against these standards have resulted in a consistent approach being applied across Scotland.

The overall aims of the *Childsmile* program are to improve child dental health and to reduce oral health inequalities. Although the toothbrushing program was a whole-population approach, one could hypothesize that this should have the most effect among the more deprived children, partly because of the high baseline dental decay levels in these children. Also, prior to the intervention, home toothbrushing was more likely to be carried out on a regular basis within more affluent families. The findings of this study support this hypothesis, since we observed a reduction in absolute inequalities, with the mean d_{mft} decreasing by 1.71 in the most deprived children, and by 0.43 in the least deprived children.

The association between post-intervention d_{mft} slopes and toothbrushing slopes is seen at the Scottish level and in 14 of the 15 Health Boards. The NHS Tayside phenomenon can be explained by the fact that there were other child oral health initiatives implemented in NHS Tayside prior to the start of the nursery toothbrushing program (Ballantyne-MacRitchie, 2000; Radford *et al.*, 2000; Curnow *et al.*, 2002; NHS Scotland, 2005). In addition to measuring the dental health of children over time, a health economic analysis is also required to calculate the costs

associated with the nursery toothbrushing program and the potential savings associated with improving dental health. This work is currently under way.

In conclusion, a major improvement in the dental health and dental health inequalities of five-year-old children in Scotland has been seen over the past decade. This trend is likely to be due, to a large extent, to the introduction and uptake of the nursery toothbrushing program across Scotland. Child oral health has improved in the face of flat-lining trends in general child health indicators.

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