

## LITERATURE REVIEW: WATER QUALITY OF PUBLIC BATHING, POTENTIAL HEALTH PROBLEMS AND WATER BORNE DISEASES ON VISITORS

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### Abstract

**Introduction:** Recreational Water Illnesses (RWIs) are diseases caused by pathogenic contaminants and harmful chemicals spread through direct contact with contaminated recreational water. Between 2011-2012, 1,700 cases caused by recreational water or Recreational Water Illness (RWIs) were recorded by the American Centers for Disease Control and Prevention (CDC). This study aims to analyze the quality of water in public baths and the health problems based on current discussions of the previously published research. **Discussion:** This study was a literature review conducted by searching, selecting, synthesizing, and studying existing scientific articles and papers relevant to the topics discussed. These articles and papers were then objectively summarized and critically analyzed. There were 11 articles included (articles with appropriate topics published after 2010, original, systematic, and those located in Asia and Europe). This study found that the quality of water was an indicator key of health problems in public bathing. It caused various kinds of diseases such as disorders in the digestive system and respiratory as well as irritations in the skin, eye, and ear. **Conclusion:** This study concluded that water quality is crucial to several health problems complained about by public baths visitors. Future research is expected to use systematic literature review and meta-analysis methods to provide more solid scientific evidence based on the strong relationship between variables.

## INTRODUCTION

Tourism is one of the biggest and most important sources of the Indonesian economy (1). The influences of tourism include several small businesses (tourist objects) in Indonesian rural areas requiring regular maintenance to upkeep its attraction (2). Some strategy to increase tourist satisfaction be equipped with four components: attractions (attractiveness offered by tourist objects), accessibility (the availability of facilities and make visitors easier to reach their destination and enjoy tourist areas), amenities (essential facilities provided to support visitors' needs), and additional facilities (organizations that encourage the development and progress of a tourist object) (3). Indonesian tourism attractions include nature, shopping, culture, education, culinary, and religion.

Areas such as beaches, lakes, swimming pools, waterfalls, public baths are types of natural tourism (water tourism). Water tourism is used as natural recreation or traveling spot and as a means of water sports and conservation. The tourists, in addition, come from all age groups (from adults to children). However, water tourism may also be a medium for water-borne disease transmissions. Public baths without good sanitation, for instance, can be a source of contaminants. The contamination of surrounding soil and water can pose a health threat to the visitors of water tourism (4). This fact must be considered seriously by managing of water tourism to provide proper and healthy tourism objects for visitors and the environment.

Public bath becomes one of the most visited and most crowded water tourisms. According to the Environmental Health Quality Standards and Water Health Requirements for Hygiene Purposes of Sanitation, Swimming Pools, *Solus per Aqua*, and Public by the Regulation of the Indonesian Ministry of Health Number 32 of 2017, the public bath is a tourism spot which water is directly derived from nature (not filtered by chemicals) and is used as a recreational place and sports. In several Indonesia regions people who live around the public bath still tend to use it as a means for bathing, washing clothes, even urinating and defecating. These activities may contaminate the public baths with dangerous chemicals such as detergents. This is in line with the fact that anthropogenic activities, land use, and fecal pollution are the biggest causes of pathogenic organisms in water tourism (5). When the public bath is contaminated, the risk of health problems is higher.

Between 2011-2012, the Centers for Disease Control and Prevention (CDC) recorded several Recreational Water Illnesses (RWIs) cases. Nearly 1,700 health complaints were found, and around 100

people received treatment. Between 2000-2014, forty-six States in the United States and Puerto Rico reported 493 outbreaks out of 27,219 RWIs cases (6).

In 2001, Helsinki and United States reported the outbreak of Norovirus, which resulted in gastroenteritis and infected 242 visitors of public baths. The baths were then equipped with chlorination and water-filtering system due to fecal contaminations (7). A study in Semarang also showed that as many as of 63.2% swimming pool visitors complained of eye irritation. A statistical test revealed that residual chlorine and pH values were associated with eye irritation complaints (8).

Gastroenteritis, skin damage, eye irritation, respiratory problems, and liver cancer are among the health complaints most associated with swimming activities. In 2015, a family in Uruguay was hospitalized due to diarrhea, vomiting, fatigue, and jaundice after doing activities at a water tourism spot (9).

In the 1950s, several cases found in water tourism began to be associated with recreational water quality. Several studies have been carried out since then. The results showed that there was an increased risk of diseases associated with exposure to recreational water. Moreover, the results also showed that the risk of developing health problems could not be taken for granted even for the least contamination levels since it can be a clinical threat with chronic symptoms (10). Besides, the visitors' behaviors and habits can also be a risk factor for health problems. In this case, visitors with the most vulnerable status are children because they still quickly get the water swallowed while swimming (11).

It is also essential to continuously monitor sanitation hygiene with regular maintenance to avoid the possibility of adverse health threats for both visitors and the management (12). Appropriate regulation from authorities related to public bath sanitation is highly required as a reference in countries where this type of tourism is developing widely. In Indonesia, one of the crucial points in the official regulation of public bath sanitation, as cited in the Regulation of the Indonesian Ministry of Health Number 32 of 2017, focuses on water quality. However, most studies concerning water tourism in Indonesia were still loaded with the aspect of tourism instead of health issues. The public baths that are used for daily activities have never been monitored for water quality. Besides, the sanitary is usually not in good condition (filled with moss, no garbage, and improper building conditions).

These conditions occur in several cities in Indonesia. For this reason, water quality inspections at public bath tourism need to be carried out by the

management and the local health center every six months. Usually, public baths do not need additional disinfectants since the water is organically derived from nature. However, at the Jarit public bath in Lumajang, chlorine was added to clean the pool's walls. Therefore, health complaints such as eye and skin irritation were found among the visitors of Jarit public bath (13).

Many studies on the topic of water quality in public baths were conducted in Asia and Europe. This study aims to analyze the quality of water in public baths and the health problems based on current discussions of the previously published research.

## DISCUSSION

This study is a literature review conducted by searching, selecting, synthesizing, and studying existing scientific articles and papers relevant to the topics discussed. These articles and papers were then objectively summarized and critically analyzed. For the research design, an integrative literature review was carried out to summarize the existing empirical or theoretical literature to provide a more comprehensive understanding of the water quality in public baths, the behavior of public bath visitors, and health complaints experienced by visitors.

The criteria of articles used in this study are those with public baths and health risks and published after 2010. The articles must be original research and systematic reviews with cross-sectional, case-control, cohort, qualitative research, and literature review as its research methods. All of the selected articles were studies located in Asia and Europe. These articles discussed public baths with natural water (freshwater) such as lakes, ponds, and rivers.

The articles were searched through the Google Scholar, Elsevier, NCBI, CDC, and DOAJ databases with the keywords "public bath, recreational freshwater, and health risk". The articles were then filtered according to the topic which has been decided in this study. The article filtering was done by reading the abstracts of each articles that match the keywords. After data filtering, 11 articles were obtained.

The synthesis process of this literature review was done through the narrative method. Articles with similar results were grouped to complement the research objectives. Several research articles that have predefined inclusion criteria were collected based on the authors' names, research title, population, research method, research results, and conclusions before they were summarized. The result is presented in Table 1.

The quality of each selected article was assessed using the Critical Appraisal Skill Program

(CASP) framework and the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guide.

Public baths are categorized as public places or *tempat-tempat umum* (TTU). A public place is a place to which many people can have access and do specific activities with or without tariffs. In public places such as public baths, a good sanitation system remains crucial to avoid harmful health risks such as dirt or other hazardous waste caused by direct or indirect interactions between visitors.

The ideal public bath should guarantee safety, cleanliness, and comfort for both visitors and the management. More specifically, cleanliness is the key factor and should be seriously considered besides safety and comfort. This is reasonable since public baths with poor cleanliness can transmit some health threats and diseases to the visitors. Potential diseases associated with water tourism are irritation of eyes and skin, jaundice (hepatitis), and indigestion which may come from contaminated water or food contacts.

### Public Bath Sanitation

Two articles discussed public baths as bathing, washing, and toilet by the local community (14-15). This condition is usually caused by geography and the local community's inability to build private bathrooms. Consequently, public baths become a place where they usually conduct activities, which then results in poor sanitation conditions. Serious health problems, therefore, often occur in this term due to poor sanitation conditions.

Another study discussed public baths as a tourism spot. They stated that the lake was overcrowding and has poor hygiene. Besides, the bathroom hygiene was poor due to overflowing garbage (16). Meanwhile, a study in stated that among the top three public baths in Lumajang, Jarit was the only public bath with inappropriate sanitation (13). Some of these required components include building equipment, facilities, and proper sanitation systems consisting of garbage, latrines, and handwashing facilities. Both studies indicated that sanitation facilities were vital requirements in public baths to ensure the comfort and health of both the visitors and the management. In addition to good sanitation facilities, the visitor's behaviors are also key to the public bath areas' safety, cleanliness, and comfort of the public bath areas.

### Raw Water Pollution

Another study on a public bath used for household activities such as drinking, cooking, washing, and rice

Table 1. Literature Review

Authors	Title	Research Method	The Number of Samples	Results	Conclusion
Franciska M. Schets, Harold H.J.L. van den Berg, Gretta Lynch, Sharona de Rijk, Ana Maria de Roda Husman, Jack F. Schijven (21).	Evaluation of water quality guidelines for public swimming ponds	Observational Study	13 public baths	The results showed that 8 out of 13 bathing pools met the microbiological quality standard (fecal indicator). There were 31%- 45% random variations of different microbes in the bathing pools	Most samples of the bathing pool water have met the requirements for microbiological quality standard
Edi Sutoyo, Sigit Dwi Pramono, Sulha, Khoiriah Widia Pawesti (14).	Pemanfaatan Mck Sebagai Salah Satu Upaya Peningkatan Perilaku Hidup Bersih Dan Sehat (Phbs) Warga Rt 04/01 Desa Sadeng	Qualitative Research	-	The study showed that the residents of Sadeng Village RT 04/RW 01 took a bath in the public bath because the residents were unable to build their own toilets. However, the conditions of the public baths are very poor.	Public baths do not meet the standard environmental sanitation requirements.
Nely Zulfa, Dhimas Oki Permata Aji (15).	Pengelolaan Sumber Mata Air di Desa Kedungoleng Kecamatan Paguyangan Kabupaten Brebes	Qualitative Research	-	The results showed that efforts to improve the quality of health and clean culture of the community as well as to develop environmental sanitation were carried out through the construction of clean water facilities in Kedungoleng village.	Public baths do not meet standard environmental sanitation requirements.
Franciska M. Schets, Harold H. J. L. van den Berg, Harry Vennema, et.al (22).	Norovirus Outbreak Associated with Swimming in a Recreational Lake Not Influenced by External Human Fecal Sources in The Netherlands, August 2012	Case-control study	100	The results showed that 100 visitors experienced gastroenteritis after swimming in Lake Zeumeren. This was mainly due to the Norovirus which contaminated the water.	Viruses contained in the public baths can cause health complaints to bath visitors after swimming.
A Polkowska, S Räsänen, H Al-Hello, et.al (16).	<i>An Outbreak of Norovirus Infections Associated With Recreational Lake Water in Western Finland, 2014</i>	Retrospective cohort	100	The results indicated that several activities carried out in the four lakes were associated with the occurrence of AGE	Non-hygiene behavior during activities in public baths can lead to AGE
Forcep Rio Indaryanto, Melisah, Dedi Trimulya (17).	Kualitas Air Situ Rampones, Kabupaten Serang	Cross-sectional study	1	The results showed that the Situ Rampones baths were in the mild polluted category. This was due to the activities of the surrounding community	Situ Rampones baths fall into the lightly polluted category.
Ira Dwi, Anggraeni Candrawati, Prasajo Pribadi, Tiara Mega Kusuma (18).	Uji Kualitatif Bakteri Escherichia Coli Pada Pemandian Umum Di Boton Balong Magelang	Qualitative study	-	The results showed the presence of <i>Escherichia coli</i> bacteria in the Boton Balong Public Bath, Magelang.	Boton Balong public baths contain <i>E.coli</i> bacteria due to the activities of local residents who pollute the water.
Lalan Kumar Arya, Sivakumar R. Rathinam, Prajna Lalitha, Usha R. Kim, Sudeep Ghatani, Veena Tandon (41).	Trematode Fluke Procerovum varium as Cause of Ocular Inflammation in Children, South India	Case-control study	42	The results showed that 42 children with ocular inflammation never swam in a pool or river. Snails are a vector and a risk factor for ocular parasitosis.	The presence of snails and vectors around public baths could cause health complaints to the visitors after they did activities in public baths.
A Jovanović Galović, S Bijelović, V Milošević, et.al (19).	Bath Water Contamination with Legionella and Nontuberculous Mycobacteria in 24-Hour Home Baths, Hot Springs, and Public Bathhouses of Nagano Prefecture, Japan	Observational study	3314	The results showed that there were 123 out of 3314 water samples tested positive for Legionella. There were thirty home baths open 24 hours from 123 samples of water contaminated with Mycobacteria bacteria	A small proportion of the water samples was tested positive for Legionella
Margaret Sanborn, Tim Takaro (11).	Recreational water-related illness	Literature Review	-	The results showed that there was 3-8% risks of developing acute gastrointestinal illness (AGI) after swimming. AGI risk groups were children under five (especially if they have not received the Rotavirus vaccine), the elderly, and immunocompromised patients.	AGI was at risk of infecting public bath visitors after they did activities in the bathwater.
Hesty Pakartiningrum (13).	Analisis Faktor Risiko yang Mempengaruhi Keluhan Kesehatan Pengguna pada Pemandian Umum di Kabupaten Lumajang	Cross-Sectional study	3	The results showed that the other habit variables and the Personal Protective Equipment variables had the health risk to the visitors of public baths. Two public baths met the requirements based on the results of sanitation observations.	Public baths are safe because they have met predetermined quality standards.
F. M. Schets, A. M. De Roda Husman, A. H. Havelaar (40).	Disease outbreaks associated with untreated recreational water use	Cohort Study	-	The results showed that all research locations were positive for <i>Vibrio</i> with different concentrations. If the temperature is high, so will the <i>Vibrio</i> .	All research sites were positive for <i>Vibrio</i> , despite different concentrations.



field irrigation suggested that the water quality in Situ Rampones had a pollution index ranging from 2 - 2.58 (17). According to Decree of the Indonesian Ministry of Environment Number 115 of 2003, water with a pollution index of 1.0 - 5.0 is categorized as lightly polluted. It means that the water quality of Situ Rampones public bath did not meet the minimum standards for healthy. Apart from public baths, lakes, and rivers also can be contaminated by factory waste around that area (11). It indicates insufficient processing of practical waste from the factory, polluting the surface water around Situ Rampones. Consequently, a polluted public bath such as Situ Rampones will harm the tourists and the people of Serang Regency since the high risk of getting several health problems.

Another study conducted at Baton Balong Magelang public baths identified *Escherichia coli*, indicating that the water was contaminated with feces (18). A study carried out in Serbia suggested that *Adenovirus* contaminated 60 out of 90 water samples with the possibility of not having adequate municipal wastewater treatment available due to technical factors and financial difficulties (19). These poor conditions can bring health threats such as gastrointestinal disorders to the visitors.

**Public Bath Water Quality**

One of the severe problems that need to be addressed in public baths, and environmental quality, is water quality. The analysis criteria included physical, chemical, and microbiological qualities in several types

of public baths such as rivers and lakes in many Asian and European countries. The results of the analysis on the physical, chemical, and microbiological quality of water are shown in Table 2.

A study conducted in the Semolon natural tourism area, Malinau Regency, North Kalimantan Province, provided information on water’s chemical and physical quality. Semolon nature tourism is a natural hot spring that is believed to have efficacy in curing skin diseases. The chemical parameters tested were pH, BOD, COD, SO<sub>4</sub>, and NO<sub>3</sub>, while the physical parameters were temperature, turbidity, and color. The results indicated that the physical and chemical quality of the Semolon hot spring met the quality standards. Therefore, Semolon hot spring was classified as ‘Class 1’ and safe for household needs and other activities (20).

The second study on *Escherichia coli*, one of the microbiological parameters, was conducted in Boton Balong Public Bath, Magelang, Indonesia. The results showed that the bath did not meet the minimum standards set by the Regulation of the Indonesian Ministry of Health Number 32 of 2017. The result suggested that the *E. coli* contained in the bath was at >1 CFU/100ml (18).

The next study was conducted in one of the public baths in Lumajang which pH was considered to have met the quality standard as the water was odorless, oily, and clear (13). However, after the quality water had been tested, the number of coliforms was very high (540-1,600 CFU/100ml) both in the crowd and empty conditions. In addition, the BOD (75.6 mg/L - 10.8 mg/L) and DO (5.4 mg/L - 6.7 mg/L) values were also high. It means that the

**Table 2. Physical, Chemical, Microbiological Quality of Fresh Water**

References	Year	Number of Samples	Types of Public Bath	Water Quality			Location of Study
				Physical	Chemical	Microbiological	
Franciska M. Schets, Harold H.J.L. van den Berg, Greta Lynch, Sharona de Rijk, Ana Maria de Roda Husman, Jack F. Schijven (21).	2020	578	Natural swimming pond	Water temperature, conductivity, turbidity	pH	<i>E. Coli, Enterococci, Pseudomonas aeruginosa, Staphylococcus aureus</i>	Netherlands
Forcep Rio Indaryanto, Melisah, Dedi Trimulya (17).	2017	18	Upstream waters	Water temperature	pH, DO, Nitrite, Nitrate, COD, BOD		Sindang Mandi, Baros District, Serang Regency, Banten.
A Jovanović Galović, S Bijelović, V Milošević, et.al (19).	2016	90	Beach	turbidity	pH, Nitrite, Nitrate, amonium	Fecal coliforms, total coliforms, Adenovirus, Rotavirus	Serbia
F. M. Schets, A. M. De Roda Husman, A. H. Havelaar (40).	2011	4	Bathing site	Water temperature		<i>Vibrio, E. Coli, Intestinal enterococci</i>	
Franciska M. Schets, Harold H. J. L. van den Berg, Harry Vennema, et.al (22).	2018	10	Recreational lake			<i>Trichobilharzia, Cyanobacteria, Vibrio, Pseudomonas aeruginosa.</i>	Lake Zeumeren in Barneveld, Netherlands
A Polkowska, S Räsänen, H Al-Hello, et.al (16).	2018	24	Recreational lake			<i>E. Coli, Intestinal enterococci, cyanobacteria, algae</i>	Lake in Tampere, Finland
Ira Dwi, Anggraeni Candrawati, Prasojo Priyadi, Tiara Mega Kusuma (18).	2016	5	Public bath			<i>E. Coli</i>	Boton Balong Public Bath, Magelang

bath did not meet the quality water standards of 'Class 1' according to Government Regulation Number 82 of 2001. Based on several findings from the above studies, it can be concluded that the threats of microbiological contamination in public baths in several regions in Indonesia are still high.

Moreover, another study explained a relationship between an increase in temperature and the presence of *Vibrio* bacteria in water. It was supported that when a water sample temperature was set below 11°C, there was no indication of the presence of *Vibrio* bacteria (21). Other studies have also stated a relationship between temperature and the presence of the bacteria *Pseudomonas aeruginosa* (22). This indicated that there was a relationship between physical and microbiological parameters in water. Therefore, control on the quality of water should also consider the microbiological parameters.

### Physical Quality of Public Bath Water

Although the temperature of several public baths cited in this article has been considered to meet the standards applicable to each country, one study conducted between 2017-2018 revealed that 16-17% of the water samples actually below the standards. As people prefer to visit water tourism in the summer, public baths number increases (21). As the public baths are crowded with more visitors, the water temperature also increases. Consequently, the high temperature of the water causes much natural flora to increase.

Moreover, the capacity of water to conduct electricity is measured through the conductivity parameter (23). One study conducted in the Netherlands suggested that the conductivity parameters of water tourism in the Netherlands were not very high (21). It is reasonable since water with a small conductivity value tends to have low electricity, a better quality of water and lower risks of danger (24). In contrast, water with a high conductivity value tends to have high electricity and thus indicates a large mineral content.

Turbidity in water occurs due to suspended solids, both inorganic and organic, in the body of water. Moreover, turbidity can also be caused by silt, sand, bacteria, germs, and chemical deposits (25). Although disinfectants have been known to have the capacity to clean cloudy water, suspended substances caused by disinfectants will only store microbes instead of destroying them. Consequently, this condition changes the water's color and poses several health threats such as digestive disorder (26). A study conducted in Serbia showed that the turbidity in Serbian public baths was quite high (5.52 - 33.16 NTU) (19). Water must undergo a filtering process

to reduce the turbidity level before poured into the pool, regular monitoring, and proper method of disinfection.

### Chemical Quality of Public Bath Water

The acidity (pH) is significantly associated with the presence of *Pseudomonas aeruginosa* (22). Moreover, pH is also used as parameter for standard quality water, while BOD and DO's presence indicates that water exceeds the quality standard (19). Meanwhile, a higher BOD value in Situ Rampones public bath caused by human activities would affect dissolved oxygen (DO).

pH can dissolve biological material from chemical elements such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium). The standard measurements of pH in public baths are not listed in the WHO Guideline for Safe Recreational Water Environment (2006); thus, it difficult to determine whether a bath meets the quality standards or not. Therefore, further studies are required to help determine an appropriate standard for pH levels in public baths since no disinfectants are normally used to clean the water in public baths. Other studies suggested that in several baths with natural water, the pH tends to be high when there are many visitors and low when it is quiet.

The direct effects caused by the presence of pH in water tourism areas are eye and skin irritations (27). Water with high pH can change the tissue protein in the eye, while water with low pH can penetrate quickly into the conjunctival tissue, which then causes a damaging effect on the eye. Meanwhile, the severity depends on the molar concentration and the amount of pH that enters. A study in the Netherlands suggested that *P. aeruginosa* depended on the pH value (21). *Pseudomonas aeruginosa* is a pathogen that often causes folliculitis and ear infections (28). *Pseudomonas aeruginosa* spreads in humid areas such as rivers, lakes, seas, and water types. Therefore, water tourism such as public baths are most amenable to the growth of *Pseudomonas aeruginosa* and the source of several water-borne infections.

One indicator of good quality water is the presence of high dissolved oxygen (DO). It is reasonable since DO does not have a direct effect on public bath visitors. Instead, DO will affect the microbiological activity and chemical oxidation in several metals such as iron (27). Meanwhile, eutrophic is most commonly experienced by people who swim at public baths (29). When waters have gone through eutrophication, it becomes progressively enriched with minerals and nutrients. This condition causes algae and higher plants to grow quickly and triggers the inequilibrium of organisms in the water (30). Eutrophic conditions increase when the DO value is low that aquatic organisms cannot absorb oxygen from

water. Meanwhile, Biological Oxygen Demand (BOD) is an indicator of pollution caused by industrial emissions (31). Both DO and BOD influence each other. The lower DO value can be a result of the high value of BOD.

The presence of *Adenovirus* is significantly associated with nitrates (19). *Adenovirus* is commonly known as a virus that causes several health problems such as conjunctivitis and respiratory disorder. This virus has a high rate of person-to-person transmission. In Brazil, *Adenovirus* has been considered as most outbreaks virus (32).

### Microbiological Quality of Public Bath Water

The last parameter for water measurement is based on the microbiological quality (*E. coli*, *Enterococci*, total coliforms and fecal coliforms). A study conducted in Netherland's bathing pools between June - September 2017 and July - September 2018 suggested that even though the water was contaminated, *E. coli* or *Enterococci* was not found (21). Another study conducted at the Baton Balong public baths with a qualitative test on *Escherichia coli* suggested that the water was contaminated by feces (19). The gastroenteritis outbreak caused by *Norovirus* was also demonstrated in a study conducted in Lake Zumeren, Netherlands (22). The study showed that *Enterococci* levels in Lake Zumeren were higher than previous routine sampling in the same swimming period. Meanwhile, the presence of total coliform and fecal coliform was quite high in Serbia.

Feces that pollute the water is a problem that requires serious attention due to their negative impact on aquatic ecosystems and human health. Examining fecal-polluted water can be done by assessing the presence of *Thermotolerant* coliform (TTC) and *Enterococcus* in the water (33). Besides, coliform group (total coliform, fecal coliforms, *E. coli*) and *Streptococci* (enterococci and fecal streptococci) can also be indicators key of fecal contamination (5). Since fecal contamination is the most common microbiological parameter in public baths, monitoring its presence in the water is necessary.

The microbiological safety of water tourism is a crucial public health issue in developing countries (34). Water contamination can occur in rivers, lakes, wells, bays, and underground water with substances that can be harmful to living things. Furthermore, pollution also causes rivers, lakes, and coasts to look awful and have pungent odors. People who swallow contaminated water can get infected by diseases.

The deterioration of water quality, especially the microbiological aspect, is related to susceptible microorganisms that cause infection in visitors (5).

Several diseases caused by water tourism are gastrointestinal disease, nausea, stomach cramps, and respiratory ailments (5). While *Escherichia coli* causes gastrointestinal disease, its outbreak is mainly due to consumption of raw meat and non-hygiene drinking water. Moreover, there were also three studies indicating that gastrointestinal outbreaks can be caused by *E. coli* spread in lakes with natural water. From these three studies, one study reported an outbreak that occurred in 2014 at a lake in Finland because of *E. coli* and *Intestinal enterococci* (35). Monitoring the presence of these bacteria should not only be done in the water since visitors can also get infected from non-hygiene sanitation facilities and contaminated food and drinks.

A study conducted at Lake Zumeren showed an increasing *Enterococci* at the time of outbreak compared to the previous months (22). The results showed a significant correlation between the DNA of *Adenovirus* and total coliform in the water (19). The presence of bacteria did not always indicate the viruses' presence, even when 75% of samples were positive for *Adenovirus*. The *Adenovirus* has two strands of genome DNA which make it more resistant to the environment.

Many total coliforms were also found in Lumajang baths when there were many visitors (13). Visitors to public baths can contaminate large amounts of water with microorganisms. Some of them lack personal hygiene behaviors such as urinating, spitting, and sweating underwater. Some of the diseases caused by total coliforms are acute colicepticemia, sub-acute pericarditis, airsacculitis, salpingitis, and peritonitis (36). Consequently, this condition may, in turn, bring health risks to the visitors themselves.

Public baths with insufficient water quality are at risk of becoming a medium for water-borne disease. Health complaints experienced by visitors of public baths include gastroenteritis, skin and eye irritation, eye disorder, respiratory disease that is usually caused by trematode pathogens, viruses, parasites, algae, and bacteria, however, considered the main cause.

A study conducted in European lakes in 2012 and 2014 reported that there had been an outbreak of gastrointestinal disease caused by *Norovirus*. Another study conducted in Lake Tampere and Finland showed that the lake water samples were positive for *Norovirus* while the samples taken from the shore of the lake were negative (16). On the other hand, a study conducted in Lake Zumeren, Italy, showed that the water samples were negative for *Norovirus* while the samples of the surrounding water were positive (22). Visitors of water tourism commonly experience mild gastroenteric symptoms (37).

Gastroenteritis outbreaks also occurred after an open water event in London’s Thames River (38). The study showed that one of the difficulties in determining the source of the disease was the differences in river water’s nature compared to synthetic water tourism, where no periodic examinations were ever done to assess the quality of the river water. Based on the analysis of stool samples, the results showed that the organism responsible for the disease remained unidentifiable, although a few cases with positive diagnoses for *Giardia* and *Cryptosporidium* were found.

A study in Canada stated that the main cause of acute gastroenteritis illness was due to reduced of water quality tourism during the dry season (11). This statement is because most people tend to visit water tourism during the dry season while the quality of the water is poor. When feces contaminate an already poor water condition, pathogens’ presence will be much worse (21).

**Health Problems of Public Bath Visitors**

Another health complaint that visitors of public baths can experience is respiratory disease. Visitors who swim will likely have a higher risk of getting infected by diseases than those who do not. A study suggested that

the diseases were not only related to digestion but also respiratory (39). Other studies suggested that respiratory disease experienced by visitors of public baths may come from the presence of *Adenovirus* droplets in the water (11). Meanwhile, children are more vulnerable to this virus. Water with chlorine is a hostile environment for *Adenovirus*. However, the absence of chlorine in public baths makes it easy for this virus to grow and transmit.

Furthermore, health complaints on the skin, eyes, and ears are also experienced by people who swam at public baths. A study in Italy has reported three outbreaks of cercarial dermatitis due to *Trichobilharzia franki* in snails as an intermediate host (40). In general, temperature can affect the spread of disease. Trematodes, for example, is very sensitive to temperature changes. A slight increase in temperature will accelerate the development and transmission of this parasite. There were as many as 50 out of 1,500 cases of skin irritation experienced by visitors who swam at water tourism (most of them were children and kayakers). This is reasonable since children usually spend more time in the water than adults. Meanwhile, skin irritation occurred in kayakers due to long exposure to water during kayaking. These incidences are the entry point of the *Furcocercariae* to the human body.

**Table 3. Health Complaints by Visitors of Public Baths**

References	Year	The Numbers of Infected People	Types of Public Bath	Pathogen	Health Complaints
Claudio De Liberato, Federica Berrilli, Teresa Bossu, Adele Magliano, et.al (39).	2019	50	Recreational lake	Trematoda/ <i>Trichobilharzia franki</i>	Cercarial dermatitis
Franciska M. Schets, Harold H. J. L. van den Berg, Harry Vennema, et.al (22).	2018	120	Recreational lake	Virus/Norovirus	Gastroenteritis
A Polkowska, S Räsänen, H Al-Hello, et.al (16).	2018	244	Recreational lake	Virus/Norovirus	Gastroenteritis
V. Hall, A. Taye, B. Walsh, H. Maguire, et.al (37).	2017	338	River	a. Parasite/ <i>Giardia</i> b. Parasite/ <i>Cryptosporidium</i>	Digestion disorders (Gastrointestinal illness)
Lalan Kumar Arya, Sivakumar R. Rathinam, Prajna Lalitha, Usha R. Kim, Sudeep Ghatani, Veena Tandon (41).	2016	42	River	Trematoda/ <i>Procerovum varium</i>	Ocular granulomatous inflammation
Alice Mannocci, Giuseppe La Torre, Alessandro Spagnoli, Angelo G. Solimini, Caterina Palazzo, Maria De Gusti (38).	2016	-	Recreational water	undefined	Respiratory diseases
Margaret Sanborn, Tim Takaro (11).	2013	-	Recreational water	a. Bacteria b. Virus c. Parasite d. Algae	a. Respiratory diseases b. Acute Gastrointestinal Illness (AGI)
F. M. Schets, A. M. De Roda Husman, A. H. Havelaar (40).	2011	1	Bathing site	Bacteria/ <i>Vibrio</i>	Worse accidental wounds
Hesty Pakartiningrum (13).	2011	45	Public baths	Risk factors caused by behaviours	a. Eye irritation b. Skin irritation
Franciska M. Schets, Harold H. J. L. van den Berg, Harry Vennema, et al. (22).	2018	5623	Bath swimming pool	a. Trematoda/ <i>Trichobilharzia</i> b. Bacteria/ <i>Cyanobacteria</i> c. Bacteria/ <i>Vibrio</i> d. Bacteria/ <i>Pseudomonas aeruginosa</i>	a. Complains on skin b. Gastroenteritis c. Complains on ear d. Other complaints



In a study in Lumajang, as many as 45 people experienced skin irritation after visiting public baths (13). It accords with a study conducted in Bilthoven, Netherlands, where 48% of people who swam in water tourism experienced health complaints related to skin (41). Compared to gastroenteritis, skin and ear irritations are more common. Moreover, eye complaints were also found in the study located in Lumajang (22 cases) (13). It is suggested that people who swim at ponds and rivers develop ocular inflammation (41). The results of several articles regarding health complaints by public bath visitors are shown in Table 3.

Swimming and other water-based sports are great ways to do physical activity, gain health, and get social benefits (42). However, water tourism may also cause health risks from exposure to chemicals and pathogens. Table 3 shows the various health complaints experienced by public bath visitors in several Asian and European countries. While viruses and parasites causes most of health complaints, visitors' lack of hygienic behavior can also cause.

### Digestive Disease

One study showed that people who took a bath in public baths were at risk of getting gastrointestinal infection symptoms compared to people who did not (43). Outbreaks associated with poorly maintained public baths are usually caused by several pathogens such as *Norovirus*, *E. coli*, *Shigella*, and *Cryptosporidium* (6). Although cases of gastrointestinal diseases due to activities in public baths are usually mild and self-limited, some other cases require further treatment (44). Cases with further treatment are called Acute Gastrointestinal Illness (AGI). According to several studies, it is a disease with symptoms such as diarrhea (three or more times in a day), vomiting, nausea, and abdominal pain. The studies suggested that AGI is likely to occur for 0-3 days after the first contact with contaminants in water tourism (44).

Several other studies (16,22) showed that there had been AGI and many other water-borne outbreaks caused by *Norovirus* (45). The existence of *Norovirus* in public baths is caused by its visitors' poor behavior, which produces fecal contamination. Fecal contamination in a body of water with an already-poor body of water is amenable to pathogen growth (40).

So far, the presence of bacteria is used as an indicator key of fecal contamination in water instead of viruses. One of the reasons is that bacteria are easier to detect than viruses. Moreover, testing on the presence of bacteria requires a much cheaper cost compared to testing on viruses. While many studies revealed that

viral pathogens cause several water-borne diseases and outbreaks, it is necessary to consider viruses as indicators of the quality of water and bacteria.

### Respiratory Disease

Apart from digestive diseases, health problems that often occur during and after swimming in public baths are respiratory. Adenovirus is a virus that causes respiratory disease in public bath visitors. Outbreaks related to viruses are mostly caused by an adenovirus (46). Respiratory infections may occur due to close contact with other visitors in crowded recreational water (38). As visitors in an extremely crowd public bath tend to have inappropriate behavior, the risk of Adenovirus transmission is higher.

### Health Complaints to Eyes, Ears and Skin

The most common cause of health complaints among public bath visitors is fecal contamination (visitors to visitors). Various studies stated that disorders related to the digestion system are the most common disease in a public bath. The results showed that the epidemic of cercarial dermatitis occurred due to *Trichobilharzia franki* in snails as an intermediate host (39). The longer the contact with the water, the higher the risk of getting infected by pathogens in the water.

## CONCLUSION

Water quality is the key factor to several health problems complained by visitors of public baths. The researcher expects future researchers to use a systematic literature review method with meta-analysis to provide more solid scientific evidence based on the strong relationship between variables.

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