Drinking Fountains and Public Health
Improving National Water Infrastructure to Rebuild Trust and Ensure Access

Rapichan Phurisamban and Peter Gleick

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Rapichan Phurisamban

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ABOUT THE AUTHORS

RAPICHAN PHURISAMBAN

Rapichan Phurisamban is a research associate with the Pacific Institute's Water Program. Her primary work centers on the economic analysis of California's water supply, storage initiatives, and efficiency measures. She brings experience in climate change adaptation in water resources management and international development to her work. Prior to joining the Pacific Institute, she worked to promote sustainable food and agricultural systems at a Thai nonprofit organization. Ms. Phurisamban holds a B.A. in Economics from the University of British Columbia and an M.P.P. from the University of California, Berkeley, where she focused on the water-energy-climate nexus and sustainable development.

PETER GLEICK

Dr. Peter Gleick is a world-renowned expert, innovator, and communicator on water and climate issues. In 1987 he cofounded the Pacific Institute, which he led as president until mid-2016, when he became president emeritus and chief scientist. He developed the first analysis of climate change impacts on water resources, the earliest comprehensive work on water and conflict, and defined the basic human need and right to water – work that has been used by the United Nations and in human rights court cases. Dr. Gleick has pioneered and advanced the concepts of the "soft path for water" and "peak water." A recipient of the prestigious MacArthur "Genius" Fellowship, Dr. Gleick was elected to the U.S. National Academy of Sciences and currently serves on the boards of numerous scientific journals and organizations. He is also the author or coauthor of many scientific papers and 11 books. Dr. Gleick holds a B.S. from Yale University, and an M.S. and Ph.D. from the University of California, Berkeley.

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INTRODUCTION

D RINKING WATER FOUNTAINS provide free public access to what is typically high-quality and safe municipal water. They serve as an alternative to bottled water or sugary drinks and accommodate a wide array of users, including children, commuters, runners, the homeless, and tourists, as well as pets.[1] While anecdotal evidence about the cleanliness and safety of specific fountains (Patel et al. 2014; Pierre-Louis 2015) and a few limited, well-publicized investigations (NSF International 2005; ABC News 2007) have resulted in some public concerns, no systematic examination of health risks in the United States exists to date. Are these concerns well founded? Are drinking fountains truly a cause of illness? Can health-related risks be mitigated?

This paper summarizes epidemiology reports and other evidence of drinking fountain-related health issues to reveal the extent of the problem and explore changes needed to improve the quality and use of this hydration option. We conclude that drinking fountains are essential for

Source: Rossario

maintaining public access to water, and additional effort is needed to expand the science and practice of ensuring that they remain clean, safe, and accessible.

A BRIEF HISTORY OF WATER FOUNTAINS

Some of the earliest records of public water fountains come from ancient Greek cities, where fountains were both a common sight and a public necessity. A second century Greek writer, Pausanias, wrote that a place is never rightfully called a "city" without water fountains.

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1 Drinking water fountains are called different things in different places, including water fountains, drinking fountains, and bubblers. For the sake of consistency, we call them "drinking fountains" or "water fountains."

Source: Peter Gleick

Spring-fed public water fountains were typically placed in or near temples and were dedicated to gods, goddesses, nymphs, and heroes (Library of Universal Knowledge 1880).

As populations grew and cities expanded, demand for public water systems and new water treatment and delivery technologies led to increased use of public water fountains. In mid-19th century England, for example, efforts to improve access to drinking water for all residents led to the establishment of the Metropolitan Free Drinking Fountain Association. The association's mission was to build public fountains throughout London, using filters and other means to ensure a higher quality of water than was available to most households. By 1872, the city had 300 drinking fountains, and the number increased to nearly 800 just seven years later, serving hundreds of thousands of people (Gleick 2010).

Some of the first water fountain designs included chained metal drinking cups, which ultimately proved to be unsanitary and capable of spreading diseases. Early scientific efforts to look at disease risks identified a wide range of potentially dangerous bacteria that spread from these cups (McCampbell 1907). Fountain technology and design later evolved to reduce exposure to infectious diseases through slanted jets with mouth guards, improved filtering systems, the elimination of shared cups, the use of residual water treatment such as chlorination, and more systematic fountain maintenance (Dunlap, Hinman Jr., and Maffitt 1920).

As modern municipal water systems developed in the United States and other countries, public water fountains became a fixture of the urban landscape. In the past few decades, however, they have been disappearing from public spaces for a number of reasons, including the advent of commercial bottled water, decreased public investment in urban infrastructure, concern over the health risks of fountains, and a *laisse-faire* attitude toward public water systems (Gleick 2010; Stoner 2012).

EVIDENCE OF CONTAMINATION AT WATER FOUNTAINS

A small number of studies have examined the safety of U.S. water fountains, offering only limited evidence of fountain-related health issues over the past 25 years. In such cases, contamination was traced to microorganisms (viruses and bacteria) and heavy metals (e.g., lead and copper). Box 1 contains additional details on common water-related contaminants. We provide a summary of our review of these studies below.

MICROBIAL CONTAMINATION

Moist surfaces, including drinking fountains, are common sources of microbial contamination. Butz et al. (1993) indicated that these surfaces are likely to be contaminated with rotavirus, a leading cause of gastroenteritis. Although they found a correlation

Box 1.

Overview of Some Water-Related Contaminants

Norovirus[1] – a group of viruses that causes inflammation of the stomach and large intestine lining. It is the leading cause of epidemic gastroenteritis in the United States and can affect a person of any age. Noroviruses are sometimes associated with "food poisoning" or "stomach flu."

Rotavirus[2] – a virus associated with upset stomach and diarrhea. Other symptoms include loss of appetite and dehydration. Transmission often occurs through ingestion of contaminated water or food, as well as contact with contaminated surfaces or objects. Children under five years of age are most susceptible to rotavirus.

Pseudomonas aeruginosa[3] – a type of bacteria that often infects people in health care facilities and/or those with weakened immune systems. These infections may cause pneumonia, ear infections, and skin rashes. It is becoming more difficult to treat Pseudomonas infections because of increasing antibiotic resistance.

Legionella subspecies[4] – a group of bacteria that can cause Legionnaires' disease, a severe form of pneumonia, and Pontiac fever, a mild flu-like illness. Collectively, these illnesses are known as legionellosis. Legionella is commonly found in freshwater environments, such as lakes and streams.

Lead[5] – lead exposure can damage any organ system, but the nervous system is the most vulnerable. Effects of chronic, low-level lead exposure may include diminished cognitive performance, anemia, hypertension, and gout. In children, lead poisoning can lead to growth and development problems.

Copper[6] – a mineral that is useful for bodily functions, but can be unsafe when ingested in large amounts. Symptoms of copper overdose include nausea, vomiting, abdominal pain, diarrhea, and anemia.

Sources:
1 CDC, 2015, "Norovirus Illness: Key Facts."
2 CDC, "Rotavirus."
3 CDC, "Pseudomonas aeruginosa in Healthcare Settings."
4 CDC, "Legionella (Legionnaires' Disease and Pontiac Fever)."
5 CDC, "Lead."
6 ATSDR, 2004, "Copper."

between rotavirus contamination and two enteric outbreaks at day care centers being studied, they could not establish a direct causal linkage to water fountains. In a similar study, Bright, Boone, and Gerba (2010) tested elementary classroom surfaces for bacteria, norovirus, and influenza A. They found that water fountain knobs and push buttons (as well as manual pencil sharpener handles) were the most contaminated surfaces per unit area. The study noted that frequent disinfection would prevent the transmission of diseases and reduce absenteeism due to illness.

In other cases, microbial contamination was associated with fountain location and water pressure. A systematic investigation into drinking fountain hygiene standards at schools in North Yorkshire, England, found that many of the fountains were in restrooms, and a number of them were "dirty, badly maintained, out of sight, and overlooked" (Walters and Cram 2002, 11). The study also found that fountains with low pressure were more likely to have a high number of bacterial colonies, partly due to stagnant water and the fountains' limited ability to flush them out. Yet in the United States, many states and cities have adopted the International Plumbing Code or the Uniform Plumbing Code, which prohibits the installation of drinking fountains in public restrooms (ICC 2000; IAPMO 2000). Addressing other concerns about drinking fountain placement (e.g., near trash cans), overall cleanliness, and water pressure necessitates the adoption and implementation of drinking fountain installation and maintenance standards, which are not currently required by law.

HEAVY METAL CONTAMINATION

Lead and copper can leach from corroded pipes and fixture parts, leading to secondary contamination of treated water (Brown and Margolis 2012; Skipton and Hay 1998). The Safe Drinking Water Act (SDWA) has prohibited the use of lead in plumbing components since 1986, but legacy lead-containing infrastructure remain in use in many cities and towns due to high replacement costs. Cech et al. (2006) found that several fountains in Texas' public buildings contained lead and copper, with some exceeding the U.S. Environmental Protection Agency (EPA) action levels for lead by up to a factor of 12, and for copper by up to a factor of 3.9 (see Box 2 for background on U.S. water quality regulations and details on lead and copper action levels). The high concentrations of these metals suggest that contamination may have occurred locally in the fixtures or plumbing at the fountains. The authors also found that the presence of filters was correlated with lower concentrations of total lead, but not of copper.

In response to the Flint, Michigan water crisis, which became widely known in 2015 and 2016, a growing number of local school and government agencies across the nation have tested the quality of water from drinking fountains. Several tests found excessive amounts of lead (Ungar 2016). However, it was sometimes unclear whether the problem was the drinking fountains themselves, the plumbing system, or both. For example, Chicago Public Schools (CPS) has shut down several fountains and sinks found to contain elevated lead levels, but has yet to identify the source of leaching (Perez Jr. 2016). While CPS has not decided on additional measures, some schools in the district have responded proactively and instituted an aggressive flushing protocol to reduce lead in the plumbing system. A number of schools in Fort Worth, Texas have replaced hundreds of older-style drinking fountains after tests showed unsafe levels of lead (Baker 2016). Yet water from some kitchen sinks also contained elevated lead levels, suggesting that contamination can originate from a range of legacy plumbing fixtures.

Box 2.

Safe Drinking Water Act (SDWA) and National Drinking Water Standards

The Safe Drinking Water Act (1974, amended 1986 and 1996) provides the legal basis for protecting and regulating the nation's public drinking water supplies.[1] Under the SDWA, the U.S. Environmental Protection Agency (EPA) is tasked with setting the **Maximum Contaminant Level (MCL)** for drinking water. These enforceable drinking water standards are set as close as possible to the level of contaminant below which there is no known or expected health risk, taking into account the best available treatment technologies and the cost of treating water.[2] These standards only apply to water systems serving at least 15 service connections or at least 25 people for 60 days of the year. Water suppliers are required to regularly monitor and test their water and submit water quality reports. Water quality violations may result in a public notification and administrative actions to bring the water system back into compliance. See here for a complete list of drinking water standards.

The 1986 SDWA amendments imposed a ban on plumbing materials and fixtures containing lead exceeding a specified amount (Section 1417). Exemptions were made for pipes and parts exclusively used for non-potable purposes.

In 1991, the EPA published the **Lead and Copper Rule**, a regulation that established **action levels** for lead and copper and set out specific actions to address contamination problems. If lead and copper concentrations exceed a level of 0.015 mg/l and 1.3 mg/l, respectively, in more than 10 percent of customer taps sampled, the water system must undertake a number of additional mitigation actions, such as corrosion control and treatment, additional monitoring, and a public education program.[3]

Sources:
1 EPA, 2004, "Understanding the Safe Drinking Water Act."
2 EPA, "Safe Drinking Water Act (SDWA) Compliance Monitoring."
3 EPA, "Lead and Copper Rule."

Other instances of contamination, such as the case of public schools in Portland, Oregon, have been more directly linked to the plumbing system, especially in old buildings. All except two of Portland's public schools were built before 1986, the year the ban on lead in plumbing components took effect (Hammond 2016). District-wide testing revealed lead exceedances at most of Portland's public school buildings, though not all drinking fountains were affected (Portland Public Schools 2016; Roth 2016).[2] Even Rosa Parks School, built in 2006, had elevated lead levels (Moore 2016). An investigation into water quality management at Portland Public Schools found several operational gaps that have contributed to the contamination problem. Findings revealed a "lack of water testing and remediation protocols" since 2001 and a "failure to maintain an updated or accurate database regarding fixtures and faucets that have

2 These results are preliminary and may change.

Source: Josfor

tested positive for excessive levels of lead in drinking water" ([DeJong and Berman 2016](#), 4-5). The Oregon Health and Science University has been experiencing similar issues at some of its century-old buildings. The university has closed at least nine drinking fountains and plans to replace lead-containing components and retest the water before reopening them to public use ([Terry 2016](#)).

LINKS TO HEALTH RISKS

Despite common misconceptions, the presence of pathogens and other contaminants does not automatically imply a health problem ([Dutka and Walsh 1984](#)). Additional factors, such as the type of contaminant, the level and duration of exposure, and the vulnerability of individuals must also be taken into account. Very few studies offer clear linkages between a sickness or a disease outbreak and contaminated drinking fountains. [Knobeloch et al. (1994)](#) found that gastrointestinal symptoms experienced by fountain users at a Wisconsin

university were linked to copper contamination. The prevalence of these symptoms, such as episodes of nausea, diarrhea, or abdominal cramps, was highly correlated with the amount of water consumed and the frequency of using fountains where contamination had been identified. In other instances, increased surveillance or a misdiagnosis may result in what appears like a disease outbreak when in fact it is not. [Lalande et al. (2001)](#) reported a "pseudo-outbreak" of *Mycobacterium gordonae* from refrigerated water fountains in a French hospital.[3] Both reports highlight the need for proper fountain maintenance and the replacement of old fixtures and fixture parts.

One study accurately linked a disease outbreak to drinking fountains: a case of nosocomial infections at a French hospital in 2013 ([Costa et al. 2015](#)).[4] This incident was an isolated case affecting vulnerable patients with cancer and severely compromised immune systems. The fountain implicated was equipped with a carbon filter, a 0.45 μm cartridge filter, and a cooling system. The hospital's maintenance procedures followed the manufacturer's recommendations and protocol. However, the fountain outlet still had high concentrations of *P. aeruginosa*, potentially due to the presence of biofilm – a thin, slimy film of bacteria that adheres to a surface. The hospital remediated the problem by installing another type of drinking fountain with a terminal UV treatment.

Overall, the identified health risks of water fountains are limited, especially when looking

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3 A "pseudo-outbreak" refers to an episode of increased disease incidence due to enhanced surveillance or other factors not related to the disease itself (e.g., new definitions, laboratory contamination, and misdiagnosis). In contrast, an "outbreak" is the occurrence of disease cases beyond what is normally expected for a certain area or population.

4 Nosocomial infections are infections acquired in a health care facility. They are typically caused by organisms that have developed resistance to antibiotics.

at the public drinking water system as a whole. Between 1971 and 2006, over 80 percent of deficiencies connected to drinking water-related outbreaks in the United States were caused by broad, systemic problems, such as the treatment and distribution of potable water, rather than specific contamination at the point of use (Craun et al. 2010). More recent reports have supported this finding, failing to identify any special linkages between water fountains and disease outbreaks between 2005 and 2012 (see Beer et al. 2015; CDC 2013; Brunkard et al. 2011; Yoder et al. 2008).

MITIGATING RISKS AND REVIVING THE USE OF DRINKING FOUNTAINS

To help ensure the availability of safe and reliable drinking fountains and encourage their use, entities providing free drinking water should adopt best management practices for maintaining fountains and invest in new, modern installations as needed. Below, we offer six recommendations for reducing health concerns tied to water fountains and improving public access to safe drinking water.

A first and critical step is **comprehensive monitoring and testing** of all public water fountains, with the top priority given to schools and parks where large numbers of young children and other vulnerable users, such as pregnant women, are present.

A second step is **developing and implementing standard protocols for water fountain maintenance, repair, and replacement**. While the Americans with Disabilities Act (ADA) has requirements for drinking fountain specifications, including spout height, location, and water flow, we have found no specific regulations on fountain maintenance at the national or state level. The EPA offers guidelines and best management practices

Source: Christina Oshinsky
Santa Clara County Public Health Department

to keep fountains sanitary.[5] Recommendations from the EPA and others include daily cleaning and regular flushing to remove sediments or stagnant water, a comprehensive schedule of systematic cleaning and repair, and maintaining sufficiently high water pressure. We have summarized key protocols in Box 3.

A third priority is a **broad nationwide effort to replace legacy distribution and plumbing systems with modern piping** to eliminate lead, copper, and sources of microbial contamination. Such an effort would, of course, address a far wider range of water-related problems than poor quality water from drinking fountains. These public water-related infrastructure investments should be a national priority.

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5   The EPA, states, and water service providers work together to monitor public water systems under the SDWA, but do not oversee water fountains directly.

Box 3.

Guidelines for Cleaning and Maintaining Drinking Water Fountains

Daily procedures:
- Gather necessary materials and suggested protective equipment;
- Obtain Material Safety Data Sheets (MSDS) for all chemicals being used and review the manufacturer's instructions for use;
- Inspect fountains and throw away any accumulated trash or debris;
- Flush the fountain outlet for a period of time[†] and check the flow of water to make sure there is a constant stream;
- Spray disinfectant solution on the inside surfaces of the mouthpiece and protective guard;
- With a scrub brush, clean the inside and outside of the mouthpiece and protective guard;
- Rinse the mouthpiece and protective guard with water;
- Wipe drinking fountain surfaces with a clean cloth dampened with water; and
- Dry floors surrounding fountains to ensure that water is not left pooling overnight.

Weekly duties:
- Remove lime and/or calcium buildup by spraying descaler onto the bowl and the back of the drinking fountain;
- Wipe any surfaces with lime buildup using a clean, lint-free cloth saturated with the descaler. Let it stand for the length of time recommended on the label;
- Wipe the surface with a clean cloth. If necessary, use a brush or scrub pad to remove hard buildup. Be careful not to damage surfaces while scrubbing; and
- Thoroughly rinse the surfaces with clean water.

Monthly duties:
- Check fountains for leaks and excessive sweating on the outside of the fountain unit;
- Check flows to see if the strainer screen is plugged with debris; and
- Fix and replace parts as necessary.

Annual duties:
- Update annual maintenance plan to include any repairs or replacements.

As appropriate:
- Maintain sufficiently high water pressure such that the flow is at least four inches high from the spout; and
- Replace or clean any filters on a schedule determined by the filter manufacturer.

Every three to five years:
- Sample water for pathogens and metals; and
- Conduct in-depth drinking fountain inventory.

† Contact your municipal water system to find out what the recommended flushing time is for your facility, based on your system size and piping. This should be done for all water outlets used for drinking or food preparation.

Adapted and modified from:

DOJ, 2010, "2010 ADA Standards for Accessible Design."

EPA, 2013, "Drinking Water Best Management Practices: For Schools and Child Care Facilities Served by Municipal Water Systems."

ISU FPMCSD, 2013, "'Green' Cleaning Guidelines."

LBNL, 2012, "Drinking Water Safety."

PRC, 2014, "Keep It Flowing: A Practical Guide to School Drinking Water Planning, Maintenance & Repair."

A fourth priority, in areas where more comprehensive system upgrades are not immediately possible, is **upgrading the type and function of older drinking fountains**. For instance, the installation of filters can mitigate health risks from fountains connected to an older plumbing system. Older fountains that may contain lead and/or copper parts should be replaced as well.[6] Newer generations of drinking fountains can offer options to better meet users' needs, including bottle filling, hot and cold service, and vandal-resistant features.

Fifth, a large-scale effort to **greatly increase the number of fountains** would help improve access to municipal water in public places and reduce reliance on bottled water, which carries its own economic and environmental costs (Gleick 2010).

Finally, after ensuring that drinking fountains are clean and well maintained, **communications efforts** by municipalities, schools, park districts, and others responsible for water fountains can help rebuild public confidence in them. This should include the use of new tools to compile and distribute information on where to find public fountains and to assess and report on their condition.

CONCLUSION

Public drinking fountains provide numerous benefits, from improving public health through broad access to safe and affordable drinking water to reducing the environmental costs of bottled drinks. However, a decline in the number of water fountains and eroding public trust in water

quality have led to a shift away from publicly accessible water toward commercial bottled water. Growing concerns over drinking water quality, widely-publicized water contamination incidents in some major cities, and the resulting fear of disease transmission from drinking fountains are all partially responsible for this trend.

Our review demonstrates limited evidence of a causal relationship between illness and the use of drinking fountains. We found seven peer-reviewed articles relating to incidences of contamination at fountains, but only one U.S. study showed a clear link between illness and drinking fountains. Identified health risks were more related to problems within public water systems and old plumbing systems in buildings. As more comprehensive testing is done, specific fountains with legacy lead or other contamination risks will be identified, helping set priorities for corrective action.

Ensuring safe water from fountains requires consistent cleaning and routine maintenance; installation of new fountains in high-traffic areas; retrofitting or replacement of old models with modern fountains that have filters, chillers, and bottle fillers; and elimination of parts and pipes that contain lead and copper. Uniform maintenance guidelines should be developed and widely adopted by cities, schools, sports facilities, building owners, and others providing free drinking water. These efforts, combined with communications on the results of regular water testing, reports on the performance of fountains, and information on how to find and access high-quality drinking fountains, can help build public trust in water fountains and revitalized communal values of sharing and respecting public resources.

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6 Some fountain models have built-in filtration systems, but others require an additional installation. Filters typically need routine servicing and the installation of filters in buildings that serve school children must abide by state laws and regulations (PRC 2014).

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