Vulnerability and One Health assessment approaches for infectious threats from a social science perspective: a systematic scoping review

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Vulnerability assessments identify vulnerable groups and can promote effective community engagement in responding to and mitigating destabilising events. This scoping review maps assessments for local-level vulnerabilities in the context of infectious threats. We searched various databases for articles written between 1978 and 2019. Eligible documents assessed local-level vulnerability, focusing on infectious threats and antimicrobial resistance. Since few studies provided this dual focus, we included tools from climate change and disaster risk reduction literature that engaged the community in the assessment. We considered studies using a One Health approach as essential for identifying vulnerability risk factors for zoonotic disease affecting humans. Of the 5390 records, we selected 36 articles for review. This scoping review fills a gap regarding vulnerability assessments by combining insights from various approaches: local-level understandings of vulnerability involving community perspectives; studies of social and ecological factors relevant to exposure; and integrated quantitative and qualitative methods that make generalisations based on direct observation. The findings inform the development of new tools to identify vulnerabilities and their relation to social and natural environments.

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Introduction

Infectious diseases such as COVID-19, severe acute respiratory syndrome, Middle East respiratory syndrome, and Ebola virus disease have attracted global attention due to their scope, severity, and infectious nature. 75% of emerging infectious threats are zoonotic diseases.[1] Akin to zoonotic pathogens, drug-resistant microbes spread between animals and humans who share the same ecosystems.[1] Infectious threats and antimicrobial resistance are not just medical problems, but emerge within and have an influence on political, economic, social, cultural, and ecological contexts.

Infectious diseases might disproportionally affect socioeconomically disadvantaged people, marginalised people, and individuals living in unstable political conditions. Similarly, people might be more susceptible due to pre-existing conditions (eg, diabetes or heart disease) and social practices that contribute to or predispose them to disease. The current COVID-19 pandemic shows that working conditions might contribute to the susceptibility of some occupational groups (eg, health-care workers).[2,3]

Vulnerable populations should, therefore, constitute a key concern of planetary health. Although all human beings are potentially susceptible to infectious diseases, social, economic, political, and health inequalities produced by a convergence of local and global processes—in interaction with destabilising events—can exacerbate these vulnerabilities, rendering some individuals less able to adhere to prevention and control strategies than others.

Many research disciplines working in the context of disaster research or climate change—have developed conceptual frameworks on vulnerability, which has led to multiple definitions of the term and various assessment approaches.[4,5] To illustrate this variety, we list the conceptions of vulnerability derived from climate change, political ecology, disaster research, and social sciences.

The fifth report (AR5) of the International Panel of Climate Change[6] defines vulnerability as a component of risk, coupled with exposure and hazard. A hazard is a potential natural or anthropogenic disaster causing damage to infrastructure and ecosystems, death, or injury. Exposure refers to people, other species, or infrastructure facing these events. Vulnerability is the predisposition for being adversely affected.[6] Contrary to other definitions, vulnerability here is understood in relation to a means for handling adverse conditions (coping); the capability to adjust to possible damage (adaptive capacity); and susceptibility (or sensitivity), which is the degree of positive or harmful consequences of climate change on a system.[6]

Key messages

- Vulnerability to infectious threats is not just a biological issue—it is also embedded in socioecological factors and practices that contribute or predispose people to diseases
- Social context and processes that make people vulnerable need to be considered during vulnerability assessments
- Including multiple stakeholders at various levels (eg, decision makers, representatives, and community members) in the assessment process enhances the effectiveness and legitimacy of subsequent interventions
- Perceptions of how diseases are transmitted and how risks are perceived often differ within social groups; vulnerability assessments conducted in the context of infectious threats should seek to understand these differences
- Applying integrated mixed-methods and using a One Health approach can provide a contextual understanding of vulnerability to infectious threats

However, vulnerability is also shaped by socioeconomic, political, and institutional contexts. According to the political ecology framework, marginalised people often live close to hazardous areas or are less able to cope with and adapt to external pressures compared with the general population due to having fewer resources, inadequate infrastructure, and marginalisation from decision making. It is therefore important to understand the root causes of vulnerability and why some groups are less able to adapt to hazards.[7,8]

In the field of disaster research, Cutter and colleagues[9] consider vulnerability as related to hazard exposure and the ability to cope with, adapt to, and recover from a hazard (as influenced by social, cultural, economic, and historical contexts). Hazard potential is influenced by the geographical place and the aforementioned social aspects. Cutter and colleagues identified the most common variables of social vulnerability to create a quantitative vulnerability index, thereby making social vulnerability a measurable entity on a large-scale basis.

Although large-scale assessments of social vulnerability are a valuable contribution to the field, vulnerability assessments should also take place at a local level, among groups of people in a more or less limited geographical or virtual environment. These assessments should take into account how vulnerability varies across time and according to context. From a biosocial perspective, social scientists have argued that vulnerability and ill health are deeply embedded in the historical, cultural, infrastructural, economic, and political environment.[10–12] While established categories of vulnerability are still pertinent, the specifics of the local context and within-group differences among marginalised groups might go unnoticed. To provide locally meaningful interventions, vulnerability assessments need to include the local factors that drive vulnerability. Social scientists (and ethnographers in particular) can play a major role in this regard.

Vulnerability is also a matter of perception,[7] and those affected might conceive some hazards as more threatening than the hazards important to public health experts or governmental organisations. Affected people might also have developed distrust of these institutions, as seen during the COVID-19 pandemic. Further, perceptions of how viruses and bacteria are transmitted often differ within particular social groups, and local understandings of biological risk and vulnerability might differ substantially.[13]

Assessments with a participatory approach can be useful, as they actively involve the people whose vulnerabilities are being assessed. The strength of participatory assessments resides in their local applicability—ie, in their ability to acknowledge and build upon local perceptions, values, and systems of meaning.[14] Participatory assessments strengthen community engagement and increase the chance that vulnerabilities are addressed and worked on in a way that integrates both top-down efforts (eg, provision of resources and infrastructure) and bottom-up efforts (eg, in-group decision making and culturally sensitive approaches).[15] Although participatory approaches are sometimes criticised for their subjectivity, their strength resides in their ability to engage diverse stakeholders and to provide a differentiated understanding of vulnerability across social sectors.[14] Moreover, engaging people in identifying their own needs and susceptibilities can not only foster a more thorough understanding of risk at community levels, but can also help circumvent the pitfall of ascribing vulnerability to particular groups, making them permanent victims.[11]

To tackle susceptibility to the potential burden of newly emerging diseases, it is necessary to consider human health as linked to animal health and the surrounding environment. Closer interaction with animals (eg, through consumption or through human settlement in newly inhabited areas) increases the possibility for diseases to spread, which is accelerated by the movement of people, animals, and goods.[16] The interdependence of species in ecosystems is mirrored in the concept of One Health. Due to the complex interconnections, the One Health approach considers cross-sector collaboration and cooperation between disciplines such as veterinary medicine, biomedicine, and public health.[17] As such, the One Health approach has become an appropriate means for tackling zoonotic diseases, antimicrobial resistance, and other threats to health.[16,18]

Social relations and human behaviour and practices play a central role in many One Health challenges (eg, infectious diseases), therefore a social science contribution is crucial.[17,19] According to Craddock and Hinchliffe,[20] social sciences can contribute to focusing on uneven geographies (eg, highlighting how unequal power relations and access to resources influence vulnerabilities and outbreak responses), and redistributing expertise (eg, listening to communities immediately affected by epidemics to provide the most suitable response that the community understands and trusts).[20]

Although a global focus is implicit to One Health, local-level and context-specific understandings are necessary to account for socioeconomic conditions; the cultural context; complex relations between host, pathogens, and environment; and social relations that contribute to disease.[19] By focusing on One Health studies that embrace the need for social science engagement in examining human exposure to zoonotic diseases, we are able to determine how local agricultural and dietary practices affect susceptibility at the level of disease transmission and mitigation.[13,20] This broader perspective enables an understanding of how human interactions with the natural environment lead to the spread and prevalence of diseases, and how society is susceptible to the potential burden of these diseases.[21] For this reason, we included studies employing a One Health approach in our search criteria, and especially those that consider exposure to zoonotic diseases as facilitated by complex, context-specific interactions between humans, animals, and the environment.

The main purpose of this scoping review was to examine how local-level vulnerability assessments were being conducted, for application in an infectious disease context. This scoping review synthesises knowledge about the assessment of vulnerabilities from different disciplines and tools developed by non-governmental organisations (NGOs) in non-academic contexts. Broadening our search in this manner allowed us to identify several instruments that matched our focus on local, context-specific vulnerabilities. We examined the tools and studies in terms of how they were conducted (ie, method, data collection, level of assessment, phase of assessment, and duration) to help readers choose the tool best fit for their planned intervention.

Methods

Scoping reviews synthesise evidence to identify and chart studies. The aim is either to scope out the available evidence (pointing to knowledge gaps and examining concepts), or to determine how research on a particular topic is performed, including research methods.[22–24] The main purpose of this scoping review is to examine, for application in an infectious context, how local-level vulnerability assessments are being conducted.

Search strategy and selection criteria

For this systematic scoping review, we used Napier's so-called barefoot manual (unpublished) as a reference document, since its premise is to identify local-level vulnerabilities. The manual acknowledges that some people are more prone to disasters because of their background and living conditions, and it focuses on processes that lead to contextual vulnerabilities that are not immediately obvious.

We developed a search strategy together with the librarian at the Medical University of Vienna (appendix, pp 2–4), which was conducted between March and April, 2019 to Ovid Medline, Global Health database (Ovid), Web of Science, and Embase. We adapted the search for Epistemonikos, Global Index Medicus, and African Journals Online, as these databases only permit a simplified search strategy. We ran an additional search in selected databases (Ovid Medline, Web of Science, and Embase) in Nov 4, 2019 to add the most recent publications. Throughout, we used a search flow diagram to map the number of records retrieved from databases, screened papers, eligible papers, and included studies (figure 1).[60]

The following main terms were included in the search (an elaborate search string can be found in the appendix pp 2–4).

vulnerab*, disadvant*, at risk*, marginal*, population*, group*, people*, communit*, qualitat*, quantitat*, participat*, assess*, approach*, analys*, evaluat*, context*, amr, antimicrobial resistance*, antibiotic*, antimicrob*, antibacterial*, antifungal*, antiparasit*, infectious disease*, hemorrhagic fever*, ebola*, lassa*, marburg virus, rift valley fever, measles, influenza, disaster*, outbreak*, disaster planning, pandemic*, endemic*, natural disaster*, climate change, crisis, crises, natural hazard*, emergency, one health, human* environment*, zoonotic* disease*, zoonos*, vector born*, one medicin*

Peer-reviewed articles were taken into consideration alongside reports from NGOs and non-profit organisations (NPOs) written in English between 1978 and 2019. We screened irrespective of method: quantitative, qualitative, and mixed-methods studies, ethnographies, and case studies were all relevant.

See Online for appendix

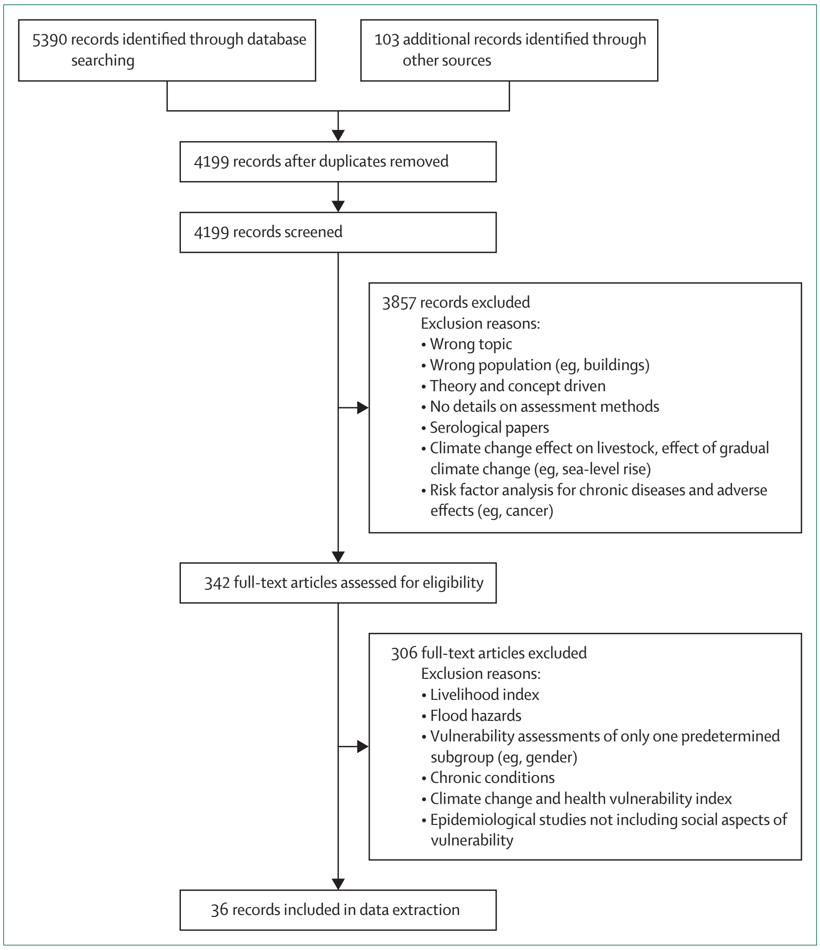

***Figure 1:* Study selection**[25,26]

We categorised all included documents into two broad themes of primary hazards to which vulnerability is assessed: biological hazards (which here includes infectious diseases and zoonotic diseases), and natural hazards (comprising of disasters and consequences of climate change that manifest over a long period of time). Within each theme, the papers were grouped according to overall assessment methods, since the overarching goal of this scoping review was to review tools for application in on-the-ground assessments. Most of the assessments were conducted in Africa,[14,21,27–34] followed by North America,[35–37] Asia,[38–42] and Europe.[43] The remaining papers were how-to manuals that were not bound to a specific country.[44–49] One Health studies were conducted in Africa[50–58] and Asia.[59] The included One Health studies did not assess vulnerability per se, but rather exposure to disease, and are therefore discussed separately.

We searched for grey literature in OpenGrey and on selected websites (Medbox, Social Science in Humanitarian Action, Social Science Research Network, Assessment Capacities Project, and Measure Evaluation). We also contacted 20 NGOs, NPOs, and selected governmental organisations directly with inquiries as to existing vulnerability assessment tools, allowing us to include five additional practical guides currently in use.[21,27,44–46]

Two researchers (MJ and LL) independently reviewed all titles and abstracts, labelling each study with reasons for inclusion or exclusion. Four members of the research team (MJ, LL, EJ-P, and RK) independently read the full texts in groups of two. The screening was blinded, so that reviewers' decisions were not visible until the discussion on conflicting results. Subsequent discussion rounds helped minimise ambiguity, resolve conflicts, and clarify further exclusion decisions.

Eligible documents assessed local-level vulnerability, targeting infectious threats and antimicrobial resistance. Since very few studies provided this focus, we included existing vulnerability assessment research in the context of climate change and disaster risk reduction that involved the perspective of vulnerable groups (eg, through a participatory approach). Although many of these assessments were based on Cutter's social vulnerability index[61] (yielding valuable insight into vulnerability assessment on a larger scale), we included these articles only when they were either integrated into local assessments or applied in the context of infectious threats.[28,47] Studies were excluded when they assessed vulnerability to chronic conditions, were globally rather than locally focused,[62] were conceptual or terminological in nature (eg, the study by Hammer and colleagues),[63] or assessed country capacity to respond to health threats.[64]

Studies specifically using a One Health approach were selected when they focused on understanding how social and cultural practices, perceptions, and behaviours influenced human–animal–environment interactions.

	Name of the tool or study topic	Document type	Location	Threat
ACAPS[27]	Ebola needs analysis project assessment	Non-peer reviewed	Sierra Leone	Ebola virus disease
Bwire et al[29]	Epidemiology of cholera outbreaks	Peer-reviewed	Uganda	Cholera
Geerlings and Heffernan[30]	Composite risk index	Peer-reviewed	Egypt	Influenza A virus H5N1
Kaba et al[31]	Vulnerability to HIV infection	Peer-reviewed	Ethiopia	HIV
Kienberger and Hagenlocher[21]	Holistic conceptual risk and vulnerability framework	Peer-reviewed	East African Community	Vector-borne diseases
Li et al[39]	K-prototypes clustering algorithm to cluster vulnerable populations	Peer-reviewed	China	Malaria
Stanturf et al[28]	Social vulnerability classification	Peer-reviewed	Liberia	Ebola virus disease

ACAPS=The Assessment Capacities Project.

Table 1: **Study characteristics of vulnerability assessments in the context of infectious threats**

Data analysis

As a guideline, we used the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist[60] and published a protocol in BMJ Open.[5] Three team members (MJ, LL, and EJ-P) extracted data by reviewing included texts and coding full-text passages according to topical variables. We followed an iterative process, during which deductively predetermined variables (according to methods, process, duration, and purpose of the assessment) were complemented with further variables that emerged from the studies as notable—eg, point in time of assessment (for preparedness, response, recovery, or mitigation), or level of assessment (eg, community or population level). Articles employing a One Health approach were extracted separately according to a similar spread of topical variables, but with a focus on methods and findings. We did not assess the quality of each study's methods, which is in line with guidelines for scoping reviews.[24,25]

Results

The literature search yielded 5390 articles from scientific databases and 103 articles from grey literature (figure 1). 36 documents were retained for the systematic review after de-duplication, title and abstract screening, and full-text reading. All included documents were written in English.

Key variables of study characteristics according to the PRISMA-ScR Checklist[60]—such as author, year, name of the tool or topic of the study, document type, country, and threat—are depicted in tables 1, 2, and 3. Key characteristics extracted from studies reviewed are provided in figure 2. Information on the process of vulnerability assessment (ie, assessment method, use of primary or secondary data, level of assessment, purpose of assessment, and duration) is charted in table 4.

The following section is divided into three sub-sections, beginning with an overview of vulnerability assessment tools tailored to infectious threats, followed by vulnerability assessments in the natural hazard context and One Health studies on human–animal interactions in relation to zoonotic diseases.

Infectious threats

We found that most tools assessing social vulnerability in relation to infectious diseases were quantitative. Seven documents assessed social vulnerability in the context of infectious diseases.[21,27,28,30,31,39] Although our search strategy was geared towards antimicrobial resistance using a wide range of search terms (appendix pp 2–4), we found no vulnerability instruments related to antimicrobial resistance within our eligibility criteria.

In this section we present each article separately due to the heterogeneity of the tools. The articles differ in the methods used (quantitative, qualitative, or mixed methods), their approach to assess vulnerability (indicator-based *vs* non-indicator based), the point in time when the assessment was done (retrospective *vs* prospective, before

	Name of the tool or study topic	Document type	Location	Threat
ActionAid[48]	Participatory vulnerability analysis	Non-peer reviewed	NA	Disasters
Ahmed et al[38]	Disaster risk perception and vulnerability	Peer-reviewed	India	Climate change
CDC[47]	Identification of at-risk groups	Non-peer reviewed	NA	Disasters
Dazé et al[45]	Climate vulnerability and capacity analysis handbook	Non-peer reviewed	NA	Climate change
Dilshad et al[40]	Root causes and drivers of social vulnerabilities	Peer-reviewed	Hindu Kush Himalayan region	Climate change
IFRC[44]	Vulnerability and capacity assessment	Non-peer reviewed	NA	Disasters
Jonsson and Lundgren[43]	Vulnerability and adaptation to heat	Peer-reviewed	Sweden	Climate change
Kuchimanchi et al[41]	Community-driven vulnerability evaluation – programme designer tool	Peer-reviewed	India	Climate change
Labbé et al[33]	Vulnerability to the health effects of climate variability	Peer-reviewed	Uganda	Climate change
Mayfield-Johnson et al[35]	Vulnerability and social resiliency	Peer-reviewed	Mississippi Gulf Coast	Disasters
Morchain and Kelsey[46]	Vulnerability and risk assessment methodology	Non-peer reviewed	NA	Disasters
Napier (unpublished)	Barefoot manual	Non-peer reviewed	NA	Disasters
Owusu Nursey-Bray[34]	Social vulnerability of urban slum residents	Peer-reviewed	Ghana	Climate change
Raemaekers and Sowman[32]	Rapid vulnerability assessment	Non-peer reviewed	South Africa, Namibia, and Angola	Climate change
Rickless et al[37]	Social vulnerability index integrated with local perceptions	Peer-reviewed	Georgia	Climate change
Springgate et al[36]	Post-disaster community needs assessment	Peer-reviewed	New Orleans	Disasters
Tiani et al[14]	Center for international forestry research vulnerability assessment	Non-peer reviewed	Congo Basin	Climate change
Tripartite Core Group[42]	Periodic review	Non-peer reviewed	Myanmar	Disasters
UNHCR[49]	The heightened risk identification tool user guide	Non-peer reviewed	NA	Disasters

CDC=The Centers for Disease Control and Prevention. IFRC=The International Federation of Red Cross and Red Crescent Societies. NA=not applicable. UNHCR=The UN High Commissioner for Refugees.

Table 2: **Study characteristics of vulnerability assessments in the context of natural hazards**

	Topic of the study	Document type	Country	Threat
Bonwitt et al[50]	Routes of exposure (hunting, preparation, and consumption of rodents)	Peer-reviewed	Sierra Leone	Lassa fever
Bonwitt et al[51]	Pathways of infection within domestic spaces	Peer-reviewed	Sierra Leone	Lassa fever
Dione et al[55]	Risk perception and risk practices that lead to spread of disease	Peer-reviewed	Uganda	African Swine Fever
Dzingirai et al[53]	Differentiated exposure (who, when, and where is at risk)	Peer-reviewed	Sierra Leone, Kenya, Ghana, and Zimbabwe	Lassa Fever, Rift Valley Fever, Henipavirus, Trypanosomiasis
Islam et al[59]	Reasons for repeated outbreaks (risk practices and cultural and socioeconomic factors that lead to the spread of disease)	Peer-reviewed	Bangladesh	Anthrax
Kamins et al[58]	Risk perception; risk practices that lead to contact with bats	Peer-reviewed	Ghana	Bat-borne zoonosis
Lawson et al[56]	Risk perception; risk practices that could lead to zoonotic spillover from bats	Peer-reviewed	Ghana	Henipavirus
Leach et al[52]	People–ecosystem–livelihood dynamics and exposure to pathogen carrying wildlife	Peer-reviewed	Sierra Leone, Kenya, Ghana, Zimbabwe, and Zambia	Lassa fever, Rift Valley Fever, henipaviruses, Human African trypanosomiasis in Zambia and Zimbabwe
Narat et al[57]	Exposure frequency and specific ecologies of non-human primate species	Peer-reviewed	Cameroon	NA
Sitali et al[54]	Perceptions, beliefs, and practices that influence disease transmission	Peer-reviewed	Zambia	Anthrax

Table 3: **Study characteristics of One Health articles**

vs after a disease outbreak), and the level of assessment (population *vs* community level).

Three of the papers assessed vulnerability through an epidemiological lens. Li and colleagues[39] used a k-prototypes clustering algorithm to assemble susceptible populations according to the variables sex, age, and occupation. The authors studied malaria cases in Tengchong County, China over a nine-year period, and identified temporal variation and the demographic structure of the affected population. Bwire and colleagues[29] reviewed epidemiological data from Uganda's Ministry of Health on cholera outbreaks in selected communities. Rainfall data was used to consider seasonal patterns of outbreaks, and socioeconomic factors and practices that

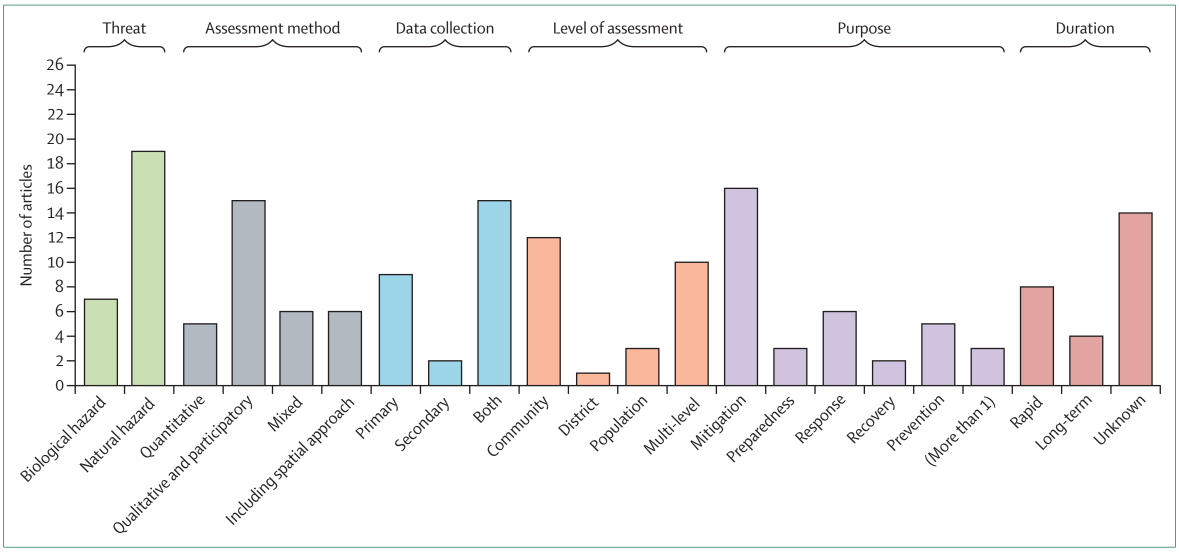

Figure 2: **Key characteristics extracted from reviewed articles (n=26)**
This figure shows how many of the 26 assessment documents fall in each category of the extracted key characteristics (summarised in overall categories: threat, assessment method, data collection, level of assessment, purpose, and duration). Details are depicted in table 4.

foster vulnerability were examined using household surveys. The Assessment Capacities Project (ACAPS)[27] analysed the effect of Ebola virus disease on multiple sectors (eg, health and education) in Sierra Leone by seeking the perspective of various community members. ACAPS identified susceptible groups by sector and across sectors.

Two indicator-based papers mapped the spatial distribution of social vulnerability, although in different ways. Kienberger and Hagenlocher[21] developed a holistic conceptual risk and vulnerability framework for vector-borne diseases in East Africa. Kienberger and Hagenlocher used the AR5[65] definition of vulnerability to identify 15 social vulnerability indicators that were categorised according to both biological (eg, immunity) and generic (eg, poverty) susceptibility and capacity to cope with and anticipate disease. This categorisation was then weighted by experts. The vulnerability index was calculated for homogeneous units and areas of high and low vulnerability and is visualised through maps. Stanturf and colleagues[28] adapted the social vulnerability index to an Ebola virus disease outbreak using secondary data in a data-poor context. Stanturf and colleagues selected census variables on the basis of five dimensions of poverty (eg, economic) to construct their vulnerability index. Through cluster analysis, the authors classified social vulnerability of rural districts in Liberia.

Another indicator-based tool, although without a spatial mapping component, employs a mixed-methods approach. Geerlings and Heffernan[30] created a Composite Risk Index (CRI) to identify groups susceptible to A(H5N1) avian influenza in Egypt, on the basis of seven indicators from a literature review (eg, previous flock exposure from past outbreaks in households). Index data were gathered from interviews and group discussions with female poultry keepers of poor governorates. CRI scores were calculated for each community, with the highest scores relating to food insecurity.

Kaba and colleagues[31] used qualitative methods to map urban spaces in Ethiopia to identify where residents are most susceptible to HIV infection. Based on expert consultations and focus group discussions with the affected population, Kaba and colleagues provide an understanding of how overcrowded housing is both an indicator and an enabling factor for exposure risk and vulnerability-enabling practices.

Natural hazards

19 documents assessed social vulnerability in the context of climate change and disaster risk reduction, either qualitatively or with a mixed-methods approach.

We identified six participatory vulnerability assessments tools[14,32,44–46,48] and eight documents that engaged participants in the assessment process.[33,35,36,38,40,41,43,49] These tools and assessments collaborate with affected people to identify which vulnerabilities or challenges exist within the group, and where capacities need to adapt to climate change or resist disasters in the long run. The tools and assessments either encourage participation with participatory methods, or involve participants in all stages of the research and assessment process. For example, in Springgate and colleagues' study,[36] stakeholders were involved in designing and conducting the research and analysing the findings. Through feedback loops, members of the general public were also included to reflect and comment on the results. The Vulnerability and Capacity Assessment tool[44] works with affected people to address

	Threat		Assessment method					Data collection			Level of assessment				Purpose of assessment					Duration		
	Biological hazard	Natural hazard	Quantitative	Qualitative	+ participatory*	Mixed	+ spatial†	Primary	Secondary	Both	Community	Population	Multilevel	Spatial	Mitigation	Preparedness	Response	Recovery	Prevention‡	Rapid§	Long-term¶	NA
ACAPS[27]	x	..	x	..	..	..	..	..	..	x	..	x	..	..	..	..	x	..	..	x	..	..
ActionAid[48]	..	x	..	..	x	..	..	..	..	x	..	..	x	..	x	x	x	..	..	..	..	x
Ahmed et al[38]	..	x	..	..	x	..	..	x	..	..	x	..	..	..	x	..	..	..	..	x	..	..
Bwire et al[29]	x	..	x	..	..	..	..	..	..	x	x	..	..	..	..	..	..	..	x	..	x	..
CDC[47]	..	x	..	..	..	x	x	..	..	x	..	..	x	x	x	x	x	x	..	..	..	x
Dazé et al[45]	..	x	..	..	x	..	..	..	..	x	..	..	x	..	x	..	..	..	..	..	..	x
Dilshad et al[40]	..	x	..	..	x	..	..	..	..	x	x	..	..	..	x	..	..	..	..	..	..	x
Geerlings and Heffernan[30]	x	..	..	..	..	x	..	..	..	x	x	..	..	..	..	..	..	..	x	x	..	..
IFRC[44]	..	x	..	..	x	..	..	..	..	x	x	..	..	..	x	x	..	..	..	..	..	x
Jonsson and Lundgren[43]	..	x	..	..	x	..	..	..	..	x	..	..	x	..	x	..	..	..	..	..	..	x
Kaba et al[31]	x	..	..	x	..	..	..	x	..	..	x	..	..	x	..	..	..	..	x	..	..	x
Kienberger and Haenlocher[21]	x	..	x	..	..	..	x	..	..	x	..	x	..	x	..	..	..	..	x	..	..	x
Kuchimanchi et al[41]	..	x	..	..	x	..	..	..	..	x	x	..	..	..	x	..	..	..	..	..	..	x
Labbé et al[33]	..	x	..	..	x	..	..	x	..	..	..	..	x	..	x	..	..		..	..	..	x
Li et al[39]	x	..	x	..	..	..	..	..	x	..	..	x	v	..		..	..		x	..	..	x
Mayfield-Johnson et al[35]	..	x	..	..	x	..	..	x	..	..	..	..	x	..	x	..	..	..	..	..	..	x
Morchain and Kelsey[46]	..	x	..	..	x	..	..	..	..	x	..	..	x	..	x	..	..	..	..	x	..	..
Napier (unpublished)	..	x	..	..	..	x	..	x	..	..	..	..	x	..	..	..	x	..	..	x	..	..
Owusu et al[34]	..	x	..	..	..	x	..	x	..	..	x	..	..	..	x	..	..	..	..	..	x	..
Raemaekers and Sowman[32]	..	x	..	..	x	..	..	..	..	x	x	..	..	..	x	..	..	..	..	x	..	..
Rickless et al[37]	..	x	..	..	..	x	x	..	..	x	..	..	x	x	x	..	..	..	..	..	..	x
Springgate et al[36]	..	x	..	..	x	..	..	x	..	..	x	..	..	..	..	..	..	x	..	..	x	..
Stanturf et al[28]	x	..	x	..	..	..	x	..	x	..	x	..	..	x	..	..	x	..	..	x	..	..
Tiani et al[14]	..	x	..	..	x	..	..	..	..	x	x	..	..	..	x	..	..	..	..	..	x	..
Tripartite Core Group[42]	..	x	..	..	..	x	x	x	..	..	..	..	x	x	..	..	..	x	..	x	..	..
UNHCR[49]	..	x	..	..	x	..	..	x	..	..	x	..	..	..	x	..	..	..	..	..	..	x

CDC=The Centers for Disease Control and Prevention. IFRC=The International Federation of Red Cross and Red Crescent Societies. UNHCR=The UN High Commissioner for Refugees. *Qualitative study or tool with a participatory approach. †Study or tool using a spatial mapping approach. ‡Assess vulnerability to reduce disease burden, target control interventions, or raise awareness. §No longer than 3 months. ¶Longer than 3 months.

Table 4: **Key characteristics of reviewed vulnerability assessments**

underlying causes of vulnerability. The project goal changes and grows throughout the assessment process, especially if community members conclude that their daily problems (eg, traffic accidents), are more important than resolving disaster effects.

Participatory tools provide a range of participatory methods from which the user can choose, such as hazard mapping (to illustrate resources in a village and hazards that affect the village and its residents), seasonal calendars (depicting key activities and changes during a year), and historical timelines (to reflect upon past threats).[14,32,44–46,48] One study[43] developed a vulnerability factor card game, which allowed participants to explore vulnerability, effects, and adaptive responses.

Most studies undertake assessments at various levels (eg, national, community, regional, or individual levels),[33,35,43,45,46,48] or involve perspectives of multiple different stakeholders (eg, community members, NGO representatives, or decision makers).[32,33,36,40,41,43,45,46,48] Involving different stakeholders at different levels allows for a diverse understanding of vulnerability from multiple perspectives, and the subjectivity inherent in this approach is minimised.[14] Other assessment tools use a mixed-methods approach[34] or provide the option to integrate qualitative and quantitative data.[37,42,47]

Napier's barefoot manual (unpublished) is conceptualised as a tool to provide local, context-specific information on vulnerability and to identify networks that are capable of building social capacity during unstable situations. By using this tool, a qualitative assessment can be integrated into a large-scale quantitative household survey.

The Centers for Disease Control and Prevention (CDC)[47] provides strategies to identify and map susceptible populations through the CDC's social vulnerability index (composed of 14 social factors), which can be combined with data from the individual or community level. Registries are used for individuals to self-identify as vulnerable, and community outreach information networks are used to locate at-risk groups at the community level in case of disaster.

The Tripartite Core Group[42] use spatial sampling to select areas in which to conduct a large-scale quantitative survey. Through qualitative interviews at the household level, additional in-depth data are provided and integrated into the large-scale household survey. Rickless and colleagues[37] promote the integration of local perceptions with the social vulnerability index (which is based on census data). Rickless and colleagues compare the results of both approaches and, by mapping similarities and differences, provide a more comprehensive picture of vulnerability—for example, they show that social relations are essential coping strategies for participants, which is not taken into account by the social vulnerability index in its original model.

One Health

The ten One Health studies included in this scoping review focus on risk perception and risk practices that lead to the spread of zoonotic diseases or zoonotic spillover,[50,54–56,58,59] either on contact frequency to non-human primate bodily fluids[57] or on differential exposure to disease.[51–53] Most of these studies are long-term, mixed-methods studies that are part of a multidisciplinary research project linking population surveys or epidemiological data with local realities, examined through qualitative, participatory approaches.

Six studies focused on risk perception and risk practices of people interacting with animals such as bats or cattle.[50,54–56,58,59] Lawson and colleagues[56] located feeding places and bat roost sites in Ghana, and identified particular groups of people as being at greatest risk of zoonotic spillover—eg, fruit farmers who ate bat meat. Dione and colleagues[55] delved into practices and perspectives of farmers, veterinarians, and traders in the pig value chain in Uganda and identified individuals at greatest and lowest risk of spreading African swine fever. The results illustrate multiple factors at play, such as socioeconomic reasons (eg, farmers selling pigs during outbreaks to avoid economic losses) and context-specific practices (eg, slaughtering in backyards under poor hygienic conditions) that contribute to the spread of African swine fever. This context-specific detail, which is sensitive to local risk perceptions and behaviours, provides information on potential at-risk groups and discloses practices that foster transmission. These details could play an essential role in controlling the spread of disease.

Four studies[51–53,57] provided a differentiated view on disease exposure, either by emphasising social components, time and place specific aspects, or exposure frequency. Dzingirai and colleagues[53] used a One Health approach and developed a social difference space–time framework. By applying this framework in four case studies (Lassa Fever in Sierra Leone, Rift Valley Fever in Kenya, Henipah Virus in Ghana, and Trypanosomiasis in Zimbabwe), Dzingirai and colleagues show how exposure is related to time (eg, seasonal variation and influence on vectors), space (eg, variation of exposure by sites), and social aspects such as gender, ethnicity, and occupation. Bonwitt and colleagues[51] focused on exposure to Lassa fever within domestic spaces in Sierra Leone, studying animal behaviour within the home and the effect of housing structures on rodent infestations. Bonwitt and colleagues[51] found that rats frequently enter houses and urinate on household members or contaminate leftover food, which some people cannot afford to throw away. Narat and colleagues[57] studied the frequency at which humans were coming into contact with various species of non-human primates (eg, monkeys, great apes, and chimpanzees) in Cameroon. The risk of direct exposure to body fluids—the biggest risk factor for transmission—is high for hunters as they butcher and prepare the meat before it is sold at markets. Moreover, higher species abundance and proximity to human settlements is associated with increased exposure and contact frequency.

Together, the selected One Health studies provide contextual understandings of disease risk and a socially diverse view on exposure. The studies also take into consideration time and place specific factors, and they view social elements as encompassing more than just humans.

Discussion

This systematic scoping review provides an overview of vulnerability assessments in the context of infectious threats and natural hazards, as well as One Health studies including qualitative, participatory approaches that discern human–animal–environment interactions and socioecological practices. Broadening our review across sectors to include climate change, disaster risk reduction tools, and One Health studies with a social science engagement was a useful strategy. The following paragraphs will discern how different elements of the reviewed tools from different disciplines can be productively combined.

Our focus on social vulnerability comes from an understanding that infectious diseases are bound to biological factors, but take place within specific political, social, economic, and cultural contexts. Other reviews propose integrating social and behavioural factors into infectious disease models and have shown how social and behavioural science and epidemiological research can be combined to enhance response effectiveness.[66,67] Similarly, we consider social science-driven approaches that assess vulnerability as complementary to more traditional epidemiological and medical disciplines.

The focus on the local level highlights how vulnerability-enabling factors play out in a specific context, and how vulnerabilities result from the multifold effects of infectious threats that otherwise go unnoticed. In this scoping review, we found participatory approaches and the social-science sensitivities of One Health studies particularly useful contributions to vulnerability assessments for infectious diseases.

Approaches used in the reviewed assessments were either quantitative (eg, surveys, social vulnerability index, or indicator-based with a spatial approach), qualitative (eg, participatory research or tools), mixed-methods, or integrated quantitative and qualitative methods.

Quantitative indicators and universal categories of vulnerability (eg, age, gender, and ethnicity) serve the purpose of operationalising vulnerability and making it a measurable entity. However, these indicators do not necessarily correspond with how people perceive their own vulnerability or key threats.[7,37,68] Some social factors, such as social ties, culture-specific practices, inter-sectionality, or cross-cutting issues[42] (ie, how different vulnerabilities overlap or how one vulnerability-enabling factor leads to many others) are difficult to measure by a social vulnerability index or by quantitative surveys.

Assessing the utility of any given health vulnerability assessment should, then, be based on its ability to address local values and context-specific issues.

Participatory tools from climate change and disaster risk reduction research provide grounds for people to actively engage in identifying vulnerability. These tools aim to understand people's perception of key threats, structural causes of vulnerability, adaptive capacity, and capacity development. These assessments often take place at multiple levels (eg, national and community), yielding a pluralistic understanding of vulnerability. This focus on collaboration, shared ownership, and coproductive practices[69] might enhance effectiveness and legitimacy of an intervention.[53] Ultimately, most of these tools are mitigation tools, and aim to reduce vulnerability before a disaster takes place. The participatory approach can be linked to co-production in health care, which focuses on integrating people's knowledge in decision making processes.[70] Co-production processes produce more than just knowledge—they develop capacity, build networks, foster social capital, and implement actions that contribute to sustainability.[69] Further, when conducted on multiple levels, vulnerability assessments can inform stakeholder dialogues and strengthen community–stakeholder communication. The COVID-19 pandemic has shown the importance of social trust and the challenge of building back trust that has been lost.[10]

In comparison to participatory tools, One Health studies do not assess vulnerability or place specific emphasis on adaptive capacity and capacity development. However, participatory tools and One Health studies do share a focus on engaging communities. The reviewed One Health studies aim to mitigate risks faced by the most susceptible populations on the planet. By analysing risk perception, differentiated exposure to diseases, and risk practices that foster transmission or zoonotic spillover, these studies can play a key role in preventing or minimising the effects of an outbreak and the risk for those who are susceptible (whether due to biological or social factors). Certain aspects of a One Health approach—such as focusing on practices that place people at risk of disease—should be integrated into a participatory vulnerability assessment or infectious threat tool to provide additional insights on exposure and transmission.

We found the absence of tools geared towards antimicrobial vulnerability assessments at a local level particularly apparent. Antimicrobial resistance and climate change share several characteristics: both have been developing over time on a global scale and pose an imminent threat; and both are related to overuse of resources.[71] To prevent and minimise the effects of climate change and antimicrobial resistance, mitigation and adaptation measures are needed, in addition to action across sectors and on national, community, and individual scales.[72] Mitigation efforts should include slowing the development of antimicrobial resistance by reducing antibiotic use.[72] On the community level, engaging people can help to tackle social and ecological issues that are specific to a particular area, including bottom-up advocacy, and co-developing solutions to antimicrobial resistance.[73] This process of engagement can help in understanding how structural level issues manifest and shape possibilities at a local level.[74] Including policy makers or experts in these processes might reduce potential conflicts between the priorities of policy makers and the needs of community members, and might thus make these mitigation projects more sustainable.

A participatory assessment paired with a One Health approach could be particularly suitable for application for antimicrobial resistance assessment. One Health has been reported to be an essential approach for tackling antimicrobial resistance given the rapid dissemination of resistant microbes among humans, animals, and environment.[75] Participatory assessments with a One Health approach take place at multiple levels, engage multiple stakeholders, and focus on mitigation and adaptation, thus are useful for making locally meaningful changes and supporting communities in finding their own context-specific solutions.[76]

A final note on applicability—all One Health studies were long-term (between three months and one year). This duration facilitates in-depth exploration, but might be inappropriate in the acute phase of an outbreak when there is a need for rapid assessments. Similarly, none of the tools reviewed were designed to be used as an immediate response to a disease outbreak.

In the early phase of a disease outbreak, efforts to identify susceptible groups could have an adverse effect, making people more susceptible—eg, by putting participants at risk of infection during face-to-face interviews. Further, labelling people as vulnerable or uncovering illegal practices (eg, hunting or consumption of animals) could lead to stigma.[53] Therefore, personal protection measures (eg, protecting participants and individuals conducting the assessment) and other potential infection risks and fears need to be addressed. Likewise, the premise of some participatory tools—eg, to include participants into all phases of the assessment process—might not be feasible during an infectious disease outbreak. Quantitative, index-based assessment tools do have advantages in this regard. If appropriate, these assessments could be paired with a qualitative, participatory, One Health-oriented assessment to yield context-specific, long-lasting response measures to an outbreak.

Limitations and conclusion

The systematic scoping review design enabled us to integrate work from various disciplines. However, during the iterative review process we narrowed down and redefined the exclusion criteria, which led to the exclusion of papers that were otherwise valuable to our overall study goals. We prioritised focus over completeness. Due to the number of grey literature publications, we did not assess each document's methodological quality. Therefore, this scoping review also points to the general difficulty in comparing scientifically structured peer-reviewed articles and comprehensive guidelines that aim to guide the user in conducting an assessment.

Overall, the results of this scoping review support the integration of social components into vulnerability assessments to meet the complex challenges posed by infectious threats and antimicrobial resistance. The results also point to the need for more study. The focus on locally manifested vulnerabilities might appear at odds with the preoccupations of planetary health; however, as recent events illustrate, not only can local zoonotic spillovers cumulate into global pandemics, the consequences of and responses to these global events vary considerably. Attention to local vulnerabilities in the face of global infectious threats are of great importance in shoring up capacities to respond effectively to the wide-ranging global health effect of pandemics in general, and COVID-19 in particular.

Contributors
TG-V, ADN, MLAD, and RK conceived the idea. RK, MLAD, and MJ conceptualised the research. MJ and LL reviewed all titles and abstracts. MJ, LL, EJ-P, and RK read all full texts. MJ, LL, and EJ-P extracted data. MJ wrote the review, LL participated in writing and editing the manuscript. MLAD, TG-V, ADN, and RK reviewed and edited the manuscript.

Declaration of interests
We declare no competing interests.

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