

# ECONOMIC VALUE OF GOOD ORAL HEALTH

Report for the Wrigley Oral Healthcare Programme

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# CONTENTS

<b>Executive Summary</b>	<b>3</b>
<b>What is good oral health?</b>	<b>5</b>
The value of good oral health	5
The current NHS accessibility challenge and impact of Covid-19	6
<b>How can we prevent poor oral health?</b>	<b>7</b>
Preventative oral health interventions	7
Water fluoridation	7
Sugarfree gum	8
Supervised brushing	9
Other interventions	10
Summary of preventative interventions considered	10
<b>What's the economic value of good oral health?</b>	<b>11</b>
Benefits and beneficiaries of good oral health	11
'What-if' scenario modelling	12
Water fluoridation	15
Sugarfree gum	17
Supervised brushing	18
Illustration for a population of 100,000	19
Limitations of our 'what-if' scenario modelling	21
<b>Conclusions</b>	<b>22</b>

# Executive Summary

The World Health Organisation has said that “oral health is a key indicator of overall health, well-being and quality of life.” Poor oral health is exacerbated when individuals don’t regularly visit the dentist. Despite NHS England spending around £2.3 billion on dentistry each year, people in many areas do not have access to a local NHS dentist, creating so-called ‘dental deserts’ across the country. Exacerbating this, the Covid-19 pandemic led to many dental appointments being cancelled, creating a significant backlog of patients. Around half of patients haven’t seen a dental professional for at least 18 months.

Given the challenges of accessing dental care, and the significant cost of treatments for oral health problems, now is a good time to consider the role of preventative oral health interventions. In this report, we have considered three interventions which illustrate the potential for improving oral health through prevention:

- water fluoridation;
- sugarfree gum; and
- supervised brushing.

These interventions differ in the groups for whom they are most beneficial and the extent to which they require individual behaviour change. They also differ in who bears the costs: typically, central government pays for water fluoridation, local government pays for supervised brushing, and individuals pay for sugarfree gum.

We have modelled the financial benefits to individuals and the NHS from these interventions. We estimated the potential dental cost savings, due to a reduction in tooth decay and associated costs of NHS dental treatment. We have illustrated these benefits for a population of 100,000 individuals:

## In a population of 100,000, preventative interventions could be targeted as follows:



Water fluoridation for 100,000 people



Sugarfree gum for 62,000 older children and adults






Supervised brushing for 1,000 younger children

This illustration assumes that all 100,000 people benefit from water fluoridation; 62,000 from sugarfree gum (70% of adults and children aged over 10); and 1,000 from supervised brushing (20% of children aged 3-6).

For this population of 100,000, we estimated the following total savings:

These preventative interventions could lead to dental cost savings for:

	NHS DENTAL PATIENTS	PRIVATE DENTAL PATIENTS	NHS	which could fund...	ADDITIONAL CHECK-UPS
	£142,800	>£142,800	£130,800	▶	21,400
	£31,000	>£31,000	£26,900	▶	4,400
	£2,300	>£2,300	£29,300	▶	4,800

Our modelling focused upon the financial benefits to NHS dental patients. The benefits to private patients would be even greater, since they are similar in number to NHS patients but tend to pay higher dental charges.

In addition to these financial benefits, there are also potentially significant wider benefits to individuals in terms of improved quality of life, and to individuals, companies and schools in terms of higher productivity and lower absenteeism.

Our findings suggest that each of these preventative oral health interventions – as well as others not considered in detail here – could play a valuable role in improving the oral health of the population, particularly at a time when NHS dental services are under pressure.

We also note considerable gaps in the evidence on the impact of preventative interventions, and would recommend improving evidence in this area. In the shorter term, targeted, localised interventions focused on areas of the country with relatively poor dental health could be a good place to start, as these are likely to have the highest impact.

We recommend that all stakeholders – including the Office for Health Improvement and Disparities, Department of Health and Social Care, NHS England, local authorities, and dental practitioners across the country – consider placing a greater focus on preventative oral health interventions as part of a wider strategy to tackle the challenges in dentistry.

## What is good oral health?

Good oral health has many components. For example, FDI World Dental Federation’s definition is as follows:

*“Oral health is multi-faceted and includes the ability to speak, smile, smell, taste, touch, chew, swallow and convey a range of emotions through facial expressions with confidence and without pain, discomfort and disease of the craniofacial complex (head, face, and oral cavity)”<sup>1</sup>*

Good oral health means avoiding tooth decay and gum disease. UK Government guidance states:

*“Oral and dental diseases are widely prevalent... most people are at risk of developing some oral disease during their lifetime. The most common diseases are dental caries and periodontal diseases...”<sup>2</sup>*

## The value of good oral health

Maintaining good oral health can avoid pain and discomfort associated with oral health problems. UK Government guidance states:

*“The impact of oral disease (most notably dental caries) includes pain, days lost from work and school, and adversely affects people’s quality of life.”<sup>3</sup>*

The World Health Organisation has said that:

*“Oral health is a key indicator of overall health, well-being and quality of life.”<sup>4</sup>*

Maintaining good oral health can also avoid the inconvenience and financial costs associated with fixing oral health problems. For example, the following table shows the typical costs to patients of common dental treatments, including how these vary depending upon whether the treatment is provided by the NHS or privately.<sup>5</sup>

**Table 1** Dental treatment costs to patients

Treatment	NHS price	Private price
New patient consultation or check-up	£23.80	£20 to £120
Filling	£65.20	£30 to £250
Root canal treatment	£65.20	£45 to £970
Tooth extraction	£65.20	£50 to £370
Crowns	£282.80	£250 to £1,180

Source: Adapted from Which? (2022), “Private and NHS dental charges”, <https://www.which.co.uk/reviews/dentists/article/private-and-nhs-dental-charges-al0jA6J1Swyl>.

<sup>1</sup> FDI World Dental Federation, <https://www.fdiworlddental.org/fdis-definition-oral-health>.

<sup>2</sup> Office for Health Improvement and Disparities (2021), “Delivering better oral health: an evidence-based toolkit for prevention”.

<sup>3</sup> Office for Health Improvement and Disparities (2021), “Delivering better oral health: an evidence-based toolkit for prevention”.

<sup>4</sup> World Health Organisation, <https://www.who.int/health-topics/oral-health>.

<sup>5</sup> For NHS treatments, which are publicly subsidised, there is also a cost to the NHS for these treatments.

The costs shown in Table 1 are only those incurred by patients. In addition, the NHS bears a significant cost of dental treatments. It is estimated that the NHS pays over 70% of the total costs of dental treatments provided by NHS dentists (with patients paying, through the charges in Table 1, the remaining 30%).<sup>6</sup> Some individual treatments can be very costly to the NHS. For example, YHEC (2016) estimated that the cost to the NHS of extracting a child's tooth under general anaesthetic was £836.<sup>7</sup> In total, NHS England spends around £2.3 billion on dentistry each year.<sup>8</sup>

## The current NHS accessibility challenge and impact of Covid-19

Poor oral health is exacerbated when individuals don't regularly visit the dentist.<sup>9</sup> Two key factors are currently driving up the number of people who do not see a dentist:

First, people in many areas do not have access to a local NHS dentist. A survey by the BBC in August 2022 showed that 90% of dentists in England are not accepting new NHS patients.<sup>10</sup>

Second, the Covid-19 pandemic led to many dental appointments being cancelled. This created a significant backlog of patients and meant that many people did not see their dentist for an extended period. The General Dental Council found that by October 2021, half of patients had not been back to their dental practice since restrictions were eased, meaning they had not seen a dental professional for at least 18 months.<sup>11</sup>

The Care Quality Commission has concluded:

*"Access to NHS dental care for all has been highlighted as an issue before the spread of COVID-19, and there are clear signs that this has been compounded by the pandemic."<sup>12</sup>*

This has created so-called 'dental deserts' across the country.

<sup>6</sup> BDA (2019), "5 things you need to know about NHS dental charges", <https://bda.org/news-centre/blog/5-things-you-need-to-know-about-nhs-charges>.

<sup>7</sup> York Health Economics Consortium (2016), "A rapid review of evidence on the cost-effectiveness of interventions to improve the oral health of children aged 0 to 5 years".

<sup>8</sup> NHS England (2022), " Hundreds of thousands more dental appointments to help recovery of services", <https://www.england.nhs.uk/2022/01/hundreds-of-thousands-more-dental-appointments-to-help-recovery-of-services/>.

<sup>9</sup> For example, see Richards & Ameen (2002), Thomson et al (2010), Crocombe et al (2011), Åstrøm et al (2014).

<sup>10</sup> BBC (2022), "90 percent of NHS dental practices in the UK are not accepting new patients, BBC survey finds", <https://www.bbc.co.uk/mediacentre/ninety-percent-of-nhs-dental-practices-not-accepting-new-patients>.

<sup>11</sup> GDC (2022), "COVID-19 and dentistry – survey of the UK public 2021", [https://www.gdc-uk.org/about-us/what-we-do/research/our-research-library/detail/report/covid-19-dentistry-survey-public-2021?sfvrsn=a42b2420\\_5](https://www.gdc-uk.org/about-us/what-we-do/research/our-research-library/detail/report/covid-19-dentistry-survey-public-2021?sfvrsn=a42b2420_5).

<sup>12</sup> CQC (2022), "State of Care 2020/21", [https://www.cqc.org.uk/publications/major-reports/soc202021\\_02i\\_dental-access](https://www.cqc.org.uk/publications/major-reports/soc202021_02i_dental-access).

## How can we prevent poor oral health?

Given the challenges of accessing dental care, and the significant cost of treatments for oral health problems, now is a good time to consider the role of preventative interventions, which support good oral health.

### Preventative oral health interventions

There are many interventions that can help to prevent poor oral health. Some of these can be implemented by government, some by dental practices, and some by individuals and families. They vary in their cost, effectiveness, and the extent to which they are ‘targeted’ at – or are most valuable for – particular groups (such as children).

Preventative oral health interventions reduce the incidence of problems such as tooth decay (caries), build-up of plaque and tartar, and gum disease. These problems often require treatments such as fillings, root canal treatments, crowns, or tooth extractions. These treatments can be uncomfortable and – as Table 1 shows – costly.

In this report, we have considered three interventions which illustrate the potential for improving oral health through prevention:

- water fluoridation;
- sugarfree gum; and
- supervised brushing.

These interventions are not alternatives from which we need to choose a single option, nor are they alternatives to regular dental check-ups. They are complementary and might all play a role in improving oral health. They are also not the only possible interventions; many others might also be considered. We have focused on these because they offer a good illustration of the range of preventative interventions, each targeting different groups.

### Water fluoridation

Fluoride can be added to public drinking water to improve dental health. Water fluoridation has been used in various parts of the world for almost 80 years, and was introduced in the UK around 60 years ago.<sup>13</sup> Currently, around 10% of the population in England have fluoride added to their water supply.<sup>14</sup> The Government’s Health and Care Bill includes provisions to encourage water fluoridation and extend it to a greater proportion of the population in England.<sup>15</sup> The Oral Health Foundation has stated:

*“We believe that water fluoridation is the single most effective public health measure there is for reducing oral health inequalities and tooth decay rates, especially amongst children.”<sup>16</sup>*

<sup>13</sup> <https://www.nhs.uk/conditions/fluoride/>.

<sup>14</sup> OHID (2022), “Water fluoridation: Health monitoring report for England 2022”.

<sup>15</sup> <https://www.gov.uk/government/publications/health-and-care-bill-factsheets/health-and-care-bill-water-fluoridation>.

<sup>16</sup> <https://www.gov.uk/government/publications/health-and-care-bill-factsheets/health-and-care-bill-water-fluoridation>.



A major benefit of water fluoridation is that its impact is universal and ‘automatic’, with no need for individuals to ‘opt in’ or to change their behaviours. All individuals in a given area will benefit from water fluoridation.

The size of the benefits from water fluoridation is subject to ongoing research and debate. A systematic review undertaken in 2015 concluded that fluoridation is likely to have a positive impact for children: reducing caries in ‘baby teeth’ by 35% and in ‘adult teeth’ by 26%.<sup>17</sup> However, the review noted that these results were largely based on data from before 1975. Since the introduction of fluoride toothpaste in the 1970s, the incremental benefits of water fluoridation may be lower, although a later review suggests that the impact may still be substantial.<sup>18</sup> Currently, research provides little evidence on benefits of water fluoridation for adults’ oral health.<sup>19</sup>

There is mixed evidence on whether fluoridation benefits children in deprived areas more than those in more affluent areas. The Office for Health Improvement and Disparities (2022) reported that water fluoridation reduced the number of children admitted to hospital for tooth extractions by between 57% and 63%, with the greatest effect in more deprived areas.<sup>20</sup> However, recent evidence from Goodwin et al (2022) suggests that there is little difference in the impact between more and less deprived areas.<sup>21</sup>

Water fluoridation requires significant up-front investment, as well as ongoing running costs, although when implemented at a large scale the costs per person can be quite low. Public Health England (2020) estimated that the costs of operating established water fluoridation schemes were around £0.52 per person.<sup>22</sup>

## Sugarfree gum

Chewing sugarfree gum can support good oral health by encouraging saliva production, which contributes to neutralising plaque acids, maintaining tooth mineralisation and removing harmful micro-organisms such as *streptococcus mutans*.<sup>23</sup> Chewing sugarfree gum could be done alongside water fluoridation; they are complementary rather than alternatives.

Evidence suggests that chewing sugarfree gum (containing sorbitol or xylitol) twice or three times a day can reduce the risk of caries, particularly amongst adolescents and young adults.<sup>24</sup> Claxton et al (2016) and Newton et al (2020) reviewed previous studies which indicated a reduction in caries of between 20% and 40% from chewing sugarfree gum.

Sugarfree gum costs approximately £55 per person per year, assuming 3 pieces per day at a cost of 5p per piece.

<sup>17</sup> Iheozor-Ejiofor et al (2015), “Water fluoridation for the prevention of dental caries”.

<sup>18</sup> Mullane et al (2016), “Fluoride and Oral Health”.

<sup>19</sup> Iheozor-Ejiofor et al (2015) and Moore et al (2021).

<sup>20</sup> OHID (2022), “Water fluoridation: Health monitoring report for England 2022”.

<sup>21</sup> Goodwin et al (2022), “Evaluation of water fluoridation scheme in Cumbria: the CATFISH prospective longitudinal cohort study”.

<sup>22</sup> PHE (2020), “Improving oral health: A community water fluoridation toolkit for local authorities”. We note that these costs appear to exclude the up-front infrastructure costs, including water fluoridation plants.

<sup>23</sup> For example, see Dawes & Macpherson (1992), Stookey (2008), Karami-Nogourani et al (2011), Nasseripour et al (2021).

<sup>24</sup> For example, see Möller & Poulsen (1973), Mäkinen et al (1995), Beiswanger et al (1998), Machiulskiene (2001), Szöke et al (2001).



Like water fluoridation, sugarfree gum is potentially appropriate for a wide population, including older children and adults. Unlike water fluoridation, chewing gum requires individuals to change their behaviour (i.e. chewing 3 pieces per day).

## Supervised brushing

Supervised brushing programmes can be used in schools or nurseries, to improve the dental health of younger children. These programmes seek to achieve two main aims:

First, supervision ensures that children brush their teeth effectively during the programme, which directly benefits their oral health. Evidence shows that brushing twice a day with fluoride toothpaste reduces the incidence of caries.<sup>25</sup>

Second, supervised brushing programmes seek to build good habits and behaviours. The long-term impact of supervised brushing depends upon individuals changing their behaviour at home, after the programme has finished.<sup>26</sup>

Several studies have shown that supervised brushing is effective in improving oral health.<sup>27</sup> A long-running programme (Childsmile) exists in Scotland, and Public Health England (2016) published a toolkit to support the commissioning of supervised brushing programmes.<sup>28</sup> However, some reviews have suggested the evidence in favour of supervised brushing is inconclusive.<sup>29</sup>

Evidence suggests supervised brushing is more valuable in deprived areas. Children in these areas are less likely to brush their teeth twice daily.<sup>30</sup> Public Health England (2016) advises that supervised brushing programmes are targeted in deprived areas to maximise their impact and cost-effectiveness.

Costs of a supervised brushing programme vary, depending in particular upon whether additional staff are required to deliver the programme and what resources are provided to the children (e.g. toothbrushes and information which can be taken home). YHEC (2016) estimates the costs of a programme to be around £17 to £35 per child per year.<sup>31</sup>

Compared with interventions such as water fluoridation and sugarfree gum, supervised brushing is much more targeted. This means it reaches fewer people, but also that investment is only made where it is expected to have a beneficial impact. However, the benefits are not 'automatic'; like sugarfree gum, individuals are

<sup>25</sup> PHE (2014), "Delivering better oral health: an evidence-based toolkit for prevention: 3rd edition".

<sup>26</sup> NICE (2014), "Public Health Guidance 55: Oral health: approaches for local authorities and their partners to improve the oral health of their communities".

<sup>27</sup> For example, see Jackson et al (2005), 4Children (2016) and Macpherson et al (2019) for UK evidence and Damle et al (2014), Babaei et al (2020) and Natapov et al (2021) for international evidence.

<sup>28</sup> Public Health England (2016), "Improving oral health: A toolkit to support commissioning of supervised toothbrushing programmes in early years and school settings".

<sup>29</sup> Dos Santos et al (2018), "A systematic review of the effects of supervised toothbrushing on caries incidence in children and adolescents".

<sup>30</sup> HSCIC (2015), "Children's Dental Health Survey 2013: Report 1: Attitudes, Behaviours and Children's Dental Health: England, Wales and Northern Ireland".

<sup>31</sup> York Health Economics Consortium (2016), "A rapid review of evidence on the cost-effectiveness of interventions to improve the oral health of children aged 0-5 years". PHE note that costs vary widely (including below and above the range given), depending upon the economies of scale achieved.

required to change their behaviours in order to improve oral health. There have been relatively few long-term studies which have explored whether the benefits of supervised brushing are sustained over time.

## Other interventions

Other preventative oral health interventions exist, but were not considered within this analysis. These include screening programmes<sup>32</sup>, fluoride varnish<sup>33</sup>, oral health education<sup>34</sup> and fluoride supplements<sup>35</sup>.

## Summary of preventative interventions considered

In this report we have considered three preventative interventions: water fluoridation; sugarfree gum; and supervised brushing. They differ in their targeting, the extent to which they require individual behaviour change, and their costs.

- **Targeting:** These interventions differ in the populations for which they can be used (or are most effective), particularly the age of the individuals. Additionally, all preventative interventions tend to be more valuable amongst individuals with poorer existing oral health, which includes more deprived communities.
- **Behaviour change:** These interventions differ in whether they require individuals to behave differently in order to achieve the benefits. For example, water fluoridation does not require any behaviour change and the benefits are 'automatic'.
- **Costs:** These interventions differ in three important ways. First, whether there are up-front costs required (e.g. to build water fluoridation infrastructure). Second, the extent of the ongoing 'delivery' costs of the intervention. Third, these interventions differ in who pays the costs.

Table 2 summarises the key characteristics of the three interventions.

**Table 2** Summary of preventative interventions considered

Intervention	Targeting	Behaviour change	Costs
Water fluoridation	Not targeted at all – benefits everyone	No	High up-front costs, low ongoing running costs. Borne by central government.
Sugarfree gum	Older children and adults	Yes	No up-front costs, ongoing costs of gum. Borne by individual.
Supervised brushing	Younger children	Yes	Some up-front costs, ongoing delivery costs. Borne by local government.

Source: *Frontier Economics*

<sup>32</sup> Arora et al (2019), "School dental screening programmes for oral health".

<sup>33</sup> Marinho et al (2013), "Fluoride varnishes for preventing dental caries in children and adolescents".

<sup>34</sup> Soldani et al (2018), Stein et al (2018).

<sup>35</sup> Tubert-Jeannin et al (2011), "Fluoride supplements (tablets, drops, lozenges or chewing gums) for preventing dental caries in children".

# What’s the economic value of good oral health?

The previous section explained how preventative interventions can support good oral health and avoid problems such as tooth decay and gum disease, and treatments such as fillings and tooth extractions. However, the potential benefits of good oral health are much broader. This section explores these benefits.

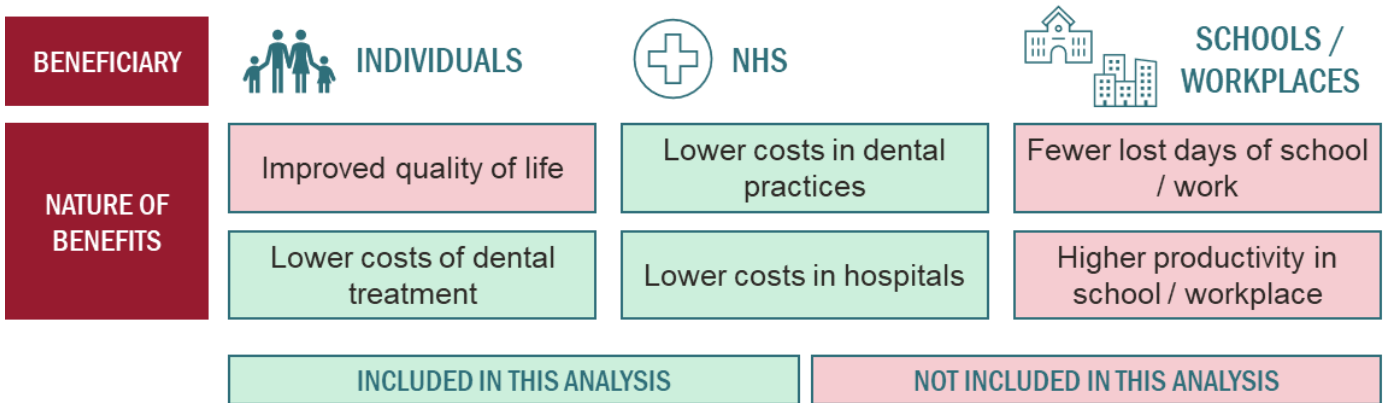
## Benefits and beneficiaries of good oral health

Good oral health most directly benefits individuals. Avoiding dental problems means avoiding pain and discomfort, which is an improvement in quality of life.<sup>36</sup> Additionally, it means fewer trips to the dentist and lower costs of dental treatment.

These benefits to individuals may be sufficient to justify the costs of preventative interventions, particularly when these costs are relatively small. However, there are also wider ‘knock-on’ or ‘spillover’ benefits from good oral health. The main beneficiaries are the NHS, schools and workplaces. Fewer dental treatments means either lower costs to the NHS in dental practices and hospitals, or additional capacity freed up for other patients. It also means fewer days off school for children, and fewer days off work for adults, either due to their own dental problems, or to accompany children to their appointments.<sup>37</sup>

Figure 1 summarises these benefits and shows which benefits have been considered within this analysis. Further work considering the wider benefits of good oral health would be valuable. We note that by excluding these benefits from this analysis, our estimates provide an underestimate of the total benefits achieved by good oral health.

**Figure 1** Benefits and beneficiaries of good oral health



Source: Frontier Economics

<sup>36</sup> For example, see Baiju et al (2017) and Lindmark et al (2020).

<sup>37</sup> For example, see Rebelo et al (2018) and Lima & Buarque (2019).

## 'What-if' scenario modelling

We have modelled the potential impact on dental costs – for both the NHS and for NHS patients – of water fluoridation, sugarfree gum and supervised brushing. We do this in four stages:

1. We have gathered together the published evidence on these preventative interventions.
2. We identify the reduction in oral health problems (e.g. tooth decay) that is estimated to result from each intervention.
3. We estimate the dental treatments (e.g. tooth extractions) that could be avoided as a result.
4. We estimate the cost saving to the NHS and NHS patients from avoided dental treatments.

These stages are illustrated in Figure 2 below.

**Figure 2** Overview of 'what-if' scenario modelling



Source: *Frontier Economics*

The published 'impact evidence' available (which links stages 1 and 2) is somewhat limited. This is due to there being relatively few long-running, 'real world' trials of preventative interventions. We believe the available evidence is sufficient to give an indication of the range of benefits that might be achieved, but not to confidently provide a firm estimate. We have therefore undertaken a 'what-if' analysis, in which we model a range of scenarios – representing larger and smaller potential impacts – to indicate the range of potential NHS dental cost savings. For each of these interventions, some published evidence suggests there is zero impact on oral health problems. We have not modelled this scenario, since it would simply show zero benefits to individuals and the NHS.

In stage 2 we estimate the number of oral health problems avoided relative to their current prevalence in the population. This data on current prevalence of oral health problems provides a 'baseline' for our economic modelling. Our baseline also includes the current frequency of dental appointments. The baseline differs for each of the preventative interventions modelled, because they are targeted at different (sub-) populations. We also model a range of values, to reflect some uncertainty in the target population which is reached and some data limitations.

**Table 3** Oral health ‘baseline’

	<b>Water fluoridation</b>	<b>Sugarfree gum</b>	<b>Supervised brushing</b>
Relevant population	Whole population	Older children / adults	Younger children
Incidence of caries in the population	10% - 40%	5% - 35%	20% - 50%
Proportion of caries which result in:			
- tooth extraction	15% - 60%	10% - 50%	20% - 70%
- filling	20% - 70%	20% - 70%	20% - 70%
- root canal treatment	3% - 15%	5% - 20%	1% - 10%
Frequency of dental appointments	Every 18 months	Every 18 months	Every 6 months

Source: Frontier Economics based on published literature and expert clinical input from the Wrigley Oral Healthcare Programme.

The baseline figures in Table 3 indicate that the incidence of caries in the whole population – the relevant target population for water fluoridation – is between 10% and 40%, meaning that amongst any 10 individuals, on average between 1 and 4 will have one cavity. Table 3 also shows how frequently these caries lead to different treatments.

Comparing the different sub-populations, the baseline figures in Table 3 reflect that:

- children experience more caries than adults;
- children with caries experience more extractions and fewer root canal treatments than adults with caries, but have similar numbers of fillings; and
- children have more frequent dental appointments than adults.

The ‘dental treatment cost evidence’ available (which links stages 3 and 4) is more readily available. Across all three interventions, we use the same estimates of the cost of specific treatments to the NHS and to individuals, for treatments undertaken in dental practices. These are shown in Table 4.

**Table 4 NHS dental costs to NHS and patients**

Treatment	Number of UDAs	Total cost	Cost to fee-paying individuals	% of fee-paying individuals	Average cost to individuals	Average cost to NHS
Check-up (Band 1)	1	£29.92	£23.80	84%	£19.97 (67%)	£9.95 (33%)
Filling, root canal treatment, tooth extraction (Band 2)	3	£89.76	£65.20	71%	£46.22 (51%)	£43.54 (49%)

Source: Frontier Economics analysis of NHS Business Services Authority data 2020-21 (<https://www.nhsbsa.nhs.uk/dental-data/nhs-payments-dentists>), Shah & Wordley (2021).

Note: Costs apply to NHS dental treatment only; UDA = Units of Dental Activity.

The cost estimates in Table 4 provide an average cost to patients and to the NHS for Band 1 and Band 2 treatments. These estimates are based on the average price paid by the NHS to dental practices for a Unit of Dental Activity (UDA).<sup>38</sup> The estimates account for the standard NHS patient charges (£23.80 and £65.20 for Bands 1 and 2, respectively) and for the proportion of individuals who pay these charges (84% and 71%, respectively). The estimates show, for example, that avoiding a filling leads to cost savings of £46.22 for individuals and £43.54 for the NHS, on average.

The costs in Table 4 apply to treatment in dental practices. Additionally, in some cases an individual requires dental treatment in a hospital, for example for a tooth extraction under sedation or general anaesthetic. This is most common for younger children. We conservatively estimate the cost of a hospital extraction to be £1,051.<sup>39</sup>

For each intervention, we consider three ‘impact scenarios’.

- Scenario 1 provides a relatively conservative view of the likely impact.
- Scenario 2 provides a more reasonable central estimate (around which there is significant uncertainty) of the likely impact.
- Scenario 3 illustrates the greater potential impact amongst groups who typically have poorer oral health, such as those in deprived areas, from vulnerable groups (e.g. homeless individuals or children in care), or those who have less-ingrained oral health routines.

We discuss our ‘what-if’ modelling for each intervention in turn below.

<sup>38</sup> For a description of UDAs, see Watson (2010), “What is a UDA?”

<sup>39</sup> Based on Frontier Economics analysis of NHS National Cost Collection data (HRG code CD07B). This is the average cost across inpatient and outpatient settings for a single extraction. Costs for multiple extractions (HRG code CD06B, as used by YHEC (2016)) are significantly higher.

## Water fluoridation

Our economic modelling of water fluoridation is based on the ‘impact scenarios’ shown in Table 5.

**Table 5** Impact scenarios – water fluoridation

	Scenario 1	Scenario 2	Scenario 3
Current incidence of caries	10%	20%	40%
Reduction in incidence of caries	10%	30%	40%
<b>Impact:</b> Caries avoided	1% or 10 caries for every 1000 people	6% or 60 caries for every 1000 people	20% or 200 caries for every 1000 people
Current frequency of dental appointments	Every 18 months	Every 18 months	Every 18 months
<b>Impact:</b> Proportion of individuals requiring fewer dental appointments	0%	5%	10%
New frequency of dental appointments	Every 24 months	Every 24 months	Every 24 months

Source: Frontier Economics based on published literature.

As noted in the previous section, the three scenarios modelled have been chosen to illustrate the broad range of potential ‘true’ impacts, given the relatively limited available evidence. Each scenario combines two different areas of underlying variation:

- Current incidence – this reflects variation across different populations, and the extent to which preventative interventions can ‘target’ the highest-need individuals in a population.
- Reduction in incidence – this reflects uncertainty in the impact of preventative interventions, even when using the best available evidence.

We note that the higher current incidence is not what leads to the higher reduction in incidence. These two separate considerations are combined in our modelling for simplicity.

Table 5 shows the modelled reduction in the incidence of caries, from baseline values of 10-40%. For example, under Scenario 1, we assume that absent water fluoridation, 10% of individuals have 1 cavity, equivalent to 100 out of every 1000 individuals. We then assume that water fluoridation reduces this incidence across the population by 10%, meaning only 90 out of every 1000 individuals has 1 cavity. The overall impact is a reduction of 10 caries per 1000 individuals in Scenario 1. We note that this is not because water



fluoridation has treated any of the initial 100 caries, rather than across the whole population, water fluoridation will prevent 10% of 'new' caries from emerging.

The current evidence on water fluoridation tends to focus on children. As noted in the previous section, the systematic Cochrane Review of Iheozor-Ejiofor et al (2015) concluded that fluoridation is likely to reduce caries in 'baby teeth' by 35% and in 'adult teeth' by 26%.<sup>40</sup> The best current evidence on the impact for adults is provided by Griffin et al (2007), based on earlier studies, which estimated a reduction in caries of 27% amongst adults.<sup>41</sup>

The reduction in caries assumed in Table 5 is an annual estimate (i.e. in Scenario 1, we assume 10 avoided caries per 1000 individuals per year), however we note that there will typically be a 'lag' in the time taken for any preventative health intervention to have an impact on the population. Additionally, if the oral health of the population were to improve over time, the 'current incidence' would also decline. For simplicity, across each of the three interventions considered, we have not modelled these interactions over time.

To estimate the cost savings associated with these impacts, we combine the above estimates of avoided caries with:

- our baseline assumptions on the proportion of caries that require tooth extraction, filling or root canal treatment (Table 3); and
- our estimates of the costs associated with these treatments, both to the NHS and to individuals (Table 4).

Table 5 also shows a reduction in dental appointments, from the baseline of 'every 18 months'. For example, under Scenario 3 we assume that 10% of individuals see the frequency of their appointments fall from every 18 months to every 24 months. Across each of the three interventions considered, a reduction in appointments may occur because dentists advise a lower frequency, or because patients (due to improved oral health in some cases) choose to attend less frequently. To estimate the cost savings of this reduction in appointments, we combine the number of appointments saved with our estimates of the costs (Table 4).

Our economic modelling finds the following benefits for water fluoridation:

- Scenario 1 results in savings to individuals of £0.18 per year and savings to the NHS of £0.17 per individual per year.
- Scenario 2 results in savings to individuals of £2.86 per year and savings to the NHS of £2.62 per individual per year.
- Scenario 3 results in savings to individuals of £11.06 per year and savings to the NHS of £10.27 per individual per year.

The savings above are based on the estimated share of costs borne by individuals and by the NHS given in Table 4.

<sup>40</sup> Iheozor-Ejiofor et al (2015), "Water fluoridation for the prevention of dental caries".

<sup>41</sup> Griffin et al (2007), "Effectiveness of Fluoride in Preventing Caries in Adults".

These savings compare favourably with the estimated costs of operating water fluoridation of £0.52 per person per year, made by Public Health England (2020). However, we note that the up-front costs of water fluoridation can exceed several hundreds of thousands of pounds, depending upon the existing infrastructure and the size of the population covered.<sup>42</sup>

## Sugarfree gum

Our economic modelling of sugarfree gum is based on the ‘impact scenarios’ shown in Table 6.

**Table 6** Impact assumptions – sugarfree gum

	Scenario 1	Scenario 2	Scenario 3
Current incidence of caries	5%	10%	35%
Reduction in incidence of caries	10%	20%	30%
<b>Impact:</b> Caries avoided	0.5% or 5 caries for every 1000 people	2% or 20 caries for every 1000 people	10.5% or 105 caries for every 1000 people
Current frequency of dental appointments	Every 18 months	Every 18 months	Every 18 months
<b>Impact:</b> Proportion of individuals requiring fewer dental appointments	0%	5%	10%
New frequency of dental appointments	Every 24 months	Every 24 months	Every 24 months

Source: Frontier Economics based on published literature.

As noted in the previous section, the best current evidence suggests that regularly chewing sugarfree gum may reduce caries by between 20% and 40%.<sup>43</sup> Given the relatively limited evidence base, in our modelling we have conservatively used slightly lower reductions in our impact scenarios.

We use the impact scenarios shown in Table 6 to calculate the benefits of sugarfree gum in the same way as outlined for water fluoridation. Our economic modelling finds the following benefits for sugarfree gum:

- Scenario 1 results in savings to individuals of £0.08 per year and savings to the NHS of £0.08 per individual per year.

<sup>42</sup> British Fluoridation Society (2012), “The cost and cost-effectiveness of water fluoridation”.

<sup>43</sup> See Claxton et al (2016) and Newton et al (2020).

- Scenario 2 results in savings to individuals of £1.00 per year and savings to the NHS of £0.87 per individual per year.
- Scenario 3 results in savings to individuals of £7.13 per year and savings to the NHS of £6.57 per individual per year.

These savings are compared with estimated costs of sugarfree gum of £55 per person per year. While this indicates a net financial cost associated with sugarfree gum, we note that the primary benefit from improving individuals’ oral health is the avoidance of pain and discomfort, rather than saving money. Under scenario 2, 1 in 50 individuals avoids a tooth cavity and the associated treatment. The above estimates suggest that in addition to this benefit of improved quality of life, there is a small financial saving. Moreover, for private dental patients (which are increasing in number, due to the challenges of accessing NHS dental services), these cost savings would be larger.

From the perspective of the NHS, encouraging sugarfree gum typically incurs no cost, while there are potential benefits from reduced NHS activity, which could save the NHS money or release NHS dentists’ capacity to treat more patients.

### Supervised brushing

Our economic modelling of supervised brushing is based on the ‘impact scenarios’ shown in Table 7.

**Table 7** Impact assumptions – supervised brushing

	Scenario 1	Scenario 2	Scenario 3
Current incidence of caries	20%	30%	50%
Reduction in incidence of caries	20%	35%	50%
<b>Impact:</b> Caries avoided	4% or 40 caries for every 1000 people	10.5% or 105 caries for every 1000 people	25% or 250 caries for every 1000 people
Current frequency of dental appointments	Every 6 months	Every 6 months	Every 6 months
<b>Impact:</b> Proportion of individuals requiring fewer dental appointments	5%	10%	20%
New frequency of dental appointments	Every 12 months	Every 12 months	Every 12 months

Source: Frontier Economics based on published literature.

The best available evidence in the UK – from the Childsmile programme in Scotland – indicates that supervised brushing can achieve a reduction in caries of around one-third, with a higher proportion amongst highest-need children.<sup>44</sup> However, the evidence overall is mixed, and this is reflected across our impact scenarios.

We use the impact scenarios shown in Table 7 to calculate the benefits of supervised brushing in the same way as outlined for the other preventative interventions. One difference is that we assume tooth extractions, given the target population of younger children, would occur in hospital rather than in dental practices. This means that the costs savings associated with an avoided tooth extraction are much higher (£1,051 in hospital compared with £89.76 in a dental practice), and these savings accrue solely to the NHS rather than to individuals (since patients don't pay for hospital care).

Our economic modelling finds the following benefits for supervised brushing:

- Scenario 1 results in savings to individuals of £1.39 per year and savings to the NHS of £9.27 per individual per year.
- Scenario 2 results in savings to individuals of £4.67 per year and savings to the NHS of £58.69 per individual per year.
- Scenario 3 results in savings to individuals of £13.24 per year and savings to the NHS of £194.62 per individual per year.

These savings are compared with estimated costs of supervised brushing of £17-35 per person per year. The range of estimated benefits indicates the importance of effective targeting in supervised brushing programmes. We note also that these savings are based upon a single year, however one aim of supervised brushing is to instil good toothbrushing habits, which could lead to future additional savings (achieved at no additional cost).

The costs of supervised brushing programmes are typically borne by the local authority, whereas the benefits identified above accrue to individuals and the NHS. While this is common in public health interventions, we note that this might reduce the incentive for local authorities to invest in these programmes.

## Illustration for a population of 100,000

Based on the above economic modelling of water fluoridation, sugarfree gum and supervised brushing, below we show what these results would look like when applied to a population of 100,000. We have used our Scenario 2 estimates in this analysis. We have also assumed that 50% of people are NHS dental patients, while the remaining 50% are private dental patients. Our illustration assumes that:

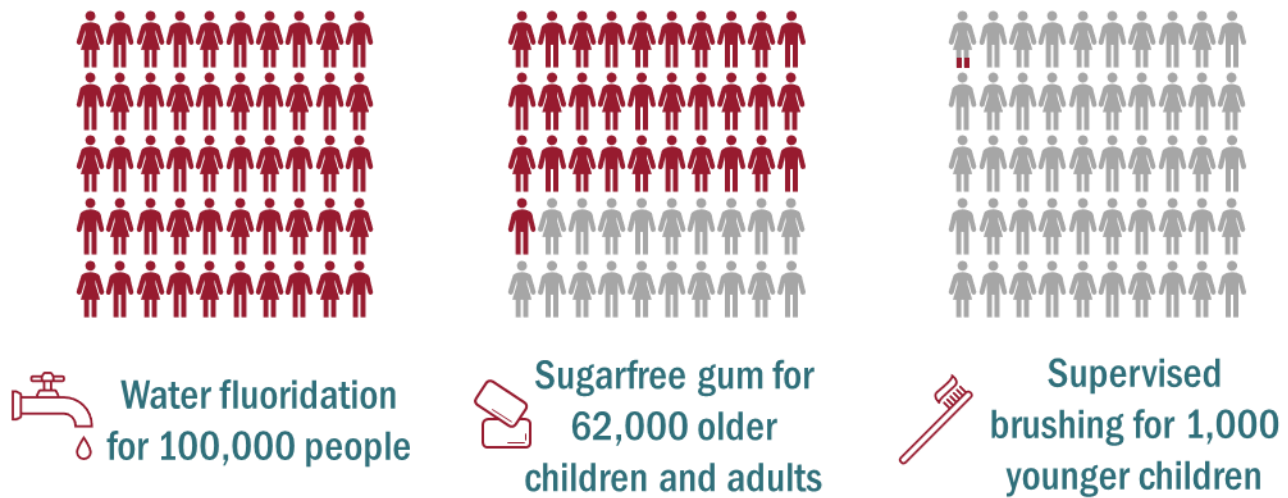
- all 100,000 people benefit from water fluoridation, and that the water was not previously fluoridated;
- sugarfree gum is chewed by 62,000 older children and adults who did not already chew regularly, based on 70% of adults and children aged over 10; and

<sup>44</sup> See Macpherson et al (2013) and Macpherson et al (2019).

- supervised brushing is provided to 1,000 younger children in the area, based on reaching 20% (the most deprived quintile) of children aged 3-6.

This targeting of interventions is illustrated in Figure 3:

**Figure 3** Preventative interventions for a population of 100,000



Source: Frontier Economics

Water fluoridation for 100,000 people could lead to 6,000 caries being avoided each year. This could mean 2,400 fewer extractions, 3,000 fewer fillings and 420 root canal treatments being avoided. In addition, 1.3% of check-ups could be avoided. The total cost savings to NHS patients would be approximately £142,800 (and greater for private patients, who are similar in number and tend to pay higher dental charges) and total savings to the NHS would be approximately £130,800.<sup>45</sup> By re-investing this saving, the NHS could provide approximately 21,400 additional patient check-ups.<sup>46</sup>

Sugarfree gum being chewed by 62,000 older children and adults could lead to 620 caries being avoided each year. This could mean 186 fewer extractions, 310 fewer fillings and 62 root canal treatments being avoided. In addition, 1.3% of check-ups could be avoided. The total cost savings to NHS patients would be approximately £31,000 (and greater for private patients, who are similar in number and tend to pay higher dental charges) and total savings to the NHS would be approximately £26,900.<sup>47</sup> By re-investing this saving, the NHS could provide approximately 4,400 additional patient check-ups.

Supervised brushing being provided to 1,000 younger children could lead to 105 caries being avoided each year. This could mean 52 fewer extractions, 52 fewer fillings and 5 root canal treatments being avoided. In addition, 5% of check-ups could be avoided. The total cost savings to NHS patients would be approximately £2,300 (and greater for private patients, who are similar in number and tend to pay higher dental charges)

<sup>45</sup> Savings of £2.86 to the patient and £2.62 to the NHS, per NHS patient (assumed to be 50%), multiplied by 100,000.




<sup>46</sup> Based on an average cost to the NHS of £6.12 per check-up, net of patient income.

<sup>47</sup> Savings of £1.00 to the patient and £0.87 to the NHS, per NHS patient (assumed to be 50%), multiplied by 62,000.

and total savings to the NHS would be approximately £29,300.<sup>48</sup> By re-investing this saving, the NHS could provide approximately 4,800 additional patient check-ups.

The potential savings are illustrated in Figure 4.

**Figure 4 Preventative interventions for a population of 100,000**

	NHS DENTAL PATIENTS	PRIVATE DENTAL PATIENTS	NHS	which could fund...	ADDITIONAL CHECK-UPS
	£142,800	>£142,800	£130,800	▶	21,400
	£31,000	>£31,000	£26,900	▶	4,400
	£2,300	>£2,300	£29,300	▶	4,800

Source: Frontier Economics

### Limitations of our ‘what-if’ scenario modelling

The modelling presented in this report is limited in two main ways:

- There is relatively little high-quality evidence available for the UK population and directly focused upon the key impacts considered in this report. We have addressed this limitation by including broad ranges around our impact scenarios to increase confidence that the ‘true’ impact would fall within the ranges modelled. More detailed local studies (e.g. to identify areas with high levels of caries) could allow better targeting of these measures and greater confidence that the benefits would be towards the top end of the ranges discussed.
- This analysis does not include all benefits. As shown in Figure 1, there are potentially significant benefits to individuals’ quality of life, to children’s education and to workers’ productivity. Modelling these benefits was beyond the scope of this report. As a consequence, the results presented are potentially significant under-estimates of the full social benefit.

The modelling results offer an indication of the likely size of financial benefits to individuals and to the NHS from preventative health interventions.

<sup>48</sup> Savings of £4.67 to the patient and £58.69 to the NHS, per NHS patient (assumed to be 50%), multiplied by 1,000.

# Conclusions

This report has explored the economic value of good oral health. We have found that there are benefits to individuals, the NHS and to schools and workplaces.

Our economic modelling considered the financial benefits to individuals and the NHS from preventative oral health interventions. We estimate the following potential dental cost savings:

**Figure 5 Summary of potential dental cost savings**

Preventative intervention:	Potential dental cost savings per NHS dental patient per year:	
	PATIENT	NHS
 <b>Water fluoridation</b>	£0.18-13.74	£0.17-12.79
 <b>Sugarfree gum</b>	£0.08-7.13	£0.08-6.57
 <b>Supervised brushing</b>	£1.39-13.24	£9.27-194.62

Source: Frontier Economics

Our findings suggest that each of these preventative oral health interventions – as well as others not considered in detail here – could play a valuable role in improving the oral health of the population, particularly at a time when NHS dental services are under pressure.

We recommend that all stakeholders – including the Office for Health Improvement and Disparities, Department of Health and Social Care, NHS England, local authorities, and dental practitioners across the country – consider placing a greater focus on preventative oral health interventions as part of a wider strategy to tackle the challenges in dentistry.



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