# Life Course Indicator: Fluoridation

## The Life Course Metrics Project

As MCH programs begin to develop new programming guided by a life course framework, measures are needed to determine the success of their approaches. In response to the need for standardized metrics for the life course approach, AMCHP launched a project designed to identify and promote a set of indicators that can be used to measure progress using the life course approach to improve maternal and child health. This project was funded with support from the W.K. Kellogg Foundation.

Using an RFA process, AMCHP selected seven state teams, Florida, Iowa, Louisiana, Massachusetts, Michigan, Nebraska and North Carolina, to propose, screen, select and develop potential life course indicators across four domains: Capacity, Outcomes, Services, and Risk. The first round of indicators, proposed both by the teams and members of the public included 413 indicators for consideration. The teams distilled the 413 proposed indicators down to 104 indicators that were written up according to three data and five life course criteria for final selection.

In June of 2013, state teams selected 59 indicators for the final set. The indicators were put out for public comment in July 2013, and the final set was released in the Fall of 2013.

## Basic Indicator Information

Name of indicator: Fluoridation (LC-05)

Brief description: Proportion of population served by community water systems that received optimally fluoridated water, defined as a fluoride concentration of 0.7-1.2 ppm, depending on the average maximum daily air temperature in the area.

Indicator category: Community Health Policy

Indicator domain: Service/Capacity

Numerator: Population on community water systems that received optimally fluoridated drinking water in a calendar year.

Denominator: Population on community water systems in a calendar year

Potential modifiers: Respective community water supply regulators

Data source: Water Fluoridation Reporting System (WFRS)

Notes on calculation: WFRS is an authenticated (password-protected) application requiring approved users to enter a passcode to access the application. Employees of state oral health and drinking water programs can be granted permission to use the WFRS database. For those who do not have access to WFRS, some states share fluoridation data from WFRS and the fluoridation status of their state via other Centers for Disease Control and Prevention (CDC) data applications that have a public access component. There are three additional sources of state-level data, including CDC's My Water's Fluoride data system, Oral Health Maps and reports from the National Oral Health Surveillance System. More information can be found under the Data Availability section.

Similar measures in other indicator sets: HP 2020 focus area OH-13; Chronic Disease Indicator; National Oral Health Surveillance System Indicator

# Life Course Criteria

### Introduction
The CDC has recognized water fluoridation as one of ten great public health achievements of the 20th century (CDC 1999). Optimally fluoridating a community's water supply has been shown to effectively reduce dental caries, a common oral disease that disproportionately affects racial minorities and low-income groups. The importance of water fluoridation as an intervention to prevent oral health conditions lies in both its proven and historical effectiveness and its ability to reach all individuals in a population, including the most vulnerable populations. Through these avenues, increasing the proportion of the population served by an optimally fluoridated water supply has the ability to improve health disparities, public health, and individual health throughout the life course.

### Implications for equity
Dental caries is the most common chronic disease for children, affecting 25 percent of children ages 6-11 years and 59 percent of children ages 12-19 years (CDC 2013). Children from lower income families and racial and ethnic minority groups are disproportionately affected by oral disease. Hispanic and non-Hispanic black children have a significantly higher prevalence of untreated dental caries than non-Hispanic white children. Children ages 3-5 years and 6-9 years living below 100 percent of the federal poverty level have higher rates of untreated dental caries than children of the same age group living above 100 percent of the federal poverty level (Dye 2012). Disparities persist into adulthood, where tooth retention varies by race, ethnicity, and poverty level (Dye 2012). Effective prevention measures, such as community water fluoridation and dental sealant programs, exist to avoid these dental problems. However, dental sealant interventions may not be reaching the most vulnerable populations, as prevalence of dental sealants also varies by poverty status and race (Dye 2012). Community water fluoridation helps to decrease dental disease disparities by providing prevention benefits to all residents of a community regardless of race, sex, age or socio-economic status. Riley et al. (1999) found in an ecologic study done in England that water fluoridation reduced dental caries more in materially deprived areas than in affluent areas and concluded that the introduction of water fluoridation could substantially reduce inequalities in dental health. In 2010, 73 percent of the United States had access to an optimally fluoridated water supply. Access to fluoridated water has a wide, varied range across the United States and is dependent on state and community residence (CDC 2012).

### Public health impact
Frieden (2010) describes the impact of different public health interventions using a five-tiered pyramid. Water fluoridation comes under the second tier, which includes interventions that change the environmental context to make individuals' default decisions healthy. An important characteristic of this group is that individuals would have to go to significant effort not to benefit from the intervention. In the case of water fluoridation, there is a reduction in tooth decay, which improves individuals' health and which is difficult to avoid because it is part of the public drinking water supply. It also provides economic benefits by reducing health care spending and productivity losses. It has been estimated that about every $1 invested in community water fluoridation saves approximately $38 in averted costs (CDC 2013). Savings are generated through avoidance of dental expenditures such as complex and expensive restorative and emergency dental treatment.

Water fluoridation is of the ten top achievements in public health according to the CDC (1999). CDC (1999) reports that studies in the mid-eighties showed mean DMFS (decayed, missing, and filled surfaces of permanent teeth) scores of children in fluoridated communities were 18 percent less than those in non-fluoridated communities, and in adolescents, there was a mean reduction of 26 percent. Armfield (2010) compared the caries prevalence in two areas of Australia, one with negligible fluoride and one with optimal fluoride. After controlling for child age, place of residence and socioeconomic status, he found that permanent caries experience was 28.7 percent higher in deciduous teeth and 31.6 percent higher in permanent teeth in non-fluoridated communities compared with fluoridated communities. Due to the diffusion of fluoridated water through bottling and processing of food and beverages using optimally fluoridated water, there has been a decline of caries prevalence even in non-fluoridated communities. Given these findings, an increase in the proportion of community water systems that receive optimally fluoridated drinking water could not only result in a decrease in tooth decay and improved oral health, but also offer significant cost savings in health expenditures to the community.

### Leverage or realign resources

Maupone and colleagues (2007) compared dental treatment expenses and costs of patients belonging to an HMO in areas with and without water fluoridation. They found that community water fluoridation was associated with lower restorative costs in patients less than 18 years old and in those greater than 58 years of age. Water fluoridation is a cost effective intervention, as the cost of community water fluoridation is less than restorative dental care. Griffin and colleagues looked at the annual cost per person of community water fluoridation and compared to the cost of averted dental disease and loss of productivity and found significant cost savings. In light of high health care costs, such findings could make water fluoridation more attractive to public and private payers of dental health care costs, and offers a simple public health message for advocacy by payers and health professionals.

The American Dental Association (ADA) has supported fluoridation of community water supplies for the purpose of preventing tooth decay since 1950. In combination with the Association of State and Territorial Dental Directors (ASTDD) and the CDC, the ADA recognizes communities, states, and organizations that have worked to implement or maintain water fluoridation with merit awards. The ADA website, ADA.org, contains information on recent fluoridation issues, evidence-based fluoridation recommendations, and a list of other water fluoridation internet resources.

Implementing water supply fluoridation programs may require decisions on multiple state or local levels (Office of Surgeon General 2000). City councils and state and local governments typically need to be engaged when attempting to implement water supply fluoridation. Information regarding current federal and state policies regarding fluoridation can be accessed using the Fluoride Legislative User Information Database (FLUID). The database contains information on all 50 states, District of Columbia, Puerto Rico, and the U.S. Virgin Islands (FLUID 2013) and is accessible at fluidlaw.org

### *Predict an individual's health and wellness and/or that of their offspring*
Although water fluoridation is a community-level intervention, it has implications for individual health. Individuals without access to fluoridated water are more likely to have dental caries, loss of productivity, and costs associated with dental disease. The prevention of dental caries is linked to improved general health, as the pain and infections caused by untreated tooth decay can eventually lead to problems with eating, nutrition, sleeping, social interactions, speaking and learning. Poor oral health may have implications for other health outcomes including cardiovascular disease and preterm birth, which also impact individual health throughout the life course (Dasanayake et al., 2008; Montebugnoli et al., 2004; and Pitiphat et al., 2008). Increasing the proportion of the population drinking from a fluoridated water supply should decrease the number of individuals experiencing dental caries and the related oral and general health issues.

## Data Criteria

### *Data availability*
The Water Fluoridation Reporting System (WFRS) (https://nccd.cdc.gov/DOH_WFRS/default/Login.aspx) is an online tool that helps states manage the quality of their water fluoridation programs. The WFRS was developed by CDC in partnership with the Association of State and Territorial Dental Directors (ASTDD). The most current data available is from 2010. The tool is only accessible by state water fluoridation program officials. WFRS information is the basis for national surveillance reports that describe the percentage of the U.S. population on community water systems that receive optimally fluoridated drinking water. Optimally fluoridated water is defined as a fluoride concentration of 0.7-1.2 ppm, depending on the average maximum daily air temperature in the area. The WFRS website provides the total population served by public water systems, the total population served by fluoridated water systems and the proportion of the population of people on public water systems that receive fluoridated water.

WFRS is an authenticated (password-protected) application requiring approved users to enter a passcode to access the application. Employees of state oral health and drinking water programs can be granted permission to use the WFRS database. For those who do not have access to WFRS, some states share fluoridation data from WFRS and the fluoridation status of their state via other CDC data applications that have a public access component. Although the WFRS database contains information for all states and the District of Columbia, only 36 states have allowed access to their water fluoridation information on the public website.

The CDC's My Water's Fluoride data system allows public access to participating states' basic community water system information, including the number of people served by the system and the fluoride level. My Water's Fluoride data system is accessible here: http://apps.nccd.cdc.gov/MWF/Index.asp.

Water fluoridation information from WFRS is also displayed in Oral Health Maps, a Web-based Geographic Information System interactive-mapping application that shows the percentage of people receiving fluoridated water at the state and county levels. Oral Health Maps can be accessed here: http://apps.nccd.cdc.gov/gisdoh/default.aspx.

CDC also prepares periodic reports of populations served by fluoridated water systems by state and for the United States. These reports are published in the National Oral Health Surveillance System (NOHSS) and provide the percentage of people served by public water systems who received fluoridated water on the national level and state level. Data is available for all states, and the most recent report contains data from 2006. These reports can be accessed here: http://www.cdc.gov/nohss/FSMain.htm

WFRS data was obtained by questionnaires sent to the directors of dental programs in all 50 states, the District of Columbia and to U.S. associated jurisdictions including American Samoa, Guam, the Commonwealth of Northern Mariana Islands, the Commonwealth of Puerto Rico, the Federated States of Micronesia (2002 only), the Republic of Palau and the U.S. Virgin Islands.

### Data quality
The water fluoridation reporting system (WFRS), started in 2000, is built on an existing database maintained by the Drinking Water Program of the Environmental Protection Agency. States update their own information directly and regularly (some as frequently as daily and as seldom as yearly). The Division of Oral Health (DOH) of the CDC completes ongoing and annual assessments to enhance the quality of data in the system.

The methodology behind the calculation of the percentage of a state's population that receives public water supplies and also receives fluoride is discussed in a CDC publication which can be accessed at http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5727a1.htm. In March 2007, CDC asked state dental directors and drinking water administrators to validate their state data reported via WFRS for 2006. Estimates of the population served by community water systems were based on the number of households served and the number of persons in each household. Some states supplemented population data in WFRS with population data from the EPA Safe Drinking Water Information System (SDWIS), which can differ slightly from WFRS.

The percentage of the population served by community water systems who received optimally fluoridated water was calculated by dividing the population served by community water systems with optimal fluoride levels by the total population served by community water systems. For eight states and DC, the reported 2006 total community water system population estimates exceeded mid-year intercensal state population estimates due to the application of a standard persons-per-household factor to the number of households served. For these eight states and DC, state community water system population estimates were set equal to the intercensal state population estimates, and estimates of the population receiving optimally fluoridated water were reduced by a factor equal to the state's intercensal population estimate divided by the initially reported total state community water system population. National community water system population estimates were calculated by adding the state community water system population estimates after this reduction.

### Simplicity of indicator
The proportion of the population served by community water systems that received optimally fluoridated water is simple to calculate using the CDC WFRS data. The estimates for each state's population on community water systems and population on optimally fluoridated community water system drinking water are available on the CDC WFRS website. The indicator is simple to explain.

## References

Armfield JM. Community effectiveness of public water fluoridation in reducing children's dental disease. *Public Health Reports* 2010; 125:655-664.

Barker L., Malvitz D. Development and status of the national oral health surveillance system. *Prev Chronic Dis* 2009;6(2):A66. Available from: http://www.ncbi.nlm.nih. gov/pmc/articles/PMC2687872.

Centers for Disease Control and Prevention. Achievements in public health, 1900-1999:fluoridation of drinking water to prevent dental caries. MMWR *Morb Mortal Wkly Rep*. 1999;48(41):933-940.

Centers for Disease Control and Prevention. Populations receiving optimally fluoridated public drinking water-United States, 1992-2006. MMWR *Morb Mortal Wkly Rep.* 2008;57(27):737-741. Available from: http://www.cdc.gov/mmwr/preview/ mmwrhtml/mm5727a1.htm.

Centers for Disease Control and Prevention. Community Water Fluoridation 2010 Statistics. May 11, 2012. Available from: http://www.cdc.gov/fluoridation/statistics/2010stats.htm. Accessed October 3, 2013.

Centers for Disease Control and Prevention. Community water fluoridation. Division of Oral Health, National Center for Chronic Disease Prevention and Health Promotion. July 10, 2013. Available from: http://www.cdc.gov/fluoridation/factsheets/fl_caries.htm

Dasanayake A.P., Gennaro S., Hendricks-Muñoz K.D., Chhun N. (2008). Maternal periodontal disease, pregnancy, and neonatal outcomes. *MCN Am J Matern Child Nurs*;33(1):45-9.

Dye BA, Li X, Thornton-Evans G. Oral health disparities as determined by selected HealthyPeople 2020 oral health objectives for the United States, 2009–2010. NCHS data brief, no 104. Hyattsville, MD: National Center for Health Statistics. 2012

Frieden TR. A framework for public health action: the health impact pyramid. *American Journal of Public Health* 2010; 100(4):590-595.

Fluoride Legislative User Informaion Database (FLUID), 2013. http://fluidlaw.org. Accessed October 3, 2013.

Griffin SO, Jones K, Tomar SL. An economic evaluation of community water fluoridation. *J Publ Health Dent* 2001;61(2):78–86.

Maupone G, Gullion C, et al. A Comparison of Dental Treatment Utilization and Costs by HMO Members Living in Fluoridated and Nonfluoridated Areas. *Journal of Public Health Dentistry* 2007; 67(4):224-233.

Montebugnoli L., Servidio D., Miaton R.A. (2004). Poor oral health is associated with coronary heart disease and elevated systemic inflammatory and haemostatic factors. *J Clin Periodontol.* 31(1):25-9.

Office of Management and Budget (OMB). (2006, September). Standards and Guidelines for Statistical Surveys. Washington, DC: White House, Office of Management and Budget. Available from: http://www.whitehouse.gov/sites/default/files/omb/assets/omb/ inforeg/statpolicy/standards_stat_surveys.pdf.

Office of the Surgeon General (OSG), (2000) U.S. Department of Health and Human Services. Executive Summary *Oral Health in America: A Report of the Surgeon General*. Washington, DC: 2000. Retrieved March 29, 2013 from http://www2.nidcr.nih.gov/sgr/sgrohweb/execsum.htm

Ottolenghi L, Muller-Bolla M, et al. Oral health indicators for children and adolescents. European perspectives. *European Journal of Paediatric Dentistry* 2007;4:205-210. Available from: http://www.egohid.eu/Documents/Publication%20EJPD%202007.pdf.

Peres MA, Peres KG, et al. The association between socioeconomic development at the town level and the distribution of dental caries in Brazilian children. *Pan Am J Public Health* 2003; 14(3):149-157.

Peres MA, Peres KG, et al. The relation between family socioeconomic trajectories from childhood to adolescence and dental caries and associated oral behaviors. *J Epidemiol Community Health* 2007;61:141-145.

Pitiphat W., Joshipura K.J., Gillman M.W., et al. (2008). Maternal periodontitis and adverse pregnancy outcomes. *Community Dent Oral Epidemiol*;36(1):3-11.

Riley JC, Lennon MA, Ellwood, RP. The effect of water fluoridation and social inequalities on dental caries in 5-year-old children. *International Journal of Epidemiology* 1999; 28:300-305. Accessed at http://ije.oxfordjournals.org/content/28/2/300.full.pdf

U.S. Census Bureau (USCB). (2012, June). Statistical Quality Standards. Washington, DC: U.S. Census Bureau. Available from: http://www.census.gov/quality/standards/ Quality_Standards.pdf.

Zhou Y, Lin HC, Lo ECM, Wong MCM. Risk indicators for early childhood caries in 2-year-old children in southern China. *Australian Dental Journal* 2011; 56:33-39.