



REVIEW

**Bioethical considerations about water fluoridation:
a critical review.**

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Abstract: Dental caries is one of the oral pathologies with greater burden of disease in the Chilean population. Fluoridation of drinking water has been used as a caries prevention strategy. However, its application as a public policy has been questioned since its implementation. The aim of this article is to analyze whether fluoridation of drinking water is a justified measure in reducing the incidence and prevalence of caries from the perspective of bioethics, taking into account the current evidence on its effectiveness. The arguments reviewed are based on the belief that water fluoridation is effective and, in general terms, ethically acceptable. A recent systematic review concludes that there is not enough evidence to support fluoridation as a public policy. There is a gap of knowledge that ought to be closed so that public health authorities can assess the significance of the intervention and make a democratic decision on its continuation or suspension based on scientific evidence. This decision should be informed and disseminated within the community.

Keywords: *Fluoride water, Bioethics; Caries, Fluorosis, Public health.*

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INTRODUCTION.

Oral damage is a major problem for the population because it affects a large percentage of people. This damage has a negative effect on their nutrition, self-esteem, interpersonal relationships, resilience, discrimination and employment opportunities. The magnitude of the problem is quantified in Chile by means of disability adjusted life years due to oral conditions. Tooth decay ranks first in this indicator¹. Available epidemiological data show that the prevalence of caries is high, affecting 16.8% of 2-year-old children and up to nearly 100% of the adult population¹. Caries severity increases with age, dmft is 0.6 at 2 years of age, 2.5 at 4 years², and 3.7 at 6 years³. Meanwhile, DMFT is 0.5 at 6 years³, 1.9 at 12 years¹ and close to 20 in the age group of 65 to 74 years⁴.

Several biological factors have been documented and studied for many years, describing the multifactorial etiology of caries, including diet, oral bacteria, saliva and ex-

posure to fluorides⁵. Recently, some non-biological factors have been associated with the presence of caries in the population, including age, sex, socioeconomic status^{6,7}, place of residence⁸ and access to dental care⁹.

One of the most recognized preventive measures in controlling caries at public health level is the use of fluorides, either systemically or topically. Fluoride is often added to drinking water as a way to reduce caries¹⁰. Since its implementation as a national policy, fluoridation of drinking water has had supporters who advocate the benefits of fluoridation in reducing the incidence and progression of caries. There have also been opponents, whose arguments are put forward in the controversy about the damage that this component would generate in humans and about the loss of autonomy, as people cannot freely choose the type of water they drink.

Given these differences regarding fluoridation of drinking water, the aim of this paper is to analyze whether

the fluoridation of drinking water is a justified measure in reducing the incidence and prevalence of caries from the perspective of bioethics, taking into account the current evidence on its effectiveness.

FLUORIDATED DRINKING WATER IN CHILE.

In the 1930s some researchers in the United States (US), found that people who drank naturally fluoridated water had fewer cavities than those living in non-fluoridated water areas¹¹. Various studies have shown that adding fluoride to the water tanks reduces the number of caries in the population¹².

Fluoridation of drinking water in Chile began in 1953. It gradually covered up to 80% of the towns and cities. The program, because of financial and administrative reasons, was not permanent and was suspended throughout the country in 1976¹³. In the mid-eighties, the prevalence of caries increased to critical levels, similar to those found in countries without fluoridation programs¹⁴. In 1981 the "National Program of Fluoridation of Drinking Water Supply" was created and followed four years later by the implementation of the first water fluoridation program in the Region of Valparaiso. Since then, the program has expanded and now approximately 82.3% of the Chilean population have access to fluoridated water, whose concentration has been adjusted optimally to prevent tooth decay¹⁵.

In the 1990's, the beginning of a debate about the legitimacy of using a product of mass consumption like water and the effects of fluoride on the human body resulted in the questioning of this public policy. Supporters of fluoridation argue that it is an excellent public health policy because it is beneficial for everyone, regardless of their socioeconomic status or access to dental services, and because the effectiveness of the method does not depend on the active participation of people¹⁶. On the other hand, there are others who argue that accepting the distribution of a drug through drinking water affects the right people have to choose what is healthy and safe for their children and for themselves. All this in addition to

the alleged harmful effects on human health that water fluoridation entails¹⁷.

Among the arguments in favor of fluoridation there is acceptance as a safe, effective, efficient and appropriate mechanism for the prevention of caries. Moreover, its use in preventing tooth decay is also recognized as one of the ten great public health achievements of the last century. The use of water as a vehicle for fluorides is internationally recognized, along with milk and salt, as a highly cost-effective course of action, and its implementation is seen as a measure of community health¹⁶.

In addition, as fluoridation of drinking water helps improve oral health, it will eventually contribute to improve people's overall health. There is no evidence of harmful effects if fluoridated water contains the optimum concentration for improving dental health. Fluoridated water reduces the number of decayed, missing and filled teeth in children and adults. Children have less pain, fewer abscesses and require fewer extractions reducing the use of general anesthesia. However, in recent years when the prevalence of carious teeth has been measured in fluoridated and non-fluoridated communities, we can see that there still remain inequities in oral health¹⁸.

Among the arguments against fluoridation are the findings of Burkner, former chief of the division of cytochemistry at the National Cancer Institute, and Ylamouylannis, scientific director of the National Federation of Health of the United States, who reported in 1975 a 19% increase in the number of cancer patients in cities with fluoridated water supply. Rapaport emphasized the significant correspondences between the concentration of fluoride in drinking water and the incidence of Down syndrome. It has also been suggested that there may be a relationship between the "death of infants" and excess of fluoride in food¹⁹.

Also, fluoridation of drinking water would have a pollutant impact that could have serious consequences for aquatic ecosystems and biodiversity. It is clearly recognized that living beings, when they ingest fluoride, they largely accumulate it in their bodies, which can cause bio-

chemical and morphological alterations. These changes may modify, directly or indirectly, communities in natural systems and reduce the ability of organisms to maintain their ecological position¹⁹.

Water fluoridation goes against all trends of using an additional chemical that does not contribute in any way to improve water quality. Nor should one forget that the inhibitory effect of fluoride on the enzymes negatively affects biological treatments and self-purification¹⁹. It has been documented that it could cause alterations at the level of the brain, thyroid, joints, bones and reproductive system¹⁷.

CONTEMPORARY EVIDENCE.

In 2015, the group the Cochrane Oral Health published a systematic review indicating the existence of little contemporary evidence evaluating the effectiveness of water fluoridation in preventing caries. The available data come predominantly from studies conducted before 1975 and suggest that water fluoridation is effective in reducing levels of caries in temporary and permanent dentition in children²⁰.

Given the high risk of bias in the available studies, and the applicability of the evidence to the lifestyles of people, the decision to implement a program of water fluoridation would lie in understanding the behavior of the population with respect to oral health, availability, preventive strategies, diet, water consumption and population movements²⁰.

The document also notes that there is insufficient evidence to determine whether fluoridated water affects distribution of inequities in caries through different socioeconomic levels. No evidence was found to support that fluoridation prevents tooth decay in adults or its effect on the levels of tooth decay if fluoridation programs were suspended. Evidence is again limited due to the high risk of bias in the studies²⁰.

After the publication written by the Cochrane Oral Health, new evidence confirms a lower prevalence of caries in people living in areas with fluoridated drinking

water. Young *et al.*²¹ in the United Kingdom found a lower prevalence of caries and lower rates of tooth extractions in children with access to fluoridated drinking water. Also, in New Zealand, another study found some significant differences between Maori and non-Maori children with and without access to fluoridated drinking water²². Both studies used an ecological study design, which does not allow to draw any conclusions about the protective role of fluoridation, given the limitations of design²³.

A natural experiment carried out in Brazil observed the relationship between access to fluoridated drinking water and its association with caries in adults¹⁰, concluding that access to fluoride water was associated with a lower prevalence of caries even with multiple exposures to fluoride during the course of life. Among the limitations noted by the authors, there are the small sample size and the fact that exposure to fluorides in water was assumed to be constant over the years, which can lead to errors in the estimation. Finally, a recent review analyzed the impact of strategies of cessation of water fluoridation in 13 countries between 1956-2003, obtaining mixed results, with a tendency to increase the levels of tooth decay after the cessation of the measure²⁴.

There are no available studies that quantify the benefits in reducing the incidence of caries in the population with fluoridated water in Chile. This, despite having a control group as the Bio Bio Region, in which authorities have never added fluoride to drinking water. The available evidence is diverse with a variable methodological quality, making it impossible to draw reliable conclusions about the effectiveness of the measure.

VIEW FROM BIOETHICS.

Several authors have proposed analyses and reflections based on a bioethical perspective on the need to artificially fluoridate water. Here are some of them.

Liberalism vs. utilitarianism

From the liberal perspective, individuals or groups can challenge and question the responsibility and authority of

governments and of other actors to influence the lives of people adding fluoride to drinking water. A consent from the community for each public health policy, which could deeply impact population health, would be necessary²⁵. Everyone has the right to be informed about the benefits of water fluoridation and how these technologies have been developed, in order to be able to decide whether the measure is adequate or not for themselves, being aware that it will not affect its principles, values and lifestyle. An individual consent could be requested in order to remove excess fluoride in regions where high levels of fluoride occur naturally in water²⁵.

On the other hand, a utilitarian approach could achieve the greatest collective benefit, where the interests of some might be sacrificed if that improves the welfare of all²⁵. Fluoridated water then would encompass the entire population under the assumption that it produces a decrease in the incidence of caries, by exposing a percentage of the population to the development of dental fluorosis, whose risk increases as the concentration of fluoride in the water exceeds 0.3 ppm²⁶. From the ethical point of view, if each of the members of society adheres to the consumption of fluoridated drinking water, the purpose of the measure would be achieved having an impact on public health. To improve oral health and self-esteem thus, they could resolve social problems such as school and work absenteeism due to dental problems. However, this benefit would imply the possibility that 3-12%²⁰ of the population may develop dental fluorosis.

Justificatory conditions

In assessing the ethical foundations of water fluoridation, some authors have performed an analysis based on the proposal of Childress²⁷: effectiveness, proportionality, necessity, minor infraction and public justification.

Regarding this first point, epidemiological studies do not fully support the effectiveness of water fluoridation in preventing tooth decay nor its reduction in vulnerable populations²⁶.

The principle of proportionality can be used to resolve the conflict between the ethical principle of welfare

(caries prevention) and non-maleficence (reduce the risk of fluorosis and possibly hypothyroidism and bone fractures) in the dispute of water fluoridation. The benefit of this intervention should be proportionally greater than the damage.

The principle of minor infringements establishes that the ethical conflict must be resolved in favor of an intervention if it results in the least possible violation of the individual or population autonomy and community health, among all available alternatives. Violation of individual autonomy is higher than with other sources of fluoride that can be chosen²⁶.

The public justification implies transparency of the authorities to justify and continue the practice of water fluoridation for a skeptical target population that is increasing, as well as allowing the parties involved to contribute in the formulation of the policy. This justification is based on the utilitarian principle of "common good", the best outcome for the greatest number. This may not be justified in the case of having another intake alternative easier to regulate²⁶.

The supporting conditions mentioned above require societies trained to sort their values and beliefs autonomously and therefore being able to act without the intervention of third parties. This reality is mainly observed in economically developed countries, where access to scientific, technological, philosophical, anthropological, sociological information is available and where ethical and moral values are part of their daily lives.

Nuffield Council on Bioethics

In 2007 this institution published a report assessing fundamental and relevant ethical considerations for public health²⁸. The first objection is based on risk reduction, which would be met by the measure of fluoridation of drinking water to reduce the prevalence of caries, but the degree to which it actually reduces risk is not clearly evidenced. Some authors have argued that the preventive role of fluoridated water has decreased significantly due to the introduction and widespread use of fluoridated products such as toothpaste²⁵.

The Nuffield Council declares that the priority programs that assess inequities can, in principle, be justified ethically²⁸. Water fluoridation is a cost-effective public health measure to improve oral health and reduce inequities. In contrast it argues that there are other methods of preventing dental caries. Instead of adjusting the levels of fluoride in water, social determinants of poor oral health should be addressed such as improving oral hygiene to reduce the incidence of caries²⁵.

Regarding the consideration of not intervening without the consent of the affected population, children born in a defined social strata and who are therefore exposed to the benefits or vulnerabilities in which they are immersed, are less capable of making informed decisions about oral health and depend on their parents and caregivers to follow or promote preventive measures such as tooth brushing²⁸.

Consent is important for medical interventions and should be used in any public health strategy. However, one could argue that the removal of fluoride from drinking water should also require universal consent. Both positions could be problematic because they give greater importance to choosing and consenting, and not allow that few people cancel the collective good that could be achieved through a public health intervention²⁵.

Precautionary principle

The precautionary principle²⁹ tries to avoid unnecessary exposure of the population and bring scientific uncertainty to decision-making in public health. In the case of drinking water, fluorinated compounds added to correct the concentration of water are chemicals with unknown risks³⁰. Potential toxic effects of fluorides justify the suspension of the measure under this principle, adopting a cautious attitude against the uncertainty surrounding potential risks of an intervention²⁹. Under this reason, it is argued that the lack of evidence about the risks and benefits of fluoridation of drinking water makes supporting this measure an immoral behavior³⁰. From the above, the need to apply technological advances to elucidate the real impact of fluoride in water is clear, as well as evaluating

other means of delivering fluoride through innovative techniques, ensuring transparency and democratic participation of people.

Ethics of protection

This proposal of Latin American reflection calls for social equality, empowerment of the excluded and care of those in need based on a paternalistic welfare system. Among the perspectives to be considered to resolve the ethical quality of a public health measure, there is the fact that it must be a real and central health need in the life of community as a whole, be an effective and efficient tool, where health effects are distributed impartially and randomly, and where there is participation of all members of society²⁹.

By applying the analysis proposed by the ethics of protection, water fluoridation would prove to be an ethically appropriate measure because: it responds to a major public health problem, has proven effective in reducing the prevalence of caries, it is the most cost effective of the alternatives and the risks are known, sustainable and random³⁰. The systematic review done by the Cochrane group would put into question the effectiveness of the intervention by not having far enough scientific evidence and quality.

DISCUSSION.

After reviewing various bioethical positions, it is admissible to consider that while the evidence for the effectiveness of water fluoridation is inconclusive, what can be done if information is scarce? If a measure is not effective, it would be unethical to expose the whole population, without their consent, to chronic exposure to fluorides.

The call is to develop lines of research to elucidate the real effectiveness that water fluoridation has on communities in order to gather enough scientific evidence, with quality methodology that allows to determine the actual impact on the population. For now, thinking about other intervention strategies given the high prevalence of caries and its consequences would be the most reasonable. As an example, we have seen that the use of probiotics has

specific inhibitory effects on oral bacteria responsible for tooth decay²⁶, which would lead to discuss their possible addition to toothpastes for preventive purposes.

Most of the bioethical perspectives analyzed correspond to cultural contexts characteristic of economically developed countries with greater access to information and autonomy in decision-making by their citizens, qualities that are not consistent with the situation of Latin American countries and of course, Chile. The ethics of protection is to try to mitigate the loss of autonomy in the region by proposing welfare paternalism.

Thinking about concrete actions, we could appeal to the principle of the common good to achieve the greatest possible welfare for people. So then the decision would be a responsibility of governments, who must ensure an optimal, emotional, psychological and social development of the population. In addition, governments should give more emphasis to those who are not entitled to exercise their autonomy as they are immersed in a disadvantageous

context with respect to the rest of the community.

States have institutions and resources to reach all sectors through public policies to provide tools to the socially excluded to achieve an equitable society and improve their quality of life.

CONCLUSION.

The arguments reviewed are based on the belief that water fluoridation is effective and, in general terms, ethically acceptable. The lack of solid scientific evidence leads to reflect and analyze if this measure is ethically justified today.

There is a gap of knowledge that ought to be closed so that public health authorities can assess the significance of the intervention and make a democratic decision on its continuation or suspension based on scientific evidence. This decision should be informed and disseminated within the community.

Consideraciones bioéticas de la fluoración del agua: una revisión crítica.

Resumen: La caries dental constituye una de las patologías orales con mayor carga de enfermedad en población chilena. Una estrategia empleada para prevención de caries ha sido la fluoración del agua potable, cuya aplicación como política pública ha sido cuestionada desde su implementación. El objetivo de este trabajo es analizar si la fluoración del agua potable resulta una medida justificada para reducir la incidencia y prevalencia de caries desde la perspectiva de la bioética, teniendo en cuenta la evidencia actual sobre su efectividad. Los argumentos revisados se basan en la convicción

de la efectividad de la fluoración del agua, considerando la intervención en términos generales como éticamente aceptable. A la luz de la revisión sistemática publicada recientemente, no existiría evidencia suficiente que avale esta política pública. Actualmente existe una brecha de conocimiento que debiese ser cerrada con la finalidad de que las autoridades de salud pública puedan evaluar la trascendencia de la intervención y tomar una decisión democrática acerca de la continuidad o suspensión de la estrategia preventiva con base científica, informada y socializada con la comunidad.

Palabras clave: Agua fluorada, Bioética, Caries, Fluorosis, Salud pública.

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