Impact of COVID-19 on Cholera Outbreaks in Kenya: A Study of Mavoko Sub-County, 2019-2023

Anne Mwende Ndolo, Keumji Jung

Department of Global Health and Disease Control, Division of Infectious Disease Control, Yonsei University, Seoul, South Korea

DOI: https://dx.doi.org/10.47772/IJRISS.2024.8110167

Received: 01 November 2024; Accepted: 11 November 2024; Published: 13 December 2024

ABSTRACT

Background: The global impact of COVID-19 on healthcare affected cholera prevention in Africa. Despite being an endemic area, Mavoko, Kenya, experienced a surprising decrease in cholera cases during the pandemic. This study analyzes the dynamics of cholera outbreaks in Mavoko before, during, and after COVID-19, aiming to refine public health strategies for cholera prevention, with broader implications for future pandemics.

Method: This study retrospectively analyzed cholera in Mavoko Sub-County during pre-COVID-19 (2019), COVID-19 (2020-2021), and post-COVID-19 (2022-2023). Participants seeking cholera-related medical care were included. Data from Mavoko's Disease Surveillance and Response Unit, supplemented by 2019 Kenya Census data, were analyzed using descriptive statistics, chi-square, and logistic regression to explore cholera's association with factors like sanitation, water access, wealth, urban/rural settings, and handwashing facilities.

Results: The study of 1,786 individuals revealed gender and age correlations, urban-rural variations, and wealth disparities. Mortality rates were higher in men, while cholera cases were evenly distributed between genders. Cholera prevalence was high pre- and post-COVID-19, lower during COVID-19. Insanitary sanitation significantly increased cholera risk (AOR=1.28, p=0.047), water source type showed potential association but not significance (AOR=1.43, p=0.064). Pre- and post-COVID-19 periods had higher cholera risks than during COVID-19 (AOR=3.38, $p<0.001$ and AOR=4.14, $p<0.001$). Age and gender did not significantly impact cholera risk ($p>0.05$). For cholera severity, poor sanitation (AOR=4.56, $p<0.001$), lack of handwashing (AOR=3.45, $p<0.001$), and age over 50 (AOR=2.24, p=0.001) were significant factors.

Conclusion: This study highlighted COVID-19's impact on cholera in Mavoko Sub-County, showing a decline during the pandemic and an increase afterward. Key factors included sanitation, water access, and cholera severity linked to sanitation, handwashing, and age over 50. Despite COVID-19 influencing cholera outbreaks, severity was primarily determined by sanitation, hand hygiene, and age, surpassing the pandemic's direct impact.

Keywords: Cholera outbreaks, COVID-19 pandemic, Health systems, Public health responses, Disease Surveillance

INTRODUCTION

Background

COVID-19 is a highly contagious respiratory illness caused by the SARS-CoV-2 virus, leading to a wide range of symptoms, severe disease, and a global pandemic (WHO, 2019). The COVID-19 pandemic has had a significant impact on the health systems and public health responses in many nations throughout the world. Authorities in charge of health have faced new difficulties because of the COVID-19 pandemic in Africa, a region where infectious diseases like cholera are common. The appearance of COVID-19 has forced the deployment of stringent public health measures, including social exclusion and lockdowns, which have disrupted healthcare systems and impacted the provision of crucial health services, including the prevention and control

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue XI November 2024

of cholera outbreaks (Shrestha et al., 2022).

The precise global prevalence of cholera remains uncertain due to underreporting, yet prior research approximates projected yearly occurrences ranging from 1.3 to 4.0 million instances, leading to global fatalities of 21,000 to 143,000(Ganesan et al., 2020). Notably, approximately 1.3 billion individuals remain susceptible to cholera within countries where the disease is endemic (WHO, 2023a). Up to 20% of people infected experience severe disease; however, most cases of the illness are minor. Out of the 31 nations affected by cholera worldwide, Africa accounts for 40–80 million people who live in cholera hotspots (WHO, 2023a).

The region of Sub-Saharan Africa bears the most significant cholera burden, with an estimated occurrence of over 140,000 suspected cases annually, encompassing both endemic and epidemic situations (Zheng et al., 2022). Since mid-2021, the world has witnessed a severe resurgence of the seventh cholera pandemic, marked by widespread outbreaks in 2021 and 2022, including in previously unaffected regions. By February 2023, around 18 countries were still reporting cholera cases. Alarming mortality rates have been observed, with the case-fatality ratio (CFR) surpassing acceptable levels in 2021, a trend that seems to continue in 2022 and 2023(WHO, 2023a). As of May 28, 2023, the WHO Regional Office for Africa received reports of 194,840 cumulative cholera cases since January 1, 2022, resulting in 3,700 deaths and a CFR of 1.9% (Table 1) (WHO, 2023b). About half of the cholera cases and deaths are estimated to occur in children ≤5 years of age, but any age group may be affected (MOH-Kenya, 2023).

Cholera outbreaks in the African Region coincide with natural calamities like cyclones (Mozambique, Malawi), floods (Mozambique, Malawi), drought (Kenya and Ethiopia), and conflicts (Cameroon, Democratic Republic of the Congo, Nigeria, Ethiopia), along with concurrent disease outbreaks such as Mpox, wild polio, measles, and C0VID-19. Scarce resources, including medical supplies like cholera kits and Oral Cholera Vaccine (OCV), deficient sanitation, unreliable water access, and heightened cross-border movements, contribute significantly to the regional outbreak dynamics (WHO, 2023d).

In Kenya, where cholera is endemic, large-scale, widespread epidemics have been observed multiple times (Kiama et al., 2023). Several factors contributed to the outbreak of cholera. These include practices of open defecation, the expansion of slums and urban areas lacking sufficient access to clean water and sanitation facilities, movement of people across borders from neighboring countries facing complex humanitarian crises and significant cholera outbreaks, densely populated environments like refugee camps accompanied by extensive displacement of individuals, large-scale gatherings, and alterations in rainfall patterns. (Cowman, 2017).

Kenya does not have universal access to safe water or safely managed sanitation facilities. The proportion of persons accessing improved water and improved sanitation facilities according to the census 2019 was 64.8% and 73.3%, respectively (MOH-Kenya, 2023). During the COVID-19 pandemic in Kenya, a noteworthy decline in cholera cases was observed, with no significant outbreaks recorded. Notably, the Ministry of Health (MOH) had identified cholera hotspots nationwide, including Mavoko Sub-County, which had been witnessing annual outbreaks, particularly in December. Remarkably, this Sub-County emerged as a COVID-19 hotspot, attributed to its proximity to Nairobi County, frequent importation of cases, its sizable population, and its industrial nature (MOH-Kenya, 2023).

Kenya's goal is to eradicate cholera by reducing the annual incidence to zero per 100,000, achieving a 90% reduction in cholera-related deaths by 2027, and lowering the Case Fatality Ratio to below 1% by the same year (MOH-KENYA, 2022b).

Purpose of the Study

This study aims to explore the impact of the COVID-19 pandemic on cholera outbreaks in Mavoko Sub-County. By investigating factors influencing cholera absence during the pandemic and challenges emerging post-pandemic, the study will contribute insights for more effective control strategies. These findings can guide evidence-based interventions and policies, enhancing health outcomes in vulnerable communities. Additionally, this research will expand knowledge on cholera management during pandemics, offering lessons applicable to

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue XI November 2024

similar challenges in other low- and middle-income countries.

Research questions

1. What is the incidence of cholera before, during, and after COVID-19?
2. What factors are associated with cholera outbreaks, including health behaviors such as hand washing facilities and sanitary conditions, before, during, and after COVID-19?
3. How does the incidence of cholera cases vary according to socioeconomic status?

General objective

This study aims to assess the impact of the COVID-19 pandemic on cholera outbreaks in the Mavoko sub-county, Kenya, and inform evidence-based strategies for prevention and management.

Specific objectives

- To compare the incidence of cholera cases before, during, and after the COVID-19 pandemic in Mavoko sub-county.
- To investigate factors related to cholera outbreak, such as health behaviors (e.g., hand washing facilities and sanitary conditions) before, during, and after the COVID-19 pandemic.
- To investigate the association between socioeconomic status and the incidence of cholera cases.

Hypothesis

- H0. There is a significant difference in the incidence of cholera cases before, during, and after the COVID- 19 pandemic.

METHODOLODY

Conceptual framework

The study's conceptual framework, illustrated in Figure 1, presents a thorough framework that enables the comprehension and examination of the intricate interactions among different factors and variables employed in this investigation. It will function as a guide, assisting in identifying essential concepts, relationships, and hypotheses to be evaluated, thereby augmenting the research's overall clarity and consistency.

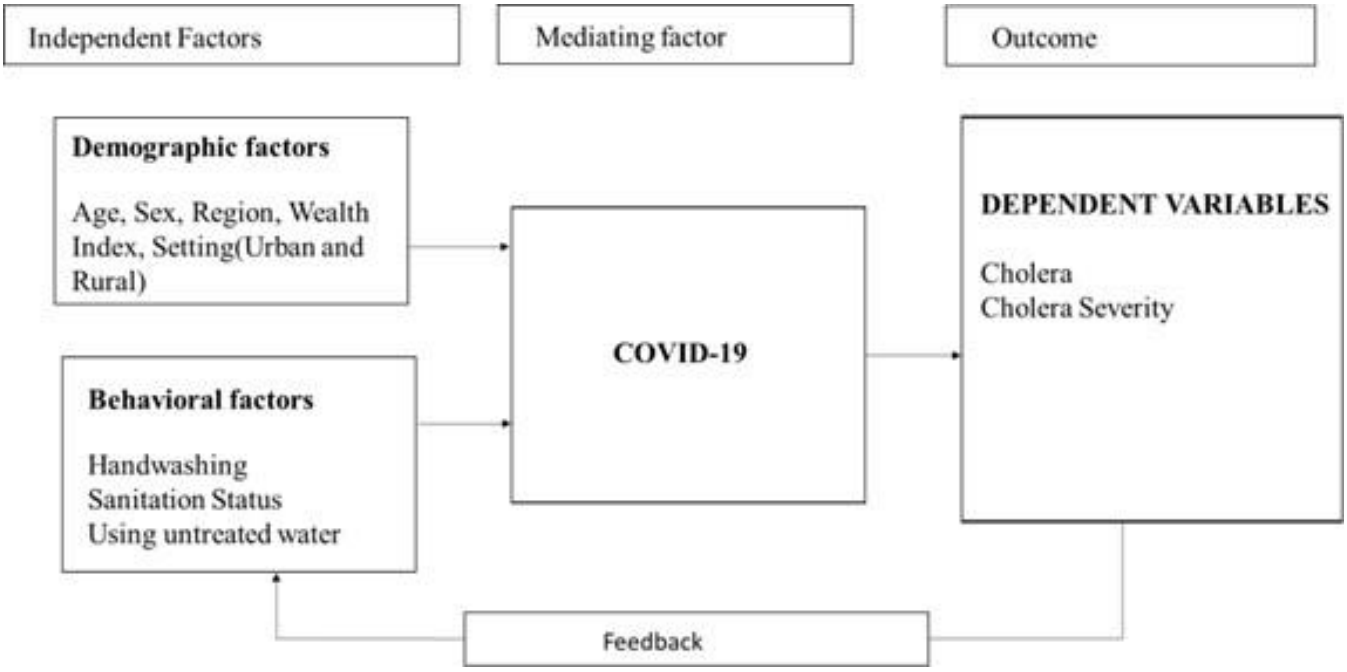

Figure 1: Conceptual Framework of the study

Definition of Terms Cholera outbreak

A cholera outbreak is characterized as an abrupt escalation in the incidence of acute watery diarrhea caused by Vibrio cholerae within a specific geographical area in Kenya during the COVID-19 pandemic((GTFCC), 2019).

Impact of COVID-19 pandemic

The effect of the COVID-19 pandemic and associated measures (e.g., lockdowns, restrictions on public gatherings, and travel restrictions) on the incidence, transmission, and control of cholera outbreaks in Kenya, which includes changes in the number of reported cholera cases, geographic distribution, case severity, and response to outbreaks compared to the pre-COVID-19, during COVID-19, and post-COVID-19 periods(MOH-KENYA, 2022a).

Study design

This study employed a quantitative retrospective cross-sectional design to investigate the occurrence of cholera at the Sub-County level. The primary focus was on examining the number of cholera cases from 2019 to 2022, which encompasses the pre-COVID-19 phase (2019), the COVID-19 period (2020-2021), and the post-COVID-19 phase (2022-2023).

Participants

The study included eligible participants of all age groups who sought medical attention for cholera-related symptoms or observable characteristics at Mavoko Sub-County healthcare during the outbreaks between 2019 and 2022.

Inclusion and Exclusion Criteria

The inclusion criteria will be as follows:

- Individuals diagnosed with cholera during the specified study period.
- Individuals who have been identified as close contacts of cholera patients, as per the established surveillance system.
- Individuals who reside in Mavoko. The exclusion criteria will be as follows:
- Individuals with incomplete or missing data in the surveillance records.
- Individuals who were diagnosed with cholera or identified as contacts outside the specified study period.
- Individuals with a diagnosis of cholera but no available information on their contacts.

Sample Size and Estimation

This study included all individuals who satisfy the criteria for both inclusion and exclusion.

Population and Setting

Mavoko Sub-County, also known as Athi River and situated 25 kilometers southeast of Nairobi, has emerged as Kenya's fastest-growing industrial hub, benefiting from its strategic proximity to the capital and the expanding industrial zone along the Nairobi-Mombasa highway. Comprising five distinct wards – Syokimau, Mlolongo, Muthwani, Athi River, and Kinanie – Mavoko accommodates a total population of 244,259 residents across an approximate area of 843.2 square kilometers (Figure 3).

The industrial landscape in Mavoko attracts low-skilled labor, contributing to its status as one of Kenya's fastest-growing sub-counties. However, challenges arise as a notable portion of the population resides in substandard slum conditions, grappling with security and health issues, often relying on the informal sector. Athi River's location within the Nairobi metropolitan municipality exposes residents to diseases like cholera due to frequent human movement.

Sanitation services in Mavoko operate mainly in a decentralized manner, with 80% relying on onsite facilities.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue XI November 2024

Only 18% are connected to a sewer system, and 2% practice open defecation. Alarmingly, 79% of excreta disposal is unsafe, leaving only 21% with proper sanitation. Environmental challenges, driven by population growth and demand for services, encompass polluted water sources, unregulated industrial pollution, and resource constraints, necessitating a concerted effort for effective solutions.

These factors — substandard living conditions, inadequate sanitation, migration, and poor health-seeking behavior collectively characterize Athi River Sub-County as a persistent cholera hotspot.

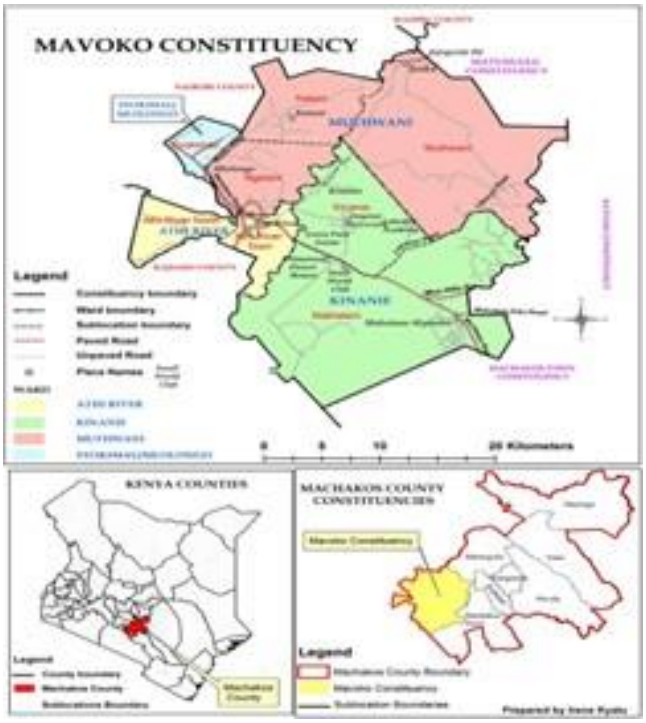

Figure 2: Map showing Mavoko Sub- County(constituency), Machakos county on the Kenyan map

Table 1: Shows the variable type, categories, classification and operational definitions

Variables	Categories	Classification	Definitions
Dependent	Cholera severity	In-Patient	A patient who admitted to a hospital. In patient in this study indicated severe illness
		Outpatient	A patient who visited hospital. Outpatient in this study indicated mild illness
	Cholera	Yes	Positive Rapid Diagnostic test (RDT) or Polymerase Chain Reaction (PCR) test
		No	Negative RDT or PCR test
Demographic Factors			
Independent	Age group, year	<25, 26-50, and >50	Age groups of cholera patients
	Sex	Female, Male	Gender characteristics of cholera patients
	Wealth index	Poor	Poor- the economic status of family < $100 a day and living in slum areas with inadequate water and sanitation

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue XI November 2024

			facilities
		Rich	Classified as having income of about >$100 a day and living in an area with established water treatment and sewer services
	Setting	Urban, Rural	Locality of Cholera patients
Behavioral Factors			
	Handwashing facilities	Yes	Means that the Patient had a handwashing facility in their home.
		No	Means the patient did not have a handwashing facility in their home.
	Sanitation status	Clean,	Means the household met the required standards of hygiene.
		Insanitary	Means the household toilet was either overflowing, not in a good condition and a likely source of infection.
	Water Source	MAVWASCO, BOREHOLE	Source of water for cholera patients
Temporal Factor			
	Period	1	Indicates the pre-COVID-19 period in this case 2019.
		2	Indicates during COVID-19 in this case 2020-2021.
		3	Indicates Post COVID-19 period in this case 2022-2023.

Data collection

Data was obtained from the Mavoko Sub-County Disease Surveillance and Response Unit, which collected and maintained data at the Sub-County level. Population data was obtained from the 2019 Kenya Population and Housing Census. Socio-demographic and household data were obtained from household registers and demographic survey reports from the Kenya National Bureau of Statistics. The investigation compared statistics on cholera cases before, during, and after the COVID-19 period regarding the different factors of cholera outbreaks, such as sanitation status, inadequate access to clean water, wealth index, setting (urban or rural), and availability of handwashing facilities.

Statistical Analysis

This investigation employed descriptive statistical methods, encompassing frequencies, percentages, and means, to succinctly encapsulate the study's outcomes. The application of chi-square analysis probed a noteworthy correlation between the incidence of cholera and distinct temporal phases, specifically the pre-COVID-19, during COVID-19, and post-COVID-19 periods. To obtain preliminary insights into the individual impacts of each predictor variable, univariate logistic regression was conducted. Subsequently, a comprehensive exploration of the intricate interactions between cholera and multiple predictor variables, while considering potential confounding factors, was undertaken through multivariate logistic regression analysis. Due to the unavailability of total population data, this study focused on cholera patients and their contacts as the dataset.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue XI November 2024

The analytical procedures were executed using Jamovi 2.3 statistical software.

RESULTS

Table 2 delineates the analysis of demographic and behavioral characteristics revealing significant associations with cholera incidence in Mavoko Sub-County. Of the 1,157 men (64.8%) and 629 women (35.2%) included in the study, age was a key factor in cholera risk. Individuals over 50 years old had significantly higher odds of contracting cholera (AOR 4.14; 95% CI: 2.4-6.7; P < 0.002), while those aged 0-25 years exhibited lower odds of infection (AOR 0.71; 95% CI: 0.4-1.5; P < 0.05). The risk of cholera also differed based on setting, with a higher proportion of both men (81.4%) and women (97.5%) living in urban areas, where the odds of cholera were significantly higher (AOR 0.96; 95% CI: 0.7-1.5; P < 0.001). In contrast, individuals in rural areas had slightly lower odds of contracting cholera (AOR 0.73; 95% CI: 0.5-0.9; P = 0.06). Although wealth index did not show a statistically significant correlation with cholera risk (P = 0.43), individuals from poorer backgrounds (97.9% of men and 94.1% of women) had higher odds of cholera compared to those from wealthier households (AOR 1.32; 95% CI: 0.8-2.3; P = 0.06). Handwashing, more common among women (44.0%) compared to men (22.5%), did not significantly reduce cholera risk (P < 0.6), despite the higher odds of handwashing among women (AOR 0.63; 95% CI: 0.5-0.8). The source of drinking water was a critical determinant, with those using MAVWASCO water having higher odds of contracting cholera than those using borehole water (AOR 0.56; 95% CI: 0.3-0.7; P < 0.001), suggesting possible contamination issues within the urban water supply. Sanitation status was also strongly associated with cholera incidence; individuals living in insanitary conditions had significantly higher odds of contracting cholera (AOR 1.36; 95% CI: 1.1-1.7; P < 0.001), with women (77.6%) more likely to report living in insanitary conditions compared to men (66.8%).

Table 2. General Characteristics of the Study Population associated with Cholera incidence N (%) N=1786

Demographic Characteristics	Variable	Men 1157 (64.8)	Women 629 (35.2)	AOR (95% CI)	P-value
Age group, year	0-25	447 (36.6)	230 (38.6)	0.71 (0.4–1.5)	<0.05
	26-50	621 (39.9)	251 (53.7)	0.88 (0.7–1.1)	<0.27
	>50	89 (23.5)	148 (7.7)	4.14 (2.4–6.7)	<0.002
Setting	Urban	1128 (81.4)	512 (97.5)	0.96 (0.7–1.5)	<0.001
	Rural	29 (18.6)	117 (2.5)	0.73 (0.5–0.9)	<0.06
Wealth index	Poor	1133 (97.9)	601 (94.1)	1.32 (0.8–2.3)	<0.06
	Rich	24 (2.1)	28 (5.9)	0.61 (0.5–0.9)	<0.07
Behavioral Characteristics					
Hand washing	Yes	260 (22.5)	277 (44.0)	0.63 (0.5–0.8)	<0.71
	No	897 (77.5)	352 (56.0)	1.16 (0.8–1.5)	<0.62
Drinking water	Borehole	103 (15.1)	188 (14.3)	0.56 (0.3–0.7)	<0.60
	MAVWASCO	1054 (84.9)	441 (85.7)	0.7 (0.5–1.5)	<0.001

Sanitation status	Clean	259 (33.2)	209 (22.4)	0.36 (0.1–0.7)	<0.05
	Insanitary	898 (66.8)	420 (77.6)	1.36 (1.1–1.7)	<0.001

Table 3 presents the cholera incidence ratio across distinct periods: pre-COVID-19, during COVID-19, and post-COVID-19. The total number of cases, incidence rates per 100,000 individuals, and corresponding period classifications. In the pre-COVID-19 period, a total of 680 cholera cases were reported, resulting in a notable incidence rate of 278.4 cases per 100,000 individuals. However, during the COVID-19 period, there was a significant reduction in cholera cases, with only 43 reported instances and an incidence rate of 17.6 cases per 100,000 individuals. Subsequently, in the post-COVID-19 period, there was a resurgence in cholera cases, reaching 651 cases and an incidence rate of 266.5 cases per 100,000 individuals. When considering the overall analysis encompassing all periods, the cumulative number of cholera cases amounted to 1324, reflecting an overall incidence rate of 562.5 cases per 100,000 individuals.

Table 3: Cholera incidence rate Across Different Periods

PERIOD	Cases	Incidence rate per 100,000
Pre-COVID-19	680	278.4
During COVID-19	43	17.6
Post COVID-19	651	266.5
Total	1324	562.5

Table 4 shows results from the multivariate logistic regression (Models 1 and 2) assessing cholera associations reveal significant findings. In Model 1, the pre-COVID-19 period has a notable association (AOR = 3.37, 95% CI: 2.19-5.17), and the post-COVID-19 period shows a higher association (AOR = 4.82, 95% CI: 3.12-7.45) compared to the reference period (COVID-19). Model 2 validates these associations with significant AORs for the pre-COVID-19 (AOR = 3.38, 95% CI: 2.20-5.19) and post-COVID-19 (AOR = 4.14, 95% CI: 2.64-6.49) periods ($p < 0.001$).

Regarding age groups, neither the 26-50 nor the >50 age group shows a significant association with cholera in either model. Similarly, no significant association is observed between gender and cholera in both Model 1 and Model 2. Regarding "Sanitation," Model 2 indicates that the insanitary category is associated with a higher cholera risk (AOR = 1.28, 95% CI: 1.00-1.64, $p < 0.005$). For the "Water Source" variable in Model 2, borehole use is associated with an increased cholera risk (AOR = 1.43, 95% CI: 0.98-2.10), but statistical significance is not reached. Lastly, the "Wealth index" variable in Model 2 does not show a statistically significant association with cholera.

Table 4. Multivariate Logistic regression to check association of cholera with Sanitation, Water Source, Age, Sex, Wealth index, and Period

	MODEL 1		MODEL 2	
Predictor	AOR (95% CI)	p-value	AOR (95% CI)	p-value
Period				
During COVID-19	1.00		1.00	

Pre- COVID -19	3.37 (2.19-5.17)	<0.001	3.38 (2.20-5.19)	<0.001
Post COVID -19	4.82 (3.12-7.45)	<0.001	4.14 (2.64-6.49)	<0.001
Age group, year				
0-25	1.00		1.00	
26-50	0.86 (0.69-1.09)	0.22	0.87 (0.69-1.10)	0.27
>50	1.21 (0.84-1.75)	0.31	1.17 (0.81-1.69)	0.42
Sex				
Female	1.00		1.00	
Male	1.08 (0.86-1.36)	0.53	1.04 (0.82-1.31)	0.76
Sanitation				
Clean			1.00	
Insanitary			1.28 (1.00-1.64)	0.05
Water Source				
Mavwasco			1.00	
Borehole			1.43 (0.98-2.10)	0.06
Wealth index				
Rich			1.00	
Poor			1.72 (0.81-3.65)	0.16

AOR – Adjusted Odds Ratio, CI – Confidential Interval

Table 5 compares cholera severity across pre-COVID-19, during COVID-19, and post-COVID-19 periods. In the pre-COVID-19 period, 42.2% had mild cholera, and 57.8% had severe cholera. During COVID-19, it was 41.9% mild and 58.1% severe. In the post-COVID-19 period, 45.3% had mild cholera, and 54.7% had severe cholera. Overall, 43.7% had mild cholera, and 56.3% had severe cholera across all periods. The p-value suggests no significant differences in cholera severity among the three periods (p = 0.520).

Table 5. Comparison of Cholera severity according to pre-COVID-19, During COVID-19 and Post COVID-19

PERIOD	Mild		Severe	P-value
		N (%)		0.520
Pre - COVID-19	266	(42.2)	364	(57.8)

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue XI November 2024

During COVID-19	18	(41.9)	25	(58.1)
Post COVID-19	295	(45.3)	356	(54.7)
Total	579	(43.7)	745	(56.3)

The results from the multivariate logistic regression analysis, as presented in Table 6, provide insights into the association between cholera severity and various influencing factors. In both Model 1 and Model 2, the variable "Period" did not exhibit a statistically significant association with cholera severity. However, the "Age group" variable revealed a noteworthy finding, with individuals aged over 50 displaying a significantly higher risk of Severe cholera outcomes (AOR = 2.24, 95% CI: 1.47-3.41, $p < 0.001$). Gender, as indicated by the variable "Sex," did not demonstrate a significant association with cholera severity.

On the other hand, factors related to sanitation and handwashing practices emerged as crucial determinants. Insanitary conditions were strongly associated with increased cholera severity (AOR = 4.56, 95% CI: 3.26-6.37, $p< 0.001$), emphasizing the importance of sanitation in preventing severe cholera cases. Additionally, individuals not practicing handwashing exhibited a higher risk of severe cholera outcomes (AOR = 3.45, 95% CI: 2.56-4.64, $p< 0.001$). Surprisingly, the "Wealth Index" did not show a statistically significant association with cholera severity.

Table 6. Results of Multivariate Logistic Regression on Cholera severity and Sanitation, Handwashing, Age, sex, Wealth Index and Period

	MODEL 1		MODEL 2	
Predictor	AOR (95% CI)	p-value	AOR (95% CI)	p-value
Period				
During COVID	1.00		1.00	
Pre COVID	1.02 (0.54-1.92)	0.96	1.07 (0.51-2.24)	0.87
Post COVID	0.83 (0.44-1.56)	0.56	0.66 (0.32-1.40)	0.28
Age group, year				
<25	1		1	
25-50	1.04 (0.79-1.36)	0.3	1.04 (0.79-1.36)	0.79
>50	2.24 (1.47-3.41)	<0.001	2.24 (1.47-3.41)	0.001
Sex				
Female	1		1	
Male	1.15 (0.88-1.52)	<0.001	1.15 (0.88-1.52)	0.31
Sanitation				
Clean			1	
Insanitary			4.56 (3.26-6.37)	<0.001

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue XI November 2024

Hand washing				
Yes			1	
No			3.45 (2.56-4.64)	<0.001
Wealth Index				
Rich			1	
Poor			0.69 (0.27-1.79)	0.45

AOR - Adjusted Odds Ratio, CI – Confidential Interval

DISCUSSION

This investigation primarily aimed to elucidate the impact of the COVID-19 pandemic on cholera incidence and severity, focusing on identifying key risk factors in Mavoko Sub-county. The findings underscore that critical determinants of cholera incidence include access to clean water and sanitation. Other factors, such as sanitation practices, hand hygiene, and age above 50 years, were also significantly associated with the severity of cholera cases. While COVID-19 influenced cholera dynamics, the severity of cases was more closely tied to these fundamental determinants, demonstrating that sanitation and hygiene factors were primary drivers, independent of pandemic effects.

Cholera Incidence and Severity Across Pandemic Phases

In our study, cholera incidence was notably higher pre-COVID-19, with 278.4 cases per 100,000 population. A marked decline to 17.6 cases per 100,000 was observed during the pandemic, likely due to lockdown measures, enhanced hygiene practices, and movement restrictions that limited cholera spread. However, cases resurged post-COVID-19 to 266.5 per 100,000, indicating challenges in sustaining cholera control measures. In total, 1,324 cases, equating to 562.5 cases per 100,000 population, underscore the need for adaptable, long-term public health strategies in cholera prevention. This incidence rate was higher than the estimated mean annual incidence of 530.7 per 100,000 in Kenya from 2015 to 2019 (MOH-KENYA, 2022b). Musa et al. (2021) observed a contrasting trend in Nigeria during early COVID-19, noting a 17% rise in cholera cases, while UNICEF (2020) reported increased outbreaks in some regions during the pandemic. These variations suggest regional differences in cholera responses during COVID-19, highlighting the need for localized approaches to cholera control, particularly in post-pandemic settings.

Associations and Risk Factors

Sanitation practices and environmental conditions significantly impacted cholera risk. Those in insanitary environments were at a heightened risk of cholera, consistent with findings from Kiama et al. (2023) and Kigen et al. (2020), emphasizing the importance of safe water and improved sanitation to reduce transmission. Only 64.8% of Kenyans had access to improved water, and 73.3% to sanitation in 2019 (MOH-Kenya, 2023), illustrating the gap that must be addressed, especially in areas like Mavoko with inadequate sanitation facilities due to informal settlements. Substantial investments in water and sanitation infrastructure are essential for long-term cholera prevention in these regions, aligning with the National Cholera Elimination Plan(MOH-KENYA, 2022).

Handwashing practices, while not significantly influencing cholera incidence in our study, were associated with reduced disease severity, suggesting that hand hygiene plays a role in lessening the impact of cholera once contracted. This finding contrasts with broader studies that emphasize the importance of hand hygiene in preventing cholera transmission, where it has been shown to be a key factor in reducing disease incidence (Luby et al., 2020). While our study highlights the limited role of handwashing in preventing cholera outbreaks, it underscores its value in minimizing severity, suggesting that cholera control should be viewed through a broader lens. Effective prevention strategies must incorporate robust sanitation practices and access to safe water, as

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue XI November 2024

these factors were found to have a more substantial influence on cholera incidence in Mavoko Sub-County. Thus, while hand hygiene is an important preventive measure, it is the integration of improved water safety and sanitation that provides a more comprehensive approach to cholera control.

Age emerged as a key demographic factor influencing both cholera incidence and severity. Individuals over 50 years old had notably higher odds of contracting cholera (AOR 4.14; 95% CI: 2.4-6.7; P = 0.002), suggesting that aging is associated with declining immunity and increased vulnerability to infectious diseases, particularly when healthcare and sanitation systems are inadequate. This finding aligns with previous research, such as that by Di Gennaro et al. (2023), which highlights the increased susceptibility of older adults to cholera. In contrast, younger individuals aged 0-25 demonstrated lower odds of contracting cholera (AOR 0.71; 95% CI: 0.4-1.5; P < 0.05), which suggests a lower susceptibility to cholera in this group. However, while younger individuals were less likely to contract cholera, age also played a crucial role in the severity of the disease. Older adults, particularly those living in urban settings without familial support, were more likely to experience severe cholera, highlighting the need for targeted interventions that address the unique vulnerabilities of this population. This underscores the importance of incorporating age-specific strategies in cholera prevention and management, such as tailored health education and vaccination programs for older adults, to reduce both incidence and severity.

Implications of Living Environment, Gender, and Wealth Index

Urban residency, particularly in informal settlements, was associated with increased cholera severity compared to rural areas, underscoring the influence of living conditions on disease outcomes. The informal settlements in Mavoko, characterized by inadequate sanitation and unsafe water, pose persistent challenges for cholera control. This is further supported by a study by Golicha et al. (2018), which identified the environment and wealth index as key predictors of cholera incidence. Additionally, gender differences were apparent, with males experiencing higher odds of severe cholera. Many male migrants in Mavoko live in low-wage, informal jobs in slum areas with inadequate sanitation, contributing to the elevated risk of severe cholera and lower health-seeking behaviors.

While wealth disparities indicated potential socioeconomic vulnerability to cholera, our findings did not reach significance. However, previous studies in highly urbanized settings, like Wahed et al. (2013) in Bangladesh, suggest that the poorest populations face increased cholera risk. Social determinants, including wealth and access to resources, are vital for comprehensive cholera control.

Study Implications and Future Preparedness

The localized focus on Mavoko is both a strength and a limitation, as the findings may not be generalizable across Kenya. Comparative data from regions without COVID-19 restrictions would have bolstered the analysis. The study underscores the need for sustainable WaSH interventions to reduce cholera risk, especially in urban areas with informal settlements. Additionally, integrating improved sanitation practices, hygiene education, and accessible clean water is essential for cholera prevention, particularly during and after health crises like the COVID-19 pandemic. For future pandemic preparedness, this study emphasizes the importance of adaptable, context-specific public health strategies to mitigate disease outbreaks in vulnerable populations.

Strengths and Limitations

This study offers valuable localized insights that are essential for developing targeted interventions tailored to Mavoko's unique context. While the study has limitations, it compensates for these by focusing on specific, contextual factors that directly inform public health responses within the area. The retrospective design, which may introduce biases due to incomplete records, was mitigated through careful data validation and triangulation from multiple sources. Although the study's geographic specificity limits generalizability, the findings provide actionable information for Mavoko, which can be used to inform similar settings. The lack of data from areas unaffected by COVID-19 restrictions is acknowledged; however, the study emphasizes the relevance of the local context during the pandemic, making the findings still highly applicable to the region. Although the cross-sectional nature limits causal inference, the study helps to establish correlations and trends that can guide future prospective research. Finally, to address potential changes in health-seeking behaviors during COVID-19, the

study incorporates data from different points during the pandemic, enhancing the reliability of its findings. Future studies with larger sample sizes and broader geographic scopes would help further validate these results and improve their generalizability.

Conclusion and Recommendations:

This study highlights the complex interplay between the COVID-19 pandemic and cholera incidence in Mavoko Sub-County, revealing that while COVID-19 restrictions contributed to a temporary reduction in cholera cases, more persistent determinants—namely sanitation practices, access to safe water, and age—had a far-reaching impact on cholera incidence and severity. The analysis suggests that COVID-19 measures, such as movement restrictions and enhanced hygiene practices, temporarily reduced cholera spread. However, following the easing of restrictions, cholera cases resurged, underscoring the challenges of maintaining preventive measures without lasting improvements in sanitation infrastructure. Access to safe water and consistent sanitation practices remain pivotal, with the pandemic functioning as a temporary, though insufficient, mitigator rather than a long-term solution. Additionally, age emerged as a significant determinant of cholera severity, with individuals over 50 years old facing heightened vulnerability—likely due to factors such as pre-existing health conditions and reduced social support in urban slum settings, which compound the risks in this demographic.

In light of these findings, the study advocates for several key interventions. First, prioritizing investments in sustainable sanitation facilities and reliable access to safe water is essential to prevent cholera beyond temporary pandemic-driven measures. Continuous promotion of hygiene practices, such as handwashing, paired with tailored health education for vulnerable age groups, will strengthen preventive efforts. Targeted cholera vaccination programs for high-risk communities, including informal settlements and older adults, can further enhance resilience against outbreaks. Securing funding—whether through government allocations or partnership-driven financial support—is also crucial to implement these recommendations effectively and meet the 2030 cholera elimination targets.

REFERENCES

1. (GTFCC). (2019). Cholera outbreak response field manual
2. Ahmed, S. H., Shaikh, T. G., Waseem, S., Hasan, M. M., Bardhan, M., & Mukerjee, N. (2022). Rise in cholera amid COVID-19: Spotlight on Pakistan and Bangladesh. Lancet Reg Health Southeast Asia, 4, 100041. https://doi.org/10.1016/j.lansea.2022.100041
3. Ajayi, A., & Smith, S. I. (2019). Correction to: Recurrent cholera epidemics in Africa: which way forward? A literature review. Infection, 47(3), 351. https://doi.org/10.1007/s15010-019-01292-8
4. Barasa, E. W., Ouma, P. O., & Okiro, E. A. (2020). Assessing the hospital surge capacity of the Kenyan health system in the face of the COVID-19 pandemic. PLoS One, 15(7), e0236308.
5. Cavdaroglu, S., Aktar, I., Hasan, M. M., Costa, A., Aborode, A. T., Ahmad, S., & Essar, M. Y. (2022). Cholera amidst COVID-19 pandemic: African healthcare system in jeopardy. Einstein (Sao Paulo), 20, eCE6938. https://doi.org/10.31744/einstein_journal/2022CE6938
6. CDC. (2023). CHOLERA PREVENTION. https://www.cdc.gov/cholera/prevention.html
7. Cohen, A., & Colford, J. M. (2017). Effects of Boiling Drinking Water on Diarrhea and Pathogen-Specific Infections in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis. Am J Trop Med Hyg, 97(5), 1362-1377. https://doi.org/10.4269/ajtmh.17-0190
8. Cowman, G. A. (2015). Cholera prevention and control in Kenya The University of North Carolina at Chapel Hill].
9. Di Gennaro, F., Occa, E., Chitnis, K., Guelfi, G., Canini, A., Chuau, I., Cadorin, S., Bavaro, D. F., Ramirez, L., Marotta, C., Cotugno, S., Segala, F. V., Ghelardi, A., Saracino, A., Periquito, I. M., Putoto, G., & Mussa, A. (2023). Knowledge, Attitudes and Practices on Cholera and Water, Sanitation, and Hygiene among Internally Displaced Persons in Cabo Delgado Province, Mozambique. Am J Trop Med Hyg, 108(1), 195-199. https://doi.org/10.4269/ajtmh.22-0396
10. Emong, D. J., Wadunde, I., Kadobera, D., Bulage, L., Kabwama, S. N., & Ario, A. R. (2022). Effect of COVID-19 Pandemic on HIV/AIDS, Tuberculosis, Malaria, and Maternal and Child Health Services, Uganda, 2020. In: Research Square.
11. Ganesan, D., Gupta, S. S., & Legros, D. (2020). Cholera surveillance and estimation of burden of cholera.

Vaccine, 38, A13-A17. https://doi.org/https://doi.org/10.1016/j.vaccine.2019.07.036
12. Golicha, Q., Shetty, S., Nasiblov, O., Hussein, A., Wainaina, E., Obonyo, M., Macharia, D., Musyoka, R. N., Abdille, H., Ope, M., Joseph, R., Kabugi, W., Kiogora, J., Said, M., Boru, W., Galgalo, T., Lowther, S. A., Juma, B., Mugoh, R., . . . Burton, J. W. (2018). Cholera Outbreak in Dadaab Refugee Camp, Kenya - November 2015-June 2016. MMWR Morb Mortal Wkly Rep, 67(34), 958-961. https://doi.org/10.15585/mmwr.mm6734a4
13. Hezam, I. M., Foul, A., & Alrasheedi, A. (2021). A dynamic optimal control model for COVID-19 and cholera co-infection in Yemen. Advances in Difference Equations, 2021(1), 1-30.
14. Holmgren, J. (2020). Supplement: Cholera Control in Three Continents: Vaccines, Antibiotics and WASH Preface. In (Vol. 38, pp. A1-A3): ELSEVIER SCI LTD THE BOULEVARD, LANGFORD LANE, KIDLINGTON, OXFORD OX5 1GB ….
15. Houpt ER, M. W., Kumpel BM. (2022). Cholera and the social determinants of health. https://doi.org/10.1097/QCO.0000000000000801. PMID: 35322250.
16. Khan, A. I., Islam, M. T., Amin, M. A., Khan, Z. H., & Qadri, F. (2023). Outbreak of diarrheal diseases causes mortality in different geographical locations of Bangladesh during the 2021 COVID-19 era [Review]. Frontiers in public health, 11, 1103518. https://doi.org/10.3389/fpubh.2023.1103518
17. Kiama, C., Okunga, E., Muange, A., Marwanga, D., Langat, D., Kuria, F., Amoth, P., Were, I., Gachohi, J., Ganda, N., Martinez Valiente, M., Njenga, M. K., Osoro, E., & Brunkard, J. (2023). Mapping of cholera hotspots in Kenya using epidemiologic and water, sanitation, and hygiene (WASH) indicators as part of Kenya's new 2022-2030 cholera elimination plan. PLoS Negl Trop Dis, 17(3), e0011166. https://doi.org/10.1371/journal.pntd.0011166
18. Kigen, H. T., Boru, W., Gura, Z., Githuka, G., Mulembani, R., Rotich, J., Abdi, I., Galgalo, T., Githuku, J., Obonyo, M., Muli, R., Njeru, I., Langat, D., Nsubuga, P., Kioko, J., & Lowther, S. (2020). A protracted cholera outbreak among residents in an urban setting, Nairobi county, Kenya, 2015. Pan Afr Med J, 36, 127. https://doi.org/10.11604/pamj.2020.36.127.19786
19. Lassi, Z. S., Naseem, R., Salam, R. A., Siddiqui, F., & Das, J. K. (2021). The impact of the COVID-19 pandemic on immunization campaigns and programs: a systematic review. International journal of environmental research and public health, 18(3), 988.
20. Luby, S. P., Davis, J., Brown, R. R., Gorelick, S. M., & Wong, T. H. F. (2020). Broad approaches to cholera control in Asia: Water, sanitation and handwashing. Vaccine, 38, A110-A117. https://doi.org/https://doi.org/10.1016/j.vaccine.2019.07.084
21. Mandal, S., Mandal, M. D., & Pal, N. K. (2011). Cholera: a great global concern. Asian Pacific Journal of Tropical Medicine, 4(7), 573-580. https://doi.org/https://doi.org/10.1016/S1995-7645(11)60149-1
22. MOH-KENYA. (2022a). COVID 19 STATISTICS IN KENYA
23. MOH-KENYA. (2022b). NATIONAL CHOLERA MULTISECTORAL ELIMINATION PLAN.
24. MOH-Kenya. (2023). National cholera response plan.
25. Musa, S. S., Gyeltshen, D., Manirambona, E., Wada, Y. H., Sani, A. F., Ullah, I., & Lucero-Prisno, D. E. (2021). Dual tension as Nigeria battles cholera during the COVID-19 pandemic. Clinical epidemiology and global health, 12.
26. Niranjan, A. K., Patel, S. K., Channabasappa, N. K., Rana, J., Agrawal, A., Kumar, R., Pandey, M. K., Tiwari, S. P., & Singh, D. R. (2023). Resurgence of cholera in the COVID-19 era: a global health concern. Ann Med Surg (Lond), 85(4), 1321-1322. https://doi.org/10.1097/MS9.0000000000000415
27. Oladapo, R. K., Oyetola, A. B., Obidiro, O. P., Olajide, A., Osuagwu-Nwogu, E., Olaitan, O. M., Ngokere, C., Monisola, I., Ibraheem, B., & Afolayan, A. (2021). Rising cholera cases: Harnessing the momentum of COVID-19 to strengthen Nigeria's health systems. Int J Health Plann Manage, 36(6), 2030-2034. https://doi.org/10.1002/hpm.3289
28. Owoicho, O., Abechi, P., & Olwal, C. O. (2021). Cholera in the era of COVID-19 pandemic: a worrying trend in Africa? International Journal of Public Health, 52.
29. Shrestha, A. B., Khatroth, S., Malreddy, A., Issa, F. A., Shrestha, S., & Shrestha, S. (2022). Cholera amid COVID-19: Call from three nations; India, Bangladesh, and Nepal. Annals of Medicine and Surgery, 84, 104936. https://doi.org/https://doi.org/10.1016/j.amsu.2022.104936
30. Sitrep. (2022). Disease outbreak Situation Report. https://reliefweb.int/report/kenya/kenya-disease-outbreak-situation-report-28th-oct-2022-epi-week-42-2022
31. Tessema, G. A., Kinfu, Y., Dachew, B. A., Tesema, A. G., Assefa, Y., Alene, K. A., Aregay, A. F.,

Ayalew, M. B., Bezabhe, W. M., & Bali, A. G. (2021). The COVID-19 pandemic and healthcare systems in Africa: a scoping review of preparedness, impact and response. BMJ global health, 6(12), e007179.

32. UNICEF. (2020, 29/4/2020). Over 5 million children face threat of cholera and acute water diarrhea in the midst of COVID-19 as Yemen gets heavy rains. Retrieved 29/5 from https://www.unicef.org/press-releases/over-5-million-children-face-threat-cholera-and-acute-water-diarrhea-midst-covid-19
33. Uwishema, O., Okereke, M., Onyeaka, H., Hasan, M. M., Donatus, D., Martin, Z., Oluwatomisin, L. A., Mhanna, M., Olumide, A. O., Sun, J., & Adanur, I. (2021). Threats and outbreaks of cholera in Africa amidst COVID-19 pandemic: a double burden on Africa's health systems. Trop Med Health, 49(1), 93. https://doi.org/10.1186/s41182-021-00376-2
34. Wahed, T., Kaukab, S. S. T., Saha, N. C., Khan, I. A., Khanam, F., Chowdhury, F., Saha, A., Khan, A. I., Siddik, A. U., & Cravioto, A. (2013). Knowledge of, attitudes toward, and preventive practices relating to cholera and oral cholera vaccine among urban high-risk groups: findings of a cross-sectional study in Dhaka, Bangladesh. BMC Public Health, 13(1), 1-12.
35. WHO. (2019). COVID-19. https://www.who.int/emergencies/diseases/novel-coronavirus-2019
36. WHO. (2022). Cholera Key facts. https://www.who.int/news-room/fact-sheets/detail/cholera?gclid=CjwKCAjwhJukBhBPEiwAniIcNZw_yoQE0CcgmJ9tSSWP4Zn4dRcIC8Z3mb_VNsqbnRSk4m22C2at7hoCXDIQAvD_BwE
37. WHO. (2023a). CHOLERA - GLOBAL SITUATION. https://www.who.int/emergencies/disease-outbreak-news/item/2023-DON437#:~:text=The%20global%20burden%20of%20cholera,95%20000%20deaths%20occur%20annually.&text=Note%3A%20Countries%20in%20white%20are,as%20of%201%20February%202023.
38. WHO. (2023b). CHOLERA IN THE AFRICAN REGION Retrieved 25 from https://apps.who.int/iris/bitstream/handle/10665/366482/AFRO%20Cholera%20Bulletin.03_Final.pdf
39. WHO. (2023c). Coronavirus disease (COVID-19) Pandemic. https://www.who.int/emergencies/diseases/novel-coronavirus-2019
40. WHO. (2023d). Multi-country outbreak of cholera, External situation report #3 - 1 June 2023. https://www.who.int/publications/m/item/multi-country-outbreak-of-cholera--external-situation-report--3---1-june-2023
41. WHO. (2023e, 13/06/2023). Reaching vulnerable populations in Kenya’s cholera outbreak. https://www.afro.who.int/photo-story/reaching-vulnerable-populations-kenyas-cholera-outbreak
42. Zheng, Q., Luquero, F. J., Ciglenecki, I., Wamala, J. F., Abubakar, A., Welo, P., Hussen, M., Wossen, M., Yennan, S., Keita, A., Lessler, J., Azman, A. S., & Lee, E. C. (2022). Cholera outbreaks in sub-Saharan Africa during 2010-2019: a descriptive analysis. Int J Infect Dis, 122, 215-221. https://doi.org/10.1016/j.ijid.2022.05.039