NFIS

National Fluoridation Information Service

Review of Scientific Papers Relating to Water Fluoridation

published between December 2010 and August 2011

National Fluoridation Information Service Review

Regional Public Health
Better Health For The Wellington Region

HUTT VALLEY DHB

MASSEY UNIVERSITY
WELLINGTON

ESR

NZ National
Poisons Centre

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NATIONAL FLUORIDATION INFORMATION SERVICE

The National Fluoridation Information Service (NFIS) is a consortium funded by the Ministry of Health, led by Regional Public Health working in partnership with:

- Hutt Valley DHB Community Dental Services
- Environmental Science and Research
- Centre for Public Health Research at Massey University
- National Poisons Centre

Our work includes:

- Following public debate and choices on water fluoridation
- Monitoring international research on the usefulness of water fluoridation
- Critically reviewing emerging research
- Working with District Health Boards and Councils to provide accurate and up-to-date information to their communities
- Providing clinical advice to the Ministry of Health
- Monitoring water fluoridation policy
- Providing access to New Zealand oral health data and research
- Sharing information via quarterly e-newsletters and e-briefings and the NFIS website

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TABLE OF CONTENTS

Communication and Community Engagement

Toxicology and Pharmacology

PAPERS RELEVANT TO THE MINISTRY OF HEALTH'S COMMUNITY WATER FLUORIDATION (CWF) PROGRAMME

Six papers in the *Oral and Public Health Epidemiology* area have relevance to the Ministry of Health's Community Water Fluoridation (CWF) programme.

The recommendations of the American Academy of Pediatrics and other professional organisations [3] to improve the oral health of children in indigenous communities in Canada has some relevance to New Zealand CWF policy. For example, the statement recommends that indigenous communities should be provided with information on CWF, and opportunities for CWF (capital and maintenance costs and training for operators) of the drinking water supply should be advocated within and for indigenous communities.

The predictive model presented by Downer et al [4] has some relevance to New Zealand cities considering CWF and estimating the potential of any improvements in dental health.

The paper by Koltermann et al [7] supports findings from New Zealand Oral Health Survey [1] and the continuation of the Ministry's current CWF policy. The paper showed that higher prevalence rates of functional dentition were associated with municipalities having higher mean income and CWF programmes and with individuals living in urban areas, younger adults, males, those with more schooling and higher income, those that reported having visited the dentist in the previous 12 months, and those with access to information on prevention.

The paper by Buzalaf et al [15] is useful if a New Zealand study were to be conducted to measure fluoride levels in individuals. It was found that urine can be used as an indicator of fluoride intake at the community level and toenails as an indicator of fluoride intake at the individual level.

Bernabe and Marcenes [17] showed that in the United States, there is a relationship between state income inequality and individual tooth loss, after adjustment for various potential state- and individual-level confounders and mediators. Individuals in states with more income inequality reported greater tooth loss than those in states with less income inequality.

[1] Ministry of Health. 2010. Our Oral Health: Key Findings of the 2009 New Zealand Oral Health Survey. Wellington.

Buchel et al [18] found the prevalences of dental fluorosis were identical in the two Swiss cantons, despite each having different fluoridation schemes. The prominent enamel fluorosis among adolescents in two areas did not indicate a general oversupply of fluoride.

The review by Lee and Messer [19] has relevance by showing there are many different risk factors for dental caries even with CWF and studies must control for their potential effect. Good oral health depends on the availability of CWF, complimented by reduced or managed intakes of sweet drinks and foods.

There are aspects of the all three papers in *Communication and Community Engagement* area which have relevance to the Ministry's continued communication of its CWF policy.

Armfield and Akers [22] recommended that health authorities should be responsible for making decisions regarding the introduction of CWF. Berg et al [23] suggested that practitioners should be aware that children are exposed to multiple sources of fluoride during the tooth development period. Sivaneswaran and Chong [24] provided practical advice to individuals charged with persuading communities to adopt CWF.
None of the six *Toxicology and Pharmacology* related papers reviewed had any practical implications or relevance for the Ministry's CWF policy.

Conclusion

No evidence emerges from the papers reviewed to suggest a change in the Ministry's current CWF policy.

SUMMARY

The Ministry of Health (the Ministry) recommends community water fluoridation (CWF) where technically feasible as a safe and effective means of improving oral health. Approximately 56% of the New Zealand population currently has access to fluoridated drinking-water. The Ministry aims to increase access to CWF programmes to 70% of the population.

Under current New Zealand law, District Health Boards are responsible for protecting the health of their populations, while local councils are charged with deciding whether to fluoridate the drinking water supplies they operate. CWF is a controversial issue and it was deemed important that District Health Boards and the Ministry have access to the best scientific evidence.

The Ministry established a National Fluoridation Information Service (the Service) to:

i. monitor public discussion and decision-making processes on CWF in New Zealand
ii. provide a central authoritative, accurate and up-to-date source of information and critical commentary on research pertaining to CWF
iii. coordinate support, communication and clinical and technical advice to, and on behalf of, District Health Boards and the Ministry
iv. ensure consistent, accurate, and up-to-date information and messages are communicated by District Health Boards and the Ministry
v. evaluate the effectiveness of the Service in advancing CWF in New Zealand.

This literature review critically appraises scientific papers published between December 2010 and August 2011, complementing previous reviews for the Service (available on the website www.nfis.org.nz).

The review identifies the implications of its findings for the Ministry's fluoridation policy.

The New Zealand Context

Important facets of the New Zealand context in relation to CWF are:

i. naturally-occurring fluoride concentrations in New Zealand's water supplies are low – generally less than 0.2 mg/L;
ii. the maximum acceptable value for fluoride in drinking water, given in the *Drinking-Water Standards for New Zealand* and based on the World Health

Organization Guideline, is 1.5 mg/L, which is designed to prevent possible undesirable health effects that may result from excessive fluoride intake;

iii. up-to-date information about the prevalence of tooth decay in New Zealand is available from a recently undertaken Oral Health Survey[2];

iv. the prevalence of tooth enamel defects does not appear to be increasing in New Zealand[3]

v. toothpaste in New Zealand is fluoridated at approximately 1000 mg/kg, which is typical of other developed countries, and considered safe for use by children[2].

Method

Papers in the following fields were of interest for this review:

i. oral and public health epidemiology associated with CWF;
ii. policy development;
iii. communication and community engagement;
iv. toxicology and pharmacology.

Two scientific bibliographic databases, Scopus and Web of Knowledge, were searched with the following rejection criteria[4]:

i. a language other than English;
ii. not primarily focused on CWF – health effects or impacts;
iii. an historical commentary, opinion piece or editorial;
iv. not falling into one of subject fields noted above;
v. a study of an area or country with a context unlike that of New Zealand;
vi. primarily concerned with fluoride in drinking water levels outside of the currently recommended fluoridation range in New Zealand (0.7–1.0 mg/L).

A total of 100 papers were identified, but only 30 were deemed relevant for critical review.

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[2] Available at: http://www.moh.govt.nz/moh.nsf/indexmh/our-oral-health-key-findings-2009-nz-oral-health-survey

[3] Ministry of Health. 2009. Guidelines for the use of fluoride. 2009. Wellington. Available at http://www.moh.govt.nz/moh.nsf/indexmh/guidelines-for-the-use-of-fluorides?Open

[4] Several animal studies, which were considered important to include, did not meet all these criteria.

Key findings and Implications for the Ministry of Health's Fluoridation Policy

The key findings listed here are those considered applicable to New Zealand and the development of the Ministry's CWF policy [reference to the reviewed papers listed in the Appendix].

Oral and Public Health Epidemiology

- Oral health promotion intervention delivered via local maternal and child health nurses (MCHNs) promoting early exposure to fluoride may be successful in reducing caries in the second year of life but less so in older children when participants have less contact with MCHNs [1]. This finding has no direct implications for the Ministry's CWF policy, but may have some interest to organisations such as Plunket.

- The American Academy of Pediatrics and other professional organisations made a number of recommendations to improve the oral health of children in indigenous communities in Canada in the areas of: clinical care, community-based promotion activities, work and access issues, advocacy and research [3]. For example, the statement recommends that indigenous communities should be provided with information on CWF, and opportunities for CWF (capital and maintenance costs and training for operators) of the drinking water supply should be advocated within and for indigenous communities.

- Downer et al [4] presented a worked example of predictive tool to provide a pragmatic indication, for planning purposes, of the expected improvements in dental health from fluoridating the drinking water supplies of the city and its environs. The predictive model may have some application for New Zealand cities considering CWF and estimating any improvements in oral health.

- Silva-Sanirgorski et al [5] provided a methodologically robust proposal for investigating the impact of drink choices on child obesity risk and oral health status, but the proposal has no implications for the Ministry's CWF policy.

- Ditmyer et al [6] found that multifactorial Risk Factor Model provided a relatively constant, valid measure of caries which could be used in conjunction with a comprehensive risk assessment in population-based screenings by school nurses/nurse practitioners, health educators, and physicians to guide

them in assessing potential future caries risk for use in prevention and referral. The paper has no implications for the Ministry's CWF policy.

- A multivariate analyses in Brazil by Koltermann et al [7] showed that higher prevalence rates of functional dentition were associated with municipalities having higher mean income and CWF programmes and with individuals living in urban areas, younger adults, males, those with more schooling and higher income, those that reported having visited the dentist in the previous 12 months, and those with access to information on prevention. The robust methodology of this study and the large number of participants adds weight to the findings from the New Zealand Oral Health Survey [1] and therefore supports continuation of the Ministry's CWF policy.

- The ecological study in Hulunbauir City, Inner Mongolia by Ding et al [11] suggested that low levels of fluoride exposure in drinking water had negative effects on children's intelligence and dental health and confirmed a dose–response relationship between urine fluoride and IQ scores as well as dental fluorosis. The ecological nature of this study has limited relevance to New Zealand. The authors also carried out a multiple linear regression analysis which showed a negative dose-response between urine fluoride exposure and IQ scores. However, this finding has little relevance to New Zealand CWF policy, as age was the only covariate included in the model. No account was taken of the possible effect of other factors which may influence a child's intelligence (eg, parental education status, maternal age at delivery etc). Therefore, it cannot be concluded that the dose-response relationship was due to the effects of fluoride.

- If a study to measure fluoride levels in individuals were to be conducted in New Zealand, the paper by Buzalaf et al [15] has relevance. It showed that urine can be used as indicator of fluoride intake at the community level and toenails as an indicator of fluoride intake at the individual level.

- The paper from Bernabe and Marcenes [17] has relevance to the future of the Ministry's policy on CWF. In the United States, there is a relationship between state income inequality and individual tooth loss, after adjustment for various potential state- and individual- level confounders and mediators. Individuals in states with more income inequality reported greater tooth loss than those in states with less income inequality.

- Buchel et al [18] found that although there was different fluoridation schemes in the two Swiss cantons, the prevalence of dental fluorosis between the two were identical. In addition, the prominent enamel fluorosis among adolescents in two Swiss cantons did not indicate a general oversupply of fluoride. The paper is of limited relevance to New Zealand's CWF policy.

- The review by Lee and Messer [19] has relevance for the Ministry's future development and implementation of its CWF policy as it shows there are many different risk factors for dental caries even with CWF and studies must control for their potential effect. Good oral health depends on the availability of CWF, complimented by reduced or managed intakes of sweet drinks and foods. The authors made four clinical recommendations.

- The review by Lee and Messer [19] has relevance for Ministry's future policy development and implementation on fluoridation as it shows there are many different risk factors for dental caries even with fluoridated water and studies must control for their potential effect. Good oral health depends on the availability of fluoridated water, complimented by reduced or managed intakes of sweet drinks and foods. The authors made four clinical recommendations:
    - the frequency and timing of drinking sweet drinks should be included in discussing dietary risk factors for dental caries and erosion with patients and parents;
    - caries risk assessment protocols should include assessment of sweet drink intake;
    - a child remaining at high caries risk despite the best efforts by the dental team may require referral to a dietitian for dietary counselling;
    - health professionals should provide the community with appropriate recommendations and cautions concerning the consumption of sweet drinks, noting the potential for deleterious effects on the dentition.

Communication and Community Engagement

Aspects of these three papers are of relevance to the Ministry's continuing communication of its CWF policy.

- Armfield and Akers [22] recommended that health authorities should be responsible for making decisions regarding the introduction of CWF.
    - They also found awareness of public opinions of CWF, its variation by population characteristics, and the beliefs and attitudes associated with

support and opposition, are important in future efforts to further extend fluoridation as a public health practice.

- The authors concluded: 'awareness of public opinions of water fluoridation, its variation by population characteristics, and the beliefs and attitudes associated with support and opposition, will be important in future efforts to further extend this important public health practice.'

- Berg et al [23] suggested that practitioners should be aware that children are exposed to multiple sources of fluoride during the tooth development period.
  - Reducing fluoride intake from reconstituted infant formula alone will not eliminate the risk of fluorosis.
  - In addition, the authors recommend that clinicians provide advice to parents regarding the proper use of fluoridated toothpastes along with the informed prescription of fluoride supplements. They also make a number of recommendations for future research.

- Sivaneswaran and Chong [24] provide practical advice to individuals charged with persuading communities to adopt CWF.
  - They found that it is possible to garner community support for CWF with the use of a multifaceted approach in educating and consulting communities and stakeholders.
  - They found if people were informed about CWF, they were more likely to be supportive of the measure.
  - The role of the media as a source of information on CWF cannot be underestimated in any efforts to introduce CWF. This was confirmed by the survey which reported that the newspaper and radio were the main sources of information from which respondents learnt about CWF.

Toxicology and Pharmacology

None of the papers reviewed have practical implications or relevance for the Ministry's CWF policy [25-30].

Conclusion

No evidence emerges from the papers reviewed to suggest a change in the Ministry's current CWF policy.

INTRODUCTION

Background and Purpose

Epidemiological studies in the first half of the 20th century showed that naturally-occurring fluoride in water could be beneficial (caries reduction) and detrimental (fluorosis) to dental health5. Work to find the fluoride concentration that offered an acceptable balance between these effects eventually led to the introduction of CWF to drinking-water supplies as a public health measure in the USA and Canada in the mid 1940s5. CWF first began in Hastings in New Zealand in 19546. CWF of drinking water supplies in New Zealand expanded rapidly during the 1960s6.

In 2011, approximately 56% of New Zealanders had access to CWF. The Ministry aims to raise the percentage of New Zealanders accessing CWF to 70%7.

Under current legislation, local authorities hold the mandate to decide whether to fluoridate the drinking water supplies in their jurisdictions. Debate concerning the pros and cons of CWF continues, with the fluoridation status of water supplies changing as the positions of councils and their communities on the issue shift.

To advance CWF in New Zealand by ensuring that debates are based on the best available scientific evidence, the Ministry established a National Water Information Service (NFIS) with the objectives of assisting the Ministry and District Health Boards through:

- Following public debate and choices on CWF
- Monitoring international literature of the usefulness of CWF
- Critically reviewing emerging research
- Working with district health boards and councils to provide accurate and up-to-date information to their communities
- Providing clinical advice to the Ministry of Health
- Monitoring water fluoridation policy
- Providing access to New Zealand oral health data and research
- Sharing information via quaterly e-newsletters and e-briefings and the NFIS website.

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[5] Parnell C, Whelton H, O'Mullane D. 2009. Water Fluoridation. European Archives of Paediatric Dentistry; 10: 141-8.

[6] http://www.moh.govt.nz/moh.nsf/pagesmh/3597 accessed 21 January 2011.

[7] Ministry of Health. 11 June 2010. Request for Proposal - Proposals for national water fluoridation support and coordination service. Wellington.

The current literature review contributes to ii) & iii) by providing a critical review of research papers in the scientific and medical literature published between December 2010 to August 2011. It complements the previous literature reviews available from the NFIS website (www.nfis.org.nz).

The Ministry of Health's Fluoridation Policy

An important function of this review is to identify the implications of research findings for the Ministry's policy on CWF, and to propose changes to this policy that appear necessary.

At present, the Ministry's policy focuses on the concentration of fluoride that is required in drinking-water to achieve the desired oral health outcomes. It is summarised in a statement approved by the Ministry's Executive Leadership Team8 as:

> "The Ministry of Health recommends the adjustment of fluoride to between 0.7 ppm and 1.0 ppm in drinking-water as the most effective and efficient way of preventing dental caries in communities receiving a reticulated water supply, and strongly recommends the continuation and extension of water fluoridation programmes where technically feasible."

Fluoridation of Drinking Water Supplies in New Zealand

The Drinking-water Standards for New Zealand 2005 (revised 2008) (DWSNZ) give the maximum acceptable value (MAV) for the concentration of fluoride in drinking-water as 1.5 mg/L. The purpose of the MAV is to prevent possible undesirable health effects that may result from excessive fluoride intake. This should not be confused with the recommended concentration range for CWF contained within the Ministry's fluoridation policy.

Although the recommended concentration range for CWF is below the MAV, it straddles 50% of the MAV which has implications for fluoride monitoring for compliance with the DWSNZ. To comply with the DWSNZ, all chemical determinands at concentrations exceeding 50% of their MAV within a water supply must be monitored on a regular basis. As fluoridating water treatment plants aim to add fluoride to achieve a concentration in the range of 0.7–1.0 mg/L (cf. 50% of the MAV is 0.75 mg/L), these treatment plants are required to test the fluoride concentration in the water they produce at least weekly to comply with the DWSNZ. They are likely to

[8] Personal communication., Corinne Thomson, Ministry of Health, email 22 November 2010

determine the fluoride concentration in their water supply on a more frequent basis because of the relatively small difference between a therapeutic fluoride concentration and the fluoride MAV.

The Annual Review of Drinking-water Quality 2008/2009 reported that of the 51 fluoridating treatment plants, two, supplying a total of approximately 11,400 people had each reported one occasion when the fluoride concentration had exceeded the MAV. The exact duration of these excursions beyond the MAV is unknown, but they cannot have been longer than seven days because of the weekly monitoring frequency. Exposures of this duration do not present a significant health risk because the MAV is determined on the basis of a lifetime's exposure to fluoride.

The New Zealand Context

Two important factors that can influence the extent to which individuals are exposed to fluoride in the absence of CWF are naturally-occurring levels of fluoride in the water and the use of fluoridated toothpaste. To contextualise the conclusions reached in this literature review, the levels of fluoride in these potential fluoride sources are discussed here.

With the exception of geothermally-influenced waters, which are not used as the source waters of community drinking water supplies, naturally-occurring fluoride levels in New Zealand waters are low, certainly by the standards of many other countries. Davies et al.[9] (2001) reported a fluoride concentration range from nd (not detectable, reported as 0.1 or 0.2 mg/L) to 1.8 mg/L, with a median concentration of nd in New Zealand drinking-water supplies. Only three drinking-water supplies showed a fluoride concentration greater than 0.75 mg/L (50% of the MAV).

In the light of this information, some of the findings relating to overseas jurisdictions in which fluoride may occur naturally at concentrations of many mg/L will not apply to New Zealand.

The Ministry's website reports that the concentration of fluoride in most New Zealand toothpastes is around 1000 ppm (parts per million)[10], which is considered safe for children. This concentration is typical of the concentrations contained in toothpaste in developed countries, and findings associated with the use of fluoridated toothpaste in

[9] Davies H, Nokes C, Ritchie J. 2001. A Report on the Chemical Quality of New Zealand's Community Drinking-water Supplies. ESR Report FW0120 to the Ministry of Health.

[10] http://www.moh.govt.nz/moh.nsf/pagesmh/3578

these countries may also be relevant to New Zealand. Toothpaste marketed for children under six years of age is available with a fluoride content of 400 ppm.

One further factor that should be considered in association with overseas reports of increasing levels of dental fluorosis is the evidence of trends in fluorosis in New Zealand. The Ministry's Guidelines for the use of fluoride[3] states that '... the prevalence of diffuse opacities has not increased compared to earlier studies and is largely unchanged from estimates reported within New Zealand over the last 25 years.' On this basis, trends of increasing fluorosis reported in overseas jurisdictions with CWF do not necessarily reflect the New Zealand context.

Structure of the Report

Following the introduction, the report describes the method used to identify papers for inclusion in this review. This is followed by a discussion of the findings of these papers with key points summarised, which acts as the basis for a discussion about implications for the Ministry's CWF policy, and proposals relating to fluoridation policy. The main body of the report closes with a presentation of possible research directions derived from the papers.

The appendix critically appraises the 30 papers and abstracts, and includes bibliographic details, a presentation of the study's findings linked, where possible, to the New Zealand context, an evaluation of the quality of the study and level of evidence it provides, other comments the reviewer wished to make, and comment on the implications for the Ministry's CWF policy.

METHOD

Selection of Papers

The Oral Health Knowledge Library (OHKL) was used as the first source of references. To augment the initial list obtained from the OHKL, two scientific bibliographic databases, Scopus and Web of Knowledge, were searched for academic peer-reviewed papers that might meet the requirements for inclusion in the literature review. Target publications were research papers published between December 2010 and August 2011 reporting scientific studies concerning CWF and the health effects of CWF that might arise in conjunction with topical application of fluoride (for example, the use of fluoridated toothpaste, fluoride varnish). The subject areas of interest were: oral and public health epidemiology, public health policy, communication and community engagement, toxicology and pharmacology.

The initial search keyword used was 'water fluorid*' (* is a wild card).

The titles and abstracts of 100 papers identified through these initial searches were reviewed, and papers and abstracts were accepted if the following criteria were met:

i. a report of a scientific study, not a review of studies, a commentary, opinion piece or editorial;
ii. primarily concerned with water fluoride/fluoridation at levels relevant to CWF levels (0.7–1.0 mg/L) currently recommended in New Zealand, or contained a major segment relevant to CWF;
iii. the subject of the paper or abstract fell into one of the four subject areas specified by the Ministry (ie, oral and public health epidemiology, policy, communication and community engagement; toxicology and pharmacology);
iv. the paper reported a population study in an area or country in which the context was similar to that of New Zealand;
v. it was published in English.

Thirty papers and abstracts were retrieved for critical review.

Critical Appraisal of Papers

The papers in the appendix were critically appraised using uniform criteria.

FINDINGS FROM THE CRITICAL APPRAISAL OF THE LITERATURE

Introduction

This section presents the key findings of the papers reviewed. The following subject areas were covered:

i. oral and public health epidemiology associated with CWF;
ii. policy development;
iii. communication and community engagement;
iv. toxicology and pharmacology.

Reviews of all 30 papers and abstracts are included in the appendix. Each paper is numbered to allow indexing in the main body of the report (in square brackets). Each entry in the appendix contains the bibliographic details of each paper, a summary of important information provided and conclusions reached relevant to the New Zealand context, an evaluation of the quality of the paper, additional comments by the reviewer, and comments on the implications of the paper for the Ministry's CWF policy.

Knowing the validity of the findings of a study is critical for understanding the study's implications. The reviewers' notes in the appendix reflect an assessment of the quality of each paper. Papers of poor quality, although reviewed are not discussed in Section 3. Reviews of these papers, including the reviewer's reasons for considering the paper to be of unacceptable quality, are contained in the appendix.

The 'key points' of each paper are highlighted in this section.

Background on the mechanism of action of fluoride in preventing dental caries

It is now generally accepted that the main actions by which fluoride acts to protect dental enamel are through remineralisation and the inhibition of demineralisation[11]. Exposure of the enamel surface of the post-eruptive tooth (a tooth exposed through the gum) to fluoride is of greatest importance in creating a surface resistant to acids formed by bacteria. The beneficial effects of the post-eruptive interaction of fluoride with teeth have been well demonstrated by epidemiological studies. A constant low level of fluoride in the oral cavity assists the post-eruptive protective mechanism[12].

[11] Kumar JV. 2008. Is water fluoridation still necessary? Advances in Dental Research; 20:8-12.
[12] Levy SM. 2003. An update on fluorides and fluorosis. Journal of the Canadian Dental Association; 69: 286-91.

The application of fluoride to the surface of the tooth to improve its resistance to caries, by using toothpaste or fluoride varnish, is termed topical application.

Although the post-eruptive effect of fluoride is well accepted, the pre-eruptive (prior to the tooth being exposed through the gum) effects of fluoride on the tooth, and the extent to which this influences resistance to caries is still under debate. The systematic application of fluoride which results from the ingestion of fluoride, through water fluoridation for example, is the means by which fluoride gains access to the pre-eruptive tooth.

Evaluating the relative contributions of the pre- and post- eruptive action of fluoride is extremely difficult, but irrespective of their relative importance, fluoridated water helps to ensure constant exposure of teeth to low concentrations of fluoride.

Excessive exposure of the tooth to fluoride during the pre-eruptive stage of enamel formation causes hypomineralisation (greater surface and subsurface porosity) of the enamel, known as enamel fluorosis[13].

Oral and Public Health Epidemiology

Observations of the effects of fluoride on populations first led to CWF being identified as a means of reducing dental caries. Epidemiological studies have investigated the human oral and general health effects, both beneficial and adverse, of water fluoridation strategies. The papers discussed in this section describe the findings of epidemiological studies in relation to dental caries (including tooth loss) and dental fluorosis.

Nineteen papers [1-19], and two abstracts [22, 23] were critically reviewed in the area of oral and public health epidemiology.

The aim of the community-intervention study by Neumann et al [1] was to evaluate the effectiveness of a community-based intervention to improve the oral health of children in non-fluoridated rural Victoria, Australia. The study was conducted across three local government areas (LGAs) in Victoria on 915 children, with two receiving the intervention (total of n=482 children for analysis) and one remaining with standard care (n=433). The primary outcome was the prevalence of caries, defined as the percentage of children with any carious lesions (cavitated alone, and cavitated and pre-cavitated together).

[13] Browne D, Whelton H, O'Mullane D. 2005. Fluoride metabolism and fluorosis. Journal of Dentistry; 33:177-86.

Key Points from Neumann et al [1]

- LGAs selected with similar socio-economic status
- Dental examinations were conducted at the time of recruitment and then annually
- Participation in the study was limited to families listed on the maternal and child health nurses (MCHN) database, which may not be reflective of all births
- Low response rate (30%) and therefore sample could be biased – bias towards families who were more interested in general health and more likely to keep up their visits to maternal and child health nurses
- 17% of participants dropped out at examination 2 and only 43% of the cohort were seen at examination 3 meaning a reduction in power to assess the effectiveness of the intervention at both of these time points
- The results suggest that an oral health promotion intervention delivered via local maternal and child health nurses promoting early exposure to fluoride may be successful in reducing caries in the second year of life but less so in older children when participants have less contact with MCHNs.

The ecological study by Comber et al [2] compared the incidence of osteosarcoma (a rare bone cancer) in Northern Ireland (NI), where CWF is not implemented, to that the Republic of Ireland (RoI), where there is a combination of drinking water supplies with CWF (70%) and non-fluoridated private or group drinking water schemes. Although the study has major methodological limitations and is of low validity, there was little evidence of a statistically significant effect of CWF on osteosarcoma incidence at any age or for either sex. No statistically significant differences were observed between areas with or without CWF in either age-specific or age-standardised incidence rates of osteosarcoma.

Key Points from Comber et al [2]

- The study has major limitations and is of low validity. For example, lack of statistical power, lack of precise data on fluoridation status of water supplies, place of residence may not be an accurate proxy for lifetime exposure to CWF.
- It does not provide evidence to support the hypothesis that osteosarcoma incidence in the island of Ireland is significantly related to public CWF.
- Osteosarcoma data was obtained from two cancer registry's with cases divided into 'fluoridated' and 'non-fluoridated' areas.

The American Academy of Pediatrics et al [3] made a number of recommendations for preventive oral health and clinical care for young infants and pregnant women by primary health care providers, community-based health-promotion initiatives, oral health workforce and access issues, and advocacy for CWF and fluoride-varnish program access. It was also recommended that further community based research on the epidemiology, prevention, management, and microbiology of early childhood caries in Indigenous communities would be beneficial.

Key Points from the American Academy of Pediatrics et al [3]

- Makes a number of recommendations to improve the oral health of children in indigenous communities in Canada in the areas of: clinical care, community-based promotion initiatives, workforce and access issues, advocacy and research.
- For example, the statement recommends that indigenous communities should be provided with information on CWF, and opportunities for CWF (capital and maintenance costs and training for operators) of the drinking water supply should be advocated within and for indigenous communities.

The study by Downer et al [4] was designed as a worked example of the use of the predictive tool described by Foster et al. (2009) to estimate the potential reduction in dental caries among 5-6-year-old children in a city in the South West of England after six years of CWF. It would provide a pragmatic indication, for planning purposes, of the expected improvements in dental health from fluoridating the drinking water supplies of the city and its environs.

Key Points from Downer et al [4]

- The study was not intended to prove that fluoridation is effective.
- On the basis of current caries levels and population demographics, it appeared that a comprehensive fluoridation scheme covering the inner and outer city districts would substantially improve the dental health of the children of a city in South-West England.
- As a conservative estimate, after six years of fluoridation a caries reduction of >40% could be expected in 5-6-year-olds for the conurbation overall and for the 20 high caries/high IMD wards, with a gain of 12 percentage points in the absolute proportion caries-free.
- The authors were not able to precisely determine which wards were within the water supply zones of the designated three water treatment works.

The paper by Silva-Sanirgorski et al [5] describes the protocol for an Australian prospective birth cohort study to examine the impact of drink choices on child obesity risk and oral health status. The authors aim to disentangle the relationship between beverage consumption and the effectiveness of CWF. It is expected that results from the study will be used by government and government agencies to influence prevention policies, social marketing, and environmental programs in health and water.

Key Points from Silva-Sanirgorski et al [5]

- The proposed study is methodologically robust and provides a model for conducting a similar study in New Zealand.

The objective of the study by Ditmyer et al [6] was to measure the validity and reliability of a multifactorial Risk Factor Model for predicting future caries risk in Nevada adolescents in a public health setting. The authors examined retrospective data from an oral health surveillance initiative that screened over 51,000 students 13-18 years of age, attending public/private schools in Nevada across six academic years (2002/ 2003-2007/2008). The Risk Factor Model included ten demographic variables: exposure to CWF, environmental smoke exposure, race, age, location (ie, metropolitan vs. rural), tobacco use, body mass index, insurance status, sex, and sealant application.

Key Points from Ditmyer et al [6]

- The study was not about the effect of CWF on oral health.
- The model provided a relatively constant, valid measure of caries which could be used in conjunction with a comprehensive risk assessment in population-based screenings by school nurses/nurse practitioners, health educators, and physicians to guide them in assessing potential future caries risk for use in prevention and referral practices.
- Dental caries remained a common chronic disease among Nevada youth during the years of the study – average prevalence rates were 66%.
- There was extensive documentation of data and screening protocols with quality control guidelines in place.
- Oral health data was collected by trained, calibrated dentists licensed to practice in the State of Nevada.

Koltermann et al [7] employed a multilevel (individual and contextual) cross-sectional population-based study design to investigate the association between individual and

contextual factors and functional dentition (defined as the presence of at least 20 teeth) in Brazilian adults in the State of Rio Grande do Sul.

Key Points from Koltermann et al [7]

- Multivariate analyses showed that higher prevalence rates of functional dentition were associated with municipalities having higher mean income and CWF and with individuals living in urban areas, younger adults, males, those with more schooling and higher income, those that reported having visited the dentist in the previous 12 months, and those with access to information on prevention.
- Municipalities with better socioeconomic conditions provide better opportunities for people to preserve their teeth through greater availability and access to dental services.
- Study showed a positive association between higher functional dentition rates and longer exposure to CWF.
- The findings suggest that research on tooth loss and functional dentition should take different socioeconomic factors into account.
- Authors acknowledge the presence of bias in the results from residual confounding.
- Data from the latest Brazilian national oral health survey lacked sampling weights thus the study in Rio Grande do Sul does not allow population inferences as to the prevalence of some outcomes and age groups.

Jimenez-Farfan et al [8] conducted a high validity cross-sectional study which included a clinical examination to evaluate caries and dental fluorosis among Mexican preschoolers and school-aged children in a non-endemic zone for fluorosis (Mexico City) and to measure its biological indicators. However, the study has little relevance to the New Zealand CWF policy as it was about the intake of fluoride from all possible sources (fluoride concentration in table salt, fluoride concentration in toothpastes), including home water supplies and drinks which included local water.

Key Points from Jimenez-Farfan et al [8]

- Data collected from clinical examination of all participants conducted by two experienced examiners and questionnaires to all parents and multiple urine samples from randomly selected children
- Results from analyzing the fluoride level in the water supply of 155 homes were higher than data reported in other non-endemic Mexican populations
- Mexico City is considered a non-endemic zone for dental fluorosis because of the low concentration of fluoride in drinking water, but the children in the study presented with epidemiological indicators of overexposure to fluoride. Urinary excretion was within normal limits, but there were high prevalences of caries and dental fluorosis.
- Data on amount, duration, and timing of fluoride ingestion was incomplete. The authors noted 'the wide ranges of fluoride concentrations in bottled water and other beverages make it difficult to assess the actual fluoride intake by the population'.
- The results of the study are specific to Mexico City with little relevance to the New Zealand context.

The Brazilian study by Martins et al [9] prospectively evaluated the variation in urinary fluoride excretion (UFE) in children exposed to fluoride from water and toothpaste, using fluoride in urine as a biomarker. Twenty-four-hour urine was collected at baseline (Day 0, F exposure from water and toothpaste) as well as after the interruption of fluoride intake from water and toothpaste (Days 1, 2, 4, 8, 12, 16, 20, 24, and 28) (F interruption) and after fluoride intake from these sources had been re-established (Days 29, 32, and 34) (F re-exposure).

Key findings from Martins et al [9]

- The study is of little relevance to CWF in New Zealand.
- The findings suggest that circulating fluoride in the body of young children rapidly decreases in the first 24 hours and again increases very fast after discontinuation and re-exposure of F from water and toothpaste.
- Urine as a biomarker can rapidly detect variations in fluoride intake and stabilization is achieved in about 24 hours.
- Small sample size (11 children)
- Single baseline measurement
- There was limited follow up after restarting the usual fluoride intake from water and toothpaste.

Malde et al [10] presented possible strategies to reduce the total fluoride intake by children in the Ethiopian Rift Valley where dental and skeletal fluorosis are endemic. In the Ethiopian Rift Valley, 41% of the drinking-water sources have a fluoride concentration exceeding 1.5 mg/L and food ingredients and food prepared with local water may also be a major fluoride source. The study simulated the fluoride intake of the children using the methods of material flow analysis (MFA) and substance flow analysis.

Key Points from Malde et al [10]

- The study has little relevance to New Zealand as it was conducted in an area with naturally high concentrations of fluoride in the water.
- Results show that only by removing fluoride completely from both drinking and cooking water does the probability of remaining below the daily tolerable upper intake level exceed 50%.
- Both prepared food and food ingredients must be taken into consideration when assessing the total fluoride intake by children living in high-fluoride areas.
- The study employed a good modelling strategy which included four steps: system analysis, model approach, calibration, and simulation including sensitivity analysis, uncertainty analysis and scenarios.

Ding et al [11] conducted an ecologic study in Hulunbuir City, Inner Mongolia, to investigate the effects of exposure to low levels of fluoride on children's intelligence and dental fluorosis. A sample of 331 children aged 7 to 14 years were randomly recruited from four sites. Intellectual ability was assessed using the Combined Raven Test-The Rural (CRT-RC3) in China using seven categories of test scores. These ranged from 70-79 borderline (below average) to 130 very superior (excellent). Dental fluorosis was diagnosed with Dean's index. Water and urine samples were collected and analysed with the fluoride-ion selective method. Intellectual ability of the participants was also assessed.

Key Points from Ding et al [11]

- This ecological study has limited relevance to New Zealand. The results suggested that low levels of fluoride exposure in drinking water had negative effects on children's intelligence and dental health and suggested the dose-response relationship between urine fluoride exposure and IQ scores as well as dental fluorosis.
- Small sample size (331 students included), with 103 subjects from the area with the highest levels of fluoride concentration in the drinking water, compared to 75, 74 and 79 subjects in the other three sites.
- Across the four study sites the level of fluoride concentration in the drinking water ranged from 0.28 (mg/L) to 2.84 (mg/L).
- The authors acknowledged the deficiencies inherent in the ecological study design.
- The multiple linear regression model showed a negative dose-response between urine fluoride exposure and IQ scores. However, this finding has little relevance to New Zealand CWF, as age was the only covariate included in the model. No account was taken for the possible effect of other factors which may influence a child's intelligence (e.g. parental education status, maternal age at delivery etc). Therefore, it cannot be concluded that the dose-response relationship was due to the effects of fluoride.
- The authors noted: 'children's intelligence is very susceptible to many social and natural factors like economic situation, culture and geological environments. Therefore, it seems difficult to determine whether the difference of children's IQ scores in two different regions is caused by the fluoride exposure or other factors.'

The low validity school-based ecological study by Ramesh et al [12] was designed to assess the prevalence and severity of developmental defects of enamel and their relationship to fluoride levels in drinking water in the Davangere district, India, a naturally fluoridated area with some high levels of fluoride in water sources. Data were collected from a cross-sectional survey. The survey included an examination of enamel defects and estimation of fluoride levels in the drinking water supply.

Key Points from Ramesh et al [12]

- The study is of little relevance to New Zealand because of its low validity: the authors essentially carried out a correlational analysis, with no control for the effect of potential confounding factors (although they collected some of the relevant data).

Steenbergen et al [13] investigated the relation between the high fluoride level from boreholes (2.6 to 7.0 mg/l) and the 'modest' incidence of fluorosis in the Halaba district in Southern Ethiopia. It was found that 5 percent of the people in the study had severe dental fluorosis and 42 percent had mild forms, which is considerably less than results of other areas with comparable fluoride levels. The incidence was highest in the older age groups. The authors suggested a likely reason may be the continued large dependence on rain water harvesting ponds for human consumption alongside the use of water from the public borehole systems.

Key Points from Steenbergen et al [13]

- The findings from this low validity study have no relevance to New Zealand CWF policy.
- The study was conducted in the high fluoride area in Southern Ethiopia, small sample size (625), poor analysis which included no control or discussion of effects of potential confounders.
- The authors did discuss the policy implications of their results.

The study by Baruah et al [14] investigated the relationship between prevalence of dental fluorosis among the population as well as concentration of fluoride ion in drinking water in four tea gardens of Assam, India. Underground drinking water samples were analysed for fluoride ion estimation and the dental health status for a total of 300 people were examined. This study found the prevalence rate of dental fluorosis for men three times higher than for females.

Key findings from Baruah et al [14]

- A low validity study that is methodologically weak with deficiencies in methods, data presentation, analyses and in the explanation of the findings.
- There is nothing in this paper to inform the Ministry's CWF policy.

The aim of the Buzalaf et al [15] multicentre study was to compare the relationship between fluoride intake from diet and dentifrice with urinary fluoride excretion and fluoride concentrations in fingernails and toenails of 4- to 6-year-old children receiving fluoride from artificially fluoridated water (CWF), naturally fluoridated water, fluoridated salt, and fluoridated milk to a control population receiving no systemic fluoride.

Key findings from Buzalaf et al [15]

- If a study to measure fluoride levels in individuals were to be conducted in New Zealand the use of urine and nails as biomarkers might be worth considering.
- The authors stressed the importance of a closer monitoring of concentrations of fluoride added to water or salt
- Urinary fluoride excretion in the control community was significantly lower when compared with that in the fluoridated cities, except for the naturally fluoridated community.
- Both urinary fluoride output and fluoride concentrations in fingernails/toenails were significantly correlated to total fluoride intake.
- The correlations for fluoride intake and urinary fluoride output were lower than those observed for fingernails/toenails suggesting that nails might be slightly better indicators of fluoride intake at the individual level.
- Urine is a better indicator of fluoride intake than nails at a community level.
- Essentially, the data were analysed by calculating correlation coefficients, rather than a more in-depth investigation of the relationships.
- The biomarkers used in the study refer to different periods of systemic fluoride exposure – nails' fluoride concentrations reflect the average level of intake and plasma concentration.

Amini and Taghavi Shahri [16] conducted an ecological study in Iran to investigate the relationship of fluoride in ground water resources (main source of drinking water supply in urban and rural areas throughout the whole country) with the blood pressure.

Key Points from Amini and Taghavi Shahri [16]

- This low validity ecological study in Iran found an increase of hypertension prevalence and the mean systolic blood pressure with an increase of fluoride in the ground water resources, especially in males.
- The mean fluoride data of the ground water resources (the main source of drinking water supply in urban and rural areas was used as a surrogate for fluoride in drinking water. These data were derived from a previous study in 2008.
- The authors concluded that; 'ultimate conclusions about the association of fluoride and the blood pressure and its effects on cardiovascular system need further experimental and epidemiological study, including better control of confounding factors and considering different conditions.'
- The study has little value to the Ministry's CWF policy except in perhaps in future policy development considering the relationship shown between fluoride occurring in ground water and hypertension and systolic blood pressure.

Bernabe and Marcenes [17] explored the relationship between state income inequality and individual tooth loss among 386,629 adults in the United States who participated in the 2008 Behavioral and Risk Factor Surveillance System (BRFSS). The authors employed multilevel models test the association of the state Gini coefficient with tooth loss after sequential adjustment for state- (median household income) and individual-level confounders (eg, sex, age, race, education, and household income), as well as state- (percent with access to CWF and dentist-to-population ratio) and individual-level mediators (marital status and last dental visit).

Key findings from Bernabe and Marcenes [17]

- The paper provides relevant information for the future development and implementation of the Ministry's policy on CWF.
- The study provides support for the relationship between state income inequality and individual tooth loss in the United States, after adjustment for various potential state- and individual- level confounders and mediators.
- Individuals in states with more income inequality reported greater tooth loss than those in states with less income inequality.
- There was a 53% response rate for the 2008 BRFSS. To address the potential effect of non-response bias, respondents and non-respondents were compared on key demographic variables. The small differences along with the large sample size suggest that, despite the moderate response rate, little non-response bias was experienced in the 2008 BRFSS
- Misclassification of exposure may have occurred if some individuals moved between states after the 2000 US Census while data on tooth loss were based on self-reports and not objective clinical assessment.
- The association between income inequality and tooth loss was somewhat attenuated when the percent of state population receiving CWF and dentist-to-population rate were considered.

The neighbouring Swiss cantons of Basel-Stadt and Basel-Landschaft had introduced different fluoridation schemes for caries prevention: Basel-Stadt provided drinking water fluoridated at 0.8-1 ppm F since 1962, while Basel-Landschaft introduced fluoridated domestic salt (250 ppm F since 1983). The goal of the study by Buchel et al [18] was to determine the prevalences of enamel opacities from systemically administered fluoride and enamel opacities not caused by the use of fluoride in 12-year-old schoolchildren in the two cantons. Representative samples of 12-year-old schoolchildren were studied to evaluate the prevalence of: (i) dental fluorosis (FOP) using the Thylstrup-Fejerskov (TF) index, (ii) non fluoride-associated enamel opacities (non-FOP), and (iii) hypoplasia of the incisors. Standardised frontal colour photographs in duplicate were taken and assessed by four examiners after projection.

Key findings from Buchel et al [18]

- Although there were different fluoridation schemes in the two cantons, the prevalences of FOP were identical. The severity of fluorosis observed corresponded to about 90% (Basel-Stadt 95%, Basel-Landschaft 89.5%) to the TF grades 1 and 2. Most fluoride-associated enamel opacities were mild or very mild. They did not represent an aesthetic problem or a public health concern.
- The authors concluded that the relatively small number of adolescents with a more prominent enamel fluorosis in both cantons does not indicate a general oversupply of fluoride.
- The study results, therefore, have some relevance for development and implementation of the Ministry's policy on CWF.

The review paper by Lee and Messer [19] showed different risk factors for dental caries and the importance of good oral health prevention, even with CWF, notably due to the high fluid intake of sweet drinks for example. The authors concluded that despite widespread fluoride availability in contemporary Australian society, the relationship between sugar consumption and caries development continues and restricting sugar intake remains key to caries prevention. Public health information should increase awareness that consuming sweet drinks can have deleterious effects on the dentition as well as the potential for promoting systemic disease. Restricting sales of sweet drinks and sweet foods and providing healthy food and drinks for purchase in schools is paramount.

Key Points from Lee and Messer [19]

- This review has relevance for future development and implementation of the Ministry's policy on CWF as it shows there are many different risk factors for dental caries even with CWF and studies must control for their potential effect.
- Good oral health depends on the availability of CWF complimented by reduced or managed intakes of sweet drinks and foods.
- The authors made four clinical recommendations:
    - The frequency and timing of drinking sweet drinks should be included in discussing dietary risk factors for dental caries and erosion with patients and parents;
    - Caries risk assessment protocols should include assessment of sweet drink intake;
    - A child remaining at high caries risk despite the best efforts by the dental team may require referral to a dietitian for dietary counselling;
    - Health professionals should provide the community with appropriate recommendations and cautions concerning the consumption of sweet drinks, noting the potential for deleterious effects on the dentition.

Neither of the abstracts by Malar et al [20] and Zhong et al [21] contained information relevant to the Ministry's fluoridation policy.

Conclusion

No evidence emerges from the papers reviewed to suggest a change in the Ministry's current CWF policy.

Communication and Community Engagement

Three papers were reviewed in the area of Communication and Community Engagement [22, 23, 24]. There are some aspects of these papers which are relevant to the Ministry's continuing communication of its CWF policy.

The aim of the Armfield and Akers study [22] was to estimate the level of support for CWF across Australia and examine the association between CWF stance and demographic and socioeconomic characteristics, commitment to the stance, and opinions, beliefs and knowledge regarding CWF. Cross-sectional questionnaire data were obtained from 510 Australian adults (response rate = 34%) who were asked to rate the strength of their support for or opposition to water fluoridation on a 7-point scale.

Key Points from Armfield and Akers [22]

- This sound study provides a methodology for assessing attitudes to CWF, and information for managing communication around the issue
- As noted by the authors: 'awareness of public opinions of water fluoridation, its variation by population characteristics, and the beliefs and attitudes associated with support and opposition, will be important in future efforts to further extend this important public health practice.'
- Approximately 70% of survey respondents supported CWF, 15.4% were opposed, and 14.5% were neutral.
- Those strongly opposed were most resistant to altering their opinion on the basis of new information or research.
- Approximately 90% of people who were neutral, slightly supportive or moderately supportive would 'maybe' or 'definitely' change their stance. Opposition to CWF was associated with lower income and educational attainment, more self-rated knowledge, and with beliefs about reduced benefits and greater harms.
- Opinions about who should be responsible for the introduction of CWF and sources of information on CWF varied significantly by CWF opinion.
- Low response rate to the questionnaire (34% - which is 'becoming increasingly common in population surveys generally ... and in studies of water fluoridation opinion specifically.'
- Potential bias was introduced by the use of an electronic white pages telephone listing for the sampling frame (mobility and under-representation of younger adults even after the reweighting of data).

Berg et al [23] present evidence-based clinical recommendations regarding the intake of fluoride from reconstituted infant formula and its potential association with enamel fluorosis. The recommendations were developed by an expert panel convened by the American Dental Association (ADA) Council on Scientific Affairs (CSA). The panel of 12 experts addressed the following question: Is consumption of infant formula reconstituted with water that contains various concentrations of fluoride by infants from birth to age 12 months associated with an increased risk of developing enamel fluorosis in the permanent dentition?

Key Points from Berg et al [23]

- The recommendations have relevance to the Ministry's future development of its CWF policy
- When advising parents and caregivers of infants who consume powdered or liquid concentrate infant formula as the main source of nutrition, practitioners should also suggest the continued use of powdered or liquid concentrate infant formulas reconstituted with optimally fluoridated drinking water while being cognizant of the potential risks of enamel fluorosis development.
- Practitioners should be aware that children are exposed to multiple sources of fluoride during the tooth development period. Reducing fluoride intake from reconstituted infant formula alone will not eliminate the risk of fluorosis development.
- It is important that clinicians provide advice to parents regarding the proper use of fluoridated toothpastes along with the informed prescription of fluoride supplements.
- Recommendations were also made for future research:
    - Identify biomarkers as an alternative to direct fluoride intake measurement.
    - Conduct descriptive and analytical epidemiological studies to:
        - Estimate the total fluoride intake from all sources individually and in combination.
        - Quantify the risk of developing moderate to severe fluorosis attributable to fluoride intake from consumption of reconstituted infant formula.
    - Conduct metabolic studies of fluoride to determine the influence of environmental, physiological and pathological conditions on pharmacokinetics, balance and effects of fluoride.

Practitioners should be aware that children are exposed to multiple sources of fluoride during the tooth development period.

Reducing fluoride intake from reconstituted infant formula alone will not eliminate the risk of fluorosis development.

It also is important that clinicians provide advice to parents regarding the proper use of fluoridated toothpastes along with the informed prescription of fluoride supplements.

The paper has implications for the MoH's fluoridation policy by showing the important role that practitioners and caregivers have in informing the population about the actual fixed amount of fluoride in water and the importance of the others sources of fluoride.

Sivaneswaran and Chong [24] conducted an evaluation of a community education and consultation strategy which led to the implementation of fluoridation in two rural NSW towns. Telephone or face-to-face interviews were conducted to determine support for CWF: 54% of respondents wanted their drinking water supplies fluoridated, 25% did not and the remaining 21% were unsure. The most common reasons for supporting CWF were: 'fluoride is good for children's teeth', 'fluoride is good for dental health'

and 'had it in the water when I was a kid and my teeth are really strong'. The most frequently cited reasons for opposing CWF were: 'personal choice" and 'worried about chemicals'.

Key findings from Sivaneswaran and Chong [24]

- Despite the comparatively low response rate of 49.6% (but higher than in many such surveys), the study has implications for the Ministry's CWF policy.
- The authors offer practical advice to individuals charged with the task of persuading communities to adopt CWF.
- They found that it is possible to garner community support for CWF with the use of a multifaceted approach in educating and consulting communities and stakeholders.
- The use of locally relevant evidence to emphasize the disparity of oral health between local children and those living in geographically nearby townships with CWF was especially critical during this campaign.
- They found that if people were informed about CWF, they were more likely to be supportive of the measure.
- They considered that the role of the media as a source of information on CWF cannot be underestimated in any fluoridation campaign. This was confirmed by the survey which reported that the newspaper and radio were the main sources of information from which respondents learnt about CWF.
- It is imperative that the community also be consulted about CWF after having been educated about the issue. Campaigns to introduce CWF that have sufficiently engaged the local community and all the stakeholders, in this fashion, are less likely to fail.

  i. *The study found that if people were informed about water fluoridation, they were more likely to be supportive of the measure.*
  ii. *The role of the media as a source of information on water fluoridation cannot be underestimated in any fluoridation campaign.*
  iii. *The use of locally relevant evidence to emphasize the disparity of oral health between local children and those living in geographically nearby but fluoridated townships was especially critical during this campaign.*
  iv. *The methodology and results of the paper should be considering in the MoH's development of policies of water fluoridating. It shows the positive results and the multifaceted approach in educating and consulting communities and stakeholders and provides practical advice for promoting fluoridation to communities.*

Toxicology and Pharmacology

Six papers [25-30] were reviewed in the area of Toxicology and Pharmacology. None have practical implications for the Ministry's CWF policy.

Basha et al [25] conducted a multigenerational study of fluoride-induced oxidative stress in rat brain. However, the doses associated with adverse endpoints were so high as to have little relevance to the assessment of risks to humans from fluoridated drinking water.

The study by Kobayashi et al [26] was on the toxicity of fluoride to the kidney, because there is theoretical and limited empirical evidence to suggest it has some such toxic impacts. The findings from the study were both limited and also of uncertain clinical significance. Furthermore, the doses (or Drinking Water Fluoride Concentrations known as DWFCs) employed in the study were more suitable for comparing a human DWFC of 1 ppm with DWFCs of 10 ppm or 0 ppm, rather than say a human DWFC of 0.2 or 0.3 ppm, which may be typical of a non-fluoridated water supply.

The paper by Mofatto et al [27] investigates experimental dose-response relationships with respect to dental fluorosis, but employs a rather novel marker of enamel damage. The doses (or DWFCs) associated with adverse endpoints were so high as to have little relevance to the assessment of risks to humans from fluoridated drinking water.

There is already substantial human epidemiological data on dental fluorosis, with more readily interpretable end points and markers than that provided by the highly specialised assessment methods (of limited availability) that were used in this study.

In the study by Luo et al [28] the fluoride doses (or DWFCs) associated with adverse endpoints were so high as to have little relevance to the assessment of risks to humans from fluoridated drinking water. In addition the extremely high lead levels given to the two experimental animal groups whose exposure included lead. This was hugely misrepresentative of daily human lead exposures.

Shashi et al [29] examined the potential liver toxicity of fluoride, focussing on certain (partly) liver derived enzymes. There are no pressing practical implications for the Ministry's CWF policy arising from this study, principally because the DWFCs (and ensuing doses) associated with the observed increases in average levels of the five enzymes were so high as to have little relevance to the assessment of risks to humans from fluoridated drinking water.

The aim of the Lupe et al [30] study was to evaluate glucose homeostasis in rats, especially those with renal impairment, which were given drinking water at a range of fluoride levels (0 ppm, 1 ppm, 5 ppm, 15 ppm); for sixty days. There were unremarkable findings in the animals given a DWFC of 5 ppm, which is thought to

produce blood fluoride levels similar to those occurring in humans consuming fluoridated water at 0.8 ppm. This suggests that significant disturbances in glucose homeostasis are unlikely to occur in humans consuming fluoridated water at 0.7 to 1.2 ppm. However the study was for 60 days only.

Key Points from reviewed Toxicology and Pharmacology papers

- None of the papers reviewed have practical implications for the Ministry's fluoridation policy.

REVIEWS

Review 1

Review Date: 2011/1

Study Identification:	
Title:	**Impact of an oral health intervention on pre-school children <3 years of age in rural setting in Australia**
Authors:	Neumann AS., Lee KJ., Gussy MG., Waters EB., Carlin JB., Riggs E. and Kilpatrick NM
Journal:	Journal of Paediatrics and Child Health
Year:	2011
Volume:	47
Pages:	367-72
Topic area	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"Aim: Australian pre-school children living in rural areas experience higher levels of dental caries than those in metropolitan areas. This may be because of a lack of community water fluoridation. The aim of this study was to evaluate the effectiveness of a community-based intervention to improve the oral health of children in non-fluoridated rural Victoria, Australia. Methods: The study was conducted across three local government areas in Victoria, with two receiving the intervention and one remaining with standard care. Although multifaceted, the primary strategy of the intervention was the promotion of early exposure to fluoridated toothpaste, including the distribution, by maternal and child health nurses (MCHNs), of an oral health starter kit including toothpaste, toothbrush and information to parents at their child's 7-8-month health check. Children were followed up annually to the age of three. Results: Infants in the intervention arm experienced less caries (cavitated and pre-cavitated lesions included) than infants in the control arm at the first and second examinations (3.1% with caries in the intervention vs. 6.9% in the control group at exam 1 (adjusted P = 0.07) and 10.8% vs. 19.5% at exam 2 (adjusted P = 0.11), respectively). However potential benefits disappeared at the third examination (29.5% vs. 28.9%, adjusted P = 0.67). Conclusions: This study suggests that an oral health promotion intervention delivered via local MCHNs promoting early exposure to fluoride may be successful in reducing caries in the

	second year of life but less so in older children when participants have less contact with MCHNs."
Location of Study:	Three local government areas (LGAs) in rural Victoria, Australia
Time of Study:	2004-05
Type of Study:	Community-based intervention
Key Points:	• LGAs selected with similar socio-economic status. • Dental examinations were conducted at the time of recruitment and then annually. • Participation in the study was limited to families listed on the maternal and child health nurses (MCHN) database, which may not be reflective of all births. • Low response rate (30%) and therefore sample could be biased – bias towards families who were more interested in general health and more likely to keep up their visits to maternal and child health nurses. • 17% of participants dropped out at examination 2 and only 43% of the cohort were seen at examination 3 means a reduction in power to assess the effectiveness of the intervention at both of these time points. • Results suggested that an oral health promotion intervention delivered via local maternal and child health nurses promoting early exposure to fluoride may be successful in reducing caries in the second year of life but less so in older children when participants have less contact with MCHNs.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Yes
Data collection quality?	Good
Analysis of data?	Good
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Strengths:	• Authors acknowledged the limitations of their study. • Multivariate analysis to control for the confounding effects of age at the time of examination.

Limitations:	• Potentially biased sample. • Low response rate. • Presence of pre-cavitated lesions was assessed visually without the use of an air syringe for drying the tooth so the results may underestimate the prevalence of pre-cavitated lesions. However, the authors believe that this bias would affect both arms equally and hence should not affect the comparison.
Can the findings be generalised?	No
Are the findings applicable to water fluoridation in New Zealand?	No
Implications for the Ministry of Health water fluoridation policy:	• The study demonstrates that oral health promotion intervention delivered via local MCHNs promoting early exposure to fluoride may be successful in reducing caries in the second year of life but less so in older children when participants have less contact with MCHNs. • Suggests that facilitating and promoting the early use of fluoridate toothpaste can reduce the burden of dental caries on very young children.

Review 2

Review Date: 2011/2

Study Identification:	
Title:	**Drinking water fluoridation and osteosarcoma incidence on the island of Ireland**
Authors:	Comber H., Deady S., Montgomery E. and Gavin A.
Journal:	Cancer Causes and Control
Year:	2011
Volume:	22
Pages:	919-24
Topic area	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"The incidence of osteosarcoma in Northern Ireland was compared with that in the Republic of Ireland to establish if differences in incidence between the two regions could be related to their different drinking water fluoridation policies. Data from the Northern Ireland Cancer Registry (NICR) and the National Cancer Registry of Ireland (NCRI) on osteosarcoma incidence in the respective populations were used to estimate the age-standardised and age-specific incidence rates in areas with and without drinking water fluoridation. One hundred and eighty-three osteosarcoma cases were recorded on the island of Ireland between 1994 and 2006. No significant differences were observed between fluoridated and non-fluoridated areas in either age-specific or age-standardised incidence rates of osteosarcoma. The results of this study do not support the hypothesis that osteosarcoma incidence in the island of Ireland is significantly related to public water fluoridation. However, this conclusion must be qualified, in view of the relative rarity of the cancer and the correspondingly wide confidence intervals of the relative risk estimates."
Location of Study:	North Ireland & Republic of Ireland
Time of Study:	1994-2006
Type of Study:	Ecological study
Key Points:	• The study does not provide evidence to support the hypothesis that osteosarcoma incidence in the island of Ireland is significantly related to public water fluoridation • Osteosarcoma data from two cancer registry's with cases

	divided into 'fluoridated' and 'non-fluoridated' areas • The study has major limitations.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Yes
Data collection quality?	Good
Analysis of data?	Good and appropriate
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Validity of study?	Low
Strengths:	• The use of data from cancer registries. • Adds to the body of evidence. • Authors acknowledged the limitations of their study.
Limitations:	• Lack of power to detect a difference. • Lack of precise data on fluoridation of water supplies in the Republic of Ireland. • The place of residence at the time of diagnosis may not be an accurate proxy for lifetime exposure to fluoridated water. • While fluoride in drinking water probably represents the greater part of the total dietary intake of fluoride, at least one third of fluoride intake is estimated to come from other sources. • Wide confidence intervals of the relative risk reflect the small number of cases and the imprecision in the relative risk estimates.
Can the findings be generalised?	No
Are the findings applicable to water fluoridation in New Zealand?	No
Implications for the Ministry of Health water fluoridation policy:	The study does not have high validity. The weaknesses preclude the findings being used in the development of New Zealand fluoridation policy.

Review 3

Review Date: 2011/3

Study Identification:	
Title:	**Early childhood caries in indigenous communities**
Authors	American Academy of Pediatrics, Committee on Native American Child Health, Canadian Paediatric Society, First Nations, Inuit and Métis Committee
Journal:	Pediatrics
Year:	2011
Volume:	127
Pages:	1190-8
Topic area	Oral and Public Health Policy
Summary of Study:	
Abstract:	"The oral health of Indigenous children of Canada (First Nations, Inuit, and Metis) and the United States (American Indian, Alaska Native) is a major child health issue: there is a high prevalence of early childhood caries (ECC) and resulting adverse health effects in this community, as well as high rates and costs of restorative and surgical treatments under general anesthesia. ECC is an infectious disease that is influenced by multiple factors, including socioeconomic determinants, and requires a combination of approaches for improvement. This statement includes recommendations for preventive oral health and clinical care for young infants and pregnant women by primary health care providers, community-based health-promotion initiatives, oral health workforce and access issues, and advocacy for community water fluoridation and fluoride-varnish program access. Further community-based research on the epidemiology, prevention, management, and microbiology of ECC in Indigenous communities would be beneficial."
Location of Study:	Canada and USA
Time of Study:	Not stated
Type of Study:	Policy statement
Key Points:	• Makes a number of recommendations to improve the oral health of children in indigenous communities in Canada in the areas of: clinical care, community-based promotion initiatives, workforce and access issues, advocacy and research.

Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated? The study method is appropriate? Data collection quality? Sound logic is used in the conclusions reached? The study reaches valid conclusions with respect to the initial hypothesis/aim?	Not applicable Not applicable Not applicable Not applicable Not applicable
Strengths:	Not applicable
Limitations:	Not applicable
Can the findings be generalised?	Yes
Are the findings applicable to water fluoridation in New Zealand?	Yes, especially in the promotion of water fluoridation and fluoride supplementation among indigenous populations. For example, the statement recommends that indigenous communities should be provided with information on water fluoridation, and opportunities for fluoridation (capital and maintenance costs and training for operators) of the community drinking water should be advocated within and for indigenous communities.
Implications for the Ministry of Health water fluoridation policy:	Some of the recommendations in the statement may be useful for the Ministry of Health to consider in the further development of its fluoridation policy.

Study Identification:	
Title:	**Estimating the potential impact on dental caries in children of fluoridating a UK city**
Authors:	Downer MC., Drugan CS., Foster GR. and Tickle M.
Journal:	Community Dental Health
Year:	2011
Volume:	28
Pages:	34-9
Topic area	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"Objective To estimate the potential reduction in dental caries among 5-6-year-old children in a city in the South West of England after six years of water fluoridation. Method Thirteen out of 35 inner city wards and seven out of 43 outer city wards (sharing the same water supply) having the highest mean dmft of 5-6-year-olds (recorded in a census survey in 2005/6) and/or highest indexes of multiple deprivation (IMD) were the principal focal point. Population demographic data and 5-6-year-old caries prevalence and experience were examined. Mean IMD scores and aggregated, weighted mean values for dmft and caries prevalence were referred to previously published regression analyses of caries levels plotted against IMD for 34 fluoridated (F) and 233 non-fluoridated (NF) health districts in England in order to estimate potential caries reductions. Results Mean dmft of 5-6-year-olds in the 20 wards with the highest caries levels and/or social deprivation was 2.10 (95% CI 1.87, 2.33) and caries prevalence 49% (95% CI 47%, 52%). In three wards, mean dmft exceeded 2.60. Population of the selected wards was similar to 210,800 with a mean IMD score of 33.70. As a conservative estimate, after six years of fluoridation a caries reduction of >40% could be expected in 5-6-year-olds for the conurbation overall and for the 20 high caries/high IMD wards, with a gain of 12 percentage points in the absolute proportion caries-free. The overall population of the 78 wards served by the three relevant water treatment works identified was similar to 700,000. Conclusions On the basis of current caries levels and population demographics, it appears that a comprehensive fluoridation scheme covering the inner and outer city districts would substantially improve the dental health of the city's

	children."
Location of Study:	England (specific city was not named)
Time of Study:	2005-06
Key Points:	• The study was designed as a worked example of the use of the predictive tool described by Foster et al. (2009) to provide a pragmatic indication, for planning purposes, of the expected improvements in dental health from fluoridating the water supplies of the city and its environs. • The study was not intended to prove that fluoridation is effective. • On the basis of current caries levels and population demographics, it appeared that a comprehensive fluoridation scheme covering the inner and outer city districts would substantially improve the dental health of the children of a city in South-West England.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Good
Data collection quality?	Good
Analysis of data?	Appropriate
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Validity of study?	High
Strengths:	• Provided a worked example of the tool developed previously to indicate expected improvements in dental health from water fluoridation. • In the previous census survey between 75-80% of inner and outer city 5-6 year olds children received clinical examinations in school by trained and calibrated clinicians as part of a national dental epidemiology programme.
Limitations:	• The study was not intended to prove that water fluoridation is effective • Not able to precisely determine which wards were within the water supply zones of the designated three water treatment works.

Can the findings be generalised?	It provides a predicative tool which could be applied in New Zealand.
Are the findings applicable to water fluoridation in New Zealand?	It does not indicate if water fluoridation is effective.
Implications for the Ministry of Health water fluoridation policy:	It provides a model which could be applied in New Zealand.

Review 5

Review Date: 2011/5

Study Identification:	
Title:	**Splash!: a prospective birth cohort study of the impact of environmental, social and family-level influences on child oral health and obesity related risk factors and outcomes**
Authors:	Silva-Sanirgorski AM., Waters E., Calache H., Smith M., Gold L., Gussy M., Scott A., Lacy K. and Virgo-Milton M.
Journal:	BMC Public Health
Year:	2011
Pages:	11:505
Topic area	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"Background: Dental caries (decay) is the most prevalent disease of childhood. It is often left untreated and can impact negatively on general health, and physical, developmental, social and learning outcomes. Similar to other health issues, the greatest burden of dental caries is seen in those of low socio-economic position. In addition, a number of diet-related risk factors for dental caries are shared risk factors for the development of childhood obesity. These include high and frequent consumption of refined carbohydrates (predominately sugars), and soft drinks and other sweetened beverages, and low intake of (fluoridated) water. The prevalence of childhood obesity is also at a concerning level in most countries and there is an opportunity to determine interventions for addressing both of these largely preventable conditions through sustainable and equitable solutions. This study aims to prospectively examine the impact of drink choices on child obesity risk and oral health status. Methods/Design: This is a two-stage study using a mixed methods research approach. The first stage involves qualitative interviews of a sub-sample of recruited parents to develop an understanding of the processes involved in drink choice, and inform the development of the Discrete Choice Experiment analysis and the measurement instruments to be used in the second stage. The second stage involves the establishment of a prospective birth cohort of 500 children from disadvantaged communities in rural and regional Victoria, Australia (with and without water fluoridation). This longitudinal design allows measurement of changes in the child's diet over time, exposure to fluoride sources including water, dental caries progression, and the risk of childhood obesity. Discussion: This

	research will provide a unique contribution to integrated health, education and social policy and program directions, by providing clearer policy relevant evidence on strategies to counter social and environmental factors which predispose infants and children to poor health, wellbeing and social outcomes; and evidence-based strategies to promote health and prevent disease through the adoption of healthier lifestyles and diet. Further, given the absence of evidence on the processes and effectiveness of contemporary policy implementation, such as community water fluoridation in rural and regional communities it's approach and findings will be extremely informative."
Location of Study:	Victoria, Australia
Type of Study:	The paper provides the design for a proposed cohort study
Key Points:	Not applicable as it is a description of a proposed study
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Good
Data collection quality?	Good
Analysis of data?	The proposed method of analysis is appropriate
Sound logic is used in the conclusions reached?	Not applicable
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Not applicable
Validity of study?	Potentially high
Strengths:	Good methodology proposed, clear inclusion and exclusion criteria specified.
Limitations:	None identified.
Can the findings be generalised?	The study has not been completed.
Are the findings applicable to water fluoridation in New Zealand?	Yes
Implications for the Ministry of Health water fluoridation policy:	The study is methodologically robust and provides a model for conducting a similar study in New Zealand.

Study Identification:	
Title:	**Validation of a multifactorial risk factor model used for predicting future caries risk with Nevada adolescents**
Authors:	Ditmyer MM., Dounis G., Howard KM., Mobley C. and Cappelli D.
Journal:	BMC Oral Health
Year:	2011
Volume:	11:18
Topic area	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"Background: The objective of this study was to measure the validity and reliability of a multifactorial Risk Factor Model developed for use in predicting future caries risk in Nevada adolescents in a public health setting. Methods: This study examined retrospective data from an oral health surveillance initiative that screened over 51,000 students 13-18 years of age, attending public/private schools in Nevada across six academic years (2002/2003-2007/2008). The Risk Factor Model included ten demographic variables: exposure to fluoridation in the municipal water supply, environmental smoke exposure, race, age, locale (metropolitan vs. rural), tobacco use, Body Mass Index, insurance status, sex, and sealant application. Multiple regression was used in a previous study to establish which significantly contributed to caries risk. Follow-up logistic regression ascertained the weight of contribution and odds ratios of the ten variables. Researchers in this study computed sensitivity, specificity, positive predictive value (PVP), negative predictive value (PVN), and prevalence across all six years of screening to assess the validity of the Risk Factor Model. Results: Subjects' overall mean caries prevalence across all six years was 66%. Average sensitivity across all six years was 79%; average specificity was 81%; average PVP was 89% and average PVN was 67%. Conclusions: Overall, the Risk Factor Model provided a relatively constant, valid measure of caries that could be used in conjunction with a comprehensive risk assessment in population-based screenings by school nurses/nurse practitioners, health educators, and physicians to guide them in assessing potential future caries risk for use in prevention and referral practices."
Location of Study:	Nevada, USA

Time of Study:	2002-8
Type of Study:	Retrospective epidemiology study
Key Points:	• Study designed to measure the validity and reliability of a multifactorial risk factor model for predicting future caries risk in Nevada adolescents. • The model provided a relatively constant, valid measure of caries which could be used in conjunction with a comprehensive risk assessment in population-based screenings by school nurses/nurse practitioners, health educators, and physicians to guide them in assessing potential future caries risk for use in prevention and referral practices. • Found confirmed that dental caries remained a common chronic disease among Nevada youth during the years of the study – average prevalence rates were 66%.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Yes
Data collection quality?	Good
Analysis of data?	Good
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Validity of study?	Medium
Strengths:	• Large sample size (51,000). • Extensive documentation of data and screening protocols with quality control guidelines in place. • Oral health data collected by trained, calibrated dentists licensed to practice in the State of Nevada.
Limitations:	• Self-reported information on demographic variables in the initial oral health screening. • Cut-off values adopted from previous study in the same population, but these could vary in different populations.
Can the findings be generalised?	No
Are the findings applicable	No – this was no about the effect of water fluoridation on oral

to water fluoridation in New Zealand?	health.
Implications for the Ministry of Health water fluoridation policy:	• The methodology for this study could be used in New Zealand. • The Risk Factor Model as a population-based screening measure is a reliable scale for predicting future caries risk for early detection and referral practices by non-dental health practitioners.

Review 7

Review Date: 2011/7

Study Identification:	
Title:	**The association between individual and contextual factors and functional dentition status among adults in Rio Grande do Sul State, Brazil: a multilevel study**
Authors	Koltermann AP., do Amaral Giordani JM. and Pattussi MM
Journal:	Cadernos de Saude Publica CSP – Reports in Public Health
Year:	2011
Volume:	27
Pages:	173-82
Topic area	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"Functional dentition plays an important role in maintaining masticatory function, which is closely related to the number of teeth present in the mouth. The objective of this study was to investigate the association between individual and contextual factors and functional dentition (defined as the presence of at least 20 teeth) in Brazilian adults. This was a multilevel cross-sectional population-based study with a two-level structure and a total sample of 10,407 adults from 84 municipalities (counties). The exposures at both levels were demographic, socioeconomic, and oral health treatment-related. Multivariate analyses showed that higher prevalence rates of functional dentition were associated ($p < 0.01$) with municipalities having higher mean income and fluoridated water supply and with individuals living in urban areas, younger adults, males, those with more schooling and higher income, those that reported having visited the dentist in the previous 12 months, and those with access to information on prevention. The findings suggest that research on tooth loss and functional dentition should take different socioeconomic factors into account."
Location of Study:	Rio Grande do Sul State, Brazil
Time of Study:	2003
Type of Study:	Cross-sectional epidemiology study conducted across 84 municipalities.
Key Points:	• Multivariate analyses showed that higher prevalence rates of functional dentition were associated with municipalities

	having higher mean income and fluoridated water supply and with individuals living in urban areas, younger adults, males, those with more schooling and higher income, those that reported having visited the dentist in the previous 12 months, and those with access to information on prevention. • Supports previous studies in Brazil showing an association between unfavourable local socioeconomic conditions and high tooth loss and lower functional dentition rates. • Municipalities with better socioeconomic conditions provide better opportunities for people to preserve their teeth through greater availability and access to dental services. • Study showed a positive association between higher functional dentition rates and longer exposure to fluoridate water supply: o Individuals living in municipalities with high schooling (defined as years of schooling) and more than ten years of fluoridation of the public water supply showed an increase of 72% (OR = 1.72; 95%CI: 1.17-2.53) and o 78% (OR = 1.78; 95%CI: 1.32-2.40) in the odds of presenting functional dentition as compared to those in municipalities with low schooling and without fluoridation. • The findings suggest that research on tooth loss and functional dentition should take different socioeconomic factors into account.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Yes
Data collection quality?	Good
Analysis of data?	Good
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Validity of study?	Medium
Strengths:	• A multilevel cross-sectional population-based study. • Wide range of analysis, eg, descriptive, bivariate and

	multivariate.
Limitations:	• Authors acknowledge the presence of bias in the results from residual confounding • Data from the latest Brazilian national oral health survey lacked sampling weights thus the study in Rio Grande do Sul does not allow population inferences as to the prevalence of some outcomes and age groups. Therefore, the functional dentition rate found in the study may not be precise. However, the authors say: "..this fact probably did not interfere in the associated reported here."
Can the findings be generalised?	Yes
Are the findings applicable to water fluoridation in New Zealand?	Yes
Implications for the Ministry of Health water fluoridation policy:	• Study showed a positive association between higher functional dentition rates and longer exposure to fluoridate water supply. • This kind of study can contribute to the identification of priority municipalities and groups of individuals for the formulation and implementation of public policies in oral health, aimed at improving the population's quality of life.

Review 8

Review Date: 2011/8

Study Identification:	
Title:	**Fluoride consumption and its impact on oral health**
Authors:	Jimenez-Farfan MD., Hernandez-Guerrero JC., Juarez-Lopez LA., Jacinto-Aleman LF. and de la Fuente-Hernandez Javier
Journal:	International Journal of Environmental Research and Public Health
Year:	2011
Volume:	8
Pages:	148-60
Topic area:	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"Objective. The purpose of this study was to evaluate caries and dental fluorosis among Mexican preschoolers and school-aged children in a non-endemic zone for fluorosis and to measure its biological indicators. Methods. DMFT, DMFS, dmft, dmfs, and CDI indexes were applied. Fluoride urinary excretion and fluoride concentrations in home water, table salt, bottled water, bottled drinks, and toothpaste were determined. Results. Schoolchildren presented fluorosis (CDI = 0.96) and dental caries (DMFT = 2.64 and DMFS = 3.97). Preschoolers presented dmft = 4.85 and dmfs = 8.80. DMFT and DMFS were lower in children with mild to moderate dental fluorosis (DF). Variable fluoride concentrations were found in the analyzed products (home water = 0.18-0.44 ppm F, table salt = 0-485 ppm F, bottled water = 0.18-0.47 ppm F, juices = 0.08-1.42 ppm F, nectars = 0.07-1.30 ppm F, bottled drinks = 0.10-1.70 ppm F, toothpaste = 0-2,053 ppm F). Mean daily fluoride excretion was 422 ± 176 μg/24 h for schoolchildren and 367 ± 150 μg/24 h for preschoolers. Conclusions. Data from our study show that, despite values of excretion within an optimal fluoride intake range, the prevalence of caries was significant in both groups, and 60% of the 11- to 12-year-old children presented with dental fluorosis. In addition, variable fluoride concentrations in products frequently consumed by children were found. © 2010 by the authors; licensee MDPI, Basel, Switzerland."
Location of Study:	Eastern area Mexico City, Mexico
Time of Study:	Period: not stated

Type of Study:	Cross-sectional epidemiological study which included a clinical examination
Key Points:	• Final sample comprised 1942 children; 373 4-5 year olds and 1569 11-12 year olds. • Data collected from clinical examination of all participants conducted by two experienced examiners and questionnaires to all parents and multiple urine samples from randomly selected children. • Results from analyzing the fluoride level in the water supply of 155 homes were higher than data reported in other non-endemic Mexican populations. • Mexico City is considered a non-endemic zone for dental fluorosis because of the low concentration of fluoride in drinking water, the children in the study presented with epidemiological indicators of overexposure to fluoride. Urinary excretion was within normal limits, but there were high prevalences of caries and dental fluoride.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Yes
Data collection quality?	Good
Analysis of the data?	Good
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Validity of the study?	High
Strengths:	Data was of high quality
Limitations:	Data on amount, duration, and timing of fluoride ingestion was incomplete – the authors noted 'the wide ranges of fluoride concentrations in bottled water and other beverages make it difficult to assess the actual fluoride intake by the population'.
Can the findings be generalised?	No – they are specific to Mexico City.
Are the findings applicable to water fluoridation in New Zealand?	No – the study was about the intake of fluoride from all possible sources (fluoride concentration in table salt, fluoride concentration in toothpastes), including home water supplies and drinks which included local water.

Implications for the Ministry of Health water fluoridation policy:	None - in Mexico, the fluoride levels in ground water vary substantially among different regions, but Mexico City is considered a non-endemic zone for dental fluorosis.

Study Identification:	
Title:	**Effect of discontinuation of fluoride intake from water and toothpaste on urinary excretion in young children**
Authors:	Martins CC., Paiva SM. and Cury JA.
Journal:	International Journal of Environmental Research and Public Health
Year:	2011
Volume:	8
Pages:	2132-41
Topic area:	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"As there is no homeostatic mechanism for maintaining circulating fluoride (F) in the human body, the concentration may decrease and increase again when intake is interrupted and re-started. The present study prospectively evaluated this process in children exposed to F intake from water and toothpaste, using F in urine as a biomarker. Eleven children from Ibiá, Brazil (with sub-optimally fluoridated water supply) aged two to four years who regularly used fluoridated toothpaste (1,100 ppm F) took part in the study. Twenty-four-hour urine was collected at baseline (Day 0, F exposure from water and toothpaste) as well as after the interruption of fluoride intake from water and dentifrice (Days 1 to 28) (F interruption) and after fluoride intake from these sources had been re-established (Days 29 to 34) (F re-exposure). Urinary volume was measured, fluoride concentration was determined and the amount of fluoride excreted was calculated and expressed in mg F/day. Urinary fluoride excretion (UFE) during the periods of fluoride exposure, interruption and re-exposure was analyzed using the Wilcoxon test. Mean UFE was 0.25 mg F/day (SD: 0.15) at baseline, dropped to a mean of 0.14 mg F/day during F interruption (SD: 0.07; range: 0.11 to 0.17 mg F/day) and rose to 0.21 (SD: 0.09) and 0.19 (SD: 0.08) following F re-exposure. The difference between baseline UFE and the period of F interruption was statistically significant ($p < 0.05$), while the difference between baseline and the period of F re-exposure was non-significant ($p > 0.05$). The findings suggest that circulating F in the body of young children rapidly decreases in the first 24 hours and again increases very fast after discontinuation and re-exposure of F from water and

	toothpaste. © 2011 by the authors; licensee MDPI, Basel, Switzerland."
Location of Study:	Ibia, Brazil
Time of Study:	May-June 2008
Type of Study:	Prospective experimental study
Key Points:	• The findings suggest that circulating F in the body of young children rapidly decreases in the first 24 hours and again increases very fast after discontinuation and re-exposure of F from water and toothpaste. • Urine as a biomarker can rapidly detect variations in fluoride intake and stabilization was achieved in about 24 hours.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Yes
Data collection quality?	Good
Analysis of data?	Good
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Validity of study	Average
Strengths:	• Able to distinguish the fluoride intake from toothpaste and water. • 24-hour urine sampling is a reliable method and measures the fluoride content of an entire day.
Limitations:	• Small sample size (11 children). • Single baseline measurement. • Limited followup after restarting the usual fluoride intake from water and toothpaste. • Study conducted under conditions of sub-optimally fluoridate drinking water and fluoride content in the water varied throughout the study period. Authors note: 'The results may have been different if the water had been optimally fluoridated'... and 'if the study had been conducted in the summer, as fluoride intake by children

	may vary depending on the season'.
Can the findings be generalised?	Yes, but for children only. The authors note that results may have been different if the study had been conducted on adults, as fluoride retention (percentage of absorbed fluoride), extra-renal clearance, skeletal uptake and fluoride removal from the plasma is generally greater in children than adults.
Are the findings applicable to water fluoridation in New Zealand?	No
Implications for the Ministry of Health water fluoridation policy:	None

Review 10

Review Date: 2011/10

Study Identification:	
Title:	**Substance flow analysis: a case study of fluoride exposure through food and beverages in young children living in Ethiopia**
Authors:	Malde MK., Scheidegger R., Julshmann K. and Bader HP
Journal:	Environmental Health Perspectives
Year:	2011
Volume:	119
Pages:	579-84
Topic area:	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"Context: Dental and skeletal fluorosis is endemic in the Ethiopian Rift Valley. Children are especially vulnerable to excessive fluoride intake because their permanent teeth are still being formed. Strategies to reduce the total fluoride intake by children are thus warranted. Case presentation: By combining the results of field studies in Ethiopia, the relevant pathways for fluoride intake have been identified in 28 children 2-5 years of age living in two villages on the Wonji Shoa Sugar Estate in the Ethiopian Rift Valley. The focus of the present study was to simulate the fluoride intake of the children using the methods of material flow analysis (MFA) and substance flow analysis. Discussion: With a model based on MFA, we quantified the potential reduction in total fluoride intake given different scenarios-for example, by reducing the fluoride intake from drinking water and cooking water. The results show clearly that only by removing fluoride completely from both drinking and cooking water does the probability of remaining below the daily tolerable upper intake level exceed 50%. Both prepared food and food ingredients must be taken into consideration when assessing the total fluoride intake by children living in high-fluoride areas. Relevance: This knowledge will help health personnel, the government, and the food authorities to give scientifically based advice on strategies for reducing the total fluoride intake by children living in high-fluoride areas in the Ethiopian Rift Valley."
Location of Study:	Rift Valley, Ethiopia (high fluoride area)
Time of Study:	Combing results from studies conducted in the late 1990 and

	early 2000
Type of Study:	Model simulation
Topic area:	Oral and public health epidemiology
Key Points:	• Results show that only by removing fluoride completely from both drinking and cooking water does the probability of remaining below the daily tolerable upper intake level exceed 50%. • Both prepared food and food ingredients must be taken into consideration when assessing the total fluoride intake by children living in high-fluoride areas.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Yes
Data collection quality?	Good
Analysis of data?	Good
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Validity of study?	Average
Strengths:	Good modelling approach which included four steps: system analysis, model approach, calibration, and simulation including sensitivity analysis, uncertainty analysis and scenarios.
Limitations:	Study conducted in an area of high concentrations of fluoride in the water.
Can the findings be generalised?	No
Are the findings applicable to water fluoridation in New Zealand?	No
Implications for the Ministry of Health water fluoridation policy:	None. The study was conducted in an area of high concentrations of fluoride in the water.

Review 11

Review Date: 2011/11

Study Identification:	
Title:	**The relationships between low levels of urine fluoride on children's intelligence, dental fluorosis in endemic fluorosis areas in Hulunbuir, Inner Mongolia, China**
Authors:	Ding Y., YanhuiGao, Sun H., Han H., Wang W., Ji X., Liu X. and Sun D.
Journal:	Journal of Hazardous Materials
Year:	2011
Volume:	186
Pages:	1942-6
Topic area:	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"There has been public concern about children's intellectual performance at high levels of fluoride exposure, but few studies provide data directly to the question of whether low fluoride exposure levels less than 3.0. mg/L in drinking water adversely associated with children's intelligence. In this survey, we investigated the effects of low fluoride exposure on children's intelligence and dental fluorosis. 331 children aged from 7 to 14 were randomly recruited from four sites in Hulunbuir City, China. Intelligence was assessed using Combined Raven Test-The Rural in China while dental fluorosis was diagnosed with Dean's index. Mean value of fluoride in drinking water was 1.31 ± 1.05. mg/L (range 0.24-2.84). Urine fluoride was inversely associated with IQ in the multiple linear regression model when children's age as a covariate variable was taken into account (P< 0.0001). Each increase in 1. mg/L of urine fluoride associated with 0.59-point decrease in IQ (P= 0.0226). Meanwhile, there was a dose-response relationship between urine fluoride and dental fluorosis (P< 0.0001). In conclusion, our study suggested that low levels of fluoride exposure in drinking water had negative effects on children's intelligence and dental health and confirmed the dose-response relationships between urine fluoride and IQ scores as well as dental fluorosis. © 2010 Elsevier B.V".
Location of Study:	Hulunbuir City, China
Time of Study:	No precise date given, but suggestion study may have been carried out in 2009

Type of Study:	Ecological epidemiological study
Key Points:	• The study suggested that low levels of fluoride exposure in drinking water had negative effects on children's intelligence and dental health and confirmed the dose-response relationships between urine fluoride and IQ scores as well as dental fluorosis.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Yes
Data collection quality?	Average
Analysis of data	Average
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Validity of study	Medium
Strengths:	• Data included taking urine samples from participants, water samples from the central water supply system; professional examiners, blinded to the fluoride exposure status of the children, determined the dental status of the participants. • Good acknowledgement of the limitations of the study by the authors.
Limitations:	• Small sample size (331 students included), with 103 subjects from the area with the highest levels of fluoride concentration in the drinking water, compared to 75, 74 and 79 subjects in the other three sites. • Across the four study sites the level of fluoride concentration in the drinking water ranged from 0.28 (mg/L) to 2.84 (mg/L). • The multiple linear regression model showed a negative dose-response between urine fluoride exposure and IQ scores. However, this finding has little relevance to New Zealand CWF, as age was the only covariate included in the model. No account was taken of the possible effect of other factors which may influence a child's intelligence (eg, parental education status, maternal age at delivery etc). Therefore, it cannot be concluded that the dose-response relationship was due to the effects of fluoride.

	• The authors noted: 'children's intelligence is very susceptible to many social and natural factors like economic situation, culture and geological environments. Therefore, it seems difficult to determine whether the difference of children's IQ scores in two different regions is caused by the fluoride exposure of other factors.'
Can the findings be generalised?	No
Are the findings applicable to water fluoridation in New Zealand?	No
Implications for the Ministry of Health water fluoridation policy:	• Although ecological studies cannot suggest causality, the results from this study suggested that low levels of fluoride exposure in drinking water had negative effects on children's intelligence and dental health. The suggested dose-response relationship between urine fluoride and IQ scores has little relevance to the Ministry's CWF policy as the multiple regression model only controlled for age. No account was taken of the possible effect of other factors which may influence a child's intelligence (eg, parental education status, maternal age at delivery etc). Therefore, it cannot be concluded that the dose-response relationship was due to the effects of fluoride

Review 12

Review Date: 2011/12

Study Identification:	
Title:	**Developmental defects of enamel in children of Davangere District and their relationship to fluoride levels in drinking water**
Authors:	Ramesh G., Nagarajappa R., Raghunath V. and Manohar R.
Journal:	Asia-Pacific Journal of Public Health
Year:	2011
Volume:	23
Pages:	341-8
Topic area:	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"To assess the prevalence and severity of developmental defects and their relationship to fluoride levels in drinking water. 739 (406 male and 333 female) schoolchildren aged 13 years formed the study population. We used the ion selective electrode method to estimate the fluoride concentration in drinking water. A modified developmental defects of enamel index was used for recording the developmental defects. The Karl Pearson coefficient for correlation and the chi-square test were used for statistical estimation. The fluoride concentration ranged from 0.64 to 2.64 ppm. The prevalence of developmental defects was 88.5%. The most common type of defect was diffuse opacity in 61.2% of the children. There was a significant positive correlation between the type (r=0.85; P<.001) and extent (r=0.92; P<.001) of developmental defects in relation to fluoride levels in drinking water. The observed prevalence demonstrates the need to ascertain factors other than fluoride levels in drinking water that could contribute to its occurrence."
Location of Study:	Davangere District, India
Time of Study:	Date not given
Type of Study:	School-based cross-sectional ecological study
Key Points:	• There was a significant positive correlation between the type and extent of developmental defects of enamel in children in relation to fluoride levels in drinking water. • At low fluoride concentrations, at least one tooth have an

	enamel defects, which the authors suggests indicates the role of other variables like climate quantity of water intake rather than the concentration of fluoride in the drinking water. • The most common type of defect was diffuse opacity in 61.2% of the children, which proportionately increased with the level of fluoride concentration in water.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated? The study method is appropriate? Data collection quality? Analysis of the data? Sound logic is used in the conclusions reached? The study reaches valid conclusions with respect to the initial hypothesis/aim? Validity of the study?	Yes Yes Good Poor No No Low
Strengths:	• Dental examinations conducted by one examiner and thorough specification of what the examination involved. • Pilot survey conducted.
Limitations:	• Essentially carried out a 'correlational' analysis of the data; no control for potential confounding factors, despite collecting some of the relevant data. • Study conducted on a specific age group: 13 years.
Can the findings be generalised?	No
Are the findings applicable to water fluoridation in New Zealand?	No
Implications for the Ministry of Health water fluoridation policy:	None – the study has low validity.

Review 13

Review Date: 2011/13

Study Identification:	
Title:	**High fluoride, modest fluorosis: investigation in drinking water supply in Halaba (SNNPR, Ethiopia)**
Authors:	Steenbergen F., Tekle Haimanot R. and Sidelil A.
Journal:	Journal of Water Resource and Protection
Year:	2011
Volume:	3
Pages:	120-6
Topic area:	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"In Halaba district in Southern Ethiopia fluoride levels from boreholes are high (2.6 to 7.0 mg/l), yet the incidence of fluorosis is modest. Drinking water users living in the vicinity of four drinking water systems that have been in operation for more than 35 years were surveyed. Out of 625 persons 5 percent had severe dental fluorosis and 42 percent had mild forms—which is considerably less than results of other areas with comparable fluoride levels. The incidence was highest in the older age groups. Possible explanations were explored. A likely reason may be the continued large dependence on rain water harvesting ponds for human consumption alongside the use of water from the public borehole systems, but more investigations would be required to confirm this proposition."
Location of Study:	Halaba District, Southern Ethiopia (high fluoride levels)
Time of Study:	Date not stated
Type of Study:	Cross-sectional descriptive study
Key Points:	• Halaba district in Southern Ethiopia has high fluoride levels from boreholes, but a modest incidence of fluorosis. • The study found that 5 percent of the 625 participants had severe dental fluorosis and 42 percent had mild forms—which is considerably less than results of other areas with comparable fluoride levels. • The incidence was highest in the older age groups. • Food habits in the district not markedly different from the rest of the country.

Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Average
Data collection quality?	Low
Analysis of data?	Poor
Sound logic is used in the conclusions reached?	No
The study reaches valid conclusions with respect to the initial hypothesis/aim?	No
Validity of study?	Low
Strengths:	• Data collected from water samples and focal group interviews discussing knowledge, attitudes and practices. • Visual inspection of the participants for the incidence of fluorosis. • Discussed the policy implications of the findings.
Limitations:	• Small sample size (625). • No relevance to New Zealand. • Poor analysis. • Didn't consider the effect of any confounders. • Low validity study.
Can the findings be generalised?	No
Are the findings applicable to water fluoridation in New Zealand?	No
Implications for the Ministry of Health water fluoridation policy:	None

Review 14

Review Date: 2011/14

Study Identification:	
Title:	**Fluoride ion in drinking water and prevalence of dental fluorosis among the population in some tea garden belt villages in Golaghat district of Assam, India**
Authors	Baruah BK., Haque A., Das B., Misra K., Medhi C. and Misra AK.
Journal:	Archives of Applied Science Research
Year:	2011
Volume:	3
Pages:	175-9
Topic area	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"A study was carried out to find out the relationship between prevalence of dental fluorosis among the population as well as concentration of fluoride ion in drinking water in four tea garden belts viz. Latakoojan, Behora, Banwanipur and Negheriting Tea Estate belt of Golaghat district of Assam, India. A total of 20 underground drinking water samples were analysed from March to October, 2009 for fluoride ion estimation. Dental health status for a total of 300 populations was examined. The fluoride concentration was found higher than the permissible limit in 41.67% water samples and prevalence of dental fluorosis in the variation from severe to questionable was 0.48% to 78.36%. The pH range in ring well and tube well water were found to be 7.00–8.40 and 6.80–8.90 respectively. In addition, electrical conductance (EC) of ring well and tube well water samples were found in the range 142-1233 Scm-1 and 93-590 Scm-1 respectively. Fluoride concentration range was recorded 0.76-1.88 and 0.86-1.98 mg/L in ring well and tube well water samples respectively. This study also indicated prevalence rate of dental fluorosis was 25.67% in female and 74.33% in male belonging to the study area. The studies further revealed that knee pain, back pain and joints pain were common especially in male population. Different eating habits, pattern of tooth brass, lack of awareness and prolong use of small content of fluoride containing water might be the probable factors in higher occurrence of dental fluorosis in this region. This occurrence was observed higher in the people who took equal or more than four cup of tea daily."

Location of Study:	Assam District, India
Time of Study:	March-October 2009
Type of Study:	Cross-sectional ecological study
Key Points:	• Claimed to be a 'comprehensive analytical and field survey result of prevalence and dental fluorosis and fluoride ion in drinking water sources in tea garden belt villages ...' • The study found a prevalence rate of dental fluorosis was 25.7% for females and 74.3% for males and that knee pain, back pain and joints pain were common especially in male population. Different eating habits, pattern of tooth brass, lack of awareness and prolong use of small content of fluoride containing water were suggested as probable factors in higher occurrence of dental fluorosis in this region.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Poor
Data collection quality?	Poor
Analysis of data?	Poor
Sound logic is used in the conclusions reached?	Poor
The study reaches valid conclusions with respect to the initial hypothesis/aim?	No
Validity of study?	Low
Strengths:	• Data collection involved a field survey and an estimation of the fluoride content in drinking water. • Sample of 300 individuals in the villages aged 8-85 years
Limitations:	• No details given about method for selecting either the water samples or the participants. • No mention of possible limitations of the study. • Data analysis is now – no control for potential confounders. • Found that knee pain, back pain and joints pain were found in the 'majority of the people of age more than 40 years', but didn't provide the age distribution of the sample.
Can the findings be generalised?	No

Are the findings applicable to water fluoridation in New Zealand?	No
Implications for the Ministry of Health water fluoridation policy:	None

Review 15

Review Date: 2011/15

Study Identification:	
Title:	**Biomarkers of fluoride in children exposed to different sources of systemic fluoride**
Authors:	Buzalaf MAR., Rodrigues MHC., Pessan JP., Leite AL., Arana A., Villena RS., Forte FDS. and Sampaio FC.
Journal:	Journal of Dental Research
Year:	2011
Volume:	9
Pages:	215-9
Topic area	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"There has been no comparison between fluoride concentrations in urine and nails of children exposed to different sources of systemic fluoride. The aim of this study was to compare the relationship between fluoride intake with urinary fluoride excretion and fluoride concentrations in fingernails and toenails of children receiving fluoride from artificially fluoridated water (0.6-0.8 mg F/L, n = 25), naturally fluoridated water (0.6-0.9 mg F/L, n = 21), fluoridated salt (180-200 mg F/Kg, n = 26), and fluoridated milk (0.25 mg F, n = 25). A control population was included (no systemic fluoride, n = 24). Fluoride intake from diet and dentifrice, urinary fluoride excretion, and fluoride concentrations in fingernails/toenails were evaluated. Fluoride was analyzed with an ion-selective electrode. Urinary fluoride excretion in the control community was significantly lower when compared with that in the fluoridated cities, except for the naturally fluoridated community. However, the same pattern was not as evident for nails. Both urinary fluoride output and fluoride concentrations in fingernails/toenails were significantly correlated to total fluoride intake. However, the correlation coefficients for fluoride intake and urinary fluoride output were lower ($r = 0.28$, $p < 0.01$) than those observed for fingernails/toenails ($r = 0.36$, $p < 0.001$), suggesting that nails might be slightly better indicators of fluoride intake at the individual level."
Location of Study:	Multicentre study in Brazil (3 cities) and Peru (2 cities)
Time of Study:	Date not stated

Type of Study:	Cross-sectional epidemiological study
Key Points:	• Urinary fluoride excretion in the control community was significantly lower when compared with that in the fluoridated cities, except for the naturally fluoridated community. • Both urinary fluoride output and fluoride concentrations in fingernails/toenails were significantly correlated to total fluoride intake. • The correlations for fluoride intake and urinary fluoride output were lower than those observed for fingernails/toenails suggesting that nails might be slightly better indicators of fluoride intake at the individual level. • Urine is a better indicator of fluoride intake than nails at a community level. • It was also found that the levels of total fluoride intake would not have been exceeded if only fluoride ingested from the die had been considered. • The authors recommend reducing the amount of dentifrice used during toothbrushing and/or using a low-fluoride dentifrice for children at risk of dental fluorosis, but at low risk for caries.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Good
Data collection quality?	Good
Analysis of data?	Fair
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Validity of study?	Average
Strengths:	• Standardised 24-hour sample collections
Limitations:	• Essentially, the data were analysed by calculating correlation coefficients, rather than a more in-depth investigation of the relationships. • The biomarkers used in the study refer to different periods of systemic fluoride exposure – nails' fluoride concentrations reflect the average level of intake and plasma concentration over a protracted period, in contract

	to the analysis of urine. • Urine values were directly relative to fluoride ingested on the respective days which could results in a higher correlation in comparison with nails.
Can the findings be generalised?	Yes
Are the findings applicable to water fluoridation in New Zealand?	Yes
Implications for the Ministry of Health water fluoridation policy:	• If a study to measure fluoride levels in individuals were to be conducted in New Zealand the use of urine and nails as biomarkers might be worth considering. • The authors stressed the importance of a closer monitoring of concentrations of fluoride added to water or salt.

Review 16

Review Date: 2011/16

Study Identification:	
Title:	**Drinking Water Fluoride and Blood Pressure? An Environmental Study**
Authors:	Amini H., Taghavi Shahri SM. et al
Journal:	Biological Trace Element Research
Year:	2011
Topic area	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"The relationship between intakes of fluoride (F) from drinking water and blood pressure has not yet been reported. We examined the relationship of F in ground water resources (GWRs) of Iran with the blood pressure of Iranian population in an ecologic study. The mean F data of the GWRs (as a surrogate for F levels in drinking water) were derived from a previously conducted study. The hypertension prevalence and the mean of systolic and diastolic blood pressures (SBP & DBP) of Iranian population by different provinces and genders were also derived from the provincial report of non-communicable disease risk factor surveillance of Iran. Statistically significant positive correlations were found between the mean concentrations of F in the GWRs and the hypertension prevalence of males ($r = 0.48$, $p = 0.007$), females ($r = 0.36$, $p = 0.048$), and overall ($r = 0.495$, $p = 0.005$). Also, statistically significant positive correlations between the mean concentrations of F in the GWRs and the mean SBP of males ($r = 0.431$, $p = 0.018$), and a borderline correlation with females ($r = 0.352$, $p = 0.057$) were found. In conclusion, we found the increase of hypertension prevalence and the SBP mean with the increase of F level in the GWRs of Iranian population.
Location of Study:	Iran
Time of Study:	2007-08
Type of Study:	Ecological study
Key Points:	• The study found the increase of hypertension prevalence and the systolic blood pressure mean with the increase of fluoride in the ground water resources of Iranian population, especially in males. • Assumed that the mean fluoride data of the ground water resources (the main source of drinking water supply in

	urban and rural areas, were used as a surrogate for fluoride in drinking water. These data were derived from a previous study in 2008. • The caries-free index of Iranian children (for both primary dentition and permanent teeth) published in 2004 was used to validate fluoride data. The data of caries-free for 6- and 9-year-old children were derived from the reports of the Ministry of Health of Iran. • The hypertension prevalence (percentage of individuals with blood pressure ≥140/90 mm Hg and the mean of systolic and diastolic blood pressures of the population by different provinces and genders were derived from the provincial report of non-communicable disease risk factor surveillance of Iran.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Fair
Data collection quality?	Fair
Analysis of data?	Good – used a variety of statistical analysis including simple regression
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Validity of study?	Low
Strengths:	• Acknowledged that future studies would require 'better control of confounding factors and considering different conditions'.
Limitations:	• Data derived from a number of sources over different time periods. • Assumed that the mean fluoride data of the ground water resources (the main source of drinking water supply in urban and rural areas, were used as a surrogate for fluoride in drinking water. These data were derived from a previous study in 2008. • The authors concluded that; 'ultimate conclusions about the association of fluoride and the blood pressure and its effects on cardiovascular system need further experimental and epidemiological study, including better control of confounding factors and considering different

	conditions.'
Can the findings be generalised?	Yes
Are the findings applicable to water fluoridation in New Zealand?	No
Implications for the Ministry of Health water fluoridation policy:	It may be of interest in future policy to consider the study finding of an the increase of hypertension prevalence and the systolic blood pressure mean with the increase of fluoride in the ground water resources.

Study Identification:	
Title:	**Income Inequality and tooth loss in the United States**
Authors:	Bernabe B. and Marcenes W.
Journal:	Journal of Dental Research
Year:	2011
Volume:	90
Pages:	724-9
Topic area	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"This study explored the relationship between state income inequality and individual tooth loss among 386,629 adults in the United States who participated in the 2008 Behavioral and Risk Factor Surveillance System. Multilevel models were used to test the association of the state Gini coefficient with tooth loss after sequential adjustment for state- (median household income) and individual-level confounders (sex, age, race, education, and household income), as well as state- (percent receiving fluoridated water and dentist-to-population ratio) and individual-level mediators (marital status and last dental visit). The state Gini coefficient was significantly associated with tooth loss even after adjustment for state- and individual-level confounders and potential mediators (Odds Ratio, 1.17; 95% Confidence Interval, 1.05 to 1.30). This study provides support for the relationship between state income inequality and individual tooth loss in the United States."
Location of Study:	USA
Time of Study:	2008
Type of Study:	Cross-sectional ecological study
Key Points:	• The study found a relationship among 386,629 adults who participated in the 2008 Behavioral and Risk Factor Surveillance System (BRFSS) between state income inequality and individual tooth loss in the United States. • A 5% change in the state Gini coefficient (a standard measure of income inequality summarising the distribution of income across the entire range of income categories) was associated with almost 20% higher odds of reporting

	greater tooth loss after control for a number of confounding factors. • In the fully adjusted model, state dentist-to-population ratio and percent receiving water fluoridation were not statistically significantly related to tooth loss.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Yes
Data collection quality?	Good
Analysis of data?	Good
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Validity of study?	Average
Strengths:	• A multilevel study. • Wide range of data used. • Controlled for a number of confounding factors at state (eg, median household income) and individual level (eg, sex, age, race, education, and household income). • The authors acknowledged the limitations of the study
Limitations:	• The authors acknowledge a number of limitations in their study: o It was a cross-sectional study and 'limited to identifying associations rather than causal relationships'. o 'The 53% response rate for the 2008 BRFSS raised concerns about non response bias. To address this concern, respondents and non-respondents were compared on key demographic variables'. The authors concluded that 'the small differences along with the large sample size suggest that, despite the moderate response rate, little non-response bias was experienced in the 2008 BRFSS.' o The Gini coefficient is incapable of differentiating among different kinds of inequality and is highly sensitive to inequalities in the middle of the income spectrum. o Misclassification of exposure may have occurred if some individuals moved between states after the

	2000 US Census. o The data on tooth loss were based on self-reports and not objective clinical assessment.
Can the findings be generalised?	Yes
Are the findings applicable to water fluoridation in New Zealand?	Yes
Implications for the Ministry of Health water fluoridation policy:	The association between income inequality and tooth loss was somewhat attenuated when the percent of state population receiving fluoridated water and dentist-to-population rate were considered.

Study Identification:	
Title:	**Prevalence of enamel fluorosis in 12-year-olds in two Swiss cantons**
Authors:	Buchel K., Gerwig P., Weber C., Minnig P., Wiehl P., Schild S. and Meyer J.
Journal:	Schweizer Monatsschrift fur Zahnmedizin = Revue mensuelle suisse d'odonto-stomatologie = Rivista mensile svizzera di odontologia e stomatologia / SSO
Year:	2011
Volume:	121
Pages:	652-6
Topic area	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"The neighbouring cantons Basel-Stadt and Basel-Landschaft had introduced different fluoridation schemes for caries prevention: Basel-Stadt provided drinking water fluoridated at 0.8-1 ppm F since 1962, while Basel-Landschaft introduced fluoridated domestic salt (250 ppm F since 1983). Representative samples of 12-year-old schoolchildren (6th-graders) were studied to evaluate the prevalence of (I) dental fluorosis (FOP) using the Thylstrup-Fejerskov (TF) index, (II) non fluoride-associated enamel opacities (non-FOP), and (III) hypoplasia of the incisors. Standardised frontal colour photographs were taken and assessed by four examiners after projection. Of 373 schoolchildren studied in 1999 in Basel-Stadt 119 (31.9%) showed fluoride-associated enamel opacities, i. e. 66 (17.7%) a very mild form (TF score 1), 47 (12.6%) a mild form (TF score 2), five scored TF3 and one TF5. In addition, non-FOP were diagnosed in 115 (30.8%) and hypoplasia in 47 (12.6%) children. Among the 448 children evaluated in 2001 in Basel-Landschaft 143 (31.9%) showed FOP, namely 74 (16.5%) scored TF1, 54 (12.2%) scored TF2, 12 (2.7%) scored TF3, and three (0.7%) scored TF5. Non-FOP were found among 93 (20.8%) and hypoplasia among 56 (12.5%) children. Thus, in spite of different fluoridation schemes in the two cantons, the prevalences of FOP were identical. Most fluoride-associated enamel opacities were mild or very mild. They did not represent an aesthetic problem and certainly not a public health concern."

Location of Study:	Basel-Stadt and Basel-Landschaft cantons, Switzerland
Time of Study:	1999-2001
Type of Study:	Clinical study
Key Points:	• Although the two cantons had different fluoridation schemes in the two cantons, the prevalences of dental fluorosis (FOP) were identical. • Most fluoride-associated enamel opacities were mild or very mild and did not represent an aesthetic problem and certainly not a public health concern. • The relatively small number of adolescents with a more prominent enamel fluorosis in both cantons did not indicate a general oversupply of fluoride.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Good
Data collection quality?	Good
Analysis of data?	Fair
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Validity of study?	Average
Strengths:	• Clinical examination (with photographs of maxillary central incisor and upper lateral incisor) of all participants. • Four examiners reviewed the photographs with the inter-examiner calibration.
Limitations:	• The authors noted: '...joint consideration [of the questionable slides/photographs] may have lead to a more sensitive assessment, which tended towards a higher prevalence of fluoride'. • Lack of thorough fluoride history for participants with more prominent enamel fluorosis.
Can the findings be generalised?	Yes
Are the findings applicable to water fluoridation in New Zealand?	Yes

Implications for the Ministry of Health water fluoridation policy:	The paper provides relevant information for the Ministry's future policy development and implementation on fluoridation.

Review 19

Review Date: 2011/19

Study Identification:	
Title:	**Contemporary fluid intake and dental caries in Australian children**
Authors:	Lee J.G. and Messer L.J.B
Journal:	Australian Dental Journal
Year:	2011
Volume:	56
Pages:	122-3
Topic area	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"In Australia, caries experience of 6-year-old and 12-year-old children has increased since the mid to late 1990s. Previously, caries rates had declined, attributable to community water fluoridation. The recent caries increase has been attributed speculatively to changes in fluid intake, including increased consumption of sweet drinks and bottled waters. Increasing urbanization and globalization have altered children's diets worldwide, promoting availability and access to processed foods and sweet drinks. Studies in Australia and internationally have demonstrated significant associations between sweet drink intake and caries experience. Despite widespread fluoride availability in contemporary Australian society, the relationship between sugar consumption and caries development continues and restricting sugar intake remains key to caries prevention. Caries risk assessment should be included in treatment planning for all children; parents should be advised of their child's risk level and given information on oral health promotion. Readily-implemented caries risk assessment tools applicable to parents and clinicians are now available. Public health information should increase awareness that consuming sweet drinks can have deleterious effects on the dentition as well as the potential for promoting systemic disease. Restricting sales of sweet drinks and sweet foods and providing healthy food and drinks for purchase in schools is paramount."
Location of Study:	Australia
Time of Study:	Not applicable

Type of Study:	Review article
Key Points:	• Despite widespread fluoride availability in contemporary Australian society, the relationship between sugar consumption and caries development continues and restricting sugar intake remains key to caries prevention. • Caries risk assessment should be included in treatment planning for all children; parents should be advised of their child's risk level and given information on oral health promotion. • The authors conclude that; 'restricting sales of sweet drinks and sweet foods and providing healthy food and drinks for purchase in schools is paramount.' • The authors made four clinical recommendations: o The frequency and timing of drinking sweet drinks should be included in discussing dietary risk factors for dental caries and erosion with patients and parents; o Caries risk assessment protocols should include assessment of sweet drink intake; o A child remaining at high caries risk despite the best efforts by the dental team may require referral to a dietitian for dietary counselling; o Health professionals should provide the community with appropriate recommendations and cautions concerning the consumption of sweet drinks, noting the potential for deleterious effects on the dentition.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes – this a review article
The study method is appropriate?	Yes
Data collection quality?	Good
Analysis of data?	Good
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Validity of study?	Average
Strengths:	• Review of the Australian and international literature. • Some recommendations for health promotion activities.
Limitations:	• Little critique of the literature, rather a presentation of

	results.
Can the findings be generalised?	Yes
Are the findings applicable to water fluoridation in New Zealand?	Yes
Implications for the Ministry of Health water fluoridation policy:	• The study review has relevance for Ministry's future policy development and implementation on fluoridation as it shows there are many different risk factors for dental caries even with fluoridated water and studies must control for their potential effect. • Good oral health depends on the availability of fluoridated water, complimented by reduced or managed intakes of sweet drinks and foods.

Review 20

Review Date: 2011/20

Study Identification:	
Title:	**A case study on dental fluorosis in Uthangarai Taluk, Krishnagiri District, Tamil Nadu, India**
Authors	Malar S., Karuppannan S., Krishnaveni M. and Venkateswaran S.
Journal:	Asian Journal of Microbiology, Biotechnology and Environmental Sciences – India
Year:	2011
Volume:	13
Pages:	47-9
Topic area	Oral and public health epidemiology
Summary of Study:	
Abstract:	"India has increased incidence of fluorosis especially Dental and Skeletal. Overall some 62 million people are at risk. Oral health investigation for students of classes V, VI, VII, VIII, IX, X were conducted in Government schools of selected villages in Uthangarai Taluk. Students tooth were characterized like chalked for discoloration, blackness, softened and chalky white appearance. Hence remediation is necessary to some extent to alleviate the side effects. The percentage of students affected with dental fluorosis was found to be 51.11% in Thiruvanapatti and 85.34% in Nochipatti. Fluorosis affecting 67.37% of students depicts the present scenario of high fluoride level in drinking water. © Global Science Publications."
Location of Study:	Villages in Uthangarai Taluk, India
Time of Study:	Not given
Type of Study:	Clinical study – abstract only available
Key Points:	• Fluorosis affecting 67.37% of students reflects the present scenario of high fluoride levels in drinking water.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated? The study method is appropriate?	No evaluation was undertaken as only the abstract was available for review.

Data collection quality? Sound logic is used in the conclusions reached? The study reaches valid conclusions with respect to the initial hypothesis/aim?	
Strengths:	Not known
Limitations:	Not known
Can the findings be generalised?	Not known
Are the findings applicable to water fluoridation in New Zealand?	
Implications for the Ministry of Health water fluoridation policy:	The abstract provides no information relevant to the Ministry's fluoridation policy.

Additional comment:

No evaluation was undertaken as only the abstract was available for review.

Review 21

Review Date: 2011/21

Study Identification:	
Title:	**Investigation on knowledge, attitude and behavior of oral health among dental clinics patients in a community hospital**
Authors:	Zhong Q., Zhou Z. B., Shi X. J., Zhong Q. Z., Zhou Z. B. and Shi X. J.
Journal:	Occupation and Health
Year:	2011
Volume:	27
Pages:	1391-3
Topic area	Oral and Public Health Epidemiology
Summary of Study:	
Abstract:	"In this study, a questionnaire survey was performed among 600 patients who had visited a dental clinic in a local hospital during January 2009-December 2010, as regards to knowledge, attitude and behaviour on oral health. Of the 600 questionnaires, only 582 were considered. Overall rate of correct answers as to knowledge ranged from 9.45% to 67.87%, that as to attitude ranged from 44.33% to 78.87%, and that as to behaviour ranged from 5.67% to 67.53%. There were significant differences in the correct answer rates for the phrases "toothbrushing can prevent tooth decay," "flossing is beneficial for gingival health," and "fluoride drinking water and fluoridation can prevent tooth decay" between local and floating populations ($P<0.05$). There were significant differences in the rates of correct opinions regarding teeth protection as very important and regular teeth cleaning is helpful to periodontal health ($P<0.05$). There were significant differences in the correct answer rates for behaviours such as flossing, using fluoride toothpaste, using gargle, regular teeth examination, and regular teeth cleaning ($P<0.05$). Thus, this group of outpatients' knowledge and attitudes about basic oral health is poor. Oral health education should be aggressively promoted and implemented."
Location of Study:	Local hospital, Baoan District, Shenzhen, Guangdong, China
Time of Study:	2009-10
Type of Study:	Knowledge, attitudes, behaviour study

Key Points:	• The knowledge and attitudes about basic oral health among 600 outpatients was poor.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated? The study method is appropriate? Data collection quality? Sound logic is used in the conclusions reached? The study reaches valid conclusions with respect to the initial hypothesis/aim?	No evaluation was undertaken as only the abstract was available for review (the original article is in Chinese.
Strengths:	Not known
Limitations:	Not known
Can the findings be generalised?	Not known
Are the findings applicable to water fluoridation in New Zealand?	Not known
Implications for the Ministry of Health water fluoridation policy:	The abstract provides no information relevant to the Ministry's fluoridation policy.

Additional comment:

No evaluation was undertaken as only the abstract was available for review (the original article is in Chinese).

Review 22

Review Date: 2011/22

Study Identification:	
Title:	**Community water fluoridation support and opposition in Australia**
Authors:	Armfield J. and Akers HF.
Journal:	Community Dental Health
Year:	2011
Volume:	28
Pages:	40-6
Topic area	Communication and community engagement

Summary of Study:	
Abstract:	"Objective: To estimate the level of support for water fluoridation across Australia and examine the association between water fluoridation stance and demographic and socioeconomic characteristics, commitment to the stance, and opinions, beliefs and knowledge regarding water fluoridation. Methods: Cross-sectional questionnaire data were obtained from 510 Australian adults (response rate = 34%) in 2008. Data were weighted by age, gender and state and territory estimated resident population. Main outcome measures: Participants were asked to rate the strength of their support for or opposition to water fluoridation on a 7-point scale. Results: Approximately 70% of survey respondents supported water fluoridation, 15.4% were opposed, and 14.5% were neutral. Those strongly opposed were most resistant to altering their opinion on the basis of new information or research. However, approximately 90% of people who were neutral, slightly supportive or moderately supportive would "maybe" or "definitely" change their stance. Fluoridation opposition was associated with lower income and educational attainment, more self-rated knowledge, and with beliefs about reduced benefits and greater harms. Opinions about who should be responsible for the introduction of water fluoridation and sources of information on fluoridation varied significantly by water fluoridation opinion. Conclusions: While this survey lends further weight to the evidence confirming extensive support for water fluoridation in Australia, a large percentage of the public may be open to changing their stance if presented with new information or research. To maintain the widespread acceptance of water fluoridation, it is important that the public are provided with unbiased and accurate

	interpretations of the continual stream of research related to fluorides and water fluoridation." Australia 2008 Cross-sectional opinion survey
Location of Study: **Time of Study:** **Type of Study:**	
Key Points:	• Approximately 70% of survey respondents supported water fluoridation, 15.4% were opposed, and 14.5% were neutral. • Those strongly opposed were most resistant to altering their opinion on the basis of new information or research. • Approximately 90% of people who were neutral, slightly supportive or moderately supportive would 'maybe' or 'definitely' change their stance. Fluoridation opposition was associated with lower income and educational attainment, more self-rated knowledge, and with beliefs about reduced benefits and greater harms. • Opinions about who should be responsible for the introduction of water fluoridation and sources of information on fluoridation varied significantly by water fluoridation opinion. • The authors concluded that: 'to maintain the widespread acceptance of water fluoridation, it is important that the public are provided with unbiased and accurate interpretations of the continual stream of research related to fluorides and water fluoridation.'
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Yes
Data collection quality?	Good – data from questionnaire
Analysis of data?	Good
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Validity of study	Average
Strengths:	• Random sample stratified by Australian states and territories.

	• Replacement sampling. • Most of the analyses use weighted data. • Presented 95% confidence intervals for the means. • Acknowledgement of limitation of the study and that 'various sampling bias may have led to an overall bias in study results.'
Limitations:	• Low response rate to the questionnaire (34% - which is 'becoming increasingly common in population surveys generally ... and in studies of water fluoridation opinion specifically.' • Potential bias introduced by the use of an electronic white pages telephone listing for the sampling frame (mobility and under-representation of younger adults even after the reweighting of data).
Can the findings be generalised?	Yes
Are the findings applicable to water fluoridation in New Zealand?	Yes
Implications for the Ministry of Health water fluoridation policy:	• The paper provides a methodology for assessing attitudes to water fluoridation, and information for managing communication around the issue. • As noted by the authors: 'awareness of public opinions of water fluoridation, its variation by population characteristics, and the beliefs and attitudes associated with support and opposition, will be important in future efforts to further extend this important public health practice.'

Review 23

Review Date: 2011/23

Study Identification:	
Title:	**Evidence-based clinical recommendations regarding fluoride intake from reconstituted infant formula and enamel fluorosis: a report of the American Dental Association Council on Scientific Affairs**
Authors:	Berg J., Gerweck C., Hujoel PP., King R., Krol DM., Kumar J., Levy S., Pollick H., Whitford GM., Strock S., Aravamudhan K., Frantsve-Hawley J. and Meyer DM.
Journal:	Journal of the American Dental Association
Year:	2011
Volume:	142
Pages:	79-87
Topic area	Review and Public Health Policy
Summary of Study:	
Abstract:	"BACKGROUND: This article presents evidence-based clinical recommendations regarding the intake of fluoride from reconstituted infant formula and its potential association with enamel fluorosis. The recommendations were developed by an expert panel convened by the American Dental Association (ADA) Council on Scientific Affairs (CSA). The panel addressed the following question: Is consumption of infant formula reconstituted with water that contains various concentrations of fluoride by infants from birth to age 12 months associated with an increased risk of developing enamel fluorosis in the permanent dentition? TYPES OF STUDIES REVIEWED: A panel of experts convened by the ADA CSA, in collaboration with staff of the ADA Center for Evidence-based Dentistry (CEBD), conducted a MEDLINE search to identify systematic reviews and clinical studies published since the systematic reviews were conducted that addressed the review question. RESULTS: CEBD staff identified one systematic review and two clinical studies. The panel reviewed this evidence to develop recommendations. CLINICAL IMPLICATIONS: The panel suggested that when dentists advise parents and caregivers of infants who consume powdered or liquid concentrate infant formula as the main source of nutrition, they can suggest the continued use of powdered or liquid concentrate infant formulas reconstituted with optimally fluoridated drinking water while being cognizant of the potential risks of enamel fluorosis development. These recommendations are presented

	as a resource to be considered in the clinical decision-making process. As part of the evidence-based approach to care, these clinical recommendations should be integrated with the practitioner's professional judgment and the patient's needs and preferences."
Location of Study:	USA
Time of Study:	Not appplicable
Type of Study:	Review article from the American Dental Association Council on Scientific Affairs
Key Points:	• Suggested that when advising parents and caregivers of infants who consume powdered or liquid concentrate infant formula as the main source of nutrition, also suggest the continued use of powdered or liquid concentrate infant formulas reconstituted with optimally fluoridated drinking water while being cognizant of the potential risks of enamel fluorosis development. • Practitioners should be aware that children are exposed to multiple sources of fluoride during the tooth development period. Reducing fluoride intake from reconstituted infant formula alone will not eliminate the risk of fluorosis development. • It is important that clinicians provide advice to parents regarding the proper use of fluoridated toothpastes along with the informed prescription of fluoride supplements.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Good
Data collection quality?	Good
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Strengths:	• Multidisciplinary panel of 12 experts on fluoride evaluated the selected papers. • Clearly specified inclusion and exclusion criteria for literature search using MEDLINE. • Each paper was critically appraised and recommendations developed.
Limitations:	• Final selection of papers was: one systematic review, one

	cross-sectional study and one prospective study.
Can the findings be generalised?	Yes – the recommendations
Are the findings applicable to water fluoridation in New Zealand?	Yes
Implications for the Ministry of Health water fluoridation policy:	• When advising parents and caregivers of infants who consume powdered or liquid concentrate infant formula as the main source of nutrition, also suggest the continued use of powdered or liquid concentrate infant formulas reconstituted with optimally fluoridated drinking water while being cognizant of the potential risks of enamel fluorosis development. • Included recommendations for research: o Identify biomarkers as an alternative to direct fluoride intake measurement. o Conduct descriptive and analytical epidemiological studies to: ▪ Estimate the total fluoride intake from all sources individually and in combination. ▪ Quantify the risk of developing moderate to severe fluorosis attributable to fluoride intake form consumption of reconstituted infant formula. • Conduct metabolic studies of fluoride to determine the influence of environmental, physiological and pathological conditions on pharmacokinetics, balance and effects of fluoride.

Study Identification:	
Title:	**Investing in professional advocacy: a case study of a successful fluoridation campaign in rural New South Wales, Australia**
Authors:	Sivaneswaran S. and Chong G. T
Journal:	Community Dental Health
Year:	2011
Volume:	28
Pages:	243-7
Topic area	Communication and community engagement
Summary of Study:	
Abstract:	"In New South Wales (NSW), Australia, the responsibility to implement water fluoridation rests with local government Councils, partly accounting for the hindrance in its statewide implementation. Since 2003, the NSW Health Department has been actively promoting water fluoridation to the remaining unfluoridated rural communities. OBJECTIVES: To describe the community education and consultation strategies which led to the implementation of fluoridation in two rural NSW towns. METHODS: In February 2005, the Mid-Western Regional Council and the NSW Health Department undertook a comprehensive community education process followed by a consultation process. The education process included the organization of public forums; distribution of fluoridation information packs; building rapport with the local media; and the use of local disease and treatment data to demonstrate oral health disparities with neighbouring fluoridated towns. The consultation process to determine support for fluoridation included seeking written submissions from the community and conducting interviews on a random sample of households by an independent research organization. RESULTS: A total of 502 (N = 1,012) interviews to determine support for fluoridation were completed, achieving a response rate of 49.6%. 54% of respondents wanted their water supplies fluoridated, 25% did not and the remaining 21% were unsure. In June 2005, the Mid-Western Regional Council resolved to implement water fluoridation and fluoride was added to the towns' water supplies in November 2007. CONCLUSIONS: This case study demonstrates that it is possible to garner community support for water fluoridation with the use of a multifaceted approach

	in educating and consulting communities and stakeholders."
Location of Study:	New South Wales, Australia
Time of Study:	2005
Type of Study:	Evaluation of a community education programme
Key Points:	• Found that if people were informed about water fluoridation, they were more likely to be supportive of the measure. • The role of the media as a source of information on water fluoridation cannot be underestimated in any fluoridation campaign. This was confirmed by the survey which reported that the newspaper and radio were the main sources of information from which respondents learnt about fluoridation. • It is imperative that the community also be consulted about water fluoridation after having been educated about the issue. Campaigns that have sufficiently engaged the local community and all the stakeholders, in this fashion, are less likely to fail. • The use of locally relevant evidence to emphasize the disparity of oral health between local children and those living in geographically nearby but fluoridated townships was especially critical during this campaign.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes
The study method is appropriate?	Good
Data collection quality?	Good – data obtained from interviews
Sound logic is used in the conclusions reached?	Yes
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Validity of study	High
Strengths:	• Despite the comparatively low response rate of 49.6% (but higher than in many such surveys), there was no significant differences in terms of age specific gender distribution of the sample when compared with that of the adult residents in the towns. • Excluded households not supplied by the towns' water and those who did not reside in the towns.

	• Included a power calculation for the sample size.
Limitations:	• More details on the demographics of the sample would have been helpful.
Can the findings be generalised?	Yes
Are the findings applicable to water fluoridation in New Zealand?	Yes
Implications for the Ministry of Health water fluoridation policy:	• The authors offer practical advice to individuals charged with the task of persuading communities to adopt fluoridation. • The case study shows that it is possible to garner community support for water fluoridation with the use of a multifaceted approach in educating and consulting communities and stakeholders. • The use of locally relevant evidence to emphasize the disparity of oral health between local children and those living in geographically nearby but fluoridated townships was especially critical during this campaign.

Study Identification:	
Title:	**Evaluation of fluoride-induced oxidative stress in rat brain: a multigeneration study**
Authors:	Basha M.P., Raj P., Begum S.
Journal:	Biological Trace Element Research
Year:	2010
Volume:	24 July
Pages:	DOI 10.1007/s12011-010-8780-4
Topic area	Toxicology and pharmacology
Summary of Study:	
Abstract:	"Multigenerational evaluation was made in rats on exposure to high fluoride (100 and 200 ppm) to assess neurotoxic potential of fluoride in discrete areas of the brain in terms of lipid peroxidation and the activity of antioxidant enzyme system. The rats were given fluoride through drinking water (100 and 200 ppm) and maintained subsequently for three generations. Fluoride treatment significantly increased the lipid peroxidation and decreased the activity of antioxidant enzymes viz, catalase, superoxide dismutase, glutathione peroxidase, glutathione S-transferase, and glutathione level in first-generation rats and these alterations were more pronounced in the subsequent second and third-generation rats in both the doses tested. Decreased feed and water consumption, litter size and organ (brain) somatic index, marginal drop in body growth rate and mortality were observed in all three generations. Decreased antioxidant enzyme activity and increased malondialdehyde levels found in the present study might be related to oxidative damage that occurs variably in discrete regions of the brain. Results of this study can be taken as an index of neurotoxicity in rats exposed to water fluoridation over several generations.
Type of study:	Experimental animal study
Key Points:	• The study methodology was quite good in terms of the detailed experimental design. However one major drawback was the decision to test only the effects of very high levels of fluoride in drinking water, which have virtually no relevance to the human situation of fluoridated water supplies containing fluoride at levels of ~ 0.7 to 1.2

	mg/L. • The results show that very high fluoride intake over successive generations can elevate lipid peroxidation and alter the anti-oxidant system, thereby leading to increased oxidative stress. • The biochemical results suggest that the elevated lipid peroxidation in fluorosis may result from decreased activity of antioxidant enzymes.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated? The study method is appropriate? Data collection quality? Analysis of data? Sound logic is used in the conclusions reached? The study reaches valid conclusions with respect to the initial hypothesis/aim?	No Fair Fair Fair Yes Yes
Strengths:	• The general design of the study was of a fairly good standard for animal studies, including for multigenerational studies.
Limitations:	• Very poor generalisability to any plausible human fluoride exposure scenario (However, the paper cites one 1998 animal study purporting to show effects on brain tissue in animals exposed to only 1 mg/L of fluoride in drinking water; and this reference should be followed up). • Some of the chosen end points (ie biochemical evidence of oxidant induced damage), while legitimate in their own right, are of uncertain clinical relevance, given the difficulty in predicting the clinical, neuropsychological and cognitive impacts or 'correlates' of such biochemical alterations.
Can the findings be generalised?	No
Are the findings applicable to water fluoridation in New Zealand?	No
Implications for the Ministry of Health water fluoridation policy:	There are no pressing practical implications for the Ministry's fluoridation policy arising from this study, principally because the doses (or DWFCs) associated with adverse endpoints were so high as to have little relevance to the assessment of risks to humans from fluoridated drinking water.

Review 26

Review Date: 2011/26

Study Identification:	
Title:	**Proteomic analysis of urine in rats chronically exposed to fluoride**
Authors:	Kobayashi C., Leite A., da Silva T., *et al.*
Journal:	Journal of biochemical and molecular toxicology
Year:	2011
Volume:	25
Pages:	8-14
Topic area	Toxicology and pharmacology
Evaluation Criterion:	
Abstract:	"Urine is an ideal source of materials to search for potential disease-related biomarkers as it is produced by the affected tissues and can be easily obtained by noninvasive methods. 2-DE-based proteomic approach was used to better understand the molecular mechanisms of injury induced by fluoride (F-) and define potential biomarkers of dental fluorosis. Three groups of weanling male Wistar rats were treated with drinking water containing 0 (control), 5, or 50 ppm F- for 60 days (n = 15/group). During the experimental period, the animals were kept individually in metabolic cages, to analyze the water and food consumption, as well as fecal and urinary F- excretion. Urinary proteome profiles were examined using 2-DE and Colloidal Coomassie Brilliant Blue staining. A dose-response regarding F- intake and excretion was detected. Quantitative intensity analysis revealed 8, 11, and 8 significantly altered proteins between control vs. 5 ppm F-, control vs. 50 ppm F- and 5 ppm F- vs. 50 ppm F- groups, respectively. Two proteins regulated by androgens (androgen-regulated 20-KDa protein and α-2μ-globulin) and one related to detoxification (aflatoxin-B1-aldehyde-reductase) were identified by MALDI-TOF-TOF MS/MS. Thus, proteomic analysis can help to better understand the mechanisms underlying F- toxicity, even in low doses. © 2010 Wiley Periodicals, Inc
Type of Study:	Experimental animal study
Key Points:	• The authors acknowledged that the method was a research tool whose findings were of uncertain significance. • The findings are imprecise and their significance uncertain.

	• The study does not reach firm conclusions, other than to suggest the methods used can contribute to clarifying certain toxic mechanisms of fluoride, by identifying key proteins which however would then need to be better addressed (or assessed).
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated? The study method is appropriate? Data collection quality? Analysis of data? Sound logic is used in the conclusions reached? The study reaches valid conclusions with respect to the initial hypothesis/aim?	No Fair Fair Fair Yes No
Strengths:	• *A* strength is probably the relatively innovative method, and that at least one relatively low DWFC (ie 5 ppm) group was involved, which is potentially relevant for human exposure at a DWFC of ~ 1ppm.
Limitations:	• The assessment method (proteomic analysis) currently appears to have very limited ability to predict the degree of functional disturbance or tissue damage corresponding to any given change in the degree of expression of any specific protein in the urine. • The selected DWFCs do not allow a good comparison between the potential effects of say a DWFC in humans of 1 ppm versus say 0.2 or 0.3 ppm (which latter may occur in non-fluoridated drinking). Theoretically, for such a comparison, an appropriate experimental DWFC for rats would be in the range of 1 to 1.5 ppm (as well as 5 ppm).
Can the findings be generalised?	No
Are the findings applicable to water fluoridation in New Zealand?	No
Implications for the Ministry of Health water fluoridation policy:	There are no pressing practical implications for the Ministry's fluoridation policy arising from this study, principally because the findings were both limited and also of uncertain clinical significance.

Review 27

Review Date: 2011/27

Study Identification:	
Title:	**Fluoride effect on the secretory-stage enamel organic extracellular matrix of mice**
Authors:	Mofatto L., Frozoni M., do Espirito Santo A., *et al*
Journal:	Connective Tissue Research
Year:	2011
Volume:	52
Pages:	212-7
Topic area	Toxicology and pharmacology
Summary of Study:	
Abstract:	"The formation of an ordered enamel organic extracellular matrix (EOECM) seems to be a crucial step for the proper formation of the enamel mineral phase. The ordered supramolecular structure of the EOECM in the secretory stage can be analyzed using polarizing microscopy, as it is strongly birefringent. Excessive fluoride (F) ingestion during tooth development can cause enamel fluorosis, leading to increased porosity in mature enamel. We analyzed the effects of F on the birefringence of the EOECM in the A/J, CBA, and DBA/2 strains of mice given 0, 11.25, and 45 ppm of fluoride in drinking water. In the CBA and DBA/2 strains, the 11.25 and 45 ppmF groups presented a significant decrease in optical retardation (OR) when compared with the respective 0 (CBA 11.25 ppmF $p = 0.0056$ and 45 ppmF $p < 0.0001$; DBA/2 11.25 and 45 ppmF $p < 0.05$). ORs in A/J 0 ppmF were significantly higher than in 45 ($p < 0.0001$). The enamel of the A/J strain was more severely affected by fluoride than it was in the other strains of mice and exhibited the lowest levels of fluoride in plasma, whereas its normal secretory enamel presented a significantly higher protein absorbance than it did in CBA and DBA mice ($p = 0.0099$ and $p = 0.0025$, respectively). The results showed that experimental fluorosis can alter the supramolecular organization of EOECM in the secretory stage of amelogenesis and that the susceptibility to dental fluorosis seems to be influenced by the inherent characteristics of the developing enamel.
Type of Study:	Experimental animal study

Key Points:	• This is a complex, highly specialised paper. • It investigates experimental dose-response relationships with respect to dental fluorosis, but employs a rather novel marker of enamel damage. • There is already substantial human epidemiological data on dental fluorosis, with more readily interpretable end points and markers than that provided by the highly specialised assessment methods (of limited availability) that were used in this study
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	No
The study method is appropriate?	Reasonable. It is difficult to comment on such a specialised topic. The method was probably appropriate to the line of investigation. However this investigation itself has little relevance to the assessment of human risk of dental fluorosis in terms of dose-response relationships.
Data collection quality?	Fair
Analysis of results	Fair
Sound logic is used in the conclusions reached?	No
The study reaches valid conclusions with respect to the initial hypothesis/aim?	The aim is not well enunciated
Strengths:	• The general design of the study was of a fairly good standard for animal studies.
Limitations:	• Given the very high fluoride concentrations in drinking water in the two study groups, it has very poor generalisability to a New Zealand fluoride in drinking water scenario.
Can the findings be generalised?	No
Are the findings applicable to water fluoridation in New Zealand?	No
Implications for the Ministry of Health water fluoridation policy:	• There are no practical implications for the Ministry's fluoridation policy arising from this study, principally because the doses (or DWFCs) associated with adverse endpoints were so high as to have little relevance to the assessment of risks to humans from fluoridated drinking water. The DWFCs used (11.25 ppm and 45 ppm) were extremely high, which limits the generalisability, and the authors do not explicitly address any adverse effects on

	enamel at more realistic levels. • This means that this study has essentially no relevance to the human situation of fluoridated water supplies containing fluoride at levels of ~ 0.7 to 1.2 mg/L.

Review 28

Review Date: 2011/28

Study Identification:	
Title:	**Reduction of CaMKII expression in the hippocampus of rats from ingestion of fluoride and/or lead**
Authors:	Luo G., et al.
Journal:	Fluoride
Year:	2011
Volume:	44
Pages:	63-9
Topic area	Toxicology and pharmacology
Summary of Study:	
Abstract:	"Co-existing as environmental pollutants in certain areas of China where lead (Pb) is mined, fluoride (F) and Pb pose serious risks to the human central nervous system (CNS). Calcium/calmodulin-dependent protein kinase II (CaMKII) expression, which is involved in the process of learning and memory, has an important role in CNS functioning. Here, in order to verify whether F and/or Pb affect CaMKII expression, we determined the CaMKII expression level in the hippocampus of rats administered 150 mg sodium fluoride/L and/or 300 mg lead acetate/L in their drinking water for 30 days. Through quantitative positioning analysis by western blotting and immunofluorescence, respectively, CaMKII expression levels in the F, Pb, and F plus Pb groups were found to be significantly depressed compared with controls. Interestingly, the western blotting technique, but not the immunofluorescence results indicated greater depression in the Pb group than in either the F or the F+Pb group. Overall, these findings may be helpful to gain a better understanding of the mechanism underlying F and Pb combined neurotoxicity. © 2011 The International Society for Fluoride Research Inc.
Location of Study:	China
Type of Study:	Experimental animal study
Key Points:	• There appear potential inconsistencies in the findings. This casts even further doubt as to the reliability and significance of these findings (let alone their relevance to human fluoridated water supplies).

Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated? The study method is appropriate? Data collection quality? Analysis of data? Sound logic is used in the conclusions reached? The study reaches valid conclusions with respect to the initial hypothesis/aim?	Reasonably covered. The hypotheses are more hinted at than clearly stated, so rather the aims can be inferred Fair Fair Fair Partially covered Yes. The conclusions are reasonable with respect to the inferred aim. but the findings and arguments are not readily generalisable to current fluoride exposure scenarios in New Zealand
Strengths:	• The general design of this study was of a fairly good standard for animal studies, and there is no evidence of major flaws (apart from the very high concentrations of the test compounds, and also the apparent lack of calcium in the drinking water).
Limitations:	• It had very poor generalisability to any plausible human fluoride exposure scenario.
Can the findings be generalised?	No
Are the findings applicable to water fluoridation in New Zealand?	No
Implications for the Ministry of Health water fluoridation policy:	• There are no practical implications for the Ministry's fluoridation policy arising from this study, principally because the fluoride doses (or DWFCs) associated with adverse endpoints were so high as to have little relevance to the assessment of risks to humans from fluoridated drinking water. • A further reason is the extremely high lead levels given to the two experimental animal groups whose exposure included lead. This was hugely misrepresentative of daily human lead exposures.

Review 29

Review Date: 2011/29

Study Identification:	
Title:	**Study on blood biochemical diagnostic indices for hepatic function biomarkers in endemic skeletal fluorosis**
Authors:	Shashi A., Bhardwaj M.
Journal:	Biological Trace Element Research
Year:	Published online 18 January, 2011
Volume:	DOI 10.1007/s12011-010-8944-2
Topic area	Toxicology and pharmacology
Summary of Study:	
Abstract:	"The aim of the study was to determine the relationship of fluoride in drinking water to liver function in individuals living in normal and seven endemic fluorosis areas of Punjab, India. The concentration of fluoride in drinking water of different areas varied from 5.9 to 24.5 mg/L. Study group consisted of 705 patients in the age group between 20 and 60 years (mean age of 39.35 +/- 11.27) affected with osteodental fluorosis were compared with 300 age- and sex-matched controls (with mean age of 35.28 +/- 8.25 years). Biochemical data was analyzed by one-way analysis of variance (ANOVA) with post hoc Tukey-Kramer and Bonferroni multiple comparison tests. The relationship between hepatic enzymes was calculated by Pearson's correlation and linear regression. The results revealed significantly ($P < 0.001$) higher concentration of serum fluoride in patients when compared to control. The mean activities of cyclic adenosine monophosphate (AMP), alkaline phosphatase (ALKP), acid phosphatase (ACP), aspartate aminotransaminase (AST), and alanine aminotransaminase (ALT) were significantly ($P < 0.05$-0.001) elevated in patients from all fluoride areas. ANOVA with post hoc Turkey-Kramer and Bonferroni multiple comparison test demonstrated a significant ($P < 0.0001$) variance in the activities of cAMP, ALKP, ACP, AST, and ALT in fluorotic patients, with elevation in water fluoride levels. Maximum elevation of 196.14% (ACP), 99.31% (cyclic adenosine monophosphate; cAMP), 72.08% (ALT), 60.14% (AST), and least 21.35% (ALKP) was recorded in patients exposed to 24.5 mg/L fluoride in drinking water. There was positive correlation between water fluoride, serum fluoride and AST ($r = 0.77, 0.91$), ALT ($r = 0.82, 0.90$), ALKP ($r = 0.88, 0.97$), and ACP ($r = 0.74, 0.85$). Pearson's correlation demonstrated highly significant ($P < 0.05$) positive relationship between water fluoride and cAMP (regression equation:

	[Formula: see text], = 0.84; r = 0.92, P < 0.05). The increased levels of transaminases in fluorotic patients suggest alteration in liver functions. The level of alkaline and acid phosphatase was increased during fluoride intoxication which is also an early marker of hepatic cell damage because of its specificity and catalytic activity. The elevated levels of enzymes are reflective of bone disorders, which are characterized by increased osteoblastic activity. There levels increased several times if cellular damage occurs in the liver. The results suggest that fluoride exposure intensifies the activities of hepatic function enzymes in osteofluorosis."
Type of Study:	Experimental study
Key Points:	• The external generalisability of the study is limited. • About the only useful data comes from the control group per se, which with a DWFC of 0.9 ppm, represents a group exposed to the same or similar levels of fluoride as those living in fluoridated regions in NZ. In that regard, this group's mean serum transaminase (AST, ALT) levels are within internationally recognised ranges of normal.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	Yes, well covered
The study method is appropriate?	Good
Data collection quality?	Good
Analysis of data?	Fair
Sound logic is used in the conclusions reached?	Yes. The logic is reasonably sound, but the findings and arguments are not readily generalisable to current fluoride exposure scenarios in New Zealand.
The study reaches valid conclusions with respect to the initial hypothesis/aim?	Yes
Strengths:	• Good distinction between groups on the basis of known DWFCs, and relatively adequate study (group) sizes and graphical analyses
Limitations:	• Very limited generalisability to issues pertaining to DWFCs in New Zealand
Can the findings be generalised?	No
Are the findings applicable to water fluoridation in New Zealand?	No

Implications for the Ministry of Health water fluoridation policy:	There are no pressing practical implications for the Ministry's fluoridation policy arising from this study, principally because the DWFCs (and ensuing doses) associated with the observed increases in average levels of the five enzymes were as high as to have little relevance to the assessment of risks to humans from fluoridated drinking water.

Review 30

Review Date: 2011/30

Study Identification:	
Title:	**Effect of Fluoridated Water on Plasma Insulin Levels and Glucose Homeostasis in Rats with Renal Deficiency**
Authors:	Lupo M., Buzalaf M., Rigalli A.
Journal:	Biological Trace Element Research
Year:	2010
Volume:	DOI 10.1007/s12011-010-8690-5
Topic area	Toxicology and pharmacology
Summary of Study:	
Abstract:	"Glucose intolerance in fluorosis areas and when fluoride is administered for the treatment of osteoporosis has been reported. Controlled fluoridation of drinking water is regarded as a safe and effective measure to control dental caries. However, the effect on glucose homeostasis was not studied so far. The aim of this study was to evaluate the effect of the intake of fluoridated water supply on glucose metabolism in rats with normal and deficient renal function. Male Sprague-Dawley rats were divided into eight groups of four rats. Renal insufficiency was induced in four groups (NX) which received drinking water containing 0, 1, 5, and 15 ppm F (NaF) for 60 days. Four groups with simulated surgery acted as controls. There were no differences in plasma glucose concentration after a glucose tolerance test between controls and NX rats and among rats with different intakes of fluoride. However, plasma insulin level increased as a function of fluoride concentration in drinking water, both in controls and in NX rats. It is concluded that the consumption of fluoridated water from water supply did not affect plasma glucose levels even in cases of animals with renal disease. However, a resistance to insulin action was demonstrated."
Type of Study:	Experimental animal study
Key Points:	• The consumption of fluoridated water from water supply did not affect plasma glucose levels even in cases of animals with renal disease. • A resistance to insulin action was demonstrated.
Evaluation Criterion:	
The aim/ hypothesis of the study are clearly stated?	No

The study method is appropriate? Data collection quality? Analysis of data? Sound logic is used in the conclusions reached? The study reaches valid conclusions with respect to the initial hypothesis/aim?	Good Good Fair Yes No. More emphasis could have been placed on the lack of positive findings in the 1 ppm groups, and the limited and inconsistent findings in the 5 ppm groups.
Strengths:	• Satisfactory overall design, appropriate control groups, good randomisation of groups, appropriate physiological and biochemical (analytical) investigations.
Limitations:	• Insufficient discussion of the findings from the 5 ppm group, and of the somewhat inconsistent differences between the renally impaired and control animals in this group (this despite the acknowledgement that these groups were more relevant than the 15 ppm group in terms of generalisability to human exposures via optimally fluoridated water supplies.
Can the findings be generalised?	No
Are the findings applicable to water fluoridation in New Zealand?	No
Implications for the Ministry of Health water fluoridation policy:	There are no pressing practical implications for the Ministry's fluoridation policy arising from this study. For example, there were unremarkable findings in the animals given a DWFC of 5 ppm, which is thought to produce blood fluoride levels similar to those occurring in humans consuming fluoridated water at 0.8 ppm. This suggests that significant disturbances in glucose homeostasis are unlikely to occur in humans consuming fluoridated water at 0.7 to 1.2 ppm. However the above study was for 60 days only.