Recreational Water-Related Illnesses: A Rapid Literature Review

(Visit Hampshire, 2016)

(Dooner, 2019)

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Background

Open-water swimming, where individuals swim in recreational waters such as lakes, rivers, and seas, is becoming increasingly popular in the United Kingdom (UK) (Outdoor Swimmer, 2021). There is developing evidence regarding the benefits of engaging with natural aquatic environments, often called ‘blue spaces’, on people’s health and wellbeing, with associations of enhanced mental well-being and increased opportunities for social interactions and physical activity (Oliver *et al.*, 2023). However, the absence of disinfectant properties in open water poses a risk to human health, individuals can be exposed to waterborne pathogens that may be naturally present in the aquatic environment or introduced through contamination from various sources of pollution: humans, sewage overflows, industrial activities, animals or wildlife; consequently, recreational water users may have a greater susceptibility to infectious disease transmission.

UK recreational water quality standards

- Most recreational waters are monitored or regulated to protect humans from illness through standard microbial water quality measurements, which are based on concentrations of faecal indicator organisms (FIOs) such as Escherichia coli (E. coli) and intestinal enterococci (Wiedenmann *et al.*, 2006).
- Since the 1990s, The Environment Agency (EA) have routinely monitored the water quality of many coastal waters and a few inland lakes in England, distinguishing them as designated ‘bathing waters’ that meet the World Health Organization (WHO) recommended levels of FIOs (Environment Agency, 2022)
- There are more than 400 designated bathing water sites, with 72% meeting the ‘excellent’ threshold for water quality (Environment Agency, 2022).
- Rivers and other recreational water locations are not classified as bathing waters; as a result, recreational contact with water not microbiologically tested may pose a higher health risk to users (Environment Agency, 2019).
- Further evidence about the microbiological risks for recreational water users will provide a better understanding of how to mitigate illness.

Research aims

- To investigate if there is evidence of adverse health outcomes linked to recreational water exposure, specifically focussing on primary contact recreation in marine and freshwater bodies and infectious disease outcomes (microbiological hazards and risks).
- To evaluate results from epidemiological studies published between 2000 and 2023 that explored the incidence of illnesses and identify the risk of illness.
- To provide evidence-based guidance and signpost the appropriate information to the public to mitigate any risks.
- Although this review focuses on infections acquired, it is important to balance the health and wellbeing benefits with these findings to inform prospective recreational water users.

Inclusion and exclusion criteria

CRITERIA	INCLUSION	EXCLUSION
POPULATION	Humans of all ages and any gender	Animals and wildlife
INTERVENTION	Primary contact recreation, Immersive-based activity in natural recreational water settings (bathing/swimming)	Recreation in non-natural swimming locations such as swimming pools and hot tubs
COMPARATOR	Non-bathers/no contact recreational water activity (e.g. visitors at the location that did not enter the water)	Other recreational activities not involving immersion e.g., boating activities, fishing
OUTCOME(S)	Any infection or illness acquired from recreational water exposure Microbial hazards or risks	Physical hazards or risks (drowning, swimming injuries) Temperature hazards or risks (cold, hypothermia) Physiological health outcomes Hazards related to wildlife and aquatic animals
STUDY DESIGN	Epidemiological studies: observational or experimental. Primary research	Case reports Secondary research (literature reviews and systematic reviews)
SETTING	Any studies conducted in Europe, from 2000 onwards	Studies conducted in countries outside of Europe to exclude pathogens that may not be present locally
LANGUAGE	English	Studies not published in English

Search strategy: PICO concepts & search terms

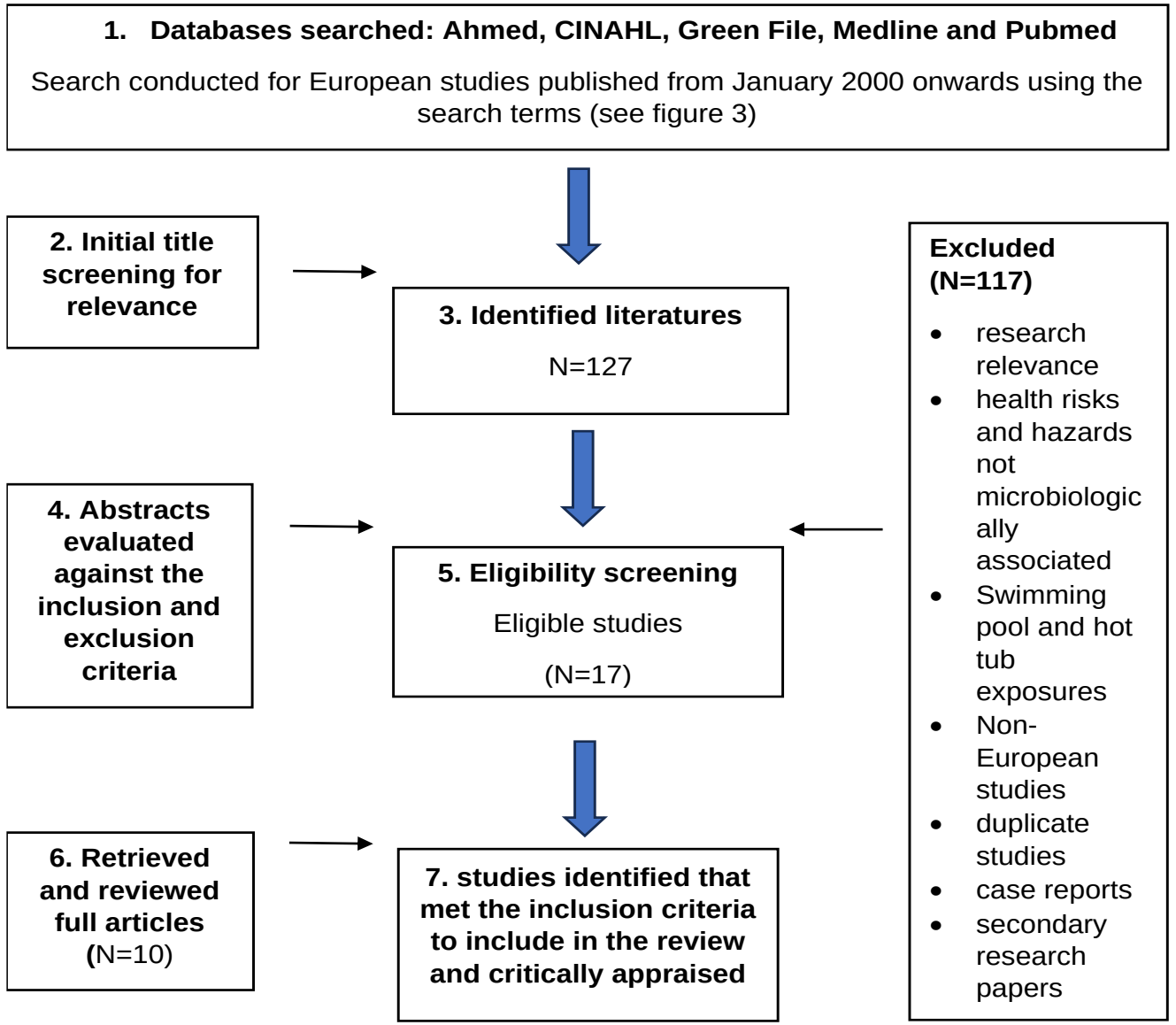
Concept 1 (P)	Concept 2 (I)	Concept 3 (C)	Concept 4 (O)
People	Swim*	“open water*”	Infectio*
Human*	Immers*	“recreational water*”	Illness*
Individual*	Bathe*	“freshwater*”	Disease*
	Dive*	Sea*	Sickness*
		River*	“health risk*
		Lake*	Outbreak*

OR

AND

Methodology

- Defined search strategy
- Five online databases were searched by one researcher: Ahmed, Cinahl, Green File Medline and PubMed, using the search terms
- Articles were screened against the inclusion criteria
- Overall discussion synthesises the evidence from 10 epidemiological studies that investigated infections acquired after recreational water exposure (marine and freshwater sites)
- Research papers used in this literature review: 7 cohort studies, 1 randomised controlled trial (RCT), 1 case-control study and 1 case series



Gastrointestinal illness

- Acute gastrointestinal illness (AGI) was the most reported recreational water-related illness.
- Pathogens that cause AGI include Giardia, cryptosporidium, Norovirus, salmonella, shigella and E. coli
- Common symptoms included nausea, diarrhoea, abdominal pain, vomiting, dizziness and fever.
- The incidence of gastrointestinal illness was consistently higher amongst bathers (individuals who were immersed in the water) compared to non-bathers (Wiedenmann *et al.*, 2006; Papastergiou *et al.*, 2012; Harder-Lauridsen *et al.*, 2013; Joosten *et al.*, 2017; Hintaran *et al.*, 2018; Prieto, 2001), suggesting that bathers may have an increased risk of AGI through immersive contact with the water.
- Variation of incidence rates: very high attack rate of AGI was observed in some studies, 42% of a cohort of 838 people in Denmark in 2010 (Harder-Lauridsen *et al.*, 2013), notably lower incidence rates in the same research but in 2011 cohort (8% overall attack rate of AGI) (Harder-Lauridsen *et al.*, 2013).
- The evidence demonstrates that the risk of recreational water-related illness can be linked to other exposure variables and conditions such as the microbiological quality of the water and user susceptibility (Prieto, 2001).

Respiratory illness

- Respiratory infections were another commonly reported illness associated with recreational water exposure.
- Can be caused by viral pathogens and pathogenic bacteria such as legionella.
- Symptoms include cold or flu-like symptoms such as coughing, dyspnoea, sore throat and dysphagia (Joosten *et al.*, 2017; Papastergiou *et al.*, 2012).
- Respiratory complaints were consistently higher in swimmers/bathers than non-bathers/non-swimmers (12% versus 4%, respectively) (Joosten *et al.*, 2017). Similarly observed by Papastergiou *et al.* (2012) attack rate of 6.2% in swimmers versus 2.6% in non-bathers.
- However, non-exposed participants were recruited by asking exposed participants to forward the questionnaire to friends and relatives, which resulted in different exposure between swimmers and non-swimmers (Joosten *et al.*, 2017); whereas, Papastergiou *et al.* (2012) control group on non-bathers where selected randomly for people who had not visited the site 15 days before the interview but lived in the same residence as bathers, a more reliable recruitment of controls as they are less likely to be implicated by secondary transmission like friends and relatives.

Ear, eye and cutaneous (skin) infections

- Infections affecting skin, ears and eyes were also associated with recreational water exposure.
- Symptoms of skin ailments included red spots/bumps or skin infection (Joosten *et al.*, 2017).
- Incidence of symptoms relating to ear, eye or skin infections were not as frequently reported as gastrointestinal and respiratory illnesses, in Joosten *et al.* (2017), skin-related health complaints made 2% of the overall total health complaints (43%).
- When compared to non-swimmers, the risk was not highly significant (swimmers 2% vs 0% non-swimmers) (Joosten *et al.*, 2017). Similarly, Papastergiou *et al.* (2012) found no significant difference in the risk of acquiring cutaneous infections among bathers.

Susceptibility to illness

- A few studies observed that children and young people had a higher incidence of illnesses: higher attack rate of AGI in 5-17 year-olds (39% of the sample) and under 5 year olds (26%) (Polkowska *et al.*, 2018). Similar observations in Schets *et al.* (2018) over half of the cases (56%) were 0-12 years of age. However, this case series study had a relatively smaller sample (45 respondents) and no matching controls were sought.
- Limitations: Both studies' recruitment is limited to volunteer bias as parents of young children may be more likely to participate and report health complaints when children are involved.
- Children may have a greater susceptibility to recreational water-related illness, this may be through increased exposure, it was observed that children had a longer duration of time in the water and higher ingestion of water; additionally, children have an incompletely developed immune system in comparison to adults which may explain their susceptibility (Schets *et al.*, 2018).
- Although cases tended to be younger than controls in the evidence, health outcomes were observed in different age groups across studies.

Factors associated with increased risk of illness

Degree of water contact

- Correlation between head immersion and the outcome of illness, particularly associated with acute gastroenteritis in Polkowska *et al.* (2018).
- Duration of bathing exposure was significantly associated with illness, particularly swimming time greater than 60 minutes, 96% increased risk of reporting AGI symptoms (Odds Ratio [OR] = 1.96, 95% CI 1.17–3.30) (Papastergiou *et al.*, 2012). Corroborated by Joosten *et al.* (2017) (aRR 1.3, 95 CI 1-1.7).

Swallowing water

- Having water in the mouth or accidentally swallowing water whilst swimming was associated with an increased risk of illness for recreational water users in several studies (HALL *et al.*, 2017; Harder-Lauridsen *et al.*, 2013; Joosten *et al.*, 2017; Polkowska *et al.*, 2018; Sartorius *et al.*, 2007).
- Wiedenmann *et al.* (2006) RCT found evidence of a true-dose relationship between mouthfuls of water swallowed and outcomes of illness, noting that the incidence of AGI was higher in bathers who swallowed water above no adverse effect levels (NOELs).
- There is great homogeneity that water ingestion is a significant risk factor associated with illness; however, it could be argued that this is factored in with the microbiological quality of the recreational water and the unpredictable susceptibility of individuals (Wiedenmann *et al.*, 2006).

Water quality

Bathing water vs non-bathing water

- Water quality may be an indicator of the incidence of illness. However, a few studies noted the incidence of illness in recreational waters that were classified as bathing waters (Wiedenmann *et al.*, 2006; Papastergiou *et al.*, 2012; Schets *et al.*, 2018).
- Recreational waters that meet the bathing-water quality standards are not risk-free, each country has differing degrees of water pollution (Prieto, 2001) and cohorts have different susceptibilities (Wiedenmann *et al.*, 2006)

Type of recreational water

- Six of the studies investigated the incidence of illness in freshwater recreational water sites, However, the evidence did not suggest the effect of the water type (marine or freshwater) being an indication of the incidence of illness.

Heavy rainfall and water quality

- Evidence suggests that the risk of illness from recreational water use fluctuates depending on weather conditions, particularly after heavy rainfall [Joosten *et al. (*2017); HALL *et al.* (2017); Harder-Lauridsen *et al. (*2013)]
- Norovirus outbreaks among two urban swimming events in city canals in The Netherlands (Hintaran *et al. (*2018); Joosten *et al. (*2017); researchers replicated the earlier study and observed differing incidence rates of illness Hintaran *et al. (*2018) attack rate of 18% vs 31% in Joosten *et al. (*2017). The higher attack rate in the previous study was attributable to heavy rainfall 2 days prior to the event causing severe flooding and sewage overflow into the canals (Joosten *et al.*, 2017)
- Similar results in Denmark retrospective cohort study: overall attack rate of AGI was 42% in 2010 cohort vs only 8% in the 2011 cohort (Harder-Lauridsen *et al.*, 2013). AGI more pronounced in 2010 event due to the preceding occurrence of heavy rainfall.
- Further corroborated in HALL *et al.* (2017) retrospective cohort study of participants of a swimming event in River Thames, London: attack rate of at least 33%, heavy rainfall may have elevated the levels of FIOs in the river.
- Faecal contamination of recreational waters is an important indicator of illness, heavy rainfall may be a predictive indicator of contamination

Preventative measures

- The evidence did not determine practical preventative measures associated with decreased risk of illness therefore limits precautions to inform bathers to reduce risk
- Having swam in a river open water previously in the last 2 years was associated with a reduced risk of illness (HALL *et al.*, 2017), possibly due to the development of resistance to the infection through recent exposure to the causal organism, or having greater experience or technique in open swimming wearing but not corroborated by other studies.
- Wearing a wetsuit was a factor found to increase the risk of illness (aRR 6·96, 95% CI 1·04–46·72), but this finding requires more consideration, this may indicate a need to raise awareness of pragmatic precautions of wetsuit washing and handling after exposure (HALL *et al.*, 2017)
- Preventative measures such as handwashing or antibacterial hand gel use within 30 minutes after the race, as well as the use of shower facilities 1-hour post-swim, were not associated with reduced risk of illness in HALL *et al. (*2017). However, the evidence is limited to potential recall bias as 3 weeks elapsed between the exposure event and survey initiation.
- Nevertheless, hand washing and use of antibacterial hand sanitised for infection prevention should be encouraged (HALL *et al.*, 2017).

Conclusion

- Epidemiological studies highlighted that gastrointestinal illness, respiratory illness, ear, eye and skin infections were common health outcomes associated with recreational water exposure.
- Evidence suggests that there is an increased risk of illness for bathers of recreational waters when compared to non-bathers, however, the magnitude of outbreaks can be attributable to other factors such as water quality, duration of exposure, ingestion of water and individual/cohort susceptibility.
- Water quality and contamination are predictive factors of illness, with a higher incidence of illness observed after rainfall and non-bathing water settings; however, studies conducted in designated bathing water sites still had outcomes of illness.
- There is currently little evidence on the effect of different types of recreational waters on the incidence of illness with no indication of the difference that settings have on outcomes.
- Most of the studies could not determine the causal microorganism of the outbreaks and is therefore limited to determining cause, only associations.
- The evidence surrounding recreational water-related illness is limited, practical preventative measures for swimmers were not determined, with little evidence of factors that reduced the risk of illness.
- However, the evidence base can be used for awareness of the health risks of swimming in recreational water settings.

Recommendations for agencies

- Agencies should communicate and provide information to community or resident groups about the potential health risks of recreational water activity, as well as proactive communication regarding the water quality and pollution risks such as heavy rainfall and location-specific information (HALL *et al.*, 2017).
- Manage pollution events and provide timely and effective information (e.g. issue media advice, communicate with community or resident groups, install warning signs) about recreational water environments affected by chemical hazards. (World Health Organization, 2021).
- More research and surveillance relating to recreational water-related illnesses, including those in urban areas, to understand the risk of outbreaks and participant susceptibility to health complaints.
- Encourage risk assessments for swimming events in recreational water settings ensuring to factor-in environmental factors such as weather condition, pollution, FIO levels and specific groups susceptibility (Hintaran *et al.*, 2018).

Recommendations for recreational water users

- Be aware of weather conditions, particularly heavy rainfall, as the quality of the water may be reduced.
- Check the bathing water quality of your recreational water: find a bathing water
- Try to avoid swallowing water whilst swimming.
- After bathing/swimming in recreational waters wash hands or use antibacterial hand sanitiser and shower as soon as possible.
- Remove wet swimwear or wet suits and shower immediately when possible after water exposure (World Health Organisation, 2021).
- Refrain from using recreational waters if experiencing symptoms of AGI or respiratory illness to avoid transmission to other users.
- If you become seriously ill after recreational water exposure, seek medical attention from GP and mention recent exposure

Further guidance and information

- GOV.uk Swim healthy leaflet details how to reduce the health risks involved in open water swimming
- Finding bathing water quality information for England Bathing water quality (data.gov.uk
- WHO Guidelines on recreational water quality: Volume 1 coastal and fresh waters (who.int)
- The river trust This map shows where the sewerage network discharges treated sewage and overflows of untreated sewage and storm water into rivers in England & Wales in 2022. The website provides near real time alerts. Is my river fit to play in? (arcgis.com)
- Surfers Against Sewage App and website combines EA pollution risk forecasts with water company sewage spill data

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