



Review

Do health risk perceptions motivate water - and health-related behaviour? A systematic literature review



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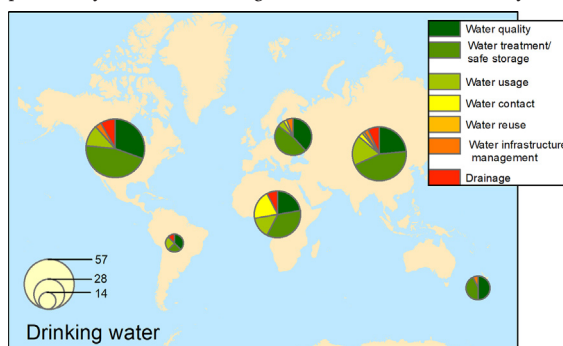
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HIGHLIGHTS

- First systematic review of risk perceptions and behaviours in the context of water and health from different continents, countries, settings and contexts around the globe
- Topics dominating literature relate to drinking water, sanitation, hygiene (WASH), waste, health risks, diseases and mental health, and preventative measures
- Evidence of perceptions determining behaviour, e.g. drinking water sources and water safety
- Contextualization with disease prevention, health seeking, variations over space, geography, socioeconomy, time, and cultural context
- Relevance for WASH governance in terms of policy, awareness raising, education and behaviour change, particularly in the face of the ongoing unprecedented pandemic

GRAPHICAL ABSTRACT

Water- and health-related risk perception and behaviour literature reports information from countries around the globe, conducted in various settings and contexts, among different target populations, from various disciplinary angles, using different methods, theories and approaches. Evidence of perceptions determining behaviour is provided particularly related to drinking water sources and water safety.



ARTICLE INFO

Article history:

Received 30 November 2021

Received in revised form 30 December 2021

Accepted 31 December 2021

Available online 6 January 2022

Editor: Damià Barceló

ABSTRACT

Health-related risk perceptions are important determinants of health behaviours and components of behaviour change theories. What someone thinks or feels will motivate or hinder their intention or hesitancy to implement a certain behaviour. Thus, a perceived potential risk to our health and well-being can influence our health-promoting and/or health-seeking behaviour. We aimed to review and synthesize available peer-reviewed literature to better understand the links between water and health-related risk perceptions and behaviours.

We conducted the first systematic review of peer-reviewed literature on risk perceptions and behaviours in the context of water and health, published between 2000 and 2021. A total of 187 publications met the inclusion criteria. We

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Keywords:

Behaviour change
Health-related knowledge
Hygiene
Sanitation
WASH governance
Water safety

extracted data relating to study characteristics and categorized our results according to the major themes emerging from the literature, namely drinking water, sanitation, hygiene and wasterelated topics, health risk factors, diseases and mental health implications, and preventative measures.

Our review shows that the literature has grown over the past twenty years, reporting information from different countries belonging to different income groups around the globe, conducted in various settings and contexts, among different target populations, from various disciplinary angles, using different methods, theories and approaches. Our review provides evidence of health risk perceptions determining behaviour particularly related to drinking water sources and water safety. Evidence on disease prevention, health seeking, variations and changes in perception and behaviour over space, geography, socioeconomic differences and time, and the relevance of cultural context is provided. Our review shows that risk perception studies are vital for WASH governance in terms of policy, raising awareness, education and behaviour change. In order to make risk perception and behaviour studies even more relevant to effective public health planning and health messaging, future research needs to increasingly focus on early culturally sensitive interventions and changes in perceptions and behaviours over time.

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1. Introduction

Health-related knowledge, awareness, and health risk perceptions - how an individual perceives a health threat - are important determinants of health behaviours and components of behaviour change theories (Ferrer and Klein, 2015). Different schools of thought exist, but generally, the notion is that what someone thinks or feels (e.g., perceived risk, worry, concerns, confidence, trust) along with social processes shaping these feelings will motivate or hinder their intention or hesitancy to implement a certain behaviour (Brewer et al., 2017). Thus, a perceived potential risk to our health and well-being can influence our health-promoting and/or health-seeking behaviour, e.g., the adoption of protective health measures, the consultation with healthcare providers or our willingness to vaccinate against a certain disease.

In this systematic literature review, we look at risk perceptions and behaviours in the context of water and health. We link two topics vital for

sustainable development and high on political agendas at local, national, regional, and global levels.

According to the Constitution of the World Health Organization (1946), health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity. The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition. We use this broad concept for a holistic approach to health and health risks in the context of water for this review.

Water is at the core of sustainable development, energy and food production, healthy ecosystems and human health and well-being, serving as the crucial link between society and the environment (United Nations Water, 2018). Water security has been classified under three broad categories: diminished water supply or quality, increased water demand, and extreme flood events (Gleick and Iceland, 2018). According to the United Nations, water and the water cycle have to be considered in their entirety, including all uses and users (UN-Water, 2017).

Access to safely managed drinking water and sanitation services and basic hygiene (WASH) are foundations of human health, well-being, socio-economic development, and human dignity (Fewtrell et al., 2005). Achieving universal access to safely managed services is a priority in global development policy, reflected in Goal 6 of the Sustainable Development Goals (SDGs). Studies related to WASH often examine technical and engineering aspects, looking at the ‘hardware’. The ‘software’, however, health risk perceptions, (mis)beliefs related to WASH, WASH-related behaviours, and the cultural context, play an equally important role (Akpabio, 2012; Anthonj et al., 2018; Bisung et al., 2015; Mara, 2003).

Interactions between water security and human health are subject to spatiotemporal dynamics and differ between locations; urban, peri-urban, and rural areas and informal settlements; with socioeconomic disparities; between low-, middle- and high-income countries; in different cultural contexts; at different scales. Interactions between water security and human health are strongly determined by geography, with place and environmental, climatic and hydrological factors, exposures to natural (and water-related) disasters, available health systems and services in terms of prevention, treatment and care; and access to education and different levels of health-related knowledge, risk perceptions and behaviours, determining communities’ and individuals’ water-related health risks and exposure to diseases (Anthonj, 2021).

With this review, we aim to fill the knowledge gaps on how water-related health risk perceptions and related behaviours are portrayed in the academic literature; which topics and concepts the literature covers; which evidence exist; and why this is relevant for water- and health-related governance.

2. Methods

This systematic review and analysis of studies on risk perceptions and behaviours in the context of water and health was conducted in adherence with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) (Moher et al., 2009, Fig. 1) and sought to answer four questions:

1. Which water- and health-related topics are covered in risk perception and behaviour research?
2. In which context are water- and health-related risk perception and behaviour studies conducted?

Table 1

Exclusion criteria for the systematic literature review on risk perceptions and risk behaviours in the context of water and health.

Exclusion criteria	Sub criteria
Abstract does not match main text	–
Not in English	–
Wrong topic	Not linked to risk perceptions; not linked to behaviour; not linked to water and health
Wrong study type	Letters to the editor, opinion pieces, or newsletters
Study quality	Low quality of study

3. How are health risk perceptions defined and measured across different settings and contexts?
4. What is the evidence on water- and health-related risk perception influencing behaviour?

2.1. Search and screening strategy

The search strategy was based on our research questions, using terminology associated with risk perceptions and behaviours in the context of water and health globally. Search terms included a perception dimension; a risk dimension; a behavioural dimension; a health and disease dimension; and water. The same dimensions were also combined with a programming and/or policy dimension (detailed in Supplementary file 1). Peer-reviewed literature published between 2000 - the year of the formulation of the United Nations Millennium Development Goals - and 2021 was identified through the databases PubMed, Web of Science and Scopus from January to May 2020, and from May 2020 to May 2021. The retrieved articles were screened using Cochrane’s online systematic review software Covidence. Titles and abstracts of each publication were screened and checked against the inclusion criteria for full-text review. Peer-reviewed literature written in English was included. Literature meeting one or more of the criteria shown in Table 1 was excluded.

2.2. Data extraction and analysis

Information extracted from each study included a study description and year of publication; country and study area where the research was

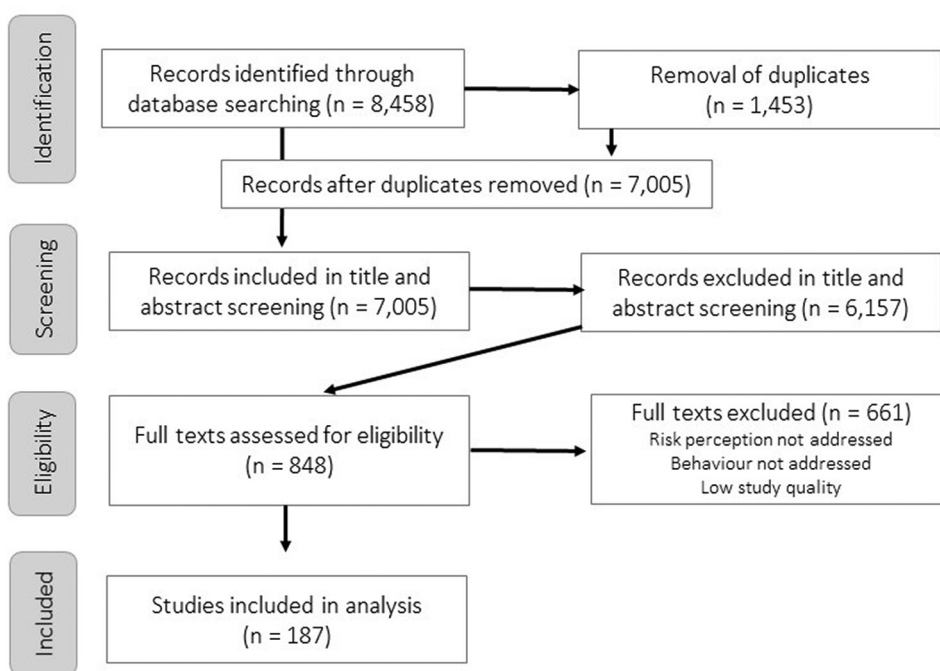


Fig. 1. PRISMA flowchart for the systematic literature review on risk perceptions and behaviours in the context of water and health, based on $n = 187$ publications (2000–2021).

conducted; setting details; study population; study methodology; limitations; assessment of risk perception and behaviour; water- and health-related focus including risk and health-promoting factors such as access to drinking water and sanitation facilities, personal hygiene, waste management, environmental hygiene, and different water-related infectious disease exposures. After extraction, data were tabulated to identify trends across studies and contextualize results (Tables 2).

3. Results

3.1. Search results, study characteristics and contexts

A total of 8458 peer-reviewed studies were identified through publication databases, and after duplicates were removed, 7005 studies were included in title and abstract screening. During title and abstract screening, 6157 studies were excluded for failure to meet inclusion criteria. Eight hundred forty-eight full texts were assessed for eligibility, and of those, a set of 187 studies were included in the final analysis (Fig. 1).

The studies included in this review point to a growth in literature on risk perception and behaviour in the context of water and health over the past twenty years (Fig. 2a).

Included studies reported information from Africa (33%), North America (27%), Asia (25%), Europe (11%), Latin America and the Caribbean (7%) and Oceania (4%). In Africa, most of the studies were conducted in Tanzania, Ethiopia, Kenya, and Ghana. In Asia, studies focused mainly on Bangladesh, India, China, and Vietnam. In Europe, most studies were conducted in Ireland, Italy and the United Kingdom. In Latin America and the Caribbean, studies mainly focused on Mexico, Brazil, Cuba and Ecuador, and in North America on the United States and Canada. In Oceania, most studies were conducted in Australia. Four studies covered more than one country (Crampton and Ragusa, 2016; Johnstone and Serret, 2012; Ragusa and Crampton, 2016; Sarti et al., 2015) (Fig. 2b, Fig. 3, Table 2).

Stratified by income groups based on the World Bank division, with income measured using gross national income per capita, 13% of studies were conducted in low-income (\$1045 or less), 42% of studies in lower middle-income (\$1046–\$4095), 11% of studies in upper middle-income (\$4096–\$12,695) and 41% of studies in high-income countries (\$12,696 or more) countries (Fig. 2c).

More than half of the studies were conducted in rural settings (56%), and 35% of studies were carried out in an urban setting, while few focused on peri-urban areas (10%) or informal settlements (2%) (Fig. 3). While most of the 187 studies were conducted at household or individual level, 9% of studies were carried out in schools, 3% in healthcare facilities, 2% in universities, one in a swimming pool and one in a refugee camp (0.5% each).

Most studies did not indicate a specific ecological context within which they were conducted. However, 5% of studies were carried out in islands or coastal zones, 2% in deltas, wetlands or the arctic, and 1% in the rainforest. Some studies indicated the environmental conditions that their target population was facing, including flooding (10%), climate change and heavy rainfall (5%), drought (2%), earthquakes (1%), cyclones and landslides (0.5% each) (Table 2).

Study populations included the general population (35%), children (13%), women (11%), community leaders or elders (9%), healthcare providers (9%), indigenous community representatives (6%) and political representatives (6%). Men, students, parents, mothers, caregivers, patients, farmers, pastoralists, school staff or teachers and international organization representatives were populations less commonly a focus of included studies (Table 2).

Health risk perception and behaviour studies were conducted by researchers from numerous disciplines, including health sciences; natural, environmental sciences and geosciences; social and political sciences; development studies; economics; planning; statistics; monitoring and evaluation; human rights; public administration and education.

3.2. Overview mapping of risk perception and behaviour research in water and health literature

Topics covered in the risk perception and behaviour literature in the context of water and health reviewed were broad. Emerging themes centred mainly around drinking water, sanitation, hygiene and waste-related topics, health risk factors, diseases and mental health implications, and preventative measures (Fig. 4). We categorized our results based on these emerging themes.

Most studies addressed WASH and waste-related topics, including 73% of studies looking at the drinking water source (water consumption, water choice, rainwater harvesting), 71% of studies addressing water safety (water quality, water treatment, safe storage), 40% of studies centring around hygiene (hygiene behaviour, handwashing, hand drying, menstrual hygiene management), 32% of studies looking at sanitation, 24% of studies focusing on water use or waste management, and 13% of studies looking at wastewater management.

Geographical representation of water, sanitation, hygiene and waste topics covered by risk perception and behaviour literature in the context of water and health varied (Fig. 5). Water treatment and safe storage were the topic most commonly reported relative to the number of publications in North America, Africa, Europe and Asia. Water quality was more reported from Latin America and Oceania. Water contact was mainly reported from Africa. For hygiene, reporting patterns were similar in North America, Africa and Asia, with hygiene behaviour being the topic mainly covered, followed by handwashing. In Europe, however, only hygiene behaviour was covered by studies. The publications addressing waste covered mainly environmental hygiene in Africa, Asia and Latin America, while focusing on waste management in Europe. For North America, literature on waste was absent altogether.

Health risk factors covered in studies included 19% of studies looking at water contamination (*Escherichia coli*, arsenic, lead, micropollutants), 10% of studies investigating the presence of mosquitoes (*Aedes aegypti*, *Aedes albopictus*, *Culex pipiens*), 9% of studies focusing on either mosquito breeding sites, risks in the living environment (i.e., housing, livestock), or swimming in open waters. In 6% of studies, proximity to rivers, dams and lakes were considered risk factors, and in 4% of studies irrigated agriculture (i.e., wastewater-irrigated agriculture, irrigation channels) was seen as a risk factor.

Preventative measures and health-promoting actions addressed ranged from 20% of studies looking at healthcare utilization (e.g., health-seeking, oral rehydration solution (ORS) use), 9% of studies addressing protection from mosquito bites (e.g., creams, sprays, wearing protective clothing, use of bednets), 8% discussing vaccination and 2% centring around physical distancing (i.e., wearing masks, not touching someone, social distancing).

Water-related diseases and mental health implications covered in the risk perception and behaviour literature often did not specify health risks (39%). Other publications specified the kind of disease exposure arising from water. Waterborne diseases were covered by 35% of studies (diarrhoea, dysentery, gastrointestinal disease, typhoid/paratyphoid, cholera), 16% of studies looked at vector-borne diseases transmitted by mosquitoes (malaria, dengue, Japanese encephalitis, Zika, West Nile, acute encephalitis), 8% of studies investigated water-based diseases (schistosomiasis) and 5% of studies water-washed diseases (trachoma, dermatological symptoms, scabies). Five percent of studies focused on mental health issues (psychological distress, mental diseases, negative emotions). Vector-borne diseases transmitted by primates (Ebola) were covered by 3% of studies. Airborne diseases (tuberculosis, respiratory disease, pandemic influenza) were the focus in 2% of studies, as were sexually transmitted infections (HIV, STIs generally). One percent of studies looked at soil-transmitted diseases (helminths, non-filarial elephantiasis), bloodborne diseases (hepatitis A, hepatitis C) or hospital-acquired infections. Other diseases (cancer, fluorosis, Buruli ulcer, urinary tract infections) and drowning were addressed by 3% of studies.

Table 2

Description of included studies on risk perceptions and behaviours in the context of water and health, based on n = 187 publications (2000 – 2021).

Study	Focus	Study country	Setting detail/context	Methods	Study population
Abu and Codjoe, 2018.	Experience and Future Perceived Risk of Floods and Diarrheal Disease in Urban Poor Communities in Accra, Ghana	Ghana	Urban, flooding	Survey questionnaire	Households
Ackumey et al., 2012.	Illness meanings and experiences for pre-ulcer and ulcer conditions of Buruli ulcer in the Ga-West and Ga-South Municipalities of Ghana	Ghana	Urban, informal settlement	Semi-structured interviews	Individuals, not specified
Aibana et al., 2013.	Cholera Vaccination Campaign Contributes to Improved Knowledge Regarding Cholera and Improved Practice Relevant to Waterborne Disease in Rural Haiti	Haiti	Rural	Survey questionnaire, intervention/evaluation	Households
Akpabio, 2012	Water meanings, sanitation practices and hygiene behaviours in the cultural mirror: a perspective from Nigeria	Nigeria	Rural	Semi-structured interviews	Households, males, community leaders, indigenous community, political representative
Akter and Ali, 2014.	Factors influencing knowledge and practice of hygiene in Water, Sanitation and Hygiene (WASH) programme areas of Bangladesh Rural Advancement Committee	Bangladesh	Rural	Spot checks, semi-structured interviews	Females
Alemu et al., 2017	A socio-ecological analysis of barriers to the adoption, sustainability and consistent use of sanitation facilities in rural Ethiopia	Ethiopia	Rural	Semi-structured interviews, focus group discussions	Females, males, health providers, political representatives
Alicea-Planas et al., 2019	Factors influencing carbonated soft-drink and bottled water consumption: survey evidence from Nicaragua	Nicaragua	NA	Survey questionnaire, choice experiment	Households
Allwood et al., 2014	Knowledge, perceptions, and environmental risk factors among Jamaican households with a history of leptospirosis	Jamaica	Urban, peri-urban, rural	Survey questionnaire, case control study, spot checks, archival research	Households
Aluko et al., 2018	The dynamics and determinants of household shared sanitation cleanliness in a heterogeneous urban settlement in Southwest Nigeria	Nigeria	Urban	Survey questionnaire, spot checks	Individuals, not specified
Andrade et al., 2019	Evaluating the effectiveness of a community-based hygiene promotion programme in a rural Salvadoran setting	Brazil	School, healthcare facility	Survey questionnaire, longitudinal study, intervention/evaluation	Households, schools
Angelo et al., 2019.	Community knowledge, perceptions and water contact practices associated with transmission of urinary schistosomiasis in an endemic region: a qualitative cross-sectional study	Tanzania	Rural	Semi-structured interviews, focus group discussions, intervention/evaluation	Individuals, not specified, children
Anthonj et al., 2019.	Health risk perceptions and local knowledge of water-related infectious disease exposure among Kenyan wetland communities	Kenya	Rural, wetland, flooding, drought	Survey questionnaire, semi-structured interviews, focus group discussions	Farmers, pastoralists, community leaders, health providers, political representatives
Anthonj et al., 2018.	Health Risk Perceptions Are Associated with Domestic Use of Basic Water and Sanitation Services-Evidence from Rural Ethiopia	Ethiopia	Rural	Survey questionnaire, case control study, spot check, intervention/evaluation	Households
Anthonj et al., 2016.	Water, sanitation and hygiene in wetlands. A case study from the Ewaso Narok Swamp, Kenya	Kenya	Rural, wetland	Survey questionnaire, spot check, semi-structured interviews	Farmers, pastoralists
Asgary et al., 2012.	Lack of patient risk counselling and a broader provider training affect malaria control in remote Somalia Kenya border: Qualitative assessment.	Kenya	Rural	Spot check, semi-structured interviews, focus group discussions, intervention/evaluation	Community leaders, health providers
Ashraf et al., 2017.	Nonrandomized Trial of Feasibility and Acceptability of Strategies for Promotion of Soapy Water as a Handwashing Agent in Rural Bangladesh	Bangladesh	Rural	Survey questionnaire, case control study, spot check, semi-structured interviews, intervention/evaluation	Households, children, caregivers
Assefa and Kumie, 2014.	Assessment of factors influencing hygiene behaviour among school children in Mereb-Leke District, Northern Ethiopia: a cross-sectional study	Ethiopia	Rural, school	Survey questionnaire, spot check	Households, schools, children
Attu and Adjei, 2018.	Local knowledge and practices toward malaria in an irrigated farming community in Ghana	Ghana	Rural	Survey questionnaire, semi-structured interviews	Individuals, not specified, community leaders, healthcare providers, political representatives
Atuyambe et al., 2011.	Land slide disaster in eastern Uganda: rapid assessment of water, sanitation and hygiene situation in Bulucheke camp, Bududa district	Uganda	Rural, land slide	Survey questionnaire, spot check, semi-structured interviews, focus group discussions	NA
Aziz et al., 2006.	Knowledge of arsenic in drinking-water: Risks and avoidance in Matlab, Bangladesh	Bangladesh	Rural	Survey questionnaire	Households
Balasubramanya et al., 2014.	Evolution of households' responses to the groundwater arsenic crisis in Bangladesh: information on environmental health risks can have increasing behavioural impact over time	Bangladesh	Rural	Survey questionnaire, water testing	Households, females
Banks et al., 2016.	Using Qualitative Methods to Explore Lay Explanatory Models, Health-Seeking Behaviours and Self-Care Practices of Podoconiosis Patients in North-West Ethiopia	Ethiopia	Rural, healthcare facility, drought	Semi-structured interviews, focus group discussions	Healthcare facility, females, males
Belay and Deressa, 2008.	Use of insecticide treated nets by pregnant women and associated factors in a pre-dominantly rural population in northern Ethiopia	Ethiopia	Urban, rural	Survey questionnaire, focus group discussions	Females

(continued on next page)

Table 2 (continued)

Study	Focus	Study country	Setting detail/context	Methods	Study population
Benbear et al., 2013.	Impact of a randomized controlled trial in arsenic risk communication on household water-source choices in Bangladesh	Bangladesh	Rural	Survey questionnaire, case control study, intervention/evaluation, community education, spatial assessment	Individuals, not specified
Bermedo-Carrasco et al., 2018.	Factors associated with drinking and being satisfied with tap water in Indigenous communities in Saskatchewan, Canada	Canada	Rural	Survey questionnaire	Indigenous community
Bisung et al., 2015.	Using Photovoice as a Community Based Participatory Research Tool for Changing Water, Sanitation, and Hygiene Behaviours in Usoma, Kenya	Kenya	Rural	Semi-structured interviews, focus group discussions, photovoice, photo and drawing discussions	Females, males, community leaders, caregivers
Bitew et al., 2017.	Knowledge, Attitude, and Practice of Mothers/Caregivers on Household Water Treatment Methods in Northwest Ethiopia: A Community-Based Cross-Sectional Study	Ethiopia	Urban, rural	Survey questionnaire	Females, mothers, children, students, caregivers
Blum et al., 2014.	Formative Investigation of Acceptability of Typhoid Vaccine during a Typhoid Fever Outbreak in Neno District, Malawi	Malawi	Rural	Semi-structured interviews, focus group discussions, exercises	Households, individuals, not specified, community leaders, healthcare providers, political representatives
Bodner et al., 2016.	Effectiveness of Print Education at Reducing Urban Mosquito Infestation through Improved Resident-Based Management	United States	Rural	Survey questionnaire, water testing, larval mosquito surveys, intervention/evaluation, community education	Households
Bradford et al., 2017.	There is no publicity like word of mouth ... Lessons for communicating drinking water risks in the urban setting	Canada	Rural, flooding	Survey questionnaire, semi-structured interviews	Households
Brown et al., 2017.	Seeing, believing, and behaving: Heterogeneous effects of an information intervention on household water treatment	Cambodia	Peri-urban	Survey questionnaire, case control study, water testing, intervention/evaluation	Households
Caldwell et al., 2005.	Trends in water usage and knowledge of arsenicosis in Bangladesh: Findings from successive national surveys	Bangladesh	Rural	Survey questionnaire, intervention/evaluation	Households
Caldwell et al., 2006.	Access to drinking-water and arsenicosis in Bangladesh	Bangladesh	Rural	Survey questionnaire, intervention/evaluation	Households, females
Caruso et al., 2014.	If you build it will they come? Factors influencing rural primary pupils' urination and defecation practices at school in western Kenya	Kenya	Rural, healthcare facility	Spot check, semi-structured interviews, focus group discussions, intervention/evaluation	Schools, children, school staff/teachers
Castleden et al., 2015.	Examining the public health implications of drinking water-related behaviours and perceptions: A face-to-face exploratory survey of residents in eight coastal communities in British Columbia and Nova Scotia	Canada	Coast	Survey questionnaire, networking dialogues	Individuals, not specified
Castro et al., 2009.	Community-based environmental management for malaria control: evidence from a small-scale intervention in Dar es Salaam, Tanzania	Tanzania	Urban, flooding, drought, heavy rainfall	Survey questionnaire, malaria parasite smears, intervention/evaluation	Individuals, not specified, children
Chan et al., 2018.	Long-Term and Immediate Impacts of Health Emergency and Disaster Risk Management (Health-EDRM) Education Interventions in a Rural Chinese Earthquake-Prone Transitional Village	China	Rural, flooding, earthquake	Survey questionnaire, intervention/evaluation, community education	Individuals, not specified
Chaturvedi et al., 2017.	Perceptions, practices and health seeking behaviour constrain JE/AES interventions in high endemic district of North India	India	NA	Semi-structured interviews, focus group discussions	Students, farmers, community leaders, health providers, patients, international organizations
Chen et al., 2006.	Differences in perception of dysentery and enteric fever and willingness to receive vaccines among rural residents in China	China	Rural	Survey questionnaire	Individuals, not specified
Chen et al., 2012.	Change of water consumption and its potential influential factors in Shanghai: A cross-sectional study	China	Urban	Survey questionnaire	Individuals, not specified, children
Cooper et al., 2020.	Perceived Risk and Intentions to Practice Health Protective Behaviours in a Mining-Impacted Region	United States	NA	Survey questionnaire	Households
Crampton and Ragusa, 2016.	Exploring Perceptions and Behaviours about Drinking Water in Australia and New Zealand: Is It Risky to Drink Water, When and Why?	Australia, New Zealand	Urban, rural, coast	Survey questionnaire, semi-structured interviews	Individuals, not specified
Czerniewska and White, 2020.	Hygiene programming during outbreaks: a qualitative case study of the humanitarian response during the Ebola outbreak in Liberia	Liberia	NA	Survey questionnaire, semi-structured interviews	International organization
Dambach et al., 2018.	A qualitative study of community perception and acceptance of biological larviciding for malaria mosquito control in rural Burkina Faso	Burkina Faso	Rural	Case control study, semi-structured interviews, focus group discussions, intervention/evaluation	Individuals, not specified
Daniel et al., 2019.	Understanding the effect of socio-economic characteristics and psychosocial factors on household water treatment practices in rural Nepal using Bayesian Belief Networks	Nepal	Rural	Survey questionnaire, semi-structured interviews	Households
Daude et al., 2017.	Widespread fear of dengue transmission but poor practices of dengue prevention: A study in the slums of Delhi, India	India	Urban	Survey questionnaire, spot check	Households, patients

Davis et al., 2011.	The Effects of Informational Interventions on Household Water Management, Hygiene Behaviours, Stored Drinking Water Quality, and Hand Contamination in Peri-Urban Tanzania	Tanzania	Urban, peri-urban	Survey questionnaire, water testing, hand rinse sample, intervention/evaluation, community education	Households
Delaire et al., 2017.	Determinants of the use of alternatives to arsenic-contaminated shallow groundwater: an exploratory study in rural West Bengal, India	India	Rural	Survey questionnaire	Households
Delpa et al., 2020.	Perception of tap water quality: Assessment of the factors modifying the links between satisfaction and water consumption behaviour	Canada	Urban	Phone survey	Individuals, not specified
Demolis et al., 2018.	A rapid qualitative assessment of oral cholera vaccine anticipated acceptability in a context of resistance toward cholera intervention in Nampula, Mozambique	Mozambique	Urban, school	Survey questionnaire, spot check, semi-structured interviews, focus group discussions, intervention/evaluation	Schools, individuals, not specified, community leaders, health providers, political representative
Dolnicar and Hurlimann, 2009.	Drinking water from alternative water sources: differences in beliefs, social norms and factors of perceived behavioural control across eight Australian locations	Australia	Urban, drought	Semi-structured interviews	Individuals, not specified
Dowling et al., 2013.	Linking Mosquito Infestation to Resident Socioeconomic Status, Knowledge, and Source Reduction Practices in Suburban Washington, DC	United States	Urban	Survey questionnaire, larval mosquito survey	Households
Dupont et al., 2014.	Drinking Water Management: Health Risk Perceptions and Choices in First Nations and Non-First Nations Communities in Canada	Canada	Urban	Survey questionnaire, case control study	Individuals, not specified, indigenous community
Edoror et al., 2019.	Knowledge and perception of the role of water, sanitation and hygiene in containment of Ebola virus disease among secondary school students in Ibadan, Nigeria	Nigeria	Urban, school	Survey questionnaire, spot check	Schools, students
Egedus et al., 2014.	Knowledge, perceptions, and practices with respect to the prevention of dengue in a mid-Pacific coastal village of Costa Rica	Costa Rica	Rural, coast	Survey questionnaire, spot check, intervention/evaluation, community education	Individuals, not specified
Eisenberg et al., 2002.	Risk factors in HIV-associated diarrhoeal disease: the role of drinking water, medication and immune status	United States	Urban	Survey questionnaire	Individuals, not specified
Elliott et al., 2008.	Determinants of risk behaviours for West Nile virus	United States	Urban	Phone survey, blood samples	Individuals, not specified
Ellis et al., 2020.	Practices and Perspectives on Latrine Use, Child Feces Disposal, and Clean Play Environments in Western Kenya	Kenya	Rural	Spot check, semi-structured interviews, focus group discussions	Households, caregivers, community leaders, health providers
Escobedo et al., 2011.	Caregiver perspectives for the prevention, diagnosis and treatment of childhood giardiasis in Havana City, Cuba	Cuba	Urban, rural, healthcare facility	Focus group discussions	Healthcare facility, caregivers
Family et al., 2019.	Reasons why low-income people in urban areas do not drink tap water	United States	Urban, healthcare facility	Survey questionnaire	Healthcare facility, patients
Ferreira da Silva et al., 2020.	Community Perceptions on Schistosomiasis in Northeast Brazil	Brazil	Urban, peri-urban, wetland, flooding	Survey questionnaire, spot check, semi-structured interviews	Households, health providers, political representative
Few et al., 2013.	Seasonality, disease and behaviour: Using multiple methods to explore socio-environmental health risks in the Mekong Delta	Vietnam	Peri-urban, island, delta, flooding, heavy rainfall	Survey questionnaire, longitudinal study, water testing, semi-structured interviews	Households
Fizer et al., 2018	Barriers to managing private wells and septic systems in underserved communities: Mental models of homeowner decision making	United States	Peri-urban	Survey questionnaire, semi-structured interviews	Households
Flanagan et al., 2015a.	Dissemination of well water arsenic results to homeowners in Central Maine: Influences on mitigation behaviour and continued risks for exposure	United States	Rural	Postal survey, water testing, well testing, spatial assessment	Households
Flanagan et al., 2015b.	Health protective behaviour following required arsenic testing under the New Jersey Private Well Testing Act	United States	Rural	Postal survey, water testing, well testing, spatial assessment	Households
Flanagan et al., 2018.	Influences on domestic well water testing behaviour in a Central Maine area with frequent groundwater arsenic occurrence	United States	Rural	Postal survey, spatial assessment	Households
Flynn, 2012.	A Study Exploring the Knowledge, Attitudes and Practices of Young People Regarding Dengue Fever and the Extent of Community Involvement in Vector Control of the Disease in Trinidad and Tobago	Trinidad and Tobago	Urban, university	Semi-structured interviews, focus group discussions	University, students
Francis et al., 2015.	Perception of drinking water safety and factors influencing acceptance and sustainability of a water quality intervention in rural southern India	India	Rural, heavy rainfall	Case control study, semi-structured interviews, focus group discussions, intervention/evaluation	Parents, community leaders
Friedrich et al., 2017.	Contextual and Psychosocial Determinants of Effective Handwashing Technique: Recommendations for Interventions from a Case Study in Harare, Zimbabwe	Zimbabwe	Peri-urban, swimming pools	Survey questionnaire, spot checks, intervention/evaluation	Children, caregivers
Galle et al., 2016.	Health-Related Behaviours in Swimming Pool Users: Influence of Knowledge of Regulations and Awareness of Health Risks	Italy	Urban	Survey questionnaire	Individuals, not specified, swimming pools

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Table 2 (continued)

Study	Focus	Study country	Setting detail/context	Methods	Study population
Gamma et al., 2019.	Contextual and psychosocial factors predicting Ebola prevention behaviours using the RANAS approach to behaviour change in Guinea-Bissau	Gambia	Urban	Survey questionnaire, intervention/evaluation, hygiene kit distribution	Health providers
Gamma et al., 2017.	The Impact of Various Promotional Activities on Ebola Prevention Behaviours and Psychosocial Factors Predicting Ebola Prevention Behaviours in the Gambia Evaluation of Ebola Prevention Promotions	Guinea-Bissau	Urban, peri-urban, rural	Survey questionnaire, intervention/evaluation	Individuals, not specified
Geerts et al., 2020.	Bottle or tap? Toward an integrated approach to water type consumption	Belgium	Urban	Online survey	Individuals, not specified
Gentili et al., 2020.	Impact of Communication Measures Implemented During a School Tuberculosis Outbreak on Risk Perception among Parents and School Staff in Italy	Italy	Schools	Survey questionnaire, intervention/evaluation, community education	Schools, parents, school staff/teachers
George et al., 2017.	Behavioural Determinants of Switching to Arsenic-Safe Water Wells: An Analysis of a Randomized Controlled Trial of Health Education Interventions Coupled With Water Arsenic Testing	Bangladesh	Rural	Survey questionnaire, case control study, water testing, intervention/evaluation, community education, media campaign	Individuals, not specified
Geremew et al., 2018.	Point-of-use water chlorination among urban and rural households with under-five-year children: a comparative study in Kersa Health and Demographic Surveillance Site, Eastern Ethiopia	Ethiopia	Urban, rural, heavy rainfall	Survey questionnaire, spot check, water testing	Schools, females, mothers, caregivers
Giles et al., 2010.	We listen to our Elders. You live longer that way: Examining aquatic risk communication and water safety practices in Canada's North	Canada	Rural	Semi-structured interviews, archival research	Indigenous community
Gizaw and Addisu, 2020.	Evidence of Households' Water, Sanitation, and Hygiene (WASH) Performance Improvement Following a WASH Education Program in Rural Dembiya, Northwest Ethiopia	Ethiopia	Rural	Survey questionnaire, focus group discussions, exercises, role-play, intervention/evaluation, installation of handwashing facilities	Households
Gorelick et al., 2011.	Perceptions About Water and Increased Use of Bottled Water in Minority Children	United States	Urban	Survey questionnaire, semi-structured interviews	Children, parents
Grandesso et al., 2014.	Risk factors for cholera transmission in Haiti during inter-peak periods: insights to improve current control strategies from two case-control studies	Haiti	Rural, earthquake	Survey questionnaire, spot checks, water testing	Individuals, not specified, patients
Gregorio et al., 2019.	Knowledge, attitudes, and practices of public secondary school teachers on Zika Virus Disease: A basis for the development of evidence-based Zika educational materials for schools in the Philippines	Philippines	Rural, school	Survey questionnaire	Schools, school staff/teachers
Guillaume et al., 2019.	It was a ravage!: Lived experiences of epidemic cholera in rural Haiti	Haiti	Rural, flooding	Focus group discussions	Individuals, not specified
Gupta et al., 2012.	Preventing waterborne diseases: Analysis of a community health worker programme in rural Tamil Nadu, India	India	Rural	Survey questionnaire, case control study, exercises, role-play, intervention/evaluation, community education, media campaign, distribution of water treatment chlorine tablets	Households, females
Haenchen et al., 2016.	Mosquito Avoidance Practices and Knowledge of Arboviral Diseases in Cities with Differing Recent History of Disease	United States	Urban	Survey questionnaire, spot checks, larval mosquito surveys	Households
Hall and Le, 2018.	Factors Influencing Mitigation of Risk of Waterborne Disease in Vietnam Among Small Scale Integrated Livestock Farmers	Vietnam	NA	Survey questionnaire, water testing, semi-structured interviews, focus group discussions, discussion and training sessions	Farmers
Halvorson et al., 2011.	Water quality and waterborne disease in the Niger River Inland Delta, Mali: A study of local knowledge and response	Mali	Delta, flooding, heavy rainfall	Spot checks, water testing, semi-structured interviews, archival research, spatial assessment	Mothers
Hanchett et al., 2002.	Increasing awareness of arsenic in Bangladesh: lessons from a public education programme	Bangladesh	Urban	Survey questionnaire, case control study, semi-structured interviews, focus group discussions, intervention/evaluation	Individuals, not specified, children
Harper et al., 2015.	Lived experience of acute gastrointestinal illness in Rigolet, Nunatsiavut: "Just suffer through it"	Canada	Coast, flooding	Survey questionnaire, semi-structured interviews	Indigenous community
He et al., 2018.	Impact of receipt of private well arsenic test results on maternal use of contaminated drinking water in a US population	United States	NA	Survey questionnaire, postal survey, longitudinal study, water testing, intervention/evaluation, community education	Females
Heard-Garris et al., 2017.	Voices from Flint: Community Perceptions of the Flint Water Crisis	United States	Urban, rural	Survey questionnaire, longitudinal study	Individuals, not specified
Herbst et al., 2009.	Perceptions of water, sanitation and health: a case study from the Mekong Delta, Vietnam	Vietnam	Peri-urban, delta, heavy rainfall	Survey questionnaire, semi-structured interviews, focus group discussions	Households, females, males, children
Heyerdahl et al., 2019.	It depends how one understands it: a qualitative study on differential uptake of oral cholera vaccine in three compounds in Lusaka, Zambia	Zambia	Urban, informal settlement	Semi-structured interviews, focus group discussions	Individuals, not specified
Hmielowski et al., 2018.	Expanding the Political Philosophy Dimension of the RISP Model: Examining the Conditional Indirect Effects of Cultural Cognition	United States	Urban, informal settlement	Online survey	Individuals, not specified

Hooks et al., 2019.	Risk Perceptions Toward Drinking Water Quality Among Private Well Owners in Ireland	Ireland	NA	Semi-structured interviews	Individuals, not specified
Houck et al., 2020.	Drinking water improvements and rates of urinary and gastrointestinal infections in Galapagos, Ecuador: Assessing household and community factors	Ecuador	Urban, island	Survey questionnaire, longitudinal survey, water testing, intervention/evaluation	Households, mothers, children
Huber and Mosler, 2013.	Determining behavioural factors for interventions to increase safe water consumption: a cross-sectional field study in rural Ethiopia	Ethiopia	Rural	Survey questionnaire	Households
Hulland et al., 2015.	Sanitation, Stress, and Life Stage: A Systematic Data Collection Study among Women in Odisha, India	India	Informal settlement, rural, flooding	Survey questionnaire, semi-structured interviews	Females, indigenous community
Hyllestad et al., 2019.	Compliance with water advisories after water outages in Norway	Norway	NA	Online survey, focus group discussions	Individuals, not specified
Hynds et al., 2018.	Efficacy of a national hydrological risk communication strategy: Domestic wastewater treatment systems in the Republic of Ireland	Ireland	Rural	Survey questionnaire	Individuals, not specified
Inauen et al., 2013.	Predicting water consumption habits for seven arsenic-safe water options in Bangladesh	Bangladesh	Rural	Survey questionnaire	Individuals, not specified
Islam et al., 2011.	Evaluation of risk communication for rural water supply management: a case study of a coastal area of Bangladesh	Bangladesh	Rural, coast	Survey questionnaire, water testing, intervention/evaluation, community education	Females
Jalloh et al., 2018.	Consumer perceptions and purchasing of packaged water products in Sierra Leone	Sierra Leone	Urban, rural	Semi-structured interviews, focus group discussions	Individuals, not specified
Jaravani et al., 2017.	Working With an Aboriginal Community to Understand Drinking Water Perceptions and Acceptance in Rural New South Wales	Australia.	NA	Water testing, semi-structured interviews, focus group discussions	Community leaders, indigenous community
Javaeed et al., 2018.	Knowledge, attitude and practices of water, sanitation and hygiene of students in Azad Kashmir	Pakistan	NA	Survey questionnaire	Students
Javidi and Pierce, 2018.	US Households' Perception of Drinking Water as Unsafe and its Consequences: Examining Alternative Choices to the Tap	United States	NA	Survey questionnaire	Households
Jin et al., 2016.	Measuring the willingness to pay for drinking water quality improvements: results of a contingent valuation survey in Songzi, China	China	Rural	Survey questionnaire	Households
Johnstone and Serret, 2012.	Determinants of bottled and purified water consumption: results based on an OECD survey	Australia, Canada, Czech Republic, France, Italy, Korea, Mexico, the Netherlands, Norway, Sweden	Urban, rural	Online survey	Households
Jones et al., 2006.	Public perceptions of drinking water: a postal survey of residents with private water supplies	Canada	Urban, peri-urban, rural	Survey questionnaire	Households
Jones et al., 2007.	A qualitative exploration of the public perception of municipal drinking water	Canada	Urban, peri-urban, rural	Focus group discussions	Individuals, not specified
Jones-Bitton et al., 2016.	Does the public receive and adhere to boil water advisory recommendations? A cross-sectional study in Newfoundland and Labrador, Canada	Canada	Rural	Phone survey	Individuals, not specified
Jordan et al., 2007.	Messages from moms: Barriers to and facilitators of behaviour change in a lead poisoning preventive education project	United States	NA	Focus group discussions, intervention/evaluation	Patients
Keraita et al., 2008.	Perceptions of farmers on health risks and risk reduction measures in wastewater-irrigated urban vegetable farming in Ghana	Ghana	Urban	Survey questionnaire, semi-structured interviews, focus group discussions	Farmers
Khan et al., 2015.	Evaluation of an Elementary School-based Educational Intervention for Reducing Arsenic Exposure in Bangladesh	Bangladesh	Rural school	Survey questionnaire, case control study, well testing, urine samples, knowledge tests, intervention/evaluation	Schools, children
Kohlitz and Smith, 2015.	Water quality management for domestic rainwater harvesting systems in Fiji	Fiji	Rural, island	Spot checks, semi-structured interviews	Households, political representatives
Kosinski et al., 2016.	A mixed-methods approach to understanding water use and water infrastructure in a schistosomiasis-endemic community: case study of Asamama, Ghana	Ghana	Peri-urban, rural	Survey questionnaire, water testing, disease screening, focus group discussions, spatial assessment	Children
Kukula et al., 2019.	A major hurdle in the elimination of urogenital schistosomiasis revealed: Identifying key gaps in knowledge and understanding of female genital schistosomiasis within communities and local health workers	Ghana	Rural	Semi-structured interviews, focus group discussions	Females, males, children, community leaders, health providers, school staff/teachers
Kumar et al., 2010.	Studies on community knowledge and behaviour following a dengue epidemic in Chennai city, Tamil Nadu, India	India	Urban	Survey questionnaire	Households
Kunii et al., 2002.	The impact on health and risk factors of the diarrhoea epidemics in the 1998 Bangladesh floods	Bangladesh	Rural, flooding	Survey questionnaire	Individuals, not specified
Lavallee et al., 2021.	Examining influential drivers of private well users' perceptions in Ontario: A cross-sectional population study	Canada	Rural	Online survey	Individuals, not specified
Legorreta-Soberanis et al., 2017.	Coverage and beliefs about temephos application for control of dengue vectors and impact of a community-based prevention intervention: secondary analysis from the	Mexico	Urban, rural, coast	Survey questionnaire, case control study, spot checks, larval mosquito surveys, intervention/evaluation	Households

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Table 2 (continued)

Study	Focus	Study country	Setting detail/context	Methods	Study population
Leong and Lebel, 2020.	Camino Verde trial in Mexico Can conformity overcome the yuck factor? Explaining the choice for recycled drinking water	Singapore	Urban, university, climate change	Case control study, choice experiment	University
Leveque and Burns, 2017.	Predicting water filter and bottled water use in Appalachia: a community-scale case study	United States	Urban, peri-urban	Online survey	Individuals, not specified
Leveque and Burns, 2018.	Drinkingwater in West Virginia (USA): tapwater or bottled water - what is the right choice for college students?	United States	Urban, university	Online survey	University, students
Lilje et al., 2015.	Factors Determining Water Treatment Behaviour for the Prevention of Cholera in Chad	Chad	Urban, rural	Survey questionnaire	Caregivers
Lilje and Mosler, 2018.	Effects of a behaviour change campaign on household drinking water disinfection in the Lake Chad basin using the RANAS approach	Chad	Urban, rural	Survey questionnaire, intervention/evaluation, monitoring of behaviour	Caregivers
Lindell et al., 2017.	Perceptions of protective actions for a water contamination emergency	United States	Urban	Survey questionnaire, postal survey	Individuals, not specified, students
Logar and Brouwer, 2017.	The effect of risk communication on choice behaviour, Welfare Estimates and Choice Certainty	Switzerland	Urban	Online survey, choice experiment	Individuals, not specified
Lothe et al., 2018.	Treating schistosomiasis among South African high school pupils in an endemic area, a qualitative study	South Africa	Rural, school	Semi-structured interviews, focus group discussions	Schools, children, health providers
Lucier et al., 2020.	“Is there anything good about a water advisory?”: an exploration of the consequences of drinking water advisories in an indigenous community	Canada	Rural	Survey questionnaire, semi-structured interviews	Community leaders, indigenous community
Lund et al., 2019.	Unavoidable Risks: Local Perspectives on Water Contact Behaviour and Implications for Schistosomiasis Control in an Agricultural Region of Northern Senegal	Senegal	Rural	Focus group discussions	Individuals, not specified
Marjadi and McLaws, 2010.	Hand hygiene in rural Indonesian healthcare workers: barriers beyond sinks, hand rubs and in-service training	Indonesia	Rural, healthcare facility, island	Spot checks, semi-structured interviews, measures of compliance	Healthcare facility, health providers, school staff/teachers
Markon and Lemyre, 2013.	Public Reactions to Risk Messages Communicating Different Sources of Uncertainty: An Experimental Test	Canada	NA	Online survey	Individuals, not specified
Maseko et al., 2018.	Schistosomiasis knowledge, attitude, practices, and associated factors among primary school children in the Siphofaneni area in the Lowveld of Swaziland	Swaziland	Rural, school	Survey questionnaire	Schools, children
Massoud et al., 2018.	Factors influencing the reuse of reclaimed water as a management option to augment water supplies	Lebanon	Urban	Survey questionnaire	Households
Maurice et al., 2019.	Drinking water quality in areas impacted by oil activities in Ecuador: associated health risks and social perception of human exposure	Ecuador	Urban, rural, coast, rainforest	Survey questionnaire, water testing, spatial assessment	Individuals, not specified, community leaders, indigenous community, political representatives
McDowell et al., 2020.	Gender-Related Differences in Flood Risk Perception and Behaviours among Private Groundwater Users in the Republic of Ireland	Ireland	Peri-urban, rural, flooding, climate change	Online survey, spatial assessment	Individuals, not specified, females, males
McLeod et al., 2014.	Risk Factors Associated with the Choice to Drink Bottled Water and Tap Water in Rural Saskatchewan	Canada	Rural	Postal survey	Individuals, not specified
McMahon et al., 2011.	Anal cleansing practices and faecal contamination: a preliminary investigation of behaviours and conditions in schools in rural Nyanza Province, Kenya	Kenya	Rural, school	Survey questionnaire, semi-structured interviews, focus group discussions	Schools, children, parents, school staff/teachers
Mitchell et al., 2018.	Understanding Knowledge, Attitudes, and Behaviours Toward West Nile Virus Prevention: A Survey of High-Risk Adults in Maryland	United States	NA	Phone survey	Individuals, not specified, patients
Mubyazi et al., 2005.	Intermittent preventive treatment of malaria during pregnancy: a qualitative study of knowledge, attitudes and practices of district health managers, antenatal care staff and pregnant women in Korogwe District, North-Eastern Tanzania	Tanzania	Rural	Semi-structured interviews, focus group discussions	Females, health providers
Mumbi and Watanabe, 2020.	Differences in Risk Perception of Water Quality and Its Influencing Factors between Lay People and Factory Workers for Water Management in River Sosiani, Eldoret Municipality Kenya	Kenya	Urban, peri-urban, rural, wetland	Survey questionnaire	Individuals, not specified
Munene et al., 2020.	Exploring Well Water Testing Behaviour Through the Health Belief Model	Canada	Rural, flooding	Survey questionnaire, water testing, semi-structured interviews	Individuals, not specified
Munene et al., 2019.	Perceptions of drinking water quality from private wells in Alberta: A qualitative study	Canada	Rural	Water testing, semi-structured interviews	Individuals, not specified
Munisi et al., 2017.	Knowledge, attitude, and practices on intestinal schistosomiasis among primary schoolchildren in the Lake Victoria basin, Rorya District, north-western Tanzania	Tanzania	Rural, school	Survey questionnaire, semi-structured interviews	Schools, children
Musacchio et al.,	Planning for the health impacts of climate change: Flooding, private groundwater	Ireland	Rural, arctic,	Survey questionnaire	Individuals, not specified

2021.	contamination and waterborne infection – A cross-sectional study of risk perception, experience and behaviours in the Republic of Ireland			climate change		
Nastiti et al., 2017.	Coping with poor water supply in peri-urban Bandung, Indonesia: toward a framework for understanding risks and aversion behaviours	Indonesia	Peri-urban	Survey questionnaire, semi-structured interviews	Households	
Nguyen et al., 2019.	Knowledge, Attitude and Practice about Dengue Fever among Patients Experiencing the 2017 Outbreak in Vietnam	Vietnam	Urban, rural, healthcare facility	Survey questionnaire	Healthcare facility, patients	
Ogoina et al., 2016.	Preparation and Response to the 2014 Ebola Virus Disease Epidemic in Nigeria-The Experience of a Tertiary Hospital in Nigeria	Nigeria	Healthcare facility	Survey questionnaire, archival research	Healthcare facility, health providers	
Orgill et al., 2013.	Water quality perceptions and willingness to pay for clean water in peri-urban Cambodian communities	Cambodia	Peri-urban	Survey questionnaire, water testing, choice experiment, intervention/evaluation	Households	
Panchang et al., 2021.	Women 'holding it' in urban India: Toilet avoidance as an under-recognized health outcome of sanitation insecurity	India	Urban	Survey questionnaire, intervention/evaluation	Households, females	
Parisi et al., 2019.	Factors associated with relevant knowledge of intestinal schistosomiasis and intention to participate in treatment campaigns: a cross sectional survey among school children at Ijinga Island on Lake Victoria, North-Western Tanzania	Tanzania	School, island	Survey questionnaire	Schools, children	
Parvez et al., 2006.	Prevalence of arsenic exposure from drinking water and awareness of its health risks in a Bangladeshi population: Results from a large population-based study	Bangladesh	Urban	Survey questionnaire, longitudinal study, well testing	Individuals, not specified	
Perez-Guerra et al., 2009.	Community beliefs and practices about dengue in Puerto Rico	Puerto Rico	Urban	Focus group discussions	Females, males	
Person et al., 2016.	Community Knowledge, Perceptions, and Practices Associated with Urogenital Schistosomiasis among School-Aged Children in Zanzibar, United Republic of Tanzania	Tanzania	School, island	Semi-structured interviews, focus group discussions, photo and drawing discussions	Schools, children, parents, community leaders, school staff/teachers	
Postma et al., 2011.	Rural children's exposure to well water contaminants: Implications in light of the American Academy of Pediatrics' recent policy statement	United States	Rural	Survey questionnaire, water testing, intervention/evaluation	Households	
Ragusa and Crampton, 2016.	To Buy or not to Buy? Perceptions of Bottled Drinking Water in Australia and New Zealand	Australia, New Zealand	Urban, rural, coast	Survey questionnaire, semi-structured interviews	Individuals, not specified	
Randell et al., 2010.	Environmental Management for Malaria Control: Knowledge and Practices in Mvomero, Tanzania	Tanzania	Rural	Survey questionnaire, semi-structured interviews, focus group discussions	Households, community leaders, health providers	
Roche et al., 2013.	Investigating public perceptions and knowledge translation priorities to improve water safety for residents with private water supplies: a cross-sectional study in Newfoundland and Labrador	Canada	NA	Phone survey	Households	
Rundblad, 2008.	The semantics and pragmatics of water notices and the impact on public health communication, perception and behaviour during a natural disaster involving a 'Do Not Drink' and a subsequent 'Boil Water' notice: a postal questionnaire study	United Kingdom	NA	Online survey	Students	
Rundblad et al., 2010.	The Causes and Circumstances of Drinking Water Incidents Impact Consumer Behaviour: Comparison of a Routine versus a Natural Disaster Incident	United Kingdom	Flooding	Postal survey	Households	
Rusca et al., 2017.	Bathing without water, and other stories of everyday hygiene practices and risk perception in urban low-income areas: the case of Lilongwe, Malawi	Malawi	Urban	Survey questionnaire, spot checks, semi-structured interviews, focus group discussions	Individuals, not specified, international organization, political representatives	
Sarti et al., 2015.	Dengue Awareness in Latin American Populations: A Questionnaire Study	Colombia, Mexico	Urban, rural	Survey questionnaire, case control study	Individuals, not specified	
Schade et al., 2015.	Self-Reported Household Impacts of Large-Scale Chemical Contamination of the Public Water Supply, Charleston, West Virginia, USA	United States	NA	Phone survey, intervention/evaluation	Households	
Schaetti et al., 2011.	Social and cultural determinants of anticipated acceptance of an oral cholera vaccine prior to a mass vaccination campaign in Zanzibar	Tanzania	Peri-urban, rural, island	Survey questionnaire, semi-structured interviews	Individuals, not specified	
Schaetti et al., 2012.	Improving Community Coverage of Oral Cholera Mass Vaccination Campaigns: Lessons Learned in Zanzibar	Tanzania	Peri-urban, rural, island	Survey questionnaire	Individuals, not specified	
Schuitema et al., 2020.	Water quality perceptions and private well management: The role of perceived risks, worry and control	Ireland	NA	Survey questionnaire, online survey	Individuals, not specified	
Schwarzinger et al., 2010.	Risk perception and priority setting for intervention among hepatitis C virus and environmental risks: a cross-sectional survey in the Cairo community	Egypt	Urban	Survey questionnaire	Households	
Scobie et al., 2012.	Use of Oral Cholera Vaccine and Knowledge, Attitudes, and Practices Regarding Safe Water, Sanitation and Hygiene in a Long-Standing Refugee Camp, Thailand, 2012–2014	Thailand	Refugee camp	Survey questionnaire, longitudinal study, spot check, water testing	Households, females	
Seimetz et al., 2016.	Effects of an awareness raising campaign on intention and behavioural determinants for handwashing	India	NA	Survey questionnaire, exercises, role-play, community meetings, intervention/evaluation, community education, media campaign	Individuals, not specified	
Severtson, 2013.	The influence of environmental hazard maps on risk beliefs, emotion, and health-related behavioural intentions	United States	Urban, rural	Survey questionnaire, water testing, spatial assessment	Students	

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Table 2 (continued)

Study	Focus	Study country	Setting detail/context	Methods	Study population
Soleimani-Ahmadi et al., 2014.	Community knowledge and practices regarding malaria and long-lasting insecticidal nets during malaria elimination programme in an endemic area in Iran	Iran	Rural	Survey questionnaire	Households
Spicer et al., 2020.	Drinking Water Consumption Patterns: An Exploration of Risk Perception and Governance in Two First Nations Communities	Canada	Rural	Semi-structured interviews	Indigenous community
Sundaram et al., 2014.	Cultural epidemiology of pandemic influenza in urban and rural Pune, India: a cross-sectional, mixed-methods study	India	Urban, rural, heavy rainfall, climate change	Survey questionnaire, semi-structured interviews	Individuals, not specified
Sundaram et al., 2016.	Sociocultural determinants of anticipated oral cholera vaccine acceptance in three African settings: a meta-analytic approach	Democratic Republic of Congo, Kenya, Tanzania	Urban, rural, island	Survey questionnaire	Individuals, not specified
Tate et al., 2003.	Change in health risk perception following community intervention in Central Havana, Cuba	Cuba	Urban, flooding	Survey questionnaire, intervention/evaluation	Individuals, not specified
Torres-Slimming et al., 2019.	Achieving the Sustainable Development Goals: A Mixed Methods Study of Health-Related Water, Sanitation, and Hygiene (WASH) for Indigenous Shawi in the Peruvian Amazon	Peru	Rural, rainforest	Survey questionnaire, semi-structured interviews, focus group discussions, photovoice, transect walks	Indigenous community
Tran et al., 2010.	Householder perspectives and preferences on water storage and use, with reference to dengue, in the Mekong Delta, southern Vietnam	Vietnam	Rural, delta, heavy rainfall	Semi-structured interviews	Females
Tsaneva, 2013.	The Effect of Risk Preferences on Household Use of Water Treatment	Mexico	Rural	Survey questionnaire, longitudinal study	Households
Turbow et al., 2004.	Impacts of beach closures on perceptions of swimming-related health risk in Orange County, California	United States	Coast	Survey questionnaire, case control study	Individuals, not specified
Uddin and Mazur, 2015.	Socioeconomic factors differentiating healthcare utilization of cyclone survivors in rural Bangladesh: a case study of cyclone Sidr	Bangladesh	Rural, coast, flooding, cyclone	Survey questionnaire	Individuals, not specified
Veronesi et al., 2014.	Climate change and the willingness to pay to reduce ecological and health risks from wastewater flooding in urban centers and the environment	Switzerland	Flooding, climate change	Survey questionnaire	Individuals, not specified
Watson et al., 2015.	Understanding modifiable risk factors associated with childhood diarrhoea in an eastern Indonesian urban setting	Indonesia	NA	survey questionnaire	Mothers
Winch et al., 2002.	Community-based dengue prevention programmes in Puerto Rico: Impact on knowledge, behaviour, and residential mosquito infestation	Puerto Rico	School, island	Survey questionnaire, larval mosquito survey, semi-structured interviews, focus group discussions, intervention/evaluation, photo and drawing discussions, community education	Schools, children, patients, school staff/teachers, political representatives
Workman, 2019.	Perceptions of drinking water cleanliness and health-seeking behaviours: A qualitative assessment of household water safety in Lesotho, Africa	Lesotho	Rural, heavy rainfall	Survey questionnaire	Households
Wright et al., 2018.	How are perceptions associated with water consumption in Canadian Inuit? A cross-sectional survey in Rigolet, Labrador	Canada	Rural, arctic	Survey questionnaire, intervention/evaluation	Indigenous community
Yuan et al., 2000.	Impact of educational videotapes on water contact behaviour of primary school students in schistosomiasis endemic areas	China	Rural, school	Survey questionnaire, case control study, focus group discussions, intervention/evaluation	Schools, children

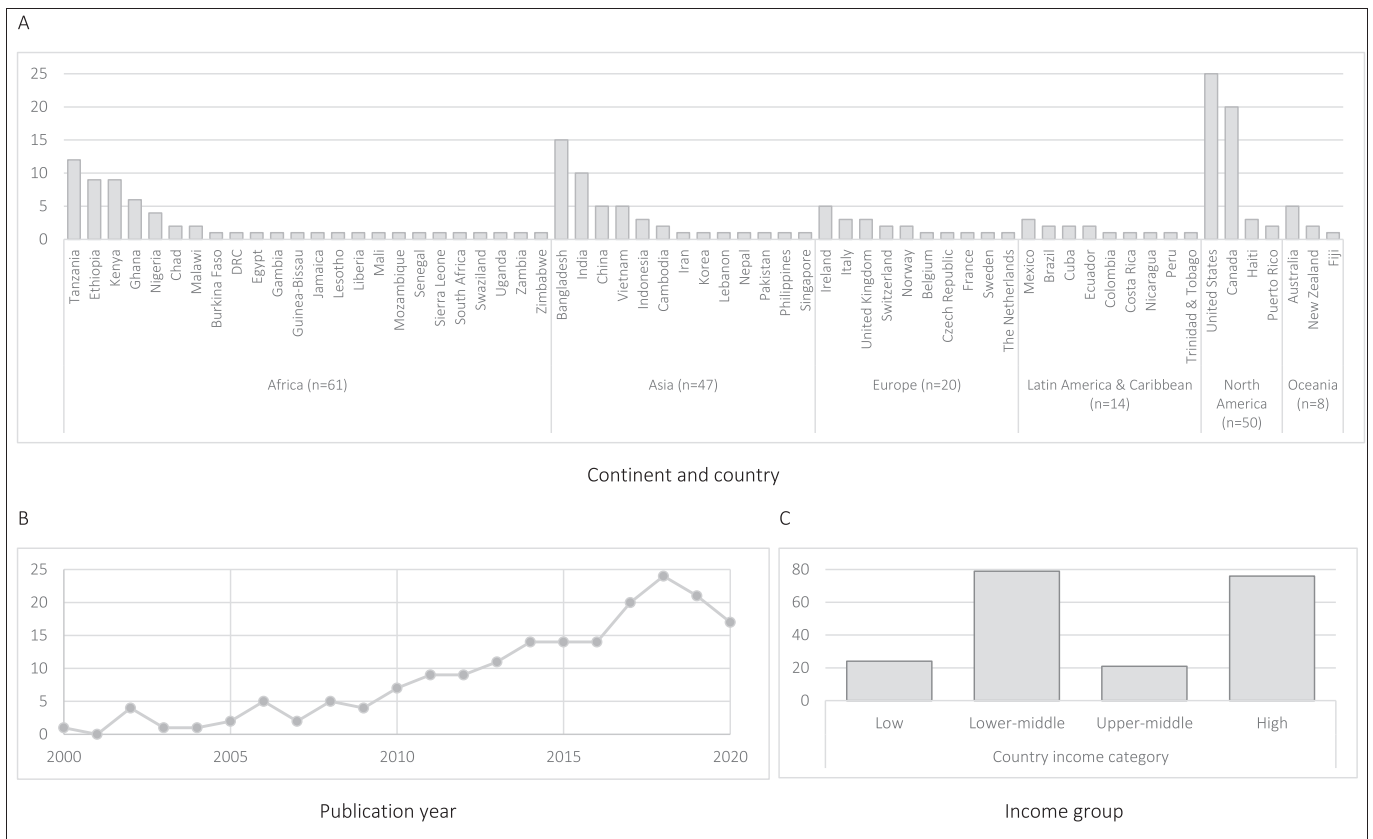


Fig. 2. Descriptive summary of included studies, based on $n = 187$ publications (2000–2021).

Geographical representation of topics related to health protection, risk and disease varied (Fig. 6). Healthcare utilization was the most commonly reported health protective factor relative to the number of publications in Latin America, Africa and Asia, but not reported from Oceania. Health risk factors showed no particular reporting trend across geographies, with

risk factors largely differing in different parts of the world. In terms of health risks, worldwide, health risks/disease in general, waterborne diseases, vector-borne related to mosquitoes and water-based diseases were reported most frequently. Diseases such as Ebola and soil-transmitted diseases were reported only from Africa.

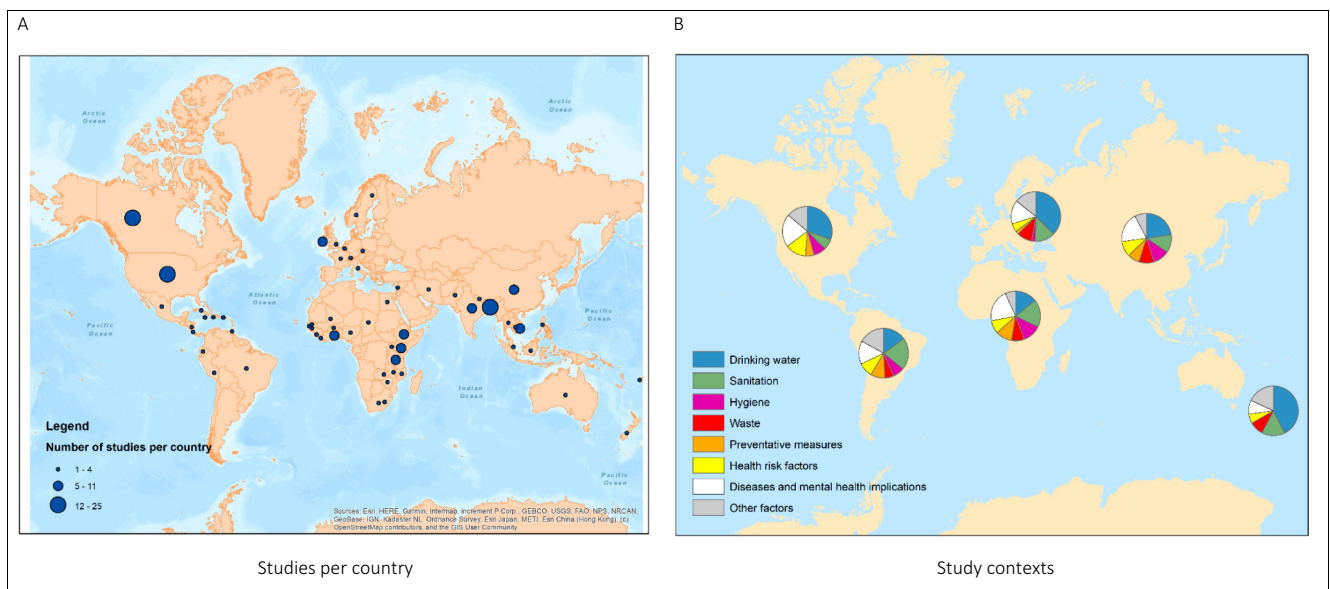


Fig. 3. Geographical context of included studies, based on $n = 187$ publications (2000–2021).

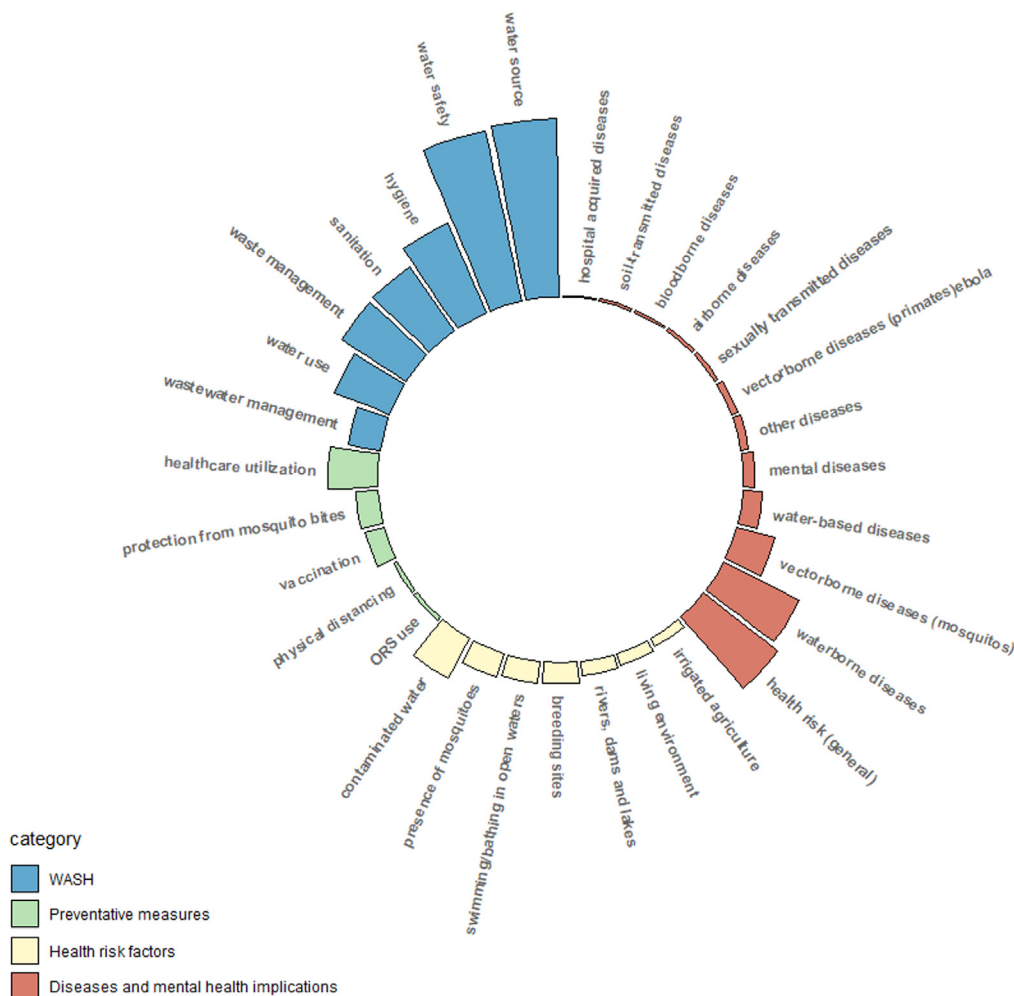


Fig. 4. Topics covered by risk perception and behaviour literature in the context of water and health, based on $n = 187$ publications (2000–2021).

3.3. Methodological approaches to risk perception and behaviour research in water and health literature

3.3.1. Methodological approaches to water- and health-related risk perception and behaviour studies

Included studies adopted quantitative, qualitative and mixed methods approaches (Table 2).

Most survey studies used a semi-quantitative on-site questionnaire (67%), while online (6%), postal (4%), and phone (4%) questionnaires were less common. Few studies were case-control studies (9%) or had a longitudinal design (4%). Studies employed different kinds of testing, including spot checks and inspections (e.g., water source, latrine, environment) (14%), water testing (12%), well testing or larval testing (3% each). Urine and blood sampling, smears for parasites, hand rinse sampling, environmental sampling, and disease screening were employed rarely. Qualitative methods were frequently employed, with 34% of studies using semi-structured interviews and 24% of studies using focus group discussions. Participatory methods such as choice experiments, exercises, role plays, photovoice or transect walks were employed by few studies. One fourth of studies were intervention studies or evaluation research (24%), including community education or risk communication components related to WASH, health and distribution of WASH-related items. Few studies conducted spatial assessments of water-related health risk factors or health-promoting features (5%). Two percent of studies included archival research.

3.3.2. Approaching risk perceptions, behaviours, and their associations in water and health literature

Few studies included in this review provided definitions for health risk perceptions.

Risk perceptions – including worry, fear, dread, or threat arousal (Mitchell et al., 2018) – or perceived seriousness of a disease – e.g. as “serious”, “real”, or “deadly” (Demolis et al., 2018) – are, to a large extent, based on prior knowledge and beliefs. Perceptions are associated with individual, social and cultural factors (Anthonj et al., 2019; Dupont et al., 2014; Lilje and Mosler, 2018; Markon and Lemyre, 2013; Musacchio et al., 2021), referring to intuitive evaluations of (health) hazards someone is or might be exposed to (Pidgeon, 1998; Rohrmann, 2008; Rohrmann and Renn, 2000).

According to Abu and Codjoe (2018), health-related actions and inactions are often triggered and influenced by our individual risk perceptions. A higher perceived risk increases the likelihood of developing positive attitudes towards protective measures; and as a consequence, risk perception is an important determinant of risk exposure, and to the kind of protective behaviour to be put in place (Anthonj et al., 2019; Aziz et al., 2006; Bradford et al., 2017; Lavalley et al., 2021; Rundblad, 2008). Demolis et al. (2018), referring to Rosenstock (1974), describe water- and health-related risk perceptions as predictors of behaviour, consisting of two components: perceived severity of consequences and perceived vulnerability to disease. A mismatch between actual hazard and perceived risk can lead to inappropriate behaviours and suboptimal compliance to recommended public health measures (Gentili et al., 2020; Wright et al., 2018).

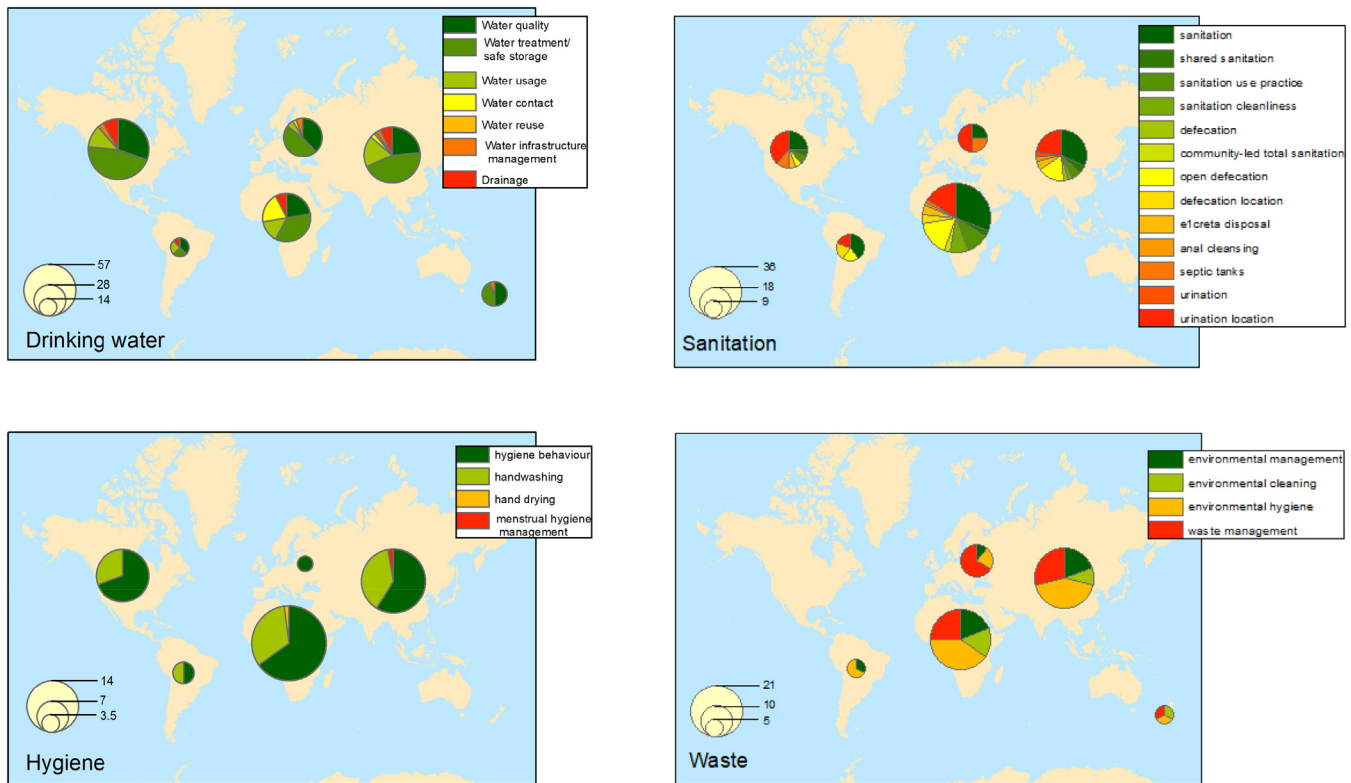


Fig. 5. Geographical representation of water, sanitation, hygiene and waste topics covered by risk perception and behaviour literature in the context of water and health, based on $n = 187$ publications (2000–2021). The size of pie charts corresponds to the number of identified studies.

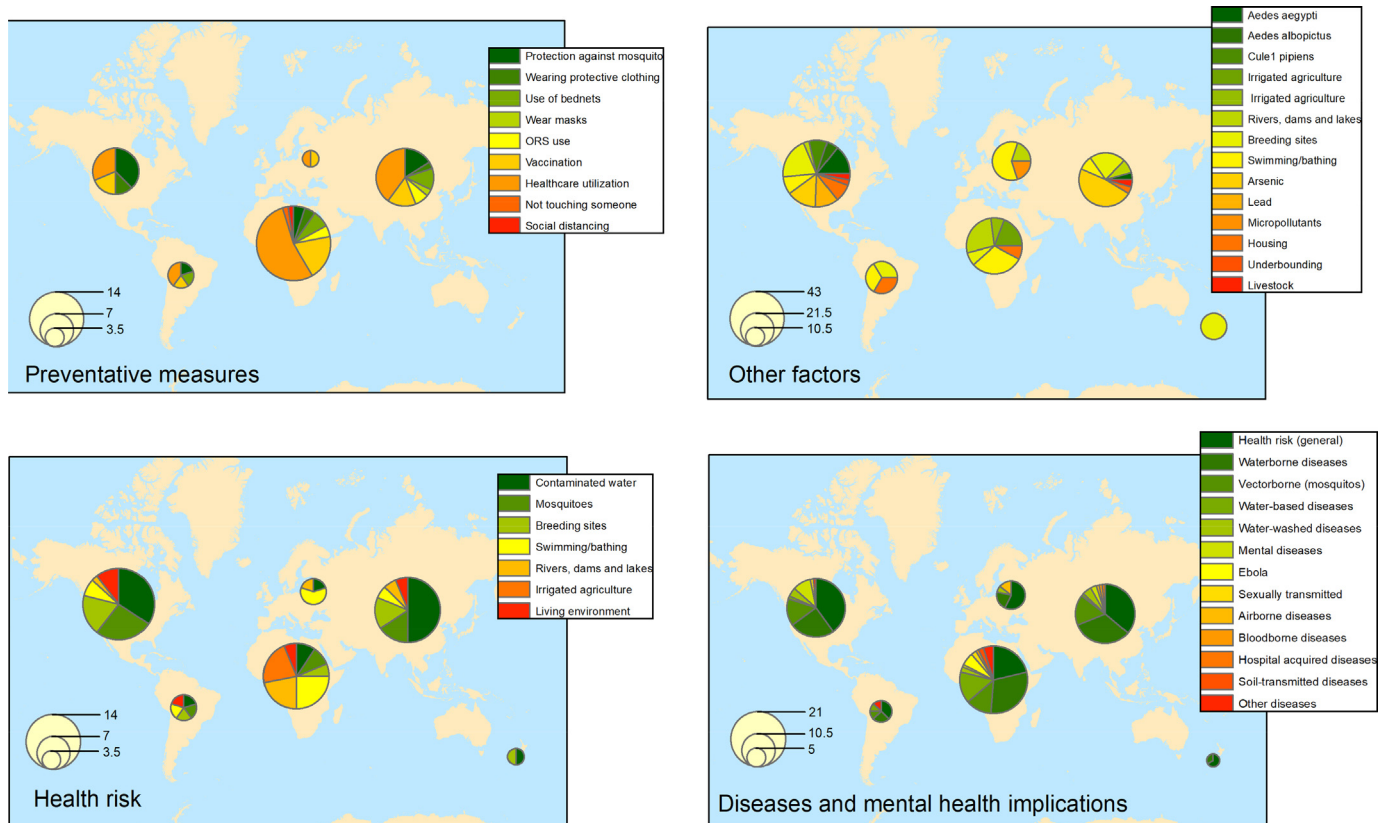


Fig. 6. Geographical representation of topics related to health protection, health risk, diseases and mental health implications covered by risk perception and behaviour literature in the context of water and health, based on $n = 187$ publications (2000–2021). The size of pie charts corresponds to the number of identified studies.

Generally, behaviour change has proven to be complex to achieve (Rusca et al., 2017; Seimetz et al., 2016). Even when individuals are aware of practices to prevent health implications of preventive behaviour, the implementation of preventive practice may be scarce. Reasons include disease prevention often not being the primary motivator for health behaviours (behaviours instead often being driven by desires for “order and control”) (Caldwell et al., 2006), meanings of cleanliness and dirtiness, and the wish to feel clean. Thus, the effectiveness of health programming, risk communication and interventions that ignore the socially embedded practices and the motivations and logic behind those practices are limited (Cooper et al., 2020; Marjadi and McLaws, 2010; Rusca et al., 2017). According to Brown et al. (2017), caution is needed before prescribing information provision as a means to encourage population-wide uptake of specific behaviours, as it may not always be effective, either due to heterogeneity in responses or insufficient responses to improve outcomes.

Rundblad et al. (2010) describe the information source of risk communication as a decisive factor in terms of behaviour change. While media has been found to impact general risk perceptions, because these perceptions are impersonal, they do not necessarily impact the personal risk perceptions that would initiate behaviour responses. Interpersonal information dissemination networks, on the other hand, are often perceived as more credible, efficient and effective than official sources, and include close contacts, family, friends, neighbours and local newspapers.

3.3.3. Theory and assessment of risk perceptions, behaviours, and their associations in water and health literature

Studies included in this review adopted different theories and assessments of risk perceptions and behaviours.

A common theoretical approach to address risk perceptions and behaviour (change) in the context of water and health is the risk, attitude, norm, ability and self-regulation (RANAS) model by Mosler (2012), which combines a set of causal determinants of health behaviour that have been specified by different well-known theories of behaviour change (Seimetz et al., 2016). These include the health belief model (HBM) (Rosenstock, 1974), the theory of planned behaviour (Ajzen, 1991), the protection motivation theory (Rogers and Prentice-Dunn, 1997), the social cognitive theory (Bandura, 2004), and the health action process approach (Schwarzer, 2008; Seimetz et al., 2016). RANAS is being adopted by using quantitative survey tools, e.g. to determine behavioural factors that increase safe water consumption in Ethiopia (Huber and Mosler, 2013); arsenic testing in New Jersey (Flanagan et al., 2015b); household water treatment in Nepal (Daniel et al., 2019); handwashing in Zimbabwe (Friedrich et al., 2017); and Ebola prevention in Guinea-Bissau (Gamma et al., 2019).

The HBM implies that the adoption of preventive health measures depends on whether individuals believe that they are vulnerable to the disease (perceived susceptibility); that the disease comes with severe health or social consequences (perceived severity); and that the benefits of preventing the disease (perceived benefits) outweigh the barriers of adoption such as cost, time, pain, and side-effects (perceived barriers) (Heyerdahl et al., 2019). In the water- and health-related literature included in this review, HBM was used, for instance, to understand consumer perceptions and purchasing behaviour of packaged water products in Sierra Leone (Jalloh et al., 2018), as well as behaviour change in the context of lead (Jordan et al., 2007), fluoride (Family et al., 2019) and arsenic (Flanagan et al., 2018) contamination of water in the United States.

Numerical risk perception measures adopting scales and scores are commonly used to capture risk perceptions and behaviours. Handwashing technique and frequency of primary caregivers in high-density suburbs in Harare, Zimbabwe, was observed and measured as an 8-point sum score, and included a scale for various key moments of handwashing (Friedrich et al., 2017). Knowledge, attitude and practices (KAPs) studies commonly adopted scores as well, e.g. on schistosomiasis in Swaziland (Maseko et al., 2018), household water treatment in Ethiopia (Bitew et al., 2017) and shared sanitation cleanliness in Nigeria, using dichotomized variables, including ‘good’ and ‘poor’, ‘positive’ and ‘negative’, and ‘clean’ and ‘dirty’ categories (Aluko et al., 2018). In their study on behavioural determinants

of switching to arsenic-safe water wells in Bangladesh, George et al. (2017) measured perceived vulnerability and severity, affective attitude, coping planning, and commitment using a Likert-type scale from 1 to 5 for unipolar items. Likert scales were also adopted in the context of household inspections for dengue-related vector control in Costa Rica (Egedus et al., 2014); housing-related health risks in Cuba (Tate et al., 2003); in an experimental test on tap water contamination in Canada (Markon and Lemyre, 2013); and for sanitation-related concerns and behaviours among women in Odisha, India (Hulland et al., 2015). Scales were also adopted in the context of hepatitis C virus and environmental risks in Egypt, assessing the short-term, i.e., directly after exposure, and the long-term implications, i.e., years after exposure (Schwarzinger et al., 2010); handwashing in India (Seimetz et al., 2016); sanitary inspection of rainwater supplies in Fiji (Kohlitz and Smith, 2015); water storage, sanitation and personal hygiene in Kenya (Anthonj et al., 2016); perceived health risks related to water sources (Lloyd-Smith et al., 2018); tap water (Leveque and Burns, 2017); and protective actions related to exposure pathways for a water contamination emergency in the United States (Lindell et al., 2017).

Looking at enteric diseases in Shanghai, Chen et al. (2012) used nine dichotomous variables to assess individuals' perceptions, including perceived prevalence in the broader community and in the village, perceived prevalence trends in recent years, perception/experience that an acquaintance had died of a disease, perception of a household member being at risk of acquiring disease, perceived unique vulnerability of infants, preschool-age children, school-age children and elderly to the disease. Individuals' perception of disease treatment and experience of vaccination assessed beliefs in the existence of effective treatment, the expense involved in treatment, and satisfaction with past vaccination services. Similarly, detailed variables to assess risk perceptions were used in a study on sanitary conditions (Chen et al., 2006).

Experiments are a tool to measure perceptions and resulting behaviours as well, e.g. in the context of diarrhoea infection as a result of flooding in Ghana. This study used ten beans, with each bean representing ten points, and thus, ten beans equaling 100%, with a focus on rating probability (on a scale of 0% to 100%) of any household member being infected with diarrhoea (Abu and Codjoe, 2018). In another study, to evaluate risk perception posed by arsenic, respondents were given ten marbles and a plastic cup and asked to put more marbles into the cup if feeling the perceived event was more likely (Bennear et al., 2013).

3.3.4. Pitfalls and limitations to water- and health-related risk perception and behaviour studies

Studies included in this review had pitfalls and various limitations.

Fifty-three studies (28%) did not provide information regarding the limitations of their research. From the other 134 publications, most frequent limitations mentioned across studies were related to the methodology of the studies ($n = 52$, 39%), such as lack of randomization (e.g., Aibana et al., 2013; Andrade et al., 2019; Ashraf et al., 2017) and lack of control group (e.g., Davis et al., 2011; Gamma et al., 2019; George et al., 2017; Severtson, 2013). Limitations concerning the sampling such as small sample sizes, sampling method and non-representative sampling were raised in 40 of the papers (30%). Study design (i.e., cross-sectional design) was cited by 39 studies (29%). Due to the nature of the studies, causality could not be assumed and temporal associations could not be assessed (Parisi et al., 2019; Chen et al., 2006). Bias across studies included social desirability bias ($n = 17$, 13%), recall bias ($n = 16$, 12%), selection bias ($n = 10$, 7%), response bias ($n = 8$, 6%), gender bias ($n = 7$, 5%), reporting bias ($n = 2$, 1%), interviewer bias ($n = 2$, 1%), observer bias ($n = 2$, 1%), researcher bias ($n = 1$, 1%), representation bias ($n = 1$, 1%), confirmation bias ($n = 1$, 1%), information bias ($n = 1$, 1%) and non-response bias ($n = 1$, 1%). Other limitations related to self-reporting data ($n = 28$, 21%), non-generalizability ($n = 24$, 18%), non-representativeness ($n = 21$, 16%), restrictions related to time such as duration of the study, time of the day of data collection and seasonal changing ($n = 13$, 10%), low response rates ($n = 11$, 8%), language barriers ($n = 3$, 2%) and ethical issues ($n = 1$, 1%).

3.4. Evidence on water- and health-related risk perception influencing behaviour

From literature identified on water and health ($n = 187$ publications), 69% of studies provided evidence on (risk) perception influencing behaviour.

The most commonly provided evidence of perceptions determining behaviour came from studies on drinking water sources and water safety (74%) and their associated health risks. The literature base also provided evidence on links between risk perception and behaviour in the context of disease prevention, health seeking, variations and changes in perception and behaviour over space, geography, socioeconomic differences and time, and the relevance of cultural context in terms of health beliefs, perceptions and behaviours (Fig. 7).

3.4.1. Perception influencing behaviour in the context of drinking water safety and WASH

Studies on drinking water sources and water safety and their associated health risks were most commonly identified in our literature review.

A study following an integrated WASH and health education intervention in Ethiopia found that risk perceptions were important determinants for the use of basic drinking water and sanitation services. Accordingly, perceiving water quality as good, or worrying about unsafe water causing diarrhoea increased the odds of using basic water services (defined as “drinking water from an improved source, provided collection time is not more than 30 minutes for a roundtrip including queuing” by World Health Organization and United Nations Children’s Fund Joint Monitoring Programme Joint Monitoring Program, 2021) (Anthonj et al., 2018). In Cambodia, the revelation of water quality information affected households’ subjective beliefs about waterborne health risks posed by their source water. The perceived safety of source water declined among those who saw a signal indicating contamination and consequently purchased and used water purification tablets, while perceived safety increased among those households who saw the opposite signal – and did not take preventative measures (Brown et al., 2017). Lilje and Mosler (2018) found that in the Lake Chad basin, a behaviour change campaign resulted in higher self-reported drinking water chlorination among participants of the intervention, positively affecting individual risk estimation for diarrheal disease, health knowledge, perceived efforts and benefits of water treatment, knowledge of how to perform chlorination, and perceived ability to do so. Participants in the

intervention felt more vulnerable to diarrheal diseases, and rated their consequences as more severe; they also had a better understanding of the association between drinking water and disease. A study on water quality perceptions and willingness to pay for clean water in peri-urban Cambodia found that households may not accurately perceive the risks associated with their existing water because, among the surveyed target group, microbial contamination is not readily observable or the germ theory of disease is not recognized. The majority of households believed that their in-house water after storage, handling, and treatment was safe to drink, and beliefs about existing water quality levels had a significant impact on the willingness to pay (WTP) for improved water quality.

However, while perceptions of quality (and thus WTP) were highly related to taste preferences, actual water quality was relatively uncorrelated with water quality perceptions (Orgill et al., 2013). When investigating reasons for drinking water source choice in low-income populations in urban areas in the United States, Family et al. (2019) found perceived health risks significantly predicted why survey participants did not drink tap water, pointing to the perceived safety and taste of tap water being key barriers to drinking fluoridated water from the tap. A study from Bangladesh looking at the prevalence of arsenic exposure from drinking water found that more than half of residents regularly consumed well water with an arsenic concentration above the acceptable government standard. Willingness to reduce exposure was positively related to awareness of the health risks (Parvez et al., 2006).

Similarly, in the United States, hazard level and proximity to an environmental hazard had the largest influences on intentions to test the water and mitigate exposure (Severtson, 2013). In the study from Bangladesh, however, the association between awareness and switching to a safe well was not stronger than the associations between awareness and using surface water (with or without treatments) or using an existing well after treatment or increasing the depth (Parvez et al., 2006). In the United Kingdom, although most respondents (88%) would buy and drink bottled water following a ‘do not drink’ notice, as many as 44% would still drink the polluted tap water (Rundblad, 2008). An evaluation of an intervention on household water management, stored drinking water quality, hygiene behaviours and their implications on hand contamination in peri-urban Tanzania revealed that respondents who received household test results were more likely to report behavioural improvements, but less likely to experience actual reductions in *E. coli* contamination in water and on

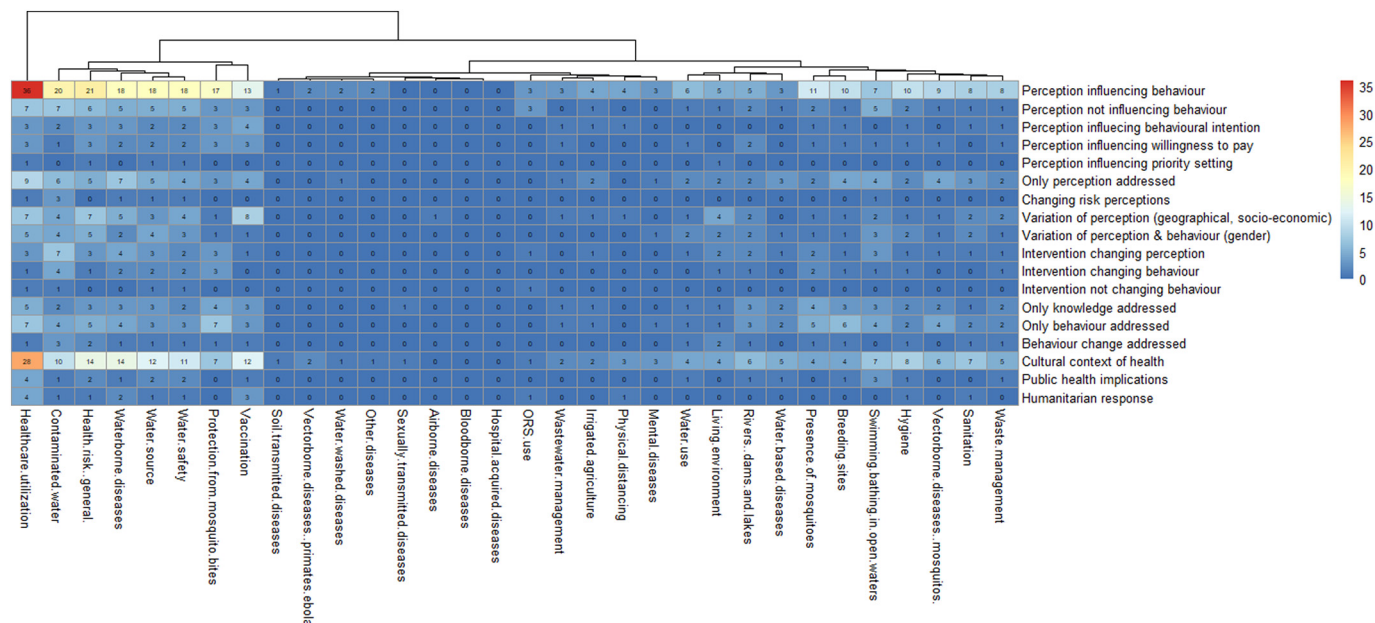


Fig. 7. Heat maps showing the co-occurrence of publications by water-and health-related topic and risk perception and/or behaviour, based on $n = 187$ publications (2000–2021).

hands (Davis et al., 2011). In rural China, the impacts of a health emergency and disaster risk management education intervention (including delivery of a disaster kit containing instructions for an oral rehydration solution recipe) following an earthquake demonstrated knowledge and behaviour improvements in household hygiene and waste management among the targeted ethnic minority community members (Chan et al., 2018).

3.4.2. Perception influencing behaviour in the context of disease prevention

The health risk perception and behaviour literature included in this review also focused on disease prevention.

In a coastal village of Costa Rica, research on dengue-related prevention knowledge, perceptions, and practices observed more mosquito breeding sites in households with lesser knowledge of dengue symptoms, a lower respondent rating on the dangers of dengue, or a lower respondent rating on the importance of preventative actions (Egedus et al., 2014). When looking at the impact of health promotion in the context of Ebola prevention in Guinea-Bissau, Gamma et al. (2017) revealed that the perceived severity of the disease and health knowledge were predictors for the intention to follow Ebola prevention behaviours. However, other predictors, such as response belief, normative beliefs, commitment, and confidence in performance, were even more important in predicting behavioural intentions. Specifically, the perception of risk with regard to touching a person who might be suffering from Ebola was an important predictor to refrain from such behaviour. Among public secondary school teachers in the Philippines, although the majority mentioned that the Zika virus is transmitted through a mosquito bite, only half of the surveyed teachers identified vector control as a preventive strategy or cleaned their water containers to prevent mosquito breeding (Gregorio et al., 2019).

3.4.3. Perception influencing behaviour in the context of healthcare

Healthcare was another important topic covered in the health risk perception and behaviour literature included in this review.

A study on the uptake of an oral cholera vaccine in Lusaka, Zambia, by Heyerdahl et al. (2019) revealed that reasons influencing people's decision against the vaccine included lack of awareness, fear of side effects, cultural notions regarding medicine, and overall lack of information. The main reasons that influenced people's choice to take the vaccine included awareness of conditions conducive to cholera and personal feeling at risk of contracting cholera, perceived effectiveness of oral cholera vaccine (OCV) and perceiving side-effects as positive. Scobie et al. (2012), when studying the use of oral cholera vaccine in the Maela refugee camp in Thailand found significant differences over time among respondents correctly identifying cholera prevention measures, including boiling or treating drinking water, and washing hands with soap. However, no difference was noted in the proportion of households testing positive for *E. coli* in stored household drinking water at the second follow-up. Overall, some positive, and no adverse changes in cholera- and WASH-related knowledge, attitude and practices after the vaccination campaign were observed. Among rural Indonesian healthcare workers, hand hygiene compliance was more likely to be undertaken after patient contacts were perceived to be dirty or risky (Marjadi and McLaws, 2010).

3.4.4. Variations in risk perceptions and behaviours in space, geography, time and with socioeconomic differences

The literature included in this review considered variations and changes in perception and behaviour over space, geography, socioeconomic differences and time.

In the Vietnamese Mekong Delta, Few et al. (2013), when investigating the relationship between seasonality, disease and behaviour found marginal temporal variations in water quality and substantial inter- and intra-household variations in risk perceptions, hygiene behaviour, seasonal behaviour and other risk factors.

Variations in knowledge uptake patterns were also detected between earthquake-prone and flood-prone communities in China regarding the use of diarrhoea mitigating oral rehydration solutions (Chan et al., 2018). In Cambodia, information provision on waterborne health risks led to

changes in beliefs about drinking water safety among households with lower than median wealth and education, households living in less developed area, and households who received a contamination signal despite having been initially optimistic about the safety of their water. These differential effects of information on beliefs were consistent with the effects on behaviour related to the purchase and use of water purification tablets. In the same study, the average effect of the signal on beliefs and behaviour waned somewhat over the study period (Brown et al., 2017). A study among minority children in the United States indicated that African American and Latin American parents were more likely to give their children mostly bottled water compared to the majority population, as they perceived bottled water as safer, cleaner, better tasting, or more convenient (Gorelick et al., 2011).

3.4.5. Health beliefs and the cultural context of health risk perceptions and behaviours

Studies included in our literature review also considered health beliefs and the cultural context of health risk perceptions and behaviours.

A study conducted in Northwest Ethiopia to understand health-seeking behaviours of Podoconiosis (endemic non-filarial elephantiasis) patients found that belief in heredity or divine punishment often delayed clinic attendance. Motivators for clinic attendance were failure of traditional treatments and severe or disabling symptoms. Such health beliefs and cultural contexts of health influencing treatment-seeking behaviour uncover the need for greater integration with traditional healers, improved access to water through collaboration with other NGOs and the government and the use of expert patients to disseminate information and signpost patients to clinics (Banks et al., 2016). Chen et al. (2006), when investigating perceptions of enteric disease treatment and experience of vaccination in China, found that perceived vulnerability of specific subgroups, knowing someone who died of the disease and satisfaction with past vaccination services were consistently associated with perceived need for vaccines of target populations of all age groups, while the association between perception of sanitary improvement and vaccine need was limited. Perceived need for a vaccine was associated with willingness to pay for the vaccine. Sundaram et al. (2014), when studying the cultural epidemiology of pandemic influenza in urban and rural Pune in India, found that worry or "tension" among rural respondents about the illness were prominent, however, they suggested reliance on prayer as main preventative measure. And finally, in the United States, misconceptions about tap water fluoridation and differences in beliefs about tap water safety were found to be prevalent across different income levels in urban areas (Family et al., 2019).

4. Discussion

4.1. Do risk perceptions motivate behaviour in the context of water and health?

This systematic review provides extensive evidence on water- and health-related risk perceptions influencing behaviour, including in the context of drinking water, disease prevention, health seeking, variations and changes in perception and behaviour over space and geography, with socioeconomic differences, and highlights the relevance of the cultural context. Studies look at household and non-household settings worldwide, cover numerous disciplines, use different methodological approaches and, related to that, very different (ly detailed) defined risk perceptions and behaviours.

What is not dealt with in detail in the literature is how risk perceptions change over time (Francis et al., 2015). We found a lack of longitudinal studies (4%), likely due to the resource intensity needed to carry them out. Most of the available longitudinal studies identified decreased knowledge or adherence to risk-informed practices over time (Brown et al., 2017), although this trend can be improved by follow-up reinforcement measures (Scobie et al., 2012). Balasubramanya et al. (2014) found that ongoing well testing for arsenic in Bangladesh promoted switching and continuous use of safer wells.

Cognitive biases (or heuristics) often lead individuals to discount future benefits and favour immediate rewards. One study among caregivers in

Kenya elicited this effect: the immediate cost to practising improved health behaviours was perceived as greater than the potential long-term benefits (Ellis et al., 2020). In Cuba, Escobedo et al. (2011) showed that the opportunity cost of time itself came into play in decision-making about health risks when combined with a lack of physical resources.

Health risks may not universally need to be shifted in the same direction, but rather recalibrated against the information available and how it stacks up against other risks. Unexpected events and sensitive life stages offer educators windows of heightened attention to health risks. In Italy, Gentili et al. (2020) studied risk perceptions in the aftermath of a school tuberculosis outbreak, finding that an informational session effectively reduced the perception of risk among parents and students. In the United States, He et al. (2018) showed that pregnant women with knowledge of arsenic contamination in their well water often reduced usage for drinking and cooking, although most continued to use it sometimes and just under half continued using it to mix infant formula.

Tailoring intervention follow-up to address changing, multiple, or layered goals may be helpful. For example, an information intervention on safe water storage and hand hygiene in Tanzania succeeded at attaining behavioural improvements, although participants did not achieve reductions in *E. coli* contamination in water and on hands (Davis et al., 2011).

4.2. Relevance of risk perception studies for WASH governance

4.2.1. Policy

Generally, risk perception studies aim to identify the population at risk for appropriate policy interventions and are important for public health policy formulation (Abu and Codjoe, 2018). Although they have become an important topic to policy-makers concerned with risk management, risk perception studies are usually the last considered option because of the difficulty in conducting and evaluating them. As experts generally have lower risk perceptions than lay-people and the target population (Mumbi and Watanabe, 2020) and due to proven associations between risk perception and behaviour, it is important to make risk perception a priority in decision making to identify high or low-risk communities, and challenges that communities are really facing beyond what is on political agendas (Abu and Codjoe, 2018). A deeper understanding of place- or community-based knowledge may positively influence policy development and management-level decision making (Castleden et al., 2015). In addition, inter-sectoral collaboration in policy-making is relevant to mitigate waterborne diseases that originate from farming (Hall and Le, 2018), to successfully implement vector management for malaria control (Castro et al., 2009) and to promote children's environmental health (Postma et al., 2011).

Multiple studies on risk perceptions associated with arsenic occurrence in drinking water supplies in Bangladesh highlighted the need for national policies on arsenic mitigation (Benneer et al., 2013; Caldwell et al., 2005; Caldwell et al., 2006; George et al., 2017). Health authorities often lack robust information on actual risks and most appropriate interventions (Caldwell et al., 2005) and wrongly rely on one-time oral messages to raise awareness on the risks associated with arsenic intake (Benneer et al., 2013). Policy should be tailored to target the identified behaviour determinants (George et al., 2017) and should be sensitive to gender differences in water usage and oversight (Caldwell et al., 2006). Exploring drinking water safety more broadly, even when it is the primary problem for residents (e.g., of Flint, USA), policymakers should address the secondary consequences, such as the impact of the water crisis on mental health (Heard-Garris et al., 2017).

4.2.2. Awareness raising

Risk awareness is lacking in several studies (e.g., Blum et al., 2014; Chaturvedi et al., 2017; Crampton and Ragusa, 2016) and may be influenced by gender (McDowell et al., 2020). Risk awareness campaigns increase knowledge and facilitate participation in prevention practices (Aziz et al., 2006; Castro et al., 2009; Haenchen et al., 2016; Islam et al., 2011). However, they are not always successful (Schade et al., 2015). Numerous methodologies have been described as effective: multimedia presentations

accompanied by verbal explanations (Islam et al., 2011), face-to-face communication mechanisms (Hynds et al., 2018), mass media (e.g., radio) campaigns (Lilje et al., 2015; Perez-Guerra et al., 2009; Roche et al., 2013), photovoice (Bisung et al., 2015), community meetings (Lilje et al., 2015; Akter and Ali, 2014) and home visits (Akter and Ali, 2014). Information should always be communicated with a variety of audience profiles in mind (Hynds et al., 2018). Campaigns should include a clear description of the risk (Hyllestad et al., 2019), be timely, relevant and easily understandable (Crampton and Ragusa, 2016) and be based on personal and social norms (Musacchio et al., 2021). To put up with fluctuating risks, as in the case of the cholera outbreaks in Haiti, intensive preventive measures such as awareness campaigns should be implemented during inter-peak hiatuses, when prevention activities are usually reduced (Grandesso et al., 2014).

4.2.3. Education

Risk perceptions have often been found to be influenced by the level of educational attainment (Aziz et al., 2006; Egedus et al., 2014; Leveque and Burns, 2017; Nguyen et al., 2019). Just under a third of the studies included in this review suggested implementation of educational programmes as part of future mitigation strategies. They recommended the implementation of educational programmes focusing on specific target groups, e.g., communities (Kumar et al., 2010; Lucier et al., 2020; Nguyen et al., 2019), community health workers (Gupta et al., 2012), housewives (Daude et al., 2017), mothers (Watson et al., 2015), school children (Munisi et al., 2017; Nguyen et al., 2019; Torres-Slimming et al., 2019), secondary school and undergraduate students (Edoror et al., 2019; Javaeed et al., 2018), teachers (Edoror et al., 2019; Gregorio et al., 2019; Maseko et al., 2018) and packaged water petty traders and consumers (Jalloh et al., 2018). Other studies suggested targeting the education of populations with lower socioeconomic status (Dowling et al., 2013; Parvez et al., 2006), residing in less developed areas (Nguyen et al., 2019) or simply the most vulnerable subgroups (Chan et al., 2018).

In general, understanding the factors behind locally perceived health risks and WASH-related choices, self-identified needs, while paying attention to local socio-cultural aspects and literacy levels should inform public health education efforts (Ackumey et al., 2012; Halvorson et al., 2011; Jones et al., 2006; McLeod et al., 2014; Nguyen et al., 2019; Sundaram et al., 2016). Akpabio (2012) advocated for an education system driven by local traditional and religious institutions (e.g., village and religious councils) to have a higher chance of success in specific contexts. As far as the methodology used in educational programmes is concerned, the importance of active teaching and learning (e.g., Niemi, 2002) has been recognized by Bodner et al. (2016). Jordan et al. (2007) noted that teaching simple strategies, demonstrating concepts and providing feedback are important features of education that do facilitate behaviour change. Routine use of multimedia formats (e.g., written or illustrated educational materials) can reduce the burden on educators (Escobedo et al., 2011). Some studies expressed the need to plan for sustainable, regular/continuous and long-term educational programmes (Atuyambe et al., 2011; Ferreira da Silva et al., 2020; Marjadi and McLaws, 2010) because the impact of the signal on behaviour and beliefs may wane over time (Brown et al., 2017).

4.2.4. Behaviour change

As a systematic review of risk perceptions and health behaviour conducted in psychology concluded, interventions that successfully shape risk perceptions lead to subsequent improvements in health behaviours (Ferrer and Klein, 2015). Behaviour change in the water, sanitation, and hygiene sector has synergies with many other development goals, such as women's empowerment, economic development, and access to education. In rural Nigeria, for example, Akpabio (2012) observed that a lack of inherent capacity to recognise and understand the logic behind the problem and resource limitations led to a failure to enact behaviour change. These limitations mainly dealt with a lack of formal education, a lack of access to information, and the bounds of poverty. Greater awareness of waterborne diseases does not always result in behaviour change (Gupta et al., 2012)

because individuals may lack possibilities and/or exhaustive information on 'healthy' behaviour (Anthonj et al., 2016). In Haiti, although aware of prevention measures to curb the risks associated with the cholera outbreak, respondents often lacked the means to implement and sustain behavioural changes (Guillaume et al., 2019).

Scobie et al. (2016) recommended periodic campaigns to reinforce knowledge, attitudes, and practices around cholera prevention and control in Thailand. Programmes to improve risk awareness and public health behaviours could be planned and implemented in a series of cycles to (a) monitor achievement of outcomes and (b) modify or adapt the approach to contextual factors as needed. During an Ebola outbreak in Liberia, assessments focused on understanding infrastructural needs but omitted hygiene behaviours or their determinants. Leaving behaviours out of outbreak assessments resulted from behaviour change techniques used in non-emergency settings being considered too complex for most humanitarian actors. Therefore, rapid research methods to explore behavioural determinants increased skills training of frontline staff, and operational research to identify behaviour change strategies suitable in emergencies must be strengthened (Czerniewska and White, 2020).

Moreover, there is growing consensus that local perceptions and indigenous knowledge should be important elements in evaluating programmes aimed at improving health (Andrade et al., 2019; Tate et al., 2003). Thus, future mitigation programmes should be looking beyond merely increasing knowledge, but should devise an approach based on reliable information on risk perceptions and tailored to target the locally identified behavioural determinants (Gamma et al., 2019; George et al., 2017; Jones et al., 2007; Seimetz et al., 2016). Implementing behaviour change interventions will be efficacious only if they are tailored to current behaviours, knowledge, and perceptions of the target population (Watson et al., 2015), as well as their cultural context (Sundaram et al., 2014). With a growing focus on community-level environmental management as a component of disease control, it becomes crucial to define existing beliefs regarding the link between disease and the environment, and how these beliefs relate to environmental management practices (Randell et al., 2010). A participatory multi-stakeholder approach has been suggested to develop behaviour change strategies tailored to local needs (Herbst et al., 2009).

4.3. Health-related risk perception and behaviour research is more important than ever: COVID-19

Although this review is not specific to COVID-19, the context of a global pandemic certainly informs discussion around risk perceptions and behaviour. In the context of transmissible and preventable infectious diseases, as new information emerges, public and individual perception is expected to change (evolve or regress). This pattern has been highly evident during the COVID-19 pandemic. For many, COVID-19 set unprecedented living and working conditions. The perceived risks of infection forced changes that would otherwise not be deliberate, giving heightened importance to wellbeing, mental and physical health (Cori et al., 2020), and population health. Due to the infectious nature and transmission route of SARS-CoV-2, the preventive measures depend heavily on prompt population behaviour changes, which rely on individual adaptation to behaviours perceived as protective (Xu and Peng, 2015). Previous studies have shown that adherence to preventive measures increases as perceived risks increase (Wise et al., 2020). Earlier studies specific to COVID-19 also showed that women, individuals with higher levels of education, and those with chronic diseases report tighter adherence to preventive behaviours (Mendoza-Jiménez et al., 2021).

At the beginning of the COVID-19 pandemic, the risk of infection was underestimated by many. The focus across the globe by public health officials has been to lessen the transmission of the SARS CoV-2 virus to eventually reduce the burden on the healthcare system to a manageable level (Wise et al., 2020). COVID-19-related closures initially led to greater hygiene awareness, although these pressures have waxed and waned with external influences (e.g., government and local agencies messaging, business practices, peer pressure) despite ongoing risk. However, throughout this

pandemic, there have been varying levels of defiance toward protective measure. Such defiance could be attributed to the prolonged nature of the pandemic, competing interests, lack of trust, or even misinformation (WHO Regional Office For Europe, 2020). Based on differences seen in the response to COVID-19 by the general population in different areas of the world, it is irrefutable that cultural perceptions have dictated success in beneficial behavioural modification (Ruiz et al., 2020). Political affiliation and conflicting sources of evidence (e.g., alternative facts) have had strong influences on vaccination rates, for example in the United States (Gao and Radford, 2021; Hamel et al., 2021).

To effectively address ongoing public health challenges such as the COVID-19 pandemic, we must understand the factors that govern adherence to beneficial health behaviours. Improved understanding will help frame interventions and communications with the general public to allow more dynamic public health responses and save lives.

4.4. Limitations

The complex search strategy, connecting terminology associating risk perceptions and behaviours in the context of WASH and health, may present a limitation to identifying and including all relevant literature. While some synergies such as variations and changes in perception and behaviour over space and geography, with socioeconomic differences, education, cultural context, and policy were identified, this approach may have limited identification of other synergies. Gray literature and non-English documents available on the topic were not included, although we acknowledge that non-peer-reviewed literature, programming and policy reports could have added further insight and value to the topic. Analyzing them in-depth, however, was outside of the scope of this work. Outcomes stemming from self-reporting or syndromic surveillance are subject to measurement bias.

Evidence in publications included in this review was captured at different geographical and organizational scales, considered different disciplinary perspectives, and used different methodological approaches and definitions. This makes the cross-comparison of risk perception- and behaviour-related evidence challenging. It is important to consider that evidence is generally context-specific, relating to culture, religion, politics, geography, ecology, social structure, etc., all of which differ globally, regionally, nationally, and locally. Therefore, our figures and maps serve as a general impression only.

5. Conclusions and recommendations

To our knowledge, this is the first systematic review on health risk perceptions and behaviour in the context of water and health. It sought to fill knowledge gaps on how water-related health risk perceptions and related behaviours are portrayed in the academic literature, which topics and concepts the literature covers, which evidence exists and why this is relevant for water- and health-related governance.

We found the literature related to risk perceptions and behaviours in the context of water and health to have grown over the past twenty years, reporting information from different continents and countries belonging to different income groups around the globe, conducted in various settings and contexts, among different target populations, across disciplinary angles, using different methods, theories and approaches. We categorized our water- and health-related risk perception and behaviour results according to the major themes emerging from the literature, and these centred mainly around drinking water, sanitation, hygiene and waste-related topics, health risk factors, diseases and mental health implications, and preventative measures.

Our review provides evidence of perceptions determining behaviour particularly related to drinking water sources and water safety. Moreover, evidence on links between risk perception and behaviour in the context of disease prevention, health seeking, variations and changes in perception and behaviour over space, geography, socioeconomic differences and

time, and the relevance of cultural context in terms of health beliefs is provided.

This review shows that risk perception studies are vital for WASH governance in terms of policy, raising awareness, education and behaviour change, particularly in the face of unprecedented public health issues like the ongoing COVID-19 pandemic that the world is currently facing. In particular, risk perception studies that identify the population at risk and the determinants of behaviour could be used to inform the development or improvement of policies. Risk awareness was found to be lacking in many studies, therefore there is the need for implementing appropriate campaigns that deliver simple and clear messages, and that use effective methodologies (e.g., community meetings, multimedia presentations). Education is a key mitigation strategy to influence WASH-related risk perception and choices, and must focus on teaching simple strategies, demonstrating concepts and providing feedback. We recommend to customize educational programmes for specific target groups (e.g., mothers, community workers, small children) while making sure that the most vulnerable groups are reached. The efficacy of behaviour change interventions depends on how health risk messages are tailored to current behaviours, knowledge, and perceptions of the target population, as well as their cultural context. Programmes that focus on health behaviour change should be planned and implemented sustainably, making sure that progress is monitored and that the approach is periodically adapted as needed. Lastly, we advise governments or other implementing agencies to make sure that the populations at risk have the means to implement and sustain behavioural changes.

As this review showed, future water- and health-related risk perception and behaviour research, policy and practice need to focus more on early interventions. As knowledge gaps remain on how perceptions and behaviours change over time, and as these are particularly relevant to effective public health planning and health messaging, we recommend future research to implement longitudinal studies to compare perceptions and behaviours at different time points. Building on this review, future research associating risk perceptions and how these influence and determine behaviours in water and health research may further analyze resulting differences across geographies, and underlying socio-economic, educational, infrastructural, WASH-related and context-specific determinants. Follow-up analyses may also dive deeper into comparison of results across various disciplinary angles and using different methods, theories and approaches.

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.scitotenv.2021.152902>.

CRedit authorship contribution statement

Carmen Anthonj: Conceptualization, Methodology, Formal analysis, Investigation, Validation, Data Curation, Writing - Original Draft, Visualization, Supervision, Project administration. **Karen Setty:** Formal analysis, Writing - Review & Editing. **Giuliana Ferrero:** Formal analysis, Writing - Review & Editing. **Kassandra Poague:** Formal analysis, Writing - Review & Editing. **Al-Mounawara A. Yaya:** Writing - Review & Editing. **Ellen-Wien Augustijn:** Software, Visualization, Writing - Review & Editing. **Alan J. Marsh:** Writing - Review & Editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

No funding was received to support this systematic literature review on health risk perceptions motivating water- and health-related behaviour. We thank librarian Beth Morenson at the Gillings School of Global Public Health at UNC Chapel Hill for her assistance in finding full texts of publications included in this work.

References

- Abu, M., Codjoe, S.N.A., 2018. Experience and future perceived risk of floods and diarrheal disease in urban poor communities in Accra, Ghana. *Int. J. Environ. Res. Public Health* 15 (12).
- Ackumey, M.M., Gyapong, M., Pappoe, M., Kwakye-Maclean, C., Weiss, M.G., 2012. Illness meanings and experiences for pre-ulcer and ulcer conditions of buruli ulcer in the gawest and ga-south municipalities of Ghana. *BMC Public Health* 12.
- Aibana, O., Franke, M., Teng, J., Hilaire, J., Raymond, M., Ivers, L.C., 2013. Cholera vaccination campaign contributes to improved knowledge regarding cholera and improved practice relevant to waterborne disease in rural Haiti. *PLoS Negl. Trop. Dis.* 7 (11).
- Ajzen, I., 1991. The theory of planned behavior. *Organ. Behav. Hum. Decis. Process.* 50, 179–211.
- Akpabio, E.M., 2012. Water meanings, sanitation practices and hygiene behaviours in the cultural mirror: a perspective from Nigeria. *J. Water Sanitation Hyg. Dev.* 2 (3), 168–181.
- Akter, T., Ali, A.M., 2014. Factors influencing knowledge and practice of hygiene in water, sanitation and hygiene (WASH) programme areas of Bangladesh rural advancement committee. *Rural Remote Health* 14 (3).
- Alemu, F., Kumie, A., Medhin, G., Gebre, T., Godfrey, P., 2017. A socio-ecological analysis of barriers to the adoption, sustainability and consistent use of sanitation facilities in rural Ethiopia. *BMC Public Health* 17.
- Alicea-Planas, J., Dresel, S., Ferrante, A., Vasquez, W., 2019. Factors influencing carbonated soft-drink and bottled water consumption: survey evidence from Nicaragua. *Int. J. Health Promot. Educ.* 58 (6), 333–346.
- Allwood, P., Munoz-Zanzi, C., Chang, M., Brown, P.D., 2014. Knowledge, perceptions, and environmental risk factors among jamaican households with a history of leptospirosis. *J. Infect. Public Health* 7 (4), 314–322.
- Aluko, O.O., Oloruntoba, E.O., Chukwunenye, U.A., Henry, E.U., Ojogun, E., 2018. The dynamics and determinants of household shared sanitation cleanliness in a heterogeneous urban settlement in Southwest Nigeria. *Public Health* 165, 125–135.
- Andrade, E.L., Bingenheimer, J.B., Edberg, M.C., Zoerhoff, K.L., Putzer, E.M., 2019. Evaluating the effectiveness of a community-based hygiene promotion program in a rural salvadoran setting. *Glob. Health Promot.* 26 (1), 69–80.
- Angelo, T., Kinunghi, S.M., Buza, J., Mwanga, J.R., Kariuki, H.C., Wilson, S., 2019. Community knowledge, perceptions and water contact practices associated with transmission of urinary schistosomiasis in an endemic region: a qualitative cross-sectional study. *BMC Public Health* 19.
- Anthonj, C., 2021. Contextualizing linkages between water security and global health in Africa, Asia and Europe. *Geography matters in research, policy and practice. Water Security* 13, 100093.
- Anthonj, C., Rechenburg, A., Kistemann, T., 2016. Water, sanitation and hygiene in wetlands. A case study from the ewaso Narok swamp, Kenya. *Int. J. Hyg. Environ. Health* 219 (7), 606–616.
- Anthonj, C., Fleming, L., Godfrey, S., Ambelu, A., Bevan, J., Cronk, R., Bartram, J., 2018. Health risk perceptions are associated with domestic use of basic water and sanitation services-evidence from rural Ethiopia. *Int. J. Environ. Res. Public Health* 15 (10).
- Anthonj, C., Diekkruger, B., Borgemeister, C., Kistemann, T., 2019. Health risk perceptions and local knowledge of water-related infectious disease exposure among kenyan wetland communities. *Int. J. Hyg. Environ. Health* 222 (1), 34–48.
- Asgary, R., Grigoryan, Z., Naderi, R., Allan, R., 2012. Lack of patient risk counselling and a broader provider training affect malaria control in remote Somalia Kenya border: qualitative assessment. *Glob. Public Health* 7 (3), 240–252.
- Ashraf, S., Nizame, F.A., Islam, M., Dutta, N.C., Yeasmin, D., Akhter, S., Abedin, J., Winch, P.J., Ram, P.K., Unicomb, L., Leontsini, E., Luby, S.P., 2017. Nonrandomized trial of feasibility and acceptability of strategies for promotion of soapy water as a handwashing agent in rural Bangladesh. *Am. J. Trop. Med. Hyg.* 96 (2), 421–429.
- Assefa, M., Kumie, A., 2014. Assessment of factors influencing hygiene behaviour among school children in mereb-Leke District, northern Ethiopia: a cross-sectional study. *BMC Public Health* 14.
- Attu, H., Adjei, J.K., 2018. Local knowledge and practices towards malaria in an irrigated farming community in Ghana. *Malar. J.* 17.
- Atuyambe, L.M., Edia, M., Orach, C.G., Musenero, M., Bazeyo, W., 2011. Land slide disaster in eastern Uganda: rapid assessment of water, sanitation and hygiene situation in Bulucheke camp, Bududa district. *Environ. Health* 10.
- Aziz, S.N., Boyle, K.J., Rahman, M., 2006. Knowledge of arsenic in drinking-water: risks and avoidance in Matlab, Bangladesh. *J. Health Popul. Nutr.* 24 (3), 327–335.
- Balasubramanya, S., Pfaff, A., Bennear, L., Tarozzi, A., Ahmed, K.M., Schoenfeld, A., van Geen, A., 2014. Evolution of households' responses to the groundwater arsenic crisis in Bangladesh: information on environmental health risks can have increasing behavioral impact over time. *Environ. Dev. Econ.* 19 (5), 631–647.
- Bandura, A., 2004. Health promotion by social cognitive means. *Health Educ. Behav.* 31, 143–164.
- Banks, H.S., Tsegay, G., Wubie, M., Tamiru, A., Davey, G., Cooper, M., 2016. Using qualitative methods to explore lay explanatory models, health-seeking behaviours and self-care practices of podoconiosis patients in north-West Ethiopia. *PLoS Negl. Trop. Dis.* 10 (8).
- Belay, M., Deressa, W., 2008. Use of insecticide treated nets by pregnant women and associated factors in a pre-dominantly rural population in northern Ethiopia. *Tropical Med. Int. Health* 13 (10), 1303–1313.
- Bennear, L., Tarozzi, A., Pfaff, A., Balasubramanya, S., Ahmed, K.M., van Geen, A., 2013. Impact of a randomized controlled trial in arsenic risk communication on household water-source choices in Bangladesh. *J. Environ. Econ. Manag.* 65 (2), 225–240.
- Bermedo-Carrasco, S., Bharadwaj, L., Waldner, C.L., 2018. Factors associated with drinking and being satisfied with tap water in Indigenous communities in Saskatchewan, Canada. *Int. J. Circumpolar Health* 77 (1).
- Bisung, E., Elliott, S.J., Abudho, B., Karanja, D.M., Schuster-Wallace, C.J., 2015. Using photovoice as a community based participatory research tool for changing water, sanitation, and hygiene behaviours in Usoma, Kenya. *Biomed. Res. Int.* 903025

- Bitew, B.D., Gete, Y.K., Biks, G.A., Adafrie, T.T., 2017. Knowledge, attitude, and practice of mothers/caregivers on household water treatment methods in Northwest Ethiopia: a community-based cross-sectional study. *Am. J. Trop. Med. Hyg.* 97 (3), 914–922.
- Blum, L.S., Dentz, H., Chingoli, F., Chilima, B., Warne, T., Lee, C., Hyde, T., Gindler, J., Sejvar, J., Mintz, E.D., 2014. Formative investigation of acceptability of typhoid vaccine during a typhoid fever outbreak in Neno District, Malawi. *Am. J. Trop. Med. Hyg.* 91 (4), 729–737.
- Bodner, D., LaDeau, S.L., Biehler, D., Kirchoff, N., Leisnham, P.T., 2016. Effectiveness of print education at reducing urban mosquito infestation through improved resident-based management. *PLoS One* 11 (5).
- Bradford, L.E.A., Idowu, B., Zagowski, R., Bharadwaj, L.A., 2017. There is no publicity like word of mouth ... Lessons for communicating drinking water risks in the urban setting. *Sustain. Cities Soc.* 29, 23–40.
- Brewer, N.T., Chapman, G.B., Rothman, A.J., Leask, J., Kempe, A., 2017. Increasing vaccination: putting psychological science into action. *Psychol. Sci. Public Interest* 18 (3), 149–207.
- Brown, J., Hamoudi, A., Jeuland, M., Turrini, G., 2017. Seeing, believing, and behaving: heterogeneous effects of an information intervention on household water treatment. *J. Environ. Econ. Manag.* 86, 141–159.
- Caldwell, B.K., Smith, W.T., Caldwell, J.C., Mitra, S.N., 2005. Trends in water usage and knowledge of arsenicosis in Bangladesh: findings from successive national surveys. *Popul. Space Place* 11 (4), 211–223.
- Caldwell, B.K., Smith, W.T., Lokuge, K., Ranmuthugala, G., Dear, K., Milton, A.H., Sim, M.R., Ng, J.C., Mitra, S.N., 2006. Access to drinking-water and arsenicosis in Bangladesh. *J. Health Popul. Nutr.* 24 (3), 336–345.
- Caruso, B.A., Dreifelbis, R., Ogutu, E.A., Rheingans, R., 2014. If you build it will they come? Factors influencing rural primary pupils' urination and defecation practices at school in western Kenya. *J. Water Sanitation Hyg. Dev.* 4 (4), 642–653.
- Castleden, H., Crooks, V.A., van Meerveld, I., 2015. Examining the public health implications of drinking water-related behaviours and perceptions: a face-to-face exploratory survey of residents in eight coastal communities in British Columbia and Nova Scotia. *Can. Geogr.* 59 (2), 111–125.
- Castro, M.C., Tsuruta, A., Kanamori, S., Kannady, K., Mkude, S., 2009. Community-based environmental management for malaria control: evidence from a small-scale intervention in Dar es Salaam, Tanzania. *Malar. J.* 8.
- Chan, E.Y.Y., Ho, J.Y.E., Huang, Z., Kim, J.H., Lam, H.C.Y., Chung, P.P.W., Wong, C.K.P., Liu, S.D., Chow, S., 2018. Long-term and immediate impacts of health emergency and disaster risk management (Health-EDRM) education interventions in a rural Chinese earthquake-prone Transitional Village. *Int. J. Disaster Risk Sci.* 9 (3), 319–330.
- Chaturvedi, S., Sharma, N., Kakkar, M., 2017. Perceptions, practices and health seeking behaviour constrain JE/AES interventions in high endemic district of North India. *BMC Public Health* 17.
- Chen, X.G., Stanton, B., Wang, X.Y., Nyamette, A., Pach, A., Kaljee, L., Pack, R., von Seidlein, L., Clemens, J., Gong, Y.L., Mao, R., 2006. Differences in perception of dysentery and enteric fever and willingness to receive vaccines among rural residents in China. *Vaccine* 24 (5), 561–571.
- Chen, H.Y., Zhang, Y.Y., Ma, L.L., Liu, F.M., Zheng, W.W., Shen, Q.F., Zhang, H.M., Wei, X., Tian, D.J., He, G.S., Qu, W.D., 2012. Change of water consumption and its potential influential factors in Shanghai: a cross-sectional study. *BMC Public Health* 12.
- Cooper, M.C., Langman, J.B., Sarathchandra, D., Vella, C.A., Wardropper, C.B., 2020. Perceived risk and intentions to practice health protective behaviors in a mining-impacted region. *Int. J. Environ. Res. Public Health* 17, 7916.
- Cori, L., Bianchi, F., Cadum, E., Anthonj, C., 2020. Risk Perception and COVID-19. *Int. J. Environ. Res. Public Health* 17 (9), 3114.
- Crampton, A., Ragusa, A.T., 2016. Exploring perceptions and behaviors about drinking water in Australia and New Zealand: is it risky to drink water, when and why? *Hydrology* 3 (1).
- Czerniewska, A., White, S., 2020. Hygiene programming during outbreaks: a qualitative case study of the humanitarian response during the ebola outbreak in Liberia. *BMC Public Health* 20 (1).
- Dambach, P., Jorge, M.M., Traore, I., Phalkey, R., Sawadogo, H., Zabre, P., Kagone, M., Sie, A., Sauerborn, R., Becker, N., Beiersmann, C., 2018. A qualitative study of community perception and acceptance of biological larviciding for malaria mosquito control in rural Burkina Faso. *BMC Public Health* 18.
- Daniel, D., Diener, A., Pande, S., Jansen, S., Marks, S., Meierhofer, R., Bhatta, M., Rietveld, L., 2019. Understanding the effect of socio-economic characteristics and psychosocial factors on household water treatment practices in rural Nepal using bayesian belief networks. *Int. J. Hyg. Environ. Health* 222 (5), 847–855.
- Daude, E., Mazumdar, S., Solanki, V., 2017. Widespread fear of dengue transmission but poor practices of dengue prevention: a study in the slums of Delhi, India. *PLoS One* 12 (2).
- Davis, J., Pickering, A.J., Rogers, K., Mamuya, S., Boehm, A.B., 2011. The effects of informational interventions on household water management, hygiene behaviors, stored drinking water quality, and hand contamination in peri-urban Tanzania. *Am. J. Trop. Med. Hyg.* 84 (2), 184–191.
- Delaire, C., Das, A., Amrose, S., Gadgil, A., Roy, J., Ray, I., 2017. Determinants of the use of alternatives to arsenic-contaminated shallow groundwater: an exploratory study in rural West Bengal, India. *J. Water Health* 15 (5), 799–812.
- Delpa, I., Legay, C., Proulx, F., Rodriguez, M.J., 2020. Perception of tap water quality: assessment of the factors modifying the links between satisfaction and water consumption behavior. *Sci. Total Environ.* 722, 137786.
- Demolis, R., Botao, C., Heyerdahl, L.W., Gessner, B.D., Cavallier, P., Sinai, C., Magaco, A., Le Gargasson, J.B., Mengel, M., Guilletmet, E., 2018. A rapid qualitative assessment of oral cholera vaccine anticipated acceptability in a context of resistance towards cholera intervention in Nampula, Mozambique. *Vaccine* 36 (44), 6497–6505.
- Dolnicar, S., Hurlimann, A., 2009. Drinking water from alternative water sources: differences in beliefs, social norms and factors of perceived behavioural control across eight Australian locations. *Water Sci. Technol.* 60 (6), 1433–1444.
- Dowling, Z., Armbruster, P., LaDeau, S.L., DeCotiis, M., Mottley, J., Leisnham, P.T., 2013. Linking mosquito infestation to resident socioeconomic status, knowledge, and source reduction practices in suburban Washington, DC. *Ecohealth* 10 (1), 36–47.
- Dupont, D., Waldner, C., Bharadwaj, L., Plummer, R., Carter, B., Cave, K., Zagowski, R., 2014. Drinking water management: health risk perceptions and choices in first nations and non-first nations communities in Canada. *Int. J. Environ. Res. Public Health* 11 (6), 5889–5903.
- Eodor, F.I., Oloruntoba, E.O., Akinsete, S.J., 2019. Knowledge and perception of the role of water, sanitation and hygiene in containment of ebola virus disease among secondary school students in Ibadan, Nigeria. *J. Water Sanitation Hyg. Dev.* 9 (4), 635–643.
- Egedus, V.L., Ortega, J.M., Obando, A.A., 2014. Knowledge, perceptions, and practices with respect to the prevention of dengue in a mid-Pacific coastal village of Costa Rica. *Rev. Biol. Trop.* 62 (3), 859–867.
- Eisenberg, J.N.S., Wade, T.J., Charles, S., Vu, M., Hubbard, A., Wright, C.C., Levy, D., Jensen, P., Colford, J.M., 2002. Risk factors in HIV-associated diarrhoeal disease: the role of drinking water, medication and immune status. *Epidemiol. Infect.* 128 (1), 73–81.
- Elliott, S.J., Loeb, M., Harrington, D., Eyles, J., 2008. Heeding the message? Determinants of risk behaviours for West Nile virus. *Can. J. Public Health* 99 (2), 137–141.
- Ellis, A., McClintic, E.E., Awino, E.O., Caruso, B.A., Arriola, K.R.J., Gomez Ventura, S., Kowalski, A.J., Linabarger, M., Wodnik, B.K., Webb-Girard, A., Muga, R., Freeman, M.C., 2020. Practices and perspectives on latrine use, child feces disposal, and clean play environments in Western Kenya. *Am. J. Trop. Med. Hyg.* 102 (5), 1094–1103.
- Escobedo, A.A., Almirall, P., Alfonso, M., Avila, I., Cimerman, S., Salazar, Y., Dawkins, I.V., Garcia, R.M., 2011. Caregiver perspectives for the prevention, diagnosis and treatment of childhood giardiasis in Havana City, Cuba. A qualitative study. *Acta Trop.* 119 (2–3), 99–106.
- Family, L., Zheng, G.L., Cabezas, M., Cloud, J., Hsu, S., Rubin, E., Smith, L.V., Kuo, T., 2019. Reasons why low-income people in urban areas do not drink tap water. *J. Am. Dent. Assoc.* 150 (6), 503–513.
- Ferreira da Silva, A.I., Diniz Cantanhede, S.P., Oliveira Sousa, J., Martins Lima, R., Silva-Souza, N., Fortes Carvalho-Neta, R.N., da Silva de Almeida, Z., Martins Silva Santos, D., Vieira de Carvalho Neta, A., Ribeiro de Souza Serra, I.M., Tchaicka, L., 2020. Community perceptions on schistosomiasis in Northeast Brazil. *Am. J. Trop. Med. Hyg.* 103 (3), 1111–1117.
- Ferrer, R.A., Klein, W.M.P., 2015. Risk perceptions and health behaviour. *Curr. Opin. Psychol.* 5, 85–89.
- Few, R., Lake, I., Hunter, P.R., Tran, P.G., 2013. Seasonality, disease and behavior: using multiple methods to explore socio-environmental health risks in the Mekong Delta. *Soc. Sci. Med.* 80, 1–9.
- Fewtrell, L., Kaufmann, R.B., Kay, D., Enanoria, W., Haller, L., Colford Jr., J.M., 2005. Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. *Lancet Infect. Dis.* 5, 42–52.
- Fizer, C., de Bruin, W.B., Stillo, F., Gibson, J.M., 2018. Barriers to managing Private Wells and septic Systems in Underserved Communities: mental models of homeowner decision making. *J. Environ. Health* 81 (5), 8–15.
- Flanagan, S.V., Marvinney, R.G., Johnston, R.A., Yang, Q., Zheng, Y., 2015. Dissemination of well water arsenic results to homeowners in Central Maine: influences on mitigation behavior and continued risks for exposure. *Sci. Total Environ.* 505, 1282–1290.
- Flanagan, S.V., Marvinney, R.G., Zheng, Y., 2015. Influences on domestic well water testing behavior in a Central Maine area with frequent groundwater arsenic occurrence. *Sci. Total Environ.* 505, 1274–1281.
- Flanagan, S.V., Gleason, J.A., Spayd, S.E., Procopio, N.A., Rockafellow-Baldoni, M., Braman, S., Chillrud, S.N., Zheng, Y., 2018. Health protective behavior following required arsenic testing under the New Jersey private well testing act. *Int. J. Hyg. Environ. Health* 221 (6), 929–940.
- Flynn, A., 2012. A study exploring the knowledge, attitudes and practices of young people regarding dengue fever and the extent of community involvement in vector control of the disease in Trinidad and Tobago. *West Indian Med. J.* 61 (6), 615–618.
- Francis, M.R., Nagarajan, G., Sarkar, R., Mohan, V.R., Kang, G., Balraj, V., 2015. Perception of drinking water safety and factors influencing acceptance and sustainability of a water quality intervention in rural southern India. *BMC Public Health* 15.
- Friedrich, M.N.D., Binkert, M.E., Mosler, H.J., 2017. Contextual and psychosocial determinants of effective handwashing technique: recommendations for interventions from a case study in Harare, Zimbabwe. *Am. J. Trop. Med. Hyg.* 96 (2), 430–436.
- Galle, F., Dallolio, L., Marotta, M., Raggi, A., Di Onofrio, V., Liguori, G., Toni, F., Leoni, E., 2016. Health-related behaviors in swimming Pool users: influence of knowledge of regulations and awareness of health risks. *Int. J. Environ. Res. Public Health* 13 (5).
- Gamma, A.E., Slekiene, J., von Medeaça, G., Asplund, F., Cardoso, P., Mosler, H.J., 2017. Contextual and psychosocial factors predicting Ebola prevention behaviours using the RANAS approach to behaviour change in Guinea-Bissau. *BMC Public Health* 17.
- Gamma, A.E., Slekiene, J., Mosler, H.J., 2019. The impact of various promotional activities on ebola prevention behaviors and psychosocial factors predicting ebola prevention behaviors in the Gambia evaluation of ebola prevention promotions. *Int. J. Environ. Res. Public Health* 16 (11).
- Gao, J., Radford, B., 2021. Death by political party: the relationship between COVID-19 deaths and political party affiliation in the United States. *World Med. Health Pol.* 13 (2), 224–249.
- Geerts, R., Vandermoere, F., Van Winckel, T., Halet, D., Joor, P., Van Den Steen, K., Van Meenen, E., Blust, R., Borregán-Ochando, E., Vlaeminck, S.E., 2020. Bottle or tap? Toward an integrated approach to water type consumption. *Water Res.* 173, 115578.
- Gentili, D., Bardin, A., Ros, E., Piovesan, C., Ramigni, M., Dalmanzio, M., Dettori, M., Filia, A., Cinquetti, S., 2020. Impact of communication measures implemented during a school tuberculosis outbreak on risk perception among parents and school staff, Italy, 2019. *Int. J. Environ. Res. Public Health* 17, 911.
- George, C.M., Inauen, J., Perin, J., Tighe, J., Hasan, K., Zheng, Y., 2017. Behavioral determinants of switching to arsenic-safe water Wells: an analysis of a randomized controlled

- trial of health education interventions coupled with water arsenic testing. *Health Educ. Behav.* 44 (1), 92–102.
- Geremew, A., Mengistie, B., Alemayehu, E., Lantagne, D.S., Mellor, J., Sahilu, G., 2018. Point-of-use water chlorination among urban and rural households with under-five-year children: a comparative study in kersa health and demographic surveillance site, eastern Ethiopia. *J. Water Sanitation Hyg. Dev.* 8 (3), 468–480.
- Giles, A.R., Castleden, H., Baker, A.C., 2010. "We listen to our elders. You live longer that way": examining aquatic risk communication and water safety practices in Canada's north. *Health Place* 16 (1), 1–9.
- Gizaw, Z., Addisu, A., 2020. Evidence of Households' Water, Sanitation, and Hygiene (WASH) performance improvement following a WASH education program in Rural Dembiya, Northwest Ethiopia. *Environ. Health Insights* 14.
- Gleick, P.H., Iceland, C., 2018. Water, security, and conflict. World Resources Institute. <https://files.wri.org/s3fs-public/water-security-conflict.pdf>.
- Gorelick, M.H., Gould, L., Nimmer, M., Wagner, D., Heath, M., Bashir, H., Brousseau, D.C., 2011. Perceptions about water and increased use of bottled water in minority children. *Arch. Pediatr. Adolesc. Med.* 165 (10), 928–932.
- Grandesso, F., Allan, M., Jean-Simon, P.S.J., Boncy, J., Blake, A., Pierre, R., Alberti, K.P., Munger, A., Elder, G., Olson, D., Porten, K., Luquero, F.J., 2014. Risk factors for cholera transmission in Haiti during inter-peak periods: insights to improve current control strategies from two case-control studies. *Epidemiol. Infect.* 142 (8), 1625–1635.
- Gregorio, E.R., Medina, J.R.C., Lomboy, Mftc, Talaga, A.D.P., Hernandez, P.M.R., Kodama, M., Kobayashi, J., 2019. Knowledge, attitudes, and practices of public secondary school teachers on zika virus disease: a basis for the development of evidence-based zika educational materials for schools in the Philippines. *PLoS One* 14 (3).
- Guillaume, Y., Raymond, M., Jerome, G.J., Ternier, R., Ivers, L.C., 2019. 'It was a ravage!': lived experiences of epidemic cholera in rural Haiti. *BMJ Glob. Health* 4 (6).
- Gupta, N., Mutukkanu, T., Nadimuthu, A., Thiyagarani, I., Sullivan-Marx, E., 2012. Preventing waterborne diseases: analysis of a community health worker program in rural Tamil Nadu, India. *J. Community Health* 37 (2), 513–519.
- Haenchen, S.D., Hayden, M.H., Dickinson, K.L., Walker, K., Jacobs, E.E., Brown, H.E., Gunn, J.K.L., Kohler, L.N., Ernst, K.C., 2016. Mosquito avoidance practices and knowledge of arboviral diseases in cities with differing recent history of disease. *Am. J. Trop. Med. Hyg.* 95 (4), 945–953.
- Hall, D.C., Le, Q.B., 2018. Factors influencing mitigation of risk of waterborne disease in Vietnam among small scale integrated livestock farmers. *Front. Vet. Sci.* 5.
- Halvorson, S.J., Williams, A.L., Ba, S., Dunkel, F.V., 2011. Water quality and waterborne disease in the Niger River Inland Delta, Mali: a study of local knowledge and response. *Health Place* 17 (2), 449–457.
- Hamel, L., Lopes, L., Sparks, G., Kirzinger, A., Kearney, A., Stokes, M., Brodie, M., 2021. KFF COVID-19 vaccine monitor: September 2021. Available at: <https://www.kff.org/coronavirus-covid-19/poll-finding/kff-covid-19-vaccine-monitor-september-2021/>.
- Hanchett, S., Nahar, Q., Van Agthoven, A., Geers, C., Rezvi, M.F.J., 2002. Increasing awareness of arsenic in Bangladesh: lessons from a public education programme. *Health Policy Plan.* 17 (4), 393–401.
- Harper, S.L., Edge, V.L., Ford, J., Thomas, M.K., McEwen, S.A., Grp, Ihacc Res, Rigolet Inuit Community, Gov, 2015. Lived experience of acute gastrointestinal illness in Rigolet, Nunatsiavut: "Just suffer through it". *Soc. Sci. Med.* 126, 86–98.
- He, X.F., Karagas, M.R., Murray, C., 2018. Impact of receipt of private well arsenic test results on maternal use of contaminated drinking water in a US population. *Sci. Total Environ.* 643, 1005–1012.
- Heard-Garris, N.J., Roche, J., Carter, P., Abir, M., Walton, M., Zimmerman, M., Cunningham, R., 2017. Voices from Flint: community perceptions of the Flint water crisis. *J. Urban Health* 94 (6), 776–779.
- Herbst, S., Benediktter, S., Koester, U., Phan, N., Berger, C., Rechenburg, A., Kistemann, T., 2009. Perceptions of water, sanitation and health: a case study from the Mekong Delt, Vietnam. *Water Sci. Technol.* 60 (3), 699–707.
- Heyerdahl, L.W., Pugliese-Garcia, M., Nkwemu, S., Tembo, T., Mwamba, C., Demolis, R., Chilengi, R., Gessner, B.D., Guillemet, E., Sharma, A., 2019. "It depends how one understands it": a qualitative study on differential uptake of oral cholera vaccine in three compounds in Lusaka, Zambia. *BMC Infect. Dis.* 19.
- Hmielowski, J.D., Wang, M.Y., Donaway, R.R., 2018. Expanding the political philosophy dimension of the RISP model: examining the conditional indirect effects of cultural cognition. *Risk Anal.* 38 (9), 1891–1903.
- Hooks, T., Schuitema, G., McDermott, F., 2019. Risk perceptions toward drinking water quality among private well owners in Ireland: the illusion of control. *Risk Anal.* 39 (8), 1741–1754.
- Houck, K.M., Teran, E., Ochoa, J., Zapata, G.N., Gomez, A.M., Parra, R., Dvorquez, D., Stewart, J.R., Bentley, M.E., Thompson, A.L., 2020. Drinking water improvements and rates of urinary and gastrointestinal infections in Galapagos, Ecuador: assessing household and community factors. *Am. J. Hum. Biol.* 32 (1).
- Huber, A.C., Mosler, H.J., 2013. Determining behavioral factors for interventions to increase safe water consumption: a cross-sectional field study in rural Ethiopia. *Int. J. Environ. Health Res.* 23 (2), 96–107.
- Hulland, K.R.S., Chase, R.P., Caruso, B.A., Swain, R., Biswal, B., Sahoo, K.C., Panigrahi, P., Dreibeilbis, R., 2015. Sanitation, stress, and life stage: a systematic data collection study among women in Odisha, India. *PLoS One* 10 (11).
- Hyllestad, S., Veneti, L., Bugge, A.B., Rosenberg, T.G., Nygard, K., Aavitsland, P., 2019. Compliance with water advisories after water outages in Norway. *BMC Public Health* 19 (1).
- Hynds, P., Naughton, O., O'Neill, E., Mooney, S., 2018. Efficacy of a national hydrological risk communication strategy: domestic wastewater treatment systems in the Republic of Ireland. *J. Hydrol.* 558, 205–213.
- Inauen, J., Tobias, R., Mosler, H.J., 2013. Predicting water consumption habits for seven arsenic-safe water options in Bangladesh. *BMC Public Health* 13.
- Islam, M.A., Sakakibara, H., Karim, M.R., Sekine, M., 2011. Evaluation of risk communication for rural water supply management: a case study of a coastal area of Bangladesh. *J. Risk Res.* 14 (10), 1237–1262.
- Jalloh, M.F., Williams, A.R., Jalloh, M.B., Sengeh, P., Saquee, G., Bartram, J., 2018. Consumer perceptions and purchasing of packaged water products in Sierra Leone. *Pan Afr. Med. J.* 30.
- Jaravani, F.G., Massey, P.D., Judd, J., Taylor, K.A., Allan, J., 2017. Working with an aboriginal community to understand drinking water perceptions and acceptance in rural New South Wales. *Int. Indigenous Policy J.* 8 (3).
- Javaeed, A., Tabbasum, T., Arif, U., Ghauri, S.K., Khan, S.H., Wajid, Z., 2018. Knowledge, attitude and practices of water, sanitation and hygiene of students in Azad Kashmir. *Rawal Med. J.* 43 (3), 536–539.
- Javidi, A., Pierce, G., 2018. US Households' perception of drinking water as unsafe and its consequences: examining alternative choices to the tap. *Water Resour. Res.* 54 (9), 6100–6113.
- Jin, J.J., Wang, W.Y., Fan, Y., Wang, X.M., 2016. Measuring the willingness to pay for drinking water quality improvements: results of a contingent valuation survey in Songzi, China. *J. Water Health* 14 (3), 504–512.
- Johnstone, N., Serret, Y., 2012. Determinants of bottled and purified water consumption: results based on an OECD survey. *Water Policy* 14 (4), 668–679.
- Jones, A.Q., Dewey, C.E., Dore, K., Majowicz, S.E., McEwen, S.A., David, W.T., Eric, M., Carr, D.J., Henson, S.J., 2006. Public perceptions of drinking water: a postal survey of residents with private water supplies. *BMC Public Health* 6.
- Jones, A.Q., Dewey, C.E., Dore, K., Majowicz, S.E., McEwen, S.A., Walner-Toews, D., Henson, S.J., Mathews, E., 2007. A qualitative exploration of the public perception of municipal drinking water. *Water Policy* 9 (4), 425–438 doi.
- Jones-Bitton, A., Gustafson, D.L., Butt, K., Majowicz, S.E., 2016. Does the public receive and adhere to boil water advisory recommendations? A cross-sectional study in Newfoundland and Labrador, Canada. *BMC Public Health* 16.
- Jordan, C.M., Lee, P.A., Olkon, R., Pirie, P.L., 2007. Messages from moms: barriers to and facilitators of behavior change in a lead poisoning preventive education project. *J. Health Commun.* 12 (8), 771–786.
- Keraita, B., Drechsel, P., Konraden, F., 2008. Perceptions of farmers on health risks and risk reduction measures in wastewater-irrigated urban vegetable farming in Ghana. *J. Risk Res.* 11 (8), 1047–1061.
- Khan, K., Ahmed, E., Factor-Litvak, P., Liu, X.H., Siddique, A., Wasserman, G.A., Slavkovich, V., Levy, D., Mey, J.L., van Geen, A., Graziano, J.H., 2015. Evaluation of an elementary school-based educational intervention for reducing arsenic exposure in Bangladesh. *Environ. Health Perspect.* 123 (12), 1331–1336.
- Kohlitz, J.P., Smith, M.D., 2015. Water quality management for domestic rainwater harvesting systems in Fiji. *Water Sci. Technol. Water Supply* 15 (1), 134–141.
- Kosinski, K.C., Kulinkina, A.V., Abrah, A.F.A., Adjei, M.N., Breen, K.M., Chaudhry, H.M., Nevin, P.E., Warner, S.H., Tendulkar, S.A., 2016. A mixed-methods approach to understanding water use and water infrastructure in a schistosomiasis-endemic community: case study of Asamama, Ghana. *BMC Public Health* 16 Apr.
- Kukula, V.A., MacPherson, E.E., Tsey, I.H., Stothard, J.R., Theobald, S., Gyapong, M., 2019. A major hurdle in the elimination of urogenital schistosomiasis revealed: identifying key gaps in knowledge and understanding of female genital schistosomiasis within communities and local health workers. *PLoS Negl. Trop. Dis.* 13 (3).
- Kumar, V.A., Rajendran, R., Manavalan, R., Tewari, S.C., Arunachalam, N., Ayanar, K., Krishnamoorthi, R., Tyagi, B.K., 2010. Studies on community knowledge and behavior following a dengue epidemic in Chennai city, Tamil Nadu, India. *Trop. Biomed.* 27 (2), 330–336.
- Kunii, O., Nakamura, S., Abdur, R., Wakai, S., 2002. The impact on health and risk factors of the diarrhoea epidemics in the 1998 Bangladesh floods. *Public Health* 116 (2), 68–74. <https://doi.org/10.1038/sj.ph.1900828>.
- Lavallee, S., Hynds, P.D., Brown, R.S., Schuster-Wallace, C., Dickson-Anderson, S., Di Pelino, S., Egan, R., Majury, A., 2021. Examining influential drivers of private well users' perceptions in Ontario: a cross-sectional population study. *Sci. Total Environ.* 763, 142952.
- Légorreta-Soberanis, J., Paredes-Solis, S., Morales-Perez, A., Nava-Aguilera, E., de los Santos, F.R.S., Sanchez-Gervacio, B.M., Ledogar, R.J., Cockcroft, A., Andersson, N., 2017. Coverage and beliefs about temephos application for control of dengue vectors and impact of a community-based prevention intervention: secondary analysis from the Camino Verde trial in Mexico. *BMC Public Health* 17.
- Leong, C., Lebel, L., 2020. Can conformity overcome the yuck factor? Explaining the choice for recycled drinking water. *J. Clean. Prod.* 24, 118196.
- Leveque, J.G., Burns, R.C., 2017. Predicting water filter and bottled water use in appalachia: a community-scale case study. *J. Water Health* 15 (3), 451–461.
- Leveque, J.G., Burns, R.C., 2018. Drinkingwater in West Virginia (USA): tapwater or bottled water - what is the right choice for college students? *J. Water Health* 16 (5), 827–838.
- Lilje, J., Mosler, H., 2018. Effects of a behavior change campaign on household drinking water disinfection in the Lake Chad basin using the RANAS approach. *Sci. Total Environ.* 1 (619–620), 1599–1607.
- Lilje, J., Kessely, H., Mosler, H.J., 2015. Factors determining water treatment behavior for the prevention of cholera in Chad. *Am. J. Trop. Med. Hyg.* 93 (1), 57–65.
- Lindell, M.K., Mumpower, J.L., Huang, S.K., Wu, H.C., Samuelson, C.D., Wei, H.L., 2017. Perceptions of protective actions for a water contamination emergency. *J. Risk Res.* 20 (7), 887–908.
- Lloyd-Smith, P., Schram, C., Adamowicz, W., Dupont, D., 2018. Endogeneity of Risk Perceptions in Averting Behavior Models. *Environ. Resour. Econ.* 69, 217–246.
- Logar, I., Brouwer, R., 2017. The effect of risk communication on choice behavior, w xxx. *Water Resour. Econ.* 18, 34–50.
- Lothe, A., Zulu, N., Oyhus, A.O., Kjetland, E.F., Taylor, M., 2018. Treating schistosomiasis among south african high school pupils in an endemic area, a qualitative study. *BMC Infect. Dis.* 18.

- Lucier, K.J., Schuster-Wallace, C.J., Skead, D., Dickson-Anderson, S.E., 2020. "Is there anything good about a water advisory?": an exploration of the consequences of drinking water advisories in an indigenous community. *BMC Public Health* 20, 1704.
- Lund, A.J., Sam, M.M., Sy, A.B., Sow, O.W., Ali, S., Sokolow, S.H., Merrell, S.B., Bruce, J., Jouanard, N., Senghor, S., Riveau, G., Lopez-Carr, D., De Leo, G.A., 2019. Unavoidable risks: local perspectives on water contact behavior and implications for schistosomiasis control in an agricultural region of northern Senegal. *Am. J. Trop. Med. Hyg.* 101 (4), 837–847.
- Mara, D.D., 2003. Water, sanitation and hygiene for the health of developing nations. *Public Health* 117, 452–456.
- Marjadi, B., McLaws, M.L., 2010. Hand hygiene in rural Indonesian healthcare workers: barriers beyond sinks, hand rubs and in-service training. *J. Hosp. Infect.* 76 (3), 256–260.
- Markon, M.P.L., Lemyre, L., 2013. Public reactions to risk messages communicating different sources of uncertainty: an experimental test. *Hum. Ecol. Risk Assess.* 19 (4), 1102–1126.
- Maseko, T.S.B., Mkhonta, N.R., Masuku, S.K.S., Dlamini, S.V., Fan, C.K., 2018. Schistosomiasis knowledge, attitude, practices, and associated factors among primary school children in the siphonani area in the lowveld of Swaziland. *J. Microbiol. Immunol. Infect.* 51 (1), 103–109.
- Massoud, M.A., Kazarian, A., Alameddine, I., Al-Hindi, M., 2018. Factors influencing the reuse of reclaimed water as a management option to augment water supplies. *Environ. Monit. Assess.* 190 (9).
- Maurice, L., López, F., Becerra, S., Jamhoury, H., Le Menach, K., Dévier, M.-H., Budzinski, H., Prunier, J., Juteau-Martineau, G., Ochoa-Herrera, V., Quiroga, D., Schreck, E., 2019. Drinking water quality in areas impacted by oil activities in Ecuador: Associated health risks and social perception of human exposure. *Sci. Total Environ.* 690, 1203–1217.
- McDowall, C.P., Andrade, L., O'Neill, E., O'Malley, K., O'Dwyer, J., Hynds, P.D., 2020. Gender-related differences in flood risk perception and behaviours among private groundwater users in the Republic of Ireland. *Int. J. Environ. Res. Public Health* 17 (2072).
- McLeod, L., Bharadwaj, L., Waldner, C., 2014. Risk factors associated with the choice to drink bottled water and tap water in rural Saskatchewan. *Int. J. Environ. Res. Public Health* 11 (2), 1626–1646.
- McMahon, S., Caruso, B.A., Obure, A., Okumu, F., Rheingans, R.D., 2011. Anal cleansing practices and faecal contamination: a preliminary investigation of behaviours and conditions in schools in rural Nyanza Province, Kenya. *Tropical Med. Int. Health* 16 (12), 1536–1540.
- Mendoza-Jiménez, M.-J., Hannemann, T.-V., Atzendorf, J., 2021. Behavioral risk factors and adherence to preventive measures: evidence from the early stages of the COVID-19 pandemic. *Front. Public Health* 9, 674597.
- Mitchell, K.C., Ryan, P., Howard, D.E., Feldman, K.A., 2018. Understanding knowledge, attitudes, and behaviors toward West Nile virus prevention: a survey of high-risk adults in Maryland. *Vector Borne Zoonotic Dis.* 18 (3), 173–180.
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., PRISMA Group, 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Ann. Intern. Med.* 151 (4), 264–269.
- Mosler, H.-J., 2012. A systematic approach to behavior change interventions for the water and sanitation sector in developing countries: a conceptual model, a review, and a guideline. *Int. J. Environ. Health Res.* 22, 431–449.
- Mubyazi, G., Bloch, P., Kamugisha, M., Kitua, A., Ijumba, J., 2005. Intermittent preventive treatment of malaria during pregnancy: a qualitative study of knowledge, attitudes and practices of district health managers, antenatal care staff and pregnant women in Korogwe District, North-Eastern Tanzania. *Malar. J.* 4.
- Mumbi, A.W., Watanabe, T., 2020. Differences in risk perception of water quality and its influencing factors between lay people and factory workers for water management in river sosiani, eldoret municipality Kenya. *Water* 12 (2248).
- Munene, A., Lockyer, J., Checkley, S., Hall, D.C., 2019. Perceptions of drinking water quality from private wells in Alberta: a qualitative study. *Can. Water Resour. J.* 44 (3), 291–306.
- Munene, A., Lockyer, J., Checkley, S., Hall, D.C., 2020. Exploring well water testing behaviour through the health belief model. *Environ. Health Insights* 14, 1–10.
- Munisi, D.Z., Buza, J., Mpolya, E.A., Angelo, T., Kinung'hi, S.M., 2017. Knowledge, attitude, and practices on intestinal schistosomiasis among primary schoolchildren in the Lake Victoria basin, Rorya District, North-Western Tanzania. *BMC Public Health* 17.
- Musacchio, A., Andrade, L., O'Neill, E., Re, V., O'Dwyer, J., Hynds, P.D., 2021. Planning for the health impacts of climate change: flooding, private groundwater contamination and waterborne infection – a cross-sectional study of risk perception, experience and behaviours in the Republic of Ireland. *Environ. Res.* 194 (110707).
- Nastiti, A., Muntalif, B.S., Roosmini, D., Sudradjat, A., Meijerink, S.V., Smits, A.J.M., 2017. Coping with poor water supply in peri-urban Bandung, Indonesia: towards a framework for understanding risks and aversion behaviours. *Environ. Urban.* 29 (1), 69–88.
- Nguyen, H.V., Than, P.Q.T., Nguyen, T.H., Vu, G.T., Hoang, C.L., Tran, T.T., Truong, N.T., Nguyen, S.H., Do, H.P., Ha, G.H., Nguyen, H.L.T., Dang, A.K., Do, C.D., Tran, T.H., Tran, B.X., Latkin, C.A., Ho, C.S.H., Ho, R.C.M., 2019. Knowledge, attitude and practice about dengue fever among patients experiencing the 2017 outbreak in Vietnam. *Int. J. Environ. Res. Public Health* 16 (6).
- Niemi, H., 2002. Active learning—a cultural change needed in teacher education and schools. *Teach. Teach. Educ.* 18, 763–780.
- Ogoina, D., Oyeyemi, A.S., Ayah, O., Onabor, A.A., Midia, A., Olomo, W.T., Kunle-Olowu, O.E., 2016. Preparation and response to the 2014 ebola virus disease epidemic in Nigeria—the experience of a tertiary Hospital in Nigeria. *PLoS One* 11 (10).
- Orgill, J., Shaheed, A., Brown, J., Jeuland, M., 2013. Water quality perceptions and willingness to pay for clean water in peri-urban cambodian communities. *J. Water Health* 11 (3), 489–506.
- Panchang, S.V., Joshi, P., Kale, S., 2021. Women 'holding it' in urban India: toilet avoidance as an under-recognized health outcome of sanitation insecurity. *Glob. Public Health*.
- Parisi, S., Mazigo, H.D., Kreibich, S., Puchner, K., Kasang, C., Mueller, A., 2019. Factors associated with relevant knowledge of intestinal schistosomiasis and intention to participate in treatment campaigns: a cross sectional survey among school children at Ijanga Island on Lake Victoria, North-Western Tanzania. *BMC Public Health* 19 (1).
- Parvez, F., Chen, Y., Argos, M., Hussain, Azmi, Momotaj, H., Dhar, R., van Geen, A., Graziano, J.H., Ahsan, H., 2006. Prevalence of arsenic exposure from drinking water and awareness of its health risks in a bangladeshi population: results from a large population-based study. *Environ. Health Perspect.* 114 (3), 355–359.
- Perez-Guerra, C.L., Zielinski-Gutierrez, E., Vargas-Torres, D., Clark, G.G., 2009. Community beliefs and practices about dengue in Puerto Rico. *Pan Am. J. Public Health* 25 (3), 218–226.
- Person, B., Ali, S.M., A'Kadir, F.M., Ali, J.N., Mohammed, U.A., Mohammed, K.A., Rollinson, D., Knopp, S., 2016. Community knowledge, perceptions, and practices associated with urogenital schistosomiasis among school-aged children in Zanzibar, United Republic of Tanzania. *PLoS Negl. Trop. Dis.* 10 (7).
- Pidgeon, N., 1998. Risk assessment, risk values and the social science programme: why we do need risk perception research. *Reliab. Eng. Syst. Saf.* 59 (1), 5–15.
- Postma, J., Butterfield, P.W., Odom-Maryon, T., Hill, W., Butterfield, P.G., 2011. Rural children's exposure to well water contaminants: implications in light of the American Academy of Pediatrics' recent policy statement. *J. Am. Acad. Nurse Pract.* 23 (5), 258–265.
- Ragusa, A.T., Crampton, A., 2016. To buy or not to Buy? Perceptions of bottled drinking water in Australia and New Zealand. *Hum. Ecol.* 44 (5), 565–576.
- Randell, H.F., Dickinson, K.L., Shayo, E.H., Mboera, L.E.G., Kramer, R.A., 2010. Environmental management for malaria control: knowledge and practices in Mvomero, Tanzania. *Ecohealth* 7 (4), 507–516.
- Roche, S.M., Jones-Bitton, A., Majowicz, S.E., Pintar, K.D.M., Allison, D., 2013. Investigating public perceptions and knowledge translation priorities to improve water safety for residents with private water supplies: a cross-sectional study in Newfoundland and Labrador. *BMC Public Health* 13.
- Rogers, R.W., Prentice-Dunn, S., 1997. Protection motivation theory. In: Gochman, D.S. (Ed.), *Handbook of Health Behavior Research 1: Personal and Social Determinants*. Plenum Press, pp. 113–132.
- Rohrmann, B., 2008. Risk Perception, Risk Attitude, Risk Communication, Risk Management: a Conceptual Appraisal. *The International Emergency Management Society Annual Conference, Prague, Czech Republic*, pp. 17–19.
- Rohrmann, B., Renn, O., 2000. Cross-cultural Risk Perception. *A Survey of Empirical Studies*. Springer, pp. 11–53.
- Rosenstock, I.M., 1974. The Health Belief Model and Preventative Health Behavior. 2, p. 4.
- Ruiz, M.C., Devonport, T.J., Chen-Wilson, C.-H.J., et al., 2020. A cross-cultural exploratory study of health behaviors and wellbeing during COVID-19. *Front. Psychol.* 11, 608216.
- Rundblad, G., 2008. The semantics and pragmatics of water notices and the impact on public health. *J. Water Health* 6, 77–86.
- Rundblad, G., Knapton, O., Hunter, P.R., 2010. Communication, perception and behaviour during a natural disaster involving a 'Do not Drink' and a subsequent 'Boil Water' notice: a postal questionnaire study. *BMC Public Health* 10.
- Rundblad, G., Knapton, O., Hunter, P.R., 2014. The causes and circumstances of drinking water incidents impact consumer behaviour: comparison of a routine versus a natural disaster incident. *Int. J. Environ. Res. Public Health* 11 (11), 11915–11930.
- Rusca, M., Alda-Vidal, C., Hordijk, M., Kral, N., 2017. Bathing without water, and other stories of everyday hygiene practices and risk perception in urban low-income areas: the case of Lilongwe, Malawi. *Environ. Urban.* 29 (2), 533–550.
- Sarti, E., Cox, H., Besada-Lombana, S., Tapia-Maruri, L., 2015. Dengue awareness in latin american populations: a questionnaire study. *Infect. Dis. Ther.* 4 (2), 199–211.
- Schade, C.P., Wright, N., Gupta, R., Latif, D.A., Jha, A., Robinson, J., 2015. Self-reported household impacts of large-scale chemical contamination of the public water supply, Charleston, West Virginia, USA. *PLoS One* 10 (5).
- Schaetti, C., Chaignat, C.L., Hutubessy, R., Khatib, A.M., Ali, S.M., Schindler, C., Weiss, M.G., 2011. Social and cultural determinants of anticipated acceptance of an oral cholera vaccine prior to a mass vaccination campaign in Zanzibar. *Hum. Vaccin.* 7 (12), 1299–1308.
- Schaetti, C., Ali, S.M., Chaignat, C.L., Khatib, A.M., Hutubessy, R., Weiss, M.G., 2012. Improving community coverage of oral cholera mass vaccination campaigns: lessons learned in Zanzibar. *PLoS One* 7 (7).
- Schuitema, G., Hooks, T., McDermott, F., 2020. Water quality perceptions and private well management: the role of perceived risks, worry and control. *J. Environ. Manag.* 267, 110654.
- Schwarzer, R., 2008. Modeling health behavior change: how to predict and modify the adoption and maintenance of health behaviors. *Appl. Psychol.* 57, 1–29.
- Schwarzinger, M., Mohamed, M.K., Gad, R.R., Dewedar, S., Fontanet, A., Carrat, F., Luchini, S., 2010. Risk perception and priority setting for intervention among hepatitis C virus and environmental risks: a cross-sectional survey in the Cairo community. *BMC Public Health* 10.
- Scobie, H.M., Phares, C.R., Wannemuehler, K.A., Nyangoma, E., Taylor, E.M., Fulton, A., Wongjindanon, N., Aung, N.R., Travers, P., Date, K., 2012. Use of Oral cholera vaccine and knowledge, attitudes, and practices regarding safe water, sanitation and hygiene in a long-standing refugee camp, Thailand, 2012–2014. *PLoS Negl. Trop. Dis.* 10 (12).
- Scobie, H.M., Phares, C.R., Wannemuehler, K.A., Nyangoma, E., Taylor, E.M., Fulton, A., Wongjindanon, N., Aung, N.R., Travers, P., Date, K., 2016. Use of Oral Cholera Vaccine and Knowledge, Attitudes, and Practices Regarding Safe Water, Sanitation and Hygiene in a Long-Standing Refugee Camp, Thailand, 2012–2014. *PLOS Neglected Tropical Diseases* 10 (12), e0005210.
- Seimetz, E., Kumar, S., Mosler, H.J., 2016. Effects of an awareness raising campaign on intention and behavioural determinants for handwashing. *Health Educ. Res.* 31 (2), 109–120.
- Severtson, D.J., 2013. The influence of environmental hazard maps on risk beliefs, emotion, and health-related behavioral intentions. *Res. Nurs.* 36 (4), 330–348.
- Soleimani-Ahmadi, M., Vatandoost, H., Zare, M., Alizadeh, A., Salehi, M., 2014. Community knowledge and practices regarding malaria and long-lasting insecticidal nets during malaria elimination programme in an endemic area in Iran. *Malar. J.* 13.

- Spicer, N., Parlee, B., Chisaakay, M., Lamalice, D., 2020. Drinking water consumption patterns: an exploration of risk perception and governance in two first nations communities. *Sustainability* 12, 6851.
- Sundaram, N., Schaetti, C., Purohit, V., Kudale, A., Weiss, M.G., 2014. Cultural epidemiology of pandemic influenza in urban and rural Pune, India: a cross-sectional, mixed-methods study. *BMJ Open* 4 (12).
- Sundaram, N., Schaetti, C., Merten, S., Schindler, C., Ali, S.M., Nyambedha, E.O., Lapika, B., Chaignat, C.L., Hutubessy, R., Weiss, M.G., 2016. Sociocultural determinants of anticipated oral cholera vaccine acceptance in three african settings: a meta-analytic approach. *BMC Public Health* 16.
- Tate, R.B., Fernandez, N., Yassi, A., Canizares, M., Spiegel, J., Bonet, M., 2003. Change in health risk perception following community intervention in Central Havana, Cuba. *Health Promot. Int.* 18 (4), 279–286.
- Torres-Slimming, P.A., Wright, C., Carcamo, C.P., Garcia, P.J., Harper, S.L., Ihacc Res Team, 2019. Achieving the sustainable development goals: a mixed methods study of health-related water, sanitation, and hygiene (WASH) for Indigenous Shawi in the Peruvian Amazon. *Int. J. Environ. Res. Public Health* 16 (13).
- Tran, H.P., Adams, J., Jeffery, J.A.L., Nguyen, Y.T., Vu, N.S., Kutcher, S.C., Kay, B.H., Ryan, P.A., 2010. Householder perspectives and preferences on water storage and use, with reference to dengue, in the Mekong Delta, southern Vietnam. *Int. Health* 2 (2), 136–142.
- Tsaneva, M., 2013. The effect of risk preferences on household use of water treatment. *J. Dev. Stud.* 49 (10), 1427–1435.
- Turbow, D., Lin, T.H., Jiang, S., 2004. Impacts of beach closures on perceptions of swimming-related health risk in Orange County, California. *Mar. Pollut. Bull.* 48 (1–2), 132–136.
- Uddin, J., Mazur, R.E., 2015. Socioeconomic factors differentiating healthcare utilization of cyclone survivors in rural Bangladesh: a case study of cyclone sidr. *Health Policy Plan.* 30 (6), 782–790.
- United Nations Water, 2018. Water scarcity. Available at: <http://www.unwater.org/water-facts/scarcity/>.
- UN-Water, 2017. Integrated monitoring guide for sustainable development goal 6 on water and sanitation. Targets and global indicators. <https://www.unwater.org/publications/sdg-6-targets-indicators/>.
- Veronesi, M., Chawla, F., Maurer, M., Lienert, J., 2014. Climate change and the willingness to pay to reduce ecological and health risks from wastewater flooding in urban centers and the environment. *Ecol. Econ.* 98, 1–10.
- Watson, L., Shibata, T., Ansariadi, Maidin, A., Nikitin, I., Wilson, J., 2015. Understanding modifiable risk factors associated with childhood diarrhea in an eastern Indonesian urban setting. *Int. J. Health Promot. Educ.* 53 (1), 42–54.
- WHO Regional Office For Europe, 2020. COVID-19 Snapshot Monitoring (COSMO Standard): monitoring knowledge, risk perceptions, preventive behaviours, and public trust in the current coronavirus outbreak - WHO standard protocol. *Psych. Arch.* <https://doi.org/10.23668/psycharchives.2782>.
- Winch, P.J., Leontsini, E., Rigau-Perez, J.G., Ruiz-Perez, M., Clark, G.G., Gubler, D.J., 2002. Community-based dengue prevention programs in Puerto Rico: impact on knowledge, behavior, and residential mosquito infestation. *Am. J. Trop. Med. Hyg.* 67 (4), 363–370.
- Wise, T., Zbozinek, T.D., Michelini, G., Hagan, C.C., Mobbs, D., 2020. Changes in risk perception and self-reported protective behaviour during the first week of the COVID-19 pandemic in the United States. *R. Soc. Open Sci.* 7 (9), 200742.
- Workman, C.L., 2019. Perceptions of drinking water cleanliness and health-seeking behaviours: a qualitative assessment of household water safety in Lesotho, Africa. *Glob. Public Health* 14 (9), 1347–1359.
- World Health Organization, 1946. Constitution of the World Health Organization. *Am. J. Public Health* 36 (11), 1315–1323.
- World Health Organization, United Nations Children's Fund Joint Monitoring Programme Joint Monitoring Program, 2021. Household data. <https://washdata.org/>.
- Wright, C.J., Sargeant, J.M., Edge, V.L., Ford, J.D., Farahbakhsh, K., Shiwak, I., Flowers, C., Gordon, A.C., Harper, S.L., Ricg, Ihacc Res Team, 2018. How are perceptions associated with water consumption in Canadian Inuit? A cross-sectional survey in Rigolet, Labrador. *Sci. Total Environ.* 618, 369–378.
- Xu, J., Peng, Z., 2015. People at risk of influenza pandemics: the evolution of perception and behavior. *PLoS ONE* 10 (12), e0144868.
- Yuan, L.P., Manderson, L., Tempongko, M.S.B., Wei, W.Y., Aiguo, P., 2000. The impact of educational videotapes on water contact behaviour of primary school students in the Dongting Lakes region, China. *Tropical Med. Int. Health* 5 (8), 538–544.