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REVIEW ARTICLE

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Outbreaks of faecal-orally transmitted diseases in displacement camps: A scoping review of pathogens, risk factors, exposure routes, and drivers of transmission

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ABSTRACT

Many forcibly displaced people reside in camps characterised by precarious living conditions, exposing them to numerous health risks. This scoping review elucidated the risk factors and exposure routes implicated in outbreaks of faecal-oral pathogens in camps, as well as the context-specific drivers of transmission that shape these outbreaks. Journal articles were identified from PubMed, Embase, Scopus, and Web of Science. Portals for grey literature were also searched. A total of 48 records, published between 1937 and 2022, were included in the analysis. Cholera outbreaks were the most frequently reported. Risk factors included drinking water from shallow wells and rivers, consuming ice and leftover food, and inconsistent handwashing. These indicate exposure through vehicles of transmission in both public and domestic domains, emphasising the importance of a multipronged approach to outbreak prevention and control. Outbreaks were often exacerbated by extreme weather events and acute population influxes that damage or overwhelm water and sanitation facilities. Such shocks warrant explicit recommendations in preparedness and response guidelines. Development projects and outbreak response measures in surrounding areas may reduce the risk of importing pathogens into camps. Future research could further investigate faecal-oral pathogens other than *Vibrio cholerae* and analyse the co-occurrence of the identified transmission drivers.

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Introduction

At the end of 2022, there were 108.4 million forcibly displaced people worldwide (United Nations High Commissioner for Refugees [UNHCR], 2023). Half of internally displaced persons (IDPs) and 20% of refugees reside in 'camps' (Calabria et al., 2022), often characterised by precarious living conditions. Among these, overcrowding, and inadequate water supply and sanitation facilities expose forcibly displaced people to numerous pathogens (Behnke et al., 2020; Cooper et al., 2021; Shackelford et al., 2020), leading to the recurrence of infectious disease outbreaks in camps.

Many pathogens primarily associated with the consumption of contaminated drinking water (e.g. *Vibrio cholerae, Shigella dysenteriae, Cryptosporidium parvum,* hepatitis E virus) are

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characterised by faecal-oral transmission, and as such, may also be spread through other means (Bartram & Hunter, 2015; World Health Organization [WHO], 2022). Accordingly, more than one exposure route, defined as 'the means by which an individual comes into contact with the hazard' (Pond, 2015, p. 137), may characterise outbreaks specific to such pathogens. The contribution of each exposure route to the overall spread of disease is likely to vary across settings. Indeed, arguing for a systems approach to the spread of diarrheal disease, Eisenberg et al. (2012) emphasised that pathogen transmission dynamics are highly contextual and ultimately shaped by multiple ecological and social processes. For instance, 'poor sanitation leads to the contamination of water sources, contaminated water sources can spread pathogens to food, and food-sharing practices within communities can cause pathogens to reach other households' (Eisenberg et al., 2012, p. 249).

The exposure routes relevant to outbreaks of faecal-orally transmitted diseases in displacement camps, as well as the context-specific drivers of transmission that characterise these outbreaks, have yet to be entirely and systematically investigated.

This knowledge gap was partly addressed by Behnke et al. (2020), Cooper et al. (2021), and Shackelford et al. (2020) in scoping literature reviews that characterised the environmental health conditions, hazards, and health outcomes specific to forced displacement. However, these did not systematically explore and report on outbreaks of faecal-orally transmitted diseases. Charnley et al. (2021) conducted the first comprehensive review of post-disaster outbreaks and their risk factors. Nevertheless, it did not explore the causal links and exposure routes specific to outbreaks of faecal-oral pathogens. Moreover, the review did not include grey literature and excluded international displacement settings. Closely related to our work, Burnet and Rudge (2019) explored the linkages between diarrheal disease outbreaks and sanitation failures in displacement camps. Their review also uncovered other factors that contribute to outbreaks of diarrheal diseases including population movement. However, it excluded grey literature, only analysed studies that contained a description of sanitation characteristics and did not explore faecal-oral pathogens that are not associated with diarrhoea (e.g. hepatitis E virus).

Therefore, we conducted a scoping review of peer-reviewed and grey literature to provide an overview of the pathogens, risk factors, and exposure routes implicated in outbreaks of faecal-orally transmitted diseases in displacement camps. Furthermore, we extracted and classified the context-specific drivers of transmission that underlie these outbreaks, providing insights into their recurrence in displacement camps. Following the principles of a scoping review, we mapped key concepts, identified main sources, and explored the types of evidence available while identifying gaps in the existing research landscape.

Methods

Concepts and definitions

Refugees are people who have been forcibly displaced outside their country of origin, who are unable or unwilling to return 'owing to a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group, or political opinion' (UNHCR, 2010, p. 3). Asylum seekers are people 'whose claim for refugee status has not yet been determined' (UNHCR, 2015, p. 5). IDPs have been forcibly displaced within their country 'as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters' (United Nations Office for the Coordination of Humanitarian Affairs, 2004, p. 1). We conceptualise 'displacement camps' as areas that primarily host forcibly displaced people (i.e. refugees, asylum seekers, IDPs) and where services are provided to them by governmental and humanitarian actors. This definition encompasses transit centres and facilities hosting asylum seekers.

Our work focuses on faecal-oral pathogens that may be spread through the consumption of contaminated drinking water, among other means. These were extracted from WHO's Guidelines for drinking-water quality (2022) and are presented in Table 1 below. We did not consider pathogens for which there is little evidence of spread through drinking water (e.g. *Ascaris lumbricoides*).

Table 1. Pathogens transmitted through drinking water.

	Pathogen	Type species	Disease
Bacteria	*Burkholderia*	*B. pseudomallei*	Melioidosis
	Campylobacter	*C. coli, C. jejuni*	Campylobacteriosis
	Escherichia coli – Diarrhoeagenic, *E. coli* – Enterohaemorrhagic	*E. coli* O157	*E. coli* infection
	Francisella	*F. tularensis*	Tularemia
	Mycobacteria (non-tuberculous)	*Mycobacterium avium* complex	MAC infection
	Salmonella typhi	–	Typhoid fever
	Other salmonellae	*S. enterica*, *S. bongori*	Salmonellosis
	Shigella	*S. dysenteriae*	Bacillary dysentery; shigellosis
	Vibrio	*V. cholerae* O1 and O139	Cholera
Viruses	Adenoviridae	Adenoviruses	Gastroenteritis
	Astroviridae	Astroviruses	Gastroenteritis
	Caliciviridae	Noroviruses, Sapoviruses	Gastroenteritis
	Hepeviridae	Hepatitis E virus	Hepatitis E; acute jaundice syndrome
	Picornaviridae	Enteroviruses, Parechoviruses, Hepatitis A virus	Polio; gastroenteritis; hepatitis A; acute jaundice syndrome
	Reoviridae	Rotaviruses	Gastroenteritis
Protozoa	*Cryptosporidium*	*C. hominis/parvum*	Cryptosporidiosis
	Cyclospora	*C. cayetanensis*	Cyclosporiasis
	Entamoeba	*E. histolytica*	Amebiasis
	Giardia	*G. intestinalis*	Giardiasis
Helminths	*Dracunculus*	*D. medinensis*	Dracunculiasis

Adapted from the World Health Organisation's Guidelines for drinking-water quality (2022), excluding *Legionella pneumophila*, *Acanthamoeba culbertsoni*, and *Naegleria fowleri* transmitted through the inhalation of water droplets. Diseases were added by the authors. License: CC BY-NC-SA 3.0 IGO.

In line with the work of Phelps et al. (2019), exposure to faecal-oral pathogens was conceived as taking place in the public (e.g. natural environment, marketplace) and domestic (i.e. household) domains through one or multiple vehicles of transmission (i.e. water-, food-, direct contact-, or hygiene-related exposures). Risk factors are individual- or household-level characteristics associated with a higher likelihood of illness, identified through epidemiological studies.

In a scoping literature review, Elimian et al. (2020) identified drivers of recurrent cholera transmission in Nigeria. Similar to their work, we defined drivers of transmission as factors potentially 'causing change in or affecting and shaping' transmission (Elimian et al., 2020, p. 2). These were extracted from outbreak descriptions and represent the circumstances that acted as the backdrop to the outbreaks (e.g. heavy rainfall, malnutrition, inadequate hygiene practices).

Scoping review

A scoping literature review aims to 'identify key characteristics or factors related to a concept' and 'identify and analyse knowledge gaps' (Munn et al., 2018, p. 2). Our specific objective was to provide an overview of the pathogens, risk factors, and exposure routes implicated in outbreaks of faecal-orally transmitted diseases in displacement camps, as well as the drivers of transmission that underlie their recurrence and severity.

The review followed the guidelines presented by Peters et al. (2015) and the PRISMA extension for scoping reviews (Tricco et al., 2018). The filled PRISMA-ScR checklist is available in Appendix A. A stepwise approach based on the framework developed by Arksey and O'Malley (2005) was employed to conduct the review, as described below.

Step 1 – Formulation of research questions

Three research questions were formulated to guide the review:

(1) What outbreaks of faecal-orally transmitted diseases have been described or investigated in displacement camps?

(2) What pathogens, risk factors, and exposure routes have been implicated in outbreaks of faecal-orally transmitted diseases?
(3) What drivers contribute to the recurrence and severity of outbreaks of faecal-orally transmitted diseases in displacement camps?

Step 2 – Identifying relevant records

The search was carried out on the 11th of April 2023 without temporal or geographical restrictions. Records were identified through the databases PubMed, Embase, Scopus, and Web of Science. Epicentre, the WASH Cluster Resource Centre, and Oxfam Digital Repository were checked for grey literature. The reference lists of included publications, and literature reviews that were identified through the screening process, were searched for relevant records.

Keywords and Medical Subject Headings (MeSH) terms (where applicable) were tailored to each database and captured the following concepts: (i) pathogens and diseases, (ii) infectious disease outbreaks, and (iii) displacement camps. The search terms employed in Scopus are presented in Table 2 as an example. The complete search strategy is available in Appendix B.

Step 3 – Selecting the records

Titles and abstracts of English, French, Spanish, and German records were assessed for eligibility using the R metagear package (Lajeunesse, 2016). Two independent reviewers screened the titles and abstracts based on pre-defined inclusion criteria (Table 3). After screening 10% of all records, the reviewers discussed and resolved any discrepancies before continuing to the remaining 90%. Records referring to an outbreak of a faecal-orally transmitted disease in a displacement camp were selected for full-text review.

A final inclusion decision was made through independent full-text reviews conducted by the two reviewers. The aim was to identify records that provided information on the setting (e.g. refugee or

Table 2. Search terms used in Scopus to retrieve records on outbreaks of faecal-orally transmitted diseases in displacement camps.

Concept	Search terms
Pathogens and diseases	'Burkholderia'; 'Melioidosis'; 'Campylobacter*'; 'Escherichia coli'; 'Francisella'; 'Tularemia'; 'Mycobacterium avium complex'; 'Salmonell*'; 'Typhoid fever'; 'Shigell*'; 'Vibrio cholerae'; 'Cholera'; 'Adenovir*'; 'Astrovir*'; 'Calicivir*'; 'Norovirus*'; 'Sapovirus*'; 'Hepeviridae'; 'Hepatitis E'; 'HEV'; 'Picornaviridae'; 'Enterovirus*'; 'Parechovirus*'; 'Hepatitis A'; 'HAV'; 'Reoviridae'; 'Rotavirus*'; 'Cryptosporidium'; 'Cryptosporidiosis'; 'Cyclospora'; 'Cyclosporiasis'; 'Entamoeba'; 'Entamoebiasis'; 'Giardia'; 'Giardiasis'; 'Dracuncul*'; 'Diarrhea*'
Infectious disease outbreaks	'Epidemic*'; 'Outbreak*'
Displacement camps	'Refugee*'; 'Displac*'; 'Asylum seeker*'

Table 3. Inclusion criteria for peer-reviewed and grey literature in a scoping literature review of outbreaks of faecal-orally transmitted diseases in displacement camps.

Inclusion criteria	Definition
Population	Forcibly displaced people (i.e. refugees, asylum seekers, internally displaced persons) residing in displacement camps
Intervention	Description of an outbreak of a faecal-orally transmitted disease (e.g. cholera, shigellosis, typhoid fever, hepatitis E)
Outcome	Pathogens, risk factors, and exposure routes implicated in outbreaks of faecal-orally transmitted diseases in displacement camps, as well as the drivers that underlie their recurrence and severity
Study design	Descriptive and analytical studies and reports
Language	English, French, Spanish, and German
Accessibility	Full text available
Date restrictions	None

IDP camp, transit centre, facility hosting asylum seekers), the disease, the year, as well as a description of environmental health conditions in and around the camp (e.g. water, sanitation, and hygiene [WaSH] facilities, overcrowding) or disease transmission dynamics.

Records that did not meet the inclusion criteria, as well as those that did not present an analysis of new data (e.g. letters to the editor, news headlines, opinion pieces, literature reviews) were excluded. Studies that only describe clinical progression and case management or solely evaluate WaSH interventions and vaccination campaigns were also excluded.

Step 4 – Data charting

A data charting form was developed for the systematic extraction of information from the included records (Appendix C). Data were initially extracted by one reviewer and documented in a Microsoft Excel database. The charting form and database underwent revision by a second reviewer and were iteratively adjusted to ensure the comprehensive extraction of relevant information. Extracted data included the article title, author(s), publication year, journal title, type (e.g. research article, short report), country in which the displacement camp was located, type of forcibly displaced people (i.e. refugees, IDPs, asylum seekers), disease(s), aetiologic agent(s), and any information on drivers of transmission. Risk and protective factors reported through case–control and case–cohort studies were also extracted.

Step 5 – Collating, summarising, and dissemination of results

The numbers of identified and included records are reported through the PRISMA flow diagram. Diseases and pathogens, as well as risk and protective factors identified through case–control and case–cohort studies, were tabulated. Exposure routes were deduced from the identified risk factors. We adapted the classification developed by Elimian et al. (2020) to group drivers of transmission. These were classified into six categories: environmental and climatic, social, WaSH facilities-related, healthcare system-related, behavioural, and biological. Narratively, the linkages between the extracted drivers were explored to better understand the mechanisms underlying the recurrence and severity of outbreaks of faecal-orally transmitted diseases in displacement camps. Countries were grouped by WHO region. Descriptive analyses were conducted on RStudio (Posit Team, 2024), with R version 4.3.3.

Results

Search results

The database search yielded 1,656 records (Figure 1). Duplicate entries were removed, leaving 700 unique records for title and abstract screening. 102 records were retrieved for full-text review, among which 41 satisfied the inclusion criteria. Reference lists yielded seven additional records, culminating in a total of 48 records included in this review. No additional reports were found through portals specific to grey literature.

Record characteristics

Most included records (85% [n = 41]) were published in peer-reviewed journals. 15% (n = 7) constituted grey literature and were published by the Centres for Disease Control and Prevention in the Morbidity and Mortality Weekly Report (12% [n = 6]) or as standalone reports (2% [n = 1]). Records were written in English (94% [n = 45]) and French (6% [n = 3]). All records were published between 1937 and 2022.

Most records (81% [n = 39]) pertained to outbreaks that occurred among refugees. Only 17% (n = 8) described outbreaks among IDPs. One record pertained to both refugees and asylum seekers (2% [n = 1]). Half (52% [n = 25]) of included records were relevant to displacement camps in the African Region. The remainder related to the South-East Asia Region (17% [n = 8]), the Eastern Mediterranean Region (15% [n = 7]), the European Region (10% [n = 5]), the Region of the Americas (4% [n = 2]), and the

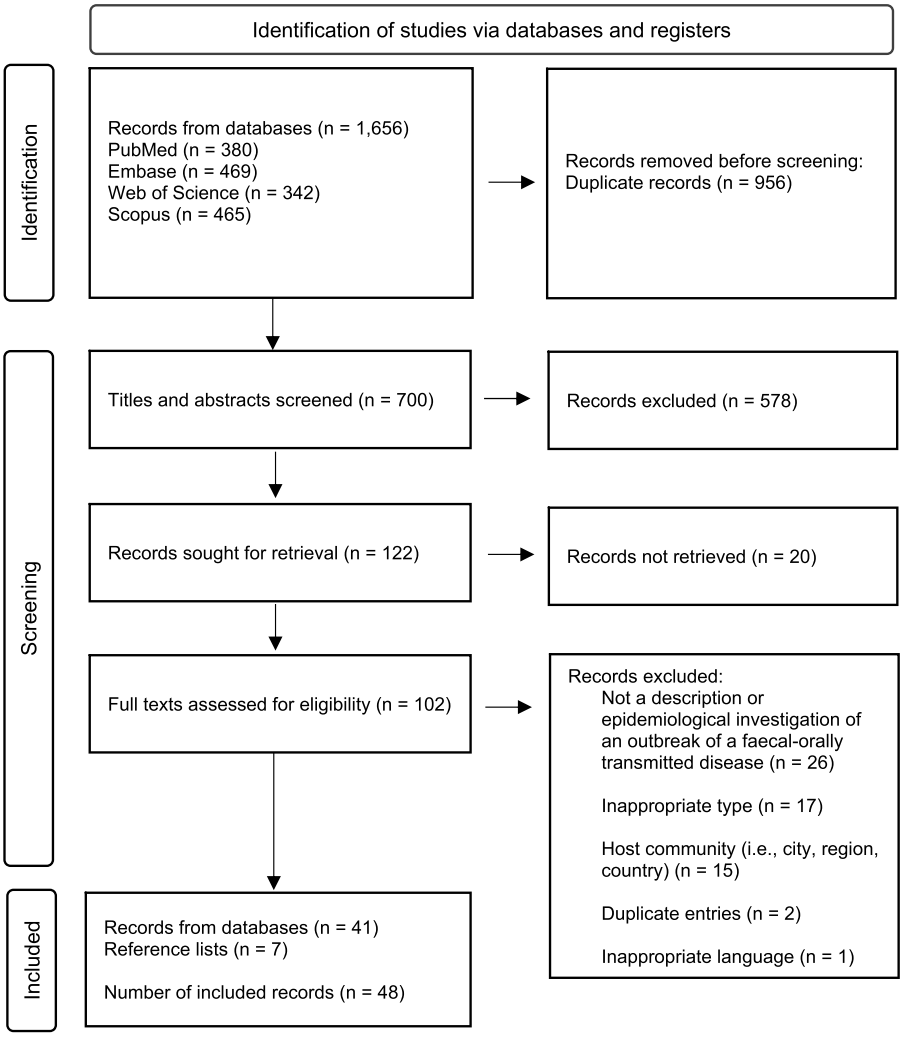

Figure 1. PRISMA diagram for a scoping literature review on outbreaks of faecal-orally transmitted diseases in displacement camps.

Western Pacific Region (2% [n = 1]). Many records described outbreaks in Sudan (15% [n = 7]), Kenya, Malawi, Bangladesh, and the Democratic Republic of the Congo (8% [n = 4], each). Outbreaks reported in Europe occurred in the United Kingdom in 1937, Croatia in 1999, Germany in 2015, and Greece in 2015 and 2016. Two records described an outbreak that occurred in the United States following Hurricane Katrina in 2005. Data on all records included in the review are listed in Appendix D.

Diseases and pathogens

The diseases and pathogens reported in the records are presented in Table 4. The most common diseases were cholera (52% [n = 25]), hepatitis E (19% [n = 9]), and shigellosis (15% [n = 7]).

Risk factors and exposure routes

Ten records reported findings from case–control and case–cohort analyses. Statistically significant risk factors (Table 5) included the consumption of water from shallow wells (Moren et al., 1991),

Table 4. Diseases and pathogens described in records included in a scoping literature review on outbreaks of faecal-orally transmitted diseases in displacement camps ($N = 48$ records).

Disease	*N* (%)[a]	Pathogen	*N* (%)[a]
Cholera	25 (52)	*Vibrio cholerae*	11 (23)
		Vibrio cholerae, Inaba	7 (15)
		Vibrio cholerae, Inaba and Ogawa	5 (10)
		Vibrio cholerae, Ogawa	2 (4)
Hepatitis E	9 (19)	Hepatitis E virus	9 (19)
Shigellosis	7 (15)	*Shigella dysenteriae*	4 (8)
		Shigella dysenteriae; Shigella flexneri	1 (2)
		Shigella flexneri; Shigella sonei	1 (2)
		Shigella, unspecified	1 (2)
Gastroenteritis	4 (8)	Norovirus	3 (6)
		Unspecified	1 (2)
Hepatitis A	3 (6)	Hepatitis A virus	3 (6)
Typhoid fever	2 (4)	*Salmonella typhi*	2 (4)
Diarrhoea	1 (2)	Rotavirus	1 (2)
Acute jaundice syndrome	1 (2)	Unspecified	1 (2)
Bacillary dysentery	1 (2)	Unspecified	1 (2)

[a]Percentages represent the number of records reporting the disease or pathogen divided by the total number of records included in the scoping literature review ($N = 48$). A single record may include more than one disease or pathogen.

Table 5. Risk and protective factors identified through case–control and case–cohort analyses in records included in a scoping literature review on outbreaks of faecal-orally transmitted diseases in displacement camps ($N = 10$ records).

Authors, publication year	Disease	Population	Region[a]	Level of analysis	Risk factors[b]	Protective factors[b]
Morris et al. (1982)	Cholera	Refugees	SEAR	Unspecified	Consumption of ice	NR
Moren et al. (1991)	Cholera	Refugees	AFR	Bivariate	Use of shallow wells	NR
Hatch et al. (1994)	Cholera	Refugees	AFR	Multivariate	Higher number of children under the age of 5; residence in transit centre	Water containers; cooking pots
Swerdlow et al. (1997)	Cholera	Refugees	AFR	Bivariate	Placing hands in water storage containers; drinking river water; consumption of leftover food among those without firewood	Reheating leftover food
Guthmann et al. (2006)	Hepatitis E	IDPs	EMR	Multivariate	Age; consumption of chlorinated surface water	NR
Shultz et al. (2009)	Cholera	Refugees	AFR	Multivariate	Time of arrival; sharing a latrine	Covered water storage containers
Mahamud et al. (2012)	Cholera	Refugees	AFR	Multivariate	Dirty water storage containers	Washing hands with soap
Nyamusore et al. (2018)	Typhoid fever	Refugees	AFR	Multivariate	Family member infected with typhoid fever; poor awareness about typhoid fever; inconsistent handwashing; consumption of food prepared at home or from the community market	NR
Golicha et al. (2018)	Cholera	Refugees	AFR	Multivariate	Human and solid waste in compound; open defecation; sharing food on a common plate	NR
Monje et al. (2020)	Cholera	Refugees	AFR	Bivariate	Drinking stream or tank water	NR

NR: Not reported.
[a]World Health Organisation regions: African Region (AFR), Region of the Americas (AMR), Eastern Mediterranean Region (EMR), European Region (EUR), South-East Asia Region (SEAR), Western Pacific Region (WPR).
[b]Where applicable, reported risk and protective factors were drawn from multivariate regression analyses. Only statistically significant results ($p < 0.05$) are reported.

placing hands in water storage containers (Swerdlow et al., 1997), dirty water containers (Mahamud et al., 2012), the consumption of ice (Morris et al., 1982), and food sharing practices (Golicha et al., 2018). Among the protective factors (Table 5) were the presence of water storage containers and cooking pots (Hatch et al., 1994), covered water storage containers (Shultz et al., 2009), and good handwashing practices (Mahamud et al., 2012). With the exception of two records, all investigated outbreaks among refugees in the African Region.

Four out of the ten records (40%) reported a statistically significant association between illness and exposures in the public domain alone. They implicated water- (Guthmann et al., 2006; Monje et al., 2020; Moren et al., 1991), and food-related exposures as vehicles of transmission (Morris et al., 1982). Two out of the ten records (20%) solely implicated the domestic domain. These indicated food- (Golicha et al., 2018), hygiene- (Golicha et al., 2018), and water-related exposures as vehicles of transmission (Mahamud et al., 2012). Finally, three out of the ten records (30%) indicated exposure to pathogens in both domains, implicating water- (Shultz et al., 2009; Swerdlow et al., 1997), hygiene- (Nyamusore et al., 2018; Shultz et al., 2009), and food-related exposures (Nyamusore et al., 2018; Swerdlow et al., 1997). Out of all ten records, four (40%) indicated more than one vehicle of transmission (Golicha et al., 2018; Nyamusore et al., 2018; Shultz et al., 2009; Swerdlow et al., 1997). No direct contact-related exposures were implicated in the records.

Drivers of faecal-oral transmission

Drivers that may have shaped outbreaks of faecal-orally transmitted diseases in displacement camps are presented in Table 6. The two most commonly mentioned environmental and climatic factors

Table 6. Drivers of transmission extracted from outbreak descriptions in records included in a scoping literature review on outbreaks of faecal-orally transmitted diseases in displacement camps ($N = 48$ records).

	Drivers	Description[a]	Population	Region[b]	*N* (%)[c]
Environmental and climatic	Rainfall or floods	Heavy rainfall or floods that damage WaSH infrastructure, fill pits and trenches with water, and lead to the contamination of water sources.	Refugees	AFR; EMR; SEAR	11 (23)
	Unfavourable soil characteristics	Soil characteristics that hinder the construction of WaSH facilities or impact drainage.	IDPs; Refugees	AFR; EMR; SEAR	7 (15)
	Contaminated water body	Faecal contamination of a surface water body near the camp.	IDPs; Refugees	AFR; EMR; SEAR	3 (6)
	Droughts	Droughts that lead to low river water levels.	Refugees	AFR	2 (4)
Social	Concurrent outbreaks	Outbreaks occurring nationwide or in nearby camps, communities, and neighbouring countries.	Asylum Seekers; IDPs; Refugees	AFR; EMR; EUR; SEAR	24 (50)
	Acute population influx	Population influx into a newly established or already existing displacement camp that leads to overcrowding and overwhelms WaSH facilities and services, in addition to healthcare capacity.	IDPs; Refugees	AFR; AMR; EMR; EUR; SEAR; WPR	22 (46)
	Overcrowding	High population density and overcrowded living conditions in the camp.	Asylum Seekers; IDPs; Refugees	AFR; AMR; EUR; SEAR	16 (33)
	Malnutrition	Malnutrition reported in the displacement camp.	Refugees	AFR; EMR; EUR; SEAR	16 (33)
	Porous boundaries	Movement at the borders of the displacement camp (e.g. informal or	Asylum Seekers;	AFR; EMR; EUR; SEAR	12 (25)

(*Continued*)

Table 6. Continued.

	Drivers	Description[a]	Population	Region[b]	*N* (%)[c]
		formal trade, interaction with the surrounding environment).	IDPs; Refugees		
	Disease endemicity in countries of origin	Disease endemicity in the countries from which forcibly displaced people arrived in the camp.	Asylum Seekers; Refugees	AFR; EMR; EUR; WPR	6 (12)
	Cultural events	Festivals that lead to mobility, food sharing, and crowding.	IDPs	AFR	1 (2)
WaSH facilities-related	Insufficient or inadequate sanitation facilities	Absent, insufficient, or inadequate sanitation facilities that lead to open defecation.	IDPs; Refugees	AFR; AMR; EMR; SEAR; WPR	30 (62)
	Insufficient or inadequate water supply facilities	Absent, insufficient, or inadequate water supply facilities that lead to unreliable water quality and quantity.	IDPs; Refugees	AFR; EMR; EUR; SEAR; WPR	25 (52)
	Poor management of solid waste and animal excreta	Inadequate management of solid waste and animal excreta (e.g. garbage deposited in and around emergency tents).	Refugees	AFR; EUR; SEAR	3 (6)
	Insufficient handwashing facilities	Lack of sufficient handwashing facilities in the displacement camp.	IDPs	AMR	2 (4)
Healthcare system-related	Staff shortage or inexperience	Shortage of healthcare workers or lack of experience and training.	IDPs; Refugees	AFR; EMR	7 (15)
	Lack of resources	Shortage of oral rehydration solution and other therapeutic resources.	Refugees	AFR; EMR	4 (8)
	Nosocomial infections	Nosocomial infections that contribute to an outbreak of a faecal-orally transmitted disease.	Refugees	AFR	2 (4)
	Delays	Delays in the construction of healthcare facilities or outbreak declaration.	IDPs	AFR	1 (2)
	Impaired movement	Impaired movement of healthcare workers due to remote location of the displacement camp.	Refugees	AFR	1 (2)
	Long waiting times	Long waiting times in the healthcare facility.	Refugees	AFR	1 (2)
Behavioural	Use of surface water	Use of surface water for drinking, washing, or bathing.	IDPs; Refugees	AFR; EMR; SEAR	17 (35)
	Open defecation	Open defecation practiced in and around the displacement camp.	IDPs; Refugees	AFR; EMR; EUR; SEAR	17 (35)
	Hygiene practices	Poor hygiene practices. These include inconsistent handwashing and the presence of faeces in households.	Asylum Seekers; IDPs; Refugees	AFR; AMR; EMR; EUR; SEAR; WPR	14 (29)
	Water storage and handling practices	Poor water storage and handling practices. These include placing hands in water storage containers and using dirty containers.	IDPs; Refugees	AFR; EMR	9 (19)
	Food sharing and consumption practices	Food sharing and unsafe consumption practices including the consumption of leftover food without reheating and the preparation of food in unhygienic conditions (e.g. next to open waste trenches).	Refugees	AFR; EUR	6 (12)
	Health seeking behaviour	Delayed presentation to the healthcare facility.	IDPs; Refugees	AFR; EMR	2 (4)
Biological	Antimicrobial resistance	Resistant strains reported in an outbreak of a faecal-orally transmitted disease.	Refugees	AFR; EUR; SEAR	10 (21)

[a]Descriptions were based on the causal links reported by the record authors.
[b]World Health Organisation regions: African Region (AFR), Region of the Americas (AMR), Eastern Mediterranean Region (EMR), European Region (EUR), South-East Asia Region (SEAR), Western Pacific Region (WPR).
[c]Percentages represent the number of records reporting a driver divided by the total number of records included in the scoping literature review ($N = 48$).

were heavy rainfall or floods (23% [n = 11]) and unfavourable soil characteristics affecting drainage or inhibiting the construction of WaSH facilities (15% [n = 7]). Social factors included concurrently occurring outbreaks (50% [n = 24]) and a population influx (46% [n = 22]). Many records alluded to absent or inadequate water facilities leading to unreliable water quantity or quality (52% [n = 25]), and inadequate or insufficient sanitation facilities (62% [n = 30]). Healthcare system-related factors included staff shortage or inexperience (15% [n = 7]) and a lack of resources (8% [n = 4]). Behaviours that may have contributed to the outbreaks were the use of surface water for drinking, washing, or bathing, and open defecation (35% [n = 17], each). Finally, antimicrobial resistance was also reported in a large number of records (21% [n = 10]).

Discussion

Search results and record characteristics

A total of 48 records were included in the scoping literature review, the majority of which were articles published in peer-reviewed journals. Analysing UNHCR data from 2009 to 2017, Altare et al. (2019) reported 123 outbreaks of faecal-orally transmitted diseases in refugee camps with a population exceeding 10,000. Moreover, Desai et al. (2020) identified 60 unique outbreaks of such diseases among forcibly displaced people in camps and enclaves between 1996 and 2016 through reports published on ProMED. Even though some records in our review cover more than one outbreak, there are few journal articles on outbreaks of faecal-orally transmitted diseases in camps, and many outbreak reports may not be easily accessible or remain unpublished.

Outbreaks of faecal-orally transmitted diseases in displacement camps

Cholera outbreaks were the most reported in records included in the review. This is consistent with the work of Behnke et al. (2020), Burnet and Rudge (2019), Cooper et al. (2021), and Desai et al. (2020). Hepatitis E and shigellosis outbreaks were the second and third most reported, respectively. Only North America and Europe reported outbreaks of norovirus, and no studies investigated protozoal or dracunculiasis infections. The absence of records on protozoa in our sample may reflect their relative contribution to the burden of faecal-orally transmitted diseases in the included countries. Moreover, even though protozoa such as *Giardia* spp. and *Cryptosporidium parvum* have been reported in displacement camps in South Sudan (Bliss et al., 2018), Uganda (Oboth et al., 2019), and Sierra Leone (Gbakima et al., 2007), as well as among IDPs in Pakistan (Ahmed et al., 2015), they have only been implicated in one outbreak in refugee camps based on data from 2009 to 2017 (Altare et al., 2019). This may be partly due to limited diagnostic capabilities in low-resource settings (Ma et al., 2022). Nevertheless, these pathogens may at the very least contribute to the endemicity, if not outbreaks, of diarrheal diseases in displacement camps.

Risk factors and exposure routes

Multiple risk and protective factors were identified through case–control and case–cohort studies. These pointed to exposure in both public and domestic domains through multiple vehicles of transmission. More specifically, these studies demonstrated possible exposure to faecal-oral pathogens in public spaces, including shallow wells (Moren et al., 1991), rivers (Swerdlow et al., 1997), streams (Monje et al., 2020), and latrines (Shultz et al., 2009). Exposure may have also taken place within households, where multiple factors have been implicated in the outbreaks, including cooking and food consumption practices (Golicha et al., 2018; Nyamusore et al., 2018; Swerdlow et al., 1997), water storage and handling practices (Mahamud et al., 2012; Shultz et al., 2009; Swerdlow et al., 1997), and the presence of faeces inside compounds (Golicha et al., 2018). These findings highlight the multiplicity of exposure routes specific to outbreaks of faecal-orally transmitted

diseases in camps. However, most of these studies investigated cholera outbreaks while only two concerned outbreaks of typhoid fever and hepatitis E (Guthmann et al., 2006; Nyamusore et al., 2018). It is surprising that only one study explored the transmission dynamics and exposure routes in relation to hepatitis E, especially that it was identified by Desai et al. (2020) to be among the most common disease outbreaks in forced displacement.

Displacement camps as 'open systems'

Camps were often characterised by porosity at their borders. One fourth of records included in the scoping review alluded to interactions between camp inhabitants and their surroundings while describing the outbreak setting. For instance, in Bangladesh, in 1974, some inhabitants of Mohammadpur camp in Dhaka worked in the city (Khan & Shahidullah, 1982). In Kenya, Kakuma and Kalobeyei camps were characterised by movement across their borders and interactions between refugees and local Kenyans (Kisera et al., 2020; Mahamud et al., 2012; Shultz et al., 2009). Trade between refugees and locals may exist even under restricted access to the camps, as was reportedly the case in Tongogara camp in Zimbabwe (Bradley et al., 1996). Interactions between camp inhabitants and their surroundings may also be heightened during religious festivals that involve mobility, crowding, and food sharing (Ngwa et al., 2020). Moreover, half of analysed records alluded to ongoing nationwide outbreaks or relatively concurrent outbreaks in other camps, nearby communities, and neighbouring countries. This implies that the risk of outbreaks in camps may never be sufficiently reduced, so long as epidemics continue to occur in neighbouring communities and countries.

Impact of shocks on outbreaks of faecal-orally transmitted diseases

WaSH facilities and practices, as well as healthcare capacity may be severely hindered by shocks, including extreme weather events and acute population influxes.

Many records included in the scoping review (23% [n = 11]) mentioned heavy rainfall or floods in the outbreak description. These shocks may trigger or exacerbate outbreaks through the destruction of WaSH facilities and the contamination of water sources. For example, in Malawi, two weeks prior to a cholera outbreak that affected Mankhokwe camp, rainfall destroyed half of the camp latrines, possibly leading to the contamination of the wells used for drinking (Moren et al., 1991). In Sudan, rainfall and flooding reportedly facilitated a cholera outbreak affecting Shagarab East One and Shagarab East Two camps (Mulholland, 1985). During the outbreak, storms and subsequent floods left stagnant pools of water in holes and trenches previously used for defecation. This stagnant water was used by the camp inhabitants for washing and possibly drinking to avoid long queues at the water collection points (Mulholland, 1985). The impact of extreme weather events may be more pronounced in settings characterised by poor drainage conditions (Mulholland, 1985; Sørensen & Dissler, 1988). This finding is not surprising given that heavy rainfall and floods have been identified as the two most common water-related weather events preceding waterborne disease outbreaks in developed and developing countries (Cann et al., 2013). Acute population influxes were also mentioned in a large proportion of records (46% [n = 22]). These shocks overwhelm WaSH services and healthcare capacity, contribute to overcrowding, and exacerbate any outbreak that may occur if a pathogen were to be introduced into a displacement camp. For instance, in 1994, the arrival of around 500,000–800,000 refugees into the Democratic Republic of the Congo (formerly Zaire) overwhelmed the response capacity of the government and humanitarian organisations (Goma Epidemiology Group, 1995). Likewise, in Kenya, the arrival of new refugees reportedly exceeded WaSH capacity in Kakuma and Kalobeyei camps, leading to a reliance on surface water (Kisera et al., 2020). These causal links are presented in Figure 2.

The consequences of extreme weather events and acute population influxes in camps were previously alluded to by Shannon et al. (2019), and more explicitly laid out by Burnet and Rudge (2019). Through their work, Burnet and Rudge (2019) reported that diarrheal disease outbreaks in camps often occurred following a population influx and highlighted the role of soil characteristics

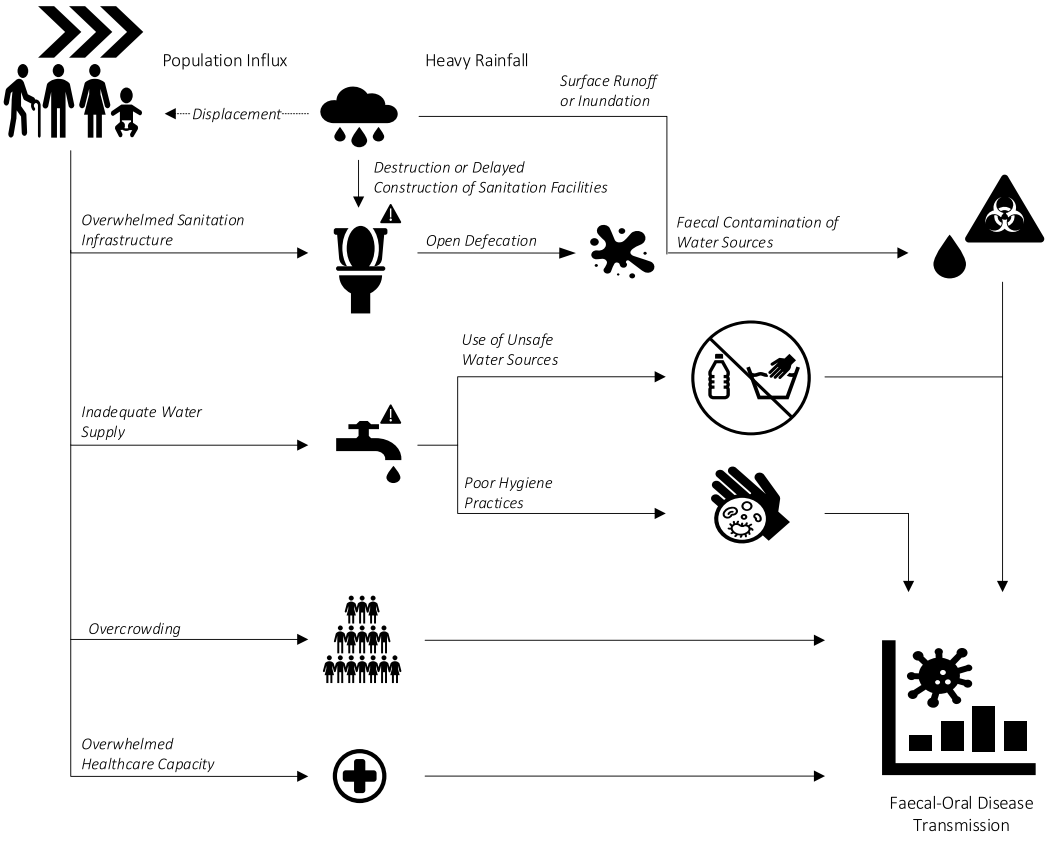

Figure 2. Impact of extreme weather events and acute population influxes on outbreaks of faecal-orally transmitted diseases in displacement camps.

and extreme weather events in such outbreaks. Our work not only reaffirms their findings, but also suggests that these shocks may play a role in outbreaks of hepatitis A and E in camps.

Recent arrivals in displacement camps

Several accounts of cholera outbreaks have pointed to a higher risk of illness among new arrivals in displacement camps (Mulholland, 1985; Shultz et al., 2009; Swerdlow et al., 1997). For instance, in Sudan, the first cholera cases originated from the area housing the most recent arrivals and later spread throughout the camp (Mulholland, 1985). More clearly, Swerdlow et al. (1997) reported that the outbreak mainly affected new arrivals. It was suggested that new arrivals may have lacked prior immunity to *V. cholerae*, and given their distance from the wells, resorted to drinking from surface water sources. Likewise, in Kakuma camp, recent arrivals were at an increased risk for illness, possibly due to a lack of immunity to *V. cholerae*, a predominance of unsafe WaSH practices, or the placement of new arrivals in areas where cholera cases were clustering (Shultz et al., 2009). *V. cholerae* may also be introduced into displacement camps by recent arrivals as was reportedly the case in Uganda (Bwire et al., 2021; Monje et al., 2020) and Sudan (Mulholland, 1985).

Limitations

Our study had several limitations. First, full texts of two records in Spanish that were identified through title and abstract screening could not be retrieved. Accordingly, these records were not

included in our analysis. This may explain why no reports or journal articles from Latin America were found. Moreover, our search was restricted to four electronic databases, as well as Epicentre, the WASH Cluster Resource Centre, and Oxfam Digital Repository. Any studies or reports published elsewhere would have been omitted. However, given that the included records spanned all WHO regions and presented a distribution relatively similar to that reported by Desai et al. (2020) we do not believe that substantial information was missed. Second, there was great variability in depth of reporting in the included records. Hence, we could not systematically explore the co-occurrence of drivers of transmission or conduct subgroup analyses. Third, although data extraction was conducted systematically using a detailed data charting form, the lack of depth and clarity in some records resulted in a degree of subjectivity when interpreting their content. Finally, due to the scope of this literature review, its findings cannot be generalised beyond outbreaks in displacement camps.

Conclusion

This scoping review is the first to provide a comprehensive overview of the pathogens, risk factors, exposure routes, and drivers of transmission implicated in outbreaks of faecal-orally transmitted diseases in displacement camps.

Cholera outbreaks were the most reported and described. This finding may not reflect the frequency of cholera outbreaks relative to outbreaks of other faecal-orally transmitted diseases due to reporting or publication bias. To ascertain the frequency and severity of these outbreaks in camps, we suggest creating an openly accessible database that tracks infectious disease outbreaks among all forcibly displaced people, enabling a detailed analysis of trends and patterns. This would require expanded testing for faecal-oral pathogens, as well as standardised reporting tools across agencies and international organisations.

Several case–control and case–cohort studies identified risk factors suggesting exposure to faecal-oral pathogens in both public and domestic domains through water-, food-, and hygiene-related exposures. However, most of these studies pertained to cholera outbreaks. Accordingly, more research is needed in camps to identify exposure routes to pathogens other than *V. cholerae*, including the hepatitis E virus.

Our review also uncovered multiple drivers of transmission that may contribute to the recurrence and severity of outbreaks of faecal-orally transmitted diseases in camps. Among these, extreme weather events and acute population influxes warrant explicit recommendations in outbreak preparedness and response guidelines. Moreover, WaSH development projects and timely outbreak response measures in surrounding areas can reduce the risk of outbreaks in displacement camps. Moving forward, a comprehensive analysis of the interdependencies between, and co-occurrence of, drivers of transmission is necessary to further untangle causal links and identify critical drivers whose effects cascade throughout the socio-ecological system. This, however, cannot be achieved without the systematic investigation and reporting of environmental and climatic, social, behavioural, WaSH facilities-related, healthcare system-related, and biological drivers of transmission in published and easily accessible outbreak reports.

Finally, some records indicated that new arrivals in camps were at a higher risk of illness. Therefore, we recommend that outbreak investigations take into account the date of arrival and thoroughly examine the factors that underlie any differential risk. This also suggests that there may be value in targeting forcibly displaced people with WaSH interventions and other public health measures upon arrival in a displacement camp.

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Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

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