April 2024

Cold plunge tanks: Considerations for environmental public health

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Key Messages

- Cold water immersion in small pools or vessels constructed from a variety of materials such as stainless steel, plastic, vinyl, fiberglass, or specially treated wood has been rising in popularity and some personal service establishments such as spas are offering these services in their facilities.
- Cold plunge tanks can be hard-plumbed with recirculating filtration and automatic disinfection systems, or they can be stand-alone units without filtration or disinfection.
- Several hazards exist in cold plunge environments, such as waterborne pathogens, sudden physiological response to the cold such as heart attacks and muscle failure, slips and falls, and suction and entrapment risks.
- Although it's commonly assumed that cold temperatures inhibit microbial growth and thus decrease infection risk in cold plunges, cold temperatures also lower disinfect effectiveness.
- Lack of guidance on appropriate cleaning, disinfection, and maintenance practices poses challenges for environmental public health professionals to ensure client safety. Only one guideline from California was found that contains some general requirements for cold plunge tank environments.
- Further research is necessary to determine best practices to develop appropriate guidance.

Introduction

Cold water immersion is a practice that dates back centuries and is associated with numerous health claims.[1-3] In recent years, immersion in frigid lakes, oceans, or an ice bath in a tub has been rising in popularity as celebrities and social media tout the physical and mental health benefits of this wellness trend.[4,5] Many athletes and sports teams have also adopted cold water immersion as an injury prevention and muscle recovery therapy.[1-3] Cold water immersion sometimes alternated with hot water immersion therapy, each bout lasting 1-10 minutes, depending on the therapy prescribed.[6,7] Although scientific evidence on these health benefits is still emerging, proponents claim that cold water immersion improves metabolic and mental health, boosts the immune system, speeds up post-exercise recovery, and alleviates chronic inflammation.[1,2,5] Consequently, environmental public health professionals (EPHPs)

have seen increasing numbers of personal service establishments (PSEs) offering cold plunge services in their jurisdictions.

For the purposes of this paper, the terms “cold plunge tanks/tubs” and “ice baths” are considered equivalent. The primary health concerns associated with cold plunge tanks are the potential infection risk from the shared use of the vessels, the effect of the cold temperature on disinfectant efficacy, and improper cleaning and disinfection practices for these vessels.[8] Another health risk is the potentially dangerous physiological response from cold water exposure on the body and organs. Injury from physical hazards in the cold plunge environment such as slips, falls, and entrapment is also possible. Children and seniors may be more susceptible to the physiological and physical hazards of cold plunge tanks.

In Canada, cold plunge tanks with recirculating filtration and treatment systems typically must comply with regulations governing swimming pools. However, cold plunge tanks differ from swimming pools and thus operators have difficulty complying with certain aspects of swimming pool regulations. Stand-alone cold plunge tanks that do not have recirculating filtration or automatic disinfection systems are not covered by swimming pool regulations, creating a regulatory gap. Stand-alone cold plunges are typically found in PSEs such as spas and wellness centers. However, in provinces where personal service settings are regulated and inspected, existing regulations and guidelines do not provide specific requirements or guidance for the safe and hygienic operations of cold plunge tanks.

As more people take interest in cold plunge practices, more businesses offering these types of services will likely emerge due to market demands, but there is limited public health guidance for this novel apparatus. The purpose of this paper is to present the potential health risks associated with cold plunge tanks and how these risks may be mitigated. This is a first step toward increasing awareness around the environmental public health risks that these vessels may pose, and to developing guidelines that would protect the health of users.

Methodology

Literature search

A literature search was conducted in EBSCOhost databases (includes Medline, CINAHL, Academic Search Complete, ERIC, etc.), Google Scholar, and Google. Peer-reviewed and grey English-language literature from 2014 to 2024 were collected, although older literature was also included if relevant. Additional references were added via forward and backward chaining of those search results and supplemental

searches, as necessary. Each study was assessed by a single reviewer and the results were synthesized narratively. The synthesis was subjected to internal and external review. Google was also used to identify additional relevant grey and industry literature. EPHPs on national and provincial personal service settings working groups in Canada were consulted on this project. Complete search terms are listed in Appendix A.

Results

Existing guidance on cold plunge tanks

Current guidance related to cold plunge tanks/basins/pools are generally aligned with those for hot spas/whirlpools. No guidance was found pertaining to disinfection and water chemistry, cleaning and draining practices, or number of concurrent users specific to cold plunge tanks. The MAHC defines spas as a structure intended for both warm or cold water, and discusses the physiological hazards associated with cold water exposure.[9] The MAHC also requires the turnover rate of cold plunge pools to be one hour or less.[9] The New Public Pool Plan Approval Requirements from California provides some general guidance on certain aspects of cold plunge environments and spells out additional requirements for cold plunge tanks in spas[10]:

- The maximum size is 49 square feet and the maximum depth is 4 feet.
- The cold plunge must be built in conjunction with a hot spa.
- The cold plunge must have a refrigeration system or other means to cool the water.
- Recirculation system requirements must comply with hot spa standards.
- A ladder and grab rail may be used in lieu of stairs.
- Benches may be omitted.

In the absence of additional guidance, existing US and Canadian hydrotherapy tanks and whirlpool spas guidelines may be consulted for similarities. The US CDC Guidelines for Environmental Infection Control in Health-Care Facilities defines hydrotherapy tanks as closed-cycle water systems with hydro jets but no filtration or automatic disinfection systems, with water temperatures ranging from 10°C-40°C.[11] The guidelines require hydrotherapy tanks to be drained, cleaned, and disinfected between each user. Additionally, an EPA-registered disinfectant product or sodium hypochlorite must be added to the water, with a 15-ppm chlorine residual in small hydrotherapy tanks or 2-5 ppm chlorine residual in whirlpools.[12] The higher chlorine residual is to account for accelerated disinfectant dissipation and reaction with organic compounds due to the higher temperature, as well as the reduction in chlorine effectiveness from water aeration with hydro jets.

Newfoundland's Environmental Health Guidelines for Hydrotherapy Pools is another guideline for which similarities to cold plunge tanks may be extrapolated.[13] In the context of these guidelines, hydrotherapy pools are required to have a recirculation and continuous disinfection system. These guidelines do not cover hydrotherapy tanks, spas, and whirlpools that are drained and disinfected after each use.

Guidance on residual disinfectant requirements for swimming pools and hot tubs may also be consulted when developing guidelines for cold plunge tank. A table summarizing the residual disinfectant requirements for recreational water in different provinces can be found in Appendix B. Additional disinfection and cleaning instructions may be available from cold plunge tank manufacturers. However, many of them are for personal and residential use only. For commercial use, the safety and suitability of each cold plunge tank equipment and set-up need to be assessed on an individual basis.

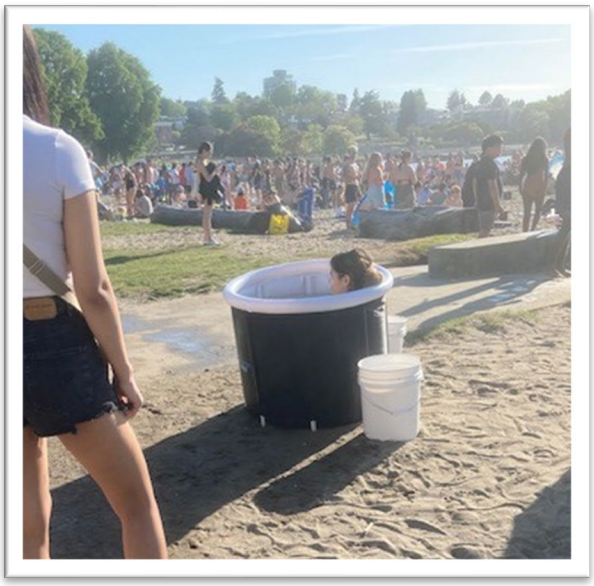
Although the Model Aquatic Health Code includes a section on disinfection protocols in floatation tanks, the highly saturated saline water in floatation tanks differs drastically from the water in cold plunge tanks; as such, the disinfectant requirements would not apply to cold plunge tanks.[9] Therefore floatation tank guidelines were not considered for the purposes of this paper.

Outbreaks associated with cold plunge tubs and shared ice baths

A review of the literature did not reveal any outbreaks associated with cold plunge tubs in personal service establishments, but outbreaks in other settings have occurred. Among athletes, hot/cold water immersion is a popular form of therapy, which may take place in shared whirlpools or ice baths. Athletes are prone to injuries and are therefore at risk for skin and soft tissue infection if proper hygiene practices are not followed in shared spaces. A survey of distance runners revealed that 12% of respondents experienced fecal incontinence while running.[14] If appropriate hygiene practices are not followed, fecal matter could potentially contaminate shared ice baths. Outbreaks of *Staphylococcus aureus*, herpes simplex virus type 1 (HSV-1), *Streptococcus pyogenes*, and some types of fungi have been documented in athletes, and the practice of sharing a whirlpool, clothing, or towels were identified as potential routes of transmission.[15] Poor hygiene practices in the shared facilities of an Australian professional football team, including a shared ice bath, were identified as potential risk factors in a methicillin-resistant *Staphylococcus aureus* (MRSA) outbreak among the players.[16] Another investigation by Public Health England found that several practices, including sharing towels, razors, and ice baths, may have contributed to an MSSA outbreak in a rugby team.[17]

Standard cold plunge tank design and use

Cold immersion can take place in different vessels, such as a tank that is hard plumbed with a recirculating filtration and automatic disinfection system, similar to traditional swimming pools, or a stand-alone tank without filtration or disinfection systems, made with a variety of materials such as stainless steel, plastic, vinyl, fiberglass, or even specially treated wood (figures 1 and 2).[8,18,19] The tanks are either pre-assembled or require some assembly upon delivery, or may be inflatable or portable. Some premium cold plunge tanks are equipped with a chiller for cold water only, or a heat pump that provides both heating and cooling, as well as 20-micron filtration and ozone and/or UV disinfection systems.[18,19] Commercial cold plunge tanks with larger capacity, larger filters with a hair catcher, and increased pump speed for quicker chilling are also available from some manufacturers.[20] These larger tanks enable simultaneous use by multiple individuals.



Figures 1 and 2: Stand-alone tanks found in local communities (personal photos)

In order to prevent formation of biofilms in the filtration and plumbing systems as well as the vessel itself, existing commercial cold plunge tanks with UV or ozone disinfection require the use of an additional residual disinfectant.[21,22] While some models recommend the use of a hydrogen peroxide product, the 2023 Model Aquatic Health Code (MAHC), which provides public health guidance for pools, hot tubs and splash pads, prohibits the use of UV/hydrogen peroxide combination systems in aquatic facilities, because neither UV nor hydrogen peroxide provide continuous disinfection in the form of a residual.[9] Therefore only chlorine or bromine should be used in conjunction with UV or ozone. In addition to regular cleaning, the presence of residual disinfectants in the water also helps minimize biofilm

formation in the filtration system as long as the water is flowing constantly as required by one of the commercial cold plunge tank manufacturers.[22]

The temperature of the water used in cold plunge tanks differs depending on personal preferences. Cold plunge facilities operate at a range of temperatures, varying from 2°C to 10°C.[23] A systematic review on the effect of water temperature and duration on muscle soreness and recovery found that immersing in water between 10° to 15°C demonstrated the best results.[24] Temperatures between 9° to 15 °C appear to be typical experimental temperatures for preventing and treating muscle soreness in another systematic review.[25] Water temperatures between 5 to 10°C are categorized as "severe cold" and may trigger the "cold shock response", which will be briefly discussed in a subsequent section. The duration of cold water immersion varies among individuals, although systematic reviews on the benefits of cold water immersion on muscle recovery found that between 11 and 15 minutes produced the best results.[24,25]

Health risks associated with cold plunge tanks

Microbiological hazards

The main microbiological hazard found in recreational water such as swimming pools and cold plunge tanks is from shedding of fecal and non-fecal organic matter from bathers through accidental release of fecal material, shedding of skin, and open cutaneous infections among other sources.[26] Pathogens that can be found in recreational water include *Escherichia coli*, *Salmonella typhi, Salmonella paratyphi, Shigella dysenteriae*, norovirus, *Pseudomonas aeruginosa*, and *Vibrio cholerae*.[26-28] Other pathogens include *Cryptosporidium* spp., *Microsporidia* spp., as well as *Legionella*.[26] Some protozoan pathogens such as *Cryptosporidium* spp. and *Giardia* can be removed with water filtration systems with a pore size of 1 micron or less.[29] However, given that existing cold plunge tank filtration systems are typically 20 microns in pore size, they are not adequate to remove these protozoa. *Pseudomonas aeruginosa* may also present a particular challenge for cold plunge tanks as it forms biofilms, which protect not only *P. aeruginosa* from disinfection but may also harbour other pathogens.[28] It is commonly assumed that at low temperatures, such as the water temperature found in cold plunge tanks, pathogen growth is inhibited. A study on temperature effects on survival and growth of *E. coli* 0157:H7 and *Salmonella* Typhimurium found that both pathogens were able to survive at 4°C; however growth was inhibited.[30]

Only one study on microbiological hazards in cold plunge tanks was found.[31] The authors collected water samples from fixed cold plunge tanks hard-plumbed into recirculating filtration and disinfection systems, and mobile inflatable tubs that do not have filtration or automatic disinfection systems, but do have a chlorine disinfectant that is manually added to the water. The fixed tanks were used solely for cold plunges, while the mobile inflatable tubs were used for both hot and cold water immersion and bathers were able to freely rotate between them (see figures 3 and 4).

Figures 3 and 4: Mobile inflatable tubs and fixed tanks (excerpted from the study)[31]

These mobile tubs were drained and cleaned only once a day, and the tubs remain inflated during cleaning to enable better access to the creases. Although bathers were encouraged to shower prior to using the tubs, this practice was not enforced or monitored. No information on number of bathers in the mobile tubs was available, although it was indicated that there was constant high bather load in all of the mobile tubs. All but one of eight water samples (87%) from the fixed tanks was found to be negative for *Escherichia coli* and coliforms, *Pseudomonas aeruginosa*, and *Staphylococcal aureus*. However, 64% of water samples from the mobile inflatable tubs were positive for one or more of *E. coli* and coliforms, *P. aeruginosa*, and *S. aureus*, even though residual chlorine levels in the water ranged from 0.05 to 4.01 mg/L. It is worth noting that the authors did not specify whether there was a difference in pathogen levels in water samples from hot mobile baths versus cold mobile baths; warm environments are more conducive to bacterial growth, and disinfectants dissipate faster in warmer water.

Physiological hazards

Sudden cold water exposure can lead to several physiological reactions, some of which can be fatal. Cold water exposure triggers the "cold shock response," which causes an increase in breathing, heart rate, and blood pressure, and places stress on the heart, which can lead to non-fatal or fatal arrhythmias.[1,32,33]

People with underlying heart conditions or those who take medications for cardiac conditions may react more adversely to cold water immersion.[32] Additional adverse reactions include hyperventilation leading to blood acidosis, temporary peripheral paralysis and muscle failure, loss of consciousness, or even nerve damage if exposed to very cold water or prolonged exposure to cold water.[1,24,34,35] Immersion in cold water lowers core body temperature and increases arterial blood pressure, which may hypothetically trigger a stroke.[36,37] Children differ from adults physiologically and physically and may be more susceptible to adverse physiological reactions. Although there is some evidence that children's thermo-regulatory response is as effective as those of adults and that they exhibit a smaller cold shock response compared to adults, they should still be closely monitored if partaking in cold plunge activities.[38]

Cases of adverse reactions to cold water immersion have been documented. A 50-year-old experienced triathlete developed swimming-induced pulmonary edema within 10 minutes of starting the swimming portion of a triathlon, and required medical intervention.[39] A 73-year-old man developed symptoms of a stroke after immersing in a cold lake which was around 6°C, and a 48-year-old man also experienced symptoms of a stroke after bathing with cold water that was stored in a tank after a steep fall in local temperature from 26°C to 14°C.[37]

Physical hazards

Similar to a swimming pool environment, certain cold plunge tank design, construction, and operation aspects may pose physical hazards to users. Firstly, there is a potential of slips and falls while entering and exiting the cold plunge tank, the risk of which may be exacerbated due to cold-induced muscle failure and loss of coordination. Some cold plunge facilities are outdoors and therefore ice formation on decks, walkways, floors, or steps could pose a fall hazard.[40] Additionally, there is a potential for suction or entrapment hazard for cold plunge tanks with a recirculation system, similar to traditional swimming pools.[40] The US Consumer Product Safety Commission recorded 11 incidents of circulation entrapments in a pool, spa, or whirlpool bathtub in 2014-2018.[41] All victims were younger than 15 years of age. Six victims experienced hair entrapment, four victims experienced limb entrapment, and one victim experienced body entrapment. For stand-alone cold plunge tanks without recirculation systems, the tanks are usually unoccupied when the water is drained, which minimizes the risk. Nevertheless, the accidental release of the water drain should be prevented, and children should be monitored when using cold plunge tanks or pools. Some anti-suction/entrapment devices for spas required or recommended in Canada include drain outlet covers and vacuum relief mechanism in the suction system.[42,43]

Disinfection methods and temperature effects on disinfectant efficacy

Limited literature on disinfection methods or disinfectant efficacy in cold water in cold plunge tank environments was found. The only study that we identified found that there was a strong correlation between low residual chlorine levels and presence of waterborne pathogens, independent of cleaning practices.[31] Recreational waters such as swimming pools and hot tubs are typically disinfected with chlorine or bromine disinfectants that are approved by Health Canada. These products are registered under the Pest Control Products Act and have a Pest Control Product number on the label.[44] Ozone or ultraviolet light (UV) must be used in combination with a bromine or chlorine disinfectant. This is because ozone and UV do not provide any residual disinfection in the water, and the effectiveness of UV disinfection is affected by the turbidity of the water.[40,45] For most waterborne pathogens except adenoviruses and protozoa, a UV dose of 40 $mJcm^{-2}$ is able to achieve at least a 4-log inactivation.[45] Additionally, because ozone is a respiratory irritant, swimming pools that use ozone as an oxidizer must be de-gassed, or use a reactor to destroy the ozone; therefore, ozone does not provide any residual disinfection.[46] The use of ozone or UV as a pre-treatment step can reduce the amount of chlorine needed to maintain the required minimum residual chlorine, as well as reduce the formation of chlorine disinfection by-products, thereby reducing bathers' exposure to these irritants.[40,46,47] Although hydrogen peroxide is permitted in some jurisdictions in conjunction with UV in settings such as floatation tanks, the MAHC prohibits its use in aquatic facilities because hydrogen peroxide is an oxidizer of organic matter and does not provide a residual for continual disinfection.[9,48] Hydrogen peroxide is also not a permitted disinfectant product for recreational waters in Canada.[46]

Protozoan pathogens such as *Cryptosporidium* spp. and *Giardia* are resistant to low-concentration chlorine and bromine disinfectants, but both are susceptible to UV light.[49,50] *Cryptosporidium* spp. is also susceptible to high concentrations of hydrogen peroxide and ozone, although humans should not be exposed to such high concentrations.[50] Furthermore, various UV light wavelengths exhibit different disinfection effects; UVA (315–400 nm) has greater penetrating ability and thus is most effective in destroying microbial membranes, while UVC (200–280 nm) has better sterilization effects through absorbance of microbial DNA and protein.[51] Therefore the combination of UVA-UVC irradiation provides synergistic effects and is an ideal way to reduce biofilm-producing pathogens.[51] Past studies have found 254 nm to be effective in drinking water disinfection.[52] Another study found that a UV wavelength of 265 nm was most effective against chlorine-resistant bacteria.[53] However, it is important to note that for smaller treatment systems, typically only low-pressure UV systems can be used. These low-pressure systems are capable of emitting a wavelength of 254 nm.[54]

The water temperature in cold plunge tanks is typically around 10-15°C or even lower, which is considerably lower than that in swimming pools at above 21°C. The literature on the effects of low temperature on recreational water disinfection is minimal; however, it is well known that chlorine disinfection occurs more slowly, and residual chlorine dissipates more slowly at low temperatures.[55,56,57] Thus, at lower temperatures, higher disinfectant residual or longer contact time is required for effective disinfection.[58] For example, to achieve a 3-log inactivation of *Giardia* cysts with residual chlorine at 2.0 mg/L of neutral pH (7), a contact time of 124 minutes would be required at 10°C, compared to 62 minutes at 20°C.[59] Therefore, pathogens shed by one user may have an increased likelihood of persisting in the water in cold plunge tanks if disinfectant residual is too low or not enough contact time is achieved. There is limited literature on the effects of temperature on bromine disinfectants.

Mitigating health risks associated with cold plunge tanks

The rising popularity of cold water immersion and the dearth of research and evidence on how to reduce microbiological health risks to bathers pose challenges for EPHPs. Based on existing evidence, a recirculating filtration and automatic disinfection system is necessary to reduce the pathogen load introduced by users in cold plunge tanks that are not drained and disinfected between users. Given that chlorine disinfection efficacy is reduced at lower temperatures and that waterborne pathogens may be able to persist in cold water, it would be prudent to require a higher disinfectant residual or a secondary treatment system such as UV or ozone in recirculating cold plunge tanks. Appropriate cleaning schedules should also be established to maintain water quality in accordance to existing swimming pool and spa requirements.

In the absence of a recirculating system, similar to hydrotherapy tanks, stand-alone cold plunge tanks should be drained, cleaned, and disinfected between each client. A registered disinfectant product should be manually added to the water, and the water should be tested regularly to ensure that the residual disinfectant is adequate to minimize the microbiological hazards in the tank. Since these stand-alone tanks do not have the ability to provide secondary treatment with UV or ozone, it would be necessary to require a higher disinfectant residual in line with hot tub and hydrotherapy tank guidelines. Mobile inflatable plunge tubs, such as those used in the cold plunge tub study discussed earlier, may have creases or crevices that hinder effective cleaning and disinfection and therefore should not be used. Further research is necessary to determine the optimal residual disinfectant concentrations, disinfection practices, and other operational requirements in the low water temperatures in both recirculating and stand-alone cold plunge tanks.

In addition, bathers should be required to shower prior to entering the water, and people with open sores or injuries should be prevented from using the cold plunge. Emergency response protocols for

medical emergencies as well as guidelines to prevent suction or entrapment hazards and slips and falls should be established.

Manufacturers of cold plunge tanks should seek to obtain NSF approval for the apparatus design and construction as well as the water treatment and circulation systems; no information on NSF approval for existing commercial cold plunge tanks was found.

Summary

The increasing popularity of cold plunging due therapeutic claims means that EPHPs will continue to encounter them in regulated facilities. Significant knowledge gaps in optimal disinfection practices and disinfectant use in cold plunge tanks remain, as the efficacy of disinfectants can be affected by the lower temperature of the water. Only two waterborne pathogen outbreaks in which shared ice baths was a potential risk factor were found in the literature. The single study that was found on microbiological hazards in fixed cold plunge pools and portable cold plunge tanks highlights the importance of appropriate disinfectant use to reduce the presence of pathogens in the water. Draining and disinfecting the tank between users as well as the addition of a residual disinfectant is another measure to minimize pathogen levels in the water. Future studies should focus on the efficacy of different types of recreational pool disinfectants in low water temperatures, whether alone or in conjunction with UV or ozone. Furthermore, best practices in filtration, cleaning, and equipment maintenance should also be explored and examined. Due to the novelty of these vessels, collaboration between public health agencies, industry, and researchers would be necessary to develop appropriate knowledge and guidance to reduce potential hazards and protect the health of those who partake in this practice.

Acknowledgements

The author would like to acknowledge the valuable feedback of those involved in the review of this document, including: Juliette O'Keeffe, NCCEH; Michele Wiens, NCCEH; Lydia Ma, NCCEH; Angela Eykelbosh, Island Health; David Ryding, Public Health Ontario; Raymond Gullekson, Public Health Ontario; Sarah Richmond, Public Health Ontario; Kelly Briscoe, Public Health Ontario; John Minnery, Public Health Ontario; James M. Johnson, Public Health Ontario.

Appendix A

A combination of the search terms below was used to find relevant literature:

(ice-bath OR “ice bathing” OR cold OR cold-water OR chiller OR “cold plunge” OR “cold water immersion” OR “ice plunge” OR hot/cold)
AND
(immersion OR immersing OR plunge OR plunging OR tank OR tanks OR tub OR tubs OR bathtub OR barrel OR recovery OR therapy OR therapeutic)

(P. aeruginosa OR pseudomonas OR florens OR aureus OR hygiene OR microbial OR risk OR e-coli OR ecoli OR coliform OR S.aureus OR health OR infection OR “Escherichia Coli” OR pathogen OR dermal OR aerosol OR legionella OR microorganism OR organisms OR *Acinetobacter OR Burkholderia OR Staphylococcus OR Ewingella)*

(disinfectant OR disinfect OR disinfection OR chlorination OR chlorine OR chemical OR dettol OR milton OR solution OR clean OR temperature OR operator)
(impact OR evaluation OR evaluate OR affect OR efficacy) AND
(guideline OR guidelines OR guidance OR regulation OR regulations OR regulate OR legislate OR legislation OR Act)

(ultraviolet light OR ozone OR bromine OR chlorine)
AND
(Escherichia coli OR Salmonella OR Shigella OR norovirus OR Pseudomonas OR Vibrio cholerae) AND
(pool OR spa OR tub OR drinking water OR recreational water) AND
(disinfection or sterilization or cleaning)

(Ozone OR ultraviolet OR UV OR chlorine OR "sodium hypochlorite")
AND
(treatment OR sanitize OR sanitizing OR cleaning OR temperature)
AND
(water OR pool OR bath OR plunge)
AND
(efficacy OR effectiveness OR effective)
NOT
(wastewater OR re-use)

Appendix B

Summary of disinfection requirements for swimming pools and spas/whirlpools across Canada

Province/Territory	Residual chlorine (ppm)	Residual bromine (ppm)
British Columbia[60]	min 0.5 if ≤ 30°C min 1.5 if > 30°C	min 1.5 if ≤ 30°C min 2.5 if > 30°C
Ontario[42]	0.5-10 for swimming pools 5-10 for spas	min 2; max 4
Saskatchewan[61]	min 2 for swimming pools min 3 for whirlpools	min 3 for swimming pools min 4 for whirlpools
Yukon Territory[62]	min 0.5 if ≤ 30°C min 1.0 if > 30°C	none
Nunavut[63]	Show a residual as close to 1.2 as possible; should fall between 1.0 and 1.5 inclusive for swimming pools 5-10 for spas	Minimum 1.5 5-10 for spas
Northwest Territories[64]	Show a residual as close to 1.2 as possible; should fall between 1.0 and 1.5 inclusive for swimming pools 5-10 for spas	Minimum 1.5 5-10 for spas
Newfoundland and Labrador[65]	1.5 for indoor pools; 3 for outdoor pools 2-3 for spas	2-3 for all pools 2-4 for spas
Alberta[66]	min 1 if ≤ 30°C min 2 if > 30°C	none
Prince Edward Island[67]	1.0-3.0 for swimming pools min 3.0 for whirlpools	none

Quebec[68]	0.8-2 for indoor pools 0.8-3 for outdoor pools 2-3 if > 35°C	2-5 for all pools 3-5 if > 35°C
Manitoba[69]	1.0-5.0 for pools and whirlpools	2-6 for whirlpools
New Brunswick	No guideline or legislation was found	No guideline or legislation was found
Nova Scotia[70]	Minimum 1 for indoor pools Minimum 2 for outdoor pools Minimum 3 for spas	Minimum 3 for all pools 4-6 for spas

References

1. Tipton MJ, Collier N, Massey H, Corbett J, Harper M. Cold water immersion: kill or cure? Exper Physiol. 2017;102(11):1335-55. Available from: https://physoc.onlinelibrary.wiley.com/doi/abs/10.1113/EP086283.
2. Espeland D, de Weerd L, Mercer JB. Health effects of voluntary exposure to cold water – a continuing subject of debate. Int J Circum Health. 2022;81(1):2111789. Available from: https://doi.org/10.1080/22423982.2022.2111789.
3. Knechtle B, Waśkiewicz Z, Sousa CV, Hill L, Nikolaidis PT. Cold water swimming-benefits and risks: a narrative review. Int J Environ Res Public Health. 2020 Dec 2;17(23). Available from: https://doi.org/10.3390%2Fijerph17238984.
4. Prendergast C. Cold Plunges: Health benefits, risks and more. Forbes Health; 2024 [cited 2024 Feb 26]; Available from: https://www.forbes.com/health/wellness/cold-plunge-what-to-know/.
5. Stone W. Ready to cold plunge? We dive into the science to see if it's worth it. National Public Radio; 2023 Oct 8 [cited 2024 Feb 1]; Available from: https://www.npr.org/sections/health-shots/2023/10/08/1204411415/cold-plunge-health-benefits-how-to.
6. Lateef F. Post exercise ice water immersion: Is it a form of active recovery? J Emerg Trauma Shock. 2010 Jul;3(3):302. Available from: https://doi.org/10.4103%2F0974-2700.66570.
7. Shadgan B, Pakravan AH, Hoens A, Reid WD. Contrast baths, intramuscular hemodynamics, and oxygenation as monitored by near-infrared spectroscopy. J Athl Train. 2018 Aug;53(8):782-7. Available from: https://doi.org/10.4085/1062-6050-127-17.
8. Mundy L. Microbiological risks of ice baths and hot/cold immersion therapy used for post-exercise recovery. Queensland: Gold Coast Public Health Unit; 2018. Available from: https://www.ehaqld.org.au/documents/item/1076.
9. US Centers for Disease Control and Prevention. Model Aquatic Health Code. Atlanta, GA: CDC. 2023. Available from: https://www.cdc.gov/mahc/editions/current.html.
10. Country of Los Angeles Public Health. New public pool plan approval requirements. Los Angeles, CA: Country of Los Angeles Public Health. 2020. Available from: http://publichealth.lacounty.gov/eh/docs/permit/public-pool-plan-approval-requirements.pdf.
11. US Centers for Disease Control and Prevention. Guidelines for environmental infection control in health-care facilities. Atlanta, GA: CDC. 2019. Available from: https://www.cdc.gov/infectioncontrol/guidelines/environmental/index.html.
12. US Centers for Disease Control and Prevention. Water use in hydrotherapy tanks. Atlanta, GA: CDC. 2021 [updated 2022 Jan 04]; Available from: https://www.cdc.gov/healthywater/other/medical/hydrotherapy.html.
13. Government of Newfoundland and Labrador. Public Pool Standards and Guidelines. St John, NL: Government of Newfoundland and Labrador. 2019. Available from: https://www.gov.nl.ca/hcs/files/Environmental-Health-Guidelines-Public-Pool-Manual.pdf.

14. Sullivan SN, Wong C. Runners' diarrhea. Different patterns and associated factors. J Clin Gastroenterol. 1992 Mar;14(2):101-4. Available from: https://doi.org/10.1097/00004836-199203000-00005.
15. Rihn JA, Michaels MG, Harner CD. Community-acquired methicillin-resistant staphylococcus aureus:an emerging problem in the athletic population. Amer J Sports Med. 2005;33(12):1924-9. Available from: https://journals.sagepub.com/doi/abs/10.1177/0363546505283273.
16. Shaban RZ, Li C, O'Sullivan MVN, Kok J, Dempsey K, Ramsperger M, et al. Outbreak of community-acquired Staphylococcus aureus skin infections in an Australian professional football team. J Sci Med Sport. 2021;24(6):520-5. Available from: https://www.sciencedirect.com/science/article/pii/S144024402030815X.
17. Public Health England. Rugby players: do you really want to share your mate's towel? London, UK: Public Health England. 2014. Available from: Rugby players: do you really want to share your mate's towel? - GOV.UK (www.gov.uk).
18. Nastasi P. The 12 best cold plunge tubs of 2024. Sports Illustrated; 2024 [updated 2024]; Available from: https://www.si.com/showcase/fitness/best-cold-plunge-tub.
19. Lanning A. 11 Best cold plunge tubs of 2024. @barbendnews; 2024; Available from: https://barbend.com/best-cold-plunges/.
20. The plunge. maintaining your water quality (The Plunge). Plunge Support. 2024; Available from: https://help.plunge.com/hc/en-us/articles/17642684886548-Maintaining-Your-Water-Quality-The-Plunge.
21. Inergize Health. FAQs - Do I need to change the water? Inergize Health. 2024; Available from: https://inergizehealth.com/pages/faqs.
22. The Plunge. Commercial cold plunge manual (The Plunge). Plunge Support. 2023. Available from: https://help.plunge.com/hc/en-us/articles/17642516893972-The-Plunge-Manuals.
23. Smith B. The growing cult of cold plunge has its fans by the emotions. Toronto, ON: Toronto Star. 2024 [updated 2024 Jan 13]; Available from: https://www.thestar.com/life/the-growing-cult-of-cold-plunge-has-its-fans-by-the-emotions/article_b4204d0c-ae6a-11ee-a150-bb4cbb17e62e.html.
24. Machado AF, Ferreira PH, Micheletti JK, de Almeida AC, Lemes ÍR, Vanderlei FM, et al. Can water temperature and immersion time influence the effect of cold water immersion on muscle soreness? A systematic review and meta-analysis. Sports Med. 2016;46(4):503-14. Available from: https://doi.org/10.1007/s40279-015-0431-7.
25. Bleakley C, McDonough S, Gardner E, Baxter GD, Hopkins JT, Davison GW. Cold-water immersion (cryotherapy) for preventing and treating muscle soreness after exercise. Cochrane Database Syst Rev. 2012 Feb 15(2):Cd008262. Available from: https://doi.org/10.1002/14651858.cd008262.pub2.
26. Hassanein F, Masoud IM, Fekry MM, Abdel-Latif MS, Abdel-Salam H, Salem M, et al. Environmental health aspects and microbial infections of the recreational water. BMC Public Health. 2023;23(1):302. Available from: https://doi.org/10.1186/s12889-023-15183-z.
27. US Centers for Disease Control and Prevention. Swimming-related Illnesses. Atlanta, GA: CDC. 2022 [updated 2022 Jul 8]; Available from: https://www.cdc.gov/healthywater/swimming/swimmers/rwi.html.

28. Guida M, Di Onofrio V, Gallè F, Gesuele R, Valeriani F, Liguori R, et al. Pseudomonas aeruginosa in swimming pool water: evidences and perspectives for a new control strategy. Int J Environ Res Public Health. 2016 Sep 15;13(9). Available from: https://doi.org/10.3390%2Fijerph13090919.
29. Centers for Disease Control and Prevention. Parasites - Cryptosporidium - A Guide to Water Filters. 2021 [updated 2021 Nov 24]; Available from: https://www.cdc.gov/parasites/crypto/gen_info/filters.html.
30. Van Der Linden I, Cottyn B, Uyttendaele M, Berkvens N, Vlaemynck G, Heyndrickx M, et al. Enteric pathogen survival varies substantially in irrigation water from Belgian lettuce producers. Int J Environ Res Public Health. 2014;11(10):10105-24. Available from: https://doi.org/10.3390/ijerph111010105.
31. Mundy L. Microbiological risks of ice baths and hot/cold immersion therapy used for post-exercise recovery. Queensland: Queensland Government, Gold Coast Public Health Unit. 2018. Available from: https://www.ehaqld.org.au/documents/item/1076.
32. Williamson L. You're not a polar bear: the plunge into cold water comes with risks. Amer Heart Assoc; 2022; Available from: https://www.heart.org/en/news/2022/12/09/youre-not-a-polar-bear-the-plunge-into-cold-water-comes-with-risks.
33. Farstad DJ, Dunn JA. Cold water immersion syndrome and whitewater recreation fatalities. Wilderness Environ Med. 2019;30(3):321-7. Available from: https://doi.org/10.1016/j.wem.2019.03.005.
34. Heil K, Thomas R, Robertson G, Porter A, Milner R, Wood A. Freezing and non-freezing cold weather injuries: a systematic review. Br Med Bull. 2016 Mar;117(1):79-93. Available from: https://doi.org/10.1093/bmb/ldw001.
35. Stocks JM, Taylor NAS, Tipton MJ, Greenleaf JE. Human physiological responses to cold exposure. Aviation Space Environ Med. 2004;75(5):444-57. Available from: https://www.ingentaconnect.com/content/asma/asem/2004/00000075/00000005/art00011.
36. Muller MD, Kim C-H, Seo Y, Ryan EJ, Glickman EL. Hemodynamic and thermoregulatory responses to lower body water immersion. Aviation Space Environ Med. 2012;83(10):935-41. Available from: https://doi.org/10.3357/ASEM.3311.2012.
37. Benedict PS, Pandian JD. Stroke after cold bath. CHRISMED J Health Res. 2014;1(4):283-5. Available from: https://journals.lww.com/chri/fulltext/2014/01040/stroke_after_cold_bath.16.aspx.
38. Bird F, House J, Tipton MJ. The physiological response on immersion in cold water and the cooling rates on swimming in a group of children aged 10 – 11 years. Int J Aquatic Res Educ. 2015;9(2):7. Available from: https://scholarworks.bgsu.edu/ijare/vol9/iss2/7.
39. Barouch LA. Swimming-induced pulmonary edema. JACC: Case Rep. 2022;4(17):1094-7. Available from: https://www.jacc.org/doi/abs/10.1016/j.jaccas.2022.05.019.
40. British Columbia Ministry of Health. BC guidelines for pool operations. Victoria, BC: Government of BC. 2021. Available from: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/documents/pool_operations_guidelines_oct_2021_v3_interim.pdf.
41. US. Consumer Product Safety Commission. 2014–2018 Reported circulation/suction entrapment incidents associated with pools, spas, and whirlpool bathtubs. Bethesda, MD: U. S. Consumer Product Safety Commission. 2019. Available from: https://www.cpsc.gov/s3fs-public/2019_Circulation_Entrapment.pdf.
42. Government of Ontario. R.R.O. 1990, Reg. 565: Public pools. (2023). Available from: https://www.ontario.ca/laws/regulation/900565.

43. Pool & Hot Tub Council of Canada. Recommended guidelines: suction entrapment avoidance provisions. Mississauga, ON: Pool & Hot Tub Council of Canada. 2009; Available from: https://www.poolcouncil.ca/wp-content/uploads/2021/11/Suction-Entrapment-Avoidance-Provisions-G-0109.pdf.
44. Health Canada. Swimming pool and spa chemicals. Ottawa, ON: Government of Canada. 2021; Available from: https://www.canada.ca/en/health-canada/services/home-garden-safety/swimming-pool-spa-cleaning.html.
45. Gao Y, Sun Z, Guo Y, Qiang Z, Ben W. Virus inactivation by sequential ultraviolet-chlorine disinfection: Synergistic effect and mechanism. Chemosphere. 2023;314. Available from: https://doi.org/10.1016/j.chemosphere.2022.137632.
46. Eykelbosh A, Beaudet S. Float tanks: considerations for environmental public health. Vancouver, BC: National Collaborating Centre for Environmental Health; 2016. Available from: https://ncceh.ca/resources/evidence-reviews/float-tanks-considerations-environmental-public-health.
47. Chowdhury S, Alhooshani K, Karanfil T. Disinfection byproducts in swimming pool: occurrences, implications and future needs. Water Res. 2014;53:68-109. Available from: https://www.sciencedirect.com/science/article/pii/S004313541400044X.
48. Ontario Ministry of Health. Recommendations for floatation tanks. Toronto, ON: Government of Ontario. 2019. Available from: https://files.ontario.ca/moh-ophs-ref-recommendations-for-floatation-tanks-2019-en.pdf.
49. Public Health Agency of Canada. Pathogen safety data sheets: infectious substances – giardia lamblia. Ottawa, ON: Government of Canada. 2012 [updated 2012 Apr 30]; Available from: https://www.canada.ca/en/public-health/services/laboratory-biosafety-biosecurity/pathogen-safety-data-sheets-risk-assessment/giardia-lamblia.html.
50. Public Health Agency of Canada. Pathogen safety data sheets: infectious substances – cryptosporidium parvum. Ottawa, ON: Government of Canada. 2014. Available from: https://www.canada.ca/en/public-health/services/laboratory-biosafety-biosecurity/pathogen-safety-data-sheets-risk-assessment/cryptosporidium-parvum-pathogen-safety-data-sheet.html.
51. Luo X, Zhang B, Lu Y, Mei Y, Shen L. Advances in application of ultraviolet irradiation for biofilm control in water and wastewater infrastructure. J Hazard Mat. 2022;421. Available from: https://zbp.xmu.edu.cn/images/literature/2021-SL-JHM.pdf.
52. Severin BF, Suidan MT, Engelbrecht RS. Effect of temperature on ultraviolet light disinfection. Environ Sci Technol. 1983 Dec;17(12):717-21. Available from: https://doi.org/10.1021/es00118a006.
53. Jing Z, Lu Z, Santoro D, Zhao Z, Huang Y, Ke Y, et al. Which UV wavelength is the most effective for chlorine-resistant bacteria in terms of the impact of activity, cell membrane and DNA? Chem Eng J. 2022 Nov;447:137584. Available from: https://www.sciencedirect.com/science/article/pii/S1385894722030716.
54. Luo X, Zhang B, Lu Y, Mei Y, Shen L. Advances in application of ultraviolet irradiation for biofilm control in water and wastewater infrastructure. J Hazad Mat. 2022 Jan;421:126682. Available from: https://www.sciencedirect.com/science/article/pii/S0304389421016472.
55. Cooke R. Chlorination efficiency. Big Stone Gap, VA: Mountain Empire Community College. n.d. Available from: https://water.mecc.edu/concepts/chlorefficiency.html.

56. García-Ávila F, Sánchez-Alvarracín C, Cadme-Galabay M, Conchado-Martínez J, García-Mera G, Zhindón-Arévalo C. Relationship between chlorine decay and temperature in the drinking water. MethodsX. 2020 Jan;7:101002. Available from: https://www.sciencedirect.com/science/article/pii/S2215016120302223.
57. Monteiro L, Figueiredo D, Covas D, Menaia J. Integrating water temperature in chlorine decay modelling: a case study. Urb Water J. 2017 Nov;14(10):1097-101. Available from: https://doi.org/10.1080/1573062X.2017.1363249.
58. Washington State Department of Health. Reminder to surface water systems: adjust operations for cold weather. Tumwater, WA: Washington State Department of Health. 2020. Available from: https://doh.wa.gov/sites/default/files/legacy/Documents/Pubs//331-649.pdf.
59. US Environmental Protection Agency. Disinfection profiling and benchmarking: technical guidance manual. Washington, DC: EPA. 2020. Available from: https://www.epa.gov/system/files/documents/2022-02/disprof_bench_3rules_final_508.pdf.
60. Government of British Columbia. Pool regulation B.C. Reg. 296/2010. (2023). Available from: https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/296_2010#section10.
61. Government of Saskatchewan. Swimming pool regulations, 1999, P-37.1 Reg 7. (2012). Available from: https://publications.saskatchewan.ca/#/products/1362.
62. Government of Yukon. Public pool regulations O.I.C. 1989/130. (2020). Available from: https://laws.yukon.ca/cms/images/LEGISLATION/SUBORDINATE/1989/1989-0130/1989-0130.pdf.
63. Government of Nunavut. Public pool regulations. (2017). Available from: https://www.nunavutlegislation.ca/en/consolidated-law/public-pool-regulations-consolidation.
64. Government of Northwest Territories. Public pool regulations R.R.N.W.T. 1990,c.P-21. (2009). Available from: https://www.justice.gov.nt.ca/en/files/legislation/public-health/public-health.r4.pdf.
65. Government of Newfoundland and Labrador. Public pool standards and guidelines. (2023). Available from: https://www.gov.nl.ca/hcs/files/Environmental-Health-Guidelines-Public-Pool-Manual.pdf.
66. Government of Alberta. Pool standards. (2018). Available from: https://open.alberta.ca/dataset/6bc9b110-3b67-4d2e-b797-ab9ee003e7a4/resource/37c20024-52c5-44f0-9faa-c8360c10b17f/download/standards-pools-2018.pdf.
67. Government of Prince Edward Island. Swimming pool and waterslide regulations. (2014). Available from: https://www.princeedwardisland.ca/en/legislation/public-health-act/swimming-pool-and-waterslide-regulations.
68. Government of Quebec. Regulation respecting water quality in swimming pools and other artificial pools. (2022). Available from: https://www.legisquebec.gouv.qc.ca/en/document/cr/q-2,%20r.%2039.
69. Government of Manitoba. Swimming pools and other water recreational facilities regulation, M.R. 132/97. (2015). Available from: https://web2.gov.mb.ca/laws/regs/current/132-97.php?lang=en#8.
70. Government of Nova Scotia. Nova Scotia operational guidelines for aquatic facilities. (2014). Available from: https://novascotia.ca/nse/environmental-health/docs/Nova-Scotia-Operational-Aquatic-Guidelines.pdf.

How to cite this document

ISBN: 981-1-988234-90-8

This document can be cited as: Chen, T. Cold plunge tanks: Considerations for environmental public health. Vancouver, BC: National Collaborating Centre for Environmental Health. 2024 April.

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