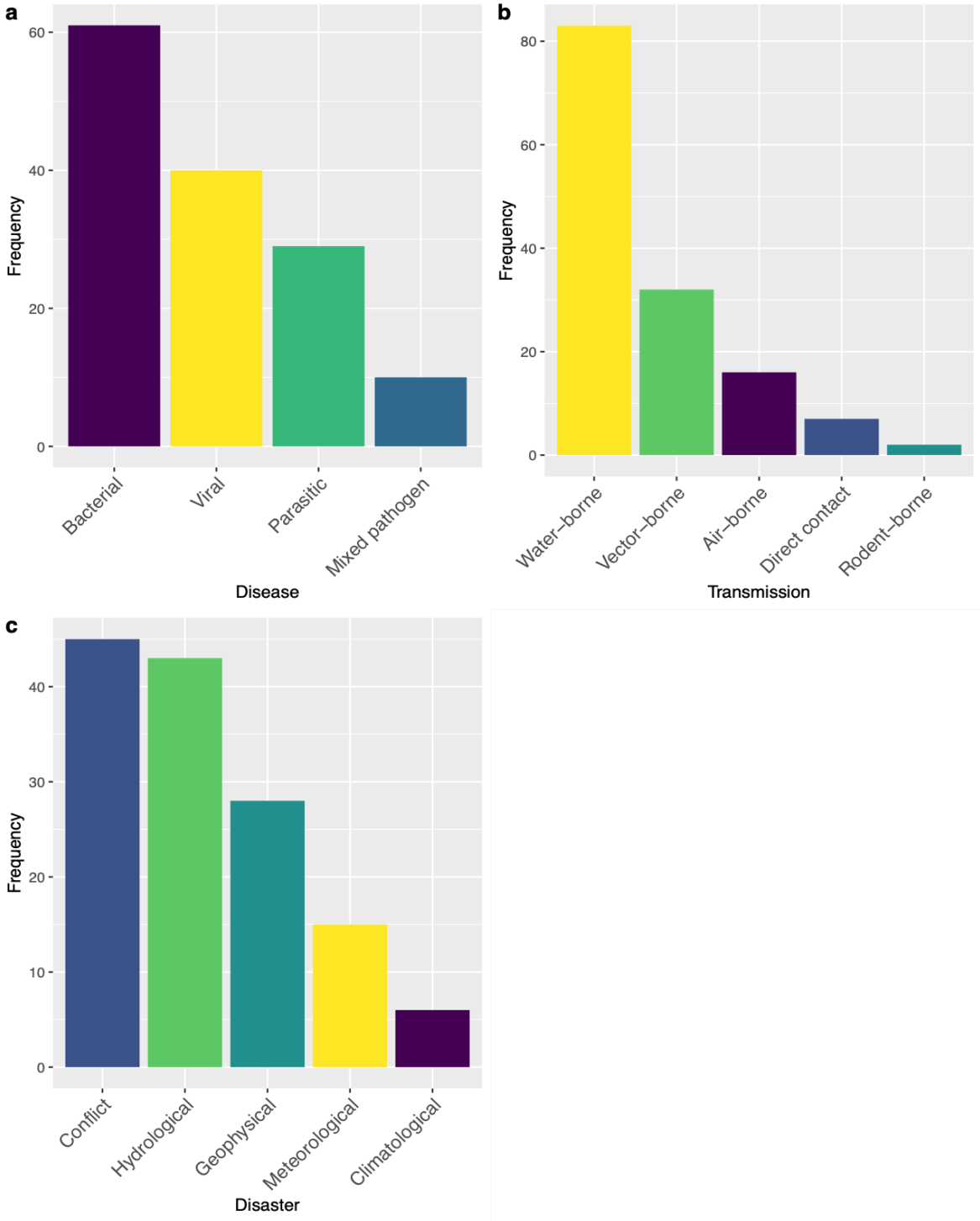
Supplementary Information

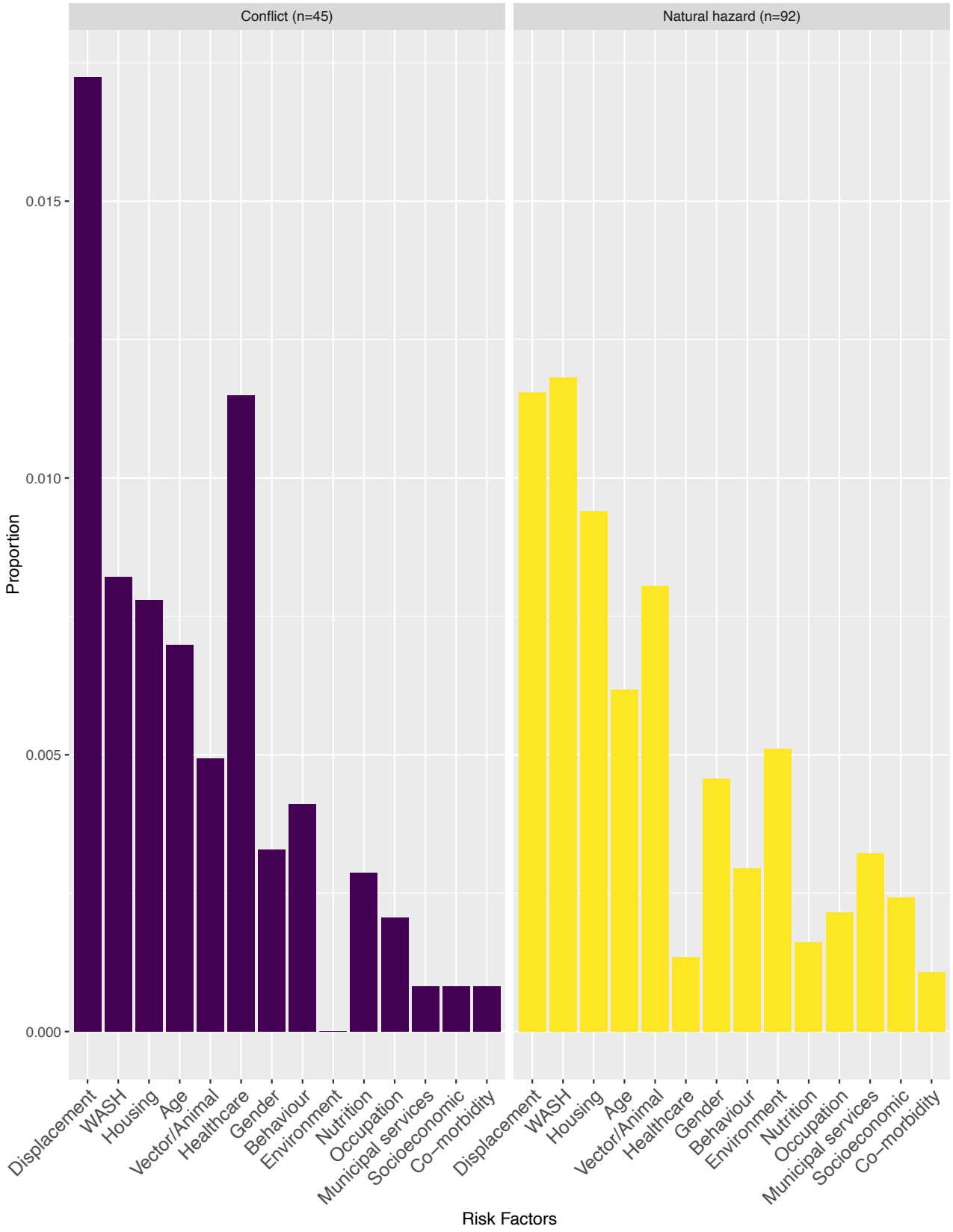
Traits and risk factors of post-disaster infectious disease outbreaks: a systematic review

Gina E C Charnley, Ilan Kelman, Katy A M Gaythorpe, Kris A Murray

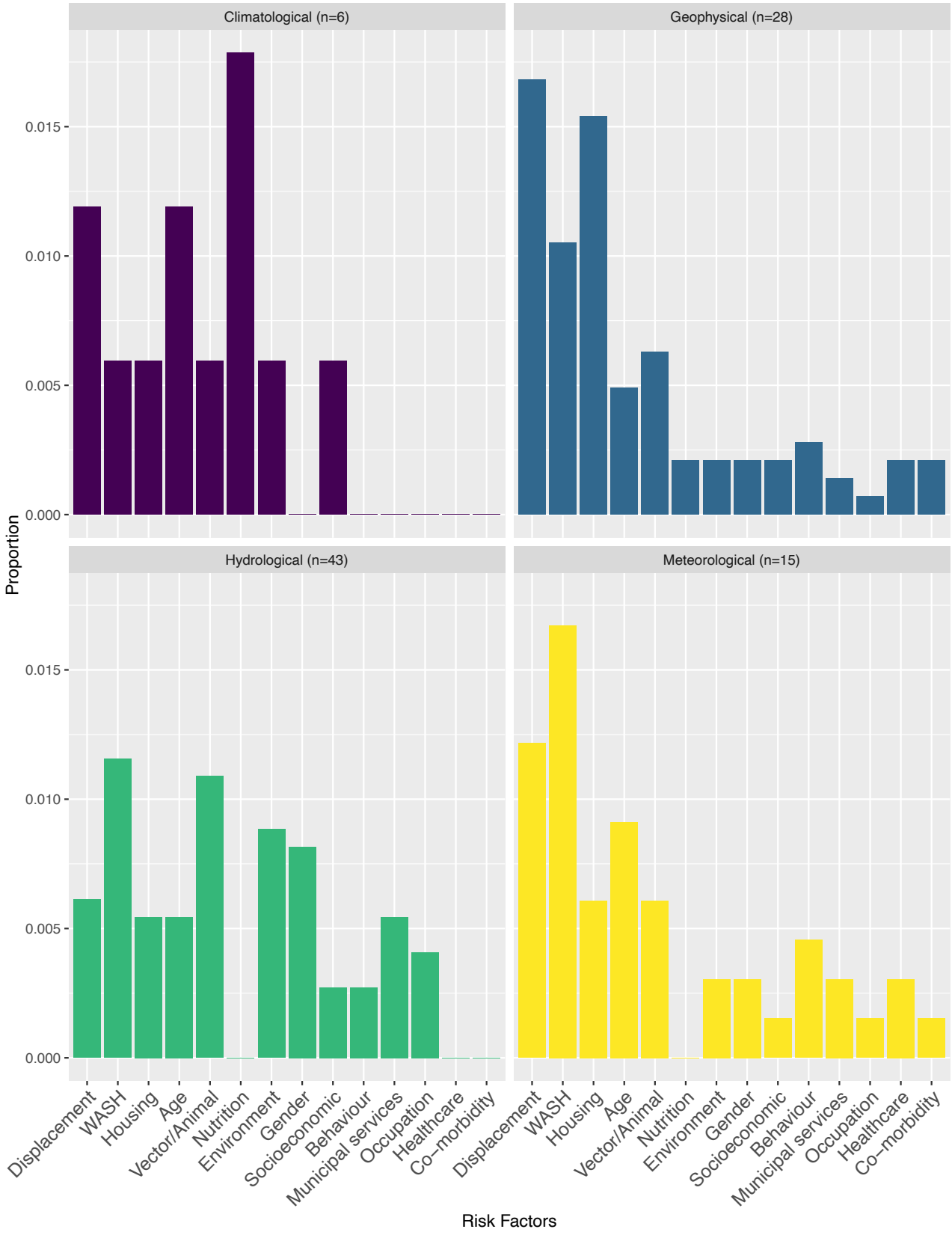
Supplementary Figures



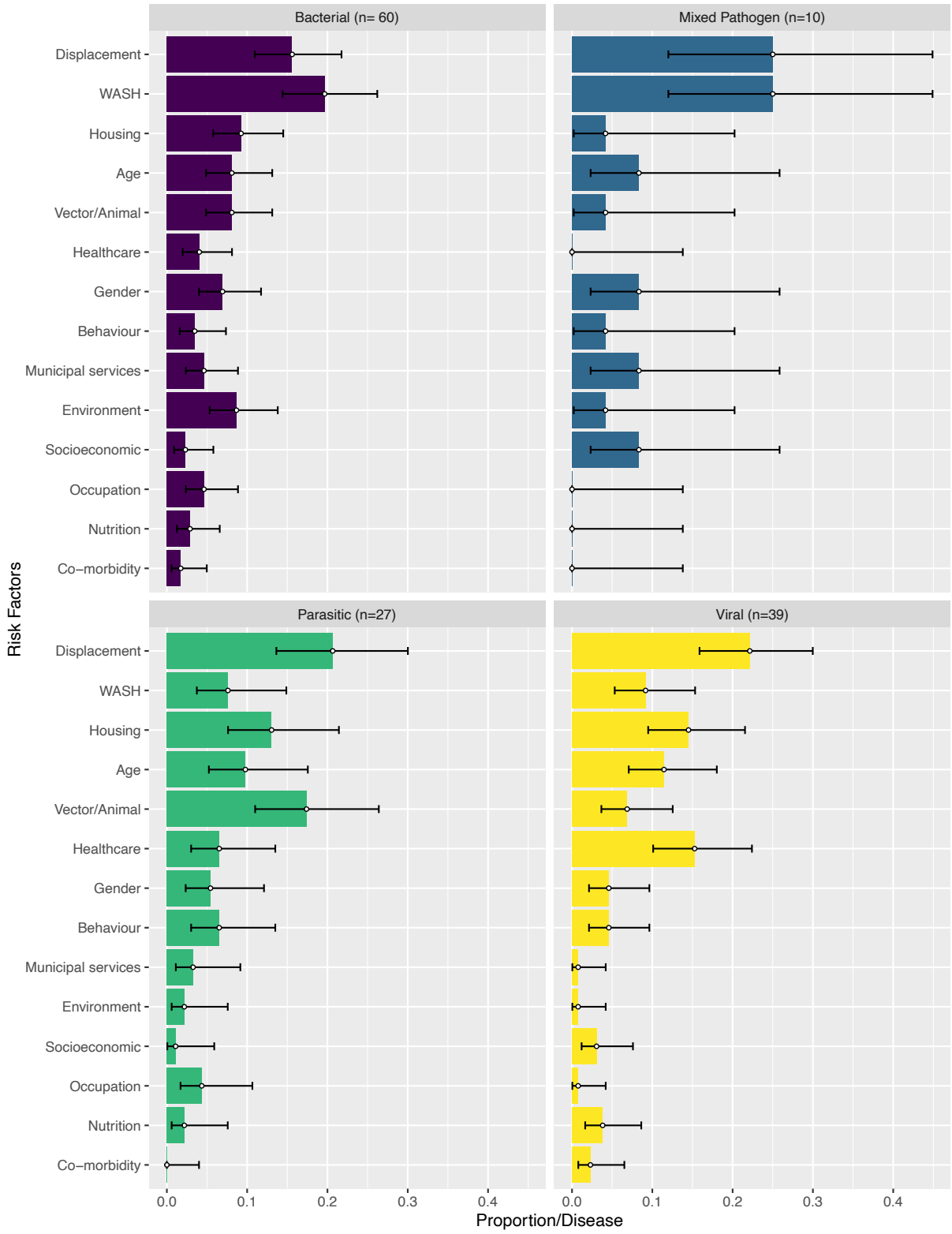
Supplementary Figure 1: Frequencies of reported disaster-related outbreaks separated into a, disease, b, disease transmission (n=140) and c, disaster (n=137)



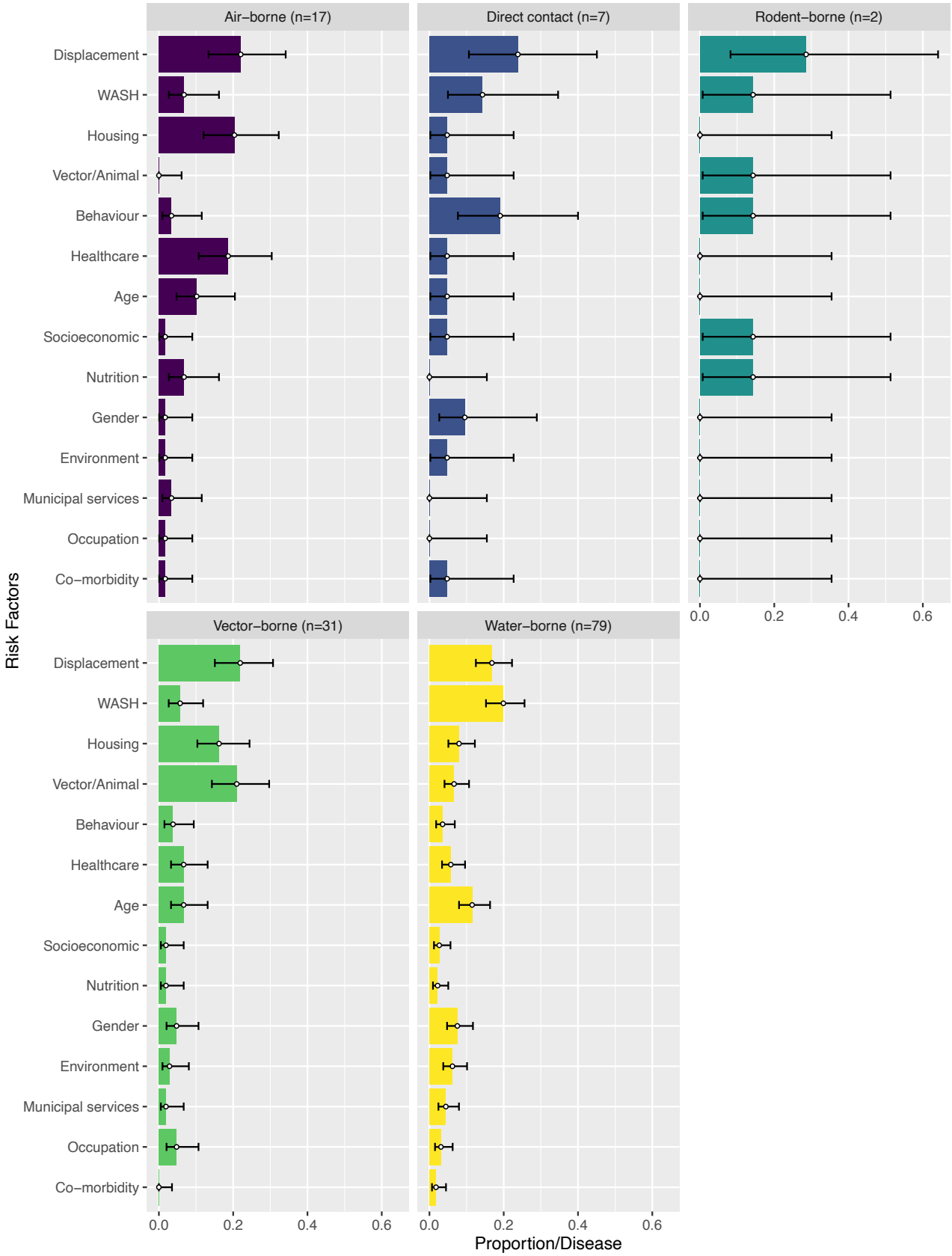
Supplementary Figure 2: Proportions of reported risk factor clusters against conflict and natural hazards



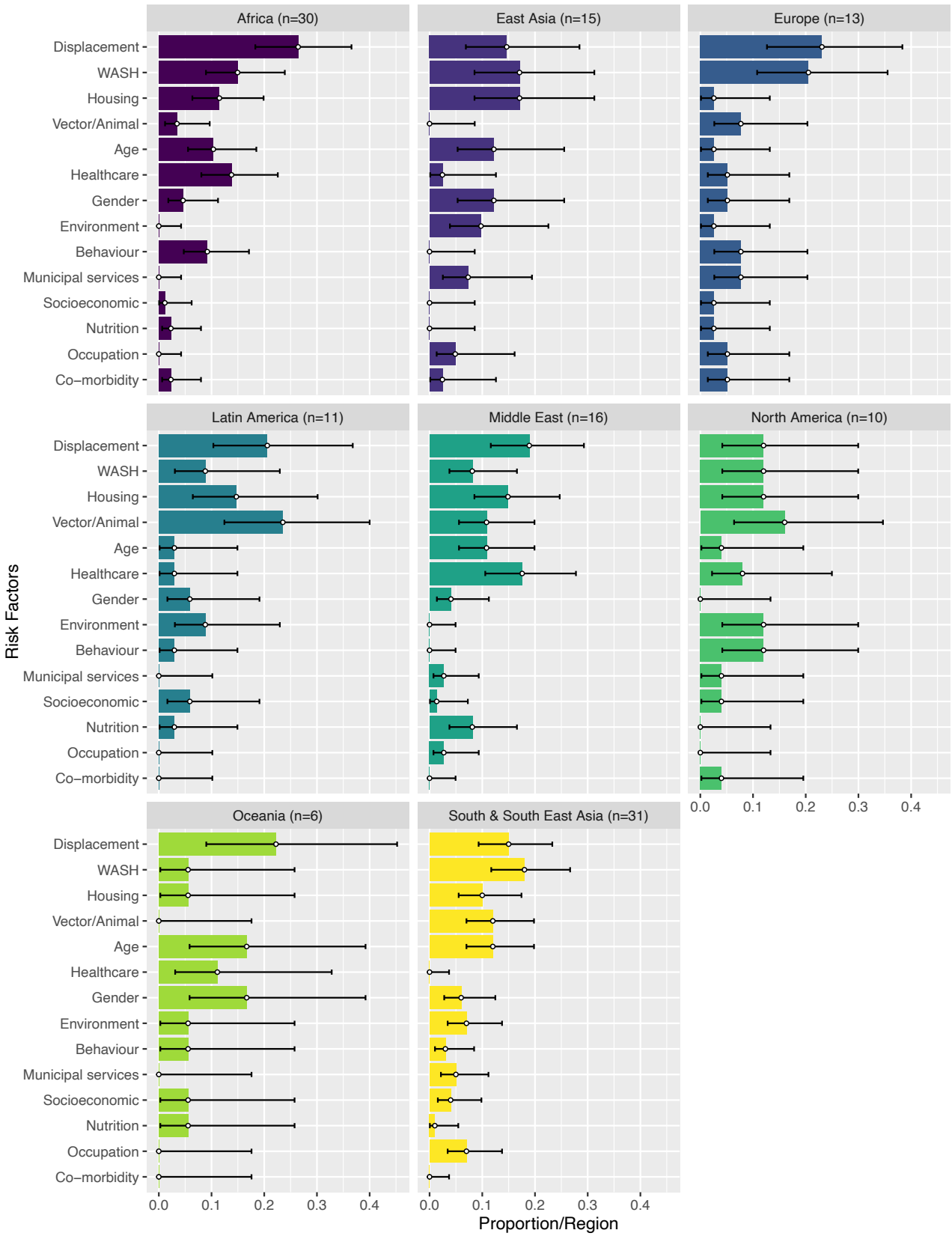
Supplementary Figure 3: Proportions of reported risk factor clusters against the four natural hazards categories



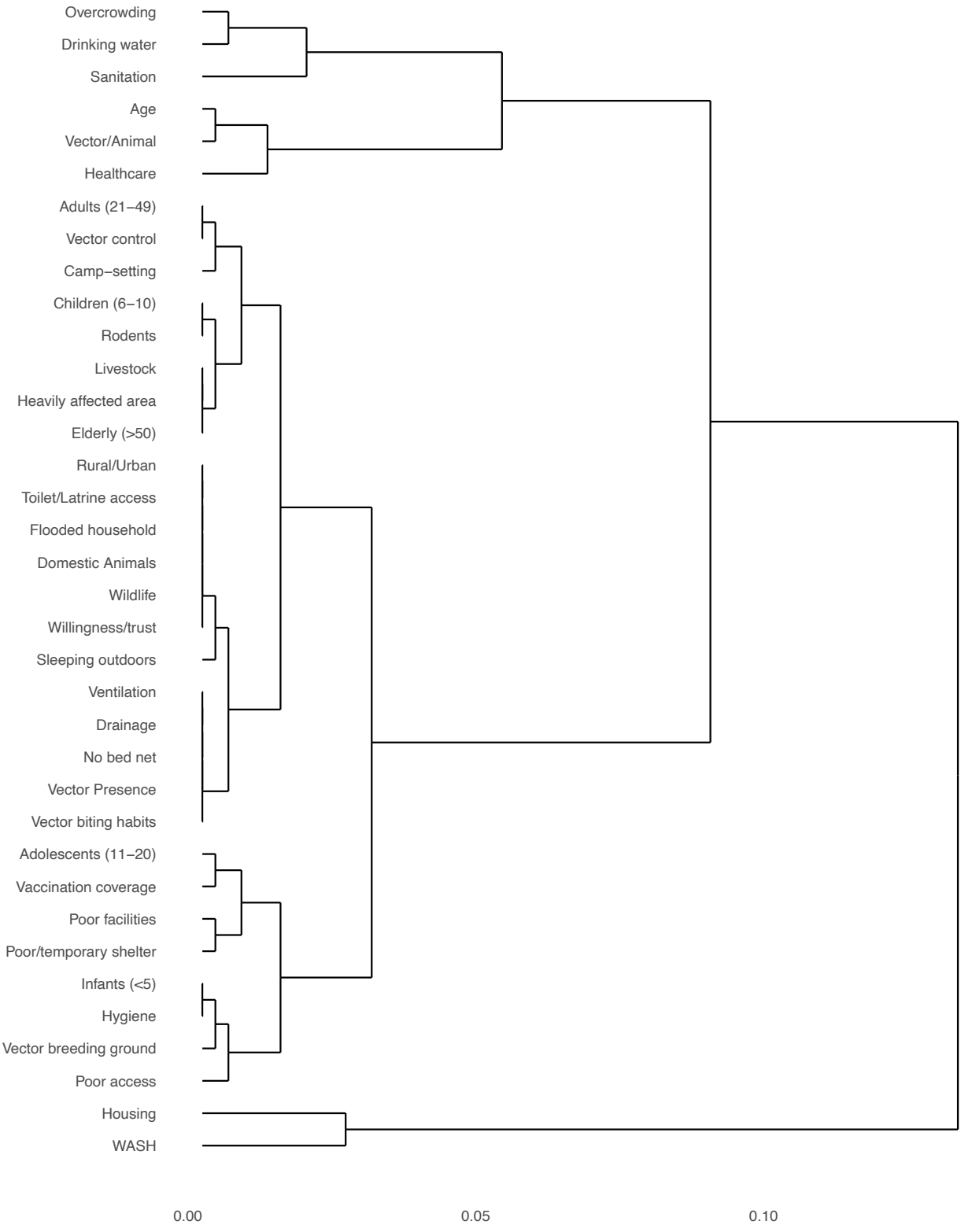
Supplementary Figure 4: Proportions of reported risk factor clusters against disease type with 95% binomial confidence intervals



Supplementary Figure 5: Proportions of reported risk factor clusters against disease transmission with 95% binomial confidence intervals



Supplementary Figure 6: Proportions of reported risk factor clusters against the eight region categories with 95% binomial confidence intervals



Supplementary Figure 7: Hierarchical cluster analysis of the top five risk factor clusters, broken down into individual risks reported within the cluster.

PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocol*

Section and topic	Item No	Checklist item
ADMINISTRATIVE INFORMATION		
Title:		
Identification	1a	Identify the report as a protocol of a systematic review
Update	1b	If the protocol is for an update of a previous systematic review, identify as such
Registration	2	If registered, provide the name of the registry (such as PROSPERO) and registration number
Authors:		
Contact	3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments
Support:		
Sources	5a	Indicate sources of financial or other support for the review
Sponsor	5b	Provide name for the review funder and/or sponsor
Role of sponsor or funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol
INTRODUCTION		
Rationale	6	Describe the rationale for the review in the context of what is already known
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)
METHODS		
Eligibility criteria	8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review
Information sources	9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated
Study records:		
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review
Selection process	11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)
Data collection process	11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators
Data items	12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis
Data synthesis	15a	Describe criteria under which study data will be quantitatively synthesised
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I^2, Kendall's τ)
	15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (such as GRADE)

*** It is strongly recommended that this checklist be read in conjunction with the PRISMA-P Explanation and Elaboration (cite when available) for important clarification on the items. Amendments to a review protocol should be tracked and dated. The copyright for PRISMA-P (including checklist) is held by the PRISMA-P Group and is distributed under a Creative Commons Attribution Licence 4.0.**

Supplementary Figure 8: PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review

Supplementary Tables

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Supplementary Table 1: Full list of included studies in the review

Disaster Type	Disaster	Frequency
Hydrological	Flood	43
Geophysical	Tsunami	9
	Earthquake	17
	Volcanic eruption	2
Meteorological	Cyclone	4
	Typhoon	4
	Tropical Storm	1
	Hurricane	6
Climatological	Drought	6
Conflict	Armed conflict	45

Supplementary Table 2: Full list of reported disasters

Region	Country	Frequency
South & South East Asia	India	12
	Nepal	1
	Bangladesh	4
	Pakistan	1
	Sri Lanka	3
	Sumatra	2
	Philippines	3
	Malaysia	1
	Thailand	2
	Indonesia	2
Middle East	Syria	3
	Iraq	2
	Iran	2
	West Bank	1
	Afghanistan	3
	Yemen	4
	Oman	1
	Lebanon	1
Oceania	Australia	1
	New Zealand	1
	Fiji	1
	Papua New Guinea	2
	Solomon Islands	1
Africa	Libya	1
	Kenya	3
	Ethiopia	2
	Somalia	2
	Sierra Leone	2
	Uganda	2
	Liberia	1
	Mauritania	1
	Mali	1
	Sudan	5
	South Sudan	4
	Central African Republic	3
	Democratic Republic of Congo	2
	Angola	1
	Mozambique	2
	Burundi	1
East Asia	China	9
	Japan	4
	Taiwan	2
Europe	Bosnia & Herzegovina	2
	Yugoslavia	2
	Czechoslovakia	1
	Croatia	1

	Turkey	2
	Italy	2
	Netherlands	1
	UK	1
	Germany	1
North America	USA	10
Latin America	Chile	1
	Ecuador	1
	Columbia	1
	Guyana	1
	Mexico	1
	Nicaragua	2
	Costa Rica	1
	Honduras	1
	Haiti	2

Supplementary Table 3: Full list of reported countries

Disease Type	Transmission	Disease	No. of outbreaks
Bacterial	Water borne	Leptospirosis	21
	Water borne	Cholera	15
	Water borne	Diarrhoeal disease	7
	Water borne	Dysentery	6
	Water borne	Typhoid	3
	Vector borne	Typhus	2
	Air borne	Pneumonia	2
	Water borne	Bacteremia	1
	Air borne	Diphtheria	1
	Air borne	Meningitis	1
	Air borne	Respiratory disease	1
	Rodent borne	Tularemia	1
Viral	Air borne	Measles	5
	Water borne	Hepatitis E	5
	Water borne	Polio	4
	Vector borne	Dengue	3
	Water borne	Diarrhoeal disease	3
	Direct contact	Ebola	2
	Vector borne	Rift Valley fever	2
	Water borne	Hepatitis A	2
	Air borne	Influenza	2
	Vector borne	West Nile	2
	Water borne	Norovirus	2
	Vector borne	Chikungunya	1
	Rodent borne	Hantavirus	1
	Direct contact	Lassa fever	1
	Air borne	Monkeypox	1
	Air borne	Respiratory disease	1
	Air borne	Rubella	1
	Vector borne	Yellow Fever	1
	Vector borne	Zika	1
Parasitic	Vector borne	Malaria	10
	Vector borne	Cutaneous leishmaniasis	5
	Water borne	Giardiasis	3
	Vector borne	Visceral leishmaniasis	3
	Water borne	Diarrhoeal disease	2
	Vector borne	Sleeping Sickness	2
	Water borne	Cryptosporidium	1
	Water borne	Fascioliasis	1
	Direct contact	Scabies	1
	Water borne	Schistosomiasis	1
Mixed pathogen	Water borne	Diarrhoeal disease	6
	Direct contact	Dermatological disease	3
	Air borne	Respiratory disease	1
		Total	140

Supplementary Table 4: Full list of reported disease outbreaks

	p value
Risk Factor Cluster	$7.2x10^{-36}$
Conflict/Displacement	0.04
Geophysical/Displacement	0.22
Hydrological/WASH	0.58
Conflict/WASH	0.14
Water-borne/WASH	0.0022
Geophysical/Housing	0.001
Hydrological/Vector	0.023
Conflict/Vector	0.126
Parasitic/Vector	0.004
Water-borne/Age	0.14
Conflict/Age	0.68
Conflict/Healthcare	0.0000003
Viral/Healthcare	0.0014
Hydrological/Gender	0.004
Water-borne/Gender	0.15

Actual p value	Africa	E Asia	Europe	LAC	Middle East	N America	Oceania	S & SE Asia
Conflict	0.0000197*		0.79565613	0.04237575*	0.00000001*		0.38814874	0.00055075*
Hydrological	0.03742919*	0.08779559	0.71072159	0.49736414	0.00819448*	0.29446618	0.31503477	0.04128529*
Climatological	0.00027878*					0.42591199		
Geophysical		0.2537846	0.55776124	0.01565516*	0.07715278	0.33047572	0.42309951	0.04748551*
Meteorological	0.11744737	0.2876211		0.14102256		0.00488033*		0.63602109
	Water-borne	**Vector-borne**	**Air-borne**	**Rodent-borne**	**Direct contact**			
Conflict	0.00002757*	0.01827592*	0.32309873	0.04164768*	0.16000299			
Hydrological	0.00000015*	0.00217725*	0.0211398*		0.31688118			
Climatological	0.16244772	0.11471884			0.18858594			
Geophysical	0.00972217*	0.21803643	0.01387154*		0.67859545			
Meteorological	0.00595018*	0.10543734	0.52184744					
	Bacterial	**Viral**	**Parasitic**	**Mixed pathogen**				
Conflict	0.00029837*	0.00604762*	0.0463105*	0.11010373				
Hydrological	0.00362129*	0.00795126*	0.16208116	0.04285716*				
Climatological	0.5726781	0.81973714	0.45566813					
Geophysical	0.53167598	0.70071662	0.57786094	0.39523447				
Meteorological	0.01736218*	0.40642793		0.3410774				

Supplementary Table 5: List of full p values from pair-wise comparisons. * shows significance at <0.05. Blank cells in the table indicate no outbreaks that fit both those categories.

Risk Cluster	Risk Factor	No. of outbreaks
Displacement		81
A report of national population movement due to the disaster	General	79
	Rural to urban	1
	Coastal to jungle	1
Age		40
Reported age-related risk factors, either a demographic group e.g., children, or a specific age category e.g., <5 years.	<2	2
	<4	1
	<5	10
	>5	2
	>5	2
	3-8	1
	<7	1
	<10	1
	Child	2
	<14	1
	15-20	1
	15-19	1
	<15	2
	15-34	1
	<18	2
	<20	2
	40-49	1
	Adults	3
	>50	2
	>65	1
	Older	1
	Elderly	2
Gender		25
Males or females being more at risk	Male	20
	Female	5
WASH		59
Any issues with access or quality of water, sanitation and hygiene provisions, separate from disruptions to specific municipal services.	Drainage	1
	Sanitation	25
	Hygiene	13
	Drinking water	17
	Toilet/latrine access	3
Housing		48
Reports of inadequate living conditions or the location of either habitual residence or temporary housing provided after displacement.	Overcrowding	19
	Urban	1
	Rural	1
	Mountainous	1
	Flooded household	3
	Living a heavily impacted area	6
	Camp-setting	5
	Poor shelter	6
	Sleeping outdoors	2
	Collapsed infrastructure	1
	No bed net	1
	Temporary shelter	2
	Ventilation	1
Healthcare		35
	Poor access	12
	Vaccination coverage	11

Any issue that prevented people seeking formal health care	Poor facilities	9
	Willingness/trust to seek care	3
Municipal services		14
Disruption to municipal services	Garbage	4
	Waste	6
	Water	4
Environment		19
Alterations in the natural environment that exacerbated risk of contracting the disease.	Contact with floodwater	13
	Higher temperatures	2
	Alterations in land moisture	1
	Water salinity	1
	Geological changes	1
	Lower temperatures	1
Vector/Animal		38
Changes in animals and vectors that accelerated contact with the population and subsequent disease spread.	Livestock (cattle, pigs, camels)	6
	Rodents	7
	Domestic animals (dogs)	3
	Wildlife (monkeys, bandicoots, beavers)	3
	Alterations in vector breeding ground	14
	Vector control	4
	Vector biting habits	1
	Vector presence	1
	Exposure to animals	1
Behaviour		19
Any report of human behaviour which heightened the risk of contact with the pathogen, except human displacement.	Recreation	1
	Swimming	1
	Hiking	1
	Camping	1
	Assisting in clean up	1
	Method of acquiring water and storing	3
	Mixing with people of different immunities	2
	Sexual contact	1
	Not being covered	1
	Sharing combs	1
	Burial practices	2
	Public distrust	1
	Nomadic	1
Occupation		13
An occupation which was associated with increased pathogen exposure and therefore disease.	Rice paddy farmer	2
	Street vendor	1
	Unemployed	1
	Homemaker	1
	Farmer	3
	Military	2
	Working outdoors	1
	Hunting	1
	International workers	1
Nutrition		12
Issues with insufficient diet or eating specific foods.	No fruits and vegetables	1
	Eating rodents	1
	Eating monkeys	1
	Malnourishment	7
	Drinking sugar cane juice	1
	Eating millet gruel	1
Co-morbidity		6
	Pregnancy	2

Significant numbers of infected individuals also presented with another morbidity.	Co-morbidities	2
	Respiratory tract infections	1
	Psychological conditions	1
Socio-economic		11
Further socioeconomic conditions that increased cases but did not fit into any other cluster. These mainly included education and inequities.	Poverty	4
	Literacy rate	1
	Poor socio-economics	2
	Education level	2
	Attending church school	1
	Fathers education	1

Supplementary Table 6: Full list of reported risk factors and how they were split into the risk factor clusters. Under each cluster is how they were defined.

Category	Keywords	MeSH MEDLINE	MeSH Embase	MeSH GlobalHealth
Natural Hazards	natural hazard* OR natural disaster* OR extreme adj2 event*	climatic process exp, cyclonic storms exp, droughts exp, floods exp, tidal waves exp, geological phenomena exp, avalanches exp, earthquakes exp, landslides exp, tsunamis exp, volcanic eruptions exp, wildfires exp, natural disasters exp	natural disaster exp, disaster victim exp, earthquake exp, drought exp, flooding exp, hurricane exp, tsunami exp, landslide exp, avalanche exp, wildfire exp, volcano exp	natural disaster exp, hurricanes exp, tornados exp, typhoons exp, droughts exp, floods exp, earthquakes exp, landslides exp, avalanches exp, tsunami exp, volcanos exp, wildfire exp
Conflicts	armed conflict* or civil war*	ethnic violence exp, exposure to violence exp, armed conflicts exp, war exposure exp	war exposure exp, ethnic conflict exp	conflict exp, war exp, aggression exp, fighting exp
Disease	infectious disease outbreak* OR communicable disease outbreak*	disease outbreaks exp, epidemics exp, communicable diseases exp, diarrhoea, vibrio infections exp, cholera exp, salmonella infections exp, typhoid fever exp, paratyphoid fever exp, leptospirosis exp, Weil disease, measles exp, measles virus exp, meningitis, bacterial exp, meningitis, escherichia coli exp, meningitis, meaningococcal exp, meningitis, pneumococcal exp, respiratory tract infections exp, malaria exp, dengue exp, tetanus exp, clostridium infections exp, haemorrhagic fevers, viral exp, poliomyelitis exp, poliovirus exp, coccidioidomycosis exp, dysentery exp, leishmaniasis, cutaneous exp, leishmaniasis, visceral exp, hepatitis exp, hepatitis a exp, hepatitis e exp	typhoid fever exp, salmonellosis exp, acute hepatitis exp, hepatitis a virus exp, hepatitis e virus exp, hepatitis a exp, hepatitis e exp, leptospirosis exp, measles exp, respiratory tract infection exp, malaria exp, dengue exp, tetanus exp, coccidioidomycosis exp, haemorrhagic fever exp, poliomyelitis exp, dysentery exp, acute diarrhoea exp, meningitis exp, skin leishmaniasis exp, visceral leishmaniasis exp	outbreaks exp, epidemics exp, infectious diseases exp, diarrhoea exp, cholera exp, vibrio cholerae exp, salmonella typhi exp, typhoid exp, salmonella paratyphi exp, paratyphoid exp, hepatitis a exp, hepatovirus a exp, hepatitis e exp, hepatovirus e exp, leptospirosis exp, measles exp, meningitis exp, bacterial meningitis exp, viral meningitis exp, respiratory diseases exp, malaria exp, dengue exp, tetanus exp, coccidioidomycosis exp, leishmaniasis exp, cutaneous leishmaniasis exp, visceral leishmaniasis exp, haemorrhagic fever exp, poliomyelitis exp, dysentery exp

Supplementary Table 7: Search strategies for MEDLINE, Embase and GlobalHealth