Review

The history of water fluoridation in Scotland

Community Dental Health
2025, Vol. 0(0) 1–6

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DOI: 10.1177/0265539X251400451
journals.sagepub.com/home/cdh

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Abstract

Objectives: To examine the history of water fluoridation in Scotland, assessing its implementation, cessation, and impact on dental caries, and to evaluate whether water fluoridation should be reconsidered in future public health strategies. **Basic research design:** A historical review of water fluoridation in Scotland conducted using peer-reviewed studies, government reports, and legal documents. Data was synthesised chronologically on fluoridation's impact, legislative challenges, policy shifts, and public attitudes. **Main outcome measures:** Dental caries prevalence and treatment costs, public and political attitudes toward fluoridation, and legislative and policy developments affecting the implementation or cessation of fluoridation in Scotland. **Results:** Scottish fluoridation schemes significantly reduced caries prevalence and treatment costs. Fluoridation was discontinued following legal challenges. Post-cessation studies reported rising caries rates and treatment costs. Recent public attitude surveys indicate majority support for fluoridation. While Childsmile has improved oral health, fluoridation remains the most effective passive intervention. **Conclusion:** Scotland's fluoridation history highlights the tension between scientific evidence, legal constraints, and public perception. While current policy prioritises individual choice, integrating fluoridation into Childsmile could enhance caries prevention across Scotland. Renewed policy discussions and public engagement are essential for reconsidering fluoridation as part of Scotland's long-term oral health strategy.

Keywords

water fluoridation, dental caries, child dental health, oral health policies, Scotland

Received: 22 June 2025; revised: 16 September 2025; accepted: 21 September 2025

Introduction

Water fluoridation, also called community water fluoridation, is the planned adjustment of the fluoride ion content in public water supplies to improve dental health (Mariño and Zaror, 2020; Parnell et al., 2009; Vasantavada et al., 2021). In the United Kingdom (UK), the fluoride concentration is typically adjusted to 1 part per million (ppm) or mg/l (Drinking Water Inspectorate, 2024). Exposure to fluoride has played a crucial role in reducing dental caries for almost a century (Mariño and Zaror, 2020). Continuous exposure can be achieved easily by adding fluoride to drinking water, making it one of the most effective public health measures for caries prevention (Iheozor-Ejiofor et al., 2015). An updated systematic review by the Cochrane Collaboration in 2024 reaffirmed that water fluoridation remains an effective public health measure in reducing dental caries, while also highlighting the importance of the population's oral health behaviour, feasibility, and cost-effectiveness in deciding its implementation (Iheozor-Ejiofor et al., 2024).

Fluoride, the negatively charged ion of fluorine, occurs naturally in almost all water sources. Fluorine itself is the lightest halogen, ranking 24th in elemental cosmic abundance and 13th in the Earth's crust. It is never found as a free element due to its high reactivity. Its role in dental health was first recognised in 1802 by Italian physician Domenico Morichini, who detected high fluorine levels in fossilised elephant and human teeth (A Riva, 2023). The earliest reference to fluorine in Scottish water supplies was made in 1846 by Wilson, who identified fluorine in a well serving a brewery in The Cowgate, Edinburgh (Wilson, 1846). He later reported its presence in seawater from the Firth of Forth, Firth of Clyde and the North Sea (Scoffern, 1849).

While water fluoridation has been implemented in Scotland in the past, currently there are no active fluoridation schemes (Al Rasheed and Jones, 2024). As of now, public drinking water supply in Scotland is not artificially fluoridated and naturally fluoridated water is typically less than 0.1 mg/l (Scottish Water, 2025). Additionally, Scotland currently relies on targeted interventions like the Childsmile programme, which aims to improve dental health and reduce oral health inequalities through supervised nursery-toothbrushing, fluoride varnish applications, and oral health education

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(Macpherson et al., 2015; Public Health Scotland, 2024; Ross et al., 2023). While Childsmile has contributed to major improvements in children's dental health since the 2000s, the 2023 and 2024 National Dental Inspection Programme data indicate that progress has plateaued, with persistent inequalities between the most and least deprived groups (Childsmile, 2025; National Dental Inspection Programme, 2023; National Dental Inspection Programme, 2024; Ross et al., 2023). Historical evidence suggests that water fluoridation remains one of the most cost-effective, population-wide strategies for caries prevention (Sanders et al., 2019). The 2022 Public Health England report has reinforced not only the effectiveness but also the role of water fluoridation in reducing oral health inequalities (Office for Health Improvement and Disparities, 2022). These findings support the broader evidence base and are highly relevant to ongoing discussions in Scotland, where fluoridation was completely ceased in the 1980s, raising questions about the future role of evidence-based strategies in addressing persistent oral health inequalities.

Beyond its dental public health benefits, community water fluoridation highlights broader challenges where strong scientific evidence is not always sufficient to shape policy. Global public health debates, such as the controversies around SARS-CoV-2 vaccinations or the discredited MMR-autism claim, demonstrate how misinformation and public mistrust can hinder evidence-based strategies. Similarly, in Scotland, public perception and legal concerns over fluoridation have outweighed decades of scientific support. This underscores the complex relationship between evidence, policy, and public trust, positioning Scotland as a valuable case study of these dynamics. More broadly, it highlights the importance of revisiting past policy choices in light of current evidence and international practice.

We aim to critically review Scotland's experience of water fluoridation examining its history, implementation, cessation, and the implications for current public health strategies such as Childsmile. The objectives include:

- Synthesising evidence from fluoridation studies, public health policies, and public perception research to explore how past experiences have shaped current debates
- Tracing the historical use of fluoride as a therapeutic and preventive agent
- Consideration of the potential role of water fluoridation in reducing dental caries among Scottish children

Methods

Given the long-standing debates and policy shifts surrounding fluoridation, this historical review provides a structured synthesis of developments from the mid-20th century (1945), when water fluoridation was first implemented in the UK, through to 2024. The review traces key milestones, policy decisions, and public attitudes to assess their relevance to contemporary public health strategies in Scotland.

A literature search was conducted using PubMed, Medline, Web of Science, and Scopus to identify studies examining the impact of fluoridation in Scotland. In addition, a targeted grey literature search was conducted using government websites including gov.scot, legislation.gov.uk, parliament.uk, Google Scholar, and legal databases to identify official reports, consultation documents, and legal rulings relevant to water fluoridation in Scotland. Studies were selected based on their relevance to fluoridation policies, caries prevalence, and public opinion. Priority was given to peer-reviewed research, government reports, and legal documents that directly influenced policy decisions.

Studies and reports were included if they:

- Assessed the impact of fluoridation on dental caries
- Analysed fluoridation cessation and its consequences in Scotland
- Examined public attitudes and legal challenges related to fluoridation
- Provided official positions, legislative outcomes, or public health recommendations from the Scottish Government, NHS Scotland, and the UK Parliament

A chronological synthesis was used to present the history of water fluoridation in Scotland. Findings from scientific studies, policy documents, and public opinion research were integrated to evaluate the relationship between evidence-based recommendations and policy decisions. The review also considered comparative evidence from fluoridated (F) and non-fluoridated (NF) water regions to assess whether Scotland's current approach aligns with best public health practices. These were contextual comparisons intended for narrative purposes and were not part of a systematic cross-country or international analysis.

Results

Scientific interest in fluoride's effects on teeth began in the early 19th century when Domenico Morichini (1802) identified high fluorine content in fossilised human and animal teeth (A Riva, 2023). Henri Moissan, a French pharmacist who won the 1906 Noble Prize in chemistry is credited for successfully isolating fluorine, contributing to our understanding of its chemical properties (Fechete, 2016).

By the mid-20th century, fluoride's protective role in dental health became a focus of public health research. Following the discovery of natural fluoride's correlation with lower caries prevalence, controlled trials in Grand Rapids, Michigan starting in 1945 demonstrated its effectiveness (Ministry of Health, 1953; Mullen, 2005). The UK soon followed, initiating small-scale fluoride application trials also in 1945, including one at a Cheshire orphanage, and a larger trial in Fife involving 3000 children (Royal Society, 2021). In 1952, the UK government sent a delegation to the United States and Canada to study fluoridation outcomes, publishing a report confirming its benefit (Ministry of Health, 1953). By 1954, Kilmarnock launched the first Scottish water fluoridation scheme, using a natural control setup of two reservoirs, one providing F water and the other serving Ayr, a town of similar size at that time, as a NF control (Mullen, 2005; Royal Society, 2021). The trial aimed to compare dental caries levels between F Kilmarnock

and NF Ayr populations (Mullen, 2005). Subsequently, additional fluoridation projects were launched in Anglesey, Watford, and Andover (Mullen, 2005; Royal Society, 2021). However, mounting public protests led to the discontinuation of several schemes, with Kilmarnock ceasing fluoridation in October 1962 (Royal Society, 2021).

During the 1970s to the 2000s, several studies (Blinkhorn et al., 1981; Downer et al., 1981; Stephen, 1978; Stephen et al., 2002) were conducted to assess the impact of fluoridation on Scottish children's dental health and treatment costs in Scotland. Studies compared F and NF regions to measure differences in caries prevalence and treatment costs.

Stephen (1978) conducted a 4-year study in F and NF areas of Dumfries and Galloway. The study found that children in F areas had significantly fewer teeth with occlusal fissure caries, reinforcing the preventive benefits of fluoridation (Stephen, 1978). Blinkhorn et al. (1981) examined dental health of urban Scottish schoolchildren in Stranraer (F) with similar children in Annan (NF), concluding that fluoridation led to substantial reductions in caries prevalence. Moreover, Stephen et al. (2002) compared the dental health of children in naturally F (since 1985) Burghead, Findhorn, and Kinloss to the nearby NF control areas of Buckie and Portessie, in rural Morayshire. The results showed a significantly lower caries levels in the F groups compared to the NF groups (Stephen et al., 2002). Additionally, Downer et al. (1981) investigated the economic impact of fluoridation on dental treatment costs, demonstrating notable cost savings in caries-related treatments.

A recent review by Al Rasheed and Jones (2024) showed that the implementation studies resulted in a 42% reduction in decayed, missing, and filled deciduous teeth (dmft) and a 54.4% decrease in decayed, missing, and filled permanent teeth (DMFT). Moreover, the review showed a lowered caries treatment cost by 56% in 4-5-year-olds and 76% in 9-10-year-olds during fluoridation (Al Rasheed and Jones, 2024).

Following the cessation of fluoridation, studies (Attwood and Blinkhorn, 1989a, 1989b, 1991; Stephen et al., 1987) assessed its long-term effects on dental health. Stephen et al. (1987) examined caries prevalence in Wick in Northern Scotland before and after fluoridation was discontinued, noting a gradual increase in decay rates after cessation. Attwood and Blinkhorn (1989a, 1991) conducted a series of reassessments on the dental health of schoolchildren where fluoridation had ceased, confirming a rise in caries prevalence over time. However, despite this increase in caries rates in previously F communities, for many years caries prevalence continued to remain lower than in NF areas (Al Rasheed and Jones, 2024). Furthermore, economic re-evaluations from Attwood and Blinkhorn (1989b) showed that dental treatment costs rose following the discontinuation of fluoridation. Nevertheless, the dental treatment costs still remained lower by 57% (5-year-olds), 37% (10-year-olds), and 63% (15-year-olds) in F areas (Al Rasheed and Jones, 2024).

Despite fluoridation's demonstrated benefits, opposition intensified, culminating in Scotland's longest-running civil case, McColl versus Strathclyde Regional Council (1980-1983) (Jones, 2000; UK Parliament, 1985). A resident challenged the legality of fluoridation, arguing that it violated personal consent and medical ethics (UK Parliament, 1985). The judge ruled that although fluoridation was safe and effective, it was ultra vires (beyond the legal power of Strathclyde Regional Council), effectively stopping existing schemes and preventing further implementation (Jones et al., 2022; UK Parliament, 1985).

In response, the Westminster Government passed the Water (Fluoridation) Act in 1985, later incorporated into the Water Act (1990), and this law still applies in Scotland (Jones, 2022). The decision to fluoridate a water supply is the responsibility of local NHS health boards, however before requesting to introduce fluoridation, they must conduct a comprehensive public consultation (Scottish Water, 2025). A public consultation reaffirmed opposition, and by 2004, First Minister Jack McConnell announced that Scotland would not pursue fluoridation, instead prioritising targeted prevention programmes like Childsmile (BBC News, 2004).

With fluoridation no longer an option, Scotland introduced Childsmile in 2006, an alternative preventive dental programme focusing on reducing oral health inequalities and improving dental health outcomes and access to dental service (Macpherson et al., 2015; Ross et al., 2023). The programme was fully implemented by 2011 and includes supervised toothbrushing in nurseries and some primary schools, fluoride varnish application for high-risk children, and oral health education for parents and children (Macpherson et al., 2015; Public Health Scotland, 2024). Childsmile has been widely praised (Ross et al., 2023), as it has led to an improvement in the dental health of the Scottish children.

Although fluoridation has been absent in Scotland for decades, discussions on its reintroduction resurfaced in 2021 following a Joint Statement by Scotland's Consultants in Dental Public Health and Directors of Dentistry (Alterado, 2021). This statement aligned with UK Chief Medical Officers' recommendations, emphasising that water fluoridation remains one of the most cost-effective methods for reducing dental caries and improving dental health inequalities in the UK (UK Government, 2021).

Public opinion remains a critical barrier. However, a survey conducted by Jones et al. (2022) in 2022 revealed that 63% of respondents supported fluoridation, 28% were unsure, and 9% opposed it. Moreover, the 2022/23 NHS Greater Glasgow and Clyde Health and Wellbeing Survey found that 46% of respondents were open to the possibility of water fluoridation in their local area, while 14% disagreed (NHS Greater Glasgow and Clyde, 2024). Additionally, 25% neither agreed nor disagreed and 15% were unsure or unfamiliar with fluoridation (NHS Greater Glasgow and Clyde, 2024). While the political climate remains uncertain, these findings indicate a growing openness toward reconsidering fluoridation as a public health strategy in Scotland.

Discussion

The history of water fluoridation in Scotland highlights the complex relationship between scientific evidence, public perception, and legal rulings in shaping public health policy.

While studies have consistently demonstrated that fluoridation reduces dental caries and treatment costs, legal challenges and public opposition ultimately led to its discontinuation. Unlike England, where fluoridation remains a key public health measure, Scotland opted for interventions such as the Childsmile programme.

Despite clear reductions in dental caries observed in F areas during the scheme's existence, concerns over consent, mass medication, and potential health risks dominated the debate, leading to policy stagnation. A common argument raised in Scotland's fluoridation debate was that it is considered as mass medication. This view was particularly emphasised during the McColl versus Strathclyde Regional Council case, where it was presented as an infringement on personal autonomy. However, public health professionals and legal experts argue that this is a misunderstanding. Fluoridation is not the addition of a medicine but rather the adjustment of fluoride, a mineral already found naturally in most water sources, to the optimal level for protecting teeth. Since fluoride occurs naturally in varying concentrations depending on the location, adjusting it does not introduce something foreign but rather optimises what is already present. Nevertheless, the way fluoridation is often described as artificial or unnatural continues to influence public concern and policy resistance.

A critical policy lesson from this review is that scientific evidence alone is not always sufficient to drive public health decisions. Public trust, ethical considerations, and legal frameworks play equally important roles. These findings illustrate how public perception has played a critical role in shaping fluoridation policies, often overriding scientific evidence in decision-making. This has long been recognised in public health theory. Roemer (1965) argued that fluoridation is a public health responsibility, but its legitimacy relies on democratic processes. Similarly, Chokshi and Stine, (2013) stressed the need to combine scientific authority with political legitimacy in the face of growing scepticism. Isaiah Berlin's concepts of positive and negative freedom also helps to explain why some view public health measures as protective while others view them as overly restrictive (Sociology.Institute, 2022).

In recent years, water fluoridation and other public health measures like vaccination have sometimes become part of political debates. In some countries, people's views on these issues are linked to their political beliefs. For example, those with more conservative views may see fluoridation as the government interfering too much, while other with more progressive views may support it as a way to protect public health and reduce inequalities. Although polarisation is less obvious in Scotland, similar ideas about personal freedom and government control have shaped the way people think about fluoridation. These political and ideological views continue to play a role in how decisions are made. These considerations raise a fundamental ethical question: Should public health measure prioritise individual choice over collective benefit? The Scottish case suggests that achieving a balance between public trust and scientific recommendations remains a key challenge.

Scotland's decision to reject fluoridation contrasts with policies in England, Ireland, and internationally F countries, where studies consistently show lower caries rates and reduced treatment costs in F areas. England continues fluoridation under legislative frameworks that mandate water companies to comply with health authorities' requests (Water Act 2003 Legislation) (British Fluoridation Society, 2020), whereas Scotland's legal rulings have created barriers to re-implementation. This legal divergence has contributed to distinct policy strategies compared to England, where fluoridation is maintained as a national strategy. Furthermore, public consultations on fluoridation in Scotland have historically influenced policy decisions, with opposition often cited as a key factor in preventing reimplementation. However, while a consultation process seeks public input, it is not a ballot, and decisions are ultimately made based on a range of factors, including expert recommendations and legal considerations (Department of Health and Social Care, 2025). This is evident in the UK government's response to the recent fluoridation consultation in the northeast of England, where public views were considered alongside scientific evidence and regulatory guidelines (Department of Health and Social Care, 2025).

Internationally, countries like Australia and the United States have maintained fluoridation as a cost-effective intervention, demonstrating long-term reductions in caries prevalence. While Scotland's Childsmile programme has effectively improved children's oral health, it requires active participation, whereas fluoridation provides passive, population-wide protection for people of all ages. Fluoridation still serves as a valuable public health measure for addressing the inequalities linked to tooth decay and should be incorporated into Childsmile as a complementary intervention (Jones, 2022). This integration would further enhance dental health improvements across Scotland (Jones, 2022).

The 2015 Cochrane Review Iheozor-Ejiofor et al. (2015) confirmed that fluoridation significantly reduces caries prevalence in the primary and permanent teeth of children. The updated 2024 Cochrane Review Iheozor-Ejiofor et al. (2024) revealed similar findings but acknowledged that most studies were conducted before 1975 (pre-fluoride toothpaste), raising concerns about applicability to modern populations. Moreover, the 2024 Cochrane Review Iheozor-Ejiofor et al. (2024) included only six studies, two for primary teeth and four for permanent teeth, due to strict inclusion criteria. These studies were all from high-income countries, and some had durations of less than 5 years, which may limit the generalisability of the findings. In contrast, a review by McDonagh et al. (2000) included over 200 studies, offering a broader and more diverse evidence base across different populations and time periods. Nevertheless, both reviews supported the effectiveness and cost-efficiency of water fluoridation, aligning with findings from past Scottish studies.

A systematic review by McLaren and Singhal (2016) examined the impact of community water fluoridation cessation on dental caries. The review found that, in most cases, cessation led to an increase in caries prevalence, suggesting that the discontinuation of fluoridation can reverse its preventive benefits. This aligns with observations in Scotland, where caries rates increased following the cessation of fluoridation programmes.

Some jurisdictions that previously ceased fluoridation have since reinstated it, offering valuable insights into how

evidence-based policy, legal frameworks, and changing public attitudes interact. Calgary, Canada discontinued fluoridation in 2011, but reintroduced it in 2025 after a 2021 plebiscite showed 62% support for its return (City of Calgary, 2025). Similarly, Buffalo, New York, reinstated fluoridation in 2024 following a period of discontinuation, citing updated approval from health authorities and a renewed focus on preventive care (City of Buffalo, 2024). These examples demonstrate that cessation is not always permanent, and policy reversals are possible when supported by robust evidence and effective public engagement.

The debate on water fluoridation in Scotland is far from over. While current policies favour individual choice over population-wide prevention, growing evidence suggests that a combined approach could offer greater benefits.

However, balancing scientific evidence, ethical concerns, and public trust will be critical in future decision-making. A shift in public perception, along with strong policy leadership, could pave the way for reconsidering fluoridation as part of Scotland's long-term oral health strategy.

Conclusion

The history of water fluoridation in Scotland highlights the ongoing tension between scientific evidence, legal constraints, and public perception. Despite strong evidence of its effectiveness in reducing dental caries and treatment costs, legal challenges and varied public perception have prevented its reimplementation.

Future policy discussions must consider that fluoridation's proven effectiveness outweighs unwarranted public concerns. A renewed focus on public education, clear communication, and non-partisan leadership may be essential to overcoming barriers to its reintroduction.

Acknowledgments

This research was part of a Master of Dental Public Health conducted at the University of Dundee, and we would like to express our sincere gratitude to the institution for providing the necessary resources and support.

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Ethical considerations

Ethical approval was not required as specified by the University of Dundee policy since the research methodology was a review of results from existing articles, essentially secondary analysis of outcomes from the publications found during the literature review search.

Author contributions

C M Jones had the original idea for the historical article and both authors contributed to the research and writing of the paper.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Availability Statement

The research data included in our paper are available within the reference list and can be accessed through online databases.

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