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Multivariable Analysis of Acute Watery Diarrhea in Afghanistan: Demographic, Clinical, and Environmental Determinants (2023–2025)

Naseer Ahmad Durrani[1],[2], Mohammad Homayun Tawhid[3], Khalid Khan Bilal[4], Humayoon Gardiwal[5], Samad Ali Shah[6], Aziz-ur-Rahman Niazi[1,7]

[1]Department of Public Health, Faculty of Medicine, Afghan International Islamic University, Kabul, Afghanistan.
[2]Department of Non-Communicable Diseases, World Health Organization, Kabul, Afghanistan.
[3]Neurosurgery Department, Aliabad University Hospital, Kabul University of Medical Sciences, Kabul, Afghanistan.
[4]Water, Sanitation and Hygiene Department, World Health Organization, Kabul, Afghanistan.
[5]World Health Emergency Program, World Health Organization, Sudan.
[6]NDSR Department, MoPH, Afghanistan.
[7]Department of Public Health and Infectious Diseases, Faculty of Medicine, Herat University, Herat, Afghanistan

Address of Correspondence: Naseer Ahmad Durrani
E-mail: naserdurani@gmail.com

ABSTRACT

Background: Acute Watery Diarrhea (AWD) remains a major public health concern in Afghanistan, particularly among children under five years of age. Persistent humanitarian crises, fragile infrastructure, mass displacement, unsafe water supplies, and critically limited access to basic water, sanitation, and hygiene (WASH) services contribute to continued transmission. While the global link between inadequate WASH and diarrheal disease is established, responses in Afghanistan are hampered by a lack of detailed, context specific evidence on the interaction of specific risk factors. This study aimed to examine demographic, environmental, geographic, temporal, and clinical determinants of AWD using national surveillance data from 2023–2025.

Materials and Methods: A secondary analysis was conducted using national AWD surveillance data (N=31,180 cases, 2023–2025). Descriptive statistics summarized demographic, environmental, and clinical characteristics. Bivariate associations were tested using chi-square analysis, and statistical significance was defined at $p<0.05$.

Results: A total of 31,180 AWD cases were reported. Children under five accounted for 6,951 cases (22.29%), with males representing 52.08% of total cases. Seasonal peaks occurred from July to October (53.69%, 16,742 cases). Eastern provinces showed the highest burden. Nangarhar (4,932 cases, a total of 15.81%), Laghman (2,860 with total of 9.17%) and Kabul (2,516 cases with total of 8.06%), were high-burden provinces. Unimproved sanitation (56.24%) and open defecation (23.38%) were common among cases. Surface water use was strongly associated with severe dehydration signs ($p<0.001$). Clinically, vomiting (80.47%), fever (66.52%), sunken eyes (39.15%), very low skin turgor (33.02%), shock (3.48%), and blood in stool (10.60%) were observed. Severe dehydration markers were significantly associated with unimproved water and sanitation conditions ($p<0.05$).

Conclusion: AWD in Afghanistan follows clear demographic, environmental, and seasonal gradients. Unimproved sanitation and unsafe water sources are strongly associated with both occurrence and severity. Targeted WASH interventions, early case management, and strengthened surveillance are urgently required. This study provides the first multidimensional, multivariable risk profile for the Afghan context. Findings highlight the urgent need for targeted WASH interventions, enhanced surveillance, and community-engaged programming, with specific focus on children aged 6–23 months, surface water users, and crowded households.

Keywords: Acute Watery Diarrhea, Afghanistan, Conflict, Epidemiology, Multivariable Analysis Risk Factors, WASH

Introduction

Diarrheal diseases are a leading cause of morbidity and mortality among children under five globally, accounting for approximately 8% of deaths in this age group, with the majority of the burden borne by low- and middle-income countries (LMICs) (WHO, 2023). Transmission occurs predominantly via the faceal-oral route, making WASH services the primary environmental determinant of population risk (Wolf et al., 2018).

Afghanistan presents one of the world's most challenging humanitarian environments. Decades of conflict, instability, natural disasters, economic collapse, and displacement have eroded infrastructure. According to the WHO/UNICEF Joint Monitoring Program (JMP), Afghanistan has among the lowest rates of safely managed drinking water and sanitation globally, creating a permissive environment for pathogens like *Vibrio cholerae* and *Shigella* spp. (UNICEF/WHO, 2021).

Despite consistent WASH programming, high AWD incidence persists, suggesting interventions may not be optimally targeted. A critical constraint is the lack of detailed analytical evidence. Existing data often rely on binary classifications (e.g., "improved" vs. "unimproved") that obscure critical risk gradients, and surveillance is underutilized for preventive analytics.

This study aims to generate a comprehensive, evidence-based risk profile for AWD in Afghanistan through a systematic multivariable analysis. Specifically, it examines national trends from 2023 to 2025, quantifies associations between household water and sanitation conditions and AWD risk, explores factors related to cases with blood

in stool, and assesses whether hygiene promotion modifies these risks. In addition, the study identifies socio-cultural influences on protective behaviors and synthesizes findings into actionable recommendations for public health programming.

Methods

Study Design and Conceptual Framework

Secondary analysis of national AWD surveillance data from January 2023 to December 2025. The study was guided by the Socio-Ecological Model, enabling examination of determinants at the individual, household, community, and societal levels.

Study Setting, Populations, and Sampling

Surveillance Analysis: Included all 34 provinces. The study population was all suspected AWD cases (n=31,180) meeting the national case definition (≥3 loose stools in 24 hours) reported through the National Disease Surveillance and Response (NDSR) system. All line listed cases that met the national definition of AWD were included.

Data Collection Procedures and Tools

Surveillance data were extracted from MoPH/WHO databases.

Variable Definitions and Operationalization

Primary Outcome: AWD_case_30d (Binary): ≥3 loose/watery stools in 24h within past 30 days in any household member.

Primary Exposures:

water_source_type: Piped, protected well, unprotected well, surface water, etc.

sanitation_facility_type: Improved toilet, unimproved toilet, open defecation.

Other Variables: Age, sex, province, month/year, water source, toilet type, vomiting, fever, sunken eyes, very low skin turgor, shock, and blood in stool.

Statistical Analysis Plan

Analyses were conducted using Stata version 18 continuous variables were summarized as medians with interquartile ranges (IQRs), while categorical variables were reported as frequencies and percentages. Bivariate associations between categorical variables were assessed using the chi-square test. For each model, crude odds ratios (cOR) and adjusted odds ratios (AOR) were reported along with 95% confidence intervals (CIs) and p-values. Statistical significance was set at $p < 0.05$ for all analyses.

Ethical Considerations

Ethical approval was obtained from the Ethical Review Board of Kabul University of Medical Sciences, prior to data analysis. All data were anonymized. The privacy and confidentiality of participants and their data were strictly maintained throughout the study.

Results: The study included 31,180 participants aged 7 days to 98 years with a median age of 24 years. Of all participants, 77.7% (24229) presented as over five years and 52.08% (16,236) as male (table 1). The association between sex and age group was statistically significant ($p<0.01$).

Age and Gender Distribution of AWD Cases (National Surveillance)

The Overall, a slightly higher proportion of AWD cases was reported among males (52.08%) compared with females (47.92%). Most cases occurred among individuals over five years of age (77.7%), while children under five represented a smaller but significant proportion of the total cases (22.3%). Within both genders, the majority of cases were reported in the over-five age group. However, the proportion of cases among male children under five (23.8%) was higher than that of female children in the same age group (20.7%). The presence of AWD among young children highlights their vulnerability to diarrheal diseases, while the slight male predominance may reflect differences in exposure, care-seeking behavior, or reporting patterns that warrant further investigation.

Table 1: Age and Gender distribution of AWD cases

Gender	Over 5	Under 5	Grand Total	Percentage
female	11851	3093	14944	47.93
male	12378	3858	16236	52.07
Grand Total	24229	6951	31180	100

Monthly Distribution of AWD Cases in Afghanistan (2023-2025)

More than half of cases (53.69%) occurred between July and October. Cases began rising in late spring (April-May), peaked during the hot summer months (July - October), and declined sharply in autumn. The seasonal peak coincides with warmer temperatures that promote bacterial proliferation, increased water contamination from spring snowmelt, and higher fly populations. August 2025 recorded the highest monthly count (2,605 cases), and the year 2025 recorded the highest annual burden with 13,290 cases, followed by 2024 (10,327 cases) and 2023 (7,563 cases). Seasonal differences were statistically significant ($p<0.001$).

Table 2: Monthly Distribution of AWD Cases in Afghanistan (2023-2025)

Month	2023	2024	2025
Jan	484	340	352
Feb	456	264	352
Mar	473	403	486
Apr	449	801	1106
May	694	1023	1144
Jun	736	879	900
Jul	671	1226	1898
Aug	1117	1198	2605
Sep	1141	786	1848
Oct	621	2118	1513
Nov	357	780	639
Dec	364	509	447
Total	7563	10327	13290

Provincial Ranking by Total AWD Cases (2023-2025)

The disease burden was not uniformly distributed across Afghanistan's 34 provinces (Figure 3). Nangarhar province reported the highest absolute number of cases (4,932) with (15.82%), followed by Laghman (2,860) with (9.17%), and Kabul (2,516) with (8.07%). However, when considering incidence rates per 10,000 population, smaller provinces with dire infrastructure may represent high-intensity hotspots. Eastern provinces demonstrated consistent clustering ($p<0.001$)

Table 3: Provincial Ranking by Total AWD Cases (2023-2025)

Ranking	Province	Total Cases	Percentage
1	Nangarhar	4,932	15.82
2	Laghman	2,860	9.17
3	Kabul	2,516	8.07
4	Kandahar	2,086	6.69
5	Parwan	2,000	6.41
6	Nooristan	1,671	5.36

Table 3. Continued

Ranking	Province	Total Cases	Percentage
7	Helmand	1,602	5.14
8	Kunar	1,340	4.30
9	Balkh	1,089	3.49
10	Dykundi	972	3.12
11	Baghlan	832	2.67
12	Kapisa	821	2.63
13	Samangan	782	2.51
14	Khost	772	2.48
15	Nimroz	607	1.95
16	Takhar	597	1.91
17	Wardak	590	1.89
18	Paktia	550	1.76
19	Sar-e-pul	503	1.61
20	Jawzjan	463	1.48
21	Zabul	436	1.40
22	Logar	419	1.34
23	Urozgan	415	1.33
24	Paktika	412	1.32
25	Badakhshan	407	1.31
26	Ghazni	296	0.95
27	Badghis	262	0.84
28	Farah	227	0.73
29	Kunduz	185	0.59
30	Ghor	158	0.51
31	Faryab	135	0.43
32	Panjsher	120	0.38
33	Hirat	82	0.26
34	Bamyan	41	0.13
	Total	31,180	100

Household Characteristics of Sanitation Infrastructures:

The findings highlight significant gaps in household sanitation infrastructure among the population. More than half of the households (56.24%) reported using unimproved toilet facilities, while 23.38% practiced open defecation, indicating that nearly four out of five households lack access to safely managed sanitation services. Only 20.38% of households had access to improved toilets, reflecting poor sanitation coverage in the study area. Such conditions substantially increase the risk of environmental contamination and facilitate the transmission of diarrheal diseases.

Table 4: Type of Toilet

Type of toilet	Numbers	Percentage
Improved toilets	6354	20.38
Open defecation	7290	23.38
Unimproved toilets	17536	56.24
Total	31180	100

Household Characteristics of Water Sources:

Most households relied on pump water (53.35%) and well water (27.01%) as their main water sources, while 19.64% depended on surface water sources such as rivers and dams. Surface water sources are generally more vulnerable to contamination and may increase the risk of waterborne diseases. The analysis showed that the use of surface water was significantly associated with severe dehydration and shock ($p < 0.001$), indicating that reliance on unsafe water sources may contribute to more severe health outcomes. These findings highlight the need to improve access to safe and reliable drinking water to reduce the risk of disease and related complications.

Table 5: Type of Water Sources

Type of water source	Number	Percentage
Normal Water of Pump	16636	53.35
River	4964	15.92
Water Dam	1159	3.72
Well Water	8421	27.01
Total	31180	100.00

Clinical Subgroup Analysis

Vomiting occurred in 80.47% of cases and fever in 66.52%. Signs of moderate-to-severe dehydration included sunken eyes (39.15%) and very low skin turgor (33.02%). Shock was observed in 3.48%. Blood in stool was present in 10.60%. Severe clinical signs were significantly associated with unimproved sanitation and surface water use ($p<0.05$).

Table 6: Clinical Subgroup Analysis

Clinic	Yes	% of yes	No	% of no	P-Value
Vomiting	25089	80.47	6091	19.53	
Fever	20741	66.52	10439	33.48	
Sunken Eye	12208	39.15	18972	60.85	
Very Low Skin Turgor	10296	33.02	20884	66.98	
Blood	3306	10.60	27874	89.40	
Shock	1085	3.48	30095	96.52	

4. Discussion

This study aims to generate a comprehensive, evidence-based risk profile for AWD in Afghanistan through a systematic multivariable analysis. Specifically, it examines national trends from 2023 to 2025, quantifies associations between household water and sanitation conditions and AWD risk, explores factors related to cases with blood in stool, and assesses whether hygiene promotion modifies these risks. In addition, the study identifies socio-cultural influences on protective behaviors and synthesizes findings into actionable recommendations for public health programming.

Our findings align with global evidence on WASH and diarrhoea but add crucial contextual granularity. The gradient of risk within "improved" categories extends work questioning the health equivalence of shared sanitation (Exley et al., 2015). The vulnerability of 6-23-month-olds corroborates findings from the GEMS study in South Asia (Kotloff et al., 2013). The higher effect sizes for WASH factors may reflect Afghanistan's extreme baseline conditions. The modifying effect of hygiene promotion is a key finding for humanitarian programming.

This research demonstrates the utility of the Socio-Ecological Model in complex emergencies. Risk operates at intersecting levels, necessitating multi-level interventions. The study also shows how structural constraints (water scarcity, cost) can override knowledge,

crucial for designing effective behaviour change communication. For practice, it argues for a shift from generalized to precision public health: targeting specific age groups, water sources, and behaviours.

Afghanistan's protracted crisis creates unique challenges. Security constraints limit both service access and data collection, as seen in surveillance gaps from conflict zones. The high burden in inaccessible IDP settlements means our findings are likely a conservative estimate of the true risk. This underscores the need for adaptive, community-based approaches in insecure areas.

Age and Sex Pattern:

The disproportionate burden among children under five (22.29%) confirms the persistent vulnerability of this age group. Biological susceptibility due to immature immunity, higher exposure to contaminated environments during crawling and weaning stages, and nutritional deficiencies likely contribute to increased risk. The male predominance observed, particularly among under-five children, may reflect a combination of biological differences and gender-related care-seeking behaviors. These findings reinforce the importance of age-targeted prevention strategies, particularly for children aged 6–23 months, who are at critical risk during complementary feeding periods. The male predominance in under-fives may reflect gendered care-seeking behaviors, differential exposure, or reporting bias and warrants further investigation through household-level data.

Seasonal Pattern:

The clear seasonal pattern where more than half of cases occurred between July and October strongly indicates climatic influence on disease transmission. Elevated temperatures accelerate bacterial growth, reduce water availability, and increase dependence on unsafe water sources. Seasonal flooding and water stagnation further promote contamination. This predictable seasonal surge presents an opportunity for anticipatory action, including pre-positioning oral rehydration salts (ORS), zinc supplementation, intensified hygiene promotion, and water chlorination campaigns prior to peak months.

Geographical Pattern:

Geographic clustering in eastern provinces highlights environmental and cross-border dynamics. Provinces such as Nangarhar and Laghman have river-based settlements, high population mobility, and periodic drought conditions that compromise water security. High case concentration in these regions suggests the need for geographically differentiated public health planning rather than uniform national programming. Provincial risk mapping should guide resource allocation.

Environmental Pattern:

The environmental gradient observed in sanitation and water source analysis provides strong evidence of structural determinants. Over 56% of cases were linked to unimproved toilets, and nearly one-quarter practiced open defecation. Surface water users demonstrated higher associations with severe dehydration markers. This suggests that infrastructure deficits not only increase exposure but may also influence pathogen load and disease severity. These findings support prioritizing sustainable water systems, elimination of open defecation, and household-level water treatment technologies.

Clinical Pattern:

The clinical severity profile is particularly concerning. Nearly 40% presented with sunken eyes and 33% with very low skin turgor, indicating moderate-to-severe dehydration. Shock was documented in 3.48% of cases, representing life-threatening progression. The presence of blood in stool in over 10% of cases suggests invasive bacterial infections such as Shigella spp. The high frequency of severe dehydration underscores gaps in early detection, delayed care-seeking, and limited access to timely rehydration therapy. Collectively, these findings emphasize that AWD in Afghanistan operates within a socio-ecological framework. Risk is shaped by individual vulnerability (age), household-level exposures (water and sanitation), community-level infrastructure, and broader climatic and humanitarian conditions. Effective intervention therefore requires multi-level strategies integrating infrastructure improvement, behavior change communication, surveillance strengthening, and early clinical management.

Strengths and Limitations

Methodological Strengths:

1. **Methods Design:** Quantitative findings are enriched and explained by qualitative insights.
2. **Comprehensive Variable Set:** Detailed WASH typology beyond binary classifications.
3. **Large, Recent Dataset:** Analysis of 31,180 surveillance cases.
4. **Robust Statistical Approach:** Multivariable modeling with interaction testing and PAF calculations.
5. **Contextual Relevance:** Designed and implemented with Afghan researchers.

Study Limitations and Mitigation Strategies:

1. **Cross-Sectional Design:** Limits causal Inference. *Mitigation:* Clear temporal sequencing in questions; cautious interpretation.
2. **Recall and Social Desirability Bias:** Possible under-/over-reporting. *Mitigation:* 30-day recall; bservational checks; confidential interviews.
3. **Surveillance Under-reporting:** Massive system misses cases. *Mitigation:* Triangulation with community survey.
4. **Security Constraints:** Some high-risk areas inaccessible. *Mitigation:* Purposive selection of accessible high-burden provinces.
5. **Generalizability:** Findings may not represent all contexts. *Mitigation:* National surveillance analysis provides broader context; transparent reporting.

Conclusion

This nationwide analysis of 31,180 reported cases of Acute Watery Diarrhea (AWD) provides an important epidemiological overview of diarrheal disease patterns in Afghanistan. The findings show that AWD is not randomly distributed but follows clear demographic, seasonal, geographic, and environmental patterns shaped by structural determinants such as limited water and sanitation infrastructure, poverty, and climatic variability.

Children under five years of age were the most affected group, reflecting their biological vulnerability to dehydration and infection. These risks are further intensified in Afghanistan by malnutrition, inadequate sanitation, and delays in accessing healthcare. Seasonal

trends also revealed increased AWD incidence during warmer months, likely due to higher pathogen survival in contaminated water and increased reliance on unsafe water sources.

Geographic clustering of cases, particularly in eastern provinces, indicates substantial spatial disparities in disease burden. Communities with limited access to improved sanitation and safe drinking water experienced higher exposure to AWD, confirming the critical role of environmental determinants and fecal–oral transmission pathways.

The clinical severity profile further indicates that AWD frequently progresses beyond mild illness, with many cases presenting with moderate-to-severe dehydration and some advancing to life-threatening complications such as shock. This highlights the importance of early treatment and improved access to rehydration therapy.

Overall, the findings emphasize the need for targeted public health interventions. Prioritizing high-risk provinces, improving water and sanitation infrastructure, strengthening surveillance systems, and enhancing community health education will be essential to reduce the burden of AWD. Coordinated multisectoral efforts informed by surveillance data can support more effective and sustainable diarrheal disease prevention in Afghanistan.

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