Analysis of the Water Fluoridation Controversy

Honors Senior Thesis 2010/2011

Megan Presutti

Introduction

Ingestion of fluoride has been known to be beneficial to dental health. The first recorded observation of the fluorosis on teeth was made by Dr. McKay in 1901 when he saw an unusual coloration of his patients' teeth which he deemed the "Colorado brown stain". He noted that teeth where this discoloration was present were less prone to dental caries. Though McKay didn't know what was causing this mottled enamel, he hypothesized that it was a component found in the water supply (Morbidity and Mortality Weekly Report, 1999).

This element was later identified as fluoride in 1930, by a chemist named Churchill; after he performed a spectrographic analysis of a well that was abandoned after mottled enamel became prevalent in patients that drank its water. The results documented the presence of a high natural concentration of fluoride (Morbidity and Mortality Weekly Report, 1999).

Dental scientists expanded on these results and found that mild fluorosis does not result in the brown discoloration but still showed the same level of cavity prevention. They hypothesized that regulating fluoride levels in public water supplies would decrease the national occurrence of dental caries.

Most water supplies contain a natural level of fluoride; however, it is usually not enough to be beneficial to the resistance of dental caries. Water fluoridation programs were developed to maintain a healthy level of artificial fluoride in water supplies, to strengthen teeth's resistance against caries, and promote strong development of oral tissues. Fluoride is added to water supplies through water soluble, fluoride-containing

chemicals. Its addition is odorless and tasteless and doesn't compromise any normal characteristics of water (WHO, 2001).

Mechanistically, fluoride replaces the OH- in hydroxyapatite and forms fluorapatite. Fluorapatite is a weaker base so it is less likely to undergo demineralization by an acid which decreases the event of tooth decay. When fluoride is present in dental biofilm it helps remineralize degraded enamel on the tooth's surface making the tooth structure stronger and more acid resistant (U.S. Public Health Service). Upon consumption, fluoride is retained in dental plaque and saliva to help protect the teeth from dental caries and can reverse the development of already existing lesions (WHO, 2001).

The first city in the United States to fluoridate their community water supply was Grand Rapids, MI in 1945. This city was picked as part of a flagship field study of the effects of fluoridation. The results of this study showed a decrease in dental caries in school children 40-60 percent lower then the un-fluoridated control city (U.S. Public Health Service). From there on, fluoride has been proven through research to be crucial in bone and teeth development (Easley, 1990). Fluoridation of the water supply is thought to have the biggest impact on children during their tooth development; however, direct contact of fluoride with teeth has been found to prevent tooth decay throughout every stage of life.

Studies have shown that adults who consume fluoridated drinking water have less dental disease and lower need for restorative procedures when compared to those who have had no exposure to fluoridated drinking water (Grembowski, 1997). Fluoridation has also been linked to the elderly, for extending tooth life and maintaining their real

teeth in their oral cavity. Fluoridation does not just prevent coronal caries, it also prevents root caries. Many elderly adults experience gingival gum recession, which leads to the exposures of the roots of teeth. Consumption of fluoride through the water supply helps protect these root surfaces by being compromised by caries (U.S. Public Health Service).

Water fluoridation has been identified as one of the top ten greatest accomplishments of the 20th century. It has been praised by the government as not only being a cost-effective treatment, but a cost-saving one (CDC 2010). The average cost per person for water fluoridation is 31 cents per year, which is a nominal fee when compared to the rates for restoration procedures.

A major emphasis of complete national fluoridation was the effect it would have on the lower socio-economic classes who can't afford health care. Studies have proven that in areas with a fluoridated water supply, the inequalities in dental health between social classes are reduced (Jones, 2000). It has been stated that at a community level, water fluoridation is the best preventative method for dental caries (Thuy, 2003). The effects of water fluoridation can reach an entire community independent of their economic status unlike toothpaste containing fluoride which is dependent on frequency of use.

However since its entry into the water systems, water fluoridation has caused severe controversy. Opponents of fluoridation have claimed that it causes several diseases including osteoporosis, cancer, and Down syndrome. Others believe that it is an ethical issue. During the 1950's it was even thought to be part of a communist plot. Recent surfacing of government documents are causing speculation to whether fluoridation is

really safe. There has been an increasing amount of data and information that support these claims.

It may seem shocking that the first person to propose the fluoridation of U.S. water sources wasn't a dentist or a doctor. In fact, fluoridated water was proposed by Gerald J. Cox, a scientist funded by Alcoa. It would have been a devastating blow to the Alcoa if fluoride was deemed harmful, as they were one of the leading fluorine emitters during WWII and would have faced countless pollution lawsuits. Since then, the chemical components of fluoride have been found to not be biodegradable. Therefore, these components will gradually accumulate in our air, teeth, and bones with no where else to go (Griffiths, 1998).

The chemical that is used to fluoridate our water, sodium fluoride, is also packaged and sold as rat poisons and pesticides. Sodium fluoride is a chemical by-product from fertilizer production and can contain traces of arsenic, mercury, radioactive elements, etc. Therefore, it may be no surprise that fluoridation has been noted to have adverse affects.

On a farm in Pasoga Springs, a group of quarter horses developed the classical symptoms of chronic fluoride intoxication after being exposed, for an extensive period of time, to water fluoridation. The fluoride from the Pasoga area water supply was the only fluoride present in the horses' diets. Though clinical examinations of the horses never included their teeth, there were plenty of other shocking ailments observed. These conditions included deformed hooves, crooked legs, and decreased conception rates. After water fluoridation to the farm stopped, the horses' health significantly improved (Krook, 2006).

Lennart Krook further investigated the possibility of the water fluoridation being the cause of these conditions by obtaining bone samples of four deceased horses, three of which were from the Pasoga Springs farm and one control from another area. After running a bone analysis of the fluoride concentration, it was apparent that the horses from the farm had chronic fluoride intoxication from long exposure from the artificially fluoridated water supply (Krook, 2006).

There is also a hypothesis that extreme exposure to fluoridation could be posing a serious risk to contracting cancer. The American Cancer Society's website proposes that this theory might be true since "fluoride tends to collect in parts of bones where they are growing" which is the same areas where osteosarcomas characteristically are found (Water Fluoridation and Cancer Risk).

An incomplete report published in 2006 from Harvard School of Public Health stated an association between high levels of fluoride in drinking water and an increased risk in osteosarcoma in boys but not girls. The full report has yet to be released and the CDC released a statement claiming no solid association has been found but the complete Harvard study should "provide further information as to whether and to what extent an association may exist between osteosarcoma and exposure to fluoride" (Water Fluoridation and Cancer Risk).

Despite that statement from the CDC, supporters of this theory kept researching and requesting actions to be made. In 2007, professionals called for a halt on water fluoridation to be stopped in the US due to recent events making it clear fluoridation was bad including a peer-reviewed study showing an increase of osteosarcoma linked to fluoridation exposure (Professionals' Statement, 2007).

Besides medical issues, some opponents believe the main controversy is the ethical issues caused by water fluoridation. Morally it is viewed to be a form of massive medication, and the consent of all individuals to receive this 'medication' can never be achieved. The actual concentration of fluoride added to the water supply cannot be properly regulated for the needs of each consumer by how much water they drink.

This massive medication poses a concern for young children and diabetics or other populations that have an above average water intake to have a fluoridation overdose (Professionals' Statement, 2007). An increase in fluorosis has become noticeable in children who have consumed fluoridated water during the period when their enamel is developing which results in permanent marks and streaks on their adult teeth (Erdal, 2005). Mr. Connett, a Chemistry Professor at St. Lawrence University states, "The teeth are windows to what's happening in the bones." Therefore, fluorosis from over fluoridation might be the insight to the cause of the increase in stress factures found in children and brittle bones resulting in fractures in older adults (Griffiths, 1997) (Environmental Health Prospectives, 1997).

The fluoridation of the water supply is currently viewed as extremely unnecessary. One reason is because fluoride is available in so many other sources to consumers. Fluoride can be found in toothpaste, mouthwash, baby food, and fruit juices. Also, dentists say it isn't necessary for fluoride to be orally ingested to effectively fight tooth decay. Fluoride in toothpaste is important in decreasing tooth decay, but excessive exposure hasn't been proven to benefit the teeth more.

Many opponents for fluoridation believe that the cost to artificially add fluoride to the water supply doesn't give significant enough results. Statistics have shown that tooth

decay has decreased at a similar rate in countries that do and do not have water fluoridation. Specifically, research done of New Zealand children over 14 years reported that areas with no water fluoridation resulted in less dental decay then areas with fluoridation. The decay had a positive correlation between income and nutrition, but not the presence of fluoride in the water supply (Wilson, 2007). These results support their argument that the government is wasting money by fluoridating the water.

These issues and claims are nothing new to the possible conspiracy theory of water fluoridation. A paper published by *Earth Island Journal* in 1997 quoted shocking manuscripts of previously confidential government documents. The first national water fluoridation experiment was secretly studied by a committee secretly full of government officials for the Manhattan Project. Their presence in the studies could have produced biased results because if lower doses of fluoride were still found to be hazardous it would have impeded the production of the atomic bomb. These members could have omitted disturbing evidence from their studies to help skew the public's outlook on fluoride to be positive (Griffiths, 1997).

The research done by Griffiths and his staff into these secret government documents continued to unearth alarming information. A Manhattan Project note from 1944 insinuated that the noticeable effects that uranium hexafluoride has on the central nervous system seems to be caused by its fluoride component then its uranium. Transcripts show the head of the Medical Section for the Manhattan Project immediately approved further research on this shocking statement, but there was no data in the file from this study (Griffiths, 1997).

Dr. Mullenix believes that these studies were conducted by the Manhattan Project but the results of fluoride affecting the central nervous system were hidden due to the damaging nature they would have on the government. In the 1990's, Dr. Mullenix and her colleagues completed research that indicated even low doses of fluoride is a powerful toxin to the central nervous system and can affect normal brain functioning. She wanted to pursue this topic further since no other studies have been recorded in the United States. Her grant application to the US National Institutes of Health was denied and attached was a personal statement to her from the institute telling her "fluoride does not have central nervous system effects" (Griffiths, 1997).

In January 2011, news broke that the U.S. government is recommending fluoride levels in community water supplies be lowered to 0.7ppm. The previous recommended levels were 0.7-1.2ppm with an average of 1ppm. This reduction in fluoride levels is in response to the increase in fluorosis in patients, which varies from mild white spots to more severe brown pits (Holt, 2011). The US National Research Council has reported up to 80% of young adults in some cities have dental fluorosis (Griffiths, 1997). Opponents to water fluoridation believe decreasing fluoride levels to be the first step in the right direction, but in their eyes there is still a long way to go. These activists are hoping for eventual elimination of fluoride from water supplies altogether since we are one of the few major nations still fluoridating our water, the other being Britain (Wilson, 2007).

The purpose of this study is to eliminate all biases and get a proper survey of the general public. There are several uncontrollable variables that are left un-assessed in this survey such as brushing habits and race. Though many other factors are left out, the goal is to determine whether fluoridated water supplies really have a positive correlation to

less dental caries and extractions when compared to un-fluoridated water. The hypothesis for this study is that person's consuming fluoridated water on a daily basis will have less dental caries then those drinking from an un-fluoridated water supply.

Materials & Methods

Basic surveys for this thesis were developed and distributed to two offices in Ohio and South Carolina. These two demographics were determined because fluoride levels are supposed to vary in different climates. Ohio was chosen to be a colder climate which would contain more fluoride concentration. South Carolina is a warmer climate which should contain less fluoride concentration due to more water consumed by residents due to the hotter weather. When analyzing these two states by the percent of the population receiving fluoridated water, Ohio is ranked 11th and South Carolina is ranked 13th (NIDCR, 2002).

Patients were asked to volunteer and complete the surveys following their appointments. The survey asked for basic data about age and gender. The survey focused on questions assessing the estimated number of cavities throughout a lifetime, the number of teeth extracted from the oral cavity, and the primary source of water.

Patients that were unaware if their main water source was fluoridated or un-fluoridated were asked to indicate their city of residence. This information was then used with the CDC's website section "My Water's Fluoride" at www.cdc.gov/fluoridation to determine the information of the water system of that area.

Results

A total of 64 patients were surveyed at two offices in Ohio and South Carolina. Twenty-nine of these patients were surveyed in an office South Carolina and thirty-five

were distributed in the Ohio office. A majority of the patients surveying from the South Carolina office indicated their primary water source was in another state which expanded the demographics of this survey. These states included Massachusetts, Connecticut, New Jersey, New York, North Carolina, Maryland, Virginia, and Puerto Rico.

The survey was 70% female, 30% male, with 4 surveyors of unknown sex. The participants ranged from 13 to 70 years of age, with a mean age of the group of 42.76 years. Forty-seven of the patients participating in this survey indicated their water source was fluoridated and seventeen had an un-fluoridated water supply.

Participants that answered the question asking for an estimate of number of cavities throughout lifetime as “too many” were thrown out of the statistics. This was so the data was not skewed with an inaccurate assumption. There was one extreme outlier who estimated their number of cavities being “50+”. This number has a potential to skew the numbers also.

The fluoridated water supply group had a mean age of 42.9348 years of age. The average numbers of cavities were 6 (Chart 1). This value ranged from zero to fifty. Cavities from the fluoridated water supply group had a standard deviation of 5.33. The participants with fluoridated water supply had a mean value of 0.7111 extractions, with numbers ranging from zero to five (Chart 3), and a standard deviation of 1.39.

Participants with non-fluoridated water had an average age of 42.33 years. Number of cavities from this group ranged from zero to fifteen, with a mean value of 5.058 cavities (Chart 4). The number of cavities in patients from an un-fluoridated water supply had a standard deviation of 5.27. Extractions of patients from a non-fluoridated

water supply varied from zero to three, an average of 0.667 extractions (Chart 5), and a standard deviation value of 0.97.

The data showed that participants from an un-fluoridated water supply had a lower average of cavities and extractions when compared to those of a fluoridated water supply (Chart 6 & 7). However, with the outlier of "50+ cavities" taken out from the fluoridated water supply data the average number of cavities drops down to 5 (Chart 2).

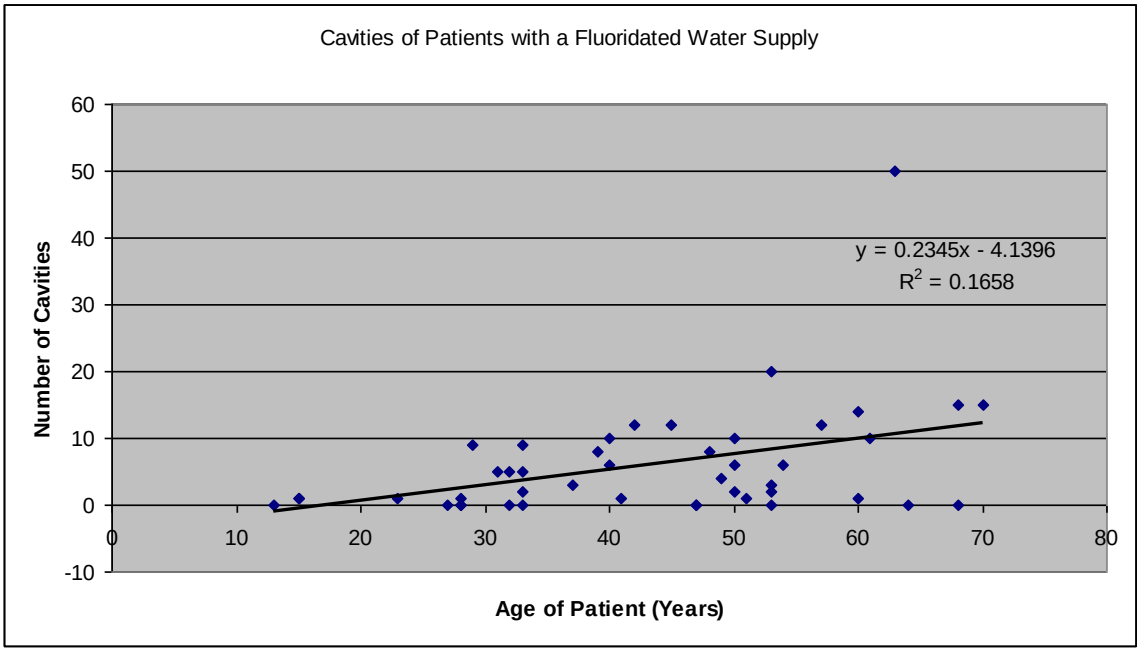

Chart One: Scatter-plot of cavities of fluoridated water supply patients according to their age. (Graph contains the outlier of 50 cavities).

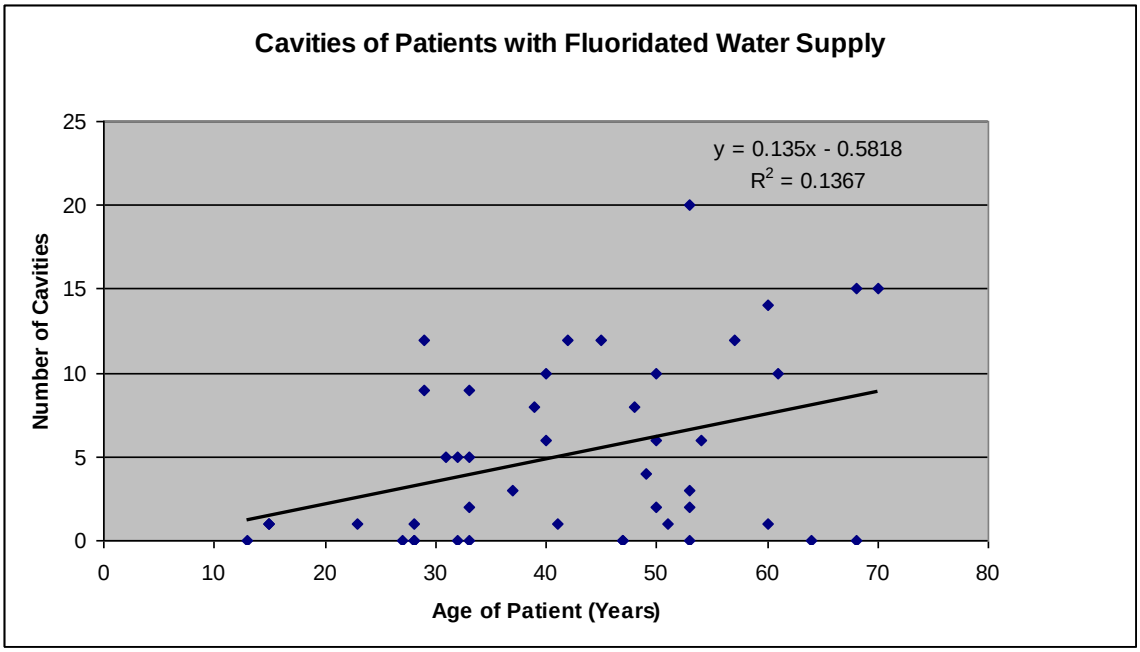

Chart Two: Scatter-plot of the number of cavities of fluoridated water supply patients according to their age, not containing the outlier.

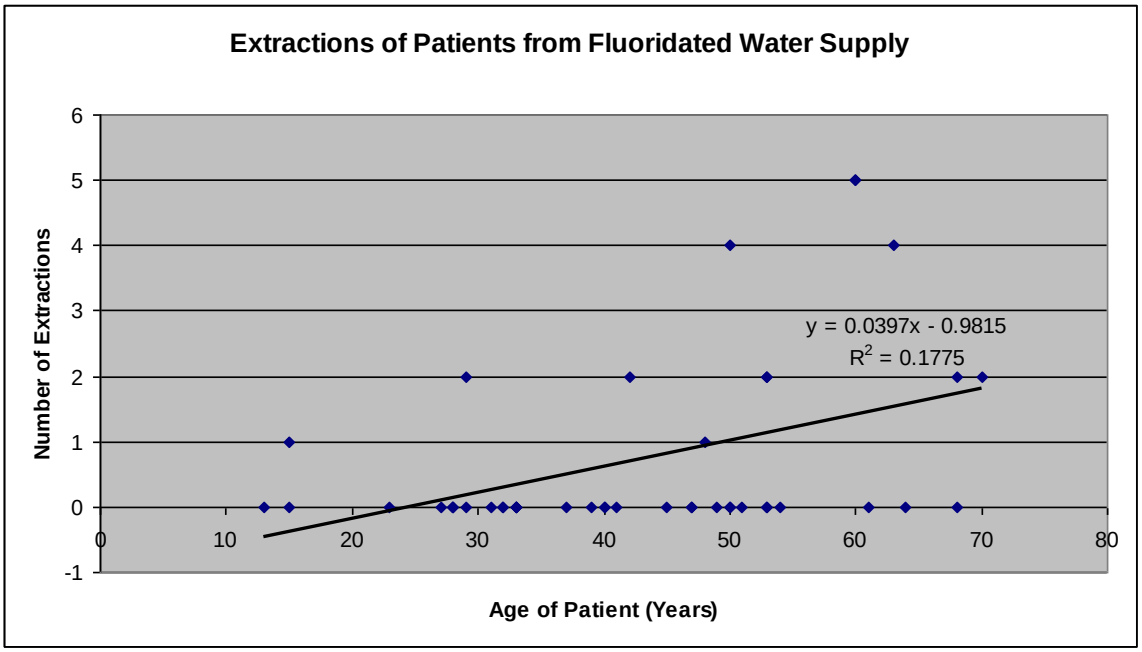

Chart Three: Relationship of age of patient from fluoridated water supply to number of extractions.

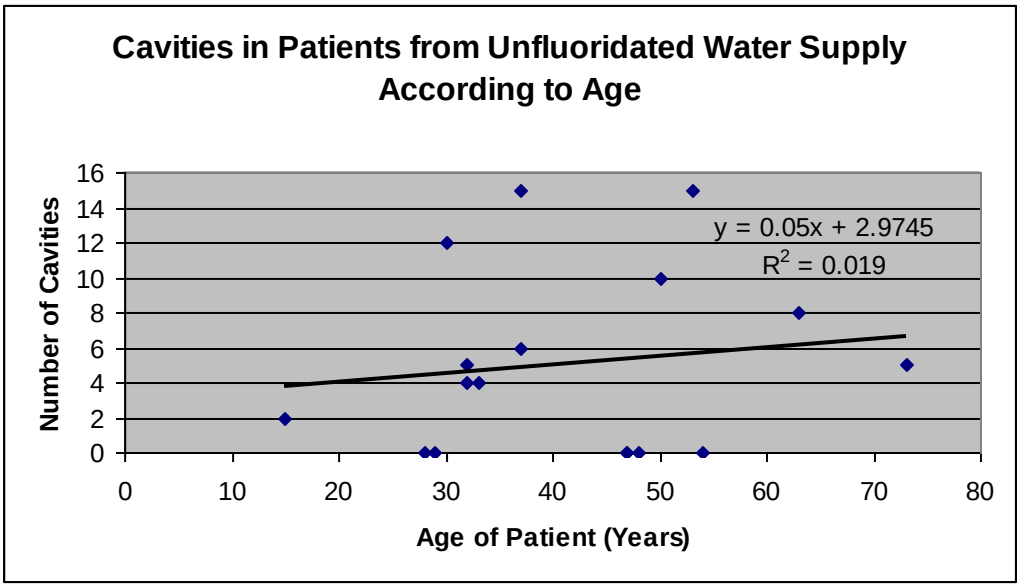

Chart Four: Number of cavities in patients from a water supply not being artificially fluoridated separated by age.

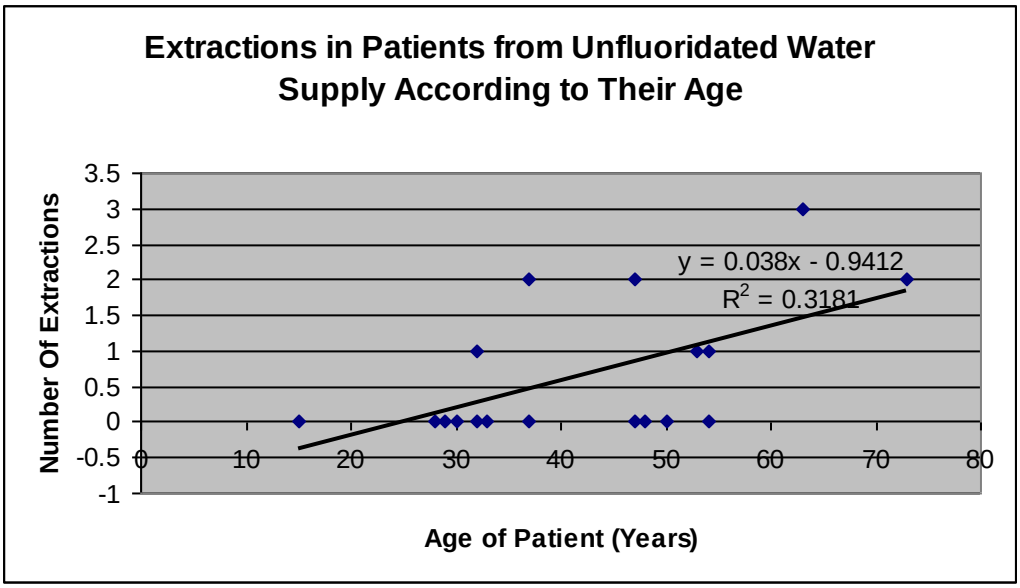

Chart Five: Number of extractions in patients from a water supply not being artificially fluoridated separated by age.

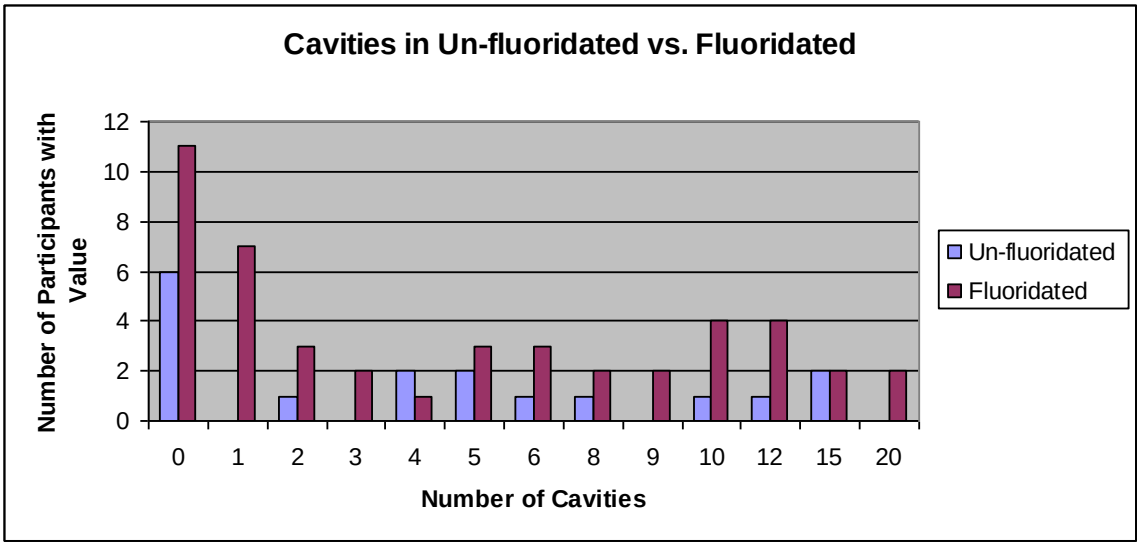

Chart Six: Comparison in the number of cavities of un-fluoridated vs. fluoridated participants

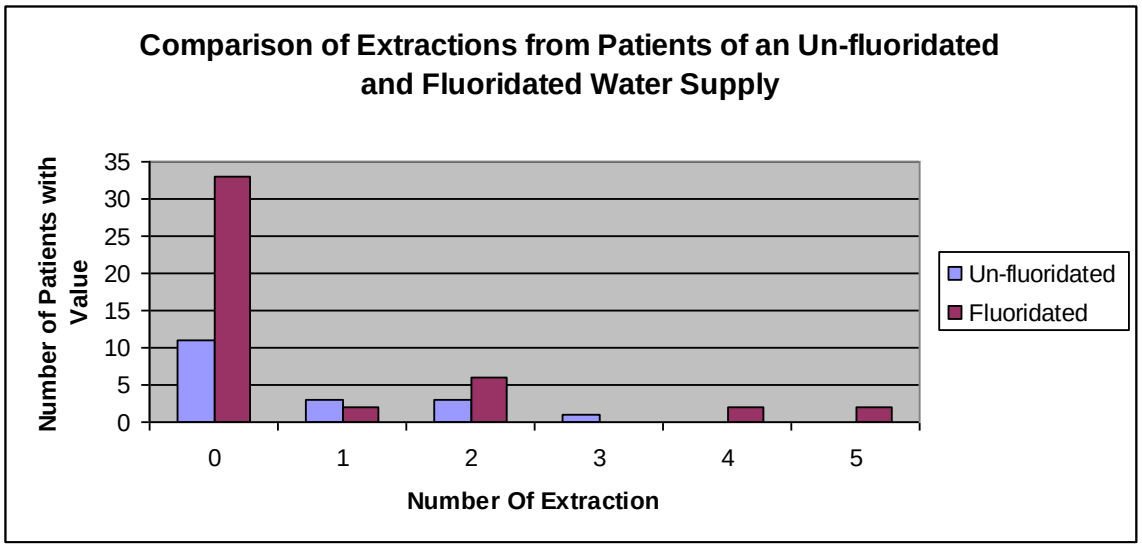

Chart Seven: Comparison in the number of extractions of un-fluoridated vs. fluoridated participants

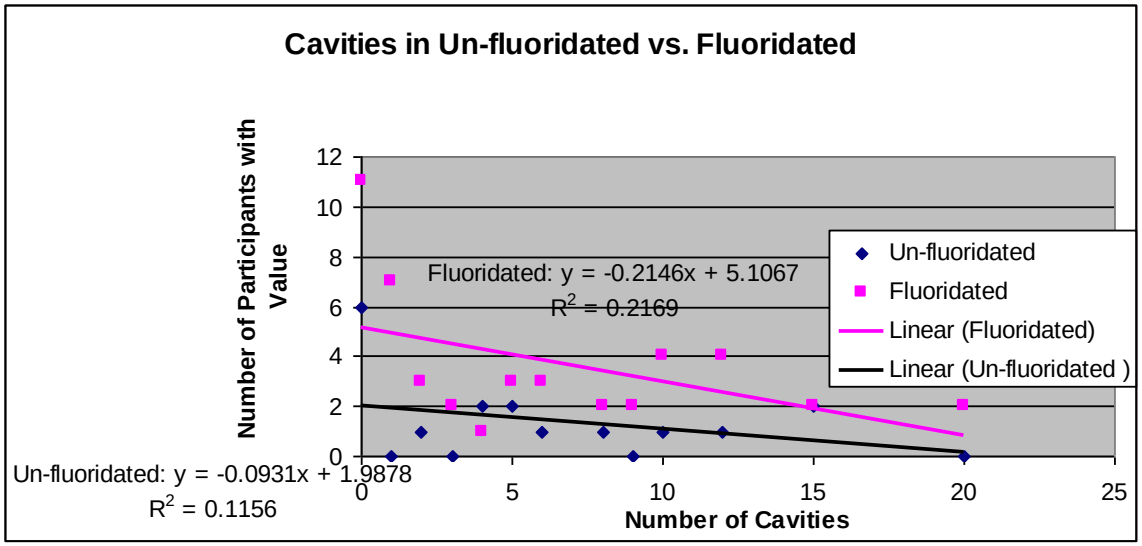

Chart Eight: Comparison in the number of cavities between patients with un-fluoridated and those of fluoridated water supplies.

Discussion

I hypothesized at the beginning of this thesis that there would be a strong association between a fluoridated water supply and a lower number of cavities. However, the results of this experiment indicate no clear link to favor or oppose fluoridation of the water supply. The calculated values for the relationship between lower cavities/water fluoridation and higher cavities/un-fluoridated water were not significant enough to make a clear determination.

The data of patients from a fluoridated water supply showed a higher average for cavities and extractions when compared to patients from un-fluoridated water. The averages for both sets of data were extremely close for both cavities and extractions. Participants with a fluoridated water supply did have a lower average number of cavities, once the "50+ cavities" outlier was removed, when compared to participants from an un-fluoridated water source.

There are many improvements that could be made to this thesis if given ample time and resources. This was a basic survey of an unknown population. It was hard to analyze more aspects of the patients' life without obtaining their identity and medical history. In order to obtain more useful data, deeper aspects of the patients' oral history need to be known such as brushing and flossing habits and presence of periodontal disease. Elements that may interfere with the results of this experiment include the use toothpaste containing fluoride because some patients may use it while others may not.

Also, patients that indicated their water source was un-fluoridated may have a high level of fluoridation naturally occurring in the water supply. This is one important aspect that should have been taken into consideration because although they do not have

artificial fluoride being added to the water, they could still be receiving the optimal level of natural fluoride in their water source which may skew the results.

The data that was obtained through this survey proved that there was no association linking lower cavities to water fluoridation. These results support the opponents of water fluoridation's argument: that it may have come to a time where adding fluoride to water supplies is extremely unnecessary because it is available in so many other sources.

Though this experiment didn't come to any solid conclusions to the effects of water fluoridation on oral health, there are bigger issues to address. The government has been adding fluoride chemicals to the public water supply for sixty-six years and counting, without full consent of the people. There is a percentage of the population that is completely unaware that water fluoridation even occurs.

Should the government discontinue the artificial fluoridation of water supply if this mass medication if is deemed unnecessary to further reducing dental caries? Other countries beside the United States have deemed that mass fluoridation of public water supplies is not the government's responsibility. Around 97% of the communities in Western European including Italy and Germany no longer have fluoridated water supplies. These people consider fluoride use as a choice and that it is unconstitutional for the government to force mass medication on the entire population (Berkey Clean Water).

Another issue to take into account is whether or not fluoridation is still economically efficient. In context the relative cost of fluoridating a public water supply is only mere cents, but that minute amount of money that it costs accumulates to large sums year after year. A study completed by Texas legislature estimated $1,998,649 as the cost

of starting up a water fluoridation system in a town the size of San Antonio. This study also estimated that it costs $182,832 per year to maintain this size of a system (Brown, 2000).

With our nation continually plummeting further into debt and not even being able to pay the daily interest on that debt, it seems that there could be more useful causes for the government to devote this money to. Supporters of this statement also present the argument that much of the fluoride put in water is wasted in other ways other then consumption such as washing dishes or watering the lawn (Berkey Clean Water). Viewing water fluoridation in this light makes it seem very uneconomical.

If research continues to show a community with fluoridated water has the same or more occurrences of dental caries then a community without fluoride in their water, it seems like a complete waste of money to continue water fluoridation. In the United States fluoridating a water supply is decided on a state or municipal level not federal so if changes are to be made to the public water systems it will need to start locally.

Works Cited

American Cancer Society. Water Fluoridation and Cancer Risk. Retrieved from http://www.cancer.org/Cancer/CancerCauses/OtherCarcinogens/AtHome/water-fluoridation-and-cancer-risk

Berkey Clean Water. Fluoride Added to Drinking Water is Scary Business. Retrieved from http://www.berkeycleanwater.com/articles/Fluoride-Added-To-Drinking-Water-Is-Dangerous-Business

Brown, J and McMahon, D (2000). Water Fluoridation Costs in Texas: Texas Health Steps (EPSDT-Medicaid). Retrieved from http://www.dshs.state.tx.us/dental/pdf/flstudy.pdf

Easley, Michael (1990). The Status of Community Water Fluoridation in the United States. *Public Health Reports (1974-),* 105 (348-353). Retrieved from http://www.jstor.org/stable/4628891

Erdal, S., Buchanan, S. (2005). A Quantitative Look at Fluorosis, Fluoride Exposure, and Intake in Children Using a Health Risk Assessment Approach. *Environmental Health Perspectives,* 113 (111-117). Retrieved from http://www.jstor.org/stable/3435756

Grembowski, D., Fiset, L., et. al (1997). Does Fluoridation Reduce the Use of Dental Services Among Adults? *Medical Care,* 35(5) (454-471). Retrieved from

Griffiths, J., Bryson, C. (1997). Fluoride, teeth and the A-bomb. (Cover story). *Earth Island Journal, 13*(1), 38. Retrieved from Academic Search Premier database.

Holt, Kelly (2011). Government to Lower Fluoride Levels, But Questions Remain. *The New American.* Retrieved from http://www.thenewamerican.com/index.php/us

news/health-care/5810-government-to-lower-fluoride-levels-but-should-it-fluoridate-at-all

Jones, C.M., Worthington, H. (2000). Water fluoridation, poverty and tooth decay in 12-year-old children. *Journal of Dentistry,* 28 (389-393). Retrieved from

Krook, L., Justus, C. (2006). Fluoride poisoning of horses from artificially fluoridated drinking water. *Research report fluoride,* 39 (3-10). Retrieved from

NIDCR: National Institute of Dental and Craniofacial Research (2002). Community Water Fluoridation Status by State. Retrieved from http://www.nidcr.nih.gov/DataStatistics/FindDataByTopic/WaterFluoridation/CommunityWaterFluoridationState.htm

The Professionals' Statement Calling for an End to Water Fluoridation (2007). Retrieved from http://www.fluoridealert.org

Thuy, T., Nakagaki, H, et. al (2003). Fluoride profiles in premolars after different durations of water fluoridation in Ho Chi Minh City, Vietnam. *Archives of Oral Biology,* 48 (369-376). Retrieved from www.elsevier.com/locate/archoralbio

U.S. Public Health Service. Community and Other Approaches to Promote Oral Health and Prevent Oral Disease. *Oral Health in America: A Report of the Surgeon General*. Retrieved from http://www2.nidcr.nih.gov/sgr/sgrohweb/chap7.htm#fluoride

Wilson, Lawrence (2007). Water Fluoridation. Retrieved from http://www.mosesnutrition.com/uploads/WATER_FLUORIDATION.pdf

World Health Organization (2001). World Water Day 2001: Oral health. Retrieved from http://www.who.int/water_sanitation_health/oralhealth/en/index2.html