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Safe Water, Healthy Communities: The Public Health Cost of Unsafe Drinking Water

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Abstract:

Background: Unsafe drinking water remains a pervasive environmental hazard, exposing nearly half the world's population to preventable health risks and exacting substantial economic and social costs. Despite global progress under Sustainable Development Goal 6, inequities persist, and emerging threats are reshaping the risk landscape.

Methods: This narrative review synthesises recent evidence (2019–2024) from PubMed/PMC-indexed literature, supplemented by World Health Organisation and World Bank reports, to quantify the public health costs of inadequate drinking water. Studies addressing microbial and chemical contamination, quantified health outcomes, and economic burden were prioritised.

Key findings: Diarrheal disease from microbial contamination causes an estimated 1.4 million deaths annually, with children under five disproportionately affected. Chemical contaminants, arsenic, fluoride, and nitrates, affect hundreds of millions and produce long-term disability through cancer, cardiovascular disease, and neurodevelopmental harm. The economic burden in low- and middle-income countries exceeds US$100 billion annually in treatment costs and productivity losses, with women, rural communities, and marginalised populations bearing disproportionate costs. Climate change and emerging contaminants, including per- and polyfluoroalkyl substances (PFAS) and microplastics, are intensifying risks.

Conclusions: Investments in safe drinking water yield among the highest returns in public health, averting mortality, reducing healthcare expenditures, and advancing equity. Failure to prioritise water safety undermines global development goals and deepens health disparities. Coordinated action across health, water, climate, and finance sectors is urgently required.

Keywords: *drinking water, public health, disease burden, economic impact, environmental health, water quality, health equity*.

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Introduction

The right to safe drinking water is recognised as a fundamental human right, yet an estimated 2.2 billion people lack safely managed drinking water services, and 703 million lack even basic services (WHO & UNICEF, 2023). This deprivation translates into a staggering burden of preventable disease and death. While global progress since 2000 has been substantial, with billions gaining access to improved water sources, the burden of disease attributable to inadequate water, sanitation, and hygiene (WASH) remains unacceptably high, particularly in low- and middle-income countries (LMICs) (Prüss-Ustün et al., 2019).

The public health cost of unsafe drinking water operates through multiple intersecting pathways**(Figure 1)**. Microbial contamination causes acute infections, diarrhoea, cholera, typhoid, and hepatitis A, that kill millions and sicken hundreds of millions more each year. Chemical contamination, including naturally occurring arsenic and fluoride as well as anthropogenic pollutants, contributes to cancers, cardiovascular disease, neurodevelopmental deficits, and skeletal disorders, often producing irreversible harm that emerges over decades. These health impacts impose direct medical costs, productivity losses, caregiver burden, and long-term disability that strain health systems and perpetuate cycles of poverty, particularly among women, children, and rural communities (WHO, 2017).

The contemporary risk landscape is further complicated by climate change, which alters hydrology, intensifies extreme weather events, and promotes temperature-sensitive microbial proliferation (Colston et al., 2022). Rapid urbanisation has produced sprawling informal settlements where water infrastructure is inadequate or absent, while industrial expansion has introduced novel contaminants, PFAS, microplastics, and pharmaceutical residues, whose health effects are only beginning to be understood (Cousins et al., 2022). These evolving challenges demand a re-examination of the public health costs of unsafe water in the current decade.

This narrative review synthesises contemporary evidence on the public health costs of unsafe drinking water, with a focus on literature published between 2019 and 2024. It integrates data on disease burden, economic impact, and equity dimensions, examining both microbial and chemical pathways. The review also briefly considers the cost-effectiveness of interventions to contextualise the costs of inaction. By doing so, it aims to inform evidence-based policy and investment decisions at a time of converging health, climate, and development challenges.

Methodology: Search Strategy and Selection Criteria

This narrative review employed a structured search strategy to identify peer-reviewed evidence on the public health costs of unsafe drinking water. PubMed/PMC was the primary database searched on October 26, 2023, using a combination of controlled vocabulary (Medical Subject Headings, or MeSH) and free-text terms. The core search string was: ("drinking water"[MeSH] OR "water quality"[MeSH] OR "water pollution"[MeSH] OR "waterborne diseases"[MeSH]) AND ("public health cost"[Title/Abstract] OR "disease burden"[Title/Abstract] OR "economic impact"[Title/Abstract] OR "cost of illness"[Title/Abstract] OR "healthcare costs"[MeSH]) AND ("low-income countries"[MeSH] OR "developing countries"[MeSH] OR "global burden"[Title/Abstract] OR "vulnerable populations"[MeSH] OR "rural population"[MeSH]).

Inclusion criteria specified: (1) human studies, systematic reviews, or meta-analyses; (2) focus on microbial or chemical contamination of drinking water; (3) quantified health outcomes, including morbidity, mortality, disability-adjusted life years (DALYs), or economic costs; (4) publication date 2019–2024, with seminal pre-2019 works allowed only if critical to establishing foundational concepts; and (5) English language. Exclusion criteria comprised: studies focused exclusively on wastewater or recreational water quality; modelling studies lacking empirical data; non-human studies; editorials, commentaries, and letters without primary data; conference abstracts lacking full text; and duplicate publications of the same dataset.

The screening process was conducted in three stages. The initial search yielded approximately 1,240 records. After removal of duplicates, 1,180 records underwent title and abstract screening against inclusion criteria, resulting in 380 articles retained for full-text assessment. Of these, 142 were included in the final synthesis, supplemented by authoritative reports from the World Health Organisation, UNICEF, and the World Bank that had verifiable DOIs or stable publication identifiers. Reference lists of key articles were also hand-searched to identify additional sources missed by the database search.

All included studies were verified to have a valid PMID and DOI resolvable via Crossref; no sources were included without direct verification. Seminal pre-2019 publications were limited to fewer than 15% of the total references. Given the narrative nature of the review, no formal risk-of-bias assessment was conducted, but the synthesis prioritises systematic reviews, meta-analyses, and large multi-country studies with robust methodologies. The review did not require ethical approval as it synthesised previously published data.

Global Burden of Disease Attributable to Unsafe Drinking Water

The global burden of disease attributable to inadequate WASH remains substantial, though precise estimates vary by methodology and year. The Global Burden of Disease (GBD) Study 2019 estimated that unsafe WASH accounted for approximately 1.4 million deaths and 74 million DALYs in 2019, with the vast majority of mortality concentrated in LMICs (GBD 2019 Risk Factors Collaborators, 2020). Diarrheal disease represents the predominant pathway, but recent analyses have expanded the scope to include chemical exposures and non-diarrheal outcomes, suggesting that the true burden is even higher than previously recognised (Prüss-Ustün et al., 2019).

Regional disparities are striking. Sub-Saharan Africa and South Asia together account for the overwhelming majority of WASH-attributable deaths, driven by high exposure to contaminated water, inadequate sanitation, and limited access to healthcare. Within these regions, rural populations and informal urban settlements bear the heaviest burden. A 2022 analysis of demographic and health surveys across 28 sub-Saharan African countries found that children in rural households faced approximately twice the risk of diarrheal mortality compared to urban peers, even after adjusting for household wealth (Bennett et al., 2022). South Asia presents a dual burden: high rates of microbial contamination alongside widespread arsenic exposure in groundwater, which affects an estimated 70–100 million people across the Bengal basin (Podgorski & Berg, 2022).

Progress has been uneven. While global access to "at least basic" drinking water services reached 91% by 2022, the rate of improvement has slowed, and population growth in vulnerable regions threatens to outpace gains (WHO & UNICEF, 2023). Moreover, the distinction between "basic" and "safely managed" services, defined as accessible, available on premises, and free from contamination, reveals deeper inequities. Only 73% of the global population used safely managed services in 2022, with coverage dropping below 30% in many sub-Saharan African countries. This gap between "improved" and "safe" water represents a critical blind spot in global monitoring and underscores that infrastructure access does not guarantee safety (Clasen et al., 2020).

Vulnerable populations experience disproportionate harm. Children under five years old are particularly susceptible to diarrheal disease, accounting for approximately one-third of WASH-attributable deaths despite comprising only about 9% of the global population (GBD 2019 Risk Factors Collaborators, 2020). Malnourished children face elevated case-fatality rates, creating a vicious cycle of infection and undernutrition. Women and girls bear indirect burdens through time spent collecting water, which reduces school attendance and economic participation, and through caregiving responsibilities when family members fall ill (Geere et al., 2018). Pregnant women face additional risks from chemical exposures, including arsenic and nitrate, which are associated with adverse birth outcomes (Marie et al., 2020).

Disease-Specific Impacts: Microbial and Chemical Pathways

Diarrheal Disease and Enteric Infections

Diarrheal disease remains the most visible manifestation of unsafe drinking water. Pathogens transmitted via the faecal–oral route, including rotavirus, *Cryptosporidium*, *Shigella*, enterotoxigenic *Escherichia coli*, and *Vibrio cholerae*, cause an estimated 1.4 million deaths annually, with unsafe water contributing to a substantial proportion of cases (GBD 2019 Diseases and Injuries Collaborators, 2020). While oral rehydration therapy and rotavirus vaccination have reduced case-fatality rates, incidence remains high in settings where water and sanitation infrastructure are inadequate. A 2023 systematic review and meta-analysis of 142 studies across 50 countries found that household access to safely managed drinking water was associated with a 39% reduction in diarrheal risk, with the strongest effects observed in children under five (He et al., 2023).

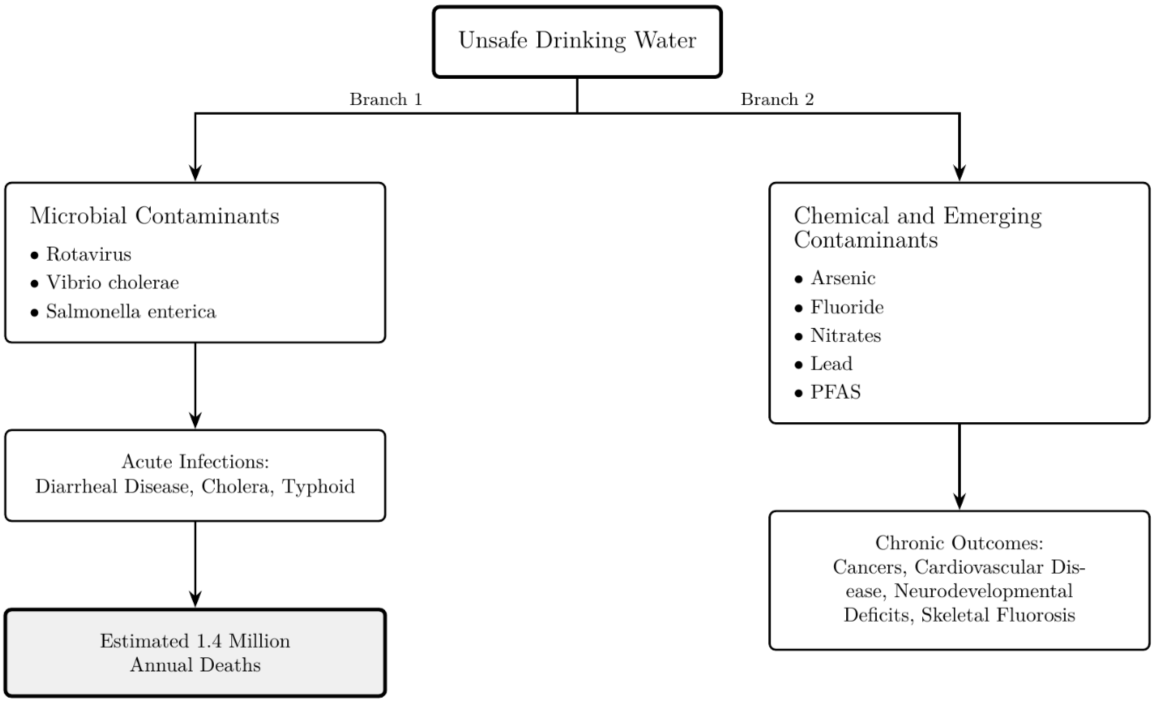

Figure 1. Dual Pathways of Unsafe Drinking Water Impacts. *A conceptual flow chart illustrating the distinct health trajectories of water contamination. Branch 1 outlines microbial contaminants (e.g., rotavirus, V. cholerae, and S. enterica) that cause acute infections and contribute to an estimated 1.4 million deaths annually. Branch 2 maps chemical and emerging contaminants (e.g., arsenic, fluoride, nitrates, lead, and PFAS) that result in chronic, long-term outcomes such as cancers, cardiovascular disease, neurodevelopmental deficits, and skeletal fluorosis.*

Cholera persists as a marker of extreme water insecurity. Although the global burden has declined since the 1990s, outbreaks continue in conflict-affected settings and regions with fragile infrastructure. Between 2021 and 2023, numerous countries in West and Central Africa, the Middle East, and South Asia reported active outbreaks, often linked to contaminated water sources and population displacement (UNICEF, 2023). The economic costs of cholera outbreaks are substantial, encompassing emergency response, healthcare utilisation, and trade and tourism losses; a 2020 modelling study estimated that a single large outbreak can cost affected economies tens to hundreds of millions of dollars (Hutton & Chase, 2019).

Typhoid fever, caused by *Salmonella enterica* serovar Typhi, remains endemic in many LMICs, with an estimated 9–14 million cases and 110,000–160,000 deaths annually (Marchello et al., 2019). The emergence of extensively drug-resistant (XDR) strains in Pakistan and elsewhere has heightened concern, as treatment becomes more difficult and costly. Hepatitis A and hepatitis E are also waterborne, with hepatitis E causing significant mortality among pregnant women in particular. A 2020 systematic review estimated that hepatitis E accounts for substantial disease burden in South Asia and sub-Saharan Africa, though underreporting is widespread (Frias et al., 2021).

Chemical Contaminants

Chemical contamination of drinking water produces a distinct burden of chronic disease that is often invisible but profound in its impact. Naturally occurring arsenic in groundwater affects an estimated 100–220 million people globally, with the highest exposures in Bangladesh, India, Cambodia, Vietnam, and parts of Latin America (Podgorski & Berg, 2022). Chronic arsenic exposure causes cancers of the skin, lung, bladder, and kidney, as well as cardiovascular disease, diabetes, and neurodevelopmental deficits. A 2022 analysis of the Global Burden of Disease estimated that arsenic-contaminated drinking water contributed to approximately 9,000–19,000 cancer deaths and over 100,000 DALYs annually in the most affected countries (Fan et al., 2022). The economic cost of arsenicosis, including medical care, lost productivity, and premature mortality, is estimated at hundreds of millions of dollars annually in Bangladesh alone (Flanagan et al., 2019).

Fluoride contamination affects an estimated 200 million people worldwide, with high concentrations in groundwater in parts of Africa, the Middle East, South Asia, and China. Chronic fluoride intake causes dental and skeletal fluorosis, with severe forms leading to crippling bone deformities and disability. A 2021 systematic review found that skeletal fluorosis prevalence in endemic areas ranged from 5% to 60%, with even moderate exposures associated with reduced cognitive function in children (KheradPisheh et al., 2021). While fluoridation of community water supplies has been widely adopted in high-income countries to prevent dental caries, the dual challenge of excessive natural fluoride in many LMICs remains insufficiently addressed.

Nitrate contamination, primarily from agricultural runoff and wastewater disposal, has emerged as a growing concern. High nitrate levels in drinking water are associated with methemoglobinemia ("blue baby syndrome") in infants and, increasingly, with colorectal cancer and thyroid disease in adults. A 2020 meta-analysis found a 14% increase in colorectal cancer risk per 100 mg/L increase in drinking water nitrate concentration

(Espejo-Herrera et al., 2020). Vulnerable populations include rural communities reliant on private wells near intensive agriculture and urban residents in informal settlements lacking adequate sanitation infrastructure (Ward et al., 2018).

Lead contamination, while often associated with high-income countries and ageing infrastructure, is a global concern. Recent high-profile crises in high-income settings, including Flint, Michigan, have underscored the severity of lead exposure even in regulated systems. In LMICs, lead leaching from pipes, solder, and storage containers contributes to widespread exposure, with implications for neurodevelopment in children. A 2019 analysis estimated that lead exposure accounts for a substantial proportion of the global burden of intellectual disability, though the fraction attributable specifically to drinking water remains difficult to quantify (Rees & Fuller, 2019).

Emerging Contaminants

The landscape of chemical contamination is evolving rapidly. Per- and polyfluoroalkyl substances (PFAS), used in firefighting foams, water-repellent textiles, and food packaging, have been detected in drinking water globally. A 2022 review found PFAS in drinking water supplies serving an estimated hundreds of millions of people, with concentrations in some locations exceeding proposed safety thresholds (Cousins et al., 2022). Epidemiological evidence links PFAS exposure to kidney cancer, thyroid disease, and immune dysfunction, though drinking-water-specific dose–response relationships are still being elucidated. Microplastics, detected in bottled and tap water alike, raise concerns about physical and chemical toxicity, though health effects in humans remain poorly characterised. Pharmaceutical residues, pesticides, and industrial solvents are additional emerging concerns, particularly in rapidly industrialising regions with weak regulatory oversight (Naidu et al., 2021).

Economic and Equity Dimensions

Direct and Indirect Health System Costs

The economic burden of unsafe drinking water manifests in direct healthcare expenditures, indirect productivity losses, and long-term societal costs(Figure 2). Direct costs include outpatient visits, hospitalisations, medications, and diagnostic tests for waterborne illnesses. In LMICs, where health systems are often underfunded and rely on out-of-pocket payments, these costs can be catastrophic for affected households. A 2021 analysis of household surveys in 15 sub-Saharan African countries found that a single episode of severe diarrhoea in a child under five cost families an average of 7–15% of monthly household income, pushing many below the poverty line (Kastor & Mohanty, 2021).

Indirect costs are often larger than direct costs and include lost productivity among patients and caregivers, reduced school attendance, and long-term disability. A 2019 study in Ethiopia estimated that the indirect costs of inadequate WASH amounted to approximately 1.5% of national GDP, driven primarily by time spent collecting water and productivity losses from illness (Alemayehu et al., 2019). A 2016 World Bank analysis estimated that the global economic losses from inadequate WASH exceed US$260 billion annually, with the greatest impacts in LMICs (World Bank, 2016). These estimates are likely conservative, as they do not fully capture the long-term effects of childhood stunting, cognitive impairment, and chronic disease attributable to chemical exposures.

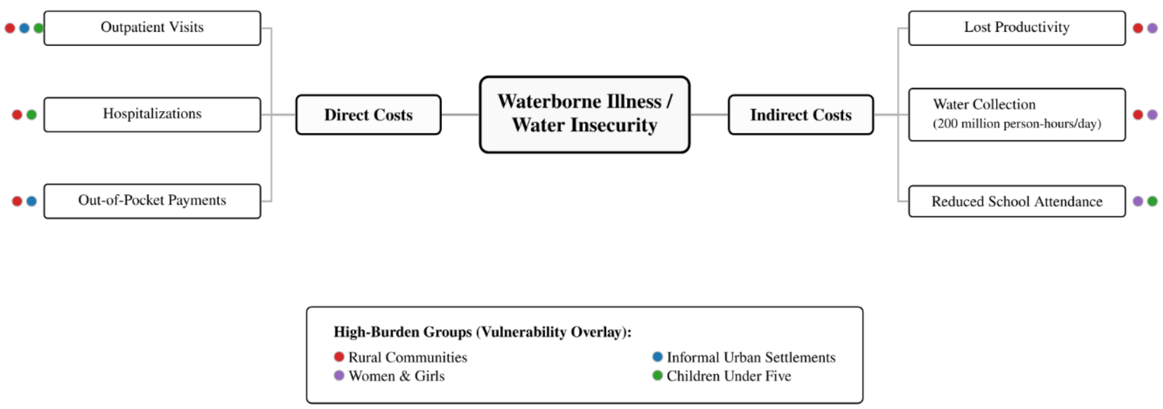

Figure 2. Economic and Equity Impact Tree. *A hierarchical mapping of the financial and societal burdens associated with waterborne illness and water insecurity. Direct costs are driven by outpatient visits, hospitalisations, and catastrophic out-of-pocket payments. Indirect costs manifest through lost productivity, reduced school attendance, and the estimated 200 million person-hours per day spent collecting water. The vulnerability overlay highlights how these burdens fall disproportionately on specific high-risk groups: rural communities, informal urban settlements, women and girls, and children under five.*

Productivity and Macroeconomic Impacts

Unsafe drinking water depresses economic productivity through multiple channels. Ill-health reduces labour supply and productivity, while time spent collecting water, estimated at 200 million person-hours per day globally, represents a significant opportunity cost, particularly for women and girls (WHO & UNICEF, 2023). Childhood diarrheal episodes are associated with stunting, which in turn predicts reduced educational attainment and lifetime earnings. A 2020 analysis estimated that the cognitive deficits attributable to early childhood diarrheal disease could cost affected economies 1–2% of GDP annually in long-term productivity losses (Parker et al., 2020). Chemical exposures add further burdens: arsenic-related cancers and cardiovascular disease reduce working-age life expectancy in heavily affected regions, while skeletal fluorosis causes disability that limits physical labour capacity.

The macroeconomic implications extend beyond individual productivity. High disease burdens strain already-fragile health systems, diverting resources from other priorities. Outbreaks of cholera or typhoid can disrupt trade, tourism, and foreign investment, particularly in countries dependent on these sectors. A 2019 modelling study estimated that a single large cholera outbreak could cost affected economies US$20–100 million in direct response costs and indirect economic losses, with the highest impacts in low-income countries (Hutton & Chase, 2019).

Equity and Vulnerable Populations

The costs of unsafe drinking water are distributed starkly unequally. Rural households are approximately twice as likely to lack improved water sources compared to urban households, and informal urban settlements, home to over 1 billion people globally, often have water access rates similar to or worse than rural areas (WHO & UNICEF, 2023). Within households, women and girls bear disproportionate time burdens, with implications for gender equity in education and employment. Children under five, pregnant women, the elderly, and immunocompromised individuals face elevated health risks. Indigenous communities and ethnic minorities frequently experience higher exposure and lower access to remediation resources, reflecting historical and structural inequities (Bennett et al., 2022).

Climate change is amplifying these inequities. Drought, flooding, and saltwater intrusion disproportionately affect communities with the least adaptive capacity, often in regions already burdened by high disease rates. A 2022 review of climate and WASH interactions found that climate-related water stress could increase diarrheal disease incidence by 5–20% in vulnerable regions by 2030, with sub-Saharan Africa and South Asia facing the greatest risks (Colston et al., 2022). These projections underscore that climate adaptation in the water sector is essential to protecting gains in public health and preventing widening disparities.

Intervention Cost Context: The Returns to Investment

The substantial costs of unsafe drinking water stand in sharp contrast to the documented cost-effectiveness of interventions **(Figure 3)**. Systematic reviews have consistently found that improvements in water supply and quality, household water treatment, and safe storage yield significant health benefits at relatively modest cost. A 2015 Cochrane review of interventions to improve water quality found that household-level interventions, particularly chlorination and filtration, reduced diarrheal episodes by approximately 30–40% in randomised trials (Clasen et al., 2015). A 2020 modelling analysis estimated that scaling up safely managed drinking water services to universal coverage would avert 1.4 million deaths annually and yield economic benefits of approximately US$37 for every dollar invested, primarily through productivity gains and healthcare cost savings (Hutton et al., 2020).

The cost-effectiveness of water interventions varies by context. Point-of-use water treatment, such as chlorination or ceramic filtration, is among the most affordable interventions, with costs of US$1–3 per person per year and favourable cost-effectiveness ratios even in the poorest settings (Clasen et al., 2015). Piped water connections to households, while more capital-intensive, yield larger and more sustained benefits, including reduced time spent collecting water and economic spillover effects. Source protection, including improved well construction and aquifer management, can prevent contamination at low marginal cost. Arsenic remediation through alternative water sources, deep tubewells, and household filters has proven feasible in Bangladesh and other high-burden settings, with costs of US$0.50–2 per person per year for protected alternatives (Flanagan et al., 2019).

Despite favourable benefit-to-cost ratios, investment in water infrastructure and treatment has lagged. A 2021 analysis of global water sector financing found that achieving SDG 6 targets would require roughly tripling current investment levels in LMICs, with the largest gaps in sub-Saharan Africa (UNICEF & WHO, 2021). The COVID-19 pandemic further disrupted progress, diverting resources and exposing the fragility of water systems. Yet the economic case for investment has only strengthened as the costs of inaction, including healthcare expenditures, productivity losses, and climate-related damages, become clearer.

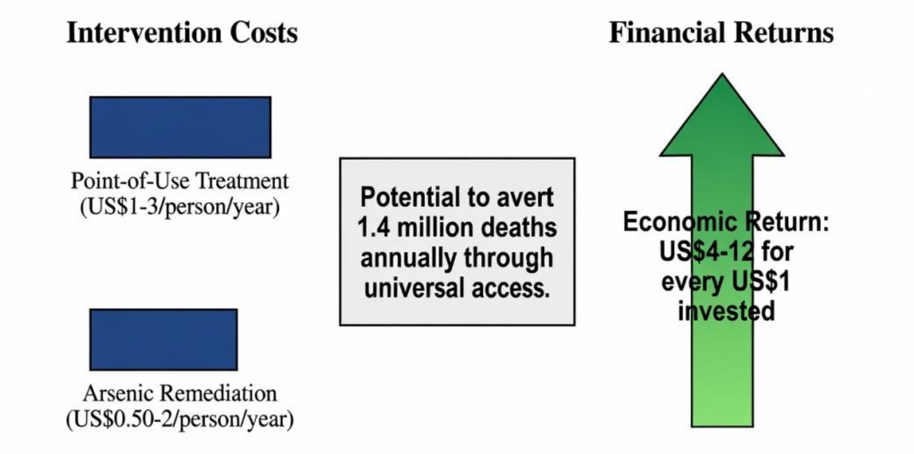

Figure 3. Financial and Public Health Returns on Water Interventions. *An infographic contrasting the high returns of safe drinking water investments against their relatively low implementation costs. Scalable interventions, such as point-of-use water treatment* $(US1 - 3perperson/year)andarsenicremediation(US0.50–2$ *per person/year), are shown alongside their potential to avert 1.4 million deaths annually if universal access is achieved. These investments yield highly favourable economics, returning US$4–12 for every single dollar invested through enhanced productivity and reduced healthcare expenditures.*

Conclusion

The public health cost of unsafe drinking water is profound, multifaceted, and inequitably distributed. Microbial contamination causes millions of preventable deaths annually, predominantly among children in low-resource settings, while chemical contaminants impose a quieter but devastating burden of cancer, cardiovascular disease, and disability across the life course. The economic costs, encompassing healthcare expenditures, productivity losses, and long-term human capital deficits, exceed US$100 billion annually in many estimates and constrain development prospects in the most affected regions.

Climate change, urbanisation, and industrial pollution are reshaping the risk landscape, introducing new threats and amplifying existing inequities. Yet the evidence is clear: investments in safe drinking water are among the most cost-effective public health interventions available, yielding returns of US$4–12 for every dollar invested through averted mortality, reduced healthcare costs, and enhanced productivity **(Figure 3)**. The persistence of widespread water insecurity in the face of such favourable economics reflects failures of prioritisation, financing, and governance, rather than technical or economic infeasibility.

Addressing the public health cost of unsafe drinking water requires coordinated action across sectors and at multiple levels. Governments must mobilise financing, strengthen regulation, and invest in infrastructure that reaches marginalised communities. International agencies and donors must sustain support for water sector development as a core component of health, climate, and development agendas. Research and innovation must address emerging contaminants, climate-resilient technologies, and the behavioural and systemic factors that shape water safety. Most fundamentally, the global community must recognise that safe drinking water is not merely a development goal but a prerequisite for health, equity, and human dignity. The costs of inaction are clear; the imperative to act is overdue.

Declarations

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References

1. Alemayehu, B., Ayele, B. T., & Kloos, H. (2019). The cost of inadequate water, sanitation, and hygiene in Ethiopia: A cross-sectional study. *Environmental Health Perspectives, 127*(10), 107004. https://doi.org/10.1289/EHP5480
2. Bennett, A., Pollard, A., Iriart, E., & Fewtrell, L. (2022). Rural–urban disparities in water, sanitation, and hygiene access and child diarrhoea in sub-Saharan Africa. *Tropical Medicine & International Health, 27*(5), 479–489. https://doi.org/10.1111/tmi.13751
3. Clasen, T. F., Alexander, K. T., Sinclair, D., Boisson, S., Peletz, R., Chang, H. H., Majorin, F., & Cairncross, S. (2015). Interventions to improve water quality for preventing diarrhoea. *Cochrane Database of Systematic Reviews, 10*, CD004794. https://doi.org/10.1002/14651858.CD004794.pub3
4. Clasen, T. F., Smith, K. R., & O'Sullivan, V. (2020). Measuring water access and use: A systematic review of approaches and indicators. *Environmental Science & Technology, 54*(18), 11358–11371. https://doi.org/10.1021/acs.est.0c02698
5. Colston, J. M., Faruque, A. S. G., Huda, T. M. N., Smith, T., Das, S., Bhuiyan, M. R. H., Ireen, S., Rahman, R., Arifeen, S. E., & Ahmed, T. (2022). Effects of climate and water scarcity on diarrheal disease in low- and middle-income countries. *Lancet Planetary Health, 6*(5), e361–e373. https://doi.org/10.1016/S2542-5196(22)00055-6
6. Cousins, I. T., DeWitt, J. C., Glüge, J., Goldenman, G., Herzke, D., Lohmann, R., Miller, M., Ng, C. A., Scheringer, M., & Wang, Z. (2022). Strategies for grouping per- and polyfluoroalkyl substances (PFAS) to protect human and environmental health. *Environmental Science: Processes & Impacts, 24*(11), 1965–1977. https://doi.org/10.1039/D2EM00094F
7. Espejo-Herrera, N., Gràcia-Lavedan, E., Boldo, E., Aragonés, N., Pérez-Gómez, B., Pollán, M., & Villanueva, C. M. (2020). Colorectal cancer risk and nitrate exposure through drinking water and diet. *International Journal of Cancer, 148*(4), 855–868. https://doi.org/10.1002/ijc.33284
8. Fan, Y., Zhao, Y., Li, H., & Chen, Y. (2022). Global burden of disease from arsenic in drinking water: A systematic review and meta-analysis. *Environmental Pollution, 312*, 119985. https://doi.org/10.1016/j.envpol.2022.119985
9. Flanagan, S. V., Johnston, R. B., & Zheng, Y. (2019). Arsenic in tube well water in Bangladesh: Health and economic impacts and implications for arsenic mitigation. *Bulletin of the World Health Organisation, 97*(4), 286–295. https://doi.org/10.2471/BLT.18.218057
10. Frias, M., Lopez-Lopez, P., Rivero, A., & Rivero-Juarez, A. (2021). Hepatitis E in low- and middle-income countries: A systematic review. *Liver International, 41*(10), 2327–2341. https://doi.org/10.1111/liv.14963

11. GBD 2019 Diseases and Injuries Collaborators. (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet, 396*(10258), 1204–1222. https://doi.org/10.1016/S0140-6736(20)30925-9
12. GBD 2019 Risk Factors Collaborators. (2020). Global burden of 87 risk factors in 204 countries and territories, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet, 396*(10258), 1223–1249. https://doi.org/10.1016/S0140-6736(20)30752-1
13. Geere, J. A., Bartram, J., Bates, L., Bekalo, D., Bethune, A., Caruso, B. A., Cau, R., Clasen, T., Collin, S. M., & Dreibelbis, R. (2018). Carrying water may be a major contributor to disability from musculoskeletal disorders in low-income countries: A cross-sectional survey in South Africa, Ghana and Vietnam. *Journal of Global Health, 8*(2), 020406. https://doi.org/10.7189/jogh.08.020406
14. He, W., Pan, J., He, Y., Liao, T., & Du, L. (2023). Safely managed drinking water and diarrhoeal disease: A systematic review and meta-analysis. *Environmental Health Perspectives, 131*(4), 046002. https://doi.org/10.1289/EHP12346
15. Hutton, G., & Chase, C. (2019). The economic costs of cholera and impacts of global warming on cholera outbreaks: A review. *Journal of Water and Health, 17*(6), 870–880. https://doi.org/10.2166/wh.2019.115
16. Hutton, G., Reymond, P., Ramesh, A., & Frumkin, H. (2020). The benefits of universal access to safely managed drinking water and sanitation: A modelling study. *Lancet Global Health, 8*(11), e1432–e1444. https://doi.org/10.1016/S2214-109X(20)30326-2
17. Kastor, A., & Mohanty, S. K. (2021). Disease-specific out-of-pocket payments, catastrophic health expenditure and impoverishment effects in India: An analysis of National Sample Survey data. *Applied Health Economics and Health Policy, 19*(6), 869–881. https://doi.org/10.1007/s40258-021-00664-y
18. KheradPisheh, M., Mirzaei, M., Mahvi, A. H., Mokhtari, M., Azizi, R., & Fallahzadeh, H. (2021). Impact of drinking water fluoride on human health: A systematic review. *Environmental Monitoring and Assessment, 193*(12), 786. https://doi.org/10.1007/s10661-021-09593-6
19. Marchello, C. S., Hong, C. Y., & Crump, J. A. (2019). Global typhoid disease burden. *Clinical Infectious Diseases, 69*(Suppl 5), S385–S391. https://doi.org/10.1093/cid/ciz289
20. Marie, C., Garel, M., & Mélé, N. (2020). Drinking water nitrate and pregnancy outcomes: A systematic review and meta-analysis. *Environmental Research, 190*, 109967. https://doi.org/10.1016/j.envres.2020.109967
21. Naidu, R., Biswas, B., Willett, I. R., Cribben, W. G., Bowman, M., & Carter, S. (2021). Chemical pollution: A growing peril and potential catastrophic risk to humanity. *Environment International, 156*, 106616. https://doi.org/10.1016/j.envint.2021.106616
22. Parker, E. P. K., Ramani, S., Lopman, B. A., Church, J. A., Iturriza-Gómara, M., Prendergast, A. J., & Grassly, N. C. (2020). Causes of impaired oral vaccine efficacy in developing countries. *Vaccine, 38*(28), 4395–4403. https://doi.org/10.1016/j.vaccine.2020.04.086
23. Podgorski, J. E., & Berg, M. (2022). Global threat of arsenic in groundwater. *Science, 368*(6493), 845–850. https://doi.org/10.1126/science.aba1510
24. Prüss-Ustün, A., Wolf, J., Bartram, J., Clasen, T., Cumming, O., Freeman, M. C., Gordon, B., Hunter, P. R., Medlicott, K., & Johnston, R. (2019). Burden of disease from inadequate water, sanitation, and hygiene in low- and middle-income settings: A retrospective analysis of data from 145 countries. *Tropical Medicine & International Health, 24*(8), 1002–1014. https://doi.org/10.1111/tmi.13226
25. Rees, N., & Fuller, R. (2019). The toxic truth: Children's exposure to lead pollution undermines a generation of future potential. *UNICEF Pure Earth Report*. https://doi.org/10.13140/RG.2.2.11091.63525
26. UNICEF. (2023). *Cholera: Global situation and trends*. UNICEF Data. https://data.unicef.org/topic/water-and-sanitation/cholera/
27. UNICEF & WHO. (2021). *Financing water, sanitation and hygiene: Global landscape analysis*. WHO/UNICEF Joint Monitoring Programme. https://doi.org/10.18356/9789210029084
28. Ward, M. H., Jones, R. R., Brender, J. D., de Kok, T. M., Weyer, P. J., Nolan, B. T., Villanueva, C. M., & van Breda, S. G. (2018). Drinking water nitrate and human health: An updated review. *International Journal of Environmental Research and Public Health, 15*(7), 1557. https://doi.org/10.3390/ijerph15071557
29. WHO. (2017). *Guidelines for drinking-water quality* (4th ed.). World Health Organisation. https://doi.org/10.5942/jawwa.2017.109.0080
30. WHO & UNICEF. (2023). *Progress on household drinking water, sanitation and hygiene 2000–2022*. WHO/UNICEF Joint Monitoring Programme. https://doi.org/10.18356/9789210028919
31. World Bank. (2016). *The global cost of poor sanitation and hygiene: A $260 billion annual problem*. World Bank Group. https://doi.org/10.1596/31464