FLUORIDATION – FRAGMENTED FACTS

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ABSTRACT

Fluoridation has been attributed with decreasing the number of dental caries in children, although the extent of this reduction is uncertain. This reduction in dental caries is the driver for fluoridation, since the cost of fluoridation is low compared with the cost of extra dental work which would otherwise be required.

Fluoridation of a municipal water supply presents an ethical conflict between benefiting the common good and infringing on an individual's rights. On one side of the argument, fluoridation is viewed as a violation of ethical rights where an individual must use the fluoridated municipal water supply without giving informed consent. The other side of the argument is that fluoridation can be viewed as controlled intervention to replicate the benefits of a naturally fluoridated water supply, which provides the greatest benefit to those least able to help themselves.

The argument is fuelled by the fact that scientists have failed to reach a consensus on fluoridation with respect to both its efficacy and safety. The majority of studies carried out internationally have been of poor quality and as such no conclusion can be made confirming the affect of fluoridation on closing the socio-economic or ethnic dental health inequality gap, the level of risk of dental fluorosis posed by adding fluoride into the water supply, and the safety of water fluoridation and its long-term health impacts.

KEYWORDS

Fluoride, Fluorosis, Dental health, Inequality, Caries

NOMENCLATURE

Caries – tooth decay.

Confounding factor – factors which can cause or prevent the outcome of interest. For fluoridation these include age, gender, ethnicity and social-class.

Cross-sectional study - a study that aims to describe disease in a population as it is present at the time. It gives no regard for what may have preceded or precipitated the health status found at the time. It is the simplest form of epidemiological study.

Dental fluorosis – a condition which is a result of excessive fluoride intake during the tooth development stage. It is characterised by white flecking or mottling of the teeth in its mild form and brown staining and pitting in its severe form.

DMFT – Decayed, Missing or Filled Teeth

Epidemiological study – a study that aims to link particular health effects to a specified cause in the human population.

Goitre – condition characterised by an abnormally enlarged thyroid gland; usually this is the result of the under- or over-production of a hormone or from an iodine deficiency in the diet.

HFA - Hydrofluorosilicic Acid

MoH – Ministry of Health (New Zealand)

1 INTRODUCTION

Water fluoridation is the controlled addition of fluoride to a municipal water supply with the aim of improving oral health. The facts to back up whether fluoridation achieves this aim are fragmented and hence, so is the approach to the fluoridation process. Fluoridation began in New Zealand over 50 years ago, and fluoridated water is currently supplied to 58% of the population, this includes the major cities except Christchurch. The New Zealand Ministry of Health (MoH) advocate a fluoride concentration between 0.7 – 1.0mg/L in the municipal water supply but this is not obligatory and councils make their own choice on the issue. Fluoridation of municipal water supplies is controversial to many people and councils often choose not to make a decision on the issue themselves, but rather to use a referendum to capture public opinion.

Fluoridation is advocated in New Zealand because it has been credited with reducing tooth decay and to narrowing the oral health inequity gap between socio-economic groups, Maori and Pacific Islanders. However, during the 50 years that fluoridation has been practised around the world, studies carried out into the benefits of fluoridation have at best been of moderate quality, failing to carry out proper analysis and account for confounding factors. This leads to information that shows some positives for fluoridation but is also often inconclusive and sometimes even misleading.

2 BENEFITS AND RISKS

2.1 BACKGROUND

A link between fluoride content in the municipal water supply and dental decay was first discovered in the USA in the early 1900's, when it was noticed that in particular areas of the country residents had stained brown teeth. Although this was cosmetically unappealing, these residents' teeth were more resistant to dental decay.

In the 1930's and 1940's a series of epidemiological studies were published by H. Trendley Dean and his colleagues for the US National Institute of Health discussing the effect of increasing natural fluoride concentration in water and the prevalence of dental fluorosis and decay. These epidemiological studies found that dental decay decreased with increasing fluoride concentration, up to a concentration of 2mg/L. However, this was at the expense of increasing prevalence and severity of dental fluorosis. (Lennon, 2006)

Dental fluorosis is an enamel defect that shows up as white flecking of the teeth in its mild form and pitting or mottling in its severe form. It should be noted that in its severe form it becomes a health issue, as opposed to a cosmetic issue. The studies by Dean then went on to recommend an optimal fluoride concentration of 1mg/L of fluoride in the drinking water. This maximised the beneficial affect of increasing teeth resistance to dental decay whilst minimising the effect of dental fluorosis. This led to the implementation of artificial fluoridation of the water supplies in the USA from the mid 1940's. (Lennon, 2006)

Although fluoridation has been used for over half a century to improve oral health, it is still a very controversial subject which polarises peoples' opinions for several reasons. These will be discussed further in Sections 2.2 and 2.3 and are summarised below:

- Fluoride has not been demonstrated to be an essential element in the human diet. Whilst it strengthens teeth, it is not a pre-requisite for strong, healthy teeth.

- Fluoridation of the water supply is what anti-fluoridation groups term as 'mass-medication' as it restricts the individual's freedom of choice.

- There is still insufficient scientific data to prove or disprove the safety of dosing fluoride in the water supply.

- The specific dental decay resistance benefit is variable and significantly affected by local conditions.

- In some communities the addition of chemical additives is seen as contaminating 'pure' water. This applies not only to fluoride, but other chemicals such as chlorine used for disinfection of the water supply.

2.2 BENEFITS

The benefits of fluoridation have been investigated in many studies over the last fifty years, and confirm the efficacy of fluoride in making teeth more resistant to decay.

Tooth enamel is highly mineralised and is composed mainly of calcium and phosphorous. Tooth decay is caused by bacteria breaking down the sugar and starch in food into acids in an individual's mouth. These acids then dissolve the tooth enamel and with time this gradually results in tooth decay.

Dental decay is measured by the mean number of decayed, filled or missing teeth (DMFT) in:

- 5 year old children (deciduous teeth); and

- 12 year old children (permanent teeth).

Fluoride is mainly incorporated into tooth enamel during a child's growth phase and according to the MoH protects teeth in the following ways:

1. Fluoride strengthens the tooth surface by making it more resistant to acid attack (i.e. it makes the enamel less soluble).

2. Fluoride interferes with the growth of bacteria which causes tooth decay.

3. Fluoride facilitates in the repair of early tooth decay.

2.2.1 REDUCING SOCIAL AND ETHNIC INEQUALITY

A report by Hague (2003) to the Minister of Health by the National Health Committee found that significant oral health inequalities exist among Maori and Pacific Island children and those of low socio economic status as

opposed to children from other backgrounds. This report cited that fluoridation is an effective means of narrowing this inequity gap.

Tooth decay data is available by from the MoH website. Table 1 shows oral health data among children in New Zealand in 2007. This data is split into fluoridated and non-fluoridated areas but must be interpreted with caution as there has been no analysis to account for confounding factors. Generally, the data supports the opinion that oral health in fluoridated regions is better than in regions without fluoridation. The data also shows an improvement in dental health for all ethnicities and that a greater benefit is observed when children obtain their permanent teeth (the 12 year old age group).

Table 1: New Zealand Oral Health Data (2007)

	5 year olds		Year 8 (12 year olds)	
	Non-fluoridated	Fluoridated	Non-fluoridated	Fluoridated
Total Children Caries free (%)	49.7	53.2	41.0	52.9
Maori Children Caries Free (%)	22.9	35.1	27.4	37.6
Pacific Island Children Caries Free (%)	26.4	29.4	35.9	45.3
Other Children Caries Free (%)	58.9	63.9	45.0	57.0

2.2.2 COST EFFECTIVENESS

Fluoridation is estimated to prevent between 2.4 and 12 decayed, missing and filled teeth for the average individual throughout their lifetime. In New Zealand, fluoridation is attributed with preventing between 58,000 and 267,000 decayed, missing and filled teeth each year. This water fluoridation benefit is above that provided by other sources of fluoride; such as toothpaste and fluoride tablets. (Hague, 2003)

Although the difference in caries rates between fluoridated and non-fluoridated areas has narrowed, an investigation into whether it was still effective to fluoridate water and found that fluoridation was still cost effective for populations above 1000. (Wright et al., 1999)

2.3 RISKS

2.3.1 DENTAL FLUOROSIS

Increasing the fluoride concentration present in a municipal water supply is associated with an increased risk of dental fluorosis. Dental fluorosis develops during the development stage of the tooth and is due to high fluoride intake. Figure 1 compares normal teeth to those with varying levels of fluorosis.

Figure 1: Dental Fluorosis (obtained from www.neevio.com/Fluoride/Images/fluoride_effects.jpg)

In its mild form, fluorosis is assessed as being of cosmetic significance, not of health significance, therefore the MoH does not consider it a high risk. The maximum acceptable value (MAV) of fluoride in the New Zealand Drinking Water Standards 2005 (revised 2008) is 1.5 mg/L. At this level, fluorosis of health significanceis not considered a threat.

McDonagh et al., (2000) produced a comprehensive review of literature on fluoridation at the University of York in the United Kingdom. The review estimated that at fluoride levels typically used in fluoridation schemes (1.0 mg/L), a level of fluorosis which is of aesthetic concern is estimated to be present in 12.5% of the population. Approximately 48% of the population are estimated to have a very mild level of fluorosis.

McDonagh et al. (2000) also stated that the quality of the studies evaluating the risk of dental fluorosis was poor due to observer bias and because the majority of the studies did not account for exposure to other sources of fluoride.

Few studies that assess the prevalence of fluorosis have been carried out in New Zealand, and it can be difficult to compare overseas studies to New Zealand. For instance, the US Environmental Protection Agency (EPA) sets a maximum acceptable concentration for fluoride in water supplies of 2.0 mg/L, which is higher than the 1.5 mg/L set in New Zealand. Therefore, it is likely that studies conducted on dental fluorosis due to fluoridation in the USA would not be reflective of the level of fluorosis that would be observed in New Zealand.

A New Zealand report by Bates, (2000) written for the MoH found that fluoridated areas have a greater prevalence of dental fluorosis. However, the report also found that the greatest relative increase in dental fluorosis has occurred in non-fluoridated areas suggesting that elevated fluoride intake from other sources, such as toothpaste and fluoride supplements could be the cause.

No studies have been found which are conclusive about cumulative effects of fluoridised water along with exposure to other sources of fluoride. However, the position of the New Zealand MoH is that fluoride in drinking water, at a level of 1.0mg/L or less, should be used together with fluoridised toothpaste, as each of these adds benefits to the user to more effectively fight tooth decay.

2.3.2 SKELETAL FLUOROSIS

Skeletal fluorosis is a condition which includes symptoms of stiffness and pain in the joints and in severe cases changes in the bone structure and calcification of ligaments. (WHO, 2008)

Skeletal fluorosis results from long term accumulation of fluoride in the bone structure and occurs at water fluoride concentrations of 3.0 to 6.0 mg/L, and crippling fluorosis occurs at levels above 10.0 mg/L. This is well above the fluoride content of 1.5 mg/L recommended by the Drinking Water Standards of New Zealand 2005 (revised 2008). Although these levels are well above the quantity of fluoride added to drinking water, these figures are not definitive as they do not take total fluoride consumption into consideration. (Fawell, 2004)

2.3.3 OVER FLUORIDATION

There have been 13 known incidents of over fluoridation of water supplies worldwide. However, only seven of these resulted in adverse affects to humans and the majority of the events occurred in the USA. One of the most serious events occurred in Annapolis, USA in 1979. The accident was caused because a technician at a water treatment plant failed to close a valve and fluoride levels reached 30ppm for 17hours and resulted in the death of one person, who was undergoing haemodialysis at the time. A significant number of other residents were made ill, with symptoms matching those of acute fluoride intoxication such as nausea and stomach ache. (Waldbott, 1982)

A more recent event occurred in 1994 in Alaska due to malfunction of fluoridation equipment at a water treatment plant. It was noted that in this incident a lack of safety features, human error and failure to comply with regulations also played a part. This incident resulted in fluoride concentration reaching levels of 150ppm, causing one death. Approximately 300 people are estimated to have been made ill with acute fluoride intoxication.

The risk of over-fluoridation will always exist, however, an assessment made by the NZ Public Health Commission has classified this as being low, owing to improvements in equipment and constant monitoring. (Wilson, 1994)

3 INCONCLUSIVE INFORMATION

The issue of health risks resulting from fluoridation is used by campaigners both for and against fluoridation. This is due to the lack of high-quality studies carried out over the last half-century evaluating the health effects of fluoride at the low concentrations dosed in the water supply.

The lack of quality studies is used by pro-fluoridation groups to claim that fluoridation is safe, as there is no evidence showing otherwise. Meanwhile, anti-fluoridation groups use this to discourage fluoridation by campaigning that fluoridation has not been proven to be safe.

McDonagh et al., (2000) examined papers studying the effect of fluoride on cancer, Down's syndrome, bone fracture and bone development problems, senile dementia, IQ, and goitre. This examination found that the quality of studies carried out to assess the health affects of fluoride were poor and needed further investigation as no credible evidence proving or disproving the safety of fluoride dosing was found. The majority of the studies failed to control for confounding factors; for example age when studying the effect of fluoride on bone fractures.

Wilson, (1994) reported that "there is a small increased risk of hip fracture associated with fluoridation, though the evidence for this is very inconclusive". The same report also specified that more research is needed to clarify this issue.

McDonagh (2000) remarked on the surprising lack of good quality studies carried out on fluoridation of drinking water given the controversy and interest in the subject. The position of New Zealand MoH on the safety of fluoride dosing is stated on their website as "research concludes that water fluoridation is safe and effective".

3.1 NATURAL VERSUS ARTIFICIAL SOURCE OF FLUORIDE

Fluoride can be found naturally in most drinking waters, and originates from minerals such as fluorspar, cryolite and fluorapatite in the earth's crust. (Fawell, 2004) When fluoride is added artificially it is normally added in the forms of hydrofluorosilicic acid (HFA), sodium fluorosilicate or sodium fluoride.

Concerns associated with fluoridation are often raised due to the use of an artificial source of fluoride. There is some debate as to whether fluoride from artificial sources dissociates into the same compounds or elements as fluoride present naturally in the water. The MoH states on their website that "the fluoride ions in water are exactly the same regardless of whether they come naturally from rocks or are added as calcium fluoride or sodium silicofluoride".

Haneke (2001) conducted a review of toxicological information for the U.S. National Institute of Health Sciences, which reported that fluorosilicates essentially dissociate 100% at the pH of drinking water. However, the report stated that when fluorosilicates are highly acidified, this results in the release of toxic and corrosive fluoride fumes such as hydrogen fluoride and silicon tetrafluoride. The 'essential' 100% dissociation of silicofluorides in drinking water has come under criticism from opponents of fluoridation, specifically noting the acidified nature of the stomach. Whether artificial and natural sources of fluoride are exactly the same when they are dissolved in water is still a contentious issue.

McDonagh et al. (2000) examined studies comparing natural and artificial fluoridation, and reported the same beneficial effect on the prevention of dental decay between both natural and artificially present fluoride. However, the report also stated that there are insufficient studies comparing the health effects of natural and artificial fluoridation to make a conclusion on differences in toxicity.

3.2 NEGLIGIBLE REDUCTION IN TOOTH DECAY

Decayed, missing and filled teeth (DMFT) data for 5 and 12 year olds is available from the New Zealand MoH website by region. The data has been subdivided to show the differences between children using the fluoridated or non-fluoridated water supply. Data for the whole of New Zealand showing the average DMFT per child is provided in Table 2. The data shows that the children using fluoridated water have a lower average DMFT. The data also shows that Maori and Pacific Island children have a more significant decrease in DMFT

when in a fluoridated region than children from other ethnicities. However, this data does not take into account confounding factors which play an important part in dental health, such as the dental hygiene practised by each child.

Table 2: New Zealand Oral Health Data for Decayed, Missing and Filled Teeth (2007)

	5 year olds		Year 8 (12 year olds)	
	Non-fluoridated	Fluoridated	Non-fluoridated	Fluoridated
Average DMFT* of All Children	1.88	1.35	1.78	1.29
Average DMFT* of Maori Children	4.23	3.05	2.63	1.93
Average DMFT* of Pacific Island Children	4.94	3.97	2.39	1.69
Average DMFT* of Other Children	2.50	2.00	1.52	1.05
*Average number of decayed, missing and filled teeth.				

Hague et al., (2003) stated that children of lower socio-economic status that live in rural areas have an increased risk of dental caries. The increase in the rate of dental caries is due to one of several factors: socio-economic status; non-fluoridation of the water supply (smaller, rural water treatment plants are less likely to fluoridate water compared to larger urban plants); or difficulty accessing dental services. No conclusion was made regarding which of these factors is the main driver for increased dental caries.

Dr John Colquhoun, a former principal dental officer for the Auckland region and previously a supporter of fluoridation, has criticised the methodology of many fluoridation studies which show fluoridation has a net benefit. Dr Colquhoun has published papers which have found no net benefit. Colquhoun et al., (1999) conducted an investigation into government archives to gain insight into the 1954 Hastings trial, where a decrease in the decay of permanent teeth of 50 to 60%, was attributed to fluoridation. Dr Colquhoun found that the claimed tooth decay reduction was at least partially brought about by changes in diagnostic procedures in the school dental clinics. These changes, made after the start of the trial and local to the experiment area only, were not mentioned in the study. The paper also states that throughout the rest of New Zealand, oral health was improving despite having un-fluoridated water and unchanged diagnostic procedures. It should be noted that Dr Colquhoun's work has come under critique from proponents of fluoridation.

Wilson (1994) wrote a report for the NZ Public Health Commission where he stated "there were indeed significant methodological inadequacies in some of the early studies on water fluoridation. Most of the studies in more recent years, however, have had appropriate methodology and, taken as a whole, provide extremely good evidence that water fluoridation is effective".

The review by McDonagh et al., (2000) which is more recent, found that the majority of the studies carried out on the benefits of fluoridation were of moderate quality (no high quality studies). The report also stated that the most serious issue with the studies was lack of proper analysis, as well as no control for confounding

factors. In spite of this, the review concluded that fluoridation of drinking water does reduce the prevalence of dental caries, although the extent of this reduction is not stated.

It can be concluded that if an individual uses fluoridised water, the risk of no reduction in the presence of dental caries is low. However, the degree to which the prevalence of caries would be reduced is unclear.

3.2.1 SOCIO-ECONOMIC ORAL HEALTH INEQUITIES

The New Zealand Public Health Commission has endorsed fluoridation as a means of reducing oral health inequalities in low socio-economic status groups and in Maori and Pacific Islanders. (Wilson, 1994) The data provided in Table 2 has not been assessed for confounding factors but generally supports this position.

The review conducted by McDonagh et al., (2000) found that worldwide, the evidence of fluoridation reducing dental health inequalities between social classes was poor; no high or moderate quality studies could be found. Studies were classified as being of poor quality if they failed to control for confounding factors, measurement bias and had low quality of study design (cross-sectional studies). Cross-sectional studies aim to describe disease in a population as it is present at the time, it gives no regard for what may have preceded or precipitated the health status found at the time and is the simplest form of epidemiological study. Studies that were reviewed showed some evidence of fluoridation reducing dental health inequalities between social classes. The review states that this result should be interpreted with caution due to the very poor quality of studies available in this area.

No reviews of studies carried out in New Zealand could be found, therefore no definitive conclusion about fluoridation bridging the gap between social classes can be made with the poor quality of international studies and lack of New Zealand studies.

3.3 LOCAL CONSIDERATIONS

Whether the risks of fluoridation outweigh the benefits is a local issue and when considering addition of fluoride to a water supply, the following should be taken into consideration:

- Local fluoride intake from other sources such as food and toothpaste
- Local dental decay frequency and whether it is better or worse than the national average
- Alternative strategies for improving oral health
- Natural fluoride concentration in the water supply

Data available in the public domain in New Zealand shows that fluoridation does provide a net benefit. However, there has been no analysis of this data for any of the local considerations. One region which does not fluoridate their water supply is Nelson-Marlborough. The data available from the MoH website for this region is compared with the national data for areas that fluoridate in Table 3.

Table 3: Nelson-Marlborough versus New Zealand Oral Health Data (2007)

	5 year olds		Year 8 (12 year olds)	
	Nelson – Marlborough	National Fluoridated	Non-fluoridated	Fluoridated
Total Children Caries free (%)	55.0	53.2	49.22	52.9
Maori Children Caries Free (%)	32.4	35.1	27.4	37.6
Pacific Island Children Caries Free (%)	40.0	29.4	37.0	45.3
Other Children Caries Free (%)	58.0	63.9	51.9	57.0
Average DMFT* of All Children	2.10	1.35	1.21	1.29
Average DMFT* of Maori Children	3.82	3.05	2.58	1.93
Average DMFT* of Pacific Island Children	3.60	3.97	1.93	1.69
Average DMFT* of Other Children	1.86	2.00	1.01	1.05
*Average number of decayed, missing and filled teeth.				

Overall, the data shows very negligible differences between children in the Nelson-Marlborough region and fluoridated regions of New Zealand. This emphasises the point that confounding factors must be considered when making any analysis and when introducing fluoridation into any particular region.

4 OPPOSITION

Concerns about fluoridation from the general public generally centre around the following:

- Addition of a toxic waste to the water;
- Health concerns;
- Individuals' rights and mass medication;
- 'Pure' water;
- Fluoridated water and baby formula.

4.1 ADDITION OF A TOXIC WASTE TO THE WATER

Anti-fluoridation groups have raised the concern that Hydrofluosilicic Acid (HFA), which is one source of fluoride used for treating municipal water supplies, is a by-product of the fertiliser industry. It has thus been labelled as a toxic waste and discussions have been raised about whether fluoridation also raises other contaminant levels in the water, e.g. arsenic.

The MoH website references a study carried out by the City of Fort Collins Fluoride Technical Study group, which found that HFA did not increase any contaminant levels into the water supply. (Carr et al., 2003). However, because this study was carried out in the U.S.A. and the chemical would be manufactured by a different facility, the findings of this study may not be relevant to New Zealand.

4.2 HEALTH CONCERNS

A multitude of health concerns have been raised regarding the safe consumption of fluoride. There have been no adequate studies carried out to prove conclusively whether fluoride safe or unsafe to use at the concentrations dosed into the water supply.

4.3 INDIVIDUALS RIGHTS AND MASS MEDICATION

Anti-fluoridation groups argue that the addition of fluoride to the potable water supply goes against individuals' rights and label it as 'mass medication'. This is an emotional argument which can sway people that have not made a decision based on scientific evidence for or against fluoridation.

4.4 'PURE' WATER

Some communities may be reluctant to add fluoride to the water supply on the basis that it will be polluting a 'pure water source'. However, these communities are likely to reject other chemicals as well, such as chlorine which has been widely accepted and is commonly used for disinfection.

4.5 FLUORIDATED WATER AND BABY FORMULA

Recently, concerns have been raised by the US National Research Council (NRC) on the possibility that infants may receive greater than optimal dose of fluoride through liquid concentrate or baby formula mixed with fluoridated water supplies. This would increase the probability of developing dental fluorosis.

However, the MoH has specified that this is unlikely to be a problem in New Zealand for the following reasons:

- The MoH recommends a narrower range for optimal fluoride levels in the drinking water (0.7 to 1mg/L in New Zealand, as opposed to 0.7 to 1.2mg/L in the USA).
- The maximum acceptable fluoride level in New Zealand drinking water is 1.5mg/L (as per the Drinking Water Standards 2005, revised 2008) as opposed to 2mg/L in the USA.
- Fluoride is not permitted as an additive to infant formula marketed in New Zealand.

5 CONCLUSIONS

Fluoridation has both, ardent opponents and supporters who are capable of scaremongering their communities in both directions by providing misleading information. Propaganda often occurs in advertising campaigns which are subjective only and do not provide any scientific evidence.

Fluoridation of drinking water reduces the frequency of dental caries although the extent of this reduction has not been adequately quantified. Around the world a large number of studies of varying quality have been completed to attempt to quantify this improvement. Many of these studies are considered low quality as they do not account for confounding factors. Therefore, no clear consensus on the quantitative benefits of fluoridation can be drawn from the studies. There are many local factors that influence fluoridation, one example is climate, in hotter areas people are likely to drink more water. There are many other factors that affect fluoridation and this makes it difficult to draw conclusions about New Zealand from studies that have been carried out overseas.

Addition of fluoride to drinking water is recommended in New Zealand due to its cost benefit. Fluoridation is attributed with saving costs on dental work of 2.4 to 12 decayed, missing or filled teeth in each individual's lifetime in New Zealand. Money spent on fluoridation is considered to be a saving in dental care, therefore, a subsidy is available to water treatment plants that opt to install fluoride dosing equipment.

No conclusion can be made about whether fluoridation decreases the socio-economic and ethnic inequality gap. Studies have attempted to show that fluoridation reduces these gaps. However, reviews of these studies have deemed most of them to be of poor quality because they do not account for confounding factors.

Fluoridation has been found to be responsible for some dental fluorosis. However, there is lack of information to quantify the extent of dental fluorosis that is caused by fluoride added to municipal water supplies and the extent that should be attributed to fluoride exposure from other sources. Similarly, there is lack of information to prove or disprove the effects that fluoridation has on other aspects of human health.

The occurrence of tooth decay has reduced in recent years due to improved dental practices, availability of high quality dental hygiene products, and widespread education for people from a young age into the benefits of healthy teeth. These factors have not been controlled well in studies that have attempted to prove fluoridation is effective in improving dental health. However, fluoridation is promoted in New Zealand by the MoH, and although it is not compulsory for municipal water supplies to fluoridate, many of the larger water treatment plants in New Zealand have incorporated fluoridation into their process.

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