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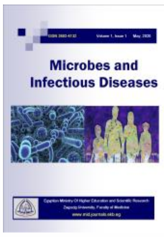

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Original article

The impact of age on cholera severity: a comparative study of pediatric and adult cases reported in 2023 in Banadir Hospital, Somalia

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ABSTRACT

Background: Despite ongoing outbreaks, no comprehensive study has been conducted in Somalia to assess the influence of age on cholera severity. This study compared the severity of cholera between pediatric and adult patients at Banadir Hospital, Somalia, in 2023. **Methods:** A retrospective observational study was conducted to analyze the records of 3,559 cholera cases reported at the Banadir Hospital from January to December 2023. The patients were stratified into four age categories (<1 year, 1–5 years, 5–18 years, and >18 years). Data on demographics, clinical presentations, and laboratory results were collected. Statistical analyses, including Pearson's chi-squared and Kruskal-Wallis tests, were performed to assess age-based differences, with the significance set at $p<0.05$. **Results:** Young children (1–5 years) represented the largest proportion of cases (37%), followed by infants (<1 year old, 27%). Sex distribution revealed a higher prevalence of females among infants, while older age groups were predominantly male ($p<0.001$). Severe dehydration occurred uniformly across all age groups, but laboratory-confirmed *Vibrio cholerae* was significantly higher in the 5–18 years category (54%, $p<0.001$). Notably, none of the patients received an oral cholera vaccine, highlighting a critical gap in preventive measures. **Conclusions:** Cholera predominantly affects young children in Somalia, with varying sex- and age-specific vulnerabilities. The absence of vaccination underscores the need for enhanced public health measures including targeted vaccination campaigns and hygiene education. Age- and gender-sensitive strategies are crucial for mitigating the impact of cholera, particularly in endemic regions such as Somalia.

Introduction

Vibrio cholerae bacteria, specifically the O1 or O139 serogroups, are responsible for cholera, a severe diarrheal illness [1]. This disease presents a significant global health issue, particularly in low- and middle-income nations where adequate water, sanitation, and hygiene facilities are often lacking. Annually, cholera is estimated to affect 1.3 to 4 million individuals worldwide, resulting in 21,000 to 143,000 fatalities. While primarily spread through contaminated water, the disease can also be transmitted via tainted food and, less frequently, direct interpersonal contact [2-4].

Cholera typically manifests as acute watery diarrhea, which can rapidly lead to dehydration and, if left untreated, death within hours [5]. However,

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the condition is treatable, with most cases responding favorably to timely administration of oral rehydration solution (ORS) [6]. Effective prevention strategies include ensuring potable water, promoting food safety and hygiene, and utilizing Oral Cholera Vaccines (OCVs) (3). Since 2023, 14 countries in Eastern and Southern Africa have reported over 230,000 cases and 4,000 deaths, with the World Health Organization (WHO) currently designating six of these nations as experiencing an 'acute crisis'[7]. In 2017, the WHO initiated the 'Ending Cholera: A Global Roadmap to 2030' campaign, aiming to decrease cholera-related mortality by 90% [8]. Sub-Saharan Africa remains one of the most severely affected regions, with more than 140,000 cases occurring annually in both endemic and epidemic settings [9].

Somalia has experienced endemic cholera with recurrent outbreaks since 2017. From January to July 2022, 7,796 cases and 37 related deaths (a 0.5% case fatality ratio) were documented in drought-affected districts [10]. By early 2024, the outbreak persisted, with Health Cluster reports indicating 474 cases and nine deaths in a single week [11]. Despite the well-documented overall impact of cholera, limited research has examined how age influences disease severity in endemic areas such as Somalia. This study aims to investigate the comparative severity of cholera between pediatric and adult cases reported at Banadir Hospital in 2023.

Materials and Methods

Study Design and Setting

A retrospective observational investigation was conducted at Banadir Hospital, a primary public healthcare facility in Mogadishu, Somalia, which serves as a cholera referral center. The research examined data from all cholera-related admissions between January and December 2023.

Study Population

The investigation encompassed 3,559 patients clinically diagnosed with cholera, as defined by World Health Organization (WHO) criteria: acute watery diarrhea with or without dehydration. Patients were stratified into four age categories: under 1 year, 1-5 years, 5-18 years, and over 18 years. Cases with incomplete demographic or clinical information were excluded.

Data Collection

Hospital records were reviewed utilizing a standardized data extraction form. Collected information included demographic details (age, gender, and geographic origin), clinical characteristics (dehydration severity, presence of rice-water diarrhea, frequency of vomiting, and laboratory confirmation of *Vibrio cholerae*), and treatment outcomes (discharge status and oral cholera vaccine administration).

Variables

Independent Variables:

Age category, gender, geographic origin.

Dependent Variables:

Dehydration severity, laboratory confirmation, clinical manifestations (diarrhea and vomiting), and treatment outcomes.

Laboratory Testing

Cholera confirmation was performed through stool culture and rapid diagnostic tests (RDT) for *Vibrio cholerae*. Results were classified as either positive or negative for *Vibrio cholerae* O1 Ogawa.

Data Analysis

The data underwent descriptive and inferential statistical analysis. Frequencies and percentages were utilized to present categorical variables, while means and standard deviations summarized continuous variables. Age group comparisons employed Pearson's chi-squared test for categorical variables and the Kruskal-Wallis test for continuous variables. Statistical significance was established at $p<0.05$.

Ethical Considerations

The Ethics Review Board of Banadir Hospital granted ethical approval. Patient privacy was safeguarded by anonymizing data during collection and analysis. Given the retrospective nature of the study utilizing routine hospital data, individual informed consent was not required.

Results

Age-wise comparison of demographic and clinical outcomes

Findings reveal significant age-based differences in gender distribution, with females predominantly represented among infants, while older age groups show a higher proportion of male cases ($p < 0.001$). Geographic analysis indicates that the majority of cases come from Banadir, with Lower Shabelle showing age-related variability. Dehydration severity and vomiting frequency are consistent across age groups, while all cases present rice-water diarrhea. Notably, laboratory-confirmed

Vibrio cholerae is significantly higher in the 5-18 years age group (54%) ($p < 0.001$). All patients were discharged without the administration of the oral cholera vaccine, highlighting a gap in preventive measures. These insights emphasize the importance of age-specific strategies for cholera prevention and treatment in this population.

Table 1. Age-wise comparison of demographic and clinical outcomes.

Character		**<1 year**	**>18 years**	**1-5 years**	**5-18 years**	**p-value**[2]
	N = 3,559[1]	N = 950[1]	N = 856[1]	N = 1,320[1]	N = 433[1]	
Gender						
Female	1,884 (100%)	420 (22%)	638 (34%)	577 (31%)	249 (13%)	<0.001
Male	1,675 (100%)	530 (32%)	218 (13%)	743 (44%)	184 (11%)	
Governorate						
Banadir	3,305 (100%)	875 (26%)	810 (25%)	1,217 (37%)	403 (12%)	
Hiran	1 (100%)	0 (0%)	0 (0%)	0 (0%)	1 (100%)	
Lower Shabelle	235 (100%)	73 (31%)	43 (18%)	93 (40%)	26 (11%)	
lower Shabelle	9 (100%)	1 (11%)	0 (0%)	7 (78%)	1 (11%)	
Middle Shabelle	9 (100%)	1 (11%)	3 (33%)	3 (33%)	2 (22%)	
Degree of Dehydration						
Mild/Moderate/Some	2,474 (100%)	648 (26%)	606 (24%)	916 (37%)	304 (12%)	0.7
Severe	1,085 (100%)	302 (28%)	250 (23%)	404 (37%)	129 (12%)	
Vomiting						
Yes	3,431 (100%)	914 (27%)	819 (24%)	1,277 (37%)	421 (12%)	0.8
No	0	0	0	0	0	
Vomiting Frequency	2.98 (1.39)	2.97 (1.36)	3.00 (1.45)	2.98 (1.35)	2.95 (1.47)	0.7
Rice Watery Diarrhea						
Yes	3,559 (100%)	950 (27%)	856 (24%)	1,320 (37%)	433 (12%)	
No	0	0	0	0	0	
Rice Watery Diarrhea	4.55 (1.70)	4.46 (1.71)	4.68 (1.87)	4.50 (1.61)	4.60 (1.56)	0.069
Blood in stool						
No	3,559 (100%)	950 (27%)	856 (24%)	1,320 (37%)	433 (12%)	0.011
Fever	3,440 (100%)	928 (27%)	833 (24%)	1,259 (37%)	420 (12%)	
Other						
Oriented	3,559 (100%)	950 (27%)	856 (24%)	1,320 (37%)	433 (12%)	
Test Performed						
RDT	3,559 (100%)	950 (27%)	856 (24%)	1,320 (37%)	433 (12%)	
Laboratory results						
Negative	3,416 (100%)	935 (27%)	831 (24%)	1,243 (36%)	407 (12%)	<0.001
Positive	143 (100%)	15 (10%)	25 (17%)	77 (54%)	26 (18%)	
Bacteria/Culture						
Negative	3,394 (100%)	932 (27%)	825 (24%)	1,235 (36%)	402 (12%)	<0.001
Vibrio cholerae 01 Ogawa	165 (100%)	18 (11%)	31 (19%)	85 (52%)	31 (19%)	
Outcome						
Discharged	3,559 (100%)	950 (27%)	856 (24%)	1,320 (37%)	433 (12%)	
OCV Given Y/N						
No	3,559 (100%)	950 (27%)	856 (24%)	1,320 (37%)	433 (12%)	
[1] n (%); Mean (SD)						
[2] Pearson's Chi-squared test; Kruskal-Wallis rank sum test						

Figure 1. The gender distribution of cholera cases across different age groups reported at Banadir Hospital, Somalia, in 2023. Notably, female cases predominate in the adult (>18 years) and older children (5-18 years) categories, suggesting potential gender-specific vulnerabilities or exposure factors within these groups. In contrast, infants (<1 year) and young children (1-5 years) exhibit a more balanced gender distribution, indicating that cholera affects both genders similarly at these ages. These findings underscore the importance of age- and gender-sensitive public health strategies to address cholera's impact effectively in this population.

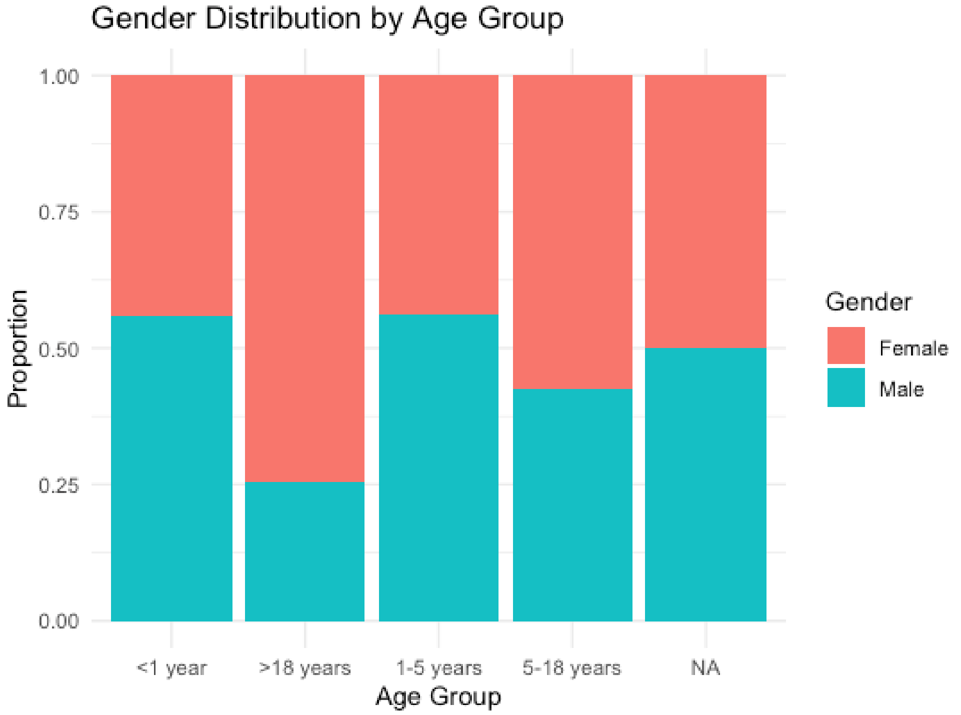
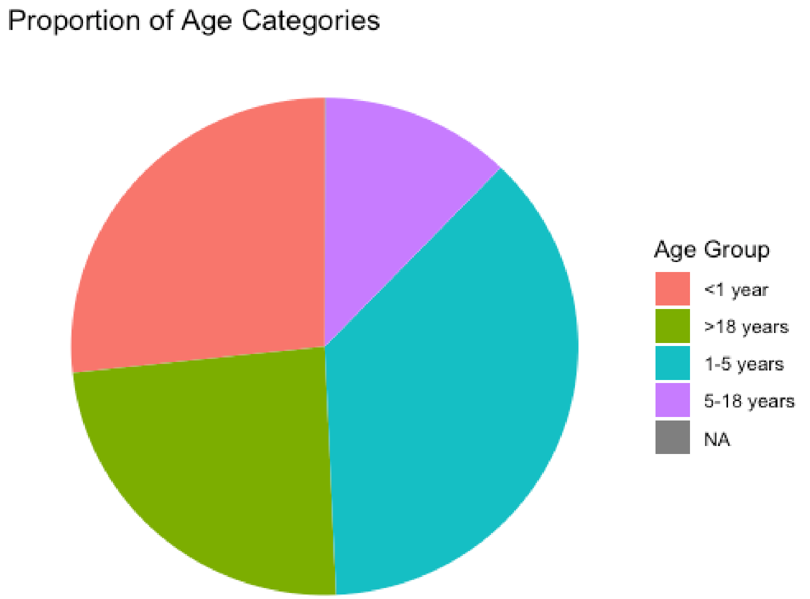


Figure 2. The age group with the largest proportion of cholera cases is children aged 1-5 years, followed closely by infants (<1 year), indicating that young children represent a significant portion of the cases. Adults (>18 years) and older children (5-18 years) have relatively smaller shares, with the latter being the least represented group among those with reported ages. A small segment corresponds to cases with unreported ages (NA). This distribution highlights the elevated vulnerability of young children to cholera in this population, underscoring the need for targeted interventions for pediatric age groups.



Discussion

This study elucidates the age-specific and gender-specific trends in cholera cases treated at Banadir Hospital, Somalia, in 2023. Cholera remains a significant public health challenge in Somalia, particularly in urban and semi-urban areas with inadequate sanitation and limited access to potable water [12, 13]. The findings from this study contribute to the understanding of cholera's impact on different demographic groups and underscore the necessity for targeted public health interventions.

One of the most salient findings in this study is the substantial gender disparity in cholera cases across age groups. Females are more prevalent among infants (<1 year), while males exhibit increased proportions in older age groups. Previous studies have observed similar gender-based differences, often attributing these to behavioral and social factors that influence exposure risks [14, 15]. For instance, social roles and caregiving practices may lead to higher cholera exposure in young female children, while older males may encounter cholera risk through occupational or recreational activities [16]. This suggests that public health efforts should consider such gender-based exposure patterns to ensure that interventions are tailored effectively.

The geographic distribution indicates that the majority of cholera cases are concentrated in Banadir, with smaller but significant cases reported from Lower and Middle Shabelle. This pattern is consistent with previous research, which highlights urban centers as hotspots for cholera outbreaks due to population density and inadequate sanitation [17, 18]. Lower Shabelle's variability across age groups may reflect localized risk factors or differences in healthcare accessibility, which are critical to understand for effective intervention strategies [19].

Clinical outcomes, including dehydration severity, vomiting frequency, and rice-water diarrhea, were similar across age groups. This aligns with established cholera symptoms reported in endemic regions [20, 21]. The slightly higher frequency of rice-water diarrhea among young children (1-5 years) is consistent with findings that young children often experience more severe cholera symptoms, necessitating rapid rehydration and medical attention [22, 23]. Given that severe dehydration remains a primary cause of cholera-related mortality, early intervention in pediatric cases is essential to reduce fatal outcomes.

The higher rate of laboratory-confirmed *Vibrio cholerae* in the 5-18 years age group is noteworthy. This trend could indicate that older children and adolescents face unique risk factors, potentially due to age-specific behaviors such as attending school with inadequate sanitation or engaging in activities that expose them to contaminated environments [24, 25]. These findings underscore the importance of targeted hygiene education and cholera awareness programs in schools and youth centers to reduce infection risks.

Although oral cholera vaccines (OCV) have demonstrated efficacy in mitigating cholera transmission and reducing its severity, none of the patients in this study received the vaccine. This absence of OCV coverage reveals a critical gap in preventative healthcare, particularly in regions where cholera is endemic, such as Somalia [20, 21]. Incorporating OCV into standard healthcare protocols and enhancing its accessibility in high-risk areas could provide essential protection for vulnerable populations [22].

This study presents several limitations. The incompleteness of data, particularly missing demographic information, and the utilization of a single hospital center restrict the study's generalizability. The retrospective nature of the investigation introduces potential bias in documentation, while the absence of environmental and socioeconomic data limits context-specific analysis. The lack of longitudinal data and vaccination history constrains insights into cholera prevention and trends. Selection bias may have occurred, as hospitalized patients likely represent more severe cases. Limited laboratory confirmation could result in misclassification, and the concentration of cases in Banadir reduces applicability to other Somali regions. Future investigations should involve multiple centers and more comprehensive data collection for broader insights.

In conclusion, the findings of this study underscore the necessity of age-specific and gender-sensitive strategies in cholera prevention and treatment. Tailoring interventions to address the specific vulnerabilities of infants, young children, and adolescents, while improving access to OCV, could significantly enhance health outcomes in populations affected by cholera. Further research is required to investigate the underlying factors contributing to these demographic patterns, which could inform more effective and equitable cholera control strategies in Somalia and similar contexts.

Funding statement

None

Conflict of interests

The authors declare no conflict of interest.

Data availability

All data generated or analyzed during this study are included in this puplished article.

Authors' contribution

All authors made significant contributions to the work presented, including study design, data collection, analysis, and interpretation. They also contributed to the article's writing, revising, or critical evaluation, gave final approval for the version to be published.

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