

A retrospective investigation of the oral health records of a cohort of preschool children who received extractions under general anaesthesia including cost analysis of treatment

Précis: Over a two-year period, a considerable number of preschool children required dental extractions under general anaesthesia, with economically-disadvantaged children at a greater risk of requiring treatment. Children who underwent extractions under general anaesthesia at an early age demonstrated poor oral health into adolescence as confirmed by a 10-year follow-up. A nationally-structured prevention programme targeting preschool children is necessary in order to lower caries levels and reduce costs.

Abstract

Internationally, a considerable proportion of children aged five years and younger require extraction of teeth due to dental caries and frequently dental general anaesthesia (DGA) is the treatment of choice.

Aims: To investigate the records of a cohort of preschool children (aged five years and younger) referred to the public dental service provided at Cork University Hospital (CUH), Cork, Ireland, for extractions under DGA between the years 2000 and 2002. To determine the characteristics of the sample: disadvantage; the presence of a significant medical history; and, fluoride status. To establish the pattern of appointments and care, before, during and after DGA, and the pattern of dental treatment required up to sixth class (aged 11 to 12 years).

Methods: A retrospective review of dental records of a cohort of preschool-aged children referred for DGA in CUH during the years 2000-2002 was completed. Demographic and clinical data were collated and analysed using Statistical Packages for Social Sciences (SPSS). Costs were provided by CUH and the Health Service Executive (HSE). Data on costs relating to preventive programmes were obtained from information presented in the Irish Oral Health Services Guideline Initiative 2009.¹

Results: A total of 347 children were included with a median age of four years and a range of one to five years. Children with a disadvantage were more likely to require extractions under DGA than their counterparts (50%, n=175). In total, 73% (n=253)

of patients had a fluoridated water supply and 91% (n=316) had no adverse medical history. For 88% (n=306), their first dental visit was an emergency appointment. The primary indication for DGA was treatment of dental caries. A recall appointment was provided for 18% (n=63). One-quarter (n=86) required an extraction, antibiotic or referral for a second DGA at their first visit following DGA. In first class, referral for a second DGA or extraction under local anaesthetic (LA) was required for 23% (n=79) of patients. Over 60% (n=211) required either an extraction or a restoration in third class. In excess of 20% (n=69) of patients did not attend the sixth class dental inspection, the final assessment appointment in the public services.

Conclusions: A considerable number of preschool children require extractions under DGA due to dental caries. The results of this study indicate that such children progress to adolescence with poor oral health, as evidenced by the need for further restorations, extractions and repeat DGA. The average cost of DGA was €819 per child. This figure has been shown to be as much as eight times the cost of a preventive/oral health promotion programme operating within a similar cohort. An integrated preventive programme targeting preschool-aged children should be considered in attempting to manage the high levels of dental caries within this age group.

Keywords: child; dental caries; dental general anaesthesia; healthcare costs; paediatric dental treatment.

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Introduction

According to the US Department of Health and Human Services, dental caries is the “single most common chronic disease of childhood,”² a conclusion emphasised by the World Health Organisation stating that caries affects 60-90% of all school children.³

Treatment of dental caries is challenging, particularly in children aged five years and younger in the preschool-aged category. Negative experiences of dentistry can result in difficulty with dental care and oral health that have lifelong implications. Dental general anaesthesia (DGA) facilitates treatment of caries within this vulnerable group, contributing to oral rehabilitation, while alleviating pain and infection, and takes into account their age, developmental status and psychosocial well-being. Access to DGA in Ireland is limited; the provision of DGA requires substantial investment and should operate with the support of a preventive programme targeting preschool-aged children.

Most authors agree that the primary indication for the provision of DGA is the treatment of dental caries and its sequelae.⁴⁻⁶ The North South Survey of Children’s Oral Health in Ireland⁷ found that the proportion of five year olds with dental caries present in their primary teeth was 40% and 55% in fluoridated and non-fluoridated areas, respectively. Whelton *et al.*⁷ found caries levels to be higher in disadvantaged areas and that most caries in five year olds was untreated. Similarly, Tuohy⁸ found that one in four three year olds (27%) had dental caries. Resource limitations often result in a focus on restorative treatment in the permanent dentition and preschool-aged children receive little or no preventive care. Treatment in this age group may only be sought when pain or infection are present.

This group of patients are at the extreme, not only of clinical care but also of financial expenditure. The costs of DGA are dependent on the country and treatment need. Reports have calculated costs varying from US\$2,000⁹ to data from Queensland, which averaged costs at £810-£2,430 per child,¹⁰ while Canadian hospitals estimate that \$10.5 million dollars is spent on DGA annually.¹¹ Early preventive dental visits have the potential to improve oral health outcomes and reduce cost through early detection and treatment, fluoride regimens, and anticipatory guidance.¹² However, evidence has shown conflicting results on the effects of such visits. A five-year longitudinal study found that children who had a preventive visit by one year of age had lower total dental costs at age five years than children who had their first preventive visit between the ages of two and five years.¹³ A further study reported that the use of more preventive and less restorative/emergency services could lead to savings in the “millions of dollars”.¹⁴ In contrast, Sohn *et al.*¹⁵ found no association between age of first visit and total dental costs, but without including costs arising from hospital settings.

It is not a question of general anaesthesia or preventive care; there will be a need for both. However, with constrained resources in healthcare, further examination is needed of the benefit of funding preventive regimes, particularly in high-risk populations.¹⁶ In the Republic of Ireland, dental services for children are part of a subset of defined core services provided by salaried general practitioners free of charge for all within the HSE public dental service. Children are invited for an oral health assessment in first/second, third/fourth and sixth classes corresponding to ages six-seven, eight-nine and 11-12 years.¹⁷

The aim of this study was to investigate, using dental records, the demographic characteristics, subsequent treatment need and average cost of care of a cohort of children referred to CUH for DGA over a 10-year period.

Table 1: Inclusion criteria for data collection.

Patient profile	Age	Gender	Service area
Potential risk factors	Medical history	Economic disadvantage DEIS as proxy	Fluoridated water
Pattern of attendance pre DGA	Presented as emergency in pain	Number of DGA referrals/record of referral	Number of dental visits prior to DGA
DGA appointment	Indication for treatment	Number of teeth extracted	Type of dental extractions
Post DGA	The provision of a recall appointment post DGA	Nature of treatment required postoperatively	
Subsequent treatment required by patient in	First class	Third class	Sixth class

The objectives were to:

- describe the demographic characteristics of children receiving DGA in CUH: area of residence, water fluoridation status of area, economic disadvantage, and medical history;
- consider the number of extractions provided for preschool children under DGA between 2000 and 2002 in CUH;
- establish the pattern of appointments and dental care received before, during and after DGA;
- document the dental treatment provided to children until the end of the primary education system; and,
- calculate the average cost of DGA per child within the public dental service.

Materials and methods

The Cork University Teaching Hospitals’ Clinical Research Ethics Committee approved the study and the HSE granted permission allowing its completion. Subjects referred from the geographic area encompassing Community Healthcare Organisation 4 (CHO 4) for DGA at CUH in the years 2000-2002 were identified on the BRIDGES database, which has been in use in the HSE South (Cork and Kerry) since 1999. A purposive sample was selected in order to obtain subjects who were representative of the preschool service user (**Table 1**). The ethos of strict confidentiality was upheld throughout the data collection process. A legally binding agreement to adhere to HSE IT policies and HSE requirements was signed. Children were selected by virtue of having attended a HSE dental clinic requiring referral for DGA prior to their fifth birthday. At this point all records were anonymised through the use of an individual identification number that could not be limited back to the database. No personal identifying data will be included in this, nor in any publications arising from the study. The location for accessing the data was chosen by the Principal Dental Surgeon of HSE South and confined to St Finbarr’s Hospital, Cork. Entry to this area was by authorised personnel only. No data were removed from this location. The data were analysed using an encrypted PC, which was password protected and securely stored. A data extraction form was

Table 2: Direct and indirect costs.

Direct costs	Source	Indirect costs (patient loss)	Source
Salaries	CUH/HSE salaries	Loss of earning	Estimated at three hours and calculated according to minimum wage
Materials	CUH ordering and purchasing department	Travel costs	Average mileage rate over average geographical distance
Maintenance of equipment IT services Capital expenditure Stationery Hotel costs	HSE service plan	Childcare costs	Half a day in day care at the average rate

created and piloted using Microsoft Excel. CUH accepts referrals from the salaried dental HSE service in CHO 4, formerly North and South Lee, North Cork, West Cork and Kerry, and is funded by the Department of Health. In considering subsequent treatment need, a hierarchy of treatment severity was used for data collection. Oral hygiene instruction, dietary analysis and referral to a dental hygienist formed one group, followed by those who required fissure sealants only. A superior level in the hierarchy was represented by those requiring a restoration due to caries, with extraction under local anaesthetic (LA) or referral for DGA signifying the most severe treatment need. It was anticipated that in addition to those children requiring fissure sealants only, within the groups requiring restorations and extractions fissure sealants were also applied as part of the treatment plan. An emergency appointment was defined as an appointment provided to a patient as a direct response to pain and/or infection. The Delivering Equality of Opportunity in Schools (DEIS) status is used as a proxy for economic disadvantage at the school level, as an individual measure of disadvantage, such as medical card status, was unavailable. DEIS was introduced as an Irish Government action plan with a focus on targeting additional resources towards particular schools. Schools are identified for inclusion based on a range of indicators, including prevalence of

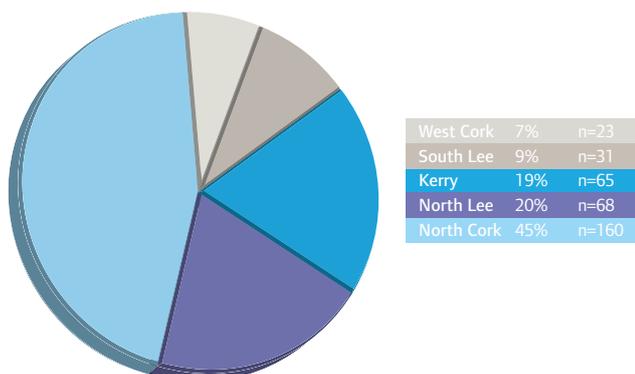


FIGURE 1: Distribution of patients attending for DGA by location.

Table 3: Characteristics of preschool children who underwent DGA.

Potential risk factors for treatment	Yes n (%)	No n (%)	Total n (%)
Attendance at DEIS school	175 (50)	172 (50)	347 (100)
Medical condition indicated	31 (9)	316 (91)	347 (100)
Served by a public piped fluoridated water supply	253 (73)	94 (27)	347 (100)

unemployment, local authority (public) housing and eligibility for the free book grant scheme. In total, around 21% of primary schools in Ireland have DEIS status, and this falls to 13% in the Cork and Kerry area.¹⁸ During the years in question, 71% of the population were served by a fluoridated public piped water supply.⁷

Statistical analysis

Analysis was undertaken using Statistical Packages for Social Sciences (SPSS) Version 20 and tests of normality conducted. Medians were used as a measure of central tendency where continuous variables were not normally distributed. Non-parametric tests were used with respect to proportions. The Mann-Whitney U test and the Kruskal-Wallis test were used to determine association. Costs were divided into direct and indirect expenditure. Direct costs were obtained from HSE service plan budgets, the HSE Principal Dental Surgeon and the CUH Theatre Manager. Such costs included total annual allocated theatre costs including personnel salaries, theatre cleaning costs and waste management costs.

Indirect costs were estimated mean values representing loss of income, mileage and childcare expenses (Table 2).

Results

Patient characteristics

A sample of 347 children aged five years and younger who were referred for DGA at CUH was obtained (Figure 1). The median age at first visit was four years, with a range of one to five years. The sample comprised 55% (n=190) males and 45% (n=157) females. The total population of zero to five year olds in the Cork and Kerry region in 2002 was 39,665.¹⁹

A higher proportion of children attending DEIS schools required DGA than was representative of the general population. In the sample 50% of the children requiring DGA attended DEIS schools yet DEIS status is assigned to only 13% of primary schools in the CHO 4 area.

In 91% (n=316) of subjects there was no medical reason necessitating DGA. The proportion of participants receiving a fluoridated water supply was 73% (n=253) (Table 3).

Table 4: Treatment provided to children (who had undergone DGA at preschool age) in first, third and sixth class.

Type of treatment	First class n (%)	Third Class n (%)	Sixth class n (%)
Not examined in first class	9 (3)	-	-
Antibiotic	2 (1)	1 (0.3)	-
Emergency extraction under GA	10 (3)	-	-
Extraction under LA	43 (12)	68 (20)	31 (9)
Failure to attend	27 (8)	35 (10)	69 (20)
Fissure sealant only	66 (19)	46 (13)	46 (13)
GDP	2 (1)	4 (1)	4 (1)
OHI/diet/hygienist/NTR	22 (6)	10 (3)	4 (1)
Ortho xLA	1 (0.3)	2 (1)	19 (5)
Ortho xGA	-	1 (0.3)	9 (3)
Referral for DGA2	36 (10)	22 (6)	5 (1)
Referral for DGA3	1 (0.3)	3 (1)	6 (2)
Referral for DGA4	-	-	2 (1)
Restoration	117 (34)	143 (41)	137 (40)
Endodontic treatment	-	-	4 (1)
Missing data	11 (3)	12 (3)	11 (3)
Total	347 (100)	347 (100)	347 (100)

Note: GDP = general dental practitioner; OHI/diet/hygienist/NTR = oral hygiene instruction/dietary advice/referral to hygienist/nothing to report; Ortho xLA = orthodontic extraction under local anaesthesia; Ortho xGA = orthodontic extraction under general anaesthesia; referral for DGA 2/3/4 = referral for extraction under a second, third and fourth general anaesthetic.

Dental experience pre DGA

For 88% (n=306) of children their first dental visit was categorised as an “emergency appointment”. The median number of appointments prior to DGA was three in a range from one to eight. The median number of days spent waiting from initial referral was 30, in a range from one to 450 days. In 78% (n=271) of cases, a record of referral was present, while in 22% (n=76) no clear documented referral was present. Two or more referrals were recorded in 48% (n=167) of patients.

Treatment under DGA

The most common indication for treatment was extraction due to dental caries (88%, n=306). The most common type of extraction was a primary molar extraction (61%, n=212). The median number of teeth extracted was four, with a minimum of one and a maximum of 17. The median number of DGAs was one, with a maximum of four.

Dental experience post DGA

In all, 18% (n=36) of patients received a recall appointment post DGA, 8% (n=28) of whom failed to attend for treatment. For 40% (n=139), the first appointment post DGA was an emergency appointment. In 8% of cases (n=27) an antibiotic was required, 7% (n=23) required an extraction under LA and 10% (35) were referred for a second DGA.

Pattern of care from first class (approximately six to seven years) to sixth class (approximately 11-12 years)

In first class, 34% (n=117) of these patients required a restoration due to

Table 5: Direct and indirect costs for DGA.

Costs	
1. Annual total allocated theatre costs	€1,266,381.09
2. Annual third-party cleaning costs	€15,246.00
3. Annual theatre consumables	€229,550.67
4. Annual waste management costs	€38,633.85
5. Annual theatre maintenance costs	€20,000.00
6. Total annual theatre operating costs (1+2+3+4+5)	€1,592,888.86
7. Cost per patient	€689.96
8. Indirect cost (patient loss)	€129.41
Total cost:	
9. Total number of patients per annum	2,310
10. Total cost per patient (9/10)	€818.97

dental caries, 12% (n=43) required an extraction under LA and 3% (n=10) had an emergency extraction completed under DGA during the course of treatment. In third class, 41% (n=143) of children required a restoration due to caries, 20% (n=68) required an extraction under LA and 6% (n=22) were referred for their second DGA.

In sixth class, 40% (n=137) of children required a restoration due to caries, 9% (n=31) required an extraction under LA, and 20% (n=69) failed to attend their school screening appointment (Table 4).

Statistical analysis

The Mann-Whitney U test showed that there was no significant association between the number of teeth extracted and socioeconomic status (P>0.05), fluoride status (P>0.05), and medical history (P>0.05). The Mann-Whitney U test also showed that there was no significant association between socioeconomic status and number of appointments prior to DGA (P>0.05). The Kruskal-Wallis test was used to determine if there was a relation between the number of appointments prior to DGA and the indicator for treatment. It showed that there was no significant association between indicator for treatment under DGA and the number of appointments prior to DGA (P>0.05).

Cost analysis

DGA cost was considered at a microeconomic level with both direct and indirect costs being collected. The total cost per patient was calculated at approximately €818.97 (Table 5).

Discussion

The aims of this study were to consider a cohort of preschool children aged five years and younger who attended for DGA in CUH: to describe their characteristics, along with treatment provided prior to DGA, under DGA and at three scheduled oral health assessment appointments subsequent to DGA within the public dental service at CUH and HSE South. In addition, the average cost of DGA per child was calculated.

The median age of the children was four years. There was a greater proportion of boys requiring treatment and the majority of patients were from the north Cork area. Most authors agree that caries levels have not decreased in the preschool category and as a result more children are undergoing treatment under DGA at an earlier age.^{7,20} This has adverse consequences for overall dental health as the younger a child undergoes such extensive treatment, the more likely they are to suffer poor dental health into adulthood and have an increased susceptibility to further caries.²¹⁻²³ The high proportion of patients referred from the north Cork region may be attributed to the fact that it represents the largest geographical region. In addition, there was a regional DGA service previously available, which may have contributed to increased referrals for DGA and increased expectation among parents.

The total population of zero to five year olds in the Cork and Kerry region in 2002 was 39,665;¹⁹ thus, our study sample is a small representation of this cohort. The majority of children referred for DGA were healthy children without a significant medical history. The proportion of children (73%, n=253) resident in an area with a fluoridated public piped water supply was similar to the proportion for the Republic of Ireland population (73%). These results indicate neither fluoride nor adverse medical history having an effect. This underlines national health promotion strategies and guidelines indicating that water fluoridation is not sufficient alone and should be supplemented by oral health promotion initiatives and targeted caries prevention measures.^{1,24,25}

DEIS was used as a proxy for economic disadvantage. Half of patients (50%, n=175) were attending DEIS schools, despite only 13% of schools falling into this category in this area.^{26,27} Evidence has long established the relationship that exists between disadvantage and an increased risk of dental caries.^{7,28} Our research indicates that children of a higher social group also required DGA. This highlights the opinion of the literature that DGA is a facility for which there is demand from all social groups. Disadvantaged children have a higher risk of requiring a DGA in their lifetime; however, this is not occurring in isolation, with their equivalents in the higher group also placing a strain on the system.²⁹ Dental caries is a disease of multifactorial aetiology, with dietary habits and tooth brushing frequency also having an effect. The North South Survey of Children's Oral Health in Ireland⁷ demonstrated poor results in these areas among eight-year-old children. The data showed that just over 50% of children in the sample brushed twice a day and more than half of children had sugary snacks at least twice a day. Dental services in Ireland are organised in a manner that assumes attendance at private practitioners outside of designated school assessment or emergency appointments. These findings would suggest that this is not the case in either social group. These results also emphasise the multifactorial aetiology of dental caries and that the role of parental counselling, oral hygiene education and high-sugar diets must be examined.

These findings would suggest that proportionate universalism must be considered. Focusing solely on the most disadvantaged will not reduce health inequalities sufficiently. To reduce the steepness of the social gradient in health, actions must be universal, but with a scale and intensity that is greater in those who are disadvantaged.³⁰

The majority of patients (88%, n=306) required extractions under DGA due to dental caries. These results are consistent with reports from the literature where most authors agree that the primary indication for the provision of DGA is the treatment of dental caries and its sequelae.^{5,31,32} The median number of DGAs required by each participant was one, with a maximum of four distinct DGAs required for dental extractions among some patients. On occasion, the maximum number of DGAs could be attributed to the presence of a complicated medical history along with anxiety. However, in most cases there were no predisposing factors that would indicate an increased likelihood of requiring treatment under DGA.

For 88% of children (n=306), their first dental visit was an emergency appointment; thus, the first interaction a child aged five years or younger had with the dental health services was for the relief of pain or infection. We must consider the negative implications on quality of life and the lasting psychological impact on attitude toward dental treatment that may arise from such service organisation.³³ Also treatment of pain only, without provision for elective care at the time when disease is identified, has a knock-on effect on services when these children reach an age of eligibility for routine care.

For 78% (n=271) of cases a record of referral was present. This was noted as a marker on the electronic patient chart. It was beyond the remit of this study to examine individual referral forms, which would have provided further insight into the referral patterns; however, this may be an area where further research is needed. Charts where there were missing referrals related to dentists who treated the child under DGA themselves or where the DGA was completed as an emergency treatment, usually within 24-48 hours.

Almost half of the children (n=166) required two or more referrals. This included children who required a subsequent DGA, but also those who were referred and while on a waiting list developed further symptoms warranting a second referral. The median waiting time was 30 days and ranged from one to 450 days. This echoes evidence from literature regarding waiting time for treatment where North *et al.*³⁴ found that while awaiting treatment, 41% of parents reported that their children required analgesics and almost half required antibiotics.

An aim of this research was to investigate the dental experience, as derived from dental records, of the cohort subsequent to DGA in order to identify any discernible patterns of treatment. The bulk of patients were not recalled for review following treatment (80%, n=277) and this runs counter to evidence of best practice. By virtue of undergoing DGA at a young age, these children are all at a high risk for future dental caries. Evidence has shown that past caries experience is an indicator of future caries development,³⁵ that children who undergo extensive treatment under general anaesthetic at a young age are at an increased risk of requiring a repeat procedure,²² and that attendance patterns postoperatively play a substantial role in the risk of repeat DGA.³² Evidence-based guidelines have been developed on the prevention and management of dental caries through a risk assessment approach, which should be incorporated into the public dental health services.¹

Our research indicates that children of a preschool age who undergo comprehensive treatment under DGA consequently retain poor levels of oral health into adolescence, which mirrors previous findings.^{21,36} This is evidenced by the requirement for extractions under LA, restorations and referrals for DGA when the child was reviewed in first, third and sixth class. One-quarter of children in the sample required either an extraction under LA (7%, n=23), referral for a further DGA (10%, n=35), or placement on an antibiotic (8%, n=27) in the immediate visit following DGA.

A finding to emphasise is poor attendance rates that exist within this group. One-fifth of patients in sixth class (20%, n=69) failed to attend their examination. This is the last appointment within the public dental service and is concerning as from evidence we know there is no culture of attendance in the private dental sector.⁷

A further aim of our study was to calculate the cost per child of DGA specific to CUH within the public dental service, and to consider this figure in light of data relating to the cost of preventive programmes within similar cohorts. An average cost of €819 per child was calculated.

The Irish Oral Health Services Guideline Initiative examined the evidence-based guidance on the use of topical fluorides for caries prevention in children in Ireland including the cost-effectiveness of the programme.¹⁷ It obtained data on the costs of school-based, supervised tooth-brushing from a Scottish-based programme (Childsmile). The scheme resulted in a 56% reduction in caries increment in the first permanent molars after two years and consistent caries reductions were evident four and a half years after the programme ended. The total two-year costs were €102 per child per year. Similarly, a recent tooth-brushing programme within the HSE was piloted, with an average cost calculated per child estimated at €14. This programme focuses on caries reduction in the permanent dentition and further research is needed in determining if the same results could be achieved for the primary dentition within the preschool cohort.¹⁷

There is an undoubted need to provide a safe, effective and child-centred DGA facility. However, the question must be asked: should some of the tremendous resources allocated to DGA be redistributed to provide an equally effective preventive and oral health promotion regime? If there was increased focus on this area, then there may be a reduction in the levels of dental caries, a corresponding reduction in the need for treatment under DGA and ultimately a reduction in cost.¹³ The presence of clear protocols around the time of DGA relating to carious teeth, recall and risk assessment may reduce the need for further treatment under DGA.

A framework for further research may be to consider the design of a preventive programme to operate within the preschool age group with limited resources, while maintaining a DGA service. We can state, tentatively, that the cost of a treatment under a DGA could be eight times that of a similar prevention/promotion scheme, bearing in mind that this is without consideration of the cost-effectiveness of this scheme.¹ Furthermore, investment in a population prevention strategy is not only more economically prudent but may yield significant improvements in oral health contributing to a reduction in dental caries, reduced need for DGA and subsequently reduced cost.³⁷ This early intervention would improve oral health in childhood but may also lead to a reduced burden of care and disease into adulthood and old age.^{38,39}

Conclusion

A significant number of preschool children require extractions under DGA. Results indicate that such children progress to adolescence with poor oral health, as evidenced by the need for further restorations, extractions and repeat DGA. The average cost of the service is €819 per child. This figure could be as much as eight times the cost of a preventive/oral health promotion programme operating within the same cohort. A nationally-structured preventive programme targeting preschool-aged children is necessary in attempting to defeat the high levels of dental caries within this group.

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