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An Exploration of Public Misconceptions of Municipal Water Fluoridation Relating to Oral and Public Health

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AN EXPLORATION OF PUBLIC MISCONCEPTIONS OF MUNICIPAL WATER FLUORIDATION RELATING TO ORAL AND PUBLIC HEALTH

by

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Abstract

Municipal water fluoridation began in 1945, and in the past 70 years, it appears to have decreased the rate of dental caries nationwide. Despite being deemed one of the top ten innovations of the 20th century, there continues to be misconceptions with this controversial practice. The intent of this thesis is to address some of the misconceptions with water fluoridation, and what possible solutions could be provided to alleviate the concerns. This was accomplished through a literature review of current research articles. Two main topics were explored: the public health and oral health concerns and how they contribute to the controversy. Results from the literature show that there was an increasing campaign from anti-fluoridators that use misleading information to advocate for ceasing water fluoridation. There was also a common concern about fluoridated water causing dental fluorosis. Furthermore, there was a trend with the lack of education and knowledge about water fluoridation, predominately in rural and low-income communities. Overall, it was reasoned that the best way to reduce the misconceptions of water fluoridation is to increase educational opportunities through medical professionals creating inter-department relationships and redirecting various government programs to target different populations.

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Chapter One: Introduction

History of Fluoridated Water

Fluoride is a naturally occurring anion that is commonly found in drinking water, but it wasn't until the early 20th century that dentists noticed the possible health benefits from this molecule ("Fluoridated Water," 2017). Starting in the beginning of the 1900s, Dr. Frederick S. McKay established his dental practice in Colorado Springs, Colorado. There, he noticed an extremely high prevalence rate of adults and children with mottled enamel, or brown stains on their teeth (Hicks, 2017). Even though the majority of the community had mottled enamel, Dr. McKay noticed that there was a low rate of tooth decay. Dr. McKay was unsure why this community had discolored teeth, and it wasn't until the 1930s with the help of chemist H.V. Churchill that the cause of the mottled enamel was determined to be from high fluoride levels in the communities drinking water, ranging from 2.0 ppm-12.0 ppm.[5] Soon after their discovery, the National Institute of Health (NIH) decided to research the side effects of fluoridated water ("The Mystery of the Colorado," 2017). They concluded that if fluoride was below 1.0 ppm in drinking water, then the rate of mottled enamel, or dental fluorosis, would decrease as well as tooth decay. After the NIH published their research, the first city to adopt the practice of municipal water fluoridation was Grand Rapids, Michigan in 1945 ("The Story of Fluoridation," 2018).

For the next 15-years, a study was conducted by dentists, epidemiologists, researchers, and physicians to review the overall oral health of 30,000 schoolchildren in

Grand Rapids. This study found that the children had a 60% decrease in dental caries, as well as a low incidence rate of dental fluorosis ("The Mystery of the Colorado," 2017). The evidence led to a major scientific breakthrough and paved the way for water fluoridation becoming more accessible to the rest of the country. The discovery of the oral benefits of fluoridated water revolutionized dentistry and introduced preventative steps to tooth decay ("The Story of Fluoridation," 2018). It also led to the exploration of administering other fluoride additives in toothpaste, supplemental pills, varnishes, and mouthwashes (Tellez & Wolff, 2016).

After the fluoridation study in Grand Rapids, the U.S. Public Health Service (USPHS) in 1962 recommended the fluoride levels to be in the range of 0.7 ppm-1.2 ppm ("The Story of Fluoridation," 2018). The range was established because fluoride levels can fluctuate in different climates and geographical locations (Tellez & Wolff, 2016). It also was modified because more research showed that 0.7 ppm was the optimal fluoride concentration to prevent dental decay and dental fluorosis. It also would be cheaper for each water treatment plant to have the maximum fluoride concentration set at 0.7 ppm (U.S. Department of Health, 2015). Fluoridation was not federally regulated until the Safe Water Drinking Act of 1974, when the Environmental Protection Agency (EPA) was designated to be responsible for creating regulatory standards for municipal water (Valachovic, 2015).

The EPA reviews any type of additives to water supplies and ensures that the water levels are safe for consumption. The EPA denoted two maximum concentration levels of fluoridated water. The second maximum contaminant level (MCL) is 2.0 ppm, and if fluoride levels exceed this, then the public must be notified within 12 months. If fluoride

levels are recorded past the first MCL of 4.0 ppm, then the EPA deems the water unsafe for consumption and immediately notifies the public (Valachovic, 2015). However, rarely does fluoride levels exceed 2.0 ppm, as the Center for Disease Control (CDC) and the USPHS recommends the fluoride levels to be at 0.7 ppm.

The EPA established the two MCLs to help prevent possible side effects of water fluoridation. The most common side effect is dental fluorosis, a cosmetic defect in tooth enamel that can range from a slight opaque discoloration to severe pitting and dark brown stains. This is more commonly found in children ranging from 8-12 years old ("EPA and HHS Announce," 2008). A more severe side effect is skeletal fluorosis, a result from a large accumulation of fluoride in bones that can cause debilitating damage to bones and joints ("Water-Related Diseases," 2016). About 1 in 4 Americans have some form of dental fluorosis, but about 2% of these cases are classified as severe ("Prevalence and Severity," 2010). Even with the possibility of developing dental fluorosis, studies show that every $1.00 spent on water fluoridation, up to $32.00 can be saved per the individual on dental care ("Cost Savings of Community," 2014).

Water fluoridation is deemed as one of the top ten innovations of the 20th century because of the significant decrease in tooth decay (Melbye & Armfield, 2013). Since the 1960s, local governments across the nation have voted to fluoridate their drinking water (Mendoza, 2009). Today, almost every major city fluoridates their water and over 70% of the population in the United States has access to fluoridated water (Brumley, Hawks, Gillcrist, Blackford, & Wells, 2001).

Fluoride in Drinking Water

Fluoride is one of the most abundant elements in the Earth's crust and is naturally occurring in almost all water supplies, in varying concentrations ("The Story of Fluoridation," 2018). Fluoride concentrations depend on the environment surrounding the bodies of water. Surface water will have different concentrations of fluoride depending on what type of rocks and soil the water runs over. Well water can have varying fluoride concentrations, depending on the rocks and minerals that surround it (World Health Organization, 2004). The United States typically requires fluoride to be added to communities drinking water supplies that have voted to accept water fluoridation, because of the low concentrations of naturally occurring fluoride. However, there are some communities that exceed the recommended fluoride levels. Less than 0.5% of the United States has fluoride that exceeds 2.0 ppm ("Center for Disease Control," 2001). These communities, like Colorado Springs, Colorado, must remove fluoride in their drinking water supplies. In the other communities, artificial fluoride source must be added to the drinking water. The most common additives are flurosilicic acid, sodium fluorosilicate, and sodium fluoride ("Cost Savings of Community," 2014). Fluoride is absorbed in the digestion tract and through the enamel as it flows over teeth. It stops early tooth decay by destroying acid buildup from bacteria colonies and allows the enamel to remineralize and repair itself (Fontana, 2018). Drinking water is the most readily available source of receiving supplemental fluoride, and because of this, it has been a practice of preventative dentistry ("Cost Savings of Community," 2014).

When fluoride washes over the enamel, only the first few layers of enamel react with the fluoride ions. The fluoride sticks to calcium ions and prevents the calcium from wearing away. However, the fluoride can wash away after eating or drinking non-fluoridated objects, so the teeth must be consistently exposed to fluoride (American Chemical Society, 2013). Another benefit of fluoride is that it has anti-microbial properties. *Streptococcus mutans* is the most common bacteria that is found in the mouth and can lead to tooth decay. It can halt the glycolysis cycle in bacteria as well as act as an enzyme inhibitor to prevent biofilms, or plaque, from forming. Also, the adhesion properties of the bacteria are reduced, making the teeth not suitable for more bacterial growth. The accumulation of plaque leads to acid buildup, and the fluoride ions will help inhibit enamel dissolution from the acid (Marquis, 1995).

Sometimes, fluoride is too high in drinking water and water treatment plants are required to try and remove some of the excess fluoride to reach the regulated levels of 0.7 ppm. This practice is more common in Virginia, Colorado, and some coastal states. It is difficult to remove excess fluoride, and some of the more common techniques used by water treatment plants is reverse osmosis and a water distillation system. Activated carbon filters will not remove fluoride.

Benefits of Water Fluoridation

There are numerous benefits from consuming fluoridated water, with the most common reducing the risk of tooth decay. Tooth decay is the most chronic infectious

disease in children, and it can be combated by drinking regulated fluoridated water ("The Story of Fluoridation," 2018). Tooth decay will eventually develop into dental caries. Dental caries if left untreated, can result in tooth loss, abscessed teeth, mastication problems, and, in more severe cases, bacterial infections that can systemically spread throughout the body.[5] Water fluoridation can help combat dental caries, and it has appeared to reduce the prevalence of dental caries by 25% in the United States since the Grand Rapids study ("Center for Disease Control," 2001). A national survey was conducted in the 1990s that compared dental decay in fluoridated and non-fluoridated regions. The results showed that a mean average of 26.5% of adolescents exhibited reduced tooth decay (U.S. Department of Health, 2015).

Water fluoridation is the epitome of preventative dentistry, because it can provide treatment to all ages just by consuming fluoridated water. It is also a relatively inexpensive practice, depending on the community location and size, that can save the consumers about $32.00-$38.00 in dental work each year (Horst, Tanzer, & Milgrom, 2018). The practice is also highly regulated by the government, CDC, and the USEPA and there have been numerous publications citing the benefits from regulated community water fluoridation (CWF) ("Center for Disease Control," 2001). The American Dental Association (ADA) also endorses CWF (Melbye & Armfield, 2013).

Even though there are several scientifically proven benefits from CWF, there are some possible side effects from the practice. The most common in the United States is dental fluorosis ("Fluoridated Water," 2017). Most dental fluorosis cases reported are predominately esthetic complaints, because teeth will have an opaque discoloration

(Mouradian et al., 2003). However, these cases do not have any damage to the enamel or tooth and can more than likely be fixed through teeth whitening. More severe dental fluorosis cases lead to the brown mottling and pitting of the teeth ("Center for Disease Control," 2001). Dental fluorosis occurs because of fluoride over exposure, because of too concentrated fluoridated water, excessive use of fluoridated mouth rinses, tooth paste, or supplements ("Fluoride and Water," 2015).

If fluoride levels are too high in drinking water and people are exposed over an extended period, then severe neurological, skeletal, and development problems can occur ("Fluoride and Water," 2015). The most infamous is skeletal fluorosis, a disfiguring disease that permanently damages the bone structure. There have not been any reported cases of skeletal fluorosis in the United States linked to CWF ("Fluoridated Water," 2017). However, it can be seen in different populations in Africa and Asia, because of the extremely high concentration of naturally occurring fluoride in their drinking water.

Controversy with Water Fluoridation

Even though water fluoridation was deemed one of the top ten innovations of the 20th century, there are numerous speculations to this practice ("Cost Savings of Community," 2014). Many people disagree with municipal water fluoridation because they view it as an unethical way to provide community medication without the consent of the consumers. Others believe that water fluoridation only benefits the wealthy and is not administered to those in low-income areas ("Top Ten Reasons," 2018). To possibly further

speculation, Surgeon General, Dr. Vivek Murthy, released a statement in 2015 lowering the recommended fluoride levels of 0.7 ppm-1.2 ppm to only 0.7 ppm. The modification was believed to help reduce the amount of dental fluorosis cases ("Surgeon General's Perspectives," 2015).

Others speculate that fluoride can cause numerous other health side effects, including: bone cancer, heart disease, autism, Alzheimer's, and lower IQ levels ("Top Ten Reasons," 2018). A 2006 study observed that high levels of fluoride in the United States led to a type of bone cancer. However, the study was later discredited as other studies did not find any correlation to municipal water fluoridation and increasing levels of bone cancer or any other serious health effects other than severe dental fluorosis ("Fluoridated Water," 2017).

Water fluoridation is approved at the local government levels, and thus different communities can vote to accept or opt out of water fluoridation (Mendoza, 2009). It is also important to note that people's exposure to drinking water is individual and voluntary, and it is up to the consumer whether to drink from the tap. If water fluoridation is approved, then the levels must be maintained and monitored to 0.7 ppm. Many citizens lobby for removing fluoride from their drinking water entirely, and there has been an increase in anti-fluoridators (Seymour, Getman, Saraf, Zhang, & Kalenderian, 2015). For example, a Florida county in 2011 voted to stop fluoridation entirely, claiming the local government did not have the right to administer this form of mass-medication without approval from the population. However, two years later, the county reversed the decision and decided to fluoridate their water again. This vote made national news and possibly fueled other

communities across the nation to reconsider their own drinking water standards (Pinellas County Utilities, 2017).

Chapter Two: Objectives

Identifying a Problem

Even though community water fluoridation (CWF) has been accepted since the 1940s, there continues to be misconceptions with the practice. Evidence of these misconceptions are apparent because of the statements released from the American Dental Association (ADA), Center for Disease Control (CDC), and United States Environmental Protection Agency (USEPA) that state the benefits of CWF. Also, there has been an increase in anti-fluoridators the past twenty years, as well as more communities and cities questioning whether to continue to accept fluoridating their drinking water. Since 2013, there have been over 70 cities that have decided to end fluoridating their water supplies, even though there continues to be scientific evidence behind the benefits of CWF (Water Topics, 2018). The controversy with water fluoridation is escalating, with a possible reason due to the lack of education and understanding behind the purpose of adding fluoride to water.

Because of the increasing misconceptions of CWF, the purpose of this thesis was to analyze current literature citing the misconceptions and controversy behind water fluoridation. Common themes throughout the articles were explored and documented to determine what possible solutions could be implemented. After conducting a literature review, a possible solution was proposed to help alleviate the continuing misconceptions with CWF.

Proposed Research

The goal of this thesis was to conduct a current literature review that will explore the different misconceptions associated with CWF. Two specific areas were analyzed, because they highlight two of the main reasons why different communities question the purpose of water fluoridation.

The first area involved public health reasons, and what possible limitations could restrict communities from accessing or accepting CWF. One of the expected limitations could be geographical location. Even though over 70% of the United States have access to CWF, there are still millions of people who do not (Brumley, Hawks, Gillcrist, Blackford, & Wells, 2001). These communities, typically, are restricted from receiving fluoridated water because they are rural, low income, and small in population size. Installing fluoridated water supplies increase in price the smaller the community (Griffin, Jones, & Tomar, 2001). Another limitation could be due to the lack of knowledge or understanding behind the purpose of CWF. Fluoridation has been accepted since the 1940s, but there are still communities that do not realize fluoride is being added to their drinking water supplies. The lack of education of CWF was explored, as well as the effectiveness of the solutions that have already been implemented. Numerous programs have been established to educate communities about their drinking water supplies, as well as to inform them about the benefits of fluoride additives. In 2012, the optimum fluoride concentration was modified from the range of 0.7 ppm-1.2 ppm to only 0.7 ppm (Palmer & Gilbert, 2012). The reactions

from the public was analyzed and how the modification from the USEPA and CDC could have contributed to some of the public health concerns.

The second area that was analyzed was the possible oral health concerns that contribute to the controversy behind CWF. Tooth decay has decreased since the 1940s, with the reasoning pointing towards water fluoridation. However, the rate of dental fluorosis has increased. Examining the possible concerns associated with tooth decay and dental fluorosis was examined from the literature review. Other reasons behind oral health concerns was also analyzed to determine if there are similar themes with the different literature.

After looking at the oral and public health concerns with CWF, a proposed solution was provided. It is difficult to develop a single solution that addressed the misconceptions of CWF.

Chapter Three: Literature Review

Methodology

This literature review was completed through analyzing current research on PubMed. The search for current literature relating to the controversy of water fluoridation relating to oral and public health started with using the phrase "Water Fluoridation." This search produced 6,516 articles. This sample size was too large for this study, so a more narrowed search of key words "Water Fluoridation Dental" and "United States" was conducted. 856 articles were produced through this search. The articles were analyzed, but the search was not specific to this thesis topic. Therefore, a finalized search was performed containing the phrases "Water Fluoridation Oral Health" and "United States." 216 articles were produced from this search. 128 were eliminated because the articles were published before 2000. This thesis will cover current data relating to water fluoridation, and articles published before 2000 would not qualify for this research project. Out of the 128 articles looked at, 83 were eliminated because they did not fit the scope of the thesis. Eight did not have the experiments in the United States. 23 did not have an available article associated with the title. 27 did not relate to the controversy of water fluoridation. 26 were a literature review. This resulted in a total of 44 articles selected to be reviewed.

Results

A summary of the selected articles, impact factors, mentioned government programs, and geographic location can be found in Appendix A.

Public and Oral Health Concerns Possibly Limiting Water Fluoridation

There were several common themes throughout the literature that related some of the public and oral health concerns surrounding water fluoridation. However, before the controversy behind fluoride in drinking water is addressed, it is important to discuss some of the other restrictions that can contribute to the public not having access to community water fluoridation (CWF) or learning about the practice.

Geographic location can prevent communities from getting access to municipal water fluoridation ("Cost Savings of Community," 2014). Some communities are too far away from a major water treatment plants, and this could be a reason as to why the public could not have access to the fluoridated water (Anderson, Martin, Flynn, & Knight, 2012). Another significant reason is the actual price of installing and maintaining CWF (J .O'Connell, Rockell, Ouellet, Tomar, & Maas, 2016). The price of installing fluoride treatment plants in these communities can be expensive and require more money (Gooch, Griffin, & Malvitz, 2006). This could potentially deter certain groups away from the practice, because it is more money upfront. Similar to the geographic limitations, small rural communities also experienced lack of CWF because of the small number of people per each water treatment system (J. O'Connell, Rockell, Ouellet, Tomar, & Maas, 2016). On

average, fluoridating water saves consumers $38.00 a year on dental costs (Horst, Tanzer, & Milgrom, 2018). In larger communities, paying for fluoridation will be cheaper than getting one cavity filled (approximately $150, depending on location) over their life time (J. M. O'Connell, Brunson, Anselmo, & Sullivan, 2005). However, the cost of adding fluoride increases the smaller the community (Griffin, Jones, & Tomar, 2001).

Another trend that was highlighted was the lack of access some minority populations had to CWF. The literature stated that the smaller, rural communities lacked exposure to CWF, and, the minority groups had higher rates of dental decay (J. O'Connell, Rockell, Ouellet, Tomar, & Maas, 2016). These populations studied, specifically Latinos and African Americans, were predominately below the poverty line and had higher rates of dental decay (Maserejian, Tavares, Hayes, Soncini, & Trachtenberg, 2008; Barker, Guerra, Gonzalez-Vargas, & Hoeft, 2016). There are several reasons as to why these rural communities have increased risk of dental decay, with one of the more prominent topics being the reduced access to dentists (Tellez & Wolff, 2016). Some of these locations stated that they had few available dentists, which could possibly contribute to the communities not having proper educational exposure to CWF. Another contribution could be the cost of a community member visiting a dentist. Dental work can be expensive, and insurance does not always cover the costs of a trip to the dentist ("Cost Savings of Community," 2014). Furthermore, these populations had a higher percentage of Medicaid insurance, and it was stated that most dentists do not accept this form of insurance (Sun et al., 2015; Kumar, Adekugbe, & Melnik, 2010). If they do, then it is mainly used to cover emergency dental trips (abscess, extreme tooth pain, infection). However, the costs of emergency dental

procedures can still be substantial, and these communities might still be unable to afford it. Because a visit to the dentist can be so expensive, some patients will deny dental work and leave with a prescription (Sun et al., 2015). It can be cheaper for patients to visit the dentist to receive a prescription for pain killers, to mask any type of oral pain they might be experiencing. This does not address the problem behind poor oral health, and it can lead to other problems like addiction and prescription abuse. If these rural communities do not visit the dentist, then they could be missing the important exposure to CWF and thus cause them to potentially have an increase in dental caries and tooth decay (Barker, Guerra, Gonzalez-Vargas, & Hoeft, 2016).

Dental office visits were also found to be reduced because some groups do not see the necessity of going to the dentist compared to visiting a primary care provider (PCP) (Tellez & Wolff, 2016). There were also statements that patients prefer seeing a physician over a dentist, because of the accessibility of physicians and a general fear of the dental profession (Cruz, Chi, & Huebner, 2016; Sun et al., 2015). This fear and lack of trust in dentists could also contribute to the lack of knowledge and understanding of accepting CWF, because they are not exposed to the practice or learn about preventative dentistry that is associated with CWF. If there is a mistrust of dentists, then some citizens would want to avoid some of the practices associated with or endorsed by dentists. Also, it is more affordable and easier for those with Medicaid insurance to find a physician that would accept this insurance. Both adults and children were found to be more likely to visit their PCP and not a dentist (Edelstein, Hirsch, Frosh, & Kumar, 2015).

The lack of dentists in an area reduces the spread of preventative dentistry practices, predominately advocating the benefits of water fluoridation. Misunderstanding water fluoridation was another common theme throughout the literature, and this lack of knowledge stemmed from a lack of education (Spencer & Do, 2016; Hayes, Wyatt, & Wiles, 2012). Several of the articles that conducted surveys about the purpose of water fluoridation had a negative trend towards CWF (Melbye & Armfield, 2013; Water Topics, 2018). This could have been either from not understanding what CWF is, or because they did not trust what fluoride could possibly do to their overall health. Education is a critical component of community members personally accepting CWF, and it was shown that there was a correlation of those advocating against CWF and not understanding its purpose (Glatt et al., 2016; Gillcrist, Brumley, & Blackford, 2001). In particular, some of the minority populations were stated to have not only a reduced understanding of CWF, but they were more likely to avoid municipal tap water (Barker, Guerra, Gonzalez-Vargas, & Hoeft, 2016). This was stated to be associated with not understanding what type of additives were placed in their drinking water. There were some government programs implemented to raise awareness of fluoridation, with many of them targeting first time families or women (Glatt et al., 2016). Some of the government programs targeted the women because they would learn about the benefits of CWF and would relay the knowledge to their families. This, ideally, would have a domino effect and would educate an entire household about the several benefits of water fluoridation ("Cost Savings of Community," 2014).

Another reason cited in the literature for opposing water fluoridation is because of the noted increase in prevalence of dental fluorosis (Mouradian et al., 2003). This semi-

permanent stain is one of the main points why anti-fluoridators oppose CWF and advocate for ceasing water fluoridation (Spencer & Do, 2016). Negative campaigning could be a reason as to why some people oppose water fluoridation. Social media is a major platform that can easily spread inaccurate information about water fluoridation to a large audience (Seymour, Getman, Saraf, Zhang, & Kalenderian, 2015). Dental fluorosis prevalence has increased since the 1990s, but the rate of dental caries has decreased over this time ("Prevalence and Severity," 2010). Increased fluoride products (toothpaste, mouth rinses, supplements) could potentially be correlated with the increase of fluorosis in the past twenty years (Griffin, Beltran, Lockwood, & Barker, 2002). Anti-fluoridators also claim that ingesting fluoride causes systemic damage to the body. Lower intelligence quotient (IQ) in children and adolescents, increase chance of heart disease, bone cancer increasing autism prevalence, and increasing attention deficit disorder (ADD) in children are some of claimed side effects from drinking fluoridated water (Bassin, Wypij, Davis, & Mittleman, 2006). While there is no accurate scientific data associated with these claims, there are reasons to believe that the anti-fluoridators platform has increased over the past few decades (Veschusio, Jones, Mercer, & Martin, 2018).

Discussion

Anti-fluoridators have advocated against CWF since the start of the practice in the 1940s, but their popularity has increased in the past twenty years. In 2014 the president of the American Dental Education Association (ADEA) released a statement with the purpose

to provide scientific facts about the positive health effects from CWF, and to dispel any discrepancies about the practice. The ADEAs article, 'Setting the Record Straight on Fluoride,' explained why communities should accept CWF and why opposing the practice could lead to serious health side effects (Veschusio, Jones, Mercer, & Martin, 2018). It is stated that removing fluoridation will lead to an increase in tooth decay in years after the cessation of the practice. This is predominately from the reduced exposure to the fluoride ions that help mineralize and strengthen enamel (Neidell, Herzog, & Glied, 2010). However, one of the more interesting statements that were addressed in this article tried to devalue an article that proposed possible negative effects from drinking fluoridated water (Spencer & Do, 2016). This article collected data from China communities that had varying concentrations of fluoride in drinking water (Veschusio, Jones, Mercer, & Martin, 2018). Anti-fluoridators were quick to use this article as proof of the detrimental side effects of fluoridation. However, the data was quickly diminished from dentists and public health researchers, because of its lack of information that was pertinent to the United States fluoridation standards (Veschusio, Jones, Mercer, & Martin, 2018). It is interesting to note that several of the articles reviewed directly addressed this anti-fluoridation article. The article, released in 2012, became very popular to anti-fluoridators because it strengthened their message with scientific data, even though the article was not relevant to the United States water regulation standards (Palmer & Gilbert, 2012). This is because the article conducted research in China, who has different water regulation standards compared to the United States.

It is important to note that the ADEA article tried to address the lack of education and knowledge about CWF. Even though over 74% of the United States has access to fluoridated water, there are still several groups that do not know their water is fluoridated or do not understand why it is fluoridated (Mork & Griffin, 2015). If these people are first exposed to fluoridation from anti-fluoridators, then they could possibly adopt their way of thinking and choose to avoid their fluoridated drinking water. One of their more prominent platforms against CWF is because it is a form of mass-medication, and the public has no choice in the matter (Spencer & Do, 2016). They also state that it is unethical to put additives in the water without every consumers consent (Mendoza, 2009). Rural communities, who in particular have restrictions to proper oral health care, have a greater chance of being misinformed about CWF and choose to find alternative methods of getting their drinking water (Barker, Guerra, Gonzalez-Vargas, & Hoeft, 2016). It is important to properly educate the public about CWF, especially these rural communities, to ensure that false information is not spread, or it is quickly rejected.

However, there appears to be a common trend in public health reforms that involve articles being published that mislead the public (Seymour, Getman, Saraf, Zhang, & Kalenderian, 2015). For example, the infamous anti-vaccination article published in 1998 linked vaccines to possibly causing autism in children (Veschusio, Jones, Mercer, & Martin, 2018). Two of the articles stated that anti-fluoridators are the original anti-vaccinators. There appears to be some type of correlation between public health reforms and the public reacting negatively to these advancements (Seymour, Getman, Saraf, Zhang, & Kalenderian, 2015). Recently, anti-vaccinators have had a larger platform and grown a larger following.

Similarly, anti-fluoridators have grown more popular (Valachovic, 2015). The literature states that CWF is addressed regularly with local government, and the topic is regularly battled between health care providers and those opposing CWF (Gillcrist, Brumley, & Blackford, 2001; Water Topics, 2018). In the past five years, over 70 communities opted to stop fluoridating their drinking water (Water Topics, 2018). Politics appear to have another say so in this practice, with the more conservative parties opting to end fluoridation (Veschusio, Jones, Mercer, & Martin, 2018). Communities changing their water fluoridation can make other communities question their own drinking water.

Another contribution towards the misconceptions with CWF is the use of social media and its ability to bring people together with the same opinion and make them appear to have a larger platform (Seymour, Getman, Saraf, Zhang, & Kalenderian, 2015). 10% of Americans view water-fluoridation as a negative practice, and even though the population is small, their presence on social media is quite extensive (Mork & Griffin, 2015). It is difficult to determine if something advertised on a social media platform is factual or not, biased, or secretly supporting a certain groups platform. Social media has been described to cause "digital pandemics," because of its ability to easily spread false information that can lead to the public questioning public health advancements (Seymour, Getman, Saraf, Zhang, & Kalenderian, 2015). For example, the 2012 anti-fluoridation article was spread through social media and could have led to misinforming the public about the true benefits of CWF. Social media more than likely plays a role in misinforming the public about the negative effects from CWF (Seymour, Getman, Saraf, Zhang, & Kalenderian, 2015). It would be interesting to determine if there is a correlation between the number of anti-

fluoridators growing over the past twenty years with the expansion of social media platforms.

Because of the false information about CWF that is becoming more prominent, education from a medical professional is stated to be one of the main methods to alleviate some of the misconceptions (Mouradian et al., 2003; Filling the gap, 2001). It was discovered that the rural communities did not even know what fluoride was or did not know the reasoning why it is put into their drinking water. Because of these results, local and federal government programs were created to promote CWF (Water Topics, 2018). The results from these programs were promising, and each study showed that there was an increase in knowledge about fluoride in drinking water (Barker, Guerra, Gonzalez-Vargas, & Hoeft, 2016). These results hopefully led to a better understanding of community water fluoridation. However, a caveat to these government programs was the common theme that these low-income communities show a lack of trust in their local government (Mork & Griffin, 2015). If there is a lack of trust between the educator and the targeted audience, then the message will not be as effective. Another study should be conducted in these areas that assessed the trust between the community and their local government. It would also be interesting to note whether the opinions fluctuated over time, especially when the 2012 anti-fluoridation article was published.

Another reason as to why the public might have apprehensions with fluoridated water is because in 2007, the United States Environmental Protection Agency (USEPA) reevaluated the appropriate levels of fluoride in drinking water (Water Topics, 2018). They changed their policy from a range of 0.7 ppm to 1.2 ppm to 0.7 ppm. This was to reduce the

incidence rate of dental fluorosis while providing the optimal concentration of fluoride to teeth to prevent tooth decay. It also was a cheaper solution for the water treatment plants to continuously add fluoride to the drinking water supply. Anti-fluoridators used the policy change to help strengthen their platform with the supposed lack of scientific knowledge associated with CWF, and how the previous range caused dental fluorosis (Palmer & Gilbert, 2012). It also promotes their message about the lack of trust with the government. This could be another factor associated why some of the government programs are not as successful. Even though each program had a positive result with their advocacy initiatives, they did not change the minds of every person who attended.

Because of the stated mistrust in the different levels of government, it would appear being educated from a medical professional in a clinical setting would potentially be more successful in promoting CWF (Melbye & Armfield, 2013). However, as previously stated, visiting the dentist is not as common as visiting a PCP (Tellez & Wolff, 2016). Like the previous statement about the lack of trust with the government, there was common verbiage that there is a "fear" of the dentist. This fear could be a factor as to why dentists are not visited as often as a PCP, and why their message about preventative dentistry and CWF cannot be advocated as often as they would like (Palmer & Gilbert, 2012). If a medical provider is feared, then they are more than likely not trusted. Increasing the accessibility and approachability of dentists would allow them to have a larger platform to promote CWF practice and other oral health care tips (Melbye & Armfield, 2013). Improving the public's perception of dentists is no easy task, and it is a challenge that cannot be addressed overnight.

Another method to help rid the misconceptions behind CWF would be to forge an inter-department relationship between dentists and other medical professionals, like PCP ("Filling the gap: strategies for improving oral health," 2001). Dentists working with physicians, and vice-versa, could help promote the benefits of CWF and dispel any discrepancies behind the practice. As previously stated, it is more common for citizens in poor, rural communities to visit their PCP over a dentist. With this information it was stated that PCP could possibly be responsible for promoting and educating their patients on the benefits of fluoridation, as well as dismissing any false information about the practice (Water Topics, 2018). If PCP and dentists worked together more, then they would be able to reach a larger population and, hopefully, lead to a better understanding of CWF.

Several of the articles that highlighted education programs targeted specific audiences, like women and children. Two of the articles discussed educating pregnant women and first-time mothers about the benefits CWF and how it could impact their children (Glatt et al., 2016; "Cost Savings of Community," 2016). It was hypothesized that women would learn about the prevalence of tooth decay in children, and how a simple solution is to drink fluoridated tap water. Ideally, they would be more accepting of the practice (Glatt et al., 2016). The other audience that was targeted was children. Children were offered free dental screenings in elementary schools, to determine their degree of tooth decay as well as to administer fluoride varnishes (Iida & Kumar, 2009). Their interactions with dentists hopefully would help alleviate the fear of the profession at an earlier age, as well as to boost their own understanding of tooth decay. The end goal would be for the dentists to provide insight about fluoride additives.

Chapter Four: Future Research

As discussed throughout this thesis, one of the main reasons why there are misconceptions associated with community water fluoridation (CWF) is because of the lack of education. Even though there are several government programs, community dentists, and medical providers working to alleviate the discrepancies tied to water fluoridation, there is still room for improvement. Several of the articles conducted surveys after their educational component promoting fluoridation, and they reported positive results. However, there were not any statements about another survey to be administered in the following years. A two- and five-year post-survey should be distributed to determine if the advocacy programs maintained these positive results. If they did not, or if their numbers were not consistent, then a reasoning as to why the opinions changed and how it was changed should be asked and addressed. This would hopefully provide beneficial feedback to the advocacy programs about their effectiveness and the possible areas of improvement.

Some of the advocacy programs that were more successful were the ones that allowed dentists to perform a quick oral screening of school children. The dentists sometimes applied a fluoride varnish to the children and analyzed their oral hygiene (Iida & Kumar, 2009). Another study should be conducted that would educate the children about CWF and then provide the parents with information about the practice. This age group is the opposite of what some of the other programs targeted, women or first-time families, but it would be interesting to see if educating children first would possibly increase the acceptance and understanding of CWF. Furthermore, educational providers and school

nurses should be able to provide a generic and simple dental screening to look for dental decay. They could provide information to parents about the necessity to see a dentist, which could provide educational opportunities to learn more about CWF. It would also combat this extremely prevalent chronic disease in children (Benjamin, 2010).

Another way to promote CWF is to increase the inter-department relationship between physicians and dentists. It was repeatedly stated that many of the rural communities that do not know the purpose behind CWF and are on Medicaid commonly see their primary care provider (PCP) more often than their dentist (Spencer & Do, 2016). There should be some type of communication between dentists and physicians to promote fluoridation to try and alleviate any of the discrepancies with the practice. It is difficult to tell current physicians to advocate for a practice that does not directly correlate with their own teachings. Therefore, it is worth exploring the relationships between medical and dental students while they are still in professional school and determine if there could be any type of overlap that could potentially help one another. An examination of the current curriculum in medical and dental school would have to be examined.

Another common theme throughout the literature review was the negative connotations associated with dentists. It would be interesting to further research why some patients have anxiety with going to the dentist and what would be a possible solution. Even though reducing the apprehension with visiting a dental office does not directly correlate with reducing the misconceptions with CWF, it would allow dentists to be more accessible. This would provide them a larger platform to possibly advocate about the benefits of fluoridation and help answer any pressing questions.

However, as previously mentioned, there could be several limiting factors that would have to be fixed before this would be able to take place. The first one would be to promote the financial accessibility of patients trying to see the dentist. One possible future study would be to start with the cost of dental school in general. Dentistry is one of the most expensive professional school in the United States, and because of the debt dental students accumulate, dental work is more expensive to help dentists pay back their student loans. There is also limited accessibility to dental insurance. Both subjects have been debated extensively, but a possible solution that promotes accessibility to dental care could possibly help alleviate some discrepancies with CWF.

Chapter Five: Conclusion

Fluoride is a naturally occurring element that is commonly found in drinking water (Spencer & Do, 2016). Water fluoridation has been a national practice starting in the 1940s, and it is deemed one of the most successful health programs of the 20th century (Melbye & Armfield, 2013; Center for Disease Control, 2001). In the past 70 years, the prevalence of dental decay has appeared to decrease nationally by 25%, because of the implementation of fluoride in municipal drinking water ("Center for Disease Control," 2001). Over 70% of the United States has access to community water fluoridation (CWF), which is one of the most cost-effective and efficient ways to prevent dental caries from developing. CWF has been highly researched and has been endorsed by the American Dental Association (ADA), Center for Disease Control (CDC), the United States Environmental Protection Agency (USEPA), and many more (Brumley, Hawks, Gillcrist, Blackford, & Wells, 2001). Because of constant research, the recommended fluoride concentration levels were modified in 2012 to a maximum fluoride concentration of 0.7 ppm.

In the past five years, there has been more controversy associated with the practice, and over 70 cities in the United States ceased CWF (Water Topics, 2018). Some of the reasonings included: the increase in dental fluorosis, citing inaccurate sources that state detrimental side effects from drinking fluoridated water, and the belief that CWF is a form of mass-medication. Anti-fluoridators do not reflect the majority opinion in the United States, however, their platform and advocacy efforts target people who are unfamiliar with

the practice or are unsure about it. They rely heavily on social media to advocate their concerns and use it to market different anti-fluoridation articles and sources. This enhances the controversy and misconceptions associated with CWF (Seymour, Getman, Saraf, Zhang, & Kalenderian, 2015).

Anti-fluoridators stress that fluoridation is a restriction of their rights as humans, because the government is administering additives to their drinking water without their consent. CWF policies are controlled at the local government level, and water fluoridation is readily addressed in several communities- either to start the practice or abandon it (Mork & Griffin, 2015). Furthermore, changing CWF status is extremely costly. Depending on the State and community size, CWF over the span of a life time costs less than one cavity being filled. Stopping fluoridation takes years to finally remove the additive fluoride and requires millions of dollars. Likewise, starting fluoridation is also expensive, with it being far more expensive in rural communities (Griffin, Jones, & Tomar, 2001).

Rural communities have a greater restriction to CWF, either from the lack of funds from the government to start CWF, the community is too small, or because of geographic limitations (Griffin, Jones, & Tomar, 2001). However, some of these communities have a greater chance of having low income families that do not readily have access to dental care, either from the financial cost or from the lack of available dentists. These communities would benefit significantly from CWF, but many of them do not know about fluoridation. If they do know fluoride is in their drinking water, then studies showed that they do not know the health benefits from it. The lack of education and knowledge contributes to the misconceptions circulating around CWF.

To increase dental availability, advocate for CWF, and dispel any misconceptions, different government programs have been created. Many of these programs targeted low income families, children, and women. These groups were targeted because of the greatest potential impact of their programs. Women were predominately targeted because the programs highlighted the oral health benefits CWF provides (Glatt et al., 2016). Children were provided dental screenings in elementary and middle schools, to determine the prevalence of dental decay in different ethnic groups as well as compare fluoridated and non-fluoridated communities. The programs stated generic oral screenings by a dentist and sometimes administering a fluoride varnish, however, children should be focused on more in the future to combat CWF discrepancies. This could provide another method to alleviate concerns with CWF.

One of the main oral health concerns with CWF is dental fluorosis. This discoloration of the teeth is typically only found in the mild form in the United States. Rarely does dental fluorosis turn into brown mottled teeth. However, this aesthetic problem can often be treated with over the counter bleaching strips or visiting a dentist (Griffin, Beltran, Lockwood, & Barker, 2002). There has also been an association with dental fluorosis having a reduced risk of dental decay. Despite this information, there continues to be misconceptions about the dangers of dental fluorosis. Other studies have shown that there could be other possible causes of dental fluorosis, besides CWF.

The misinformation about dental fluorosis goes hand-in-hand with the recurrent theme of misguiding information that could be solved through proper education. Medical professionals should provide their patients or costumers scientific facts about the benefits

of CWF. Inter-department programs and relationships should be established to encourage the spread of CWF. These relationships should be created during graduate or professional school. Patients who rely on Medicaid are more likely to visit their primary care provider (PCP) over the dentist because of financial cost and availability (Spencer & Do, 2016). Therefore, the PCP should provide information about the patient's oral health status and educate them about some of the ways to combat tooth decay.

Overall, CWF is a proven scientific accomplishment that provides preventative measures towards tooth decay. However, there continues to be hesitation with the practice. Providing and enhancing educational opportunities will combat the negative perceptions circulating around water fluoridation, and, hopefully, encourage the spread of CWF.

Appendix A: Literature Review Summary

Title			
Public Health Conclusions	**Oral Health Conclusions**	**Government Program Mentioned**	**Location**
Readying Community Water Fluoridation Advocates through Training, Surveillance, and Empowerment			
Small, rural areas oppose water fluoridation	Increasing understanding of CWF will improve overall oral health	"Spectrum of Prevention," dentists, physicians, legislators, environmental engineers together to advocate for CWF	South Carolina
Assessment, Education, and Access: Kona Hawai'i WIC Oral Health Pilot Project			
Targeted pregnant women and children to educate them about water fluoridation; 78% agreed to the practice if it benefited their children	Lack of oral hygiene, knowledge of water fluoridation, and lack of accessible dentists	"Special Supplemental Nutritional Program for Women, Infants, and Children (WIC)	Hawaii
Fluorides and Other Preventive Strategies for Tooth Decay			
Educate public according to age about benefits of fluoridation; advocate for taxes on sugar	Performing dental screenings in elementary schools educate children about water fluoridation	Not applicable (N/A)	N/A
The Public Health Reach of High Fluoride Vehicles: Examples of Innovative Approaches			
More children see primary care physicians than dentists; lack of dentists in low income areas	Dental decay is a common issue in children and the elderly	Medicaid does not provide adequate dental insurance	N/A
Fluorides and Other Preventive Strategies for Tooth Decay			
Modifying the recommended fluoride levels was done too quickly	Not enough research conducted about preventing the increasing rate of dental fluorosis	US Public Health Service Panel on Community Water Fluoridation presented its	N/A

without enough research		modified fluoride levels	
Caution needed in altering the 'optimum' fluoride concentration in drinking water			
More children see primary care physicians than dentists; lack of dentists in low income areas	Dental decay is a common issue in children and the elderly	Medicaid does not provide adequate dental insurance	N/A
Costs and Savings Associated With Community Water Fluoridation In The United States			
Updated economic model about the cost effectiveness of CWF and states the savings from dental care surpass the cost of CWF	CWF reduces prevalence of dental caries and provides $32 in savings per capita	"Healthy People 2020" aimed to reduce tooth decay and increase accessibility of CWF	N/A
Evaluation of an oral health education session for Early Head Start home visitors			
A survey was conducted to determine the knowledge of CWF and tooth decay	Oral health knowledge was asked to pregnant women and first-time families	"Early Head Start Homes" targets women and children; uneven implementation of the program because of finances	Wisconsin
Oral health services within community based organizations for young children with special health care need			
Increased prevalence of tooth decay in special needs children	This county does not fluoridate their water; lack of dentists available to see special needs children	Access to Baby and Children Dentistry (ABCD) strives to find dentists willing to see special needs children	Spokane, Washington
Acceptability of Salt Fluoridation in a Rural Latino Community in the United States: An Ethnographic Study			
Survey conducted to analyze the knowledge and understanding of fluoride and CWF	Higher prevalence of tooth decay in Latino communities also lack knowledge about CWF	"Early Head Start Homes" targets women and children; uneven implementation of the program because of finances	California's Central Valley
Setting the Record Straight on Fluoride			

Increasing speculation of CWF led to the American Dental Education Association to release a statement about its benefits	CWF is safe, effective, and cost saving	The CDC should be used as a resource for current knowledge about CWF	N/A
Emergency Department Visits for Nontraumatic Dental Problems: A Mixed-Methods Study			
Increased prevalence of emergency dental visits from Medicaid patients; Oregon has large areas of non-fluoridated water	Fear of dentists contribute to lack of dental office visits, thus increasing rate of tooth decay	Increased prevalence of emergency dental visits from Medicaid patients; Oregon has large areas of non-fluoridated water	N/A
When advocacy obscures accuracy online: digital pandemics of public health misinformation through an antifluoride case study			
Increased social media use provides a stronger platform for anti-fluoridators	Digital pandemics from social media use lead to possible changes in health care	N/A	N/A
Perceived safety and benefit of community water fluoridation: 2009 HealthStyles survey			
Survey conducted to determine current knowledge about CWF based on ethnicity and location	Common theme about CWF causing dental fluorosis, and not understanding what it is	Reasons why opposing CWF is because of lack of trust with the government rules	National Survey
Reducing early childhood caries in a Medicaid population: a systems model analysis			
Stopping CWF is extremely costly; lack of dentists willing to accept Medicaid	CWF is best treatment plan to reduce tooth decay in Medicaid patients	Stopping CWF is extremely costly; lack of dentists willing to accept Medicaid	N/A
Fluoride Use in Caries Prevention in the Primary Care Setting			
Slight increase since the 1990s of dental fluorosis and dental caries	Children who do not have access to CWF have increased risk of tooth decay	Under the Safe Drinking Water Act, the EPA is responsible for contacting consumers of	N/A

		improper fluoride levels	
The dentist's role in promoting community water fluoridation: a call to action for dentists and educators			
Lack of knowledge about CWF, dentists need to promote CWF, not government programs	Dentists need to be responsible for informing patients about benefits of CWF	Local dentists do not always advocate for CWF because community is not supporting it	Oregon
Developmental delays and dental caries in low-income preschoolers in the USA: a pilot cross-sectional study and preliminary explanatory model			
Children with developmental delays have increased risk of tooth decay	CWF helps reduce dental caries in low income families	Head Start, a pre-school readiness program for low income families	Washington
Position of the Academy of Nutrition and Dietetics: the impact of fluoride on health			
Dietitians support CWF because it supports oral and bone health	Anti-fluoridators instill fear in the general public about fluoride use	N/A	N/A
The prevalence of dental caries in Missouri and its relation to systemic disease: opportunities for Missouri to improve the health of its citizens			
The US EPA modifications to acceptable fluoride concentrations caused confusion in consumers	Small percentage of dental visits, many rural areas that do not have access to CWF	Health Information Exchange, increase insurance dental coverage	Missouri
The importance of substate surveillance in detection of geographic oral health inequalities in a small state			
Lack of fluoridated water in Coos county and large number of low-income communities contribute to high tooth decay rates	Lack of dentists available to poor communities	N/A	Coos County, New Hampshire
Validation of a multifactorial risk factor model used for predicting future caries risk with Nevada adolescents			

School nurses, educators, and physicians should consider screening for dental caries	Adolescents with access to CWF had reduced rates of dental caries	School nurses, educators, and physicians should consider screening for dental caries	Adolescents with access to CWF had reduced rates of dental caries
Inequalities of caries experience in Nevada youth expressed by DMFT index vs. Significant Caries Index (SiC) over time			
Increasing CWF access is important and needs to continue to be implemented	Higher rates of dental caries in non-white communities as well as reduced access to CWF	N/A	Nevada
The association between community water fluoridation and adult tooth loss			
CWF access at birth is more important than drinking fluoridated water later in life	CWF reduces likely hood of developing dental caries in primary teeth	N/A	National Survey
Geographic variation in Medicaid claims for dental procedures in New York State: role of fluoridation under contemporary conditions			
Needs more dentists to accept Medicaid and patients to have access to CWF	Increased rate of dental procedures with Medicaid patients in non-fluoridated areas	Medicaid, Guide to Community Preventive Services	New York
A case-control study of determinants for high and low dental caries prevalence in Nevada youth			
Dentists conducted oral exams in middle and high schools; Hispanics had highest rate of dental decay	Dental caries prevalence was determined in communities with and without CWF	Crackdown on Oral Cancer, screening initiative to detect early levels of oral cancer	Clark County, Nevada
Assessing a multilevel model of young children's oral health with national survey data			
Improving children's oral health requires more than just fluoridating water and educating them	Tooth decay was reduced in populations with higher incomes and access to CWF	N/A	National survey
Oral Health: The Silent Epidemic			
Surgeon general released a	Tooth decay is the most chronic	Children's Health Insurance Program	N/A

statement stating the decline in dental caries and increase in CWF since 1990s	disease in children, and very common in adults	Reauthorization Act, increases funding for dental programs in low income areas	
Prevalence and Severity of Dental Fluorosis in the United States, 1999–2004			
Dental fluorosis has increased as well as CWF accessibility	Children and young adults have higher rate of developing dental fluorosis today compared to twenty years ago	National Health and Nutrition Examination Survey; collected information about dental fluorosis	National survey
Promoting Social Welfare Through Oral Health: New Jersey's Fluoridation Experience			
New Jersey has had fluctuating policies regarding CWF; policy debates between two opposing parties lead to ineffective policy making	To provide fluoride to non-fluoridated regions, fluoride sealants are administered (e.g. Montana does this and has low CWF percentage)	Federal government does not opt to regulate CWF, requires local governments to control policy	New Jersey
The Association Between Enamel Fluorosis and Dental Caries in U.S. Schoolchildren			
Policies should not modify the fluoride concentration because mild dental fluorosis can easily be treated while dental caries cannot	Teeth affected with dental fluorosis had lower risk of developing dental caries	N/A	National survey
Rural and Urban Disparities in Caries Prevalence in Children with Unmet Dental Needs: The New England Children's Amalgam Trial			
Comparing rural and urban families oral health status	Farmington had lower prevalence of dental decay, but relied on well water; Boston had CWF, but lower income families	New England Children's Amalgam Trial, provided free dental care to participants in the study	Boston, Massachusetts Farmington, Maine
A Comparison of Dental Treatment Utilization and Costs by HMO Members Living in Fluoridated and Nonfluoridated Areas			
Increased dental trips for those who did not have CWF	More dental restorations were completed for those	Kaiser Permanente Northwest region, not-for-profit organization that	Northwest Oregon; Southwest Washington

	who did not have CWF	allows restorations to be done by dentists	
The Role of Evidence in Formulating Public Health Programs to Prevent Oral Disease and Promote Oral Health in the United States			
Water Fluoridation Reporting Systems provide community members access to their current CWF status	The CDC establishes several methods to increase overall oral health awareness	Sealant Efficiency Assessment for Locals and States, provides policy makers about dental practices and prices	N/A
Age-specific fluoride exposure in drinking water and osteosarcoma (United States)			
Exploratory analysis showed association between drinking fluoridated water and developing osteosarcoma in males, other similar studies do not show this correlation	CWF levels can fluctuate depending on the climate	N/A	National Study
Costs and Savings Associated With Community Water Fluoridation Programs in Colorado			
Colorado would save over $50 million in dental costs if all water supplies fluoridated their water	Policy makers need to advocate about fluoride helping prevent dental caries	N/A	Colorado
Addressing Disparities in Children's Oral Health: A Dental-Medical Partnership to Train Family Practice Residents			
Targeting small, rural communities should be the focus for educational purposes regarding CWF	Physicians and dentists working together could educate communities lacking CWF or knowledge of the practice	Interdisciplinary Children Oral Health Promotion; works with dentists, physicians, and ABCD programs to advocate for better oral hygiene	Washington; Idaho
Esthetically objectionable fluorosis attribute to water fluoridation			
School children are self-conscious of having dental fluorosis or are	CWF can make children susceptible to mild forms of dental fluorosis	N/A	National Survey

worried about developing it.			
An Economic Evaluation of Community Water Fluoridation			
Annual savings from CWF would range from $15-$18, depending on the size of the community	CWF is cost effective and is more important for permanent teeth that have erupted	Interdisciplinary Children Oral Health Promotion; works with dentists, physicians, and ABCD programs to advocate for better oral hygiene	Washington; Idaho
Quantifying the diffused benefit from water fluoridation in the United States			
CWF communities possibly help neighboring non-fluoridated communities	CWF communities showed to have better oral hygiene compared to non-fluoridated communities	N/A	National Survey
Community Fluoridation Status and Caries Experience in Children			
School screening was conducted by a dentist to determine the prevalence of dental caries	Children drinking fluoridated water had better oral hygiene and lower risk of dental caries	N/A	Tennessee
Successful Implementation of Community Water Fluoridation via the Community Diagnosis Process			
Survey conducted to help promote CWF and implement it in other communities in Tennessee	Reviewed analyze current oral hygiene standards in school children and determine the knowledge of oral health of the parents	Tennessee Department of Health, advocated for increasing access to CWF	Tennessee
Filling the Gap: Strategies for Improving Oral Health			
Non-Hispanic and African Americans are more likely to have dental caries	Increasing access to CWF would improve overall oral health in a cost-effective manor	Grantmakers in Health and Children's Dental Health Project	Washington, DC
Disparities in Children's Oral Health and Access to Dental Care			
There should be financial incentives implemented to	Lack of dentists seeing Medicaid patients and	Medicaid, provides access to Early Periodic Screening,	N/A

encourage dentists to see Medicaid patients	providing services in low income areas	Diagnostic, and Treatment	

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