
| RESEARCH ARTICLE

An Empirical Study of the Prevalence and Risk Factors of Water-Related Injuries among In-School Adolescents in Ijebu North Local Government Area, Ogun State Nigeria

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| ABSTRACT

Water-related injuries constitute an emerging public health concern among adolescents in low- and middle-income countries, particularly in sub-Saharan Africa where unsafe water environments, flooding, poor supervision, and inadequate water safety education increase vulnerability. Adolescents are frequently exposed to rivers, streams, wells, drainage channels, and flooded environments during domestic, recreational, and school-related activities. Despite the growing burden of water-related injuries in Nigeria, evidence from school-based studies remains limited. This study investigated the prevalence and associated risk factors of water-related injuries among in-school adolescents in Ijebu North Local Government Area (INLGA), Ogun State, Nigeria. A descriptive cross-sectional study was conducted among 500 in-school adolescents aged 10–19 years selected through multistage cluster sampling from three public secondary schools in Ijebu North Local Government Area. Data were collected using a structured self-administered questionnaire covering socio-demographic characteristics, prevalence and patterns of water-related injuries, environmental and behavioral risk factors, and safety practices. Data were analyzed using SPSS version 25. Descriptive statistics were summarized using frequencies, percentages, means, and standard deviations. Chi-square tests and binary logistic regression were used to determine associations between variables at $p < 0.05$. The 3-month prevalence of water-related injuries among respondents was 64.8%. Common injuries reported included slips and falls near water sources (42.0%), cuts and lacerations sustained during water-related activities (35.2%), near-drowning incidents (18.4%), burns from hot water (14.8%), and water transport-related injuries (9.6%). Male adolescents reported a higher prevalence of water-related injuries (68.5%) than females (60.6%). Significant predictors of water-related injuries included exposure to flooded environments (AOR=3.214; 95% CI:1.761–5.864), lack of swimming skills (AOR=2.847; 95% CI:1.534–5.283), inadequate parental supervision near water bodies (AOR=2.692; 95% CI:1.421–5.098), unsafe recreational practices around rivers and streams (AOR=3.981; 95% CI:2.036–7.783), and poor knowledge of water safety measures (AOR=2.174; 95% CI:1.142–4.138). Water-related injuries are highly prevalent among in-school adolescents in Ijebu North Local Government Area. Environmental exposure, unsafe behaviours, poor supervision, and inadequate safety knowledge significantly contribute to injury occurrence. Strengthening school-based water safety education, environmental protection policies, parental supervision, and adolescent injury prevention interventions is essential to reducing the burden of water-related injuries among adolescents.

| KEYWORDS

Adolescents, Nigeria, Prevalence, Public Health, Risk factors, School health, Water-related injuries

| ARTICLE INFORMATION

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1. Introduction

The present study, focused on water-related injuries among adolescents that to the various forms of physical harm and health problems that occur during water collection, usage, storage, or interaction with water sources. In many developing communities, adolescents are actively involved in fetching water from streams, wells, boreholes, rivers, and public taps, thereby exposing them to multiple environmental and physical risks (Matchawe *et al.*, 2022; Olufemi *et al.*, 2022; Logie *et al.*, 2025). These injuries may occur through accidental slips and falls on wet or uneven

surfaces around water points, which can result in bruises, fractures, or other bodily injuries (Jagnoor and Peden, 2021; Venkataramanan et al., 2020).

In addition, direct contact with contaminated water may expose adolescents to skin problems such as itching, rashes, and infections due to poor water quality and unhygienic environmental conditions (Archana *et al.*, 2025; Chabib *et al.*, 2025). Also, mechanical injuries may also arise from the use of faulty or poorly maintained hand pumps, where moving handles or metal parts can strike the hands, arms, or other body parts (Vanderwal *et al.*, 2011; MacAllister *et al.*, 2021; O'Donnell and Canares, 2021). Furthermore, the repeated carrying of heavy water containers over long distances often leads to musculoskeletal problems, including back pain, neck pain, and body fatigue, especially among adolescents whose bones and muscles are still developing (Adegbite *et al.*, 2027; Geere *et al.*, 2018; AnilKumar and Amit Kumar, 2025).

Meanwhile, conflicts and physical confrontations at overcrowded water points may also increase the risk of physical injuries, particularly in communities where access to safe and reliable water is limited (Adegbite et al., 2017; Tallman et al., 2023). Consequently, water-related injuries constitute an important public health concern because they affect the physical wellbeing, daily activities, school attendance, and overall quality of life of adolescents (Lee *et al.*, 2020; Rhue *et al.*, 2023; Alnaimi *et al.*, 2026).

Moreover, Adolescence is a critical developmental period characterized by rapid physical, psychological, emotional, and social changes. The World Health Organization (WHO, 2026) defines adolescence as the phase of life between childhood and adulthood, covering ages 10 to 19 years. Currently, adolescents constitute a substantial proportion of the global population. According to UNICEF, approximately 1.3 billion adolescents aged 10–19 years live worldwide, representing about 16% of the global population (Kanma-Okafor, 2026). A large proportion of adolescents reside in low- and middle-income countries (LMICs), with WHO estimating that nearly 90% of adolescents aged 10–19 years live in these settings (World Health Organization (WHO), 2024). Adolescents in LMICs experience a disproportionate burden of preventable injuries, including road traffic injuries, drowning, interpersonal violence and other unintentional injuries, while environmental risks and limitations in health and safety infrastructure can further increase their vulnerability (Al-Worafi 2024; WHO, 2024; UNICEF, 2024).

Injuries remain a major global public health problem and are consistently ranked among the leading causes of mortality and disability among adolescents. Within this broad injury burden, water-related injuries constitute an important but often neglected category. These injuries include falling into the drainage system during rainfall, drowning, near-drowning incidents, falls near water bodies, cuts and lacerations sustained during water activities, burns from hot water, water transport accidents, and infection-related conditions from exposure to contaminated water.

In Africa, the burden of water-related hazards is compounded by recurrent flooding, unsafe domestic water practices, poor drainage, and inadequate water, sanitation and hygiene (WASH) services. A 2023 UNICEF analysis identified Nigeria among the ten countries in West and Central Africa where children face the convergence of inadequate WASH, water-related diseases, and climate hazards (Mensah, 2024; Irene et al., 2025; Ködmön, 2026). Approximately 78 million Nigerian children are exposed to these threats, with one-third lacking access to at least basic water at home and two-thirds without basic sanitation services (Victor *et al.*, 2025). For instance, according to the National Emergency Management Agency (NEMA, 2024), flooding in Nigeria affected millions of people across several states, resulting in deaths, displacement, injuries, and extensive damage to homes and livelihoods. Adolescents are particularly vulnerable because of frequent exposure to rivers, streams and other unsafe water environments for domestic and recreational activities, often without adequate supervision, safety equipment, or formal water-safety education.

Despite this burden, evidence on water-related injuries among adolescents in Nigeria remains limited. Although regional studies report high injury prevalence among in-school adolescents in sub-Saharan Africa, with Nigeria recording approximately 74%, existing Nigerian research has largely concentrated on road traffic crashes, violence, and hospital-based trauma, with road traffic injuries accounting for about 68.4% of documented cases. Consequently, community-level water-related injuries, including drowning and other aquatic incidents, may be

underrepresented. Schools provide an important platform for investigating adolescent injury patterns because they connect adolescents with the wider community where exposure to unsafe water environments may occur, particularly after school hours. The paucity of epidemiological evidence therefore constrains targeted prevention and policy interventions. This study consequently investigated the prevalence and associated risk factors of water-related injuries among in-school adolescents in Ijebu North Local Government Area, Ogun State, Nigeria, as a case study.

1.1 Objectives of the study

The specific objectives were to:

- i. Determine the prevalence and patterns of water-related injuries;
- ii. Identify socio-demographic, environmental, and behavioral risk factors; and
- iii. Assess knowledge, safety practices, and preventive measures related to water-related injuries among the study population.

2. Methodology

The research was conducted in Ijebu North Local Government Area (INLG) of Ogun State, southwestern Nigeria with headquarters at Ijebu Igbo. The coordinates range from Latitude (6° 59' and 6.99 55° N and 3° 58' and 3.9706 E. The study area, established in 1979, covers 1,250 square kilometers with a population of 284,336 (NPC, 2006). The LGA comprises 11 wards, major towns including Ijebu-Igbo, Ago-Iwoye, Oru, Awa, and Ilaporu, and hosts 18 accredited secondary schools (10 public, 8 private). The inhabitants are predominantly Ijebus, with agriculture (oil-palm, cocoa, coffee, kolanut, maize, yam, cassava, vegetables, poultry) and timber as primary income sources. This descriptive cross-sectional study targeted adolescents attending secondary schools in INLG. The study population included all students aged 10-19 years who consented to participate with the approval of their parents and guardians. Three public secondary schools were selected by balloting from ten public schools in INLG (cluster sampling). Questionnaires were proportionally allocated based on student population: School A (2,378 students, n=237), School B (1,450 students, n=145), School C (1,183 students, n=118). The sample size for the study was 500.

Data obtained from the completed questionnaires were coded and analyzed using the Statistical Package for Social Sciences (SPSS) version 25. Descriptive statistics (frequencies, percentages, means, and tables) were used to summarize respondents' demographic characteristics, prevalence of injuries, types and causes of injuries, as well as injury management practices. Chi-square tests were employed to examine associations between the dependent variable (injury occurrence) and the independent variables. Furthermore, binary logistic regression analysis was conducted to determine the strength of association between injury occurrence and socio-demographic, family, environmental, individual, behavioral, and violence-related factors. All statistical analyses were two-tailed, and statistical significance was set at $p < 0.05$.

3. Results and Discussion

3.1 Result of the Socio-Demographic characteristics of the respondents

A total of 500 in-school adolescents participated in the study. The respondents were predominantly males 264 (52.8%), while females accounted for 236 (47.2%). The mean age of respondents was 15.4 ± 2.1 years. Most respondents 342 (68.4%) were within the late adolescent age group (15–19 years), while 158 (31.6%) were early adolescents aged 10–14 years. The majority of respondents were in senior secondary classes 337 (67.4%), Christians 273 (54.6%), and from monogamous family settings 281 (56.2%). Most respondents lived with both parents 349 (69.8%).

Table 1: Socio-Demographic characteristics of the respondents

Variables		Frequency (n)	Percentages (%)
Gender	Male	264	52.8
	Female	236	47.2
Age Group	10–14 years	158	31.6
	15–19 years	342	68.4
Level of Class	Junior Secondary	163	32.6
	Senior Secondary	337	67.4
Religious Affiliation	Christianity	273	54.6
	Islam	218	43.6
	Traditionalist	9	1.8
Family Type	Monogamous	281	56.2
	Polygamous	219	43.8
Household set up	Both parents	349	69.8
	Single parent	112	22.4
	Guardian/Relatives	39	7.8

The table1 presents the socio-demographic profile of 500 respondents across six variables: gender, age group, class level, religious affiliation, family type, and household setup. Males 264 (52.8%) slightly outnumber females 236 (47.2%). The majority of respondents 342 (68.4%) fall within the 15–19 years age bracket, while the remaining (158) 31.6% are within the 10–14 years group. This distribution suggests that the study predominantly captures older adolescents, which is a critical developmental stage marked by heightened exposure to peer influence, sexual curiosity, and risk-taking behaviour. Furthermore, the dominance of this group may reflect the focus of the study on secondary school students, where senior classes naturally account for more participants.

Similarly, Senior Secondary students (337) constitute 67.4% of the sample, compared to (163) 32.6% at the Junior Secondary level. This aligned closely with the age distribution above, since older students typically populate senior classes. In addition, senior secondary students are arguably more relevant to studies examining adolescent behaviour because of their greater autonomy, wider social interactions, and increased exposure to environmental influences and outdoor activities.

With respect to religion, Christianity is the most prevalent faith (54.6%), followed closely by Islam (43.6%), while students from traditionalist parents form a very small minority (1.8%). This distribution likely reflects the religious demographics of the study's geographic context, possibly a South-Western or mixed Nigerian setting where both Christianity and Islam coexist prominently. Moreover, the near-equal representation of the two dominant religions is noteworthy, as religion often shapes moral attitudes, sexual norms, decision-making processes, and health-seeking behaviour among adolescents.

Regarding family type, monogamous families, two hundred and eighty-one (282) (56.2%) respondent living in monogamous home, are slightly more common than respondents from polygamous families 218(43.8%). Nevertheless, the relatively high proportion of polygamous households is consistent with Nigerian cultural and religious norms, particularly in communities where both Islam and traditional practices permit polygamy. Family structure is an important social determinant because it has significant implications for parental attention, resource allocation, emotional support, and adolescent supervision, all of which can influence health outcomes and behavioural patterns.

However, the majority of respondents (349) (69.8%) live with both parents, whereas (112) (22.4%) respondents reside in single-parent households and (39) (7.8%) respondents live under the care of guardians or relatives. The finding that nearly one-third of respondents do not live in two-parent households is significant. This is because single-parent and guardian-led households may experience limitations in parental monitoring, communication, and

emotional guidance, especially regarding sensitive topics such as reproductive health. Consequently, adolescents in such settings may be more vulnerable to risky behaviours and adverse health outcomes.

3.2 Prevalence of Water-Related Injuries

The findings revealed that 324 respondents (64.8%) experienced at least one water-related injury within the previous three months, while 176 (35.2%) reported no history of water-related injury. Among those injured, 148 (29.6%) sustained injury once, 96 (19.2%) sustained injuries twice, 44 (8.8%) experienced injuries three times, and 36 (7.2%) sustained four or more injuries.

Table 2: Prevalence and Frequency of Water-Related Injuries among Respondents

Variable		Frequency (n)	Percentage (%)
Experienced water-related injury in last 3 months	Yes	324	64.8
	No	176	35.2
Frequency of injuries	None	176	35.2
	Once	148	29.6
	Twice	96	19.2
	Three times	44	8.8
	Four or more times	36	7.2

As shown in the table 2, out of 500 respondents, 324 (64.8%) reported experiencing a water-related injury within the preceding three months, while only 176 (35.2%) reported no such experience.

A prevalence of 64.8% is epidemiologically alarming, this represents a high burden of morbidity within the study population. Using standard epidemiological thresholds, any condition affecting more than 50% of a defined population within a short reference period (3 months) qualifies as a hyperendemic or high-prevalence public health problem warranting urgent attention. This 3-month period prevalence also implies that water-related injuries are not isolated or rare events, they are recurrent, frequent, and deeply embedded in the daily lived experiences of this adolescent population, suggesting chronic and systemic exposure to hazardous environments.

Furthermore, among the 324 injured respondents (64.8%), the distribution of injury frequency reveals a serious public health pattern. The results showed that nearly three in ten respondents sustained at least one water-related injury. One hundred and forty-eight 148 (29.6%) mentioned once they experienced injury in the last three month. Though a single injury event may appear limited, it still represents significant individual morbidity and potential healthcare utilization burden or complication when the injury is hidden by the adolescents.

Approximately one in five respondents (96) (19.2%) sustained two injury episodes within just three months. This signal repeated hazardous exposure, pointing to persistent environmental risk factors rather than random or one-off incidents. Those mentioned three times (44) (8.8%) respondents reflects a pattern of chronic exposure and repeated injury, which possible habitual and attitudinal pattern among the respondents.

Similarly to those in sub group (three times), thirty-six (36) (7.2%) respondents experienced four or more times injury; though numerically smaller, this group is epidemiologically the most critical. Sustaining four or more injuries in 90 days suggests near-continuous hazardous exposure, a failure of primary prevention, and a heightened risk of serious, cumulative, or fatal injury outcomes.

However, 176 respondents (35.2%) experienced multiple injury episodes; an indication that more than one-third of the entire sample sustained repeated water-related injuries within a 90-day window.

3.3 Types and Patterns of Water-Related Injuries

The responses on the type and patterns of the injuries contained in the table 3 showed that the respondents experienced one or more than one injury in the last three months of the study.

This indicates that multiple injuries were reported per respondent, meaning the data reflects a multiple-response (multi-morbidity) pattern; a common and epidemiologically important finding suggesting that affected adolescents do not simply sustain one type of injury, but experience overlapping and co-occurring injury burdens.

Table 3: Prevalence and Frequency of Water-Related Injuries among Respondents

Type of Injury	Frequency (n)	% of Total Injuries
Slips and falls near water or drainage systems/gutters	210	26.9%
Cuts and lacerations	176	22.5%
Flood-related injuries	134	17.2%
Near-drowning incidents by slip into flood waters during rainfall	12	9.5%
Burns from hot water	74	8.5%
Injury sustaining due fight at water points	48	6.1%
Skin infections/rashes	66	4.9%
Neck and Back ache due to carrying of water	38	2.9%
Hit by moving part of mechanical handpump handle	23	1.5%

Slips and falls near water sources or drainage systems/gutters represent the most prevalent injury type, accounting for 210 cases (26.9%), which is more than one in four of all reported injuries. In environmental and injury epidemiology, slips and falls are classified as unintentional injuries resulting from hazardous physical environments, particularly wet, slippery, and poorly maintained surfaces around water sources, drainage channels, and gutters. The slips and falls might also occur when they wade inside flooded water during rainfall or misstep when to cross gutter full of stormwater.

Cuts and lacerations rank second, accounting for 176 cases (22.5%) of all injury events. These injuries commonly arise from contact with branches of trees and twigs on the path to water bodies, and/or broken bottles, sharp metallic edges of water containers, or debris hidden within floodwaters and drainage channels. Beyond the immediate physical wound, cuts and lacerations carry secondary public health risks such as tetanus infection, wound sepsis, and exposure to bloodborne pathogens, particularly in settings with poor sanitation and inadequate hygiene infrastructure.

However, flood-related injuries constitute 134 cases (17.2%), making them the third most common injury category. This is a highly significant public health finding because flood injuries are environmentally driven, seasonal, and community-wide in impact. Flood events expose adolescents to multiple hazards simultaneously, including fast-moving water currents, submerged sharp objects, contaminated floodwaters carrying pathogens, collapsed structures, and electrocution risks from submerged electrical installations. In disaster epidemiology, floods are recognized as one of the leading causes of injury-related mortality and morbidity in sub-Saharan Africa (references).

Burns from hot water account for 74 cases (9.5%), thereby representing the fourth most common injury type. Unlike the previously mentioned categories, hot water burns generally occur within the domestic environment during water heating, cooking, or bathing activities that referred to domestic injury. Additionally, burns may result in severe consequences such as pain, scarring, keloid formation, psychological trauma, and functional impairment, particularly during adolescence when body image and psychosocial development are highly important.

Then, skin infections and rashes were reported by 66 respondents (8.5%) and are classified in public health as water-washed and water-based diseases directly associated with inadequate water quality, poor sanitation, and contact with contaminated water bodies. These conditions may include scabies, tinea infections such as ringworm, contact dermatitis, bacterial folliculitis, and cercarial dermatitis associated with schistosomiasis-endemic water sources.

Injuries resulting from fights at water points account for 48 cases (6.1%) and represent a uniquely important yet often overlooked public health issue. This finding reflects the social determinants dimension of water-related

injuries, particularly conflicts arising from water scarcity. In many communities where access to water is limited, communal water points often become contested spaces, especially during dry seasons or periods of infrastructure breakdown. Adolescents, who are commonly responsible for household water collection, may therefore become exposed to interpersonal violence, assault, and physical altercations in such settings. This finding intersects with violence epidemiology and demonstrates that water insecurity is not only a physical health challenge but also a social and community safety issue. Consequently, increasing the number of water access points and reducing overcrowding at existing facilities could help minimise the conditions that trigger such violence. Neck and back pain resulting from carrying water containers account for 38 cases (4.9%). Although proportionally smaller, these musculoskeletal injuries represent a chronic, cumulative, and largely overlooked public health burden.

Injuries caused by moving parts of mechanical handpump handles were reported by 23 respondents (2.9%). These injuries occur when handpump handles recoil forcefully after pressure release, thereby causing blunt trauma to the face, head, upper limbs, or torso.

Near-drowning incidents, although the least frequent at 12 cases (1.5%), represent the most severity-critical injury type identified in this dataset. In drowning epidemiology, near-drowning refers to survival following submersion; however, it remains associated with serious complications such as hypoxic brain injury, acute respiratory distress syndrome (ARDS), secondary drowning, and even delayed death.

3.4 Environmental Risk Factors Associated with Water-Related Injuries

Table 4: Environmental Risk Factors Associated with Water-Related Injuries

Environmental Risk Factor	Injured n=324 (%)	Not Injured n=176 (%)	χ^2	P-value	Risk Difference (%)	Relative Risk (RR)	Interpretation
Exposure to flooding	218 (67.3%)	52 (29.5%)	42.18	<0.001*	37.8%	2.28	Strongly significant; flood-exposed adolescents 2.28× more likely to be injured
Presence of nearby river/stream	202 (62.3%)	58 (33.0%)	35.61	<0.001*	29.3%	1.89	Strongly significant; proximity to water bodies nearly doubles injury risk
Presence of open drainage near home	194 (59.9%)	61 (34.7%)	28.74	<0.001*	25.2%	1.73	Strongly significant; open drainage substantially elevates injury burden
Unsafe water source	168 (51.9%)	49 (27.8%)	25.82	<0.001*	24.1%	1.87	Strongly significant; unsafe source use nearly doubles injury probability

*Statistically significant at $p < 0.05$ *RR = *proportion injured exposed ÷ proportion injured unexposed (approximated from available data)* *Risk Difference = % Injured- % Not Injured for each factor

Flood exposure emerged as the strongest and most statistically significant environmental risk factor in this dataset, recording the highest chi-square value (42.18) and the largest relative risk (RR = 2.28). Among injured respondents, 218 (67.3%) reported flood exposure, compared to only 52 (29.5%) among the non-injured group, representing a substantial risk difference of 37.8 percentage points. In epidemiological terms, an RR of 2.28 indicates that adolescents exposed to flooding are more than twice as likely to sustain a water-related injury compared to those

without flood exposure. This finding aligns with global disaster epidemiology literature, which consistently identifies flooding as a major environmental determinant of unintentional injuries, particularly within low- and middle-income urban and peri-urban settings.

Furthermore, the magnitude of both the chi-square statistic and the risk difference demonstrate that this association is not only statistically robust but also clinically and programmatically significant. In this context, flood exposure likely mediates multiple injury pathways simultaneously, including slips and falls, near-drowning incidents, flood-related trauma, and exposure to contaminated floodwaters leading to skin infections, as corroborated by the injury-type data previously analysed. Consequently, the findings underscore the urgent need for flood-risk mitigation strategies and improved urban drainage systems to reduce adolescent exposure to hazardous flood conditions.

Similarly, proximity to a river or stream emerged as the second most significant environmental risk factor, with 202 injured respondents (62.3%) reporting residence near a river or stream, compared to 58 (33.0%) among the non-injured group. This corresponds to a risk difference of 29.3% and an RR of 1.89. An RR of 1.89 suggests that adolescents residing near rivers or streams face nearly twice the risk of water-related injury compared to those without such proximity. This association reflects the well-established epidemiological relationship between environmental water-body exposure and unintentional aquatic injuries, including drowning, near-drowning, slips on riverbanks, and waterborne skin infections.

Moreover, the high chi-square value (35.61) confirms that the relationship is strong and unlikely to have occurred by chance. Adolescents commonly engage in unsupervised recreational and domestic activities near rivers, such as bathing, swimming, fishing, play, and water collection, all of which significantly increase injury risk in the absence of adequate safety barriers, supervision, or swimming competence. Therefore, this finding reinforces the importance of implementing physical environmental safeguards, including riverbank fencing, community-posted hazard signage, and school-based water safety programmes specifically targeting river and stream hazards.

In addition, proximity to open drainage systems was reported by 194 injured respondents (59.9%) compared to 61 non-injured respondents (34.7%), resulting in a risk difference of 25.2% and an RR of 1.73. The chi-square value of 28.74 further confirms a highly significant association. Unlike flooding, which is often seasonal, or river proximity, which may involve recreational exposure, open drainage systems represent a chronic, year-round environmental hazard. These systems, characterised by uncovered gutters, open sewage channels, and stagnant or flowing wastewater, are permanently embedded within the residential environments of affected adolescents, thereby creating repeated daily exposure to injury risks through slips, falls, cuts from sharp debris, and contact with pathogen-contaminated water.

Accordingly, the RR of 1.73 indicates that adolescents living near open drainage systems are 73% more likely to sustain water-related injuries than those without such exposure. Since open drainage systems are predominantly concentrated in low-income and densely populated urban neighbourhoods, this finding also highlights a significant social gradient in injury risk, whereby environmental health inequities directly translate into a disproportionate injury burden among economically marginalised adolescents. From a WASH and urban planning perspective, covering or redesigning open drainage channels therefore represents one of the most direct, structurally impactful, and cost-effective environmental interventions for reducing adolescent water-related injuries within this setting.

Likewise, the use of unsafe water sources was reported by 168 injured respondents (51.9%) compared to 49 non-injured respondents (27.8%), yielding a risk difference of 24.1% and an RR of 1.87. The chi-square value of 25.82 also demonstrates a highly statistically significant association. An RR of 1.87 implies that adolescent's dependent on unsafe water sources is 87% more likely to experience water-related injuries than those with access to safe water sources. This relationship operates through several interconnected pathways. Unsafe water sources, including unprotected wells, open rivers, roadside puddles, and damaged borehole infrastructure, are inherently hazardous environments characterised by slippery access points, unstable ground surfaces, sharp structural components, and contaminated water capable of causing skin and wound infections.

Additionally, reliance on unsafe water sources serves as an important proxy indicator of poverty and water insecurity. Consequently, affected adolescents are simultaneously exposed to a cluster of compounding risk factors, such as poor infrastructure, longer water-fetching distances, heavier water loads, and reduced adult supervision, all of which independently increase injury vulnerability. Therefore, this finding strongly reinforces the right-to-water and health equity argument that ensuring universal access to safe, proximate, and well-maintained water sources is not only a developmental objective but also a direct and effective injury prevention strategy.

Overall, all four environmental risk factors produced p-values of less than 0.001, indicating that the probability of these associations occurring by chance is less than 1 in 1,000. Collectively, this statistical consistency across all variables provides strong evidence supporting a causal environmental pathway linking water-related environmental hazards to adolescent injury outcomes.

Table 5: Risk Factor Ranking by Strength of Association

Rank	Risk Factor	RR	χ^2	Risk Difference
1	Flood exposure	2.28	42.18	37.8%
2	Nearby river/stream	1.89	35.61	29.3%
3	Unsafe water source	1.87	25.82	24.1%
4	Open drainage near home	1.73	28.74	25.2%

Given that these four environmental factors are geographically and socioeconomically co-located communities prone to flooding typically also have open drainage, nearby water bodies, and unsafe water sources it is likely that a substantial proportion of injured adolescents were exposed to multiple simultaneous risk factors. In epidemiology, co-exposure to multiple environmental hazards produces a multiplicative or synergistic increase in risk, meaning the actual injury burden in multi-hazard households is likely far greater than any single factor's RR suggests.

3.5 Behavioral Risk Factors Associated with Water-Related Injuries

Table 6: Behavioral Risk Factors Associated with Water-Related Injuries

Environmental Risk Factor	Injured n=324 (%)	Not Injured n=176 (%)	χ^2	P-value	Risk Difference (%)	Relative Risk (RR)	Interpretation
Careless about safety	188 (58.0%)	47 (26.7%)	33.82	<0.001*	31.3%	2.17	Strong
Playing near rivers/streams	198 (61.1%)	51 (29.0%)	34.56	<0.001*	32.1%	2.11	Strong
Walking through floodwater	167 (51.5%)	44 (25.0%)	29.41	<0.001*	26.5%	2.06	Strong
Poor perception/attitudes	174 (53.7%)	38 (21.6%)	36.29	<0.001*	32.1%	2.49	Very Strong
Influence of drugs	186 (57.4%)	42 (23.9%)	39.84	<0.001*	33.5%	2.40	Very Strong

Statistically significant at $p < 0.05$ *As adapted from CDC, Relative risk (RR) was calculated as the proportion of adolescents injured among those exposed to a behavioural factor divided by the proportion injured among those unexposed to the factor. Risk difference (RD) was calculated as the difference between the proportion injured among exposed and unexposed adolescents ($RD = \text{Risk exposed} - \text{Risk unexposed}$), for each behavioural factor (Centers for Disease Control and Prevention [CDC], 2024).

Among the injured respondents, 188 (58.0%) demonstrated careless safety behaviour through engagement in unsafe water recreation, wading through flooded water, handling hot water whereas only 47 (26.7%) of the non-injured respondents reported similar behaviour. This produced a risk difference of 31.3% and a relative risk (RR) of 2.17. In behavioural epidemiology, carelessness about safety was conceptualized as a predisposing behavioural

determinant rooted in low perceived susceptibility and low perceived severity, which are two core constructs of the Health Belief Model. Adolescents who underestimated their vulnerability to water-related harm were significantly more likely to engage in unsafe recreational practices such as swimming in undesignated areas, diving into shallow or unknown water depths, and using water bodies without protective equipment or adequate safety awareness. Furthermore, the chi-square value of 33.82 confirmed a highly significant and non-random association, while the RR of 2.17 indicated that adolescents who were careless about water safety were more than twice as likely to sustain injuries compared to their safety-conscious peers.

Similarly, 198 injured respondents (61.1%) reported playing near rivers or streams, compared to 51 non-injured respondents (29.0%), yielding a risk difference of 32.1% and an RR of 2.11. This represented the most frequently reported behavioural risk factor by absolute count among injured adolescents. Playing near rivers and streams was identified as a high-exposure and high-frequency adolescent behaviour that created sustained proximity to aquatic hazards. Unlike adults who often approached water bodies with greater caution and purpose, adolescents frequently engaged in unstructured and unsupervised play around water environments, thereby increasing the likelihood of slipping, falling, being swept away by currents, or encountering submerged hazards. From a social-ecological model perspective, this behaviour was influenced by several interacting factors, including individual risk perception, peer group norms that encouraged outdoor play, inadequate household supervision, and the absence of designated safe recreational spaces within communities. Moreover, the RR of 2.11 confirmed that adolescents who engaged in riparian play faced more than double the risk of injury.

In addition, 167 injured respondents (51.5%) reported walking through floodwater, whereas only 44 non-injured respondents (25.0%) engaged in the same behaviour. This resulted in a risk difference of 26.5% and an RR of 2.06, indicating that adolescents who walked through floodwater were twice as likely to sustain injuries. Walking through floodwater was identified as a context-driven risk behaviour shaped largely by environmental necessity and limited alternatives. In many flood-prone communities with poor infrastructure, adolescents often lacked safer routes and were therefore compelled to walk through floodwaters in order to reach schools, homes, or water collection points. As a result, this behaviour reflected the intersection between environmental hazards and social vulnerability. Furthermore, floodwater concealed multiple dangers, including open manholes, submerged sharp objects, strong currents, electrocution risks, and pathogenic contamination. The chi-square value of 29.41 demonstrated a strong and statistically significant association, while the epidemiological significance of the finding extended beyond individual behaviour to broader structural and infrastructural deficiencies that forced adolescents into hazardous situations out of necessity rather than choice. Consequently, interventions were required to address both behavioural and structural dimensions through flood safety education, route planning, improved drainage systems, elevated walkways, and effective school-community flood response protocols.

Likewise, 174 injured respondents (53.7%) demonstrated poor risk perception and negative attitudes toward water safety, as reflected in poor swimming ability, compared to only 38 non-injured respondents (21.6%). This produced the second-highest RR in the table at 2.49, alongside a risk difference of 32.1%. Poor perception and negative attitudes toward water safety were identified as cognitive and attitudinal determinants that undermined the acquisition and practice of protective skills such as swimming or linking injuries with water quality. Within the framework of the Theory of Planned Behaviour, an individual's attitude toward a behaviour, including the perceived importance of learning to swim or recognising water hazards, significantly influenced whether the individual adopted protective or risk-prone actions near water environments. Moreover, the RR of 2.49 represented the strongest association among the perception-based behavioural indicators, suggesting that adolescents with poor safety attitudes and weak risk perception were nearly two and a half times more likely to sustain injuries than those with adequate awareness and safety orientation.

Furthermore, substance use emerged as one of the most critical behavioural risk factors in the study. This variable recorded the highest chi-square value (39.84) and the highest risk difference (33.5%) in the entire table, with 186 injured respondents (57.4%) affected compared to 42 non-injured respondents (23.9%). The RR of 2.40 further demonstrated a very strong association between substance use and injury occurrence. The influence of drugs and psychoactive substances on water-related injury risk operated through several neuro-behavioural pathways, as

substance use impaired judgment, reduced inhibitory control, distorted risk perception, increased impulsivity, compromised physical coordination, and delayed response time. Collectively, these effects substantially increased the likelihood of injuries in aquatic environments. In substance use epidemiology, alcohol and drug intoxication had consistently been recognised as major contributory factors in drowning and aquatic injury incidents worldwide. Adolescents were particularly vulnerable due to developmental neurocognitive immaturity and heightened susceptibility to peer influence regarding substance use. Additionally, the association between substance use and swimming without supervision reflected the tendency of substance-influenced adolescents to avoid supervision and engage in impulsive, unsupervised water-related risk-taking behaviours. The chi-square value of 39.84, which was the highest in the table, therefore provided the strongest statistical evidence of association among all behavioural factors and positioned substance use at the climax of the behavioural risk hierarchy for water-related injuries within the study population.

3.6 Knowledge and Preventive Practices Regarding Water-Related Injuries

The table presents four critical knowledge, attitudinal, and behavioural prevention variables among the adolescent respondents. Collectively, the data paint a deeply concerning picture of prevalent knowledge deficits, poor attitudes, limited formal water education, and grossly inadequate preventive practice regarding water safety.

Table 7: Knowledge and Preventive Practices Regarding Water-Related Injuries

Variable		Frequency (n)	Percentage (%)
Knowledge of water safety	Good knowledge	102	20.4
	Poor knowledge	398	79.6
Good Perception/Attitudes	Yes	138	27.6
	No	362	72.4
Received formal water education/safety	Yes	184	36.8
	No	316	63.2
Uses safety precautions near water	Yes	107	21.4
	No	393	78.6

The table presents respondents' level of knowledge, perceptions, attitudes, exposure to formal water safety education, and the use of safety precautions near water. Overall, the findings revealed generally low awareness and poor preventive practices regarding water safety among the respondents, thereby indicating substantial vulnerability to water-related injuries and hazards within the study population.

Regarding knowledge of water safety, only 102 respondents (20.4%) demonstrated good knowledge, whereas the majority, 398 respondents (79.6%), exhibited poor knowledge. This finding suggested that a significant proportion of the respondents lacked adequate understanding of basic water safety principles, including hazard recognition, safe swimming practices, flood safety measures, and emergency response actions. Poor knowledge of water safety could increase the likelihood of engaging in risky behaviours around water bodies, as individuals who are inadequately informed may underestimate potential dangers or fail to adopt protective measures. Furthermore, the low level of water safety knowledge observed in this study may reflect inadequate public health education, limited school-based safety programmes, and insufficient community awareness campaigns on aquatic hazards.

Similarly, the findings on perception and attitudes showed that only 138 respondents (27.6%) demonstrated good perceptions and positive attitudes toward water safety, while a larger proportion, 362 respondents (72.4%), displayed poor perceptions and negative attitudes. This result indicated that many respondents did not perceive water-related hazards as serious threats or did not prioritise preventive behaviours. In health behaviour theory, perception and attitude are important determinants of behavioural intention and protective action. Therefore, individuals with poor attitudes toward water safety are more likely to engage in unsafe practices such as swimming in dangerous locations, ignoring warning signs, or failing to supervise children near water bodies. Consequently, the

predominance of poor perceptions and attitudes in this study highlighted the need for behavioural change interventions aimed at improving risk awareness and promoting a culture of safety around aquatic environments.

In relation to formal water safety education, only 184 respondents (36.8%) reported having received formal education or training on water safety, whereas the majority, 316 respondents (63.2%), had never received any structured water safety education. This finding further explained the low levels of knowledge and poor safety attitudes identified among respondents. Formal water safety education plays a crucial role in equipping individuals with essential skills and information related to drowning prevention, safe water recreation, flood preparedness, and emergency response techniques. The limited exposure to such educational programmes suggested possible gaps in school curricula, community outreach initiatives, and public health interventions targeting water safety awareness. Therefore, the absence of widespread formal education may have contributed significantly to unsafe behaviours and increased susceptibility to water-related injuries within the population.

Furthermore, the table revealed that only 107 respondents (21.4%) reported using safety precautions near water, while a substantial majority of 393 respondents (78.6%) did not adopt any form of safety precaution. This finding demonstrated a very low level of preventive practice among respondents despite the potential dangers associated with water environments. Safety precautions such as wearing life jackets, avoiding deep or fast-flowing water, supervising children, observing warning signs, and avoiding risky recreational activities are essential measures for reducing water-related injuries and fatalities. However, the low utilisation of these precautions suggested that respondents either lacked awareness of protective measures or underestimated the severity of water-related risks. Additionally, socioeconomic limitations, inadequate access to safety equipment, and weak enforcement of water safety regulations may also have contributed to the poor adoption of precautionary practices.

3.7 Logistic Regression Analysis of Predictors of Water-Related Injuries

Table 8: Logistic Regression Analysis of Predictors of Water-Related Injuries

Variable	Adjusted Odds Ratio (AOR)	95% CI	P-value	Interpretation
Environmental Factors				
Exposure to flooding	3.214	1.761–5.864	<0.001*	Flood-exposed adolescents 3.2× more likely to be injured
Presence of open drainage near home	2.538	1.389–4.637	0.002*	Open drainage proximity doubles injury odds
Presence of nearby river/stream	2.763	1.498–5.101	0.001*	Riparian proximity nearly triples injury odds
Unsafe water source	2.341	1.271–4.312	0.006*	Unsafe source use significantly elevates injury risk
Behavioural Factors				
Unsafe water recreation (careless about safety)	3.981	2.036–7.783	<0.001*	Strongest behavioural predictor; nearly 4× injury odds
Playing near rivers/streams	3.127	1.689–5.791	<0.001*	Riparian play triples adjusted odds of injury
Walking through floodwater	2.614	1.402–4.873	0.002*	Floodwater walking more than doubles injury odds
Poor perception/attitudes	2.847	1.534–5.283	0.002*	Attitudinal deficit nearly triples injury odds
Influence of drugs/unsupervised water activities/cooking	3.456	1.847–6.464	<0.001*	Substance influence and supervision absence 3.5× injury odds
Knowledge & Prevention Factors				
Poor water safety knowledge	2.174	1.142–4.138	0.018*	Poor knowledge doubles adjusted odds of injury
No formal water safety education	2.489	1.334–4.643	0.004*	Absence of formal training significantly predicts injury
Non-use of safety precautions near water	2.892	1.561–5.358	0.001*	Failure to use precautions nearly triples injury odds
Poor attitudes toward water safety	2.637	1.418–4.901	0.002*	Negative attitudes more than double injury odds

*Statistically significant at $p < 0.05$ AOR adjusted for age, gender, class level, family type, and household setup category for all variables = absence of the stated risk factor

The figures and analysis showed that behavioural predictors collectively produce the highest AOR values (ranging 2.614–3.981), confirming that modifiable adolescent behaviours are the primary proximal determinants of water-related injury in this population. Environmental factors (AOR 2.341–3.214) are the second most powerful domain, while knowledge and prevention factors (AOR 2.174–2.892), though significant, operate more distally through their influence on behaviour.

3.8 Discussion of the results

The study found prevalence of water-related injuries among in-school adolescents in Ijebu North Local Government Area, with 64.8% reporting at least one injury within the preceding three months. This finding is comparable with the high burden of adolescent injuries reported in Nigeria. Azubuike and Onyemaka (2012), for example, reported a 73.6% prevalence of non-fatal injuries among adolescents in an urban Niger Delta community. Similarly, a recent study among out-of-school adolescents in Ojo Local Government Area, Lagos State, reported a 51.7% prevalence of unintentional injuries (Ayodeji & Salawu, 2026). The higher prevalence observed in the present study may partly reflect its specific focus on water-related injuries and the frequent exposure of adolescents to unsafe water environments. The occurrence of multiple injury episodes among a considerable proportion of respondents further suggests repeated exposure to environmental and behavioural hazards rather than isolated incidents. This interpretation is consistent with evidence that injuries associated with water access and water-related activities remain an under-recognised public health problem in low- and middle-income settings (Venkataramanan et al., 2020).

Slips and falls were the most commonly reported injuries, followed by cuts and lacerations and flood-related injuries. The predominance of falls is consistent with Venkataramanan et al. (2020), who identified falls as the leading mechanism of water-fetching injuries and reported dangerous terrain as a major contextual factor. In the present study, the finding may reflect exposure to wet and slippery surfaces around water sources, drainage channels and other poorly maintained environments. Cuts and lacerations may similarly result from contact with broken materials, sharp objects and debris around water points and flood-prone areas. Flood-related injuries also constituted an important proportion of reported injuries, highlighting the multiple hazards associated with exposure to floodwater, including strong currents, submerged objects, contaminated water and unstable structures. These findings reinforce the need to consider water-related injury prevention within broader environmental health and flood-risk management strategies.

The study also identified musculoskeletal injuries associated with water carrying, as well as injuries arising from conflicts at water points and mechanical hazards associated with water infrastructure. Although these injuries were less frequently reported, they remain important because repeated water carrying can contribute to musculoskeletal discomfort and injury. Evidence from Nigeria and other low-income settings has documented associations between water carriage and musculoskeletal problems, particularly among women and children (Adegbite *et al.*, 2017; Geere *et al.*, 2018). Venkataramanan *et al.* (2020) also identified falls and other physical injuries associated with water collection. These findings indicate that the health consequences of inadequate water access extend beyond infectious diseases and include physical injuries arising from the processes of obtaining and using water. Near-drowning was less frequently reported in the present study, but its potential severity makes it an important prevention priority. WHO (2024) identifies drowning as a major cause of death among children and young people, while evidence from Nigeria suggests substantial underreporting of drowning-related mortality (McKeever & Hossain, 2021).

Furthermore, environmental factors were significant predictors of water-related injuries. Adolescents exposed to flooding, living near rivers or streams, residing close to open drainage systems, or relying on unsafe water sources had higher odds of injury. Flood exposure emerged as an important environmental determinant, consistent with evidence that adverse weather and flooding increase exposure to hazardous water environments. Proximity to rivers and streams may increase opportunities for swimming, bathing, playing, fishing and water collection, particularly where supervision, safety barriers and appropriate recreational facilities are limited. Open drainage systems represent a persistent residential hazard because they may contribute to slips, falls and direct contact with contaminated water. Similarly, reliance on unsafe or off-premise water sources may increase exposure to unstable terrain and hazardous water points. Venkataramanan et al. (2020) found that reliance on surface and off-premise

water sources was associated with water-fetching injuries, supporting the relationship between inadequate water access and physical injury.

Behavioural factors demonstrated particularly strong associations with water-related injuries. Unsafe water recreation, substance use, playing near rivers or streams, poor safety attitudes, failure to use safety precautions and walking through floodwater were significant predictors. These findings indicate that adolescent behaviour is an important proximal determinant of injury risk. Substance use may increase vulnerability through impaired judgement, reduced risk perception and compromised coordination, while recreational activities near rivers and streams increase direct exposure to aquatic hazards. Poor safety attitudes and non-use of precautions may further increase vulnerability by reducing the likelihood of adopting protective behaviours. The finding is consistent with previous Nigerian evidence linking alcohol consumption with adolescent injury experience (Azubuike & Onyemaka, 2012). From a behavioural perspective, the findings also support the importance of addressing risk perception, social norms, supervision and perceived behavioural control in adolescent water-safety interventions.

The study further revealed substantial gaps in water-safety knowledge and preventive practices. A relatively small proportion of adolescents demonstrated good water-safety knowledge, while the majority reported inadequate use of safety precautions and limited exposure to formal water-safety education. This gap is particularly important given the observed association between poor knowledge, inadequate safety education, poor attitudes, non-use of precautions and injury occurrence. The findings suggest that knowledge and behaviour should be addressed together because awareness alone may not necessarily result in safer practices. WHO (2024) emphasises the importance of swimming and water-safety skills, safe environments and other preventive measures as components of effective drowning prevention. Strengthening school-based water-safety education, therefore, provides an important opportunity to improve risk perception, promote safer behaviour and enhance adolescents' ability to respond appropriately to water-related hazards.

Overall, the findings demonstrate that water-related injuries among in-school adolescents in Ijebu North are influenced by interconnected environmental, behavioural and knowledge-related factors. The high injury burden, combined with exposure to unsafe water environments and inadequate preventive practices, indicates that these injuries should be addressed as an important component of adolescent and community public health. The study adds to the limited Nigerian evidence on non-fatal water-related injuries by demonstrating that prevention requires more than individual behavioural change. Improvements in safe water access, drainage and flood-risk management should be complemented by water-safety education, behavioural interventions, community awareness and appropriate injury surveillance. Such integrated measures are essential for reducing preventable water-related injuries among adolescents in Ijebu North and comparable communities.

4. Conclusion

The study concluded that water-related injuries constitute a significant and preventable public health problem among in-school adolescents in Ijebu North Local Government Area, Ogun State, Nigeria. The study established that the occurrence and patterns of these injuries are associated with hazardous environmental conditions and risky water-related behaviours. It further concluded that exposure to flooding, proximity to rivers and streams, open drainage, unsafe water sources, unsafe water recreation, playing near water bodies, and substance use are important factors associated with increased injury risk. The study also established substantial gaps in water-safety knowledge and preventive practices among adolescents, indicating that inadequate knowledge and limited adoption of safety measures may further increase vulnerability to water-related injuries. Generally, the findings demonstrate that adolescent water-related injuries are multifactorial, predictable, and largely preventable through appropriate environmental, behavioural, educational, and public health interventions.

4.1 Recommendation

Based on the findings, the study recommends:

- i. The provision and maintenance of safe and accessible water sources, improvement and covering of drainage systems, strengthening of flood-risk reduction measures, and installation of appropriate safety barriers and warning signs around hazardous water bodies.

- ii. Water-safety education, including drowning prevention, safe swimming, emergency response, and responsible water-related practices, should be integrated into school health programmes and reinforced through community awareness initiatives targeting adolescents, parents, and community leaders.
- iii. School-based interventions should also promote safer behaviours and substance-use prevention. At the policy level, water safety and injury prevention should be integrated into WASH, public health, urban planning, and disaster-risk reduction programmes, supported by routine surveillance of water-related injuries.
- iv. Further research should employ prospective and intervention-based designs and extend investigations to other part of the state especially the riverine communities with local indigenous knowledge to strengthen evidence on causal factors and effective strategies for preventing adolescent water-related injuries.

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References

- [1] Adegbite, A. A., Sikiru, S., & Okanlawon, P. O. (2015). Assessment of water provision and associated risks among children in Abeokuta peri-urban, Ogun State, Southwestern Nigeria: The gender implications. *Wh2O: The Journal of Gender and Water*, 4(1), 73–80.
- [2] Alnaimi, I. A., Yamani, I. A. J., & Alkhatib, A. J. (2026). Children, Water Insecurity, and Environmental Stress: Educational, Social, and Health Implications. *International Journal of Aquatic Research and Environmental Studies*, 6(S1), 762–771.
- [3] Al-Worafi, Y. M. (2024). Injuries: causes in developing countries. In *Handbook of Medical and Health Sciences in Developing Countries: Education, Practice, and Research* (pp. 1–20). Cham: Springer International Publishing.
- [4] AnilKumar, A., & Amit Kumar, P. (2025). The Impact of Heavy Backpacks on Musculoskeletal Pain in School Going Children: A Scoping Review. *Journal of Chemical Health Risks*, 15(6), 2356.
- [5] Archana, C. M., Kanakalakshmi, A., Nithya, K., Kaarunya, E., & Renugadevi, K. (2025). Health effects of emerging contaminants: Effects on humans via ingestion of contaminated water. In *Emerging contaminants in water* (pp. 269–306). Cham: Springer Nature Switzerland.
- [6] Azubuike, S. O., & Onyemaka, E. O. (2012). Epidemiology of non-fatal injuries among adolescents in an urban Niger Delta community of Nigeria. *International Journal of Critical Illness and Injury Science*, 2(3), 180–185. <https://doi.org/10.4103/2229-5151.100936>
- [7] Chabib, L., Nurbillah, A., Lubis, A. A., Batubara, A. W., Purwanti, E., Armi, N., ... & Hamid, M. (2025). Assessment of stream quality and health risks in Indonesian river systems: A social analysis and water quality index approach. *Case Studies in Chemical and Environmental Engineering*, 11, 101200.
- [8] Geere, J. A. L., Cortobius, M., Geere, J. H., Hammer, C. C., & Hunter, P. R. (2018). Is water carriage associated with the water carrier's health? A systematic review of quantitative and qualitative evidence. *BMJ global health*, 3(3), e000764.
- [9] Geere, J. A., Bartram, J., Bates, L., Danquah, L., Evans, B., Fisher, M. B., ... & Hunter, P. 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(1), 010406.
- [10] Irene, J., Irene, B. N., & Daniels, C. (2025). Not a drop to drink: Addressing Nigeria's deepening freshwater crisis. *Water*, 17(12), 1731.
- [11] Jagnoor, J., & Peden, M. (2021). Injuries as global health risk factor: causes, burden, and prevention. In *Handbook of global health* (pp. 823–854). Cham: Springer International Publishing.
- [12] Kanma-Okafor, O. J. (2026). Adolescent Health: A Global Perspective. In *Maternal and Child Health, Vol. 3: Global Challenges, Programs, and Policies* (pp. 197–228). New York, NY: Springer US.
- [13] Ködmön, Z. (2026). Mapping the Climate–Water–Health Nexus Across African Climatic Regions (2000–2020). *Water*, 18(7), 767.
- [14] Lee, J., Perera, D., Glickman, T., & Taing, L. (2020). Water-related disasters and their health impacts: A global review. *Progress in Disaster Science*, 8, 100123.
- [15] Logie, C. H., Hasham, A., Kagunda, J., Evelia, H., Pellatt, A., Gachoki, C., ... & Gittings, L. (2025). Young adolescent recommendations for advancing water, food, and sanitation security in Kenya: Qualitative insights. *Preventive Medicine Reports*, 103325.

- [16] MacAllister, D. J., Fallas, H., MacDonald, A. M., Kebede, S., Mkandawire, T., Mwathunga, E., Owor, M., & Whaley, L. (2021). *Determinants of hand-pumped borehole functionality: Preliminary evidence from Ethiopia, Malawi and Uganda*. Proceedings of the 42nd WEDC International Conference: Equitable and Sustainable WASH Services: Future Challenges in a Rapidly Changing World. Water, Engineering and Development Centre (WEDC), Loughborough University.
- [17] Matchawe, C., Bonny, P., Yandang, G., Mafo, H. C. Y., & Nsawir, B. J. (2022). Water shortages: Cause of water safety in sub-Saharan Africa. *Drought-impacts and management*.
- [18] Mckeever, A., & Hossain, S. (2021). 6B. 003 Underreporting of drowning in Nigeria: A retrospective survey of national newspaper reports. *Injury Prevention*, 27(Suppl 2), A51-A51.
- [19] Mensah, C. M. (2024). Children's rights and the Sustainable Development Goals. In *International children's rights: International and comparative children's rights; Human rights–children's rights* (pp. 279–312). Central European Academic Publishing.
- [20] National Emergency Management Agency. (2024). *Flood dashboard 2024*. <https://nema.gov.ng/flood-alert-2024/>
- [21] O'Donnell, E. P., & Canares, T. L. (2021). Accidents waiting to happen: a review of unintentional household injuries in children. *Pediatrics in review*, 42(3), 109-122.
- [22] Olufemi, A. C., Mji, A., & Mukhola, M. S. (2022). Potential health risks of lead exposure from early life through later life: implications for public health education. *International journal of environmental research and public health*, 19(23), 16006.
- [23] Rhue, S. J., Torrico, G., Amuzie, C., Collins, S. M., Lemaitre, A., Workman, C. L., ... & Stoler, J. (2023). The effects of household water insecurity on child health and well-being. *Wiley Interdisciplinary Reviews: Water*, 10(6), e1666.
- [24] Tallman, P. S., Collins, S., Salmon-Mulanovich, G., Rusyidi, B., Kothadia, A., & Cole, S. (2023). Water insecurity and gender-based violence: A global review of the evidence. *Wiley Interdisciplinary Reviews: Water*, 10(1), e1619.
- [25] Vanderwal, L., Rautiainen, R., Kuye, R., Peek-Asa, C., Cook, T., Ramirez, M., ... & Donham, K. (2011). Effectiveness, Safety, and Sustainability of a hand water pump among women vegetable farmers in the Gambia. *Journal of sustainable agriculture*, 35(4), 394-407.
- [26] Venkataramanan, V., Geere, J. A. L., Thomae, B., Stoler, J., Hunter, P. R., Young, S. L., & aa. (2020). In pursuit of 'safe'water: the burden of personal injury from water fetching in 21 low-income and middle-income countries. *BMJ global health*, 5(10), e003328.
- [27] Victor, C., Kupoluyi, J. A., Oyinlola, F. F., & Sule, V. O. (2025). Prevalence and factors associated with water, sanitation and hygiene (WASH) facilities deprivation among children in Nigeria. *BMC pediatrics*, 25(1), 102.
- [28] World Health Organization. (2024). *The adolescent health indicators recommended by the Global Action for Measurement of Adolescent Health: Guidance for monitoring adolescent health at country, regional and global levels*. World Health Organization.
- [29] World Health Organization. (2026). *Adolescent health*. [World Health Organization – Adolescent Health](https://www.who.int/adolescent-health)