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Dental health impact of water fluoridation in children living in Bedford Borough Council in 2008, 2009 and 2015

Cross–sectional ecological study of the impact of water fluoridation on dental health

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Published November 2015
PHE publications gateway number: 2015457

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339

Contents

1.0 Executive Summary

1.1 This report has collected the results of the National Dental Public Health Epidemiology Programme which collected data from dental surveys which included dental surveys of five-year-old children living in Bedford Borough in 2008 and again in 2015.

1.2 The survey counted the number of children who had tooth decay and the severity of decay in both years.

1.3 Some of the children lived in areas within Bedford Borough that had fluoride in the water, and others lived in areas which had never had water fluoridation.

1.4 The data showed that there was no statistically significant change in the number of children with tooth decay or the severity of tooth decay between 2008 and 2015.

1.5 However there was a suggestion that more children experienced tooth decay in 2015 compared to 2008.

1.6 The data also suggested that, in areas where fluoridation was suspended in 2015, the number of children experiencing tooth decay was higher than in the areas in 2015 that had never received fluoridated water.

1.7 A separate survey in Bedford Borough asked twelve-year-old children whether they had noticed white marks on their teeth. If this is due to high levels of fluoride (which can be from different sources) then this is called ‘fluorosis’. In the survey 19.1% of twelve- year-olds reported that they had white marks on their teeth.

1.8 It is difficult to draw conclusions about fluoridation from the data because of the small numbers of children examined.

1.9 The data cannot account for other factors that might lead to tooth decay such as diet and dental hygiene practice that might have influenced the results.

1.10 This report focused on the dental health of five-year-old and twelve-year-olds. There is the possibility that other groups within the Bedford Borough population may have been affected by the absence of water fluoridation, as water is consumed by the vast majority of residents daily. These groups include vulnerable groups such as the elderly with poor manual dexterity and others who are unable to maintain good dental health through oral hygiene practices alone or residents requiring assistance with oral hygiene practices.

2.0 Background

2.1 Water fluoridation schemes have been in place in many parts of the world to reduce dental decay.

2.2 Water fluoridation has existed in Bedfordshire since the early 1970's. In 2009 there were three water fluoridation plants in Central Bedfordshire and a single plant (Manton Lane) in Bedford Borough. In 2009 the Manton Lane plant was taken off line for refurbishment. The single water fluoridation plant which provides water fluoridation for the majority of Bedford Borough has not fluoridated since September 2009 i.e. since the process to refurbish the water treatment works at Manton Lane began.

2.3 The main health benefit of water fluoridation is to reduce the prevalence of dental decay. If the fluoride concentration is at optimal levels (1ppm) or as close to 1ppm as possible and the fluoridated water is consumed by the population at the optimal levels daily and continually throughout the day then this could reduce dental decay. The prevalence of dental decay is reduced by stopping the progress of dental decay and strengthening the tooth enamel to prevent early dental decay lesions. Water fluoridation allows the population, regardless of age, social advantage/disadvantage, physical/mental impairment and other vulnerable groups to have better dental health and be supported in maintaining good oral health in conjunction with their oral hygiene practice.

2.4.1 The aims of the report

2.4.2 This report has been prepared for the Bedford Borough Council Adult Services and Health Overview and Scrutiny Committee by jointly working with the Bedfordshire Public Health team. The aims of the report were as follows:-

a) To assess the impact of water fluoridation on the dental health of five-year-olds in Bedford Borough and Central Bedfordshire

b) To assess the impact of water fluoridation on the dental health of five-year-olds in areas of advantage/dis-advantage in Bedford Borough and Central Bedfordshire

c) To assess the level of fluorosis in the twelve year-old population in Bedford Borough and Central Bedfordshire

2.5 The Bedfordshire Community Dental Service Community Interest Company has undertaken dental surveys in Bedfordshire and undertook both a survey in 2008 as well as a recent 2015 survey.

2.6 With regards to the known negative effects of water fluoridation i.e. fluorosis, the twelve year-old child dental health survey for the academic year 2008/09 was analysed to understand the perceptions of fluorosis as reported by twelve year-old children themselves.

2.7 In 2008, water fluoridation existed in Bedford Borough and was supplied by the Manton Lane water fluoridation plant. Water fluoridation is supplied to most of Bedford Borough; however some areas of Bedford Borough are not covered by fluoridated water. The areas of Bedford Borough which do not have or have very little supply of water fluoridation are as follows:- Podington, Wymington, Little Barford, St Neots Eaton Socon, St Neots Eaton Ford, Roxton, Willington, Cople, Cardington, Eastcotts, Wlishamstead, Elstow, Wootton. The fluoride concentrations for 2008 and 2015 were obtained to analyse and link the dental health with the fluoride concentrations.

3.0 Aims and Objectives

Impact of water fluoridation on the dental health in five-year-old children living in Bedford Borough where water fluoridation was present and is currently suspended.

3.1 Aims

- To assess the impact of water fluoridation on the dental health of five-year-olds in Bedford Borough
- To assess the impact of water fluoridation on the dental health of five-year-olds in areas of advantage/disadvantage in Bedford Borough
- To assess the level of fluorosis in the twelve-year-old population in Bedford Borough

3.2 Objectives

- To understand through data comparison the dental health of five-year-old children and the level of change to dental health with water fluoridation in 2008 and without water fluoridation in 2015
- To understand the dental health of five-year-old children living in areas of advantage/disadvantage with and without water fluoridation in Bedford Borough and the level of change when water fluoridation was suspended in the same areas of advantage/disadvantage.
- To assess the perception of fluorosis in twelve year-old children in Bedford Borough in areas where water fluoridation was present

4.0 Methods

4.1 To understand the impact of water fluoridation on dental health, data collected on the dental health of five-year-olds was selected. Dental surveys in this age cohort are undertaken more frequently than in other age groups, and therefore past data could be used to compare dental health before water fluoridation was suspended and dental health currently, whilst water fluoridation has been suspended in Bedford Borough.

4.2 The five-year-old dental survey results from the academic year 2007/08, conducted in 2008, was selected as water fluoridation was present at levels below and close to optimal levels in many areas in Bedford Borough. A total of 1,010 children (higher than the minimum examined number of children as specified in the national dental survey protocol) were included in the survey.

4.3 Bedford Borough Council's Public Health team took the opportunity to compare the dental survey results from 2008 with the latest survey conducted in 2015. The dental survey conducted in 2015 (for the academic year 2014/15) was selected as a comparison as this would be the first five-year-old child cohort in Bedford Borough who had not been exposed to water fluoridation. A total of 863 children were examined in 2015 as part of the survey and were included in the analysis.

4.4 A protocol was agreed with dental survey analysts and the Bedfordshire Public Health team to analyse dental survey data to meet the aims of the report requested by the Bedford Borough Council Adult Services and Health Overview and Scrutiny Committee to look into the impact water fluoridation on dental health.

4.5 The dental surveys in 2008 and 2015 were undertaken in accordance with the national protocol for dental surveys. The national protocol requires all examiners undertaking the national dental surveys to undergo training and calibration[i] so examinations are consistently performed to the same criteria and standard each year. The survey provides the opportunity to compare the dental health across different local authorities.

4.6 The five-year-old children were examined using caries diagnostic criteria and examination techniques based on those agreed by the British Association for the Study of Community Dentistry (BASCD), Diagnostic Criteria for Caries Prevalence Surveys 1996/97[ii]. The BASCD recommended sampling procedures described in BASCD guidance on sampling for surveys of child dental health- A BASCD co-ordinated dental epidemiology programme quality standard[iii] was used by the dental survey teams. The National Dental Public Health Epidemiology Survey Programme incorporates the diagnostic criteria to examine teeth as agreed by BASCD and the sampling technique agreed by BASCD is used to measure the dental health of the average child living within a Local Authority.

4.7 To undertake the analysis the following information was used:-

4.8 The data from the academic year 2007/08 and 2014/15 five year-old National Dental Pubic Health Epidemiology Programme for England oral health survey data

4.9 Data from the 2007/08 National Dental Epidemiology Programme for England for Bedford Borough was analysed to determine the average “dmft”. The abbreviation ‘dmft’ stands for decayed, missing and filled teeth (i.e. the average number of obvious decayed “dt”, that is decay into dentine, missing due to decay mt and filled teeth ft. The proportion of children with dental decay experience (dmft>0) was also calculated from the data.

4.10 The child’s home postcode was linked to a Lower Super Output Area (LSOA). LSOAs are homogenous small areas of relatively even size (around 1,500 people). Index of Multiple Deprivation 2010 scores are published for small geographical areas known as ‘Lower Super Output Areas’ (LSOAs).

The Index of Multiple Deprivation 2010 is an overall measure of multiple deprivation experienced by people living in an area. It is a composite score based on 38 indicators grouped in seven domains: income; employment; health and disability; education, skills and training; barriers to housing and other services; crime; living environment. Each domain’s contribution to the overall score is weighted differently, with income and employment deprivation weighted the most.

Linking the data in this way allowed the data to be weighted by IMD quintile populations and to understand the link between dental health and deprivation and the impact of water fluoridation on children’s dental health depending on whether the LSOA was fluoridated or not.

4.11 The analysis included the time period when the survey examinations occurred so that the mean fluoride concentration supplied by the Manton Lane fluoridation plant could be used to determine whether the LSOAs during the period that surveys were undertaken were fluoridated or not. As fluoride concentrations were lower than the optimal level of 1ppm, the lower level of 0.7ppm was used as a cut-off point. Any LSOAs with a water fluoridation concentration of 0.7ppm or above was included in the study as having water fluoridation. The mean water fluoridation concentration for the LSOAs during the dental survey period was used to note whether the LSOA was fluoridated or not as there needed to be some way of identifying the LSOA as being fluoridated or not. The water fluoridation concentrations vary considerably, from plant to plant across Bedfordshire and the concentrations vary on a daily basis. When calculating the water fluoridation means for a year in a fluoridated area it was noted that concentration fell below 0.7ppm for the plant in certain years.

4.12 Data was also collected for the survey years 2008 and 2015 and the five years prior to these dental survey years i.e. 2002 to-2007 and 2009 to-2014 to determine whether the five-year- old child living in that area has continuously been supplied fluoridated water at a concentration that provides dental health benefits levels at 1ppm or close to 1ppm. Many studies have used 1ppm as the water fluoridation level when water fluoridation has been studied as this is an optimal level.

4.13 In the five year period prior to 2008, the mean (average) water fluoridation concentration means each year ranged between 0.51-0.83ppm. The LSOAs in Bedford Borough which had water fluoridation were not dosing at the optimal level of 1ppm. In the five year period prior to 2015 when water fluoridation was suspended in Bedford Borough, the mean (average) water fluoride concentration each year ranged between 0.24-0.26ppm.

4.14 In 2008 the survey to examine the dental health of children took place between January 2008 and April 2008. In accordance with the Dental Public Health Epidemiology Programme protocol, data were not reported where there were too few children examined (less than 20 in a given category, as such low figures do not give accurate results). For example where there were less than 20 children with missing teeth ('mt') in a particular quintile or area these data were not reported. This has been highlighted in the tables and caution must therefore be used when interpreting some data where the numbers of children involved are low.

4.15 The fluoride concentration levels in the water network zones during January 2008 –to July 2008 were sought from Anglian Water and the mean fluoride concentration in the water during the four months (January to-April) in 2008 when the survey was conducted was undertaken to identify LSOAs which were fluoridated and those that were not fluoridated. The mean fluoride concentrations during the 4 month period in Bedford Borough for all the water fluoride zones reached a combined mean of 0.69ppm (the values ranging 0.61-0.73ppm) this is very much on the borderline. That said LSOA with a minimum of 0.7ppm were recorded as having water fluoridation. The public can access information about the fluoride concentrations in the drinking water by their postcode by going to the Anglian Water website.

4.16 Data from the 2015 National Dental Public Health Epidemiology Programme for England for the academic year 2014/15 was analysed using the provisional data. Provisional data has been used in this report as the national Dental Public Health Epidemiology statistics is awaiting completion of analysis so there might be minor changes when comparing the data for Bedford Borough in this report with the national data. Data was cleaned and analysed in accordance with protocols developed by the national dental epidemiology team.

4.17. The provisional data contained within the dataset used for the analysis, and which has been used throughout this report, may change slightly when the national five-year-old dental health survey is published formally by Public Health England in 2016. This is because the data from all areas nationally are collated together for analysis and during the collation process there might be data incorporated from other areas potentially resulting in minor changes to the published data for Bedford Borough.

4.18 The 2015 data has been analysed to determine the average dmft (obvious decayed, missing due to decay and filled teeth), dt (obvious decayed teeth) and mt (missing due to decay teeth) levels. The child's home postcode was linked to a Lower Super Output Area (LSOA) to enable a linkage to Index of Multiple Deprivation (IMD) to allow the data to be weighted by IMD quintile populations and to understand the link between dental health and deprivation and a population health improvement measure such as water fluoridation. The methodology was the same as used for 2008 data. The sets of data were handled carefully as the data was confidential.

4.19 The analysis included the time period when the survey examinations occurred so that the mean fluoride concentration supplied by the various water fluoridation zones could be used to determine whether the LSOAs were fluoridated at the time of the survey. In 2015 the survey to examine the dental health of children took place between February 2015 and July 2015. During this time the fluoride concentration ranged in fluoridation zones between 0.26-0.27ppm the mean therefore being 0.27ppm. This level is what is expected as background levels of fluoride.

4.20 Understanding the water fluoridation concentration as well as whether the five- year-old population being studied in the analysis have had consistent exposure to fluoride at the near optimal levels at the very least, a concentration at the lower threshold of 0.7ppm was chosen as the lower cut off point. The greater the time consistently exposed to fluoridated water the greater the chance of remineralisation occurring in teeth where bacterial acid attack has resulted in demineralisation and the formation of an early caries lesion.

4.21 As with the 2008 data, the 2015 data was analysed and results were excluded where too few children were examined (less than 20) to draw accurate conclusions and this has been highlighted in the tables. Caution must therefore be used when interpreting some data where the numbers of children involved are low.

4.22 Confidenice Interval bars are illustrated in the figures throughout this report. They are shown in the figures and stated in the tables as the 95% Confidence Intervals (CI). The CIs show that in 95% of the time that the true average dental health measure lies within the range of values that you can be 95% certain contains the correct average dental health measure of the total five-year-old population in Bedford Borough. The CIs have been noted to show that there is a 95% chance that the average mean values in 2008 and 2015 lie somewhere between these bars. P-values noted in the tables provide the information as to whether the dental health measures noted have been achieved by pure chance (if the P-value is large).or whether there was a real effect (if the P-value is small).

4.23 The data from the academic year of 2008/09 of twelve year-old’s using National Dental Epidemiology Programme for England oral health survey data was used to assess levels of fluorosis

4.24 The 2008/09 data on twelve-year-old children were analysed to determine the prevalence of fluorosis as reported and perceived by the twelve year-olds examined. This was carried out to facilitate understanding of the impact of any dental fluorosis.

5.0 Results

5.1 To assess the impact of water fluoridation on the dental health of five-year-olds in Bedford Borough Council

5.2 To understand the impact that water fluoridation had on dental health in 2008 and in 2015, analysis was undertaken using the five-year-old dental health survey undertaken in 2008 when there was water fluoridation and the provisional results of the five-year-old dental health survey undertaken in 2015 when water fluoridation had been suspended. The analysis below shows the results of the dental health surveys comparing the examined sample sizes and average obvious decayed, missing (due to decay) and filled teeth (dmft) for both the survey years.

5.3 The data in **Tables 1-3** were cleaned and analysed using the Dental Public Health Epidemiology Programme (DPHEP) protocol and guidance, for error checking to quality assure the data, and includes data for residents of Bedford Borough only.

5.4 Results in **Table 1** show that in general there has been a slight increase in dental decay severity from 2008 to 2015. Average dmft has risen by +0.12 when the whole population is included. In children with some form of dental decay experience either through obvious signs of dentinal decay, missing teeth or filled teeth (avg dmft>0) the average dental decay experience has gone up by +0.31 in those with dental decay. The large P-values suggest that the slight deterioration could have occurred by chance or because of variations within the sample of children.

Table 1. Comparison average dmft in five-year-olds in 2008 and 2015 (PROVISIONAL DATA)

	Avg dmft			**% dmft>0**			**Avg dmft>0**		
Local Authority	**2008**	**Provisional 2015**	P value	**2008**	**Provisional 2015**	P value	**2008**	**Provisional 2015**	P value
Bedford	0.85	0.97	0.18	26.2	27.1	0.51	3.26	3.57	0.21
Difference	+0.12			+0.9%			+0.31		

5.5 **Figure 1** illustrates using confidence intervals the average dmft of five-year-olds in 2008 and 2009. The **Figure 1** shows the changes in the average dental health with and without water fluoridation. **Figure 1** also shows the worsening of dental health in 2015 compared to 2008, however this result is not statistically significant and could have occurred by chance.

Figure 1: Average dental health of five-year-olds in, 2008 and 2015 (PROVISIONAL DATA)

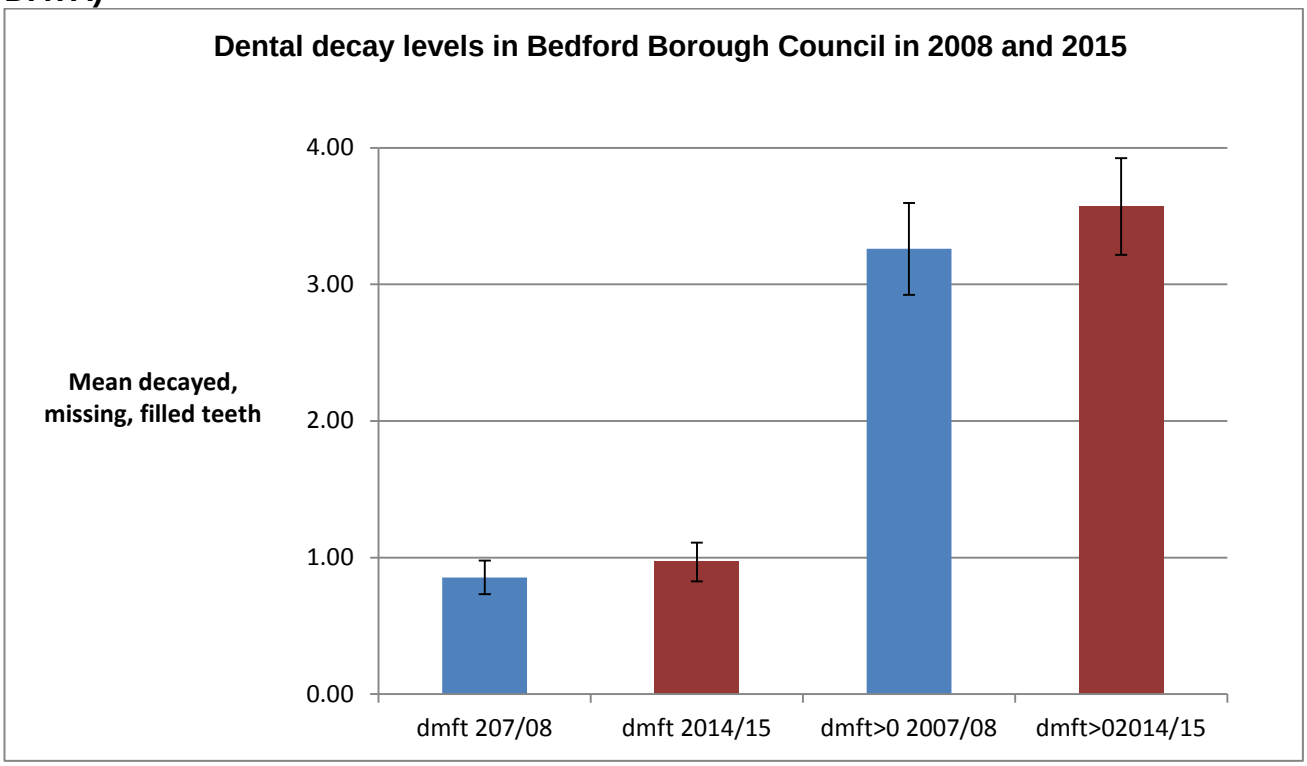
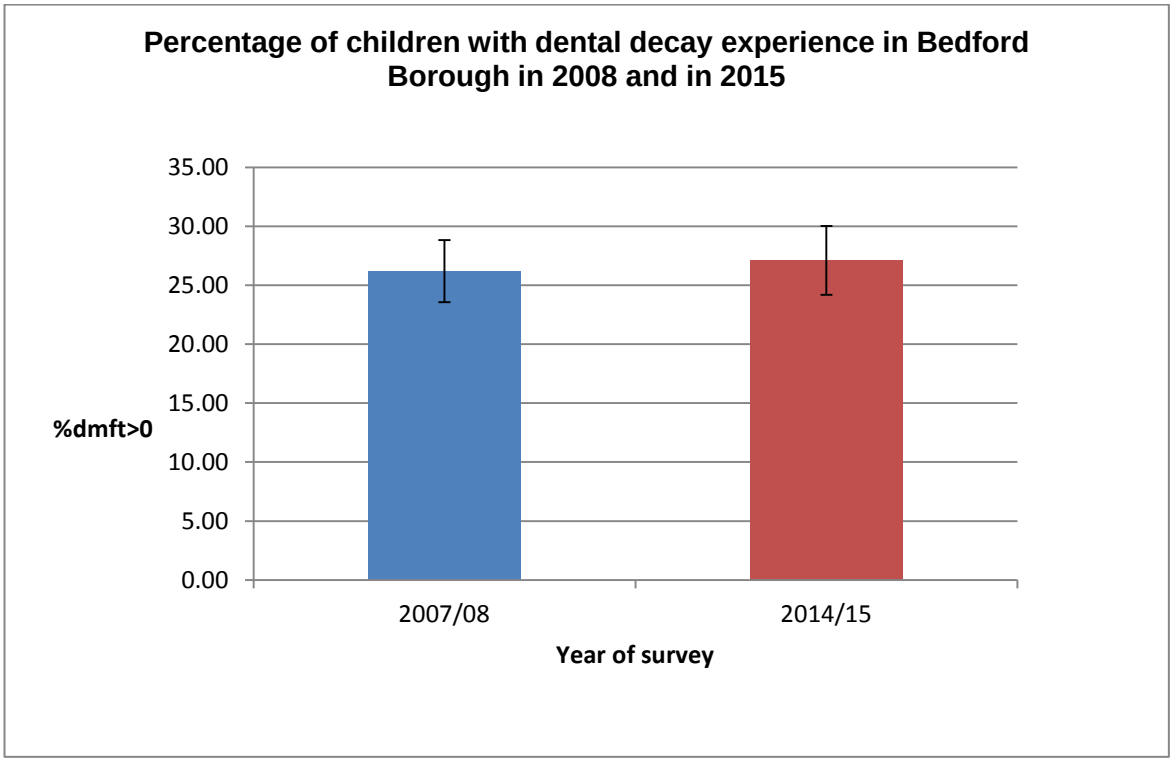


Figure 2. The percentage of children with decay experience in 2008 compared to those in 2015 (PROVISIONAL DATA)



5.6 **Figure 2** shows the increase of decay experience indicating that, overall, there has been an increase in the percentage of children with dental decay by almost 1% in 7 years. This equates to 21 children being affected during the 7 years without water fluoridation for the 2015 survey - the mid-2013 population estimates was used for weighting. However this difference is not significant.

Table 2. Average decayed (dt) and missing due to decay (mt) teeth in 2008 and in 2015 (PROVISIONAL DATA)

	Examined number of children	**Avg dt (Lower CI, Upper CI)**	**% dt>0 (Lower CI, Upper CI)**	**Avg dt>0 (Lower CI, Upper CI)**	**Avg mt (Lower CI, Upper CI)**	**% mt>0 (Lower CI, Upper CI)**	**Avg mt>0 (Lower CI, Upper CI)**
Bedford Borough 2008	n= 1010	0.65 (0.55, 0.75)	23.1 (20.6, 25.7)	2.81 (2.49, 3.14)	0.07 (0.03, 0.10)	2.20 (1.30, 3.10)	3.16 (2.34, 3.98)
Bedford Borough 2015	n=863	0.73 (0.61, 0.85)	23.6 (20.8, 26.4)	3.09 (2.74, 3.43)	0.12 (0.07, 0.17)	3.20 (2.10, 4.40)	3.70 (2.77, 4.63)
Difference 2008-2015		+0.08	+0.5	+0.28	+0.05	+1	+0.54

5.7 The results in **Table 2.** show that a slightly higher percentage of those with dental decay experience were more likely to have missing teeth in 2015 than in 2008.

5.8 Further analysis indicates that there was an increase in the proportion of children with untreated dental decay from 23.1% to 23.6% in the 7 years between 2008 to 2015.

5.9 Those that had any form of dental decay experience suffered poorer dental health noted by an increase in average dental decay avg dt>0.The children with dental decay (dt>0) in Bedford Borough in 2015 had on average 3.09 decayed teeth compared to the average five-year-old child in 2008 who had 2.81 decayed teeth -a difference of 0.28.

Table 3. Comparison of impact of water fluoridation on dental health in five-year-olds in 2007/08 and 2014/15 by LSOA (PROVISIONAL DATA)

Year of dental survey of 5- year- olds and fluoridation status of LSOA at time of survey(number of children examined within LSOA in survey)		Average dmft			% dmft>0			Avg dmft>0		
		2008 (LCI, UCI)	2015 (LCI, UCI)	Ave dmft difference 2008-2015	2008 (LCI, UCI)	2015 (LCI, UCI)	% dmft>0 difference 2008-2015	2008 (LCI, UCI)	2015 (LCI, UCI)	dmft>0 difference 2008-2015
LSOA 2008 fluoridated= No (n=446)	LSOA 2015 fluoridated =No (n=297)	0.57 (0.42, 0.72)	0.56 (0.38, 0.74)	-0.01	18.0 (14.41, 21.69)	19.0 (14.55, 23.47)	+1.0	3.16 (2.67, 3.66)	2.95 (2.26, 3.64)	-0.21
LSOA 2008 fluoridated =Yes (n=564)	LSOA 2015 fluoridated =No (n=439)	1.16 (0.95, 1.36)	1.36 (1.11, 1.60)	+0.2	34.0 (30.0, 37.9)	36.5 (31.80, 41.17)	+2.5	3.41 (2.96, 3.86)	3.72 (3.26, 4.17)	+0.31

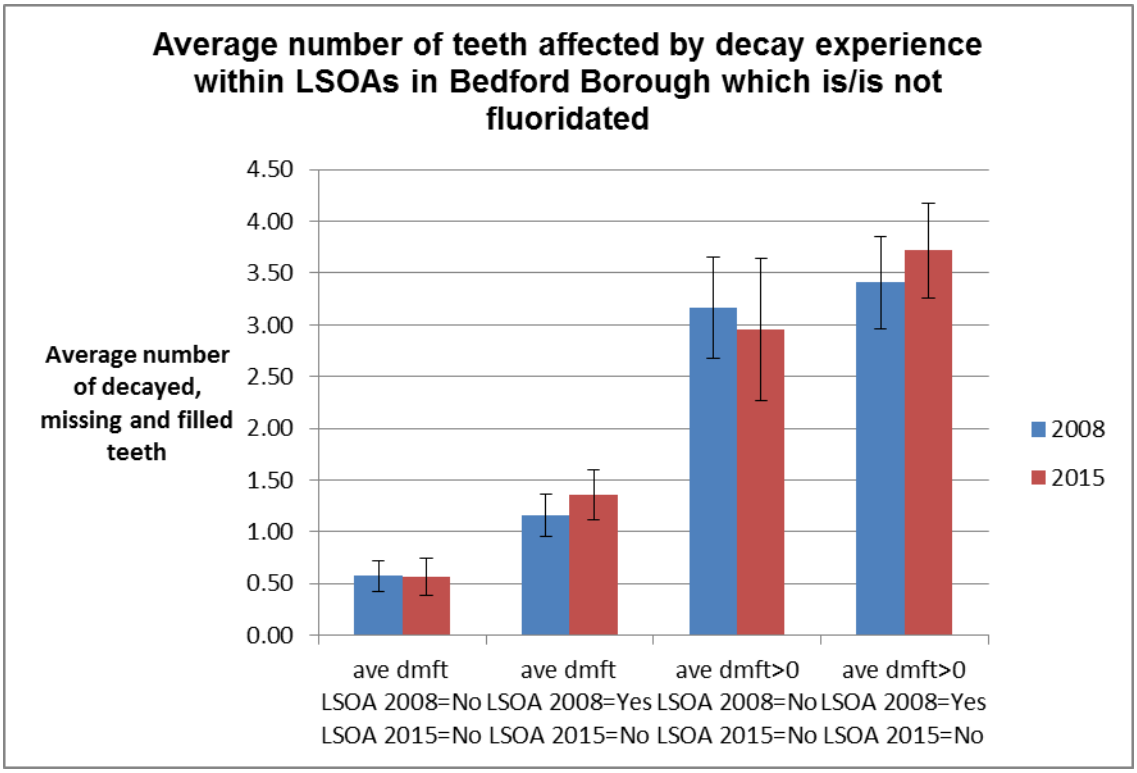
5.10 **Table 3** In 2015 an additional 2.5% children had experience of dental decay compared to 2008 in areas where water fluoridation was present in 2008 and absent in 2015. Table 3 shows the dental health of children living in Lower Super Output Areas in Bedford Borough which had water fluoridation in 2008 and those that did not have water fluoridation in 2015. In 2015 as the Manton Lane plant in Bedford Borough was not dosing fluoride; there were no LSOAs which had water fluoridation. Lower Super Output Areas which had fluoride concentration levels at 0.7 ppm or greater (0.7 ppm is the lower level for fluoride concentration at which water fluoridation could provide a positive benefit) were recorded as having water fluoridation.

5.11 **Table 3.** shows the 2008 dental survey data compared to the 2015 dental survey showing dental health of five-year-old children in all LSOAs which had or did not have water fluoridation in 2008 with those in 2015 which did not have water fluoridation. The data shows that children living in LSOAs which did have water fluoridation in 2008 had better dental health than those that live in the same LSOA in 2015 without water fluoridation.

5.12 LSOAs within Bedford Borough which never had water fluoridation in 2008 or in 2015 could be used as a control group when comparing dental health of five-year-olds in LSOAs when water fluoridation was present in 2008 and then suspended in 2015.

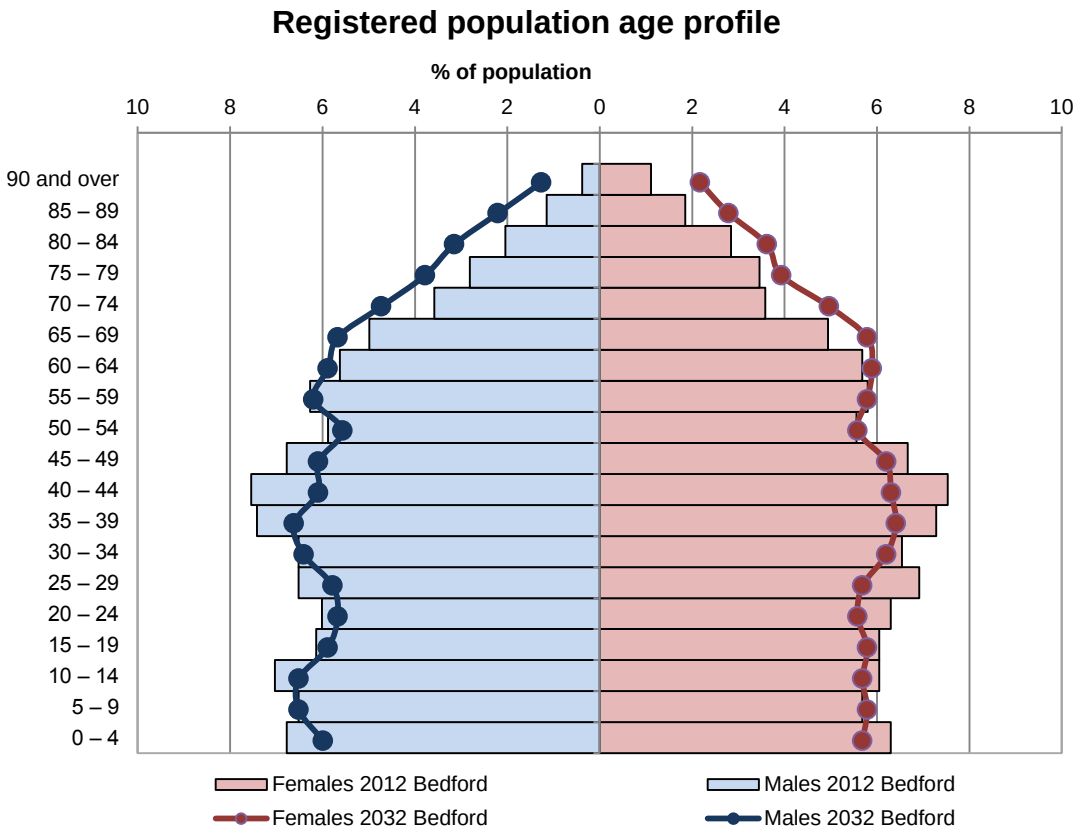
5.13 It can be seen in **Table 3** that average dmft and % dmft remained very similar in 2008 and 2015 in the same LSOAs where water fluoridation was absent in 2008 and 2015, compared with LSOAs that had water fluoridation in 2008 and which was suspended in 2015.

Figure 3. Average dmft change of children with decay experience with and without water fluoridation living in the same LSOA (PROVISIONAL DATA)



5.14 **Figure 3** shows how children living in LSOAs that did not have water fluoridation in 2015 had poorer dental health than children who were five-years-old in 2008 who had received water fluoridation. However these differences are not statistically significant.

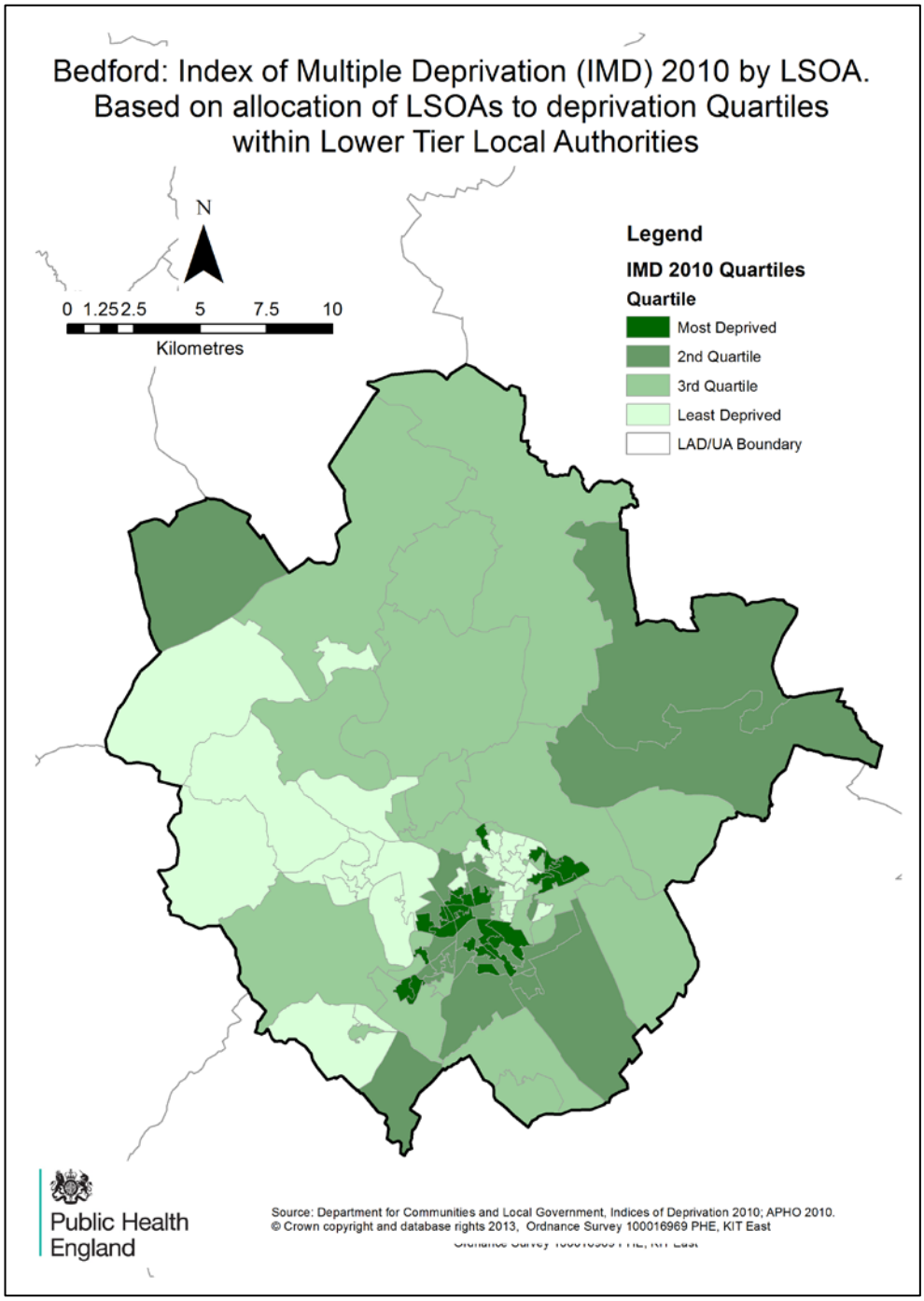
Figure 4 Registered population age profile for Bedford Borough



5.15 **Figure 4** above shows the population age distribution within Bedford Borough. This report has focussed on dental health changes in five-year-olds and the perception of fluorosis in twelve year-old children, however other age groups within the population will also be impacted as they will also be consuming fluoridated water. If the water fluoride concentrations were 1ppm or very close to it then the impact of water fluoridation in improving dental; health may have been greater in each age group.

5.16 To assess the impact of water fluoridation on dental health of five-year-olds in areas of advantage/disadvantage in Bedford Borough

Map 1 Index of Multiple Deprivation IMD by quartiles for Bedford Borough



5.17 **Map 1** shows the LSOAs in Bedford Borough by deprivation using the Index of Multiple Deprivation. The map shows the LSOAs areas grouped into quartiles. The water fluoridation is supplied for most of Bedford Borough with the exception of some areas in the East of Bedford Borough.

Table 4. The average number of decayed, missing (due to decay) and filled teeth and percentage of children with decay experience in 2008 compared with 2015 for the LSOAs which had water fluoridation in 2008 but none in 2015 (PROVISIONAL DATA)

IMD National Quintile	2008 Average dmft (LCI, UCL) n=number examined	2015 Average dmft (LCI, UCL) n=number examined	P value	% dmft>0 with decay experience		
				2008	2015	P value
1 (most deprived)	1.40 (0.91, 1.90) **n=114**	1.51 (1.06, 1.95) **n=106**	0.75	34.2 (25.5, 42.9)	40.6 (31.2, 49.9)	0.33
2	1.56 (1.18, 1.95) **n=193**	1.57 (1.14, 1.98) **n=173**	0.98	44.0 (37.0, 51.0)	39.9 (32.4, 47.4)	0.43
3	0.72 (0.39, 1.05) **n=103**	1.03 (0.53, 1.53) **n=147**	0.31	27.2 (18.6, 35.8)	30.8 (19.5, 42.0)	0.62
4	0.74 (0.27, 1.20) **n=57**	0.72 (0.19, 1.25) **n=163**	0.96	24.6 (13.4, 35.7)	22.0 (10.5, 33.5)	0.75
5 (most affluent)	0.22 (0.10, 0.34) **n=97**	0.58 (0.23, 0.93) **n=149**	0.06	14.4 (7.4, 21.4)	21.8 (10.9, 32.7)	0.25
Total	1.16 (0.95, 1.36) **n=564**	1.36 (1.11, 1.60) **n=446**	0.20	34.0 (30.0, 37.9)	36.5 (31.8, 41.2)	0.41

5.18 **Table 4** shows the average dmft of five-year-old children and the percentage with decay experience (dmft>0) grouped by IMD quintile of LSOAs which were fluoridated during the four-month survey period in 2008 and not fluoridated in 2015 (six month survey period). The P-values show that comparing LSOAs by deprivation shows no statistical significance of change in dmft in 2008 and 2015 with the water fluoridation concentration which was being tested.

5.19 The average dmft in the most affluent group quintile increased showing poorer dental health. The cause of the change in this group when compared to other more deprived group is difficult to explain but might be due to larger numbers being examined in the survey or other issues such as migration.

5.20 The results show that children living in the deprived communities have worse dental health than those in the more affluent communities regardless of whether fluoridation is present or not.

Figure 5. Percentage dmft change in children with dental decay experience in Bedford LSOAs which had water fluoridation (>0.7ppm) in the dental survey period in 2008 and where water fluoridation was absent in 2015 (PROVISIONAL DATA)

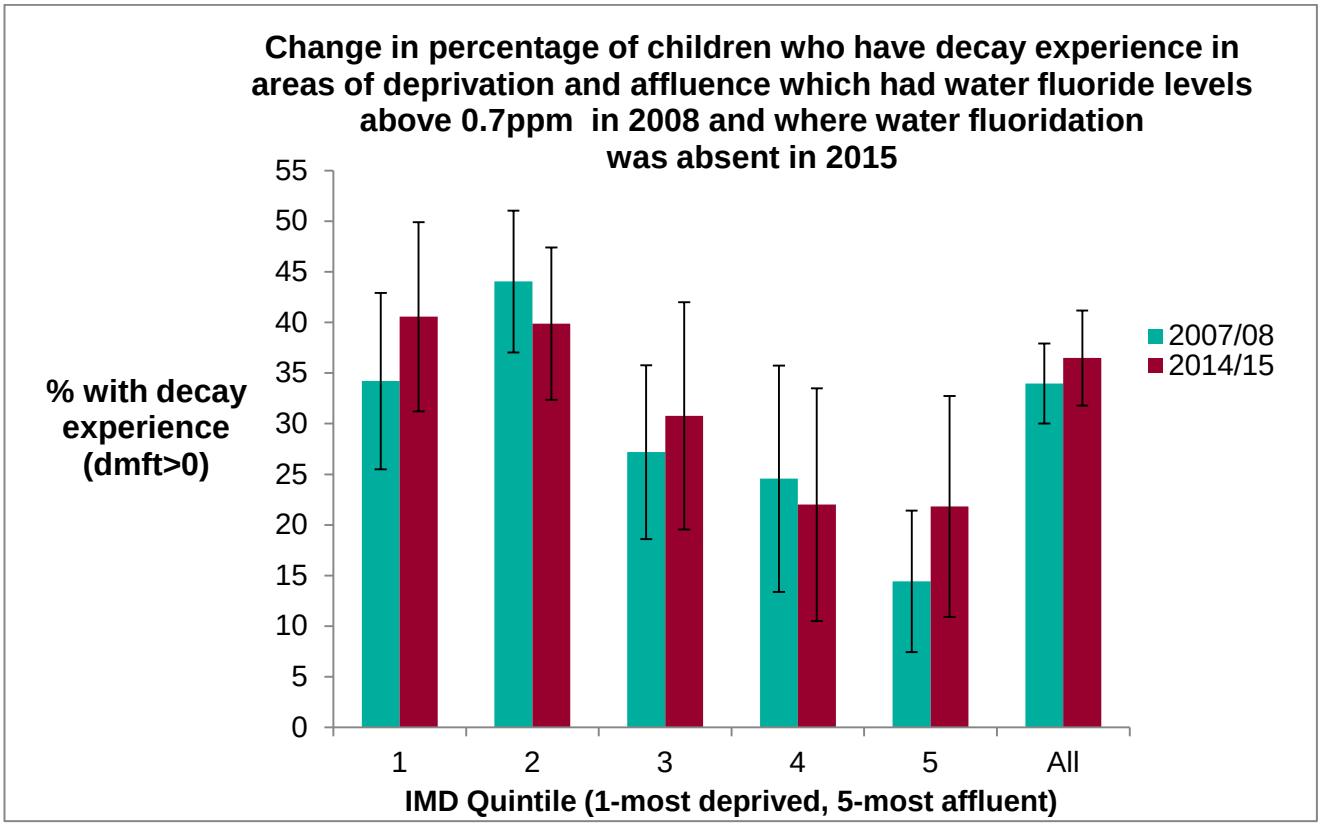
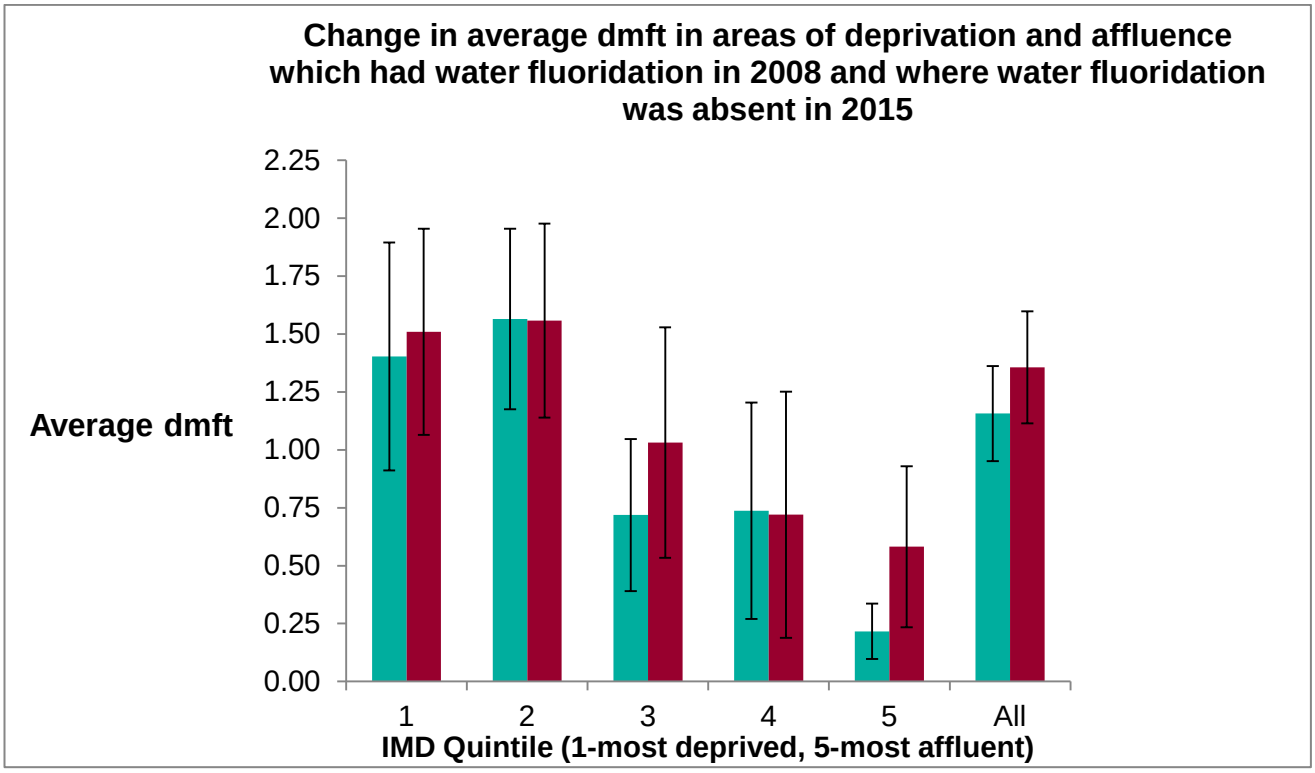


Figure 6. Average change dmft in Bedford Borough LSOAs which had water fluoridation in the dental survey period in 2008 and where water fluoridation was absent in 2015 (PROVISIONAL DATA)



5.21 **Figures 5 and 6** shows the results in graphical form of results in **Table 4**. The results show that overall dental health deteriorated when comparing the five-year-old age cohort in 2008 compared with the five-year-old age cohort in 2015. However, data shown in Figure 7 and Figure 8 show results that are statistically not significant so the results may have been due to chance.

Table 5. The average number of decayed, missing (due to decay) and filled teeth and percentage of children with decay experience in Bedford Borough LSOAs which did not have water fluoride concentration levels close to optimal levels (<0.7ppm) in 2008 and none in 2015 during the dental survey period (PROVISIONAL DATA)

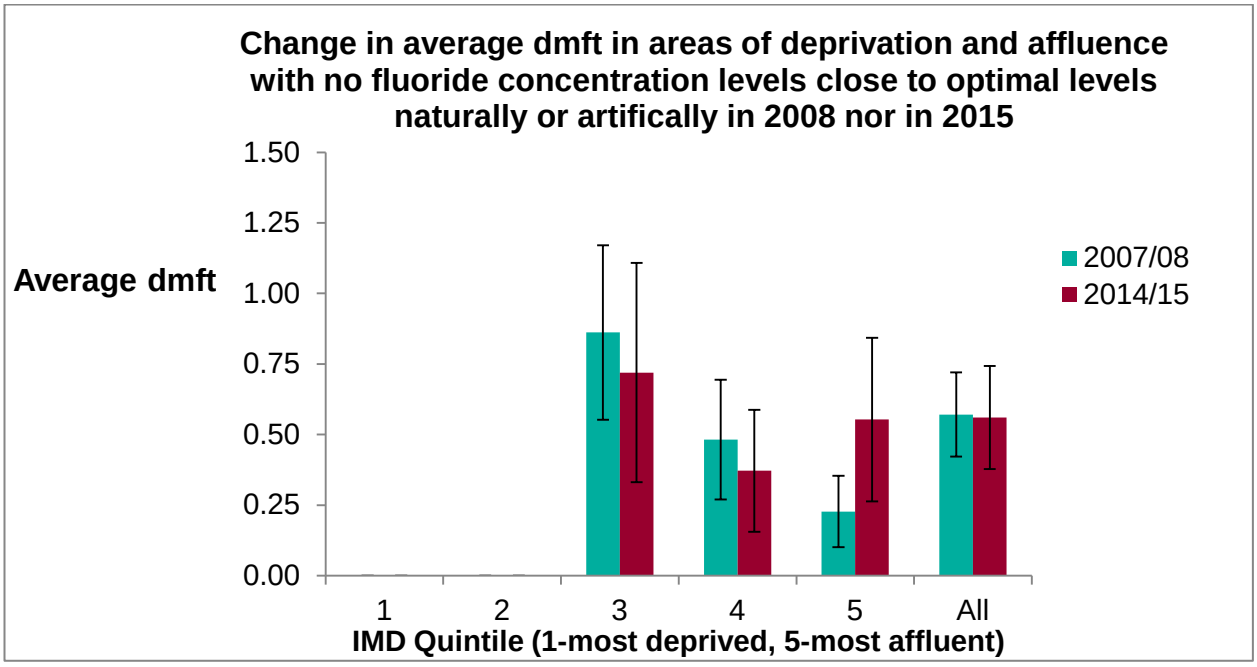
	Average dmft			% with decay experience		
IMD National Quintile	**2007/08**	**2014/15**	**P value**	**2007/08**	**2014/15**	**P value**
1 (most deprived)	-	-	-	-	-	-
2	*	*	*	*	*	*
3	0.86 (0.55, 1.17) n=152	0.72 (0.33, 1.11) n=82	0.57	23.7 (16.9, 30.4)	23.2 (14.0, 32.3)	0.93
4	0.48 (0.27, 0.69) n=141	0.37 (0.16, 0.59) n=113	0.48	18.4 (12.0, 24.8)	14.2 (7.7, 20.6)	0.36
5 (most affluent)	0.23 (0.10, 0.35) n=145	0.55 (0.26, 0.84) n=94	0.05	9.0 (4.3, 13.6)	20.2 (12.1, 28.3)	0.01
Total	0.57 (0.42, 0.72) n=438	0.56 (0.38, 0.74) n=289	0.80	18.0 (14.4, 21.7)	19.0 (14.6, 23.5)	0.56

No data collected in these areas. *Examined number of children below 20 so excluded from results table as too few in number to support valid conclusions

5.22 **Table 5** shows the change in dmft and the change in percentage of children with dental decay experience by IMD quintiles. The table shows that in some groups dental health improved from 2008 to 2015 whilst for the most affluent group, dental health worsened as shown by the increase in dmft and the increase in percentage of children with decay experience. Although the CIs do not demonstrate significance here, the P-value result for the percentage of children with decay experience living in the most affluent communities does show strong significance.

5.23 The P-value when comparing the average dmft for 2008 to that in 2015 was 0.05- this result was statistically significant. When comparing the percentage of children with experience of dental decay between 2008 and 2015 the P-value was strongly significant at 0.01.

Figure 7. Change in average dmft in Bedford Borough LSOAs with deprivation and affluence which had no water fluoridation levels provided close to optimal levels in 2008 or in 2015 during the dental survey period (PROVISIONAL DATA)



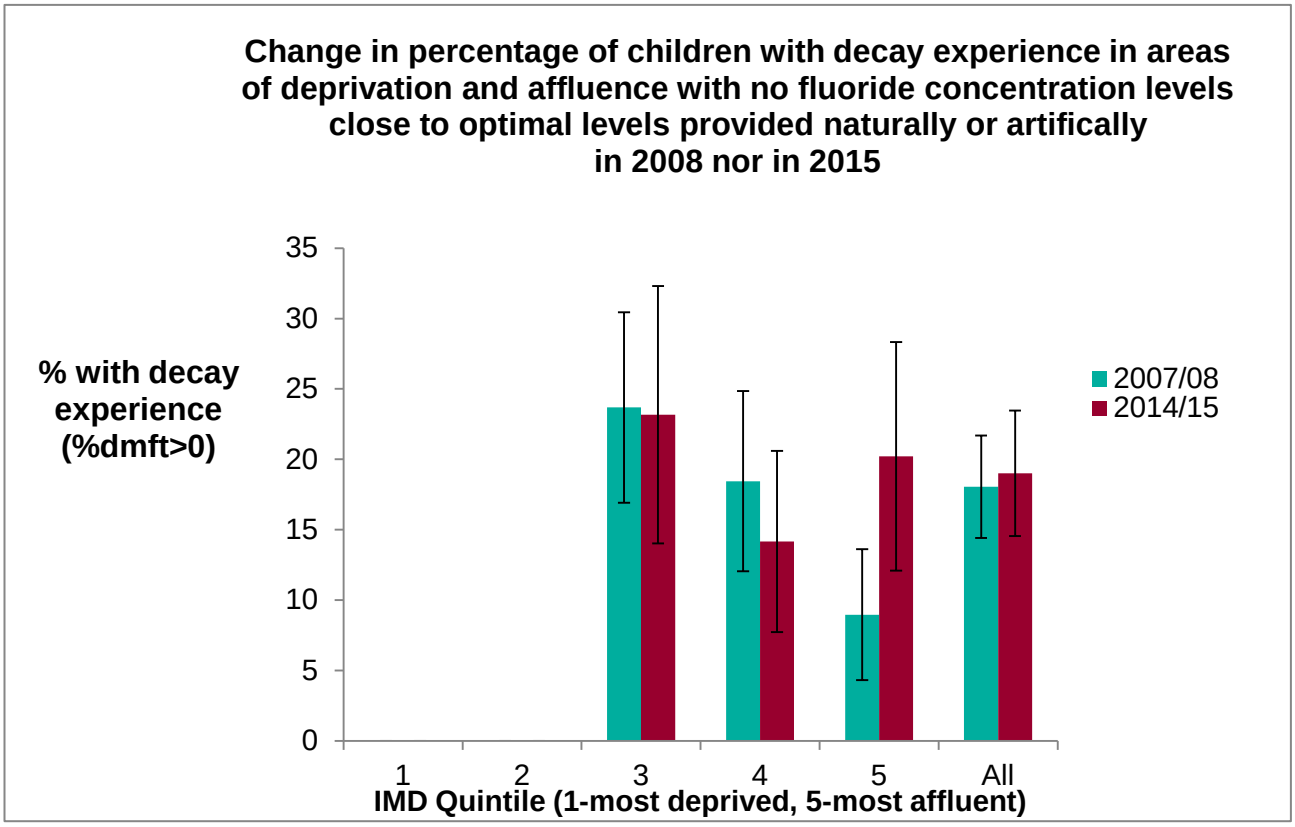


Figure 8. Change in percentage of children with experience of decay in Bedford Borough LSOAs with deprivation and affluence which had no water fluoride concentration levels close to optimal levels provided naturally or artificially in 2008 or in 2015 during the dental survey period (PROVISIONAL DATA)

5.24 **Table 5** shows the average dmft of five-year-old children and the percentage with decay experience (dmft>0) grouped by IMD quintile of LSOAs which were not fluoridated in 2008 and not fluoridated in 2015. The mean dmft overall, shows very little change in dental health between 2008 and 2015.

5.25 **Figures 7- 8** shows there was very little overall change in dmft in five-year-old children between 2008 and 2015. **Figure 8** shows the percentage change in five-year-old children who have dental decay experience in 2008 and five-year-old children in the same LSOAs in 2015 that lived in LSOAs without fluoridation during the survey period in both years. It shows a slight worsening of dental decay experience though this is very small. The change was not as marked as the change in dmft or percentage dmft in those that lived in LSOAs in 2008 with water fluoridation which was then later suspended though this was not statistically significant.

5.26 To assess the level of fluorosis in the twelve year-old population in Bedford Borough

Table 6 Perception of fluorosis (white marks) by twelve year-old children living in Bedford Borough in 2008/09

Local Authority	Examined	% said "Yes" I have white marks	% said "No" I haven't any white marks	% said "I don't know" if I have any white marks
Bedford	240	19.1	58.9	21.6

5.27 Table 6 shows the percentage of twelve year-olds living in Bedford Borough in 2009 that self-reported the presence of white marks on their teeth. Nineteen percentage of twelve year-olds perceived that they had white marks on their teeth. However the majority of children, 80%, this includes 58.9% percent of children who reported that they did not have any white marks and the 21.6% that reported that they or did not know if they had white marks on their teeth.

5.28 This shows that concern about fluorosis is very low because children either do not have it or are not concerned by it cosmetically. At twelve years old most of the permanent teeth will be present to assess whether the teeth have been affected by fluorosis as opposed to other reasons for the presence white marks of teeth, for example infection caused by dental decay in deciduous teeth.

6.0 Conclusion

6.1 There was no statistically significant change in dental health of five-year-old children between 2008 and 2015. However the data suggested that dental health deteriorated over the time period although this was not statistically significant. It was also possible to use the data to explore the difference in dental health between areas in Bedford Borough that received water fluoridation in 2008 and did not receive it in 2015. The data suggested that dental health worsened in this group however in the group of children who lived in areas that had never received water fluoridation there was little or no change in dental health.

6.2 The aims of the report in assessing the impact of water fluoridation on dental health have shown the following when comparing the dental health of five-year-olds in Bedford Borough before and after water fluoridation had been suspended that:-

6.3 To assess the impact of water fluoridation on the dental health of five-year-olds in Bedford Borough

6.3.1 The dental health (measured by obvious dental decay, missing teeth due to decay and filled teeth due to decay) deteriorated between 2008 and 2015 although this was not statistically significant.

6.3. 2 That dental health in children at greatest risk of developing dental decay (by measuring those who already had dental decay experience (i.e. dmft>0 or %dmft>0) was worse in areas where water fluoridation was suspended although this was not statistically significant.

6.4 To assess the impact of water fluoridation on the dental health of five-year-olds in areas of advantage/disadvantage in Bedford Borough

6.4. 1 When comparing the dental health of children living in different deprived and affluent communities as measured by IMD deprivation quintiles, has shown that dental health has deteriorated in all groups however this was not statistically significant.

6.5 To assess the level of fluorosis in the twelve-year-old population in Bedford Borough

6.5.1 That 20% of twelve-year-old children reported that they had white marks on their teeth.

References

[i] Pine, C.M., Pitts, N.B., Nugent, Z.J. (1997b): British Association for the Study of Community Dentistry (BASCD) guidance on the statistical aspects of training and calibration of examiners for surveys of child dental health. A BASCD co-ordinated dental epidemiology programme quality standard. Community Dental Health 14, (Supplement 1), 18-29.
[ii] Pitts, N.B., Evans, D.J., Pine, C.M. (1997): British Association for the Study of Community Dentistry (BASCD) diagnostic criteria for caries prevalence surveys – 1996/97. Community Dental Health 14: (Supplement 1), 6-9.
[iii] Pine, C.M., Pitts, N.B., Nugent, Z.J. (1997a): British Association for the Study of Community Dentistry (BASCD) guidance on sampling for surveys of child dental health. A BASCD coordinated dental epidemiology programme quality standard. Community Dental Health 14: (Supplement 1), 10-17.