

# The Dental Benefits of Water Fluoridation

### Key points

- Fluoridation of water supplies reduces the number of decayed, missing and filled teeth in children and adults.
- As a result of fluoridation, children experience less toothache, have fewer dental abscesses, and require fewer dental extractions and general anaesthetics.
- The cost to the NHS of treating avoidable disease is therefore reduced substantially.
- While decay levels have fallen in both fluoridated and non-fluoridated communities in recent years, inequalities in dental health remain wide. There is still a strong case for targeted fluoridation in parts of the UK, particularly the North of England, Scotland, Wales, Northern Ireland and Inner London.



### How fluoride works to prevent tooth decay

Tooth decay begins when the enamel, the outer surface of the tooth, is destroyed by acid. The acid is produced by bacteria, which form on the surfaces of the teeth as a layer called plaque. When foods or drinks containing sugars enter the mouth, the bacteria within the plaque rapidly convert the sugars into acid. The plaque can hold the acid in contact with the tooth surface for up to 2 hours before it is neutralised by saliva.

During the time that the plaque is acidic, some of the calcium and phosphate minerals, of which enamel is largely composed, are dissolved out of the enamel into the plaque. This process is called demineralisation. However, once the plaque acid has been neutralised the minerals can return into the enamel – a process called remineralisation. This whole process is often described as an ‘ionic see-saw’ in which mineral ions constantly move back and forth between the tooth enamel and the plaque [1].

The capacity for remineralisation is, however, limited. If sugars enter the mouth too frequently the net loss of mineral from the enamel surface will result in a cavity, through which bacteria can penetrate and infect the inner structure of the tooth. This is tooth decay. If left untreated, it will gradually destroy the tooth causing pain and leading to the formation of a dental abscess.

The relationship between fluoride and tooth decay is complex and probably not yet fully understood. However, it is known that fluoride modifies the process of tooth decay in at least three ways:

- If children take in sufficient fluoride during the period of enamel development, the fluoride improves the chemical structure of the enamel, making it more resistant to acid attack. This effect can theoretically occur from the first stage of mineralisation in the foetal stage until the last teeth erupt, which for the wisdom teeth can be about 20 years of age. This was originally thought to be the most important mechanism of fluoride; however, with advances in knowledge this is now understood to be of lesser importance.
- When teeth are subjected to alternating demineralisation and remineralisation, as described above, the presence of low levels of fluoride in the plaque and saliva both encourages remineralisation, and ensures that



Severe tooth decay

the enamel crystals that are laid down are of improved quality. This means that low levels of fluoride in the mouth gradually improve the strength of the tooth enamel and its ability to resist acid attack. This important mechanism was first described in 1966 and means that early patches of decay can be arrested and damaged enamel will 'heal'. This topical effect explains the dramatic improvement in dental health since the introduction of fluoride into toothpaste formulations in the mid-1970s.

- The third way in which fluoride works is by reducing the ability of the plaque bacteria to produce acid. This is another factor in the prevention of tooth decay. It results from the ability of the plaque bacteria to concentrate the low levels of fluoride at the tooth surface up to a level that inhibits the function of some enzymes, which are essential to the bacteria's ability to produce acid.

Work to further develop our knowledge of the mechanism of fluoride continues. However, our knowledge is sufficiently well developed to be able to say that the, topical, remineralisation effect is the most significant. The goal of maintaining low levels of fluoride in everybody's mouths for as long as possible is therefore critical. Hence, the importance of water fluoridation, and the regular use of fluoride toothpaste.

#### *The dental benefits of fluoridation*

All water supplies contain fluoride naturally, and early studies of tooth decay in the United States established that a natural concentration of 1 part of fluoride per million parts of water was associated with significantly lower levels of tooth decay [2]. In most places in the UK the natural fluoride level is too low to be of benefit to dental health. However, it is possible by a process known as water fluoridation to 'top up' the natural fluoride in order to reproduce the dental benefits. Water fluoridation was first introduced in the United States in 1945, and in the UK and many other countries throughout the world since the mid-1950s. Its impact on tooth decay has been closely observed since.

The evidence of the dental benefits of water fluoridation has been reviewed by the University of York NHS Centre for Reviews and Dissemination [3]. The York review included 26 studies representing the best available evidence on the effectiveness of water fluoridation, and found that:

- Water fluoridation reduces the number of decayed, missing and filled teeth by on average just over 2 teeth per child.
- Water fluoridation increases the percentage of children totally free from tooth decay by approximately 15%.
- The reduction in the number of decayed, missing or filled teeth following fluoridation is greatest in those areas with the highest levels of tooth decay at the outset.

#### *Why fluoridate water when people can use fluoride toothpaste?*

Since fluoride toothpaste became the norm in the UK (from the 1970s), tooth decay rates have fallen in both fluoridated and non-fluoridated communities. The key question, therefore, is whether children living in fluoridated communities still have better dental health. To answer this question, the York review focussed on studies conducted since 1975 when widespread use of fluoride toothpaste can be assumed.

- York concluded that the benefits of water fluoridation are in addition to the benefits derived from the use of fluoride toothpaste.
- Furthermore, a Cochrane systematic review of 74 studies of the effectiveness of fluoride toothpaste also concluded that water fluoridation had a benefit over and above the benefits of fluoride toothpaste [4].

#### *Does water fluoridation reduce inequalities in dental health?*

Improvements in dental health (mainly due to the introduction of fluoride in toothpaste) have not been evenly distributed across all social groups. Because the more well-informed and affluent parents are the most likely to restrict their children's sugar intake, and ensure that they brush twice daily with fluoride toothpaste, children from these environments have benefited more than those from poorer backgrounds. [5]. Severe tooth decay remains a problem among young children in disadvantaged communities; for example more than half of Manchester's 5-year-olds have some tooth decay. As a result of these higher levels of disease, young children living in poverty suffer more of the problems associated with tooth decay: toothache, dental abscesses, and tooth extractions. As many as 1 in 5 Manchester 5-year-olds have had at least one tooth extracted, and tooth extraction in such young children is generally performed under general anaesthetic. Clearly, a reduction in the number of tooth extractions required would bring

significant benefits to the health and well being of young children living in poverty - and allow better use to be made of scarce NHS resources.

The reduction of dental health inequalities is therefore an important goal and, although the small number of studies and their low quality rating suggest caution in interpreting these results, it is worth noting here that:

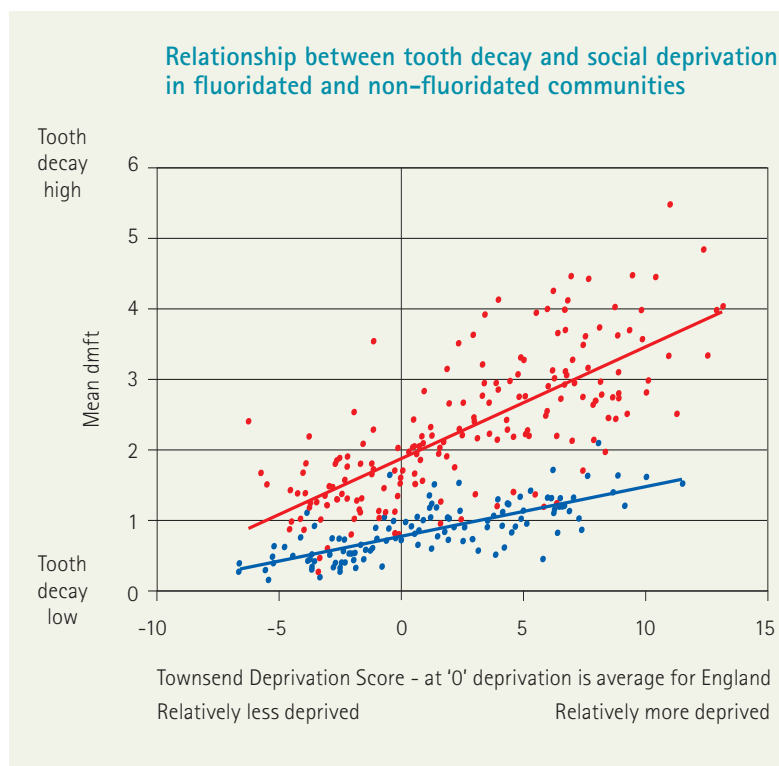
- The York review found that, in terms of the average number of decayed missing and filled teeth, 'there appears to be some evidence that water fluoridation reduces the inequalities in dental health across social classes in 5 and 12 year olds'.

One important study included in the York review looked at the dental health of 5-year-olds living in fluoridated and non-fluoridated areas of varying degrees of social deprivation [6]. It concluded that water fluoridation reduces tooth decay more in disadvantaged communities than in affluent communities, and that the introduction of water fluoridation in areas where levels of poverty and tooth decay are high - such as Manchester - 'would substantially reduce inequalities in dental health'. Figure 1 shows the relationship between tooth decay and social deprivation in both fluoridated communities and non-fluoridated communities. It demonstrates that:

- Young children living in poverty have higher levels of tooth decay than more affluent children.
- However, fluoridation reduces the effects of deprivation on tooth decay.

Where the level of deprivation is the same, children in non-fluoridated communities have more tooth decay than those in fluoridated communities. The difference is just over one tooth per child at 'average' levels of deprivation, but importantly the difference increases as levels of deprivation increase. So, for example, at deprivation score 10 children in non-fluoridated communities have around two more decayed teeth per child than children in fluoridated communities. The link between poverty and tooth decay is well established in non-fluoridated areas, but weaker in fluoridated areas.

Figure 1



- Fluoridated
- Linear (Fluoridated)
- Non-Fluoridated
- Linear (Non-Fluoridated)

Graph reproduced from Riley et al [6], by permission of Oxford University Press

The position of each community shown on the chart below is determined by two factors:

1. The average number of decayed, missing or filled teeth (mean dmft) per 5-year-old child, and
2. The level of social deprivation in the community as measured by the Townsend score.

Blue dots mark the positions of fluoridated communities, and the position of non-fluoridated communities are marked by red dots. The average number of decayed, missing or filled teeth per 5-year-old child is shown on the vertical (upright) axis.

#### Measuring relative social deprivation

Along the bottom or horizontal axis is a ranking for social deprivation - the Townsend score [7]. The average Townsend score for England is a score of 0. A very socially deprived community would have a score of +10 or more (over on the right hand side of the chart). Whereas, a relatively affluent community would be less than 0 (so a score of say -5, over to the left-hand side of the chart, indicates low levels of social deprivation).

*What does the graph tell us about the relationship between water fluoridation, tooth decay and social deprivation?*

Both lines slope upwards. This tells us that young children living in poverty have higher levels of tooth decay than more affluent children. However, the red line (non-fluoridated communities) is steeper than the blue line (fluoridated communities) which tells us that fluoridation is reducing the effects of deprivation on tooth decay.

In addition, the red (non-fluoridated) line is always higher up the chart than the blue (fluoridated) line. This tells us that, where the level of deprivation is the same, children in non-fluoridated communities have more tooth decay than those in fluoridated communities. The difference is just over one tooth per child at 'average' levels of deprivation, but importantly the difference increases as levels of deprivation increase. So, for example, at deprivation score 10 children in non-fluoridated communities have around two more decayed teeth per child than children in fluoridated communities. The link between poverty and tooth decay is weaker in fluoridated than non-fluoridated communities.

The York review looked at a number of UK studies investigating the relationship between tooth decay, social deprivation and water fluoridation (including the study described above). Five of the

studies focussing on the dental health of 5-year-olds used the same classification of social class so York were able to combine these results [8-12]. The combined results are shown in Figure 2:

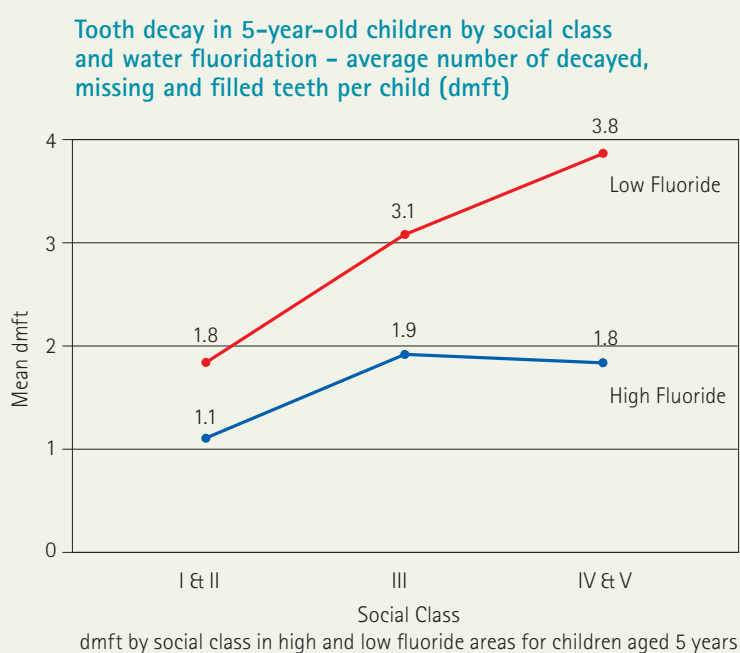
- Across all social classes, the number of teeth affected by decay is lower in the fluoridated than the non-fluoridated communities; and importantly,
- The teeth of 5-year-old children in the lowest social classes (IV and V) in the fluoridated communities are as healthy as those of children in the highest social classes (I and II) living in the non-fluoridated communities – demonstrating that water fluoridation can modify the usual link between poverty and severe tooth decay.

The constraints of studies in human populations mean that there is virtually no such thing as a perfect study; nevertheless it is important to strive to improve the quality of research. Therefore, following publication of the York Review in September 2000, the Department of Health asked the Medical Research Council (MRC) to set up a Working Group to advise on what further research was needed to improve the quality of evidence on fluoridation, much of which was considered by York to be of only low to moderate quality.

*Review by the Medical Research Council*

The 2002 review by the Medical Research Council (MRC) noted the findings of the York review, and also considered evidence from several relevant UK studies not included in the York review [13]. In terms of reductions in tooth decay, the results of the studies included in the MRC review were remarkably similar to those reported by York. However, the MRC review highlighted additional benefits such as reductions in both the prevalence of both toothache and dental treatment needing general anaesthetic, as well as the cost of dental treatment. Also included in the review were studies of reductions in tooth decay in very young children, in adults up to 75 years of age, and of the topical effect of water fluoridation on teeth already erupted at the start of fluoridation. These studies are important because as well

**Figure 2**

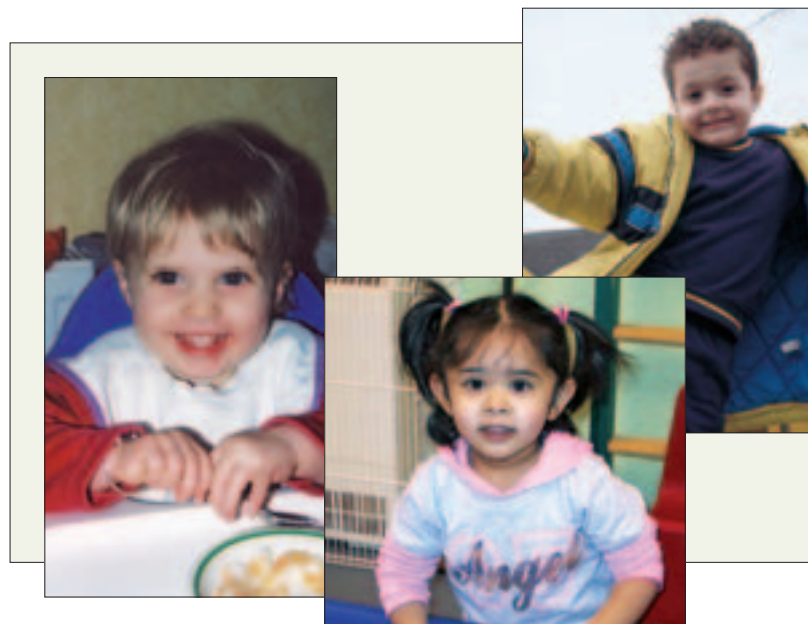


as confirming that water fluoridation reduces tooth decay, they also tell us something about:

- The effects of tooth decay on the quality of children's lives;
- Savings in the cost of dental treatment in fluoridated communities;
- The benefits of water fluoridation for adults;
- The importance of the 'topical' effect of fluoride, and hence the benefits of water fluoridation on teeth already present in the mouth at the start of fluoridation (see How fluoride works to prevent tooth decay Page 3).

*Improved dental health for all age groups, from the very young...*

The results of studies demonstrating the benefits of water fluoridation are given in Tables 1 – 12.



The study in Table 1 compared tooth decay in children as young as 3 years in fluoridated and non-fluoridated communities in Yorkshire. 3-year-olds in the fluoridated community had 59% less tooth decay than those in the non-fluoridated community.

*Table 1: The effect of water fluoridation on average number of decayed, missing and filled teeth per 3-year-old child (dmft)*

Reference	Year of survey	Fluoridated community	dmft	Non-fluoridated community	dmft	Difference in dmft	% difference in dmft
[14]	1989	Huddersfield	0.30	Dewsbury	0.74	0.44	59%

Tables 2 and 3 (5-year-olds and 14 to 15-year-olds respectively) show the average number of decayed, missing and filled teeth (dmft, or, for permanent teeth, DMFT) per child in fluoridated compared with similar non-fluoridated communities. The actual difference and the percentage difference between the two scores is shown in the right-hand columns.

*Table 2: The effect of water fluoridation on the average number of decayed, missing or filled teeth per 5-year-old child (dmft)*

Reference	Year of survey	Fluoridated community	dmft	Non-fluoridated community	dmft	Difference in dmft	% difference in dmft
[15]	1981	Newcastle	1.4	Northumberland	3.4	2.0	59%
[16]	1985	Newcastle	1.3	N. Manchester	3.3	2.0	61%
[17]	1987	Newcastle	1.8	Northumberland	3.9	2.1	54%
[18]	1987	Anglesey	0.8	Gwynedd (Mainland)	2.3	1.5	65%

*Table 3. The effect of water fluoridation on the average number of decayed, missing or filled teeth per 14–15 year old child (DMFT)*

Reference	Year of survey	Fluoridated community	DMFT	Non-fluoridated community	DMFT	Difference in DMFT	% difference in DMFT
[19]	1987	Birmingham	2.3	Bolton	3.8	1.5	40%

Tables 4 and 5 (5-year-olds and 14 to 15-year-olds respectively) show the percentage of children who are 'caries free' (i.e. have no tooth decay at all) in fluoridated compared with non-fluoridated communities.

*Table 4: The percentage of 5-year-old children who are caries free in fluoridated and non-fluoridated communities.*

Reference	Year of survey	Fluoridated community	Proportion (%) of children who are caries free	Non-fluoridated community	Proportion (%) of children who are caries free	Difference in proportion (%) of children who are caries free
[15]	1981	Newcastle	55	Northumberland	31	24
[16]	1985	Newcastle	62	N. Manchester	29	33
[17]	1987	Newcastle	50	Northumberland	32	18
[18]	1987	Anglesey	67	Gwynedd (Mainland)	48	19

*Table 5: The percentage of 14-15 year old children who are caries free in fluoridated and non-fluoridated communities.*

Reference	Year of survey	Fluoridated community	Proportion (%) of children who are caries free	Non-fluoridated community	Proportion (%) of children who are caries free	Difference in proportion (%) of children who are caries free
[19]	1987	Birmingham	32	Bolton	19	13

The study presented in Tables 3 and 5 focuses on the important benefits of fluoridation for adolescents. It shows that 14-year-olds in fluoridated communities had 40% fewer teeth affected by decay than 14-year-olds in non-fluoridated communities. In addition, in the fluoridated communities 13% more teenagers had no experience of tooth decay at all.

The Hardwick et al study (Table 6) clearly demonstrates that water fluoridation benefits teeth that are already present in the mouth when fluoridation starts [20]. This means that not only children and teenagers benefit, everyone does!

*Table 6: The effect of water fluoridation on caries increment over a 4-year period in children aged 12 at start of fluoridation as expressed as average number of new decayed, missing and filled teeth per child (DMFT)*

Reference	Year of survey	Fluoridated community	DMFT Increment over a 4-year period	Non-fluoridated community	DMFT Increment over a 4-year period	Difference in DMFT Increment	% Difference in DMFT Increment
[20]	1974/9	Alsager, Middlewich and Nantwich	3.76	Northwich	4.85	1.09	22.4%

Adults with their own teeth have much to gain from water fluoridation. In general more adults are keeping more of their own teeth into old age, and the studies presented in Table 7 demonstrate that adults living in fluoridated communities keep more of their own teeth longer and have much less trouble with them than those in non-fluoridated communities.

*Table 7: The effect of water fluoridation on adult dental health*

Reference	Year of survey	Fluoridated community	Non-fluoridated community	Age of subjects	Findings
[21]	1968/9	Hartlepool	York	15 – 65 years	Fluoridation reduced caries experience, tooth mortality, and the need for partial dentures in all 5-year age bands between 15 and 65 years.
[22]	1979 – 1989	Review, several studies included			In adults, including older adults, fluoridation reduced caries by between 15 and 35%.
[23]	Early 1980s	Iowa 8 communities naturally fluoridated 3 communities artificially fluoridated	Iowa 6 non-fluoridated communities	Average age: 75.2 Fluoridated 74.1 Non fluoridated	Significant benefits resulted for those with 30 – 40 years of exposure to fluoridated water which suggested that fluoridation was beneficial even though exposure started in adulthood.
[24]	1989/90	Ireland Communities fluoridated since mid-1960s	Ireland Communities never fluoridated	16 – 65+ years	<ul style="list-style-type: none"> <li>In fluoridated areas the percentage of adults with no natural teeth was lower– e.g. in 45-54 year olds only 10.8% in fluoridated communities compared with 29.5% in non-fluoridated, had no natural teeth.</li> <li>In fluoridated communities adults had more natural teeth – e.g. in 45-54 year olds had 16.4 natural teeth in fluoridated communities compared with only 10.7 in non-fluoridated – a 34% difference.</li> </ul>
[25]	1986/1987	Anglesey	Gwynedd mainland	Antenatal patients up to 32 years	Lifelong residents of fluoridated Anglesey had on average 30% fewer decayed, missing or filled teeth.

*... to the very old*

Professor Robin Heath, former Director of Dental Care for the Elderly at the Royal London Hospital, is convinced of the benefits of water fluoridation. He says: *‘Fluoridation of drinking water provides a safe, cheap and practical method of reducing dental disease, and reducing the consequent pain and severe problems that can result from tooth loss in old age.’*



### Improved quality of life

The studies in Tables 8, 9, 10, 11 and 12 show that fluoridation reduces:

- the risk of toothache;
- the need for tooth extractions and general anaesthesia;
- the prevalence of dental abscess.
- the prevalence of severe tooth decay.

### Experience of toothache

Table 8 shows the difference in toothache experience between children from fluoridated and non-fluoridated communities. In three out of four studies, children from non-fluoridated communities were more than twice as likely to have had toothache during their lives.

*Table 8: The experience of toothache among 5-year-old children*

Reference	Year of survey	Fluoridated community	% Prevalence	Non-fluoridated community	% Prevalence	Difference in % Prevalence
[15]	1981	Newcastle	12%	Northumberland	27%	15%
[16]	1985	Newcastle	9%	N. Manchester	24%	15%
[17]	1987	Newcastle	18%	Northumberland	27%	9%
[18]	1987	Anglesey	5%	Gwynedd (mainland)	13%	8%



### Tooth extractions

Tables 9 and 10 look at tooth extractions and general anaesthetic among 5-year-old children. In the four studies reported in Table 9, children from non-fluoridated communities were substantially more likely to have had at least one tooth extracted. In such young children tooth extraction is generally performed in hospital under a general anaesthetic with all its attendant risks – a distressing experience for all concerned, and one which is often mentioned by adults as the beginning of a lifelong fear of dental treatment. The studies in Table 10 show that 5-year-olds in non-fluoridated communities are much more likely to have had a general anaesthetic for tooth extraction than those in fluoridated communities.

*General anaesthetics carry significant risks, and have to be given in hospital*

*Table 9: The experience of tooth extractions among 5-year old children*

Reference	Year of survey	Fluoridated community	% Prevalence	Non-fluoridated community	% Prevalence	Difference in % Prevalence
[17]	1981	Newcastle	8%	Northumberland	23%	15%
[16]	1985	Newcastle	6%	N. Manchester	18%	12%
[17]	1987	Newcastle	8%	Northumberland	18%	10%
[18]	1987	Anglesey	6%	Gwynedd (mainland)	9%	3%

*Table 10: The experience of general anaesthetic for tooth extractions among 5-year-old children*

Reference	Year of survey	Fluoridated community	% Prevalence	Non-fluoridated community	% Prevalence	Difference in % Prevalence
[15]	1981	Newcastle	7%	Northumberland	21 %	14 %
[16]	1985	Newcastle	7%	N. Manchester	12%	5%
[17]	1987	Newcastle	9%	Northumberland	17%	8%
[18]	1987	Anglesey	5%	Gwynedd (mainland)	8%	3%

**Abscesses**

The study in Table 11 illustrates that 5-year-olds in non-fluoridated Northumberland were five times more likely to suffer dental abscesses than 5-year-olds in fluoridated Newcastle.



*Severe tooth decay with abscess in a young child*

*Table 11: The prevalence of dental abscesses in 5-year-old children*

Reference	Year of survey	Fluoridated community	% Prevalence	Non-fluoridated community	% Prevalence	Difference in % Prevalence
[17]	1987	Newcastle	1%	Northumberland	5%	4%

**Severe tooth decay**

Table 12 shows the results of three studies focussing on particularly high levels of tooth decay (five or more teeth affected per child). These studies found that children in non-fluoridated communities were several times more likely to experience such problems.

*Table 12: The prevalence of severe tooth decay (5 or more teeth affected) among 5-year-old children*

Reference	Year of survey	Fluoridated community	% Prevalence	Non-fluoridated community	% Prevalence	Difference in % Prevalence
*[16]	1985	Newcastle	1%	N. Manchester	10%	9%
[17]	1987	Newcastle	16%	Northumberland	31%	15%
[18]	1987	Anglesey	4%	Gwynedd (mainland)	20%	16%

\* In this study high caries was defined as 10 or more teeth affected.



#### *Use of NHS resources: cost of dental treatment*

A number of studies have compared the cost of dental treatment needed by children in fluoridated and non-fluoridated communities. Costs have usually been calculated according to the NHS General Dental Service fee scale, which is based on the average time taken to complete specific items of treatment. Table 13 shows that 5-year-old children in non-fluoridated communities have been found to need treatment costing 61% more than that needed by those in fluoridated communities.

*Table 13: Cost of dental treatment needed by 5-year-old children*

Reference	Year of survey	Year of fee-scale	Fluoridated community	Cost	Non-fluoridated community	Cost	% Difference
[17]	1987	1986	Newcastle	£5.00	Northumberland	£12.75	61%

Clearly, water fluoridation in areas of high need would free up scarce NHS resources (both financial and human) to be used for other health care needs. Water fluoridation has been shown to be highly cost-effective in areas where tooth decay rates are high, and water from a single water treatment works serves a population of at least 200,000. (See Section 11 on costs and cost effectiveness.)

Other key points of note from these additional studies reviewed by the Medical Research Council are:

- In all of the studies, children from the fluoridated communities had better teeth - with fewer teeth affected by decay;
- A greater proportion of children in fluoridated areas had no tooth decay at all;
- Fluoridation saves around 2 teeth per child - similar to the difference reported by York;
- Children in fluoridated communities had between 42% and 65% fewer decayed, missing and filled teeth than those in similar non-fluoridated communities.

If introduced in regions with the worst dental health such as the North West of England, Yorkshire, the West of Scotland, Northern Ireland, and Inner London, water fluoridation could significantly improve health and well being for all, but particularly children and young people living in less prosperous communities.

#### *National league table for 5-year-olds' dental health*

The most recent survey of 5-year-olds' teeth in England, and Wales was co-ordinated by the British Association for the Study of Community Dentistry (BASCD) in 2001/2002 [26]. In Scotland the most recent national survey of the dental health of such young children was 1999/2000 [27], and in Northern Ireland 1998 [28]. These studies show that:

- Inequalities in dental health in Britain remain wide; for example, there is an almost eight-fold difference in dental health between the best and the worst English Primary Health Care Trusts (PCTs).
- The average number of decayed, missing and filled teeth ranged from 0.49 per child in Daventry PCT - one of the most affluent districts in the country, to 3.87 per child in Rochdale PCT - among the most socially deprived districts. (See Table 15 for data by PCT).
- Areas with the best teeth in the country include fluoridated Birmingham and the West Midlands, and more affluent areas such as Kent & Medway.

*Areas with the worst dental health are the less prosperous, non-fluoridated areas including large parts of the north of England, parts of Inner London, parts of Wales, the West of Scotland and Northern Ireland.*

Table 14 Ranked table compiled using data from national surveys<sup>1</sup> co-ordinated by the British Association for the Study of Community Dentistry (ranked by Health Authority).

Rank	Health Authority	<sup>2</sup> Mean dmft	Fluoridation status <sup>3</sup>	<sup>4</sup> % of Pop on F supplies
1	KENT & MEDWAY SHA	0.84	NF	0
= 2	ESSEX SHA	0.96	Natural <sup>5</sup>	
= 2	WEST MIDLANDS SOUTH SHA	0.96	Fluoridated	65
4	BIRMINGHAM, SOLIHULL & BLACK COUNTRY SHA	0.98	Fluoridated	97
5	SURREY & SUSSEX SHA	1.04	NF	0
6	AVON, GLOUCESTERSHIRE & WILTSHIRE SHA	1.07	Natural <sup>5</sup>	
7	HAMPSHIRE & ISLE OF WIGHT SHA	1.14	Natural	0
8	SHROPSHIRE & STAFFORDSHIRE SHA	1.15	Partial	35
9	TRENT SHA	1.16	Partial	22
10	DORSET & SOMERSET SHA	1.17	NF	0
11	SOUTH EAST LONDON SHA	1.18	NF	0
12	LEICESTERSHIRE, NORTHAMPTONSHIRE & RUTLAND SHA	1.20	NF	0
13	THAMES VALLEY SHA	1.23	NF	0
14	BEDFORDSHIRE & HERTFORDSHIRE SHA	1.25	Partial	12
15	SOUTH WEST LONDON SHA	1.26	NF	0
16	NORFOLK, SUFFOLK & CAMBRIDGESHIRE SHA	1.29	Natural <sup>5</sup>	
17	BORDERS HB	1.39	NF	0
18	SOUTH WEST PENINSULA SHA	1.46	NF	0
19	NORTH CENTRAL LONDON SHA	1.48	NF	0
20	N & E YORKSHIRE & NORTHERN LINCOLNSHIRE SHA	1.49	NF	8
21	SHETLAND HB	1.58	NF	0
22	NORTHUMBERLAND, TYNE & WEAR SHA	1.68	Fluoridated	47
23	NORTH EAST LONDON SHA	1.72	Natural <sup>5</sup>	
24	CHESHIRE & MERSEYSIDE SHA	1.77	Partial	6
25	NORTH WALES HA	1.86	NF	0
26	GRAMPIAN HB	1.89	NF	1
27	FIFE HB	1.94	NF	0
28	SOUTH YORKSHIRE SHA	1.98	NF	0
29	DUMFRIES & GALLOWAY HB	2.03	NF	0
30	CO DURHAM & TEES VALLEY SHA	2.08	Partial	20
31	CUMBRIA & LANCASHIRE SHA	2.12	Partial	6
32	DYFED POWYS HA	2.14	NF	0
33	LOTHIAN HB	2.24	NF	0
34	IECHYD MORGANNWG HA	2.27	NF	0
= 35	BRO TAF HA	2.28	NF	0
= 35	NORTH WEST LONDON SHA	2.28	NF	0

→ DoH target for 2003

Rank	Health Authority	<sup>2</sup> Mean dmft	Fluoridation status <sup>3</sup>	<sup>4</sup> % of Pop on F supplies
37	AYRSHIRE & ARRAN HB	2.37	NF	0
38	SOUTHERN HSSB	2.43	NF	0
39	FORTH VALLEY HB	2.45	NF	0
40	WEST YORKSHIRE SHA	2.46	NF	0
= 41	TAYSIDE HB	2.47	NF	0
= 41	GREATER MANCHESTER SHA	2.47	NF	0
43	HIGHLAND HB	2.65	NF	0
44	ORKNEY HB	2.68	NF	0
= 45	GWENT HA	2.73	NF	0
= 45	LANARKSHIRE HB	2.73	NF	0
= 45	ARGYLL & CLYDE HB	2.73	NF	0
48	WESTERN HSSB	2.91	NF	0
49	EASTERN HSSB	2.97	NF	0
50	NORTHERN HSSB	3.30	NF	0
51	WESTERN ISLES HB	3.46	NF	0
52	GREATER GLASGOW HB	3.51	NF	0

1 England & Wales Health Authorities data from national 2001/2002 survey [26], Scotland Health Boards data from 1999/2000 survey [27], Northern Ireland Health and Social Services Boards data from 1998 survey [28].

2 Mean dmft = average number of decayed missing or filled teeth per 5-year-old.

3 Fluoridated = 40% or more of population receiving fluoridated water supplies (NF=not fluoridated).

4 Pop on F supplies % = percentage of population receiving fluoridated water supply.

5 Naturally occurring fluoride levels varying between 0.21 and 1.05 ppm – difficult to quantify accurately and therefore not designated as 'Fluoridated'.

Table 15 Compiled using data from national surveys<sup>1</sup> co-ordinated by the British Association for the Study of Community Dentistry. Data ranked by health authority, including data for Primary Care Trusts where available (not all districts examined enough children in each PCT to allow the dmft for the PCT to be calculated).

*Tooth decay in 5-year-old children in the United Kingdom showing detail by Primary Care Trust where available.*

Rank	Health Authority/PCT	<sup>2</sup> Mean dmft	Fluoridation status <sup>3</sup>	<sup>4</sup> % of Pop on F supplies
1	KENT & MEDWAY SHA	0.84	NF	0
Including:	Maidstone & S.W.Kent PCT	0.62	NF	0
	Maidstone & Malling PCT	0.77	NF	0
	Canterbury & Coastal PCT	0.81	NF	0
	Ashford PCT	0.83	NF	0
	Dartford Gravesham & Swanley PCT	0.83	NF	0
	Medway & Swale PCT	1.02	NF	0

Rank	Health Authority/PCT	<sup>2</sup> Mean dmft	Fluoridation status <sup>3</sup>	<sup>4</sup> % of Pop on F supplies
= 2	ESSEX SHA	0.96	Natural <sup>5</sup>	
Including:	Maldon & Chelmsford PCT	0.91	NF	
	Billericay, Basildon & Thurrock PCT	1.37	Variable low levels	
= 2	WEST MIDLANDS SOUTH SHA	0.96	Fluoridated	65
Including:	Redditch & Bromsgrove PCT	0.57	Fluoridated	91
	North Warwickshire PCT	0.64	Fluoridated	100
	South Warwickshire PCT	0.65	Fluoridated	68
	Rugby PCT	0.69	Fluoridated	100
	South Worcestershire PCT	0.87	Fluoridated	32
	Coventry PCT	0.93	Fluoridated	85
	Wyre Forest PCT	1.16	Partially	14
	Herefordshire PCT	1.75	NF	0
4	BIRMINGHAM, SOLIHULL & BLACK COUNTRY SHA	0.98	Fluoridated	97
Including:	Castle & Beacon PCT	0.64	Fluoridated	100
	Dudley South PCT	0.69	Fluoridated	61
	South Birmingham PCT	0.78	Fluoridated	100
	Solihull PCT	0.81	Fluoridated	100
	Wednesbury & West Bromwich PCT	0.84	Fluoridated	100
	North Birmingham PCT	0.88	Fluoridated	100
	Rowley Regis & Tipton PCT	0.90	Fluoridated	100
	Wolverhampton City PCT	0.94	Fluoridated	100
	Walsall Area PCT	1.00	Fluoridated	100
	Oldbury & Smethwick PCT	1.01	Fluoridated	100
	East Birmingham PCT	1.19	Fluoridated	100
	Heart of Birmingham PCT	1.57	Fluoridated	100
5	SURREY & SUSSEX SHA	1.04	NF	0
Including:	East Elmbridge & Mid Surrey PCT	0.90	NF	0
	Mid Sussex PCT	0.94	NF	0
	Woking PCT	1.00	NF	0
	Brighton & Hove PCT	1.02	NF	0
	Guildford & Waverley PCT	1.15	NF	0
	Adur, Arun & Worthing PCT	1.20	NF	0
	Western Sussex PCT	1.25	NF	0
6	AVON, GLOUCESTERSHIRE & WILTSHIRE SHA	1.07	Natural <sup>5</sup>	
Including:	Swindon PCT	0.59	NF	
	North Wiltshire PCT	1.45	NF	
	West Wiltshire PCT	1.63	NF	
7	HAMPSHIRE & ISLE OF WIGHT SHA	1.14	Natural	0
Including:	Winchester PCT	0.97	NF	0
	Southampton City PCT	1.23	NF	0
	Isle of Wight PCT	1.32	NF	0
	Portsmouth City PCT	1.37	NF	0

Rank	Health Authority/PCT	<sup>2</sup> Mean dmft	Fluoridation status <sup>3</sup>	<sup>4</sup> % of Pop on F supplies
8	SHROPSHIRE & STAFFORDSHIRE SHA	1.15	NF	35
Including:	Cannock Chase PCT	0.52	Fluoridated	100
	East Staffordshire PCT	0.62	Fluoridated	100
	South West Staffordshire PCT	0.63	Fluoridated	53
	Burntwood, Lichfield & Tamworth PCT	0.64	Fluoridated	100
	Staffordshire Moorlands PCT	1.07	NF	0
	Shropshire County PCT	1.32	Partial	8
	Newcastle-under-Lyme PCT	1.47	NF	0
	South Stoke PCT	1.47	NF	0
	Telford & Wrekin PCT	1.89	NF	0
	North Stoke PCT	2.13	NF	0
9	TRENT SHA	1.16	NF	22
Including:	West Lincolnshire PCT	0.56	Fluoridated	100
	South West Lincolnshire PCT	0.58	Partial	20
	Derbyshire Dales & South Derbyshire PCT	0.78	Partial	20
	Erewash PCT	0.82	0	0
	Bassetlaw PCT	0.83	Fluoridated	100
	Gedling PCT	0.86	NF	0
	Rushcliffe PCT	0.86	NF	0
	Greater Derby PCT	0.88	NF	0
	Chesterfield PCT	1.05	NF	0
	Ashfield PCT	1.11	Fluoridated	100
	North Eastern Derbyshire PCT	1.12	Variable	?
	Amber Valley PCT	1.18	NF	0
	East Lincolnshire PCT	1.18	NF	0
	Newark and Sherwood PCT	1.19	NF	0
	Broxtowe & Hucknall PCT	1.20	NF	0
	Mansfield PCT	1.21	Fluoridated	100
	High Peak & Dales PCT	1.42	NF	0
	Central Derby PCT	2.04	NF	0
	Nottingham City PCT	2.23	NF	0
10	DORSET & SOMERSET SHA	1.17	NF	0
Including:	Taunton Deane PCT	1.03	NF	0
	Mendip PCT	1.15	NF	0
	South Somerset PCT	1.26	NF	0
	Somerset Coast PCT	1.27	NF	0
11	SOUTH EAST LONDON SHA	1.18	NF	0
Including:	Lewisham PCT	0.95	NF	0
	Bromley PCT	1.12	NF	0
	Southwark PCT	1.17	NF	0
	Bexley PCT	1.21	NF	0
	Lambeth PCT	1.22	NF	0
	Greenwich PCT	1.40	NF	0
12	LEICESTERSHIRE, NORTHAMPTONSHIRE & RUTLAND SHA	1.20	NF	0
Including:	Daventry PCT	0.49	NF	0
	Melton Rutland & Harborough PCT	0.80	NF	0
	Northampton PCT	0.89	NF	0

Rank	Health Authority/PCT	<sup>2</sup> Mean dmft	Fluoridation status <sup>3</sup>	<sup>4</sup> % of Pop on F supplies
	Northamptonshire Heartlands PCT	0.96	NF	0
	Southern Leicester PCT	1.04	NF	0
	Hinckley & Bosworth PCT	1.13	NF	0
	Charnwood & NW Leicestershire PCT	1.25	NF	0
	Leicester City West PCT	1.70	NF	0
	Eastern Leicester PCT	2.40	NF	0
13	THAMES VALLEY SHA	1.23	NF	0
Including:	South East Oxfordshire PCT	0.62	NF	0
	Wokingham PCT	0.80	NF	0
	Bracknell PCT	0.83	NF	0
	North East Oxfordshire PCT	0.83	NF	0
	South West Oxfordshire PCT	0.84	NF	0
	Milton Keynes PCT	0.97	NF	0
	Wycombe PCT	1.02	NF	0
	Aylesbury PCT	1.11	NF	0
	Newbury PCT	1.16	NF	0
	Windsor, Ascot and Maidenhead PCT	1.27	NF	0
	Oxford City PCT	1.48	NF	0
	Cherwell Vale PCT	1.53	NF	0
	Slough PCT	2.04	NF	0
	Reading PCT	2.30	NF	0
14	BEDFORDSHIRE & HERTFORDSHIRE SHA	1.25	NF	12
Including:	Bedfordshire Heartlands PCT	0.73	Partial	22
	Bedford PCT	1.04	Fluoridated	100
	North Herts & Stevenage PCT	1.24	NF	0
	Luton PCT	2.07	NF	0
15	SOUTH WEST LONDON SHA	1.26	NF	0
Including:	Croydon PCT	1.06	NF	0
	Kingston PCT	1.14	NF	0
	Sutton and Merton PCT	1.32	NF	0
	Wandsworth PCT	1.62	NF	0
16	NORFOLK, SUFFOLK & CAMBRIDGESHIRE SHA	1.29	Natural <sup>5</sup>	
Including:	Suffolk Central & South PCT	0.89	Variable	?
	South Cambridgeshire PCT	0.90	Variable	?
	East Cambridgeshire PCT	0.98	Variable	?
	Suffolk Coastal PCT	1.03	Variable	?
	Ipswich PCT	1.04	Variable	?
	Huntingdonshire PCT	1.05	Variable	?
	Suffolk West PCT	1.06	Variable	?
	Great Yarmouth PCT	1.07	Variable	?
	Fenland PCT	1.19	Variable	?
	West Norfolk PCT	1.25	NF	0
	Lowestoft & Waveney PCT	1.26	Variable	?
	South Peterborough PCT	1.32	Variable	?
	Broadland PCT	1.37	Variable	?
	Cambridge City PCT	1.55	NF	0
	South Norfolk PCT	1.63	Variable	?

Rank	Health Authority/PCT	<sup>2</sup> Mean dmft	Fluoridation status <sup>3</sup>	<sup>4</sup> % of Pop on F supplies
	North Peterborough PCT	1.65	Variable	?
	Breckland PCT	1.71	Variable	?
	Norwich City PCT	1.75	NF	0
	North Norfolk PCT	1.88	Variable	?
17				
	BORDERS HB	1.39	NF	0
18				
	SOUTH WEST PENINSULA SHA	1.46	NF	0
19				
Including:	NORTH CENTRAL LONDON SHA	1.48	NF	0
	Enfield PCT	1.16	NF	0
	Haringey PCT	1.55	NF	0
	Barnet PCT	1.75	NF	0
20				
Including:	N & E YORKSHIRE & NORTHERN LINCOLNSHIRE SHA	1.49	NF	8
	North Lincolnshire PCT	1.08	Fluoridated	75
	North East Lincoln PCT	1.28	Partial	15
	Selby & York PCT	1.30	NF	0
	Craven, Harrogate & Rural PCT	1.42	NF	0
	Hambleton & Richmondshire PCT	1.83	NF	0
	Scarborough, Whitby & Ryedale PCT	1.93	NF	0
21				
	SHETLAND HB	1.58	NF	0
22				
	NORTHUMBERLAND, TYNE & WEAR SHA	1.68	Fluoridated	47
Including:	North Tyneside PCT	1.17	Fluoridated + variable	50 + 50 variable low
	Gateshead PCT	1.31	Fluoridated	Virtually 100
	Newcastle PCT	1.60	Fluoridated	100
	Northumberland PCT	1.81	NF	33
	South Tyneside PCT	2.05	NF	0
	Sunderland PCT	2.05	NF	0
23				
	NORTH EAST LONDON SHA	1.72	Natural <sup>5</sup>	0
Including:	Havering PCT	0.91	NF	0
	Barking & Dagenham PCT	1.15	NF	0
	Waltham Forest PCT	1.15	NF	?
	Redbridge PCT	1.58	Natural variable	0
	City & Hackney PCT	1.68	NF	0
	Tower Hamlets PCT	2.50	NF	0
	Newham PCT	2.87	NF	0
24				
	CHESHIRE & MERSEYSIDE SHA	1.77	Partial	6
Including:	Central Cheshire PCT	0.91	Fluoridated	52
	Eastern Cheshire PCT	1.13	NF	0
	Halton PCT	1.21	NF	0
	Southport & Formby PCT	1.24	NF	0
	Cheshire West PCT	1.30	NF	3
	Bebington & West Wirral PCT	1.30	NF	0
	Warrington PCT	1.30	NF	0
	Ellesmere Port & Neston PCT	1.70	NF	0
	South Sefton PCT	1.92	NF	0

Rank	Health Authority/PCT	<sup>2</sup> Mean dmft	Fluoridation status <sup>3</sup>	<sup>4</sup> % of Pop on F supplies
	St Helens PCT	2.14	NF	0
	Birkenhead & Wallasey PCT	2.20	NF	0
	South Liverpool PCT	2.29	NF	0
	Central Liverpool PCT	2.30	NF	0
	North Liverpool PCT	2.30	NF	0
	Knowsley PCT	2.86	NF	0
25	NORTH WALES HA	1.86	NF	0
26	GRAMPIAN HB	1.89	NF	1
27	FIFE HB	1.94	NF	0
28	SOUTH YORKSHIRE SHA	1.98	NF	0
Including:	Sheffield South West PCT	1.37	NF	0
	Sheffield West PCT	1.45	NF	0
	Doncaster Central PCT	1.56	NF	0
	Rotherham PCT	1.89	NF	0
	Doncaster East PCT	2.02	NF	0
	Doncaster West PCT	2.12	NF	0
	Sheffield South East PCT	2.23	NF	0
	Sheffield North PCT	2.27	NF	0
	Barnsley PCT	2.44	NF	0
29	DUMFRIES & GALLOWAY HB	2.03	NF	0
30	CO DURHAM & TEES VALLEY SHA	2.08	Partial	20
Including:	Hartlepool PCT	0.86	Fluoridated	100
	Darlington PCT	2.16	NF	0
	North Tees PCT	2.53	NF	0
31	CUMBRIA & LANCASHIRE SHA	2.12	Partial	6
Including:	West Cumbria PCT	1.30	Fluoridated	100
	Fylde PCT	1.39	NF	0
	West Lancashire PCT	1.39	NF	0
	Chorley & South Ribble PCT	1.57	NF	0
	Carlisle & District PCT	1.65	NF	0
	Eden Valley PCT	1.76	NF	0
	Morecambe Bay PCT	2.03	NF	0
	Wyre PCT	2.26	NF	0
	Blackburn with Darwen PCT	2.39	NF	0
	Burnley, Pendle & Rossendale PCT	2.58	NF	0
	Blackpool PCT	2.62	NF	0
	Hyndburn & Ribble Valley PCT	2.67	NF	0
	Preston PCT	2.88	NF	0
32	DYFED POWYS HA	2.14	NF	0
33	LOTHIAN HB	2.24	NF	0
34	IECHYD MORGANNWG HA	2.27	NF	0

Rank	Health Authority/PCT	<sup>2</sup> Mean dmft	Fluoridation status <sup>3</sup>	<sup>4</sup> % of Pop on F supplies
= 35	BRO TAF HA	2.28	NF	0
				0
= 35	NORTH WEST LONDON SHA	2.28	NF	0
Including:	Harrow PCT	1.52	NF	0
	Hillingdon PCT	1.73	NF	0
	Hounslow PCT	2.13	NF	0
	Kensington & Chelsea PCT	2.19	NF	0
	Ealing PCT	2.59	NF	0
	Brent PCT	2.68	NF	0
	Hammersmith & Fulham PCT	2.68	NF	0
	Westminster PCT	3.04	NF	0
				0
37	AYRSHIRE & ARRAN HB	2.37	NF	0
				0
38	SOUTHERN HSSB	2.43	NF	0
				0
39	FORTH VALLEY HB	2.45	NF	0
				0
40	WEST YORKSHIRE SHA	2.46	NF	0
Including:	Airdale PCT	1.83	NF	0
	Wakefield West PCT	1.91	NF	0
	Eastern Wakefield PCT	2.06	NF	0
	Calderdale PCT	2.18	NF	0
	North Kirklees PCT	2.87	NF	0
				0
= 41	TAYSIDE HB	2.47	NF	0
				0
= 41	GREATER MANCHESTER SHA	2.47	NF	0
Including:	Trafford South PCT	1.45	NF	0
	Stockport PCT	1.67	NF	0
	Trafford North PCT	2.01	NF	0
	Ashton, Leigh & Wigan PCT	2.14	NF	0
	Salford PCT	2.37	NF	0
	Bury PCT	2.43	NF	0
	Tameside & Glossop PCT	2.55	NF	0
	South Manchester PCT	2.56	NF	0
	North Manchester PCT	2.58	NF	0
	Bolton PCT	2.61	NF	0
	Heywood & Middleton PCT	2.85	NF	0
	Central Manchester PCT	2.87	NF	0
	Oldham PCT	2.96	NF	0
	Rochdale PCT	3.87	NF	0
				0
43	HIGHLAND HB	2.65	NF	0
				0
44	ORKNEY HB	2.68	NF	0
				0
= 45	GWENT HA	2.73	NF	0
				0
= 45	LANARKSHIRE HB	2.73	NF	0
				0
= 45	ARGYLL & CLYDE HB	2.73	NF	0

Rank	Health Authority/PCT	<sup>2</sup> Mean dmft	Fluoridation status <sup>3</sup>	<sup>4</sup> % of Pop on F supplies
48	WESTERN HSSB	2.91	NF	0
49	EASTERN HSSB	2.97	NF	0
50	NORTHERN HSSB	3.30	NF	0
51	WESTERN ISLES HB	3.46	NF	0
52	GREATER GLASGOW HB	3.51	NF	

1 England & Wales Health Authorities data from national 2001/2002 survey [26], Scotland Health Boards data from 1999/2000 survey [27], Northern Ireland Health and Social Services Boards data from 1998 survey [28].

2 Mean dmft = average number of decayed missing or filled teeth per 5-year-old.

3 Fluoridated = 40% or more of population receiving fluoridated water supplies. NF= not fluoridated.

4 Pop on F supplies % = percentage of population receiving fluoridated water supply.

5 Naturally occurring fluoride levels varying between 0.21 and 1.05 ppm – difficult to quantify accurately and therefore not designated as ‘Fluoridated’.

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