FOREWORD

In 1955 the Ministry of Health stated that 1 ppm fluoride in the drinking water reduces decay by about 60 per cent and ‘that any delay in taking general and immediate steps to obtain these benefits for all the children in this country is not justified and indeed, that the Government has no right to withhold these benefits any longer...’ Nevertheless in 1975 most children in this country are being denied the benefits of fluoridated water.

In an attempt to provide more information to those interested in effectively improving dental health, the Questions and Answers originally compiled by The Fluoridation Study Group of the Society of Medical Officers of Health, has been modified and expanded by a team led by Dr Aubrey Sheiham on behalf of the British Dental Association, the Fluoridation Society and the Health Education Council.


If you are interested in improving dental health by fluoridation of the water supply in your area, contact your Area Dental Officer at the Area Health Authority or contact your Community Health Council and your Member of Parliament. You can obtain information about fluoridation from your own dentist, from The Fluoridation Society or from the British Dental Association.
## CONTENTS

<table>
<thead>
<tr>
<th>Subject</th>
<th>Question No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults, benefits to</td>
<td>4</td>
</tr>
<tr>
<td>Ages of benefit</td>
<td>1, 2, 3, 5, 6</td>
</tr>
<tr>
<td>Accuracy of addition</td>
<td>67</td>
</tr>
<tr>
<td>Adverse effects</td>
<td>32</td>
</tr>
<tr>
<td>Allergy</td>
<td>30</td>
</tr>
<tr>
<td>Alternative methods of administration</td>
<td>10</td>
</tr>
<tr>
<td>Areas in England with fluoridation</td>
<td>85</td>
</tr>
<tr>
<td>Arthritis</td>
<td>36</td>
</tr>
<tr>
<td>Attractive teeth</td>
<td>54, 56</td>
</tr>
<tr>
<td>Boiling fluoridated water</td>
<td>19</td>
</tr>
<tr>
<td>Bone, development</td>
<td>35</td>
</tr>
<tr>
<td>changes in cattle</td>
<td>16, 34</td>
</tr>
<tr>
<td>bones in soup</td>
<td>16</td>
</tr>
<tr>
<td>Bread, fluoride in</td>
<td>15</td>
</tr>
<tr>
<td>Breast-fed babies</td>
<td>17</td>
</tr>
<tr>
<td>Brewing</td>
<td>21</td>
</tr>
<tr>
<td>Bromine</td>
<td>31</td>
</tr>
<tr>
<td>Calcium, effect on absorption depriving calcium</td>
<td>22</td>
</tr>
<tr>
<td>Calcium fluoride</td>
<td>78</td>
</tr>
<tr>
<td>Cancer</td>
<td>41</td>
</tr>
<tr>
<td>Canning</td>
<td>15, 21</td>
</tr>
<tr>
<td>Cell Growth</td>
<td>51</td>
</tr>
<tr>
<td>Climate</td>
<td>14, 66</td>
</tr>
<tr>
<td>Coagulation of blood</td>
<td>49</td>
</tr>
<tr>
<td>Concentration, in water</td>
<td>14, 5, 65, 66, 69</td>
</tr>
<tr>
<td>checking</td>
<td>68</td>
</tr>
<tr>
<td>Cost of implementation</td>
<td>81</td>
</tr>
<tr>
<td>Countries with fluoridation</td>
<td>84</td>
</tr>
<tr>
<td>Cows' milk</td>
<td>17, 18</td>
</tr>
<tr>
<td>Corrosion of pipes</td>
<td>80</td>
</tr>
<tr>
<td>Death rates</td>
<td>28, 29</td>
</tr>
<tr>
<td>Defluoridation</td>
<td>82</td>
</tr>
<tr>
<td>Dental caries</td>
<td>1, 2, 3, 4, 5, 6, 8</td>
</tr>
<tr>
<td>reduction of caries</td>
<td>3</td>
</tr>
<tr>
<td>deciduous teeth</td>
<td>4</td>
</tr>
<tr>
<td>permanent teeth</td>
<td>8, 9</td>
</tr>
<tr>
<td>delay in caries</td>
<td>62</td>
</tr>
<tr>
<td>with high F levels</td>
<td>5</td>
</tr>
<tr>
<td>differences in reduction treatment times</td>
<td>6</td>
</tr>
<tr>
<td>in hard and soft water areas increases in caries</td>
<td>7</td>
</tr>
<tr>
<td>Diabetes</td>
<td>59</td>
</tr>
<tr>
<td>Enzymes, effect of fluoride</td>
<td>46</td>
</tr>
<tr>
<td>Eruption, delay in</td>
<td>50</td>
</tr>
<tr>
<td>Essential element</td>
<td>12</td>
</tr>
<tr>
<td>Expectation of life</td>
<td>28</td>
</tr>
<tr>
<td>Excretion</td>
<td>37</td>
</tr>
<tr>
<td>Extractions, teeth</td>
<td>6</td>
</tr>
<tr>
<td>Eyesight</td>
<td>44</td>
</tr>
<tr>
<td>Fillings, fluorides and</td>
<td>6, 8, 58</td>
</tr>
<tr>
<td>Fish, effects on</td>
<td>43</td>
</tr>
<tr>
<td>Fluoridation, effects on caries</td>
<td>1, 2, 3, 4, 5, 6, 8</td>
</tr>
<tr>
<td>method of concentration</td>
<td>64</td>
</tr>
<tr>
<td>hard and soft water</td>
<td>65, 66</td>
</tr>
<tr>
<td>legal aspects</td>
<td>76</td>
</tr>
<tr>
<td>cost of</td>
<td>90</td>
</tr>
<tr>
<td>financial savings</td>
<td>81</td>
</tr>
<tr>
<td>Fluoride, mode of action</td>
<td>8</td>
</tr>
<tr>
<td>natural versus artificial</td>
<td>77</td>
</tr>
<tr>
<td>in hard and soft water</td>
<td>7</td>
</tr>
<tr>
<td>prevent or delay decay</td>
<td>8</td>
</tr>
<tr>
<td>delay in eruption</td>
<td>9</td>
</tr>
<tr>
<td>topical</td>
<td>11</td>
</tr>
<tr>
<td>necessary element in foods</td>
<td>12</td>
</tr>
<tr>
<td>in drinks</td>
<td>15</td>
</tr>
<tr>
<td>intake in breast-fed babies</td>
<td>17</td>
</tr>
<tr>
<td>effect on cows' milk</td>
<td>18</td>
</tr>
<tr>
<td>effect of boiling</td>
<td>19</td>
</tr>
<tr>
<td>in tea</td>
<td>20</td>
</tr>
<tr>
<td>in canning and brewing</td>
<td>21</td>
</tr>
<tr>
<td>defluoridation</td>
<td>22, 39</td>
</tr>
<tr>
<td>in industrial pollutants</td>
<td>23, 24</td>
</tr>
<tr>
<td>is it poisonous?</td>
<td>22</td>
</tr>
<tr>
<td>toxic effects</td>
<td>26, 27</td>
</tr>
<tr>
<td>Fluorine</td>
<td>72</td>
</tr>
<tr>
<td>Food, fluoride in</td>
<td>15, 24</td>
</tr>
<tr>
<td>Freedom of individual</td>
<td>86</td>
</tr>
<tr>
<td>Gingivitis</td>
<td>60</td>
</tr>
<tr>
<td>Hemodialysis</td>
<td>43</td>
</tr>
<tr>
<td>Hemophilia</td>
<td>48</td>
</tr>
<tr>
<td>Hard water</td>
<td>7, 76</td>
</tr>
<tr>
<td>Hydrofluosilic acid</td>
<td>60</td>
</tr>
<tr>
<td>Idiopathic white spots</td>
<td>53</td>
</tr>
<tr>
<td>Industrial processes</td>
<td>23, 24</td>
</tr>
<tr>
<td>Infant foods</td>
<td>17</td>
</tr>
<tr>
<td>Irregular teeth</td>
<td>2</td>
</tr>
<tr>
<td>Kidney disease</td>
<td>42, 43</td>
</tr>
<tr>
<td>Mass medication</td>
<td>89</td>
</tr>
<tr>
<td>Metabolism, effect on</td>
<td>31</td>
</tr>
<tr>
<td>Method of adding to water</td>
<td>64</td>
</tr>
<tr>
<td>Milk, human</td>
<td>17</td>
</tr>
<tr>
<td>Mode of action</td>
<td>2</td>
</tr>
<tr>
<td>Mongolism</td>
<td>40</td>
</tr>
<tr>
<td>Mottling</td>
<td>52, 53, 54, 55</td>
</tr>
<tr>
<td>Grades of Osteoporosis</td>
<td>55</td>
</tr>
<tr>
<td>Over-fluoridation of a town</td>
<td>38</td>
</tr>
<tr>
<td>Peptic ulcers</td>
<td>47</td>
</tr>
<tr>
<td>Periodontal disease</td>
<td>60</td>
</tr>
<tr>
<td>Placenta, concentration in</td>
<td>39</td>
</tr>
<tr>
<td>Poisoning</td>
<td>25, 26</td>
</tr>
<tr>
<td>Pollution, industrial</td>
<td>23, 24</td>
</tr>
<tr>
<td>is F a pollutant?</td>
<td>88</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>39</td>
</tr>
<tr>
<td>Pure water</td>
<td>74</td>
</tr>
<tr>
<td>Safety of fluoridation</td>
<td>52</td>
</tr>
<tr>
<td>Sniff</td>
<td>83</td>
</tr>
<tr>
<td>Sodium fluoride</td>
<td>70, 71</td>
</tr>
<tr>
<td>Sodium silicofluoride</td>
<td>70</td>
</tr>
<tr>
<td>Soft Water</td>
<td>7</td>
</tr>
<tr>
<td>Soup</td>
<td>15, 16</td>
</tr>
<tr>
<td>Still births</td>
<td>39</td>
</tr>
<tr>
<td>Tablets, fluoride</td>
<td>10</td>
</tr>
<tr>
<td>Taste</td>
<td>83</td>
</tr>
<tr>
<td>Tea</td>
<td>15, 20</td>
</tr>
<tr>
<td>Temperature</td>
<td>66</td>
</tr>
<tr>
<td>Third molars</td>
<td>61</td>
</tr>
<tr>
<td>Tissue culture</td>
<td>51</td>
</tr>
<tr>
<td>Toothpaste</td>
<td>10, 11</td>
</tr>
<tr>
<td>in fluoridated areas</td>
<td>11</td>
</tr>
<tr>
<td>Topical fluoride</td>
<td>10</td>
</tr>
<tr>
<td>Toxic effects</td>
<td>25, 26, 27, 79</td>
</tr>
<tr>
<td>Water, suitable for public</td>
<td>75</td>
</tr>
<tr>
<td>Waterworks staff</td>
<td>73</td>
</tr>
<tr>
<td>Wholesome water</td>
<td>87</td>
</tr>
</tbody>
</table>
FLUORIDATION OF WATER SUPPLIES

QUESTIONS AND ANSWERS

BENEFICIAL EFFECTS OF FLUORIDE

1. Q. Has it been shown conclusively that fluoride in drinking water really does reduce the incidence of dental decay?

A. Yes. This is no longer in doubt. Studies by H. Trendley Dean¹ and his collaborators, of 7,257 white children aged 12 to 14 years in 21 cities in four states in the United States of America showed an inverse relationship between the fluoride content of the drinking water and the incidence of dental caries. In the low-fluoride areas dental caries rates were high, but dropped rapidly as the fluoride concentration in the water rose until about one part per million (1 ppm) was reached, after which there was little further improvement. A study by Forrest² in this country, though on a smaller scale, gave similar results. In a further study in Birmingham, after 5½ years of fluoridation there was a reduction of 62.4 per cent in the mean number of decayed extracted or filled deciduous teeth in 5-year-old children. In fluoridated Anglesey 5-year-old children had 38 per cent fewer attacked teeth and 47 per cent fewer attacked tooth sites than had the control children: 15-year-old Anglesey children had 44 per cent fewer attacked teeth and 48 per cent fewer attacked sites on teeth than the control children. Attacked sites on the approximal surfaces of permanent incisors were 85 per cent fewer in Anglesey³. The References of further confirmatory studies in this and other countries are given below:

References
1 Dean, H. T. et al. (1942) US Public Health Reps., 57, 1155.
11 The Fluoridation Studies in the United Kingdom and results achieved after eleven years (1969) H.M.S.O.

2. Q. How does fluoride bring about a reduction in the incidence of dental caries?

A. Although there is decisive evidence that fluoride is effective in reducing the incidence of caries, its mode of action is not so clear cut. It may work in several ways.

(1) There is considerable evidence that the solubility of enamel in acids can be substantially reduced in vitro by increasing its fluoride content. There is also a small but consistent tendency for enamel receiving extra fluoride during its formation to be less soluble in acids¹.

(2) It is believed that the progress of caries depends on the relative rates of enamel demineralisation and remineralisation. The effectiveness of fluoride may lie in its ability to reprecipitate the dissolved calcium and phosphate in the form of apatite. Consequently, the higher the concentration of fluoride in the vicinity of the initial caries lesion, the greater the tendency for remineralisation to occur so that the progress of caries is retarded or arrested³.

(3) There is evidence that fluoride may exert an effect directly on plaque by reducing the ability of plaque bacteria to form acid and to store sugars in the form of polysaccharides or by changing the microbial composition of plaque³.

References
3. **What are the reductions in the numbers of deciduous decayed teeth in fluoridated areas?**

A. In the studies of fluoridated towns the reductions in the numbers of decayed deciduous teeth varied for the following reasons. First, the length of time that children drank fluoridated water differed from one study to another. Second, the methods used to detect decay differed; in some studies radiographs, which detect more decay, were used whilst others did not. Third, the level of dental disease varied from one country to another.

In a report for the World Health Organisation, which summarised the results of all the available publications on the effect of water fluoridation on deciduous teeth, children in fluoridated areas had the following numbers of fewer decayed teeth after fluoridation:

<table>
<thead>
<tr>
<th>Age</th>
<th>Fewer Decayed Teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2.7 to 1.1</td>
</tr>
<tr>
<td>4</td>
<td>3.5 to 2.1</td>
</tr>
<tr>
<td>5</td>
<td>4.3 to 2.5</td>
</tr>
<tr>
<td>6</td>
<td>4.5 to 3.2</td>
</tr>
<tr>
<td>7</td>
<td>3.7 to 3.0</td>
</tr>
<tr>
<td>8-10</td>
<td>2.6 to 0.5</td>
</tr>
</tbody>
</table>

The smaller reductions after the age of 6 are to be expected because children’s deciduous teeth are replaced by permanent ones after that age. Therefore there are fewer deciduous teeth in the mouth of 7 compared to 6-year-olds.

These reductions mean, for example, that instead of averaging 2.7 decayed, missing or filled deciduous teeth before the introduction of fluoridation in Watford as part of the United Kingdom Fluoridation Studies, the average 3-year-old had only 0.6 teeth affected after fluoridation. In the 4-year-old Watford children instead of 3.6 deciduous teeth being affected by decay there were 1.3 after fluoridation. 5-year-olds had 5.4 teeth affected before and 1.6 after fluoridation.

The findings from Watford have been confirmed by Beal and James in Birmingham. They found that Birmingham 5½-year-olds had 5.2 deciduous teeth affected by decay before fluoridation whereas only 1.9 teeth were affected after fluoridation.

The percentage reductions were 77 per cent at 3 years of age in Watford, 63 per cent at 4 years, 70 per cent at 5 and 58 per cent at 7 years. In Birmingham at 5½ years the reduction was 62.4 per cent. There were also reductions in the overall percentages of children who suffered from decay. In Watford seven year olds, the percentages before and after fluoridation with decay were 92 per cent and 54 per cent respectively. In Birmingham 93 per cent had deciduous teeth affected by decay before fluoridation and 53 per cent after fluoridation. A further measure of the effectiveness of fluoridation is the percentage of children with 10 or more teeth affected by decay. In Watford the percentage was reduced from 10 per cent to zero in five-year-old children, whilst in Birmingham there were only 1.5 per cent after fluoridation compared with 30.4 per cent before.

**References**


4. **What are the reductions in the numbers of decayed permanent teeth in fluoridated areas?**

A. Absolute reductions in the number of decayed permanent teeth in children with lifelong exposure to fluoridated water vary from 1.2 to 0.6 at age 6; from 2.0 to 0.3 at age 7; from 2.5 to 0.9 at age 8; from 2.4 to 1.3 at age 9; from 3.0 to 1.3 at 10; from 3.4 to 0.8 at 11 and from 4.6 at age 12 to 6.3 at age 16. (For reasons for variation see Question 5.) The United Kingdom studies reported that in 8-year-olds instead of 2.4 permanent teeth affected in Watford before fluoridation 1.1 were affected after fluoridation. At 10 years of age the teeth affected in Watford before and after fluoridation were 3.6 and 2.0 respectively, at 11 the numbers were 4.6 compared to 3.0 at 12 years, 5.6 compared to 3.5 and at 14 years 8.4 compared to 5.8. The percentage of children with dental decay was reduced from 80 per cent before fluoridation to 47 per cent after fluoridation in Watford 8-year-olds. Recently Jackson, James and Wolfe have reported that the mean number of decayed, missing and filled teeth in 15-year-old Anglesey children (fluoridated) was 6.4 compared to 11.4 in children from the neighbouring mainland which had low fluoride.
—a 44 per cent difference. Children living in the fluoridated area had one-third the number of teeth extracted compared to the children living in an unfluoridated area: 0·6 compared to 1·8 per child.

A single tooth can develop more than one cavity. Children in fluoridated areas have a greater degree of protection from decay on the sides of teeth (approximal and bucco-lingual surfaces) than on the biting surfaces (pit and fissure surfaces). In 15-year-olds, the total savings were 22 surfaces per child in Hastings, New Zealand, made up of 6 pit and fissure surfaces, 12 approximal surfaces and 4 bucco-lingual surfaces. In Tilburg, The Netherlands, the saving was 15 surfaces per child. In the Anglesey study the mean number of tooth surfaces attacked by decay was 7·96 in 15-year-olds compared to 14·67 in the non-fluoridated area, a difference of 7·11 sites per child. In Anglesey only 4·2 per cent of incisor teeth were decayed compared to 23·0 per cent in the non-fluoridated areas.

References

5. Q. Why do the percentage reductions in dental caries differ by age?

A. Fluoride has its maximum effect on the teeth if it is available to an individual from birth, right through childhood, and into adult life. In early years, during the development and calcification of the teeth the fluoride is incorporated into their substance, giving a lifelong protection. After eruption of the teeth into the mouth the fluoride in the water continues to give some small additional benefit by its direct action on all the tooth surfaces. So a person who is born and spends all his childhood and adult life in an area where the water contains an optimum level of fluoride is the best protected; but at present this sort of person does not exist in artificially fluoridated districts as no fluoridation programme has run for more than thirty years. It is interesting and relevant to consider the reduction in dental caries that can be demonstrated following the introduction of water fluoridation. This reduction depends on two main factors: first the age of each individual living in the community when the water was fluoridated. Everybody, child or adult, who has teeth in the mouth will have some immediate benefit from the topical effect of the fluoride on their tooth surface; this effect, although significant in preventing decay and in slowing down the rate of existing decay, is a small one. As already stated the maximum benefit will be to those who are newborn at the time of water fluoridation. So if a community had its water treated in 1970, one would expect to wait until 1974 before demonstrating the full effect on 3-year-old children, 1977 for 6-year-olds and so on. As the age groups are examined in successive years after the water treatment it is evident that the amount of demonstrable reduction in caries due to the fluoride fluctuates at different ages. This is because some tooth surfaces derive more benefit from fluoride than others, and this is the second factor affecting the improvement that can be expected. The smooth surfaces are better protected against dental caries than the fissures, in chewing surfaces of the cheek teeth. So the total reduction in dental caries due to fluoride is dependent on the type of tooth surfaces at risk at different ages, and during childhood the dentition is continuously changing. Some practical examples of the dental state of children at different ages will make this point clearer.

The full deciduous dentition is present in the mouth of the child at the age of three years. The clinical dental caries problem, by virtue of the anatomy of the deciduous teeth is a smooth surface one, taking the form of decay at the point where the tooth touches its neighbour. Because of the greater protection by fluoride of smooth tooth surfaces, the reduction in decay at this age is often very considerable, sometimes as high as 60 or 70 per cent.

After the age of about 8 years the situation becomes complicated by the change from the primary teeth to the permanent teeth. The ages at which primary teeth are shed are very variable; the evidence on 'decayed' or 'not decayed' primary teeth is lost and statistical interpretation of clinical trials on the primary dentition becomes unreliable. So after this age attention must be concentrated on the permanent teeth. At first these are few in number. In 9 year children the permanent dentition is probably represented only by the four first permanent molar teeth and eight permanent incisors. The clinical problem of dental caries at this age for these teeth is completely different from that previously described in the primary dentition. In Britain there is very little decay in incisor teeth at this age, and by contrast many first permanent molars are affected by caries on their fissured occlusal surface, which is the type of surface less well protected by the fluoride. So study of the effects of fluoride on the permanent teeth of children between the ages of approximately 8 to 12 years shows a reduced benefit varying between approximately 20 per cent and 50 per cent.
Variations between reductions in different areas and different countries are due to such factors as the local dental caries rate, whether the incisors or smooth surfaces of first permanent molars are generally attacked by that age in that particular district; and the availability of dental services in the area.

After the age of approximately 11 to 12 years, many permanent teeth erupt into the mouth: four more molars, eight premolars and four canine teeth. Now the second dentition is complete except for the wisdom teeth and once again the most serious clinical dental problem is smooth surface caries. Fissure caries occurs in addition but filling these cavities is relatively simple. The smooth surfaces are better protected by the fluoride and the benefits again become readily demonstrable.

It is evident that the dynamic nature of the dentition during childhood, the varied degree of resistance to decay in different tooth sites, and the different levels of availability and acceptance of dental treatment make the assessment and interpretation of the effects of fluoride in the water a complicated problem.

A further factor accounts for the variations in the percentage reduction. That is the number of teeth in the mouth. It is probable that the percentage reduction will decrease as the number of teeth erupted increases. For example, a difference between 2 and 1 carious teeth is a 50 per cent difference whereas a difference between 20 and 12 teeth decayed is only 40 per cent.

References

6. Q. Do children living in fluoridated areas require fewer dental fillings and tooth extractions than children in unfluoridated areas?

A. Yes. Studies in the United States\(^1\), New Zealand\(^2\) The Netherlands\(^3\) and Great Britain\(^4\), \(^5\) have shown that fewer teeth were filled or extracted in fluoridated areas than in low-fluoride areas. In the US study\(^1\) 41 per cent of 5 and 6-year-old children in the fluoride town had no decay experience compared with 17 per cent in the control low-fluoride town. These latter children required twice as many corrective dental services as the children in the fluoride area. In addition more of the fillings they required were larger; 75 per cent were compound fillings compared to 55 per cent in the fluoride town. At both ages 5 and 6 there were twice as many deciduous tooth extractions required per child in the low-fluoride compared to the fluoride town. The time in the dentist’s chair was 1 ½ times as long for the low-fluoride children\(^1\). In New Zealand after 10 years of fluoridation children aged 2½ to 3½ years had on average 2·64 fillings per child and 6 teeth extracted per 100 children compared to 5·10 fillings per child and 16 extracted teeth per 100 children in the low-fluoride areas. Because of the reduction in treatment required in fluoridated areas one dental operator could now treat 690 compared to 439 children\(^2\). In the Netherlands after 16 years of fluoridation children aged 15 years had on average 14 fewer cavities than children in the low-fluoride control town and children in the low-fluoride town had 132 more teeth per hundred children extracted than the children in the fluoridated town\(^3\). A study in fluoridated Birmingham reported that whereas 47 per cent of 5-year-olds in that city were free of dental decay, only 24 per cent of 5-year-olds in non-fluoridated Dudley were in a similar state. Birmingham children had 1·9 decayed deciduous teeth in 1970 compared to 5·09 in Dudley. In addition, in Dudley 90 teeth were extracted per 100 children compared to only 4 per 100 in Birmingham\(^4\). In Hartlepool, a natural fluoride area (F 1·5-2·0 ppm) 5-year-olds had 1·5 teeth which had been attacked by caries compared to 4·1 in York (F 0·15-0·25 ppm). Half the Hartlepool children had no decay at all (51·2 per cent) whereas less than a quarter of York children were caries free. In 15-year-old Hartlepool children only 5·0 permanent teeth had been attacked compared to 9·0 in York. Twice as many permanent molars had been extracted by the age of 15 years in York compared with Hartlepool children. In adults aged 45 years and over there was a 44 per cent difference in the number of tooth sites attacked demonstrating that fluoride in drinking water produces substantial lifelong benefits\(^5\).

References
3 Kirant, G. W., et al. (1973) Netherlands Dent. J., 80, Suppl. 9.
7. Q. Is fluoride equally effective in hard and soft waters?

A. Hardness of water does not appear to reduce the effectiveness of fluoride. Dean\(^1\) reported on data obtained from dental caries studies in 21 cities in the USA with differing concentrations of fluoride and differing degrees of hardness in the water. For instance, Colorado Springs a soft water area (2.6 ppm of fluoride and 27 ppm of total hardness) and Elmhurst, a hard water area (1.8 ppm F and 323 ppm of total hardness) had average DMF counts at age 12 to 14 years of 2.46 and 2.52 respectively.

In this country Forrest\(^2\) demonstrated a high resistance to dental caries in West Mersea (5.8 ppm F) and Burnham-on-Crouch (3.5 ppm F) both with relatively soft waters, 70 and 60 ppm of total hardness respectively (figures from British Waterworks Year Book 1962). Weaver\(^3\) at West Hartlepool (2 ppm of fluoride and 390 ppm of total hardness) found an average DMF at age 12 of 0.96 and the percentage free from dental caries, 59.8 per cent. A recent report gave details of fluoride content and hardness of water supplied to 34 different areas in England and confirmed that fluoride concentrations in excess of 1.5 ppm occurred in both hard and soft waters\(^4\).

Further confirmation that the hardness of the drinking water has no influence on caries experience and that fluorides added to drinking water give the same benefit irrespective of water hardness, has been presented by Jackson et al.\(^5\) They found reductions in caries after fluoridation in Anglesey which has relatively hard water and Cockermouth and Workington with very soft water.

References


8. Q. Does fluoride really prevent decay and not merely postpone its onset?

A. There is considerable evidence that fluoride taken systemically prevents decay rather than postpones its onset. The evidence to support this is as follows:

First, the original observations and studies by Dean\(^1\)\(^-\)\(^2\) which first drew attention to fluoride as a possible preventive agent in dental decay. He examined 7,257 children aged 14 years in 21 cities which had varying amounts of fluoride in the drinking water. This study showed that the amount of decay fell sharply as the amount of fluoride in the water increased from 0.0 to 1.0 ppm.

Second, numerous controlled fluoridation studies have been conducted and these have been reported to produce similar results to those obtained in areas where fluoride occurs naturally. The study\(^8\) conducted in The Netherlands illustrates the levels of prevention obtained. In that study, groups of children were examined each year so that the effect on each individual could be monitored. Over the 16 years of the study, children in each age group in the low-fluoride town had an increase in decayed teeth whilst in the fluoridated town there was a decrease. There were 563 approximal cavities per 100 children in the low-fluoride compared to 140 per 100 in the fluoridated town, a difference of 75 per cent. The numbers of approximal cavities per child in molars and maxillary anterior teeth in the low-fluoride and fluoridated towns are given for each age when the children were examined.

<table>
<thead>
<tr>
<th>Age</th>
<th>Fluoride town</th>
<th>Low-fluoride town</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of cavities</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>0.2</td>
<td>1.1</td>
</tr>
<tr>
<td>11</td>
<td>0.8</td>
<td>2.9</td>
</tr>
<tr>
<td>13</td>
<td>1.2</td>
<td>6.1</td>
</tr>
<tr>
<td>14</td>
<td>1.7</td>
<td>7.7</td>
</tr>
<tr>
<td>15</td>
<td>2.3</td>
<td>9.7</td>
</tr>
</tbody>
</table>

The children in the fluoridated towns were getting new cavities at the rate of 0.4 per year compared to 1.7 per year in the low-fluoridated towns\(^5\). Supposing that fluoride did only delay the decay, if the rate
continued at 0.4 per year then it would take 70 years for all the approximal surfaces to become decayed; a situation which does not in fact arise.

Russell has shown that in adults aged 25-34 living in a fluoridated area caries inhibition persisted on the smooth approximal surfaces of teeth. He found, for example, that whereas 40 per cent of all tooth surfaces at risk had been attacked in the non-fluoride town only 4 per cent had been in the fluoride town.

Third, it is obvious from the studies cited that the preventive capacity of fluoride persists into adulthood. Further evidence to support this will be given. Russell and Elvove compared 385 adults, aged 18-44 years, who had drunk water containing 2.5 ppm fluoride all their lives, with a similar group of adults from a nearby low-fluoride town. There were 66 per cent fewer decayed, missing or filled teeth, for each age group in the fluoride rich town. Deatherage and found less decay in American servicemen aged 25 years who had lived in fluoride communities than in those who had lived in fluoride deficient communities. McKay observed low dental caries experience and tooth loss in adults with dental fluorosis and Englander and Wallace found that adults aged 18-59 years living in a town with 1-2 ppm fluoride had 10 decayed missing or filled teeth compared to 17 adults from a fluoride free town. The authors concluded that ‘This study provides additional evidence that the low dental caries experience of children who consume water containing approximately 1 ppm of fluoride almost continuously from birth persists during adult life.’ This conclusion is supported by a large study carried out in the natural fluoride areas of Hartlepool (1.5-2.0 ppm F) and the low fluoride area of York (0.15-0.28 ppm F). Adults in Hartlepool aged 15 to 65 years had less decay experience for all age groups than adults in York.

Fourth, the cost of dental treatment is consistently lower in fluoridated areas. For example, in Wisconsin, the average cost of dental care for children from birth to 14 years before fluoridation was $172.32 per child. After 20 years of fluoridation the average cost was $46.39 representing a saving of $124.93 per child. After totalling the costs of fluoridation the State Board of Health calculated that the savings represented a return of $55.77 for each $1 invested. Part of the savings was on salaries of dentists or dental auxiliaries. In the New Zealand study reported by Davies, instead of 8 dental auxiliaries in a non-fluoridated area a comparable fluoridated area required 5.5. Because of this reduced need for dental auxiliaries after fluoridation fewer auxiliaries are being trained in New Zealand. In addition their training has changed because they no longer need to extract teeth in children. In the United States, Frank et al. have reported that it took only one-third to one-quarter of the time of dentists to treat children from fluoridated areas compared to non-fluoridated areas. In the non-fluoridated Kingston, Ast et al. found

![Proximal Cavities](image-url)
that the chair time to examine and treat children was 1½ times more than in fluoridated Newburgh. The cost of treatment was less than half in the fluoridated city. Douglas et al. compared the numbers of patients treated by 278 dentists in 15 communities which were paired by absence or presence of optimal fluoride. They found that dentists in fluoridated communities treated a substantially larger number of patients than dentists in non-fluoridated towns—14·5 per cent more.

In Karl Marx Stadt prior to the introduction of fluoridation 15-8 dentists were required to care for 19,000 children aged 3-18 years; 1 dentist to 1,200. After 8 years of fluoridation only 9-4 dentists were required—a rate of 1 dentist to 2,700 children.

Some opponents of fluoridation have distorted statistical data in an attempt to show that decay is delayed a few years at most and benefits of fluoride do not last into adulthood. An example of such an approach is the comparison of statistics on decay in older children who have used fluoridated water only part of their lives, with data on younger children who have benefited from fluoride since birth. Naturally the older children show a greater rate of decay. Information given here demonstrates the fallacy of their argument.

References
2 Dean, H. J., (1942) Ibid., 57, 1155.
3 Kwant, G. W., et al. (1973) Netherlands Dent. J., 80, Suppl. 9.
7 Deatherage, C. F. (1943) Ibid., 22, 173.

9. Q. Can the effect of fluoride in reducing tooth decay be explained by delays in eruption?

A. Whether there is a real delay in eruption in fluoridated areas or a relatively early eruption in non-fluoridated communities (due to early extractions or shedding of decayed deciduous teeth) is difficult to decide. However, detailed statistical analysis has indicated that this is not an important cause for the caries reduction in fluoridated areas.

Fluoridation does not retard the eruption of deciduous teeth. In naturally fluoridated areas some authors have found a negative correlation between the number of erupted teeth and the fluoride content of drinking water, while others did not find such a correlation. In a number of studies a non-significant delay in eruption of teeth was observed after the beginning of water fluoridation but in other studies the reverse was found. The data from the well documented Tiel-Culemborg study gives support to the contention that fluoridation does not retard tooth eruption to an extent which will affect the interpretation of the beneficial effects of fluorides on dental health. In addition, delays in eruption could not possibly explain reductions in caries in middle aged people.

References
8 Kwant, G. W., et al. (1973) Netherlands Dent. J., 80, Suppl. 9.
10. **Q. Is fluoridation the only successful method of reducing dental caries?**

A. Fluoridation of the public water supplies is the most successful public health method of reducing decay, but other methods are available. These have been critically analysed by a World Health Organisation Scientific Group.

  School Water Fluoridation. This is a safe and effective procedure that should only be recommended where children are provided with regular meals at school and when maintenance of equipment and of fluoride levels can be properly controlled.

  Fluoride tablets. The regular administration of soluble fluoride tablets is an effective method of caries prevention in children. However, when it is used within the family, its success depends upon a high degree of parental responsibility and persistence.

  Fluoride mouthrinses. Provided the school authorities co-operate, mouthrinsing can be recommended. The application of fluoride gels or solutions is a procedure to be recommended in cases of high susceptibility to caries.

  Fluoride toothpastes. Clinical trials have consistently shown that regular use of some properly formulated preparations is an effective preventive measure.

  Advice on diet. Studies have established that the incidence of caries can be diminished by reducing the frequency of sugar consumption. Where dietary counselling is practicable, emphasis should be laid on the underrating of taking fermentable carbohydrates such as sugar-containing snacks, sweets and drinks frequently between meals.

**Reference**


11. **Q. Is it safe to use fluoridated toothpaste or other topical fluorides if the water is fluoridated, and does a fluoridated toothpaste influence tooth decay when the fluoride is also being received from the water?**

A. Numerous studies have shown that the amount of fluoride retained by children or adults from fluoride toothpastes is small and therefore it is safe for children aged six and over to use them in fluoridated areas.

  At a recent symposium on Fluorides and Dental Caries Reductions it was concluded that '... the use of fluoride rinses by individuals age 6 and above, whether they reside in an optimally water fluoridated or non-fluoridated community, can be safely recommended' (p. 171).

  Topically applied fluorides, including fluorides in toothpaste, do influence tooth decay when fluoride is being obtained from the water. At the symposium mentioned earlier, the Committee agreed that topical application of fluoride should be included in practising dentists' caries control practice in fluoridated communities and that the use of such treatment should be based on each patient's needs.

**References**


**INGESTION OF FLUORIDE**

12. **Q. Are fluorides necessary to the human body?**

A. It is impossible to carry out total deprivation tests on man, because nearly all foods contain some fluoride. Animal experiments in which diets are very low in fluoride have suggested that this element is essential for life, though this question has not been finally settled. There is evidence that at least some fluoride is necessary for the formation of the crystals (hydroxapatite) normally present in bones and teeth.

  The World Health Organisation has classified fluorine as one of the 14 trace elements which are believed to be essential for animal life.

**References**


13. Q. How many milligrams of fluoride are there in one litre of water with 1 ppm fluoride?
A. There is 1 milligram fluoride in a litre of water with 1 ppm fluoride.

14. Q. How will each person receive the appropriate amount of fluoride when each drinks differing amounts from the same source of water having a given concentration in parts per million fluoride?
A. In calculating the optimal level of fluoride in the water to prevent dental decay, individual variations in water and food consumption were taken into account, and a fair margin of safety was allowed. It was found that the amount of water required by an individual depends on body size and weight, kind of food eaten, habit patterns and physical activity. The external factors such as climatic factors particularly mean annual temperatures, excessive daytime temperatures, radiant heat gain, relative humidity and wind movements were of the greatest importance. Studies using the formula derived by Galagan and Vermillion\(^1\) have found that the water intake of individuals falls between a limited range and therefore the fluoride consumption is reasonably stable\(^2\).

References

15. Q. How much fluoride is found in common foods and drinks in fluoridated areas?
A. Almost every known food and water supply contain traces of fluoride\(^1\), \(^2\), \(^3\), \(^4\), \(^6\). The following fluoride values were for food cooked at a hospital in a fluoridated city\(^4\).

<table>
<thead>
<tr>
<th>Food item</th>
<th>Average</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roast Beef</td>
<td>0.55</td>
<td>0.22-0.96</td>
</tr>
<tr>
<td>Chicken Broth</td>
<td>0.76</td>
<td>0.55-1.04</td>
</tr>
<tr>
<td>Chicken Thigh</td>
<td>0.32</td>
<td>0.16-0.48</td>
</tr>
<tr>
<td>Beef Broth</td>
<td>1.22</td>
<td>1.04-1.48</td>
</tr>
<tr>
<td>Bread</td>
<td>1.12</td>
<td>0.75-1.38</td>
</tr>
<tr>
<td>Potatoes</td>
<td>0.60</td>
<td>0.32-0.95</td>
</tr>
<tr>
<td>Rice</td>
<td>1.14</td>
<td>0.90-1.67</td>
</tr>
<tr>
<td>Spaghetti</td>
<td>1.50</td>
<td>1.22-1.82</td>
</tr>
<tr>
<td>Canned Peas</td>
<td>0.86</td>
<td>0.34-2.02</td>
</tr>
<tr>
<td>Canned Carrots</td>
<td>0.59</td>
<td>0.24-1.07</td>
</tr>
<tr>
<td>Canned Green Beans</td>
<td>0.43</td>
<td>0.32-0.72</td>
</tr>
<tr>
<td>Canned Tomatoes</td>
<td>0.46</td>
<td>0.14-0.63</td>
</tr>
<tr>
<td>Canned Pears</td>
<td>0.77</td>
<td>0.48-1.11</td>
</tr>
<tr>
<td>Canned Apple Juice</td>
<td>0.77</td>
<td>0.44-1.15</td>
</tr>
<tr>
<td>Canned Orange Juice</td>
<td>0.40</td>
<td>0.21-0.76</td>
</tr>
<tr>
<td>Brewed Coffee</td>
<td>0.98</td>
<td>0.80-1.19</td>
</tr>
<tr>
<td>Brewed Tea</td>
<td>2.18</td>
<td>1.90-2.78</td>
</tr>
</tbody>
</table>

If one lived in a fluoridated area and were to eat the diet listed below the total fluoride consumed would be 1.96 ±0.48 mgs F/day; 0.65 mgs for breakfast; 0.75 mgs for lunch and 0.57 mgs for supper.

<table>
<thead>
<tr>
<th>Meal</th>
<th>Food item</th>
<th>g or ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>Fruit Juice</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Eggs</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Bacon</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Sweet Roll</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>Toast</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Butter</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Cornflakes</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Cream</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Sugar</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Milk</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>Coffee</td>
<td>200</td>
</tr>
<tr>
<td>Meal</td>
<td>Food item</td>
<td>Amount of food</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
<td>----------------</td>
</tr>
<tr>
<td>Lunch</td>
<td>Apple Juice</td>
<td>120 g or ml</td>
</tr>
<tr>
<td></td>
<td>Beef Stew</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>Strawberries</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Bread</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Butter</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Cream</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Sugar</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Milk</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>Coffee</td>
<td>200</td>
</tr>
<tr>
<td>Supper</td>
<td>Roast Beef</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Potatoes</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Gravy</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Peas</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Cherry Pie</td>
<td>160</td>
</tr>
<tr>
<td></td>
<td>Bread</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Butter</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Sugar</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Milk</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>Coffee</td>
<td>200</td>
</tr>
</tbody>
</table>

When the daily fluoride intake from food before and after fluoridation were compared the pre-fluoride levels were on average 0·86 mgs F (range 0·73-0·94 mgs) compared to 1·96 mgs F (range 1·23-2·41 mgs) after fluoridation.

References

16. Q. Would soup made from bones with an abnormally high fluoride content also have a high fluoride content?

A. Assuming a high daily intake of 15 gallons of water containing 1 ppm of fluoride by a lactating cow over a period of several years, a significant increase in the bone/fluoride content is unlikely. On such a water intake an average cow weighing 500 kg (about 10 cwt) would receive approximately 0·14 mg of fluoride per kg of body weight per day. The results of a number of long-term feeding trials with sodium fluoride indicate that fluoride intakes of from 1·6 mg/kg/day or more are required to raise the bone/fluoride content from the normal bovine range of 500-1,000 ppm to 4,000 ppm, the threshold value at which skeletal damage is likely to occur.

A bovine bone with a particularly high fluoride content of about 20,000 ppm of fluoride was boiled for 48 hours in water as in the preparation of soup stock. The resulting stock was found to contain less than 1 ppm of fluoride.

References

17. Q. What is the difference in the fluoride intake between the breast-fed baby and the one that is given an infant formula? Does the mother who has been drinking fluoridated water secrete milk of the same fluoride concentration as is present in the water she drinks?

A. The concentrations in foods made from dried milk plus fluoridated water depend upon the relative proportions of water and solids used, but would be about ten times that of breast milk.

The mother who is drinking fluoridated water does not secrete milk of the same fluoride concentration as is present in the water she drinks. The fluoride content of her milk is considerably less than one-tenth.
of the concentration in her drinking water, when this contains one or more parts per million of fluoride. It has been found that the concentration of fluoride in breast milk was 0.046 ppm in a town with 0.1 ppm F and 0.052 in a fluoridated town. There appears to be no special mechanism in the breast for the provision of a special supply of fluoride to the child; the concentrations in breast milk probably merely reflect the concentrations in the mother's blood. The amounts of fluoride in the body of the newborn child may be sufficient for any needs of tooth development during the suckling period.

References

18. Q. Does fluoride in the water have any effect on cow's milk?
A. The concentration of fluoride in milk is small, varying between 0.09-0.28 ppm F. This concentration is not altered significantly by changes in the amount of fluoride consumed by the cow, either in its food or drink. Even if an excessive amount of fluoride is consumed, the fluoride content of the milk is not increased very much. Backer Dirks et al. have found that milk from cows in ordinary pastures was 0.103 ppm (twice as high as human breast milk) whilst cows feeding in heavily contaminated pastures had 0.283 ppm F.

Reference

19. Q. Does boiling water increase the concentration of fluoride?
A. Boiling water away increases the concentration. But water from a public service supply is not normally boiled for drinking as plain water. One of the commonest uses to which boiling water is put is tea-making, but here the golden rule is to bring the water up to the boil only. This holds good for most beverage-making. On the other hand, some of the water used for cooking purposes for example, vegetables, may boil away, and this increases the concentration of any fluoride proportionately. But after cooking the water remaining is usually thrown away, and, therefore, one would not expect any significant increased consumption of fluoride from this source. It is true that a little of the fluoride will get into the cooked vegetables, but, even so, the amount cannot be more than was originally in the water.

If soft water containing fluoride is boiled down say to one-tenth of its original bulk the fluoride concentration can be up to 10 ppm but such excessive boiling down is most unlikely in practice. Samples taken from domestic kettles after prolonged boiling have never exceeded 3 ppm and the occasional use of water with this concentration is quite harmless. With very hard water even evaporation does not lead to concentration of fluoride as the salts in the water lead to the precipitation of the fluoride which would then enter the fur lining of the kettle in hard water areas.

The optimal concentration of fluoride ion in drinking water for dental caries prevention has been worked out by observed results. The complete lack of harmful effect, even in the highest of the naturally high-fluoride areas in this country, from accidental prolonged boiling or prolonged boiling when cooking, shows that any theoretical dangers from such procedures are not borne out by experience.

20. Q. Is there danger of consuming too much fluoride due to heavy consumption of tea in fluoridated areas?
A. This question was considered by the special Research Committee set up in connexion with the studies in this country to consider the safety aspects of fluoridation and there was not thought to be any danger. The effect of tea in increasing the amount of fluoride in the diet is for two reasons often over-stated. First, figures for dry tea leaves are quoted between 100 and 260 ppm, but the important factor is the concentration in tea infusions, about 1-4 ppm (average 2.3 ppm) in fluoridated areas. Second, even this can give a false impression because most of the fluoride in tea is extracted within a few minutes of adding the water and so enters the first infusion. The custom of adding water to the pot results in the fluoride extracted in the first brew being considerably diluted and very little extra fluoride would be extracted. The second and later cups of tea will, therefore, contain lower concentrations than those in a fresh brew.

A survey of the tea drinking habits in the fluoridated area of Newcastle upon Tyne show that the majority of a random survey of about 1,000 people drank between 5-10 cups a day from which they would receive
between 2 and 4 mgs of fluoride. The 1 per cent who took the highest volume of tea did of course receive larger amounts of fluoride, but except in one case, this was less than 8 mg\(^t\). The population of the high fluoride areas stated by Heasman and Martin\(^5\) must have included some heavy tea drinkers yet no evidence of any harmful effect was detected.

References
2. Reports on Public Health and Medical Subjects, No. 105, p. 47, H.M.S.O.

21. **Q. Will the introduction of fluoride have any effect on canning and brewing?**

**A. No.** The United Kingdom Mission to America\(^1\), despite persistent enquiries, were unable to learn of an effect on canners or brewers or, indeed, on any industry. Brewers in America have carried out special industrial studies and have satisfied themselves that water containing 1 ppm F can have no effect.

References

22. **Q. Does the intake of calcium affect the absorption or excretion of fluoride?**

**A.** It is true that fluoride absorption is reduced in the presence of concentrations of calcium and phosphate which are sufficiently high to form a precipitate of calcium phosphate. This substance can bind fluoride to the precipitate, an example of which is that fluoride in bone meal has been found not to be readily absorbed. Further, when fluoride is absorbed, if an excess of calcium is also consumed, less fluoride may be retained in the body. Retained fluoride normally combines with constituents of bone, including calcium and phosphate and small traces may be 'fixed' by minerals present in other tissues containing calcium; a small remainder circulates in body fluids, presumably dissociated from calcium or other mineral. These are perfectly natural metabolic processes and occur in fluoridated and unfluoridated areas.

It has been suggested that where the calcium intake is inadequate, the effects of fluoride may be more marked than they would otherwise be. However, the intake of calcium in this country is as high or higher than that of any other country. In a study made in high fluoride areas in this country of the relationship between dental fluorosis and malnutrition, no indication emerged that such malnutrition as was found (it was limited) was associated with increased mottling.

References

23. **Q. Does fluoride occur in industrial pollutants?**

**A.** Yes. The industrial use of fluoride rich minerals such as fluorite, rock phosphate and cryolite, may give rise to fumes and dusts that may contaminate vegetables and herbage in the environment. While such fluorine contamination may be serious for herbivorous animals, it has not been found to involve any health hazard to man. For example if an air quality standard is set at less than 10 ppb (10\(^{-4}\) g/l) of fluoride, the total intake by man from this source can be calculated as less than 0.2 mg/day\(^1\).

Exposure to fluorides in factories and rare cases of water contamination by fluoride-rich industrial wastes are specific problems that should be solved by industrial hygiene and environmental sanitation\(^2\).

References

24. **Q. Do people living in fluoridated areas which have industries giving off fluoride fumes take in excessive amounts of fluoride overall?**

**A.** Suggestions that where water is fluoridated at 1 ppm the additional fluoride intake of the population in areas where there is industrial pollution might create a hazard, may be easily discounted. The average
man engaged in moderately strenuous work is known to inhale about 20 cubic metres of air per day. If the fluoride in the air is known it is simple to calculate the upper limit of fluoride uptake on the assumption that all fluorides inhaled are retained. Using this method it was found that in central London the fluoride intake of the average man would be about 0.003 mg per day normally and 0.03 mg during a thick fog. In heavily polluted Stoke on Trent the intake was calculated as 0.04 mg per day. These levels, allowing for the increased air intake of a workman during strenuous work are a very small fraction of that contained in the diet. However, one study in the USSR carried out near a superphosphate plant found atmospheric levels of 0.098 to 0.485 mg per m³ suggesting an adult intake of 1.9 mg to 9.7 mg. In that area there were higher levels of mottled enamel and a lower incidence of caries in children.

The fluoride levels in milk from cows taking in high levels of fluoride was negligible. In addition, there was no significant accumulation in the soft tissues and the prolonged boiling of bones from such animals was shown to have no hazards for soups or stews.

No appreciable increase occurs in the fluoride content of vegetables grown on soils rich in fluorides and any hazard if its exists would arise from surface contamination of vegetables. From our knowledge of the amounts of fluoride deposited in affected areas of the United Kingdom, of the amounts of vegetables consumed by man, and from the practice of washing vegetables and discarding the outer and older leaves, it is apparent that any additional intake in the diet would also be negligible.

References

SAFETY OF WATER FLUORIDATION

25. Q. Is fluoride a poisonous substance?
A. A substance may be said to be poisonous or toxic when, on being absorbed or introduced into the human organism, it destroys life or injures health. If, irrespective of dosage, it be correct so to label all substances which have that potentiality, there is practically nothing in the human environment that might not be considered poisonous in the sense that a level of dosage must ultimately be found that will cause harm. If, on the other hand, the epithet be applied only to that dose or concentration which will bring harmful results, then perhaps there is no poison popularly so called that is not capable of being ingested without harm and even with benefit. Thus the use of the term poison is a relative one. There are many substances essential to human life, and nutrition, which according to combination or dose are capable of being either beneficial or toxic.

Fluorides are no different. On the one hand, at very high levels they may be toxic (see Question No 26) but at much lower levels they are beneficial to the teeth (see Question No 1) and may be essential to life.

References

26. Q. What are the known toxic effects of fluoride and at what level do they occur?
A. Many minerals including salts of manganese, cobalt, copper and zinc are beneficial and frequently essential to health in trace amounts but poisonous in larger quantities. With fluorides there is an ample margin between the small amounts such as are to be found in many foods, or such as it is suggested should be added to water, and the larger amounts needed to cause toxic symptoms.

The following is the scale of toxicity of fluoride in adults:

Acute fatal poisoning . . . . . . . . . . . . . . 2,500 mg (approx.)
Acute non-fatal symptoms . . . . . . . . . . 125 mg
Chronic poisoning . . . . . . . . . . . . . . . in excess of 20 mg daily

Acute fluoride poisoning has been studied in many kinds of domestic animals and has been observed in man. The symptoms consist of thirst, vomiting, abdominal pain and diarrhoea, besides excessive salivation, sweating, dyspnoea and paresis. Inflammatory changes in the kidneys have been frequently observed at autopsy in animals. Death usually results from respiratory paralysis and autopsy shows a marked
hæmolytic gastroenteritis with a tendency to fatty degeneration of the liver and kidneys. On occasion a dose of 250 mgs has been taken by a human volunteer. It was recorded that it produced nausea in two minutes, followed by salivation and retching, followed by vomiting and nausea, which persisted throughout the following day.

Chronic fluoride poisoning has been studied in workers exposed to cryolite dust, and to dust and fumes in the course of production of aluminium. It has also been observed in hot countries in areas where the fluoride content and consumption of the water is very high. Changes in bone are invariably found, including excessive calcification often involving ligaments. The resultant signs and symptoms may include stiffness and pain, particularly in the spine, and breathlessness due to restricted respiratory movement. Anemia may be present due, presumably, to encroachment upon cancellous space. There may also be symptoms of cord involvement. Where the fluoride has been inhaled as dust or fumes, cough may be common, sometimes with emphysema or other lung involvement, and gastro-intestinal disturbances, which have frequently been reported, may be due to a direct action of swallowed fluoride as dust or in solution. In severe cases impaired kidney function has been observed.

The possibility of chronic fluoride poisoning arising from fluoridation at 1 ppm in this country was fully considered and dismissed by the special Research Committee which was set up to consider safety aspects in connection with the studies being carried out in Great Britain.

References

27. Q. How much water with 1 ppm fluoride must we consume before toxic effects will occur?
   A. The lowest toxic dose for even a 9 lb baby would be that amount contained in 26 gallons of fluoridated water at 1 ppm. The equivalent amount for an adult is something in excess of 450 gallons consumed at one time.

28. Q. Has fluoride in the drinking water any effect on the expectation of life?
   A. No survey, either in natural fluoride areas or fluoridation areas, in which mortality data have been studied, has revealed any effect on life expectancy of fluoride at 1 ppm. In 1954, Hodge and Smith\textsuperscript{4} analysed mortality statistics in 22 Illinois cities, 18 having no fluoridation and 4 with more than 0.7 ppm F; no correlation was found. Hagan \textit{et al.}\textsuperscript{3} compared death rates in 32 pairs of cities, each of one naturally and one non-fluoridated city and an analysis before and after introduction of controlled water fluoridation. They found no relationships between mortality experience and presence of fluorides. An examination of mortality experience in five large cities before and after fluoridation was made by comparing the 1940 and 1950 mortality experiences with that of their fluoridation year. The study showed no significant difference\textsuperscript{5}. In Great Britain, the Ministry of Health\textsuperscript{4} reported that ‘... comparisons have been made in this country of vital statistics in high and low fluoride areas and the following rates have been studied; neo-natal and infant mortality rates; still birth rates; death rates from all causes; death rates from kidney diseases; cancer (all forms); ulcer of the stomach; cardio-vascular diseases, cancer of the stomach; and cancer of the breast. In none of these were there any differences between high and low fluoride areas which could be interpreted as indicating any harmful effect on health; nor even is there a slight pointer to the need for any further studies to demonstrate this.’

In the 1962 Government Report on Fluoridation there was an impressive report of the lack of effect of fluorides on mortality. Thirty-six areas were chosen consisting of 18 naturally occurring fluoride (5.8 to 0.7 ppm) matched with 18 non-fluoridated areas. It was concluded that ‘the results indicated that the over-all mortality was the same in the fluoride and control areas.’

A similar study has been conducted in Canada; 18 municipalities with fluoride at 1 ppm or greater were compared with nearby municipalities having a fluoride concentration of 0.4 ppm or less. It was concluded that ‘differences between pairs of municipalities bear no relation to the concentration of water fluoride in the “fluoride” member of the pair.’ Similar results have been reported in Russia and Switzerland\textsuperscript{5, 6}. Recently a study\textsuperscript{7} which investigated the relationship between mortality, natural fluoride socio-
environmental factors and water hardness found no significant associations thus confirming the earlier findings of Heasman and Martin\(^9\).

**References**

4. United Kingdom Ministry of Health (1956) Reports on Public Health and Medical Subjects No 105, p. 44. H.M.S.O.
5. United Kingdom Ministry of Health (1962) The conduct of the fluoridation studies in the United Kingdom and the results achieved after five years. H.M.S.O.

29. **Q.** Is it true that in the Bartlett/Cameron study a significantly higher death rate was found in the high fluoride area?

A. In the Bartlett/Cameron study, calculations, after the figures had been corrected for differences in the age and sex constitution of the two groups, showed a higher death rate, with the probability of such a difference not having occurred by chance of approximately 1 in 20\(^1\). Caution has to be exercised in making any deductions from figures at this level of probability and the findings have to be interpreted in relation to the nature of the problem being considered and the degree of support for the findings obtainable from other sources. In this case the numbers are so small that the occurrence, or non-occurrence of a single death, or a difference in the age of one of the persons dying, would considerably affect the final results. The figures are of deaths from all causes and are therefore affected by many factors. No confirmation of any effect upon mortality can be found in a study by Roholm\(^3\) of Danish cryolite workers. Although these Danish workers were ingesting much more fluoride than the inhabitants of Bartlett, no effect on mortality was found. Nor was any difference in mortality from all causes shown in Heasman and Martin's study of high and low fluoride areas in this country\(^4\), or the study by Hagan and others in the United States\(^5\). It would be wrong, therefore, to attempt to draw any conclusions from the Bartlett-Cameron deaths particularly as the fluoride level was eight times that recommended for fluoridation.

**References**


30. **Q.** Is it possible that fluoride, although perfectly safe for most people, may produce an unfavourable response like an allergy, in some people?

A. Allergy to water-borne fluoride has been claimed only by Waldbott\(^1\)\(^2\) and Shea *et al.*\(^3\) These papers are open to serious criticism and their claims have not been substantiated. Theoretically an allergy to fluoride would be surprising since covalent bonding of fluoride to amino acids is unlikely to occur. With highly provocative sensitising methods using sodium fluoride and dinitrofluorobenzene in guinea pigs Blohm and Nilzen\(^4\) were unable to produce allergic reactions to fluoride. Allergy to fluoride has not been reported among the millions of tea consumers nor among people who come into contact with sea water (1-4 ppm F). If allergy to fluoride in water exists at all it must be extremely rare and extremely mild otherwise it would have been widely reported by now. The claims that allergy occurred in persons drinking fluoridated water have been investigated by a number of commissions and research committees and all have considered them unsubstantiated. These include the Ontario Royal Commission, Commission of Inquiry in New Zealand, the Commission on Fluoridation in Tasmania, the Irish High Court, the Research Committee of the British Ministry of Health.

**References**

31. **Q.** Fluorine belongs to the same group of elements as iodine and bromine, both of which have potent actions on the body; is there not therefore some danger that fluorine may have some hitherto undisclosed effects on metabolism, apart from strengthening the teeth against decay?

A. Iodine has a physiological action on the body; that is, it plays a necessary part in the maintenance of health when taken in minute quantities. Animal experiments suggest this may also be true with fluoride, though the evidence for an essential role for fluoride is still sparse because of the difficulty of preparing diets completely free of fluorine. An important difference between these elements is the high affinity of skeletal tissues for fluorine and this, together with the ease of elimination by the kidneys, keeps plasma fluoride levels low\(^2\). There is no evidence for accumulation of fluorine in the thyroid, salivary glands or other soft tissues\(^3\).

Bromine has no known physiological effect; it has a pharmacological effect, but in doses greater than the amounts of fluorine provided by water containing 1 ppm F (at least 50 times greater). Amounts of bromine of the order of those which fluoridated water provides have never been found to have any effect at all.

**References**


32. **Q.** For how long has fluorine been added to water supplies in America and Canada? Have any adverse effects been observed there?

A. Fluoridation of water has been in operation in some areas for at least 30 years. The first fluoridation, study started in Grand Rapids, Michigan early in 1945, and others at Newburgh, and Evanston; Brantford Ontario followed shortly after\(^4\).

In all these and later studies significant reductions in caries incidence have been obtained but no ill effects, either of a dental or medical nature, have been found.

**References**


33. **Fluoride is said to accumulate in the bones and cause severe bone changes. Is this so?**

A. Accumulation of fluoride occurs in all human beings over the years no matter whether they live in fluoridated areas or not. In the amounts provided by fluoridated water this accumulation is harmless\(^1\). It has been found (on analysis of bone) in this country that the process continues throughout life, the amount depending upon the concentration of fluoride in the water\(^2\).

It is only when very large amounts of fluoride are present in the water (more than 8 ppm) or where there is some other form of heavy exposure to fluoride, for example of workers in certain industries, that this accumulation has in the past become harmful. The earliest signs of this are changes in bone formation. The bone is excessive in amount but poorly mineralised.

A substantial margin exists above the 1 ppm of fluoride proposed for use in this country. Radiological surveys of 114 residents at Bartlett, Texas where the water contained 8·0 ppm of F showed evidence of increased bone density in 10-15 per cent of those examined, and in none was there evidence of deformity or interference with skeletal function. Over 60 per cent of those studied were 50 years old or more\(^5\).

An interesting finding was that osteoporotic changes in the aged and hip fractures, a common occurrence in ageing groups, were absent in those studied in the high fluoride area. Similarly a recent study of the inhabitants of Watford (fluoridated at 1 ppm for the preceding five years) and Leigh in Lancashire (less than 0·2 ppm) has shown a lower incidence of osteoporosis in families in Watford\(^6\); and an extension of the Bartlett-Cameron Study in Texas to the town of Framlingham, which has only 0·04 ppm of fluoride in its water, has revealed an unusually high incidence of osteoporosis in the latter town\(^6\). It appears that fluoridation may have a beneficial effect in preventing osteoporosis.

It should also be noted that a large portion of the total fluoride ingested is eliminated in the urine, faeces and body sweat. McClure and his collaborators\(^7\) demonstrated that elimination was virtually com-
plete. Longwell reporting on tests with two young men with water or tea containing 1 ppm F found that after a period of about seven days 80 per cent of the ingested fluoride was excreted in the urine and when a balance was obtained between that ingested and the total excretion between the urine, faeces and perspiration, about 95 per cent was accounted for.

References

34. Q. How would fluoridated drinking water affect the fluoride content of bones in cattle?
A. The normal fluoride intake of the cow is rather high (±0·2 mg F/kg body weight) compared to humans on a fluoridated water supply (±0·04 mg F/kg body weight). If fluoridated water is consumed by cows the fluoride intake will be increased by about 0·1 mg/kg body weight. The fluoride content of the bone will probably increase by 50 per cent. Because the fluoride is strongly bound it will not be available if the bones are cooked in water—the bone will not release but take up fluoride from the water.

Reference

35. Q. Is it true that fluoride deprives the body of calcium and will bone development be retarded?
A. No. The average daily intake of calcium in this country is about 1,000 mg, whereas the total intake of fluoride from drinking water, tea and foods, would be only 1-5 mg for most people in an area with water fluoridated at 1 ppm. The amounts of calcium that could be rendered unavailable by chemical action are negligible. In a study in Newburgh, where the water was fluoridated and Kingston, a control town, no retarding of bone development was reported. Similar findings were reported in The Netherlands where radiographs of the hands of 15-year-olds showed no differences between fluoridated and non-fluoridated areas.

References

36. Q. Does a high fluoride intake cause arthritis?
A. With very high intakes of fluoride, pain and stiffness of joint movement can occur. But arthritis was not found to be more prevalent in residents studied in Bartlett (8 ppm F) compared with Cameron (0·4 ppm F). Steinberg and others studied the fluoride content of bone, ligament, and muscle in arthritic and normal individuals, and found no relationship to these conditions. Steinberg and others also found that the fluoride content of bones from 14 patients with various types of arthritis, who had ingested fluoridated water for three years or more, showed no excessive concentration of fluoride. As an extension of a survey of ‘rheumatism’ already in progress at Leigh, Lancs, where the fluoride content of the drinking water is low, Ansell and Lawrence undertook a comparative study of the incidence of ‘rheumatism’ in Leigh and Watford, one of the UK fluoride study areas. They found no difference in the amount of rheumatoid arthritis, osteoarthritis, spondylitis, gout or disc degeneration between the two towns. However, there were significantly fewer complaints of ‘rheumatism’ and less incapacity due to rheumatism in Watford than Leigh but the authors were cautious in attributing this to fluoride.

References
37. **Q. Are old people less able to excrete fluoride?**

A. On the contrary the percentage of an oral intake of fluoride which is excreted in the urine is actually greater in older people. It has not been found that old people are any less able to excrete the amounts of fluoride which they consume, than are the young. In a study of the fluoride content of bones in this country, the fluoride content of bone is not found to increase more rapidly in the older than in the younger age groups.

Reference

38. **Q. What is the relationship between fluoride and osteoporosis?**

A. Large doses of fluorides have been used therapeutically in cases of osteoporosis and tested in animals with induced osteoporosis. In addition clinical investigations of population in areas with high and low water fluoride content support a protective effect of fluoride against osteoporosis. There is, however, no evidence that the low concentration of fluoride in fluoridated water increases bone density or strength.

There are several studies which indicate that simultaneous high calcium and moderately high fluoride supply may be most effective against osteoporosis.

References

39. **Q. Is it true that fluoride concentrates in the placenta? Are still-births commoner in ‘fluoride’ than in ‘non-fluoride’ areas?**

A. It is known that the placenta is richer in fluoride in areas with fluoridated drinking water. Gardner and others have shown that placentas from women living in Newburgh N.Y. (1.2 ppm F) contained three times as much fluoride as those from women in Rochester N.Y. (0.6 ppm F), but this had no detrimental influence on mother or child. It is also known that whatever the concentration in water, the mother normally provides some fluoride to the child within her. Presumably, therefore, the function of the placenta is as a regulator of fluoride supplies to the foetus, rather than merely as a barrier.

No harmful effect on the mother or baby has been shown to result from the ingestion of water containing 1 ppm fluoride by pregnant women and in harmony with this is the finding that still-birth and neonatal death rates are unaffected by the presence of fluoride.

References

40. **Q. Does fluoridation cause an increase in the rate of children born with mongolism (Down’s syndrome)?**

A. There is no sound evidence of any relation between the prevalence of mongolism and the level of fluoride in drinking water. The question arose because of studies published by Rapaport. He claimed the prevalence of mongoloid births was two to three times as frequent in births occurring to women living in Illinois cities with 1 ppm fluoride in the water supply than in those to women living in cities with little or no fluoride in the water. Rapaport's first study contained inadequate sampling techniques—his water histories were inadequate and a further serious error was that he correlated place of birth with fluoride content of the water. This ignored the fact that many mothers from surrounding rural areas came to the city hospital for birth. In addition the number of mongoloids he found in both fluoride
and non-fluoride communities (1 per 2,250 births) falls so far short of the rates found in many other parts of the United States and other countries by other observers that grave doubt is cast on the validity of the findings. Reliable figures are 1 mongol per 600-700 births.

Berry\(^7\), \(^8\) has carried out a study in Britain which refutes Rapaport's conclusions. He found no difference in the incidence of mongol births between low and high fluoride areas. The incidence figures reported by Berry (1 per 688 births) is within the range reported by Penrose\(^9\) for the incidence of mongolism in the USA, Switzerland, Great Britain, and Denmark and by Cohen et al.\(^10\).

Berry's findings have been corroborated by a detailed study carried out by Needleman et al.\(^11\) They based their study on 2,469 mongol births in Massachusetts during a 17 year period. This represented virtually all mongol births during that period\(^12\). During the study period 30 communities introduced fluoridation. Each subject was classified as either a fluoride or non-fluoride case determined by the fluoridation status of the town of residence nine months before the date of birth. A rate of 1·5 cases per 1,000 births was found both for fluoride and non-fluoride related births. This is identical to the rate (1·53 per 1,000) reported by Berry. "Thus, the data provides strong evidence that fluoridation does not cause any important elevation in risk for Down's syndrome . . ."\(^11\)

The authors also stated that 'Although the present study evaluates only the short term effect of fluoride on risk of Down's syndrome, the results of Berry's survey comparing risk for Down's syndrome in areas with high and low concentrations of naturally occurring fluoride support the notion that the longer term effects if any are also minimal\(^11\).'

References

5 Division of Medical Sciences (1971) Biologic effects of atmospheric pollutants; Fluorides, Washington D.C. Nat. Acad. of Sciences, p. 199.

41. Q. Is it true that fluoridation causes cancer?

A. A number of statements were published in 1961-62 alleging that there is some evidence in the USA that populations supplied with artificially fluoridated water have shown an increased incidence of cancer. These have been found to be based on misleading information regarding the incidence of cancer of the thyroid and fluoridation in the City of San Francisco. The prevalence was stated to be 400 per cent above normal expectation. The San Francisco figures relate to hospital diagnosis of cancer of the thyroid for the years 1950-53, inclusive, 18 cases having been found in 1950, 26 in 1951, 29 in 1952, and 36 in 1953. Fluoridation of approximately two-thirds of the water supply did not begin until August 1952 and of the whole city water supply until 1955. The rise, if indeed it was anything more than a chance fluctuation or a failure to find all the cases in 1950, therefore began before fluoridation commenced. The 400 per cent is completely misleading since this refers to the average number of cases during the four year 1950-53 being four times as great as a hypothetical expected number derived from studies in other cities.

In 1965 Taylor\(^4\) referred to his research purporting to show a cancer promoting property of fluoride in cancer-susceptible mice. However, similar experiments carried out by Bittner, the eminent cancer biologist, and Armstrong failed to confirm Taylor's work. In their experiments, Bittner and Armstrong used a blind testing technique to eliminate bias and showed that the cancer-susceptible mice drinking water containing 5-10 ppm fluoride did not develop tumours any more quickly than those drinking fluoride-free water.

As doubts continued to be raised about the safety of fluoride, health workers are constantly monitoring the possible effects on health and the environment. Cancer is one of the few diseases for which there are reliable data on incidence. Recently an extensive study was undertaken by Kinlen\(^4\); to compare the incidence of cancer in certain organs in areas of England and Wales with relatively high levels of fluoride in water (both natural and artificial) with that in control areas having low levels. In addition data were also examined from fluoridated and control areas of the United States, The Netherlands, and New Zealand. In England and Wales, data on cancer incidence was supplied by the Office of Population Censuses and
Surveys, from the National Cancer Registration Scheme for the following sites: thyroid, kidney, bladder, bone, stomach, oesophagus, colon, rectum and breast. Kinlen found ‘no tendency for the numbers of cancer of any organ to be greater in areas where the level of fluoride in water is higher than in control areas with little or no fluoride in the water.’ From his analysis of cancers of the thyroid, kidney and bladder in fluoridated areas of the United States, New Zealand and The Netherlands, Kinlen concluded that ‘again there was no appreciable tendency for the incidence of these cancers to be higher in the fluoridated areas and indeed rather the reverse was the case’ and later goes on to say that ‘the lack of any relationship between fluoride and cancer incidence is in keeping with studies of cancer mortality in England, Wales and USA and Italy.’

References
1 Taylor, Alfred (1965) Saturday Review, October 2, p. 73.

42. Q. Has fluoride in the drinking water an adverse effect on the kidneys?
A. It appears that both in health and disease the kidneys are remarkably tolerant to concentrations of fluoride far in excess of those relevant to fluoridation at 1 ppm. From a large body of animal data it has been calculated that the minimal fluoride concentration in the drinking water necessary to cause kidney injury on repeated administration is 100 ppm.

Daily fluoride doses exceeding 50 mg which have been given for many months to a large number of patients with osteoporosis have not resulted in any impairment of kidney function.

Recently hemodialysis has been used in cases with kidney failure without estimating the fluoride, calcium and other ions in the dialysis water. Fluoridated water may have too high a fluoride content for use in hemodialysis and should be controlled in the same way as all other substances in the dialysis water.

References

43. Q. Should fluoridated water be used in the operation of artificial kidney equipment (hemodialysis)?
A. In hemodialysis, the blood of the patient with kidney disease is passed through a unit containing permeable tubing or membranes immersed in a water solution of special composition so that blood impurities will be removed. During this process there is also a transfer of solutes from the water solution into the blood.

Many studies have been conducted of the detrimental effects that may be caused by excessive amounts of solutes being absorbed from the 900 litres of water (50 to 100 times the amount normally consumed per week) to which the patient is exposed to for 18 to 25 hours each week. In some renal dialysis units it has been considered advisable to deionise tap water to remove the very small amounts of iron, calcium, magnesium and other natural or added solutes, like fluoride, before its use in dialysis. Therefore no special arrangements need to be made because the water is fluoridated as the fluoride will be removed with the other ions.

Reference

44. Q. Is it true that fluoridation can affect eye-sight?
A. No, there is no evidence of any harmful effect on any part of the eye from fluoridation. As part of research into damage to the retina from drugs it was found that retinal damage was caused in some rabbits by giving them near lethal doses of sodium fluoride.

Massive doses of sodium fluoride (60 mgm/day) bordering on the limits of toxicity have been used to treat cases of osteoporosis and Paget’s disease and in one such case a retinal lesion was found to develop.
These doses are far in excess of any fluoride intake which could possibly arise from the use of fluoridated water. Singer and Armstrong have shown that even when the fluoride content of drinking water is 2.5 ppm the level of fluoride in plasma remains the same as when drinking water containing 0.15 ppm fluoride. It is clear that the body has a regulating mechanism which prevents the plasma fluoride rising to a level likely to influence cell multiplication. That mechanism protects organs such as the eye from the effects of any excess concentrations except when the intake is grossly excessive as in Geil and Bellin's case.

References

45. Q. Is fluoridated water harmful to fish?
A. In Indianapolis the Water Company has placed an aquarium in the entrance lobby of their offices showing healthy goldfish living in fluoridated town water. As regards salt water fish, sea water already contains approximately 1 ppm of fluoride.

Reference

46. Q. Is the diabetic at risk from fluoridation?
A. If the diabetic was so severely out of balance that he drank enormous amounts of fluid then, without proper treatment, he would be severely ill long before he was in any danger from fluorides. With the proper care the diabetic does not suffer from excessive thirst.

47. Q. Has fluoride in the drinking water any adverse effect on peptic ulcers?
A. There is no evidence that fluoride in drinking water has any influence on the prevalence of peptic ulceration.

48. Q. Will a high fluoride content of the blood cause haemophilia?
A. No. The onset of haemophilia is determined by genetic factors.

49. Q. Will a high fluoride content of the blood affect coagulation time?
A. While high concentrations of fluoride can be added to blood drawn for analytical procedures in order to prevent it from clotting, the concentrations required are far above any that could be reached by use of fluoridated water. No problem of delayed or accelerated coagulation has been encountered in the National Blood Transfusion Service in high fluoride areas of Britain.

50. Q. Are not fluorides potent enzyme inhibitors and thus liable to have a toxic effect?
A. There is no evidence that at the optimum concentrations of fluoride for good dental health any enzymes in the tissues are inhibited significantly. High concentrations of fluoride certainly do inhibit many enzyme systems. However, owing to the effects of binding of fluoride by the skeleton and of its rapid excretion in the urine, the body has a built-in mechanism which maintains the concentration of fluoride ions in the blood at very low levels approximating to 0.1 ppm. Recent work has shown that fluoride ions are in the blood at a lower concentration than was previously thought.

References

51. Q. Is it true that it has been shown that multiplication of cells growing in tissue culture is inhibited by fluorides added to the media?
A. Tissue culture is a technique used extensively in cell biology. Considerable skill and a high degree of control of the environment are required to produce reliable and comparable results. Further, since the
conditions of tissue culture vary so widely from the conditions in the living body, the interpretation of findings must be made with the greatest care and reserve.

Much publicity has been given to the letter by Berry and Trillwood published in the *British Medical Journal* and describing experiments which were claimed to show that fluorides added in small concentrations to tissue culture media caused the inhibition in growth of a strain of human cancer cells and mouse fibroblasts. The details of the method given in this letter were insufficient to enable a full evaluation of the evidence. For example, it appears that the fluoride content of the culture media before the addition of fluoride was not known.

Berry and Trillwood's experiments were repeated and extended by Armstrong and his colleagues, who not only analysed the contents of the culture media, but, as additional evidence of cell growth, estimated the cell protein content. Their results showed that sodium fluoride in concentrations of up to 4·5 ppm of fluoride ions failed to influence the multiplication of cancer cells. They also showed that the protein synthesis in human oesophageal cells was affected only when the fluoride ions concentration reached 15 ppm.

Further, work by Proffit and Ackerman showed that deoxyribonucleic acid (DNA) and collagen synthesis were reduced only when the fluoride concentration exceeded 10 ppm.

References


52. Q. Since it is agreed that too much fluoride may cause mottling of the teeth how can we be sure that fluoride is perfectly safe?

A. While nobody can guarantee the safety of any human measure under all circumstances, the safety of the adjustment of drinking water fluoridated to about 1 ppm is supported by so much scientific evidence and clinical data that any health hazard with this measure is extremely improbable. Specific claims of such hazards from competent observers have been few. New developments in nutrition and therapy may lead to increased levels of fluoride intake. It is the responsibility of the proponents and users of such techniques to establish their safety.

53. Q. Is fluoride in excess the only cause of mottling of the teeth?

A. No. There are other types of mottling, usually known as idiopathic enamel defects. These are white or brown patches on the enamel caused through some defect of development or calcification. Unlike fluoride mottling these defects are often asymmetrical in distribution and are usually seen, when present, in the permanent incisors. Altogether, over 100 different environmental and genetic factors have been associated with enamel opacities or mottling of the enamel. There is evidence that this type of defect is less when there is the optimum concentration of fluoride, i.e. about 1 ppm in the drinking water.

References


54. Q. Is all enamel mottling unattractive?

A. In the inquiry into water fluoridation in Tasmania the Royal Commissioner stated 'I do however find as a fact that Dean's first two grades, i.e. questionable and very mild, are inconspicuous and would not under ordinary conditions of social intercourse be noticed by any but the professional observer' (Para. 351) and later he says 'I think that Dean's index is a negative one, an index of defect. He did not take into account as a balancing factor the positive aspect of the improved shape, colour and lustre which optimum quantities of fluoride will bring in the great majority of teeth exposed to its influence' (Para. 352).

In areas with fluoride at 1 ppm in the water the prevalence of mottling is about 10 per cent. Of those affected, some will have 'mild,' a few 'very mild' and the majority will be no more than 'questionable.'
At such levels even in the most pronounced cases the cosmetic defect will be doubtfully apparent to the casual observer without clinical aids, and of very slight consequence, if any.

Recently Al-Alousi, et al. found that the tooth prevalence of mottling was 9 per cent in fluoridated Anglesey as against 12 per cent in non-fluoridated Leeds and confirms previous findings that mottling is less common in fluoridated communities with 1 ppm than in non-fluoridated communities.

References

55. Q. Are there different grades of mottling?
A. Yes. According to Dean's classification there are six grades of mottling ranging from 'questionable' where a definite diagnosis is not warranted. The next is 'very mild' mottling; here small opaque paperwhite areas or faint white lines are found which do not cover more than a quarter of the tooth's surface. In the mild degree, white marks are more noticeable and involve half a tooth's surface while in 'moderate' mottling brown staining occurs. In the moderately severe grade this is accompanied by slight pitting of the enamel and in the severe grade there is marked hypoplasia and widespread brown stain. In the lowest grades, 'questionable' and 'very mild' very little change is apparent to the untrained eye. Even in 'mild' mottling the white spots or lines usually pass unnoticed.

References

56. Q. Will white mottling become more noticeable and unattractive with the passage of time, and will staining, if present, become more marked?
A. When the fluoride concentration in the water supply is around 1 ppm genuine fluoride mottling is minimal and in no way objectionable or disfiguring. In fact the quality of the enamel is very good, and the appearance of the teeth more pleasing. There is no increase in the area of mottling with age nor is there any change in colour, other than may occur under certain conditions with any teeth. For instance all teeth tend to become darker with age.

Even when the mottling is severe, or moderately severe, the affected areas do not increase in size. When there is staining, and this can occur in quite young children, it is possible that the staining may become darker with age.

Clarke and Chalmers photographed a number of children with mottling, some severe, from a small natural fluoride area in Lincolnshire, where the drinking water contained 4 ppm of fluoride. He photographed the same children five years later and found that the brown staining had neither changed in size or density in the intervening period. In 1951 Russell and Elvove included mottling in a dental caries survey made in two high- and low-fluoride areas in USA. The proportions of the varying degrees of mottling from 'questionable' to 'severe' showed no significant differences throughout the age-groups 20 to 44 years.

References

57. Q. Can too much fluoride so damage the teeth as to encourage decay?
A. Excessively high concentrations of fluoride in the drinking water can cause severe mottling with staining and pitting of the enamel but teeth so affected show a resistance to decay. Severe mottling has never been reported in areas with fluoride at 1 ppm.

References
58. **Q.** Does excess fluoride so affect the teeth that they cannot be filled satisfactorily?

A. Excessive fluoride intake, such as may occur in a number of cases where the teeth have been formed when the fluoride content of the water was 4 ppm or more occasionally produces dental enamel which is hypoplastic. It may chip and flake off making it difficult to restore the teeth satisfactorily.

59. **Q.** Is it true that although the enamel may be hardened by fluoride, the dentine is softened, so that, when decay takes hold the disease progresses more rapidly?

A. This is certainly not true. Experience with teeth from fluoride areas is that when caries does occur it spreads more slowly and the cavities are smaller.

---

**References**


60. **Q.** Does fluoride in the drinking water cause or hasten the onset of periodontal disease (gum disease)?

A. There is no evidence that fluoride in drinking water hastens the onset of periodontal disease. Studies of the incidence of gingivitis (gum disease) in children from the fluoridated towns of Newburgh (New York State), Brantford (Ontario) and Tiel (The Netherlands) have shown slightly less gingivitis and pocketing compared with children living in the control towns. No difference in the prevalence or extent of gingivitis was observed between 15-year-old children living in Hartlepool (1-5-2-0 ppm F) and York (0-15-0-28 ppm F). Furthermore, there is no significant difference in the prevalence of periodontal disease in adults from high and low fluoride areas.

**References**


61. **Q.** Does fluoride in the drinking water cause impaction or loss of the third molar (wisdom) teeth?

A. The jaws of modern man are often too small to accommodate the full complement of teeth, and this is true of both fluoride and non-fluoride areas. If the full complement of teeth is retained the third molar, being the last tooth to erupt is liable to impaction. This is more likely to occur in fluoride areas where the lowered incidence of dental caries reduces the number of teeth lost.

**Reference**


62. **Q.** What would happen to the teeth of children who for one reason or another drank high levels (greater than 5 ppm) of fluoride in the water?

A. Children in areas of the United States have been drinking water with 5 ppm fluoride whilst at school with no harmful effects. Only one child had a very mild enamel fluorosis. The children had 39 per cent fewer decayed, missing and filled teeth than did their counterparts before fluoridation.

**References**

63. **Q.** Does fluoride in the drinking water increase the chances of children having irregular teeth?

**A.** No. On the contrary there is some evidence that in fluoride areas, whether natural or artificially controlled, there are fewer children with irregular teeth. 1, 2, 3, 4.

**References**

**ENGINEERING ASPECTS**

64. **Q.** How is fluoride added to the water supply?

**A.** Two basic types of feeders are used—dry feeders and solution feeders. Dry feeders are of two types, volumetric and gravimetric. Where solid chemicals can be supplied in fairly uniform particles and uniform density, feeders delivering a controlled volume of the dry material to the water to be treated are satisfactory and these are called volumetric feeders. Gravimetric feeders weigh the chemical continuously as it is being delivered to the water. Solution feeders are either carefully calibrated pumps or rotameters. All types of feeders can be instrumented so that the rate of feeding is varied in direct ratio to the amount of water being treated. In addition, most plants are equipped with automatic metering and recording instruments providing charts which may be filed for a permanent record. It is customary to provide automatic controls which will shut down the feeders: if the equipment either overfeeds or underfeeds, if the water supply to the feeder fails, if the hopper overloads or if the rate of flow drops below a predetermined feeding rate.

**References**

65. **Q.** How was the level of fluoride in the drinking water appropriate to this country determined?

**A.** The concentration of 1 ppm of fluoride in the drinking water has been chosen in relation to observed effects in temperate climates, such as ours, in both natural and controlled fluoridation areas in this country and in North America. Those effects are inhibition of dental caries attack and the absence of objectionable mottling. It has also been checked in relation to the excretion of fluoride in the urine of children and others, as this provides a valuable guide to the amount of fluoride consumed from all sources. Water being a biological necessity its consumption is largely self-limiting.

**References**
1. Reports on Public Health and Medical Subjects No. 105 (1962) H.M.S.O.
4. Excretion of Fluorides. Chap. 5 in Fluorides and Human Health. Ibid.

66. **Q.** Does the optimum level of fluoride in the water vary according to the climate and temperature of the area?

**A.** Yes. As the temperature affects the quantity of water consumed, the optimum fluoride concentration to prevent dental decay does vary. For example, in Arizona where the mean annual temperature is about 70°F the optimum fluoride concentration was found to be 0.7 ppm. But in areas with a temperature range similar to that found in Great Britain the optimal level is 1.0 ppm.

**Reference**

67. **Q.** To what limits of accuracy is modern plant capable of adding fluoride compounds to water at the waterworks?

**A.** The application of a steady level of fluoride to public water supplies is not more difficult than other additions of some 38 chemicals used in normal waterworks practice. It has been the experience in America that concentrations of fluoride can be maintained in drinking waters within 10 per cent of the intended...
level\(^1\). This has been confirmed in the fluoridation studies in the United Kingdom, where for over five years the average concentration had been kept at 0.9 ppm, the standard deviation being 0.1 ppm\(^2\).

References

68. Q. How is it possible for the waterworks staff to check accurately that the concentration of fluoride in the water supply is maintained within acceptable limits of 1 ppm?

A. A number of simple colour tests are available to determine fluoride in the range 0.1-5 mg/litre. These employ the well known ability of the fluoride ion to bleach certain dyes. For routine use the colour density may be estimated visually against a simple colour disc comparator. A review of these methods has been made by Patterson, Bunton and Crosby who also evaluate the fluoride selective ion electrode. This was found to give excellent results in daily use; it is simple to use and may be employed both in the laboratory or as part of an automatic recording device at the waterworks. If a colorimetric procedure is preferred, the Palin method gives satisfactory results even in the presence of common interfering ions. Colorimetric methods of determination are used in water treatment in connection with chlorination and pH readings and are well within the capacity of the ordinary waterworks personnel. Meters to record automatically the concentration of fluoride in the water are available for use in the larger water undertakings\(^3\).

References
1 Maier, F. J. Manual of Water Fluoridation Practice, Chap. 11, p. 158.

69. Q. Although fluoride may be added at uniform rate at the source of water supply, is there any likelihood of the fluoride tending to form pockets in water pipes which would give rise to uneven concentrations?

A. No. At the concentration of 1 ppm F, the fluoride is completely soluble and will not be precipitated out of solution, even in hard water. The concentration of fluoride at the plant tap will be carried throughout the distribution system, but if a change in the concentration occurs at the plant there will be a time lag before the change reaches outlying parts of the distribution system. The time lag depends on the length of pipe through which the water has to pass. In the Fluoridation Study Areas in this country the concentration of fluoride ion over 5 years has been the same at the plant taps and at various points in the distribution system. This confirms that pockets of fluoride were not formed in the water pipes\(^4\).\(^5\).

References

70. Q. Is it correct that on the addition to water of sodium fluoride, sodium silicofluoride or hydrofluosilicic acid, the result is the precise equivalent of similar concentrations of naturally occurring fluorine compounds (usually calcium fluoride)?

A. Yes. Sodium fluoride, sodium silicofluoride or hydrofluosilicic acid will give identical fluoride ions when present in water at a concentration of 1 ppm F. This applies also to calcium fluoride, and when a chemical determination of the fluoride is made it would be impossible to differentiate between fluorides naturally present and those added in water fluoridation.

Thus they have identical chemical properties and the evidence is conclusive that the effects of naturally occurring fluoride and added fluoride in reducing the incidence of dental caries are also identical\(^6\).

Reference

71. Q. It is claimed that when sodium fluoride is added to the water supply hydrofluoric acid will be formed. Is this so?

A. No, the pH value of water is about 7.0 or above, that is, it is neutral or slightly alkaline in reaction. Hydrofluoric acid would only be formed in strongly acid solutions. In any case, if it were present in the water it would be completely ionised yielding fluoride ions.

29
72. Q. Since sodium fluoride loses its identity, being completely ionised when added to water, why is it not the case that fluorine in water, being a gas, evaporates or is capable of being driven off by heat?

A. Fluorine, the element, must not be confused with the fluoride ion which is a product of the dissociation of inorganic fluorides in extremely dilute aqueous solution. Fluorine is never encountered in the free state naturally, it is much too reactive and it certainly is never present, as such, in water. The fluoride ion differs from the atom of the fluorine element in that it possesses one additional electron and it cannot be driven off by heating the water.

A useful comparison is with sodium chloride (common salt). On dissolving in water this forms sodium ions and chloride ions, free chlorine is not and never will be present.

73. Q. Are not fluorides very dangerous substances to have to handle at a waterworks?

A. It is advisable to observe a few simple precautions when fluorides in bulk are handled. Rubber gloves and simple respirators are worn and staff are instructed in their use and maintenance. Other chemicals are in common use at waterworks and the handling of such materials is no novel experience for the staff concerned.

During the course of the Fluoridation Studies in this country the urine of waterworks plant operators have been tested for fluorides. The results have not indicated any increased fluoride intake.

Reference

74. Does pure water exist?

A. Chemically pure water is very difficult to obtain for strictly speaking distilled water is not pure because it contains gases in solution. Rainwater is not chemically pure and appreciable concentrations of total solids can occur depending on the locality and intensity of the fall. For example the solids have been found to vary in the range 5 to 570 parts per million, calcium traces to 11 ppm; sodium to 1 to 200 ppm; chloride 1 to 400 ppm and sulphate 1 to 60 ppm.

Reference

75. Q. What are the more important methods used to render water suitable for public supply?

A. Thirty-eight chemicals are used in various processes of water treatment. These and some physical processes improve the quality by:
(a) Removing objectionable bacteria;
(b) Removing colour and turbidity;
(c) Removing taste and odour;
(d) Removing iron and manganese;
(e) Rendering the water non-corrosive and preventing solvency;
(f) Removing excess hardness;
(g) Removing excess sodium chloride.

Reference

76. Q. Does hardness of water make the introduction of fluoridation difficult?

A. No. Calcium and magnesium can reduce the solubility of fluorides but this effect is negligible with the concentration present in natural waters. It may be necessary to soften water used to make a solution of the fluoride salt to enable it to be added homogenously to the supply but this presents no difficulty.

77. Q. Is the fluoride obtained from ‘natural’ and ‘artificial’ fluoride compounds different?

A. No. When a fluoride compound is dissolved in water, the element fluorine will be present mainly as fluoride ion, F-. However, depending on the ionic concentration and on the pH of the solution, the...
fluorine will also be present in solution as HF$_2^-$ and undissociated HF. In dilute solutions and at neutral 
pH, virtually all the fluoride will be present as fluoride ion, F$^-$. If we assume that calcium fluoride is representative of natural fluorides while sodium fluoride is 
representative of artificial fluorides and dissolve these compounds in water under the equivalent condition 
it will be found that they ionise as shown in the equations below:

**Calcium Fluoride**

\[ \text{CaF}_2 \rightleftharpoons \text{Ca}^{2+} + 2\text{F}^- \]

\[ \text{F}^- + \text{H}^+ \rightleftharpoons \text{HF} \]

\[ \text{HF} + \text{F}^- \]

**Sodium Fluoride**

\[ \text{NaF} \rightleftharpoons \text{Na}^+ + \text{F}^- \]

\[ \text{F}^- + \text{H}^+ \rightleftharpoons \text{HF} \]

\[ \text{HF} + \text{F}^- \]

In both instances fluoride is yielded in the forms F$^-$, HF and HF$_2^-$ and these will be chemically and 
physiologically identical irrespective of which two compounds they are derived from. Thus it is apparent 
that when occurring naturally or added artificially all fluorides in solution are in the form of fluoride 
ions and it is impossible to determine the source from which they were derived.

78. Q. Is it possible to use calcium fluoride in fluoridation projects?

A. Calcium fluoride is difficult to use, it being only sparsely soluble in water to the extent of 18 ppm. 
Advantage can, however, be taken of the fact that calcium fluoride is soluble in solutions of aluminium 
compounds, as for example, aluminium sulphate. Fluoridation plants using this method have been in 
operation for some years in Bel Air, Maryland and Rosiclare, Illinois$^1$.

Reference


79. Q. What is the danger, if any, that a whole town will be over-fluoridated?

A. Such a danger is non-existent. In this country the apparatus, chemicals and mode of operation are 
so arranged that it is absolutely impossible to administer a dangerous dose. The type of pump chosen 
operates at about its maximum capacity in adding the fluoride solution at the rate of 1 ppm. Moreover, 
the pump is frequently calibrated, and the fluoride content of the water is checked several times daily, 
so that any deviation from the desired level is immediately seen$^1$.

Nevertheless it is suggested by some that either by accident or design it is possible to have mass poisoning 
of a community. Though such ideas are unrealistic, they are entertained by some members of the community 
and therefore the logistics of the suggestion will be examined. It takes about 22 lb of solid sodium 
fluoride or 16.7 lbs of sodium silico fluoride in solution to fluoridate 1 million gallons of water at 1 ppm. 
To fluoridate 10 million gallons of water would require 2 cwt or 1$\frac{1}{2}$ cwt respectively. To raise that concentration 
to the level where the minimum fatal dose (2 grams) could be consumed in say, a 10 oz glass of water, 
it would be necessary to add to the same water supply 700 tons of sodium fluoride or 525 tons of sodium 
silico fluoride at one time. The hopper capacity of the fluoridator is designed to be limited to two days 
supply ($\pm$50 lbs) even if one put in one week's supply at one time, it would still be about one five-hundredth 
of the quantity required for the minimal fatal dose. Obviously it is impossible to get 700 tons into the 
water at one time$^4$.

References

80. Q. Is it true that fluoride corrodes and forms incrustation in water pipes?

A. Pipes are not affected. No problem arises from water supplied for drinking which contains 1 ppm F or even in the higher levels found naturally in some drinking water.

Reference
1 Fluoridation Engineering Manual by E. Bellack, Environmental Protection Agency, Water Supply Programs Division (1972) Chapter IX.

81. Q. What is the cost of implementing fluoride?

A. The capital costs comprising the purchase and installation of the plants and the construction of the fluoride stores come to £15,000 for the Elan Valley Works which supplies the city of Birmingham. The annual operating costs in 1966-67 were as follows:

<table>
<thead>
<tr>
<th>Service</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium silicofluoride</td>
<td>£9,439</td>
</tr>
<tr>
<td>Additional Lime Treatment</td>
<td>£1,030</td>
</tr>
<tr>
<td>Electricity Charges</td>
<td>£70</td>
</tr>
<tr>
<td>Wages and Materials</td>
<td>£1,102</td>
</tr>
<tr>
<td>Service Charges</td>
<td>£135</td>
</tr>
<tr>
<td>TOTAL</td>
<td>£11,776</td>
</tr>
</tbody>
</table>

The population in the area of supply was 1,286,172 and water was supplied in bulk to neighbouring undertakings and authorities. If only the population in the area of supply is taken into account, fluoridation costs were under 2.2 pence per head for the year. This is very similar to the cost of 2.61 pence per person in the Watford area. Current (1975) estimates of the cost per person in Newcastle are 5 pence per person.

References
2 Borough of Watford—Water Department (1972) Cost of Fluoridation (Mimeo).

82. Q. Is there any simple and inexpensive method whereby those not wishing to take fluoride in the drinking water may defluoridate in the home?

A. Yes. The New Zealand Royal Commission reports as follows: "Professor Shroff stated that the same principle (i.e. defluoridation) can be applied to the water supply of a single household, by using treated bone or synthetic apatite filters. This simple and effective means of removing fluoride from water could be used by people who prefer not to take fluoridated water. Professor H. V. Smith (Arizona), in a letter to Mr Woodhouse (Counsel appointed to assist the Commission) dated March 13, 1957, confirmed the efficacy of the household bone filter and stated that the purchase and cost of operating the filters is within range of the average American family."

A home-made defluoridator has been described by Fremlin and Challin. Such a defluoridator would not remove salts such as calcium and magnesium from a water supply.

References

83. Q. Does fluoride add taste, smell or colour to the water supply?

A. It does not affect the smell or colour. In a test on taste, only eight male students out of 187 thought they could detect a very slight taste at a level of 10 ppm F. At 1 ppm no taste was detected.

Reference

84. Q. Which countries have fluoridation?

A. In 1970 it was estimated that at least 110 million people living in 32 countries were drinking fluoridated water. The majority of these people are in the United States where nearly 4,000 communities are fluoridated. These include New York, Chicago, Philadelphia, San Francisco, Washington D.C., Baltimore and Detroit. The USSR has fluoridation in 24 communities, including Leningrad, serving a population of 13 million
people. New Zealand has two-thirds of its public water supplies fluoridated and in Australia 46·5 per cent of the population of 13 million and in Canada 6·6 million are drinking fluoridated water. In Paraguay and Puerto Rico both have nearly 100 per cent of their piped water supplies fluoridated and in Panama fluoridated water reaches 72 per cent of the population. Brazil has fluoridation in 86 communities and Colombia (1·1 million), Chile (86 communities) and Surinam has fluoridated water. The Irish Republic has mandatory fluoridation for the whole country. In Europe, Czechoslovakia has 10 per cent of its population drinking fluoridated water. Poland, Warsaw, is fluoridated and five per cent of British population drinks fluoridated water. In Asia, Malaysia, Singapore, Japan and Hong Kong have fluoridation.

Reference

85. Q. Which Area Health Authorities in England are wholly or partly supplied with fluoridated water in 1975

Reference
1 Department of Health and Social Security, May 1975.

LEGAL AND PUBLIC ASPECTS OF FLUORIDATION

86. Q. Is fluoridation an interference with individual freedom?
A. Objections of this class are based on value judgments which do not lend themselves to scientific evidence. Ultimately decisions of policy are required, which belong to the body politic. The question how far the rights of individuals in a given society should be curtailed in the public interest is one which constantly recurs in the political sphere. A particular issue's force as a political consideration cannot be determined without consideration of countervailing benefits, their certainty and their safety.

Fundamental rights are not absolute rights; individual liberty as an abstraction should never be allowed to destroy or blur the necessary limitations which must be imposed in the interests of a viable society. The conflict between the individual's right to live life as he pleases and the demands of a civilised, orderly and healthy society is more apparent than real because society in its own interests as a group has an interest in the preservation of a high degree of individual liberty. But it does suppose a balance.

The evidence available does not establish or raise any presumption of detriment to health or comfort other than the injury to a personal sense of liberty. This may be a serious matter to those who, having been persuaded wrongly that water fluoridated at 1 ppm will injure their health, will be distressed by the difficulty of avoiding it.

The fact that some consider that fluoridation is mainly intended to benefit children introduces a difficulty for those who object on the grounds of personal freedom. There are some who claim that the principle involves the right of parents to determine what was or was not good for their children. But the fact is that in the interests of children as a class, society has long recognised and accepts without reservation as right and proper a considerable limitation on the rights of parents to do what they like in regard to their children's health, education and welfare. It has been considered that the fact that children of tender years are the primary object of benefit is of overwhelming weight. Such children as a class are incapable of group initiative in matters relating to their health and welfare. The evidence as to the prevalence of dental decay in children makes it clear that reliance on parental responsibility is not an answer to the problem.

Some opponents of fluoridation do not see it in such terms. To them fluoridation of communal water supplies is an intolerable invasion of liberty and the term 'moral' objection is used to express their sense of outrage. In such a context the argument tends to become emotional rather than ethical.

References
87. **Q. What is wholesome water?**  

A. Under the Waterworks Clauses Act 1847 water for domestic use had to be ‘pure and wholesome’ but in the later Acts of 1936 and 1945 water was required to be wholesome. In fact a pure water is unobtainable in nature; even rain water contains chemicals.  

A wholesome water can be defined as one that contains no objectionable bacteria and can be consumed without injury to health. It should be free from turbidity, colour and taste, non-corrosive to metal piping, essentially free from iron and manganese and should not be lead solvent.

**Reference**  

88. **Q. Is fluoridation a form of pollution?**  

A. Opponents of fluoridation frequently allege that fluoridation is pollution and may have detrimental environmental effects. In response to such allegations, the United States Environmental Protection Agency issued the following statement in February 1973:  

‘Since the safety and efficacy of water fluoridation have been well established, the Environmental Protection Agency endorses the principles of such practice. The Environmental Protection Agency does not consider the adjustment of the fluoride content of drinking water for purposes of dental decay reduction to be a form of pollution. By definition, water pollution is the addition of a substance to water which makes such water unfit for its intended use. Since adjusting the natural fluoride content of drinking water to a level which is optimal for the reduction of dental decay does in no way make the water unfit for drinking, water fluoridation cannot be considered to be pollution.  

At the concentrations used in water fluoridation, the fluoride ion has no detrimental effects on the environment. Fluoride is a natural constituent of fresh water, soil, sea water and most living organisms, often at higher concentrations than are used in water fluoridation. A recent study on the environmental impact of fluorides, conducted by the National Research Council under contract to the Environmental Protection Agency, has confirmed that the only hazard to our environment from fluorides is from industrial discharges.’

89. **Q. Is fluoridation ‘mass medication?’**  

A. The following answers have been put forward to the allegation that fluoridation is mass medication:  

Black concluded that fluoridation was ‘merely a process of supplementation that is, adjusting a normal constituent of most natural waters to its optimum content from the standpoint of the public’s health. Obviously, fluoridation is not medication either mass or individual.’  

The Tasmanian Commissioner stated ‘I do not propose to indulge in any semantic debate as to what is “medication;” as to whether fluoride is a drug, a nutrient or a medicament. The last does not appear to be a term of art in the sense of having a precise and certain meaning in a technical context but even if it did I do not see that the identification of a label to be attached to the process under examination in any way advances or detracts from the merits of the matter. These should be determined not by the emotional context of any verbal category to which the subject can be ascribed, but by its dispassionate comparison of benefits and disadvantages.’

**References**  

90. **Q. Which public bodies have the power to decide whether or not artificial fluoridation is to be implemented in any area?**  

A. Under the National Health Service Reorganisation Act 1973 it is the responsibility of each Area Health Authority to decide in respect of its own Area whether it wishes fluoridation to be introduced and, if so, to approach the appropriate Regional Water Authority.