Children, Water Insecurity, and Environmental Stress: Educational, Social, and Health Implications

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Abstract:

Water is a fundamental human right and essential for the well-being of every person. Water insecurity affects children's health, education, and social functioning, severely disrupting their development, well-being, and life chances. A recent global research agenda for children, outlining global priorities in WASH and Health, prioritizes the urgent interdisciplinary and global research needed to support coordinated action across sectors that can deliver improved WASH. To examine these links in more depth, this summary paper presents 15 evidence reviews exploring the pathways through which water insecurity impacts on children's health, education, and development in low-resource settings. Together these reveal consistent themes in our understanding of these pathways; the groups of children at highest risk; and those elements of effective responses. While effective responses vary widely by context, the evidence points to some key components. Providing reliable household access to drinking water promotes health and development through different pathways and is essential to ensure children are protected from the WASH-related health risks of water insecurity. School-based water, sanitation, and hygiene services promote attendance and learning at school and can dramatically improve children's access to WASH. Collecting accurate monitoring data on children in WASH interventions helps agencies in both sectors improve child-sensitive responses to impacts. Supporting caregivers to share the burden of water insecurity reduces time poverty and stress, promoting household well-being. Building equitable and resilient social and systems that support children and caregivers enables them to better navigate the direct and indirect risks associated with water insecurity, which never impacts in isolation from WASH-related health, nutrition, education, or protection systems. Supporting equitable and resilient systems through water-sensitive and child-sensitive planning and investment is critical to building the conditions needed for water insecurity to be safely navigated. In addition to these key components, we highlight the need to better understand children's experiences of and responses to water insecurity, especially in relation to their school participation, psychosocial stress, and health outcomes. Globally, progress towards universal safe access to water is hindered by neglect of children in WASH service design, delivery, and monitoring. We need to improve WASH responses for children.

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Introduction

Water is vital for human life and health (1). Over 663 million people worldwide lack access to safe drinking water and adequate sanitation, resulting in over a million deaths each year (2). Young children are particularly affected, with an estimated 1.4 million dying each year from diseases related to inadequate water, sanitation, and hygiene (3). The ability to secure water dramatically affects households worldwide, and accessing water is time intensive and potentially dangerous in many regions (4). This work is focused on water and hygiene as inseparable transformation factors for the socio-economic empowerment of children. Transformational learning aimed at the appropriation of water allows children to play with awareness and develop equity for the future (5). Water scarcity and insufficient water may also prevent children from attending school or concentrating once in class (6).

Water insecurity, defined as the insufficient and uncertain access to adequate water, affects over 663 million people, predominantly in Low- and Middle-Income Countries (LMICs) (7). This situation is aggravated by population growth, rapid urbanization, inefficient use, climate change, poor infrastructure, lack of transparent governance, and conflict (8). The relationship between water insecurity and children's health, schooling, and overall development has received little attention (7). The accumulation of environmental stresses determines each child's developmental trajectory (9). Water-related diseases impair hydration, sanitation, and hygiene, affecting both survival and development (10). Schooling is essential for the development of cognition, life-skills, and socioemotional capabilities (11). Any interruption during critical stages can lead to lethal consequences (12). Access to safe and sufficient water remains a major challenge across several countries (13). Water chain is necessary for biodynamic children's growth and development (14). Hence, further in-depth studies are warranted to investigate the relationship between water and hygiene insecurity and child cognitive and physical development (15).

Conceptual Framework

Dynamic perspectives on the connections between environmental stress and child development highlight the importance of understanding how broader determinants create threats to children's safety, learning engagement, and well-being (16). One mechanism through which water insecurity negatively affects children is through its impact on learning and school participation (17). Water collection can require substantial time, diverting caregivers from educational and recreational interactions (18). Water-collection burden may accompany geographic mobility in search of water, further disrupting time spent in school and encouraging attendance at schools with fewer resources (19). The decentralization of local systems of governance and diminished community social capital due to aging and migration further limit the ability to cope effectively with the unavailability of water (20). Children may therefore respond to experiences of frequent water scarcity with greater reluctance to attend school, diminished engagement while in school, or even school drop-out altogether (21).

The implications of water-security challenges for educational equity also raise important considerations (22). Children from different demographic groups may face starkly divergent, salient, or compounding vulnerabilities or benefit from different protective factors (23). For example, where water insecurity occurs disproportionately among the rural population, water-access policies risk reinforcing existing urban-rural divides in educational opportunity (24). Aspects of position privilege such as neighborhood poverty and ethnic minority status may further deepen inequities by heightening environmental and other risks or by restricting access to institutional and material support in coping with external challenges (25). Children's time-use resulting from domestic water collection, attention capacity, perceptions of water problems and related safety concerns remain unmonitored. Indicators such as repeat grade, non-enrollment, school drop-out, and attendance patterns among the child count need to be evaluated (1).

Household and community social functioning at the family level can shift under pressures related to water security (26). Caregivers may adapt by reducing or rearranging time allocated to teaching, supervising, interaction, recreational play, and other activities that support children's school readiness and overall psycho-social development (27). Possible changes in the labor composition of caregiving activities are yet to be estimated. Important family and community social-interaction mechanisms include: (1) time devoted to water collection and sanitation; (2) transitions in domestic tasks taken on by various household members and gender shifts in parental expenditure of time; and (3) some extent of avoidance of social interactions due to stigma or related feelings in domestic water scarcity situations (28-30) (table 1, figure 1).

Table 1. Conceptual pathways linking water insecurity to child outcomes

Water-related stressor	Household or school mechanism	Child-level pathway	Potential implication
Insufficient quantity	Caregivers and children ration water for drinking,	Reduced hydration and hygiene practice	Illness risk, discomfort, and lower school readiness

	hygiene, and cleaning		
Unreliable access	Families spend time planning, waiting, fetching, or purchasing water	Time poverty and uncertainty	Absenteeism, lateness, and reduced study time
Unsafe water quality	Exposure to contaminated sources or poor storage conditions	Waterborne infection and repeated illness	Missed schooling and impaired growth or concentration
Long collection distance	Children or caregivers travel to distant sources	Physical fatigue and reduced supervision	Reduced play, rest, and educational engagement
Weak school WASH services	Schools cannot support drinking, sanitation, menstrual hygiene, or cleaning needs	Unsafe or uncomfortable learning environment	Reduced attendance, especially for vulnerable children

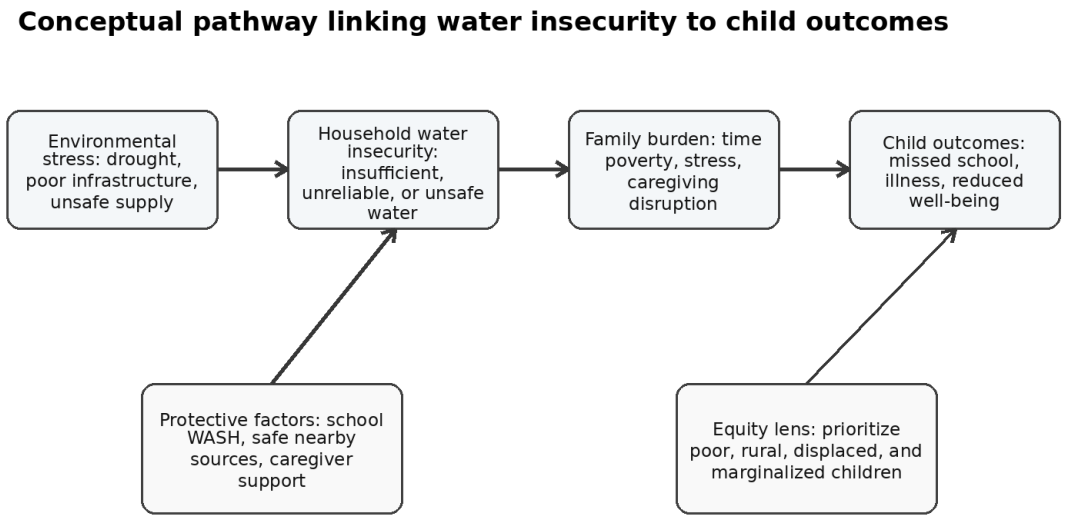

Figure 1: Conceptual pathway linking environmental stress, water insecurity, family burden, and child outcomes

Educational Impacts of Water Insecurity on Children

Water insecurity negatively affects school attendance among children living in rural Uganda (8). The impact of unreliable access to clean, potable water on educational enrollment and participation is conditioned by the age structure of the household (16). Securing water for household needs requires a considerable share of the time and energy of parents and caregivers; where these are in short supply, children undertake additional water-collection work, reducing the time available for school (17). Water-stressed families experience an elevated psychosocial burden, which is thought to compromise school performance, although the evidence base for this assumption remains underdeveloped (20).

The relationship between water insecurity and education is further complicated by gender, with girls significantly more likely than boys to withdraw from school when water access is problematic (16). Water scarcity disproportionately influences the educational engagement of children from poor households, as does rural residence (1). Addressing these issues in Uganda's educational system may require integrating water-supply initiatives with ongoing sectoral investments and improvements in the overall governance environment (31). Relevant indicators would encompass access to improved

water supply, volume used, physical accessibility, time taken to collect, treatment performed, and sources utilized for drinking, cooking, and food preparation (32) (table 2, figure 2).

Table 2: Educational implications of child water insecurity and suggested monitoring indicators

Educational domain	Likely water-related pressure	Observable indicator	Suggested data source
Attendance	Time spent collecting water or coping with household shortages	Absenteeism, lateness, interrupted school day	School attendance registers and household surveys
Participation	Fatigue, dehydration, illness, or sanitation discomfort	Lower classroom engagement and participation	Teacher reports and child interviews
Performance	Reduced study time and impaired concentration	Lower test scores or grade repetition	School records and assessment data
Retention	Persistent household stress and economic coping demands	Dropout, non-enrollment, early work involvement	Administrative records and community follow-up
Equity	Gendered collection roles and rural or poverty-related barriers	Gaps by gender, residence, income, or minority status	Disaggregated education and WASH datasets

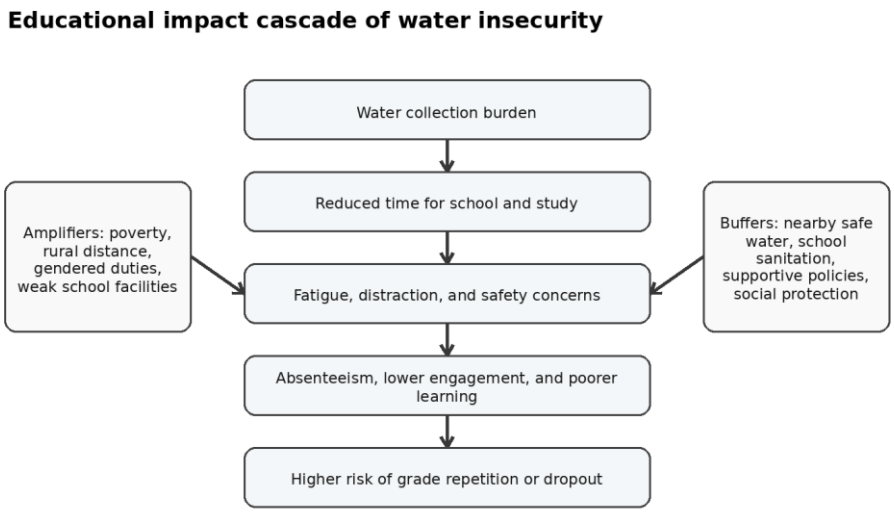

Figure 2: Educational impact cascade of water insecurity among children

Social Consequences for Families and Communities

Water insecurity imposed on households, particularly those with children, exerts a considerable strain on families and communities, compromising social functioning, support systems, and resilience (33). Along with the exertion of additional labour and time in acquiring water (and, consequently, a reduction of time available for other activities), water stress aggravates existing gender inequalities and affects the division of responsibilities, carework productivity, and access to social and community support (34). Experiencing distress, stigma, anxiety, and social pressures associated with

water insecurity has negative consequences for both adults and children, constraining parental capacity to provide emotional support and influencing development, behavior, and educational performance (35).

Health Implications Linked to Water Insecurity

Children depend on water to learn, grow, and thrive. Yet more than a third of children worldwide face water insecurity (16). This level of risk compromises access to safe water for both drinking and hygiene, diluting the significance of at-home and in-school sanitary facilities (13). Water insecurity has strong negative health effects independent of access to safe drinking water, sanitation, and hygiene (9).

Health risks linked to water insecurity accumulate through direct physiological exposures and indirect social determinants (36). Physiological pathways arise from insufficient hydration or the consumption of contaminated water; sanitation and hygiene inability lowers infection control and adds exposure to inadequate healthcare (37). Social avenues emerge as less attention is placed on nutrition, waterborne-water-related disease transmission grows with social disruption, and water demands increase households' time and labor burdens (38).

Water insecurity jeopardizes child health through multiple pathways (16). Adequate drinking water hydration supports optimal physical health and cognitive development, while lacking it alters metabolic regulation, growth, and brain development, reducing learning, school engagement, and education quality and impeding sustainable development growth and improvement (1). Waterborne diseases—diarrheal illness, typhoid fever, cholera, schistosomiasis, leptospirosis, and viral hepatitis—affect children's health and educational potential (22). Inadequate sanitation and hygiene services heighten water illness risk and limit retention of appropriate knowledge and practice. Water scarcity can lead to poor hygiene practices, contributing to waterborne diseases (33) (table 3).

Table 3. Health and psychosocial consequences associated with water insecurity in children

Pathway	Main exposure	Child implication	Preventive or protective response
Hydration	Insufficient drinking water or restricted intake	Fatigue, poor concentration, and reduced physical well-being	Ensure safe drinking water at home and school
Infection	Contaminated water and inadequate hygiene	Water-related infections and school absence	Improve water quality, storage, sanitation, and hand hygiene
Nutrition	Water shortages affecting food preparation and household food security	Poor dietary quality and growth concerns	Integrate water support with nutrition and social protection
Psychosocial stress	Family stress, stigma, uncertainty, and caregiving disruption	Distress, reduced safety, and lower school engagement	Strengthen caregiver support and child-sensitive services
Development	Cumulative illness, school disruption, and environmental stress	Reduced learning, play, and developmental opportunity	Use cross-sector child-development monitoring

Environmental Stress and Child Development

Environmental stressors such as inadequate water supply, hygiene, and sanitation—along with related pressures on caregivers and communities—threaten children's developmental prospects (39). A diverse literature links physical environments to child growth, health, education, and cognition, yet limited research systematically characterizes how specific environmental stresses—such as water scarcity and insecurity—affect these dimensions (40). Because more than two out of five children globally cannot access basic water services—including safe collection and sufficient quantities

for health and wellbeing—they are at heightened risk (39). Water insecurity or scarcity shapes four developmental pathways: children's educational participation and attainment; psychosocial well-being; social and community functioning; and health (41). Stressors—including limited access, lengthy collection times, contaminated supplies, and competing demands—affect caregivers' time use, income, health, social capital, and gender roles (42). These pressures cascade through families to children, impinging on their schooling, cognitive load, safety, and broader well-being (43).

Although improved water supply and sanitation—delivered alongside hygiene education—are among the most widely implemented and documented public health interventions, rigorous evidence on how insufficient water access affects children remains scarce (44). Moreover, scant research exists on developmental channels through which environmental stressors, including water insecurity, impede children's prospects (45). Enhanced understanding of water-related and other environmental stressors—and the cross-sectoral effects they engender—can inform interventions to simultaneously improve educational attainment and developmental outcomes (8).

Policy and Institutional Responses

Water is central for child development, yet an estimated 330 million children experience water insecurity—disrupted access to safe, sufficient water—indicating significant global concern (8). Water insecurity can impede educational attainment, destabilize households and communities, and aggravate health risks, requiring urgent attention from national and international policymakers (46). Crucial for development, regular access to suitable water is essential for maintaining hydration levels, promoting proper hygiene practices, and preventing water-related disease transmission (47). Furthermore, water insecurity constitutes an environmental stressor and socio-emotional hazard, with adverse effects on cognitive development, psychosocial functioning, and overall well-being (48).

Disparities in water availability can perpetuate, exacerbate, or widen pre-existing inequities across educational, social, and health dimensions (49). Already disadvantaged children face substantial barriers to educational performance, suitable social environments, and solid health determinants. Insufficient water access compounds negative conditions and amplifies existing challenges, especially among poor, rural, and/or minority households (50). In stressful environments, health risks escalate considerably, diminishing development prospects through additional stressors affecting care practices and physical growth (51).

Community Interventions and Resilience Building

Water security matters to child development. The educational, social, and health dimensions of water insecurity are analyzed (39).

While water-related challenges such as the water-food-energy nexus, the climate crisis, and population growth threaten water supplies, there is a lack of understanding of water insecurity that articulates the links between environmental effects and children's development (52). Definitions of water insecurity for households, schools, and communities need to be specified. No child should suffer the consequences of an environmental issue (53).

Young people born into disadvantaged contexts—be they marked by rural-urban differences, socio-economic disparities, or ethnic inequalities—face immediate hindrances to their personal agency or capability to drive change in their own lives (54). Children in poor environments also tend to use their agency to indulge in activities that do not promote human or capability development (55). Deprived families are less likely, for instance, to enrol their children in pre-school. Such situations undermine human development and lifetime capabilities (56) (figure 3, table 4).

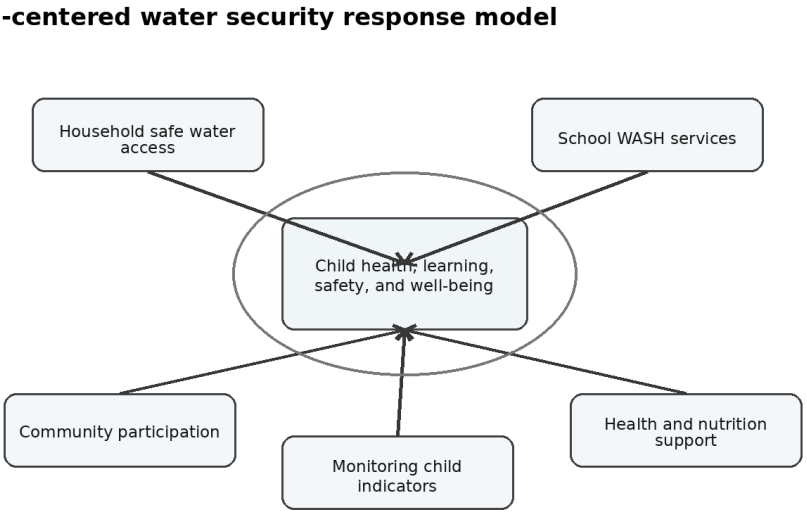

Figure 3: Child-centered water security response model

Table 4: Policy, school, health, and community responses to protect children from water insecurity

Household and community	Improve nearby, affordable, reliable, and safe water access	Reduce time poverty, illness, and household stress	Prioritize poor, rural, informal, and displaced communities
School system	Provide functional drinking water, sanitation, hygiene, and cleaning services	Protect attendance, dignity, concentration, and retention	Track facilities by school type, geography, and gender needs
Health and nutrition services	Screen for water-related illness, dehydration, and household water stress	Prevent avoidable morbidity and developmental harm	Integrate with child health, nutrition, and caregiver support
Social protection	Support families facing high water costs or long collection burdens	Reduce harmful coping strategies affecting schooling	Target households with children, disability, or economic vulnerability
Data and governance	Collect child-sensitive indicators and include children's perspectives	Make water insecurity visible in education and health planning	Disaggregate data by age, gender, income, residence, and marginalization

Measurement, Data, and Research Gaps

Measurement of water insecurity presents a challenge for scholarship and policy. Measurement must account for multiple processes acting independently of access (57). Children's experiences can differ from those of adults, and capturing household access does not address environmental dimensions (1). Simply measuring supply or access fails to gauge exposure to environmental risk (58).

Data availability impedes understanding of children's water-related school participation and psychosocial stress (59). Informal data-sharing agreements can facilitate sharing existing datasets with extensive coverage of schools and communities in vulnerable areas (60). Representation of children's perspectives is absent from both children's and adult subjective measures of water access (61).

Ethical Considerations in Research and Practice

Children are often uniquely vulnerable to the effects of environmental stressors, such as climate extremes and air pollution, resulting in detrimental impacts on health, safety, learning, and overall wellbeing (62). Research has been increasingly focused on exploring the relationships between environmental stressors and child development in low- and middle-income countries (LMICs) situated in climate-sensitive regions (62). Yet there are still numerous gaps in understanding how children are impacted, particularly regarding community-level risks where populations are significant, public policy is limited, and potential intervention opportunities abound (63). Climate change is expected to exacerbate multiple environmental stressors, further elevating the urgency of addressing these children's needs (64).

Conclusion

Water security plays a vital role in the healthy development of children; neglecting this factor has substantial consequences for educational systems, among other dimensions. A framework is proposed to analyze the broader implications of water insecurity on education, social dynamics, and health processes, integrating interdisciplinary perspectives from the literature.

Urgent action is needed to address water insecurity and its multifaceted consequences for children. Evidence shows that lack of access to reliable water for households and institutions is a key impediment to children's learning. Countries across the globe—especially rural communities in low-income countries—experience intermittent or total unavailability of water. Water insecurity at school increases logistical burdens associated with basic activities such as cleaning, drinking, and sanitation, which in turn detracts from time available for education. Children face important trade-offs between education and various household activities, such as fetching water and engaging in paid work. Scarcity of water can generate additional psychological burdens that compromise concentration and retention of knowledge, ultimately resulting in poorer educational outcomes.

School environments characterized by the absence of domestic water supply may also hinder pedagogical processes. Water unavailability increases corrosion and the frequency of damage to teaching materials and sanitary facilities, can expose classrooms to dust and other air pollutants, and is associated with increased multi-class teaching, thus reducing the time devoted to each class. Excessive heat associated with climatic conditions occurring in the absence of water supply affects cognitive performance and learning capacity. These conditions not only undermine educational effectiveness, but can also increase school dropout rates, contributing to long-term accumulative disadvantage.

Access to water from domestic sources is restricted in many rural and low-income households. Water-fetching time represents a significant share of children's daily activities and increases with the distance travelled to water points. Such

time poverty limits educational engagement in vulnerable constituencies while allowing children to enter the workforce. Investments in water supply and sanitation improvement at the community level help not only address health concerns, but also expand educational engagement and contribute to broader sustainable development efforts.

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References:

1. Nounkeu C, Kamgno J, Dharod J. Assessment of the relationship between water insecurity, hygiene practices, and incidence of diarrhea among children from rural households of the Menoua Division, West Cameroon. 2019. ncbi.nlm.nih.gov
2. Okafor CO, Ude UI, Okoh FN, Eromonsele BO. Safe drinking water: The need and challenges in developing countries. InWater quality-new perspectives 2024 Jan 24. IntechOpen. intechopen.com
3. Health Organization W. State of the world's drinking water: an urgent call to action to accelerate progress on ensuring safe drinking water for all. 2022. google.com
4. Reader GT. Access to drinking water, food security and adequate housing: challenges for engineering, past, present and future. Symposium on responsible engineering and living. 2022. [HTML]
5. Hope R. Four billion people lack safe water. Science. 2024. [HTML]
6. Ali S. Clean drinking water and future prospective. Pakistan Journal of Science. 2022. paas-pk.org
7. Barrington DJ. Inadequate water, sanitation and hygiene in the South Pacific: how might it be impacting children? 2016. [PDF]
8. E. Cooper-Vince C, Kakuhikire B, Vorechovska D, Q. McDonough A et al. Household water insecurity, missed schooling, and the mediating role of caregiver depression in rural Uganda. 2017. ncbi.nlm.nih.gov
9. Young SL, Bethancourt HJ, Ritter ZR, Frongillo EA. Estimating national, demographic, and socioeconomic disparities in water insecurity experiences in low-income and middle-income countries in 2020–21: a cross-sectional, observational study using nationally representative survey data. The Lancet Planetary Health. 2022 Nov 1;6(11):e880-91. thelancet.com
10. Shah SH, Harris LM, Menghwani V, Stoler J, Brewis A, Miller JD, Workman CL, Adams EA, Pearson AL, Hagaman A, Wutich A. Variations in household water affordability and water insecurity: An intersectional perspective from 18 low-and middle-income countries. Environment and Planning F. 2023 Sep;2(3):369-98. sagepub.com
11. Kimutai JJ, Lund C, Moturi WN, Shewangizaw S, Feyasa M, Hanlon C. Evidence on the links between water insecurity, inadequate sanitation and mental health: A systematic review and meta-analysis. Plos one. 2023 May 25;18(5):e0286146. plos.org
12. Ahmad S, Zahra J, Ali M, Ali S, Iqbal S, Kamal S, Tahir M, Aborode AT. Impact of water insecurity amidst endemic and pandemic in Pakistan: Two tales unsolved. Annals of Medicine and Surgery. 2022 Sep 1;81. nih.gov
13. Khalil S, Bader Sheikh S, Jamal U, Khan HF. Household water insecurities and willingness to pay in Karachi. Water Policy. 2023. iwaponline.com
14. Patrick E, Butsic V, Potts MD. Assessing land use change trajectories following food insecurity shocks in 25 low-and middle-income countries. Global environmental change. 2025. sciencedirect.com
15. Rhue SJ, Torrico G, Amuzie C, Collins SM, Lemaitre A, Workman CL, Rosinger AY, Pearson AL, Piperata BA, Wutich A, Brewis A. The effects of household water insecurity on child health and well-being. Wiley Interdisciplinary Reviews: Water. 2023 Nov;10(6):e1666. wiley.com
16. Gyan KA, Duan H. Impact of Water Scarcity on Education Outcomes: Evidence from 26 African Countries. Journal of the Knowledge Economy. 2025. [HTML]
17. Ezennia J, Schmidt LA, Ritchie LD, Blacker L, McCulloch CE, Patel AI. Water security experiences and water intake among elementary students at low-income schools: A cross-sectional study. Academic pediatrics. 2023 Jan 1;23(1):68-75. sciencedirect.com
18. FitzGerald SOD. Water Insecurity in K-12 Schools in the US: Understanding State Laws, Drinking Water Violations, and Lived Experiences. 2024. olemiss.edu
19. Martey E, Asante BO, Prah S, Etwire PM. Access to dry season community water resources and children's school attendance and work: Evidence from Ghana. International Journal of Educational Development. 2025 Oct 1;118:103401. [HTML]
20. Eshun EC. Beyond the Household: Embodied Experiences and Well-Being Implications of Water Insecurity in an Urban Ghanaian Girls' Boarding School. 2023. ohiolink.edu
21. Izah SC, Ogwu MC. Water Scarcity and Insecurity: Causes and Consequences. InWater Quality and Safety in the Global South: Challenges, Solutions and Future Directions 2026 Jan 10 (pp. 1-24). Cham: Springer Nature Switzerland. [HTML]
22. Brewis A, DuBois LZ, Wutich A, Adams EA, Dickin S, Elliott SJ, Empinotti VL, Harris LM, Ilboudo Nébié E, Korzenevica M. Gender identities, water insecurity, and risk: Re-theorizing the connections for a gender-inclusive toolkit for water insecurity research. Wiley Interdisciplinary Reviews: Water. 2024 Mar;11(2):e1685. nsf.gov
23. Olatoye TA, Fru RN. Water security and livelihoods in the arid zones of South Africa: A human geography approach to rural education and curriculum development. Frontiers in Education. 2025. frontiersin.org

24. Gu W, Qin Y. Targeted opportunities to mitigate water scarcity, inequality, and inequity embedded in international food trade for vulnerable countries. Water Research. 2024. [HTML]
25. Humphreys KL, King LS, Guyon-Harris KL, Zeanah CH. Caregiver regulation: A modifiable target promoting resilience to early adverse experiences. Psychological trauma: theory, research, practice, and policy. 2022 Apr;14(S1):S63. apa.org
26. Szlamka Z, Hanlon C, Tekola B, Pacione L, Salomone E, WHO CST Team, Servili C, Hoekstra RA. Exploring contextual adaptations in caregiver interventions for families raising children with developmental disabilities. Plos one. 2022 Sep 28;17(9):e0272077. plos.org
27. Wong PW, Lam YY, Lau JS, Fok HK, WHO CST Team Servili Chiara 4 Salomone Erica 5 6 Pacione Laura 4 5 Shire Stephanie 6 Brown Felicity 7 8. Adapting and pretesting the World Health Organization's Caregiver Skills Training Program for children with autism and developmental disorders or delays in Hong Kong. Scientific Reports. 2022 Oct 8;12(1):16932. nature.com
28. Sundberg F, DeBeaufort C, Krogvold L, Patton S, Piloya T, Smart C, Van Name M, Weissberg-Benchell J, Silva J, A diMeglio L. ISPAD clinical practice consensus guidelines 2022: managing diabetes in preschoolers. Pediatric Diabetes. 2022 Dec 20;23(8):1496. nih.gov
29. Chaudhary N, Swanepoel A. Editorial Perspective: What can we learn from hunter-gatherers about children's mental health? An evolutionary perspective. Journal of Child Psychology and Psychiatry. 2023 Oct;64(10):1522-5. wiley.com
30. Psaki S, Haberland N, Mensch B, Woyczynski L, Chuang E. Policies and interventions to remove gender-related barriers to girls' school participation and learning in low-and middle-income countries: A systematic review of the evidence. Campbell Systematic Reviews. 2022 Mar;18(1):e1207. wiley.com
31. Adane Y, Ambelu A, Yenesew MA, Mekonnen Y, Kassahun T. Effect of menstruation on school attendance of girls along with water, sanitation, and hygiene services in Northwest Ethiopia. The Pan African Medical Journal. 2025 Jan 16;50:28. nih.gov
32. Kangmennaang J, Bisung E, J. Elliott S. 'We Are Drinking Diseases': Perception of Water Insecurity and Emotional Distress in Urban Slums in Accra, Ghana. 2020. ncbi.nlm.nih.gov
33. Azupogo UW, Achore M, Dery FA, Bisung E. Health implications of coping with water insecurity at the household level. Water Security. 2023. [HTML]
34. Rosinger AY. Water needs, water insecurity, and human biology. Annual Review of Anthropology. 2023. annualreviews.org
35. Parker SY, Parchment KF, Gordon-Strachan GM. The burden of water insecurity: a review of the challenges to water resource management and connected health risks associated with water stress in small island developing states. Journal of Water and Climate Change. 2023 Dec 1;14(12):4404-23. iwaponline.com
36. Hasan MM, Habib A, Alam MJ, Islam S et al. Industrial applications, environmental fate, human exposure, and health effects of PFAS. Pollutants. 2025. mdpi.com
37. Thakur R, Joshi V, Sahoo GC, Jindal N, Tiwari RR, Rana S. Review of mechanisms and impacts of nanoplastic toxicity in aquatic organisms and potential impacts on human health. Toxicology Reports. 2025 Jun 1;14:102013. sciencedirect.com
38. Butzin-Dozier Z, N. Mertens A, T. Tan S, A. Granger D et al. Stress Biomarkers and Child Development in Young Children in Bangladesh. 2023. ncbi.nlm.nih.gov
39. Gaffan N, Kpozehouen A, Degbey C, Ahanhanzo YG, Paraïso MN. Effects of household access to water, sanitation, and hygiene services on under-five mortality in Sub-Saharan Africa. Frontiers in Public Health. 2023 Apr 27;11:1136299. frontiersin.org
40. Health Organization W. State of the world's drinking water: an urgent call to action to accelerate progress on ensuring safe drinking water for all. 2022. google.com
41. Gaffan N, Kpozèhouen A, Dégbey C, Glele Ahanhanzo Y, Glele Kakai R, Salamon R. Household access to basic drinking water, sanitation and hygiene facilities: secondary analysis of data from the demographic and health survey V, 2017–2018. BMC Public Health. 2022 Jul 14;22(1):1345. springer.com
42. Khilchevskyi V, Karamushka V. Global water resources: distribution and demand. Clean water and sanitation. 2022. [HTML]
43. Brown J, Acey CS, Anthonj C, Barrington DJ, Beal CD, Capone D, Cumming O, Fedinick KP, Gibson JM, Hicks B, Kozubik M. The effects of racism, social exclusion, and discrimination on achieving universal safe water and sanitation in high-income countries. The Lancet Global Health. 2023 Apr 1;11(4):e606-14. thelancet.com
44. Tinazzi I. Water scarcity, migrations and climate change: an assessement of their nexus. 2024. unive.it
45. Collins SM. What are we missing when we measure water insecurity?. 2023. [HTML]
46. Lwandiko M. Health Water Scarcity: A Deadly Problem to Children. Available at SSRN 4818236. 2024. ssrn.com
47. Jahura S, Islam MS, Mostafa MG. Impact of water scarcity on rural livelihood in the drought-prone region: A review of global perspectives. Indonesian Journal of Social Science. 2024 Jan 1;16(1). researchgate.net
48. David O, Hughes S. Whose water crisis? How policy responses to acute environmental change widen inequality. Policy Studies Journal. 2024. wiley.com
49. Rad J. Health inequities: a persistent global challenge from past to future. International journal for equity in health. 2025. springer.com
50. Rusca M. Water inequalities. Routledge handbook of water and development. 2023. [HTML]

51. Wright CY, Kapwata T, Cook C, Howard SJ, Makaula H, Merkley R, Mshudulu M, Tshetu N, Naidoo N, Scerif G, Draper CE. Inadequate access to potable water impacts early childhood development in low-income areas in Cape Town, South Africa. Annals of global health. 2023 Nov 24;89(1):82. nih.gov
52. Adams EA, Byrns S, Kumwenda S, Quilliam R, Mkandawire T, Price H. Water journeys: Household water insecurity, health risks, and embodiment in slums and informal settlements. Social Science & Medicine. 2022 Nov 1;313:115394. sciencedirect.com
53. Ilahy AD, Kaaffah MS, Latipah E, Har AA, Bestari D. Developmental Psychology of Learners: Environmental Factors Influencing Child Development. Linguanusa: Social Humanities, Education and Linguistic. 2025 Nov 20;3(2):98-114. [HTML]
54. Mousavi SZ, Gharibzadeh S. Growing up in a challenging environment: A cultural analysis of self-regulation development in poverty. European Journal of Developmental …. 2022. [HTML]
55. Bao K, Zhang X, Cai L. The closed loop between parental upbringing and online game addiction: a narrative study of rural children's growth in China. Psychology Research and Behavior Management. 2024 Dec 31:1703-16. tandfonline.com
56. Islam MZ, Dhanekula A. Measuring the Security Impact of Zero Trust Access Controls: A Mixed-Methods Study of Identity-Based Policies (Cisco ISE+ AD) and Incident Reduction. American Journal of Data Science and Analytics. 2023 Jun 28;4(06):01-42. ajdsa-journal.org
57. Chen O, Paas F, Sweller J. A cognitive load theory approach to defining and measuring task complexity through element interactivity. Educational Psychology Review. 2023. springer.com
58. Riquelme-Arredondo A, Torres-Contreras H, Quiroz V, Gutiérrez-Martinetti S. Let's take care of the water: Social representations in preschoolers. International Journal of Early Childhood. 2025 Apr;57(1):231-54. [HTML]
59. Rasmussen AB, Schmidt CH. Access to children's perspectives?. Social Sciences. 2024. mdpi.com
60. Gans KM, Chacón V, Warykas SW, Baird M, Esquivel V, Zhang S, Tovar A, Ray S, Inman N, McCauley P, Zambrano Rodriguez VC. Exploring barriers and facilitators to water availability and accessibility, and potential strategies for improving water accessibility and children's intake in family childcare homes: a qualitative study. Frontiers in Nutrition. 2025 Mar 12;12:1442070. frontiersin.org
61. L. Sprague N, M. Zonnevylle H, Jackson Hall L, Williams R et al. Environmental health perceptions of urban youth from low-income communities: A qualitative photovoice study and framework. 2023. ncbi.nlm.nih.gov
62. B. Fisher C. Privacy and Ethics in Pediatric Environmental Health Research—Part I: Genetic and Prenatal Testing. 2006. ncbi.nlm.nih.gov
63. Health Organization W. Global climate change and child health: training for health care providers. 2023. who.int