Reggio Emilia, 9 giugno 2023

Climate change and water-related health issues

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DIPARTIMENTO INTERDISCIPLINARE DI MEDICINA

Cambiamento climatico

…rappresenta una grave minaccia per la salute globale e una grande sfida per il 21° secolo.

comparsa/diffusione di malattie di origine infettiva (vettori patogeni, infezioni enteriche, malattie parassitarie).

conflitti

migrazioni

ineguaglianze di genere

marginalizzazione sociale ed economica

Disastri

eventi estremi

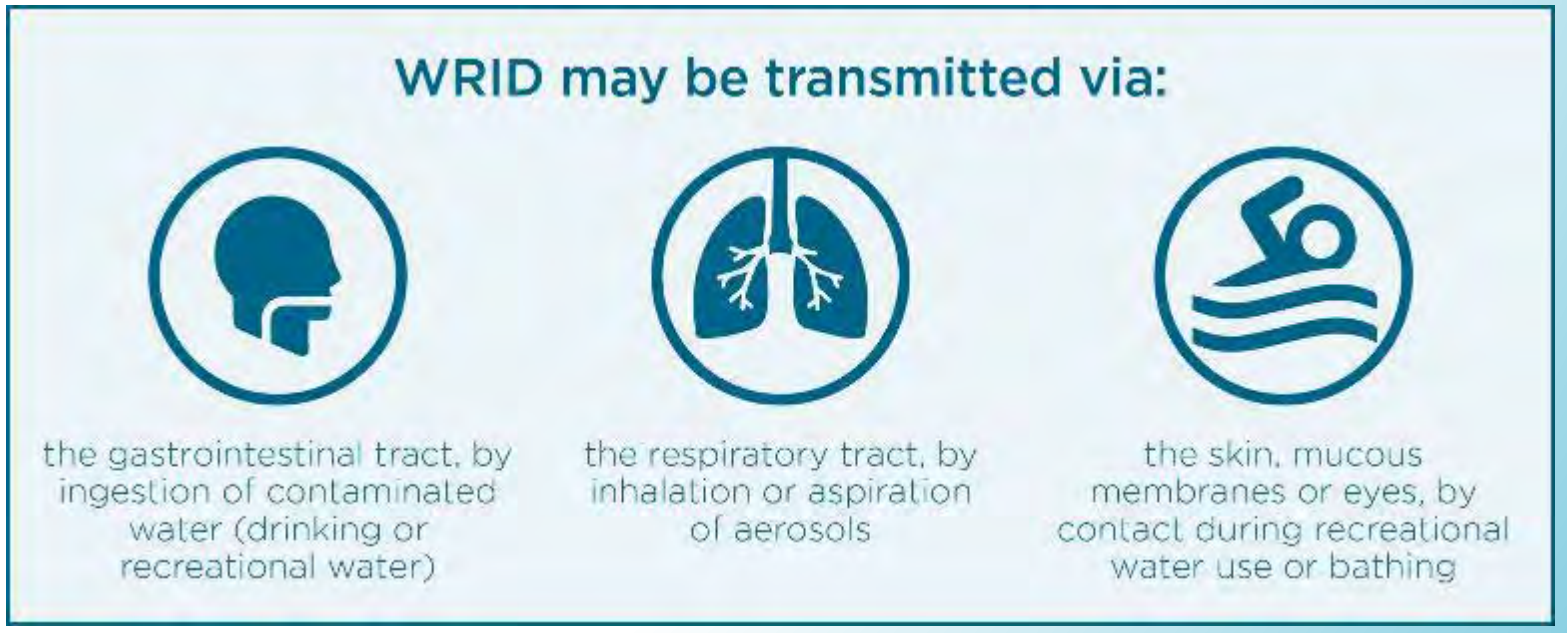
disponibilità idrica

sicurezza alimentare

Il Piano Nazionale della Prevenzione 2020-2025

«Water-related disease (WRID)»

- effetti negativi sulla salute umana causati dalle condizioni dell'acqua



Classification of WRID

Category	Description	Examples
Water-borne	Ingestion or inhalation of pathogens in contaminated water	Typhoid fever, legionellosis, poliomyelitis Enteric viruses
Water-washed a) Skin and eyes b) Diarrhoeal diseases	Poor hygiene / lack of access to safe water	Scabies, trachoma, bacillary dysentery Cholerae Typhoid fever
Water-based a) Skin penetration b) Ingested	Infection by agents that spend part of their life-cycle in water	Schistosomiasis
Water-related vectors a) Biting near water b) Breeding in water	Spread by vectors that breed or bite near water	Malaria, West Nile Fever, Dengue, Leishmaniasis

Da WHO – Guidelines for drinking-water quality - 2011

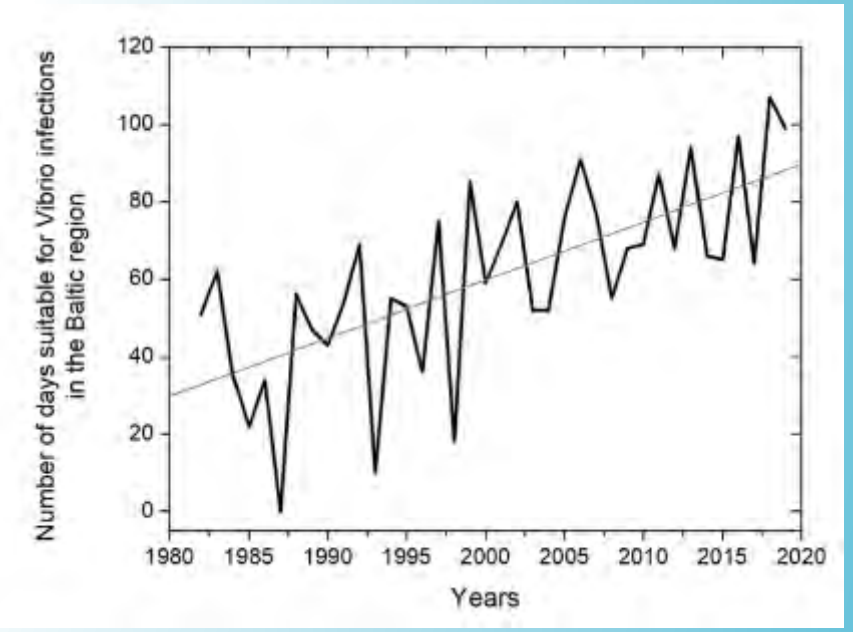
WARMER WATER FLOODING

CLIMA-SALUTE: ACQUE RICREATIVE

Alcuni batteri marini hanno maggiori probabilità di sopravvivere e crescere man mano che gli oceani si riscaldano.

Vibrio parahaemolyticus è responsabile di malattie diarroiche legate al consumo di ostriche crude o poco cotte del Golfo del Messico.

Vibrio vulnificus provoca vomito, diarrea e dolore addominale negli adulti sani. Il *Vibrio vulnificus* è più grave del *Vibrio parahaemolyticus* ed è responsabile della maggior parte delle morti legate ai frutti di mare negli Stati Uniti.



N°annuo di giorni adatti alle infezioni da *Vibrio* nella regione Baltica. Lancet 2021

Entrambi possono causare gravi infezioni gastroenteriche o da contatto di ferite con acqua contaminata durante il nuoto.


Climate change
&
Water related disease

Climate change & Water

- **Pioggia**: trasporto e diffusione di agenti infettivi
- **Allagamento**: tracimazione degli impianti di depurazione; fonti d'acqua contaminate, carenza secondaria di acqua potabile pulita
- **Innalzamento del livello del mare:** aumenta il rischio di gravi inondazioni
- **Temperature più elevate**: aumenta la crescita e prolunga i tassi di sopravvivenza degli agenti infettivi (es.*Vibrio*)
- **Siccità**: aumenta le concentrazioni di agenti patogeni, ostacolando l'igiene

comment

Cascading risks of waterborne diseases from climate change

Climate change can trigger a sequence of events of significant magnitude with consequences for waterborne diseases. Heavy rainfall, flooding and hot weather are associated with waterborne diseases, but early warning systems could intercept these cascading risks.

Jan C. Semenza

2020

- L'aumento della temperatura superficiale media globale accelera l'evaporazione e aumenta il contenuto di acqua nell'atmosfera.
- L'aumento delle precipitazioni e gli eventi di pioggia estrema possono mobilitare le feci provenienti dalla fauna selvatica o dagli animali domestici, che possono entrare e sopraffare la capacità degli impianti di trattamento delle acque.
- Microrganismi patogeni di origine fecale umana e animale possono infiltrarsi nel sistema di distribuzione dell'acqua e causare *waterborne outbreak*.
- Le inondazioni possono danneggiare gli impianti fognari o contaminare i pozzi delle acque sotterranee con *waterborne* patogeni e i contaminanti provenienti dalla zootecnia possono inquinare la falda acquifera.
- Incendi durante le ondate di calore possono degradare la qualità dell'acqua del fiume e ostacolare il trattamento delle acque.

In letteratura ….

2022

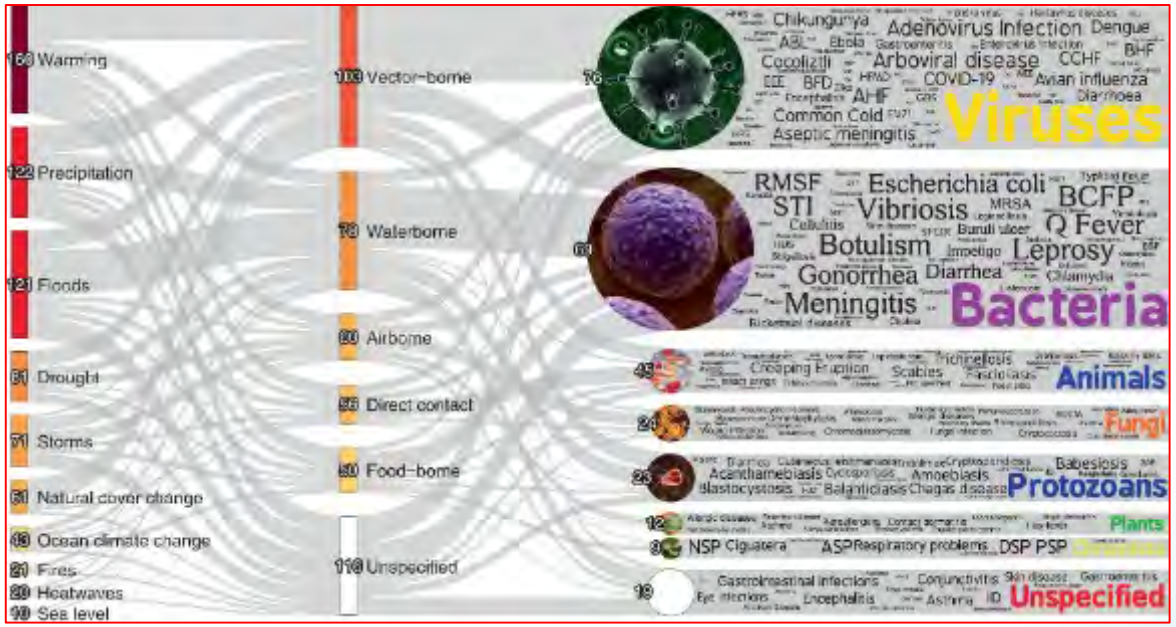
nature climate change

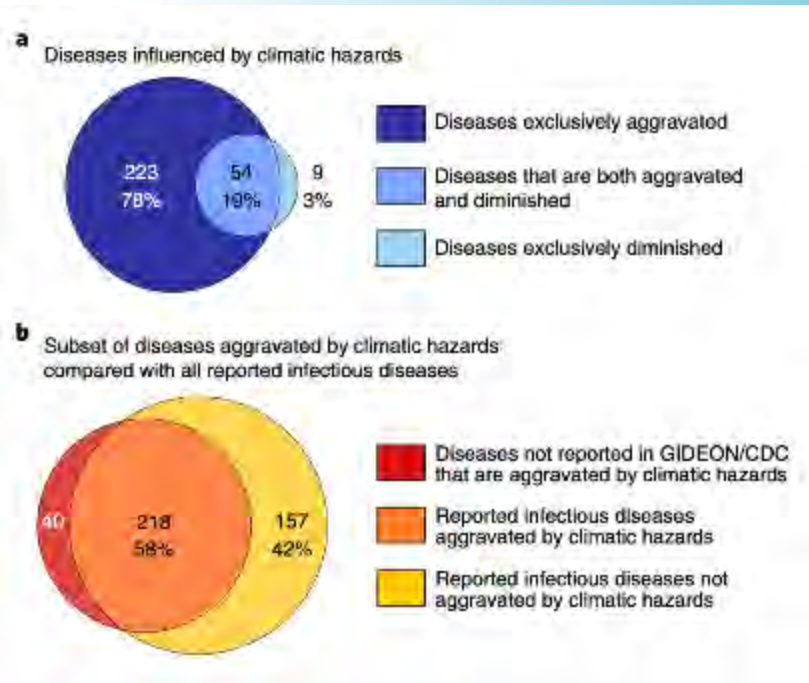
ANALYSIS

Over half of known human pathogenic diseases can be aggravated by climate change

Camilo Mora[1,2], Tristan McKenzie[2,3], Isabella M. Gaw[4], Jacqueline M. Dean[1], Hannah von Hammerstein[1], Tabatha A. Knudson[1], Renee O. Setter[1], Charlotte Z. Smith[5], Kira M. Webster[1], Jonathan A. Patz[6] and Erik C. Franklin[1,7]

It is relatively well accepted that climate change can affect human pathogenic diseases; however, the full extent of this risk remains poorly quantified. Here we carried out a systematic search for empirical examples about the impacts of ten climatic hazards sensitive to greenhouse gas (GHG) emissions on each known human pathogenic disease. We found that 58% (that is, 218 out of 375) of infectious diseases confronted by humanity worldwide have been at some point aggravated by climatic hazards; 16% were at times diminished. Empirical cases revealed 1,006 unique pathways in which climatic hazards, via different transmission types, led to pathogenic diseases. The human pathogenic diseases and transmission pathways aggravated by climatic hazards are too numerous for comprehensive societal adaptations, highlighting the urgent need to work at the source of the problem: reducing GHG emissions.





Il 58% delle malattie infettive umane sono state aggravate dai cambiamenti climatici

Il 16% è stato a volte diminuito

WATERBORNE DISEASE IN AUMENTO PER CAMBIAMENTO CLIMATICO

- **Siccità: scarsa disponibilità di acqua**

Cases of trachoma, Chlamydia, cholera, conjunctivitis, *Cryptosporidium*, diarrhoeal diseases, dysentery, *Escherichia coli*, Giardia, *Salmonella*, scabies and typhoid fever.

- **Inondazioni, forti piogge e tempeste: danni in sistemi fognari e Acqua potabile interrotta**

Cases of cholera, diarrhoea, hepatitis A, hepatitis E, leptospirosis, acanthamoebiasis, cryptosporidiosis, cyclosporiasis, giardiasis, Rotavirus, shigellosis and typhoid fever

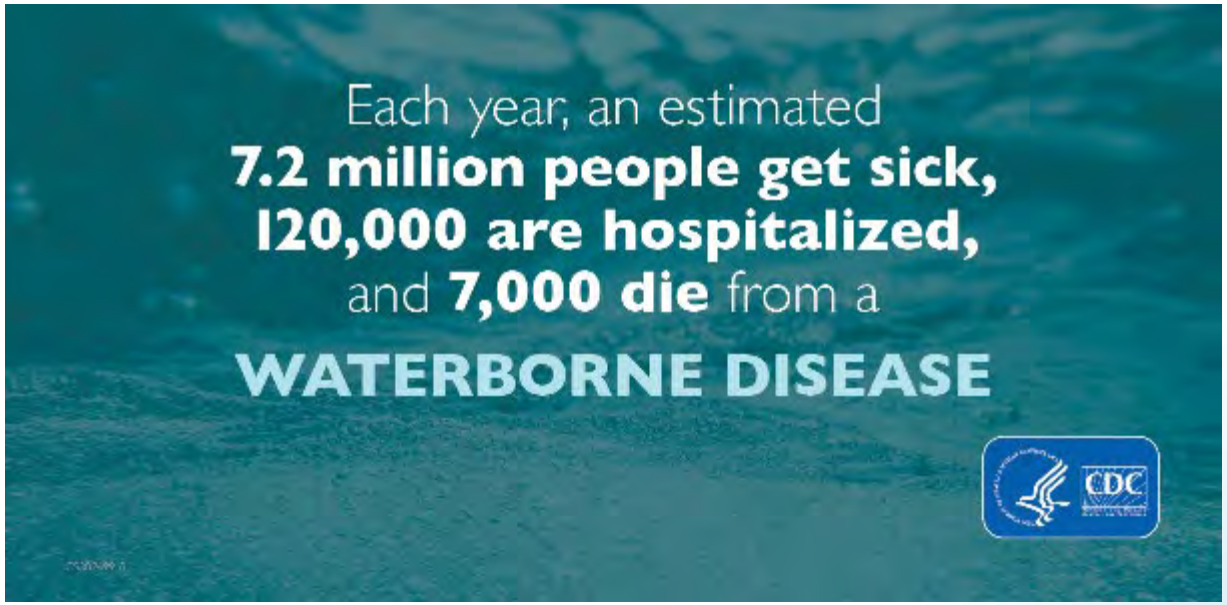
WATERBORNE DISEASE IN DIMINUIZIONE PER CAMBIAMENTO CLIMATICO

Riscaldamento: condizioni avverse per virus e più forte sistema immunitario per l'ospite

Casi di gastroenterite da Noro- e Rotavirus e Malaria e Chikungunya a causa della riduzione di *mosquitos* nei luoghi di riproduzione.

Innondazioni: riduzione schisostomiasi per ambiente non idoneo per lumache

Water related disease



www.cdc.gov/healthywater/global

Last Reviewed: January 4, 2023

Cost of Infectious Waterborne Disease in the United States.
https://doi.org/10.3201/eid2701.190676

United States..

https://health2016.globalchange.gov

Extreme precipitation events have been statistically linked to increased levels of pathogens in treated drinking water supplies.

Clinical Infectious Diseases
REVIEW ARTICLE

Climate Change and the Epidemiology of Infectious Diseases in the United States

Paul J. Edelson,[1] Rachel Harold,[2] Joel Ackelsberg,[3] Jeffrey S. Duchin,[4,5] Steven J. Lawrence,[6] Yukari C. Manabe,[7] Matt Zahn,[8] and Regina C. LaRocque[9]

[1]College of Physicians and Surgeons, Columbia University, New York, New York, USA; [2]Medical Society Consortium on Climate and Health, Center for Climate Change Communication, George Mason University, Fairfax, Virginia, USA; [3]New York City Department of Health and Mental Hygiene, Bureau of Communicable Disease, New York, New York, USA; [4]Public Health–Seattle and King County, Seattle, Washington, USA; [5]Division of Infectious Diseases, University of Washington, Seattle, Washington, USA; [6]Washington University School of Medicine, St. Louis, Missouri, USA; [7]Division of Infectious Diseases, Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland, USA; [8]Orange County Health Care Agency, Santa Ana, California, USA; and [9]Division of Infectious Diseases, Massachusetts General Hospital, Boston, Massachusetts, USA

2023

2023

Infectious Diseases

REVIEW ARTICLE

IDSA Infectious Diseases Society of America | hivma hiv medicine association | OXFORD

Climate change and antimicrobial resistance

Climate Change and the Epidemiology of Infectious Diseases in the United States

Paul J. Edelson,[1] Rachel Harold,[2] Joel Ackelsberg,[3] Jeffrey S. Duchin,[4,5] Steven J. Lawrence,[6] Yukari C. Manabe,[7] Matt Zahn,[8] and Regina C. LaRocque[9]

[1]College of Physicians and Surgeons, Columbia University, New York, New York, USA; [2]Medical Society Consortium on Climate and Health, Center for Climate Change Communication, George Mason University, Fairfax, Virginia, USA; [3]New York City Department of Health and Mental Hygiene, Bureau of Communicable Disease, New York, New York, USA; [4]Public Health–Seattle and King County, Seattle, Washington, USA; [5]Division of Infectious Diseases, University of Washington, Seattle, Washington, USA; [6]Washington University School of Medicine, St. Louis, Missouri, USA; [7]Division of Infectious Diseases, Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland, USA; [8]Orange County Health Care Agency, Santa Ana, California, USA; and [9]Division of Infectious Diseases, Massachusetts General Hospital, Boston, Massachusetts, USA

4.2% *E.coli*
2,2% *K.pneumoniae*
2.7% *S.aureus*

ANTIMICROBIAL RESISTANCE

Recent evidence links global temperature changes to expanding antimicrobial resistance. The immediate temperature surroundings of bacteria directly affect bacterial growth, survival, and adaptation. Temperature trends in local geographic areas, in addition to selective pressure from antibiotics, have been associated with antimicrobial resistance [63]. MacFadden et al found that a 10°C difference in temperature across regions of the United States was associated with increases in antibiotic resistance of 4.2% for *E. coli*, 2.2% for *Klebsiella pneumoniae*, and 2.7% for *Staphylococcus aureus* [64]. A subsequent ecological study replicated these results across Europe and also found that rates of antibiotic resistance correlated with ambient temperature [65]. Climate change may also affect fungal evolution, including contributing to the thermotolerance that led to the expansion of *Candida auris* into the human population. Antifungal resistance was already in existence at the time this organism was first identified in humans [66]. These findings suggest that efforts to manage the public health concern of antimicrobial resistance may need to incorporate climate factors.

Mondo….

2022

Microbes and Infectious Diseases 2022; 3(4): 776-779

Microbes and Infectious Diseases

Journal homepage: https://mid.journals.ckb.cg/

Editorial

Pakistan floods: Incidence of vector- and water-borne infectious diseases soars

Andrew W. Taylor-Robinson [*,1,2]

1- College of Health Sciences, VinUniversity, Gia Lam District, Hanoi 100000, Vietnam.
2- Center for Global Health, Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA 19104, USA

Increasing incidence of the mosquito-transmitted dengue and malaria, as well as severe gastrointestinal infections such as cholera and typhoid

Over 90,000 diarrhea cases, mainly in children, were reported from Sindh in just one day at the start of September

2020

Heavy Rainfall Events and Diarrheal Diseases: The Role of Urban–Rural Geography

Aniruddha Deshpande,[1] Howard H. Chang,[2] and Karen Levy[3]*

[1]Department of Epidemiology, Emory University, Atlanta, Georgia, [2]Department of Biostatistics and Bioinformatics, Emory University, Atlanta, Georgia, [3]Gangarosa Department of Environmental Health, Emory University, Atlanta, Georgia, [4]Department of Environmental and Occupational Health Sciences, University of Washington, Seattle, Washington

diseases remain a significant contributor to the global burden of disease. Climate change may by altering the epidemiology of waterborne pathogens through changes in rainfall patterns. To s of future changes in rainfall patterns, we analyzed 33,927 cases of diarrhea across all Ministry of Health clinical facilities in Esmeraldas Province, Ecuador, for a 24-month period from 2013 to 2014, using mixed-effects Poisson regression. We assessed the association between the incidence of diarrheal diseases and heavy rainfall events (HREs) and antecedent rainfall conditions. In rural areas, we found no significant associations between HREs and incidence. In urban areas, dry antecedent conditions were associated with higher incidence than wet conditions. In addition, HREs with dry antecedent conditions were associated with elevated incidence by up to 1.35 (incidence rate ratio, 95% CI: 1.14–1.60) times compared with similar conditions without HREs. These patterns may be driven by accumulation of fecal contamination during dry periods, followed by a flushing effect during HREs. This phenomenon is more important in dense urban environments with more impervious surfaces. These findings suggest that projected increases in rainfall variability and HREs may increase diarrhea burden in urban regions, which are rapidly expanding globally.

Incidence of diarrheal disease > heavy rainfall events in urban areas

Ecuador

Mondo….

2019

Iranian Journal of Microbiology
Volume 11 Number 2 April 2019 85-89

MINI REVIEW

Possible viral infections in flood disasters: a review considering 2019 spring floods in Iran

Jila Yavarian, Nazanin Zahra Shafiei-Jandaghi, Talat Mokhtari-Azad*

Department of Virology, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

A study (2008-2014) has reported *Aedes albopictus* (chikungunya and dengue viruses) in Southern Iran.

2018

Hindawi
International Journal of Environmental and Public Health
Volume 2018, Article ID 5452538, 8 pages
https://doi.org/10.1155/2018/5452538

Review Article

Relationship between Flooding and Out Break of Infectious Diseasesin Kenya: A Review of the Literature

Fredrick Okoth Okaka and Beneah D. O. Odhiambo

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Received 14 February 2018; Accepted 6 September 2018; Published 17 October 2018

Academic Editor: Maria R. Gualano

Flooding can potentially increase the spread of infectious diseases. To enhance good understanding of the health consequences of flooding and facilitate planning for mitigation strategies, deeper consideration of the relationship between flooding and out break of infectious diseases is required. This paper examines the relationship between occurrence of floods in Kenya and outbreak of infectious diseases and possible interventions. This review intended to build up the quality and comprehensiveness of evidence on infectious diseases arising after flooding incidence in Kenya. An extensive literature review was conducted in 2017, and published literature from 2000 to 2017 was retrieved. This review suggests that infectious disease outbreaks such as waterborne, rodent-borne, and vector-borne diseases have been associated with flooding in Kenya. But there is need for more good quality epidemiological data to cement the evidence. Comprehensive surveillance and risk assessment, early warning systems, emergency planning, and well-coordinated collaborations are essential in reducing future vulnerability to infectious diseases following flooding.

infectious disease outbreaks such as waterborne (cholera), rodent-borne, and vectorborne diseases have been associated with flooding in Kenya.
In overall, **during the El Niño period, their study indicates that 33,137 cholera cases were reported with an estimated 1,549 deaths**

2023

PROCEEDINGS B
royalsocietypublishing.org/journal/rspb

Research

Cite this article: Goren A, Viljugrein H, Rivrud IM, Jore S, Bakka H, Vindenes Y, Mysterud A. 2023 The emergence and shift in seasonality of Lyme borreliosis in Northern Europe. *Proc. R. Soc. B* **290**: 20222420. https://doi.org/10.1098/rspb.2022.2420

The emergence and shift in seasonality of Lyme borreliosis in Northern Europe

Asena Goren[1], Hildegunn Viljugrein[1,2], Inger Maren Rivrud[3], Solveig Jore[4], Haakon Bakka[2], Yngvild Vindenes[1] and Atle Mysterud[1,5]

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Europa..

Borrelia burgdoferi → Zecche Ixodes → UOMO

2020

www.nature.com/scientificreports

SCIENTIFIC REPORTS
nature research

OPEN

Campylobacter infections expected to increase due to climate change in Northern Europe

Katrin Gaardbo Kuhn[1*], Karin Maria Nygård[1], Bernardo Guzman-Herrador[2], Linda Selje Sunde[2], Ruska Rimhanen-Finne[3], Linda Trönberg[4], Martin Rudbeck Jepsen[5], Reija Ruuhela[6], Wai Kwok Wong[1] & Steen Ethelberg[1,4]

Global climate change is predicted to alter precipitation and temperature patterns across the world, affecting a range of infectious diseases and particularly foodborne infections such as *Campylobacter*. In this study, we used national surveillance data to analyse the relationship between climate and campylobacteriosis in Denmark, Finland, Norway and Sweden and estimate the impact of climate changes on future disease patterns. We show that *Campylobacter* incidences are linked to increases in temperature and especially precipitation in the week before illness, suggesting a non-food transmission route. These four countries may experience a doubling of *Campylobacter* cases by the end of the 2080s, corresponding to around 6,000 excess cases per year caused only by climate changes. Considering the strong worldwide burden of campylobacteriosis, it is important to assess local and regional impacts of climate change in order to initiate timely public health management and adaptation strategies.

The zoonotic pathogen *Campylobacter* is the most commonly reported cause of human bacterial gastroenteritis

Relazione tra clima e campilobatteriosi in **Danimarca, Finlandia, Norvegia e Svezia**

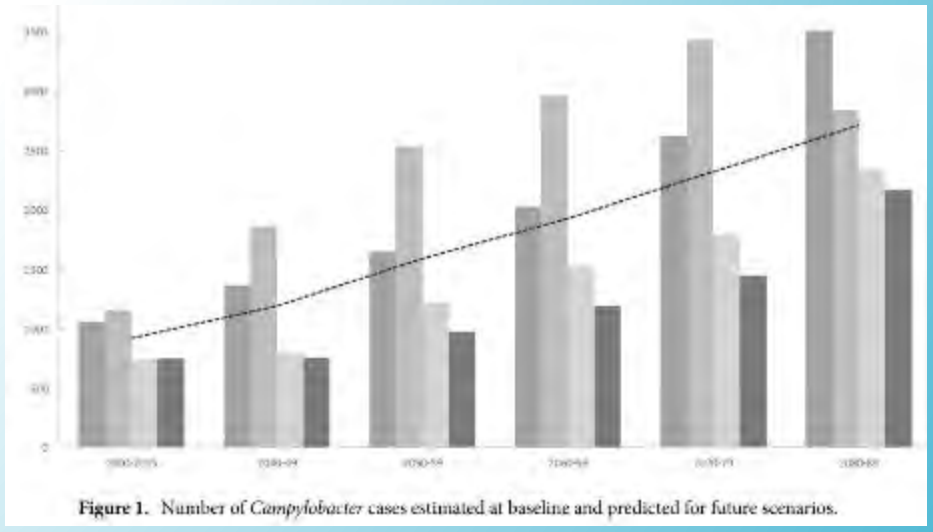

Figure 1. Number of *Campylobacter* cases estimated at baseline and predicted for future scenarios.

2019

OUTBREAKS

An outbreak of cryptosporidiosis associated with drinking water in north-eastern Italy, August 2019: microbiological and environmental investigations

Armando Franceschelli[1], Lucia Bonadonna[2], Simone M Cacciò[3], Anna Rosa Sannella[3], Christian Cintori[4,5], Raffaele Gargiulo[6], Anna Maria Coccia[2], Rosa Paradiso[2], Marcello Iaconelli[2], Rossella Briancesco[2], Alberto Tripodi[1]

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2. Department of Environment and Health, Istituto Superiore di Sanità, Rome, Italy
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6. Provincial Laboratory of Microbiology, Local Health Unit of Modena, Modena, Italy

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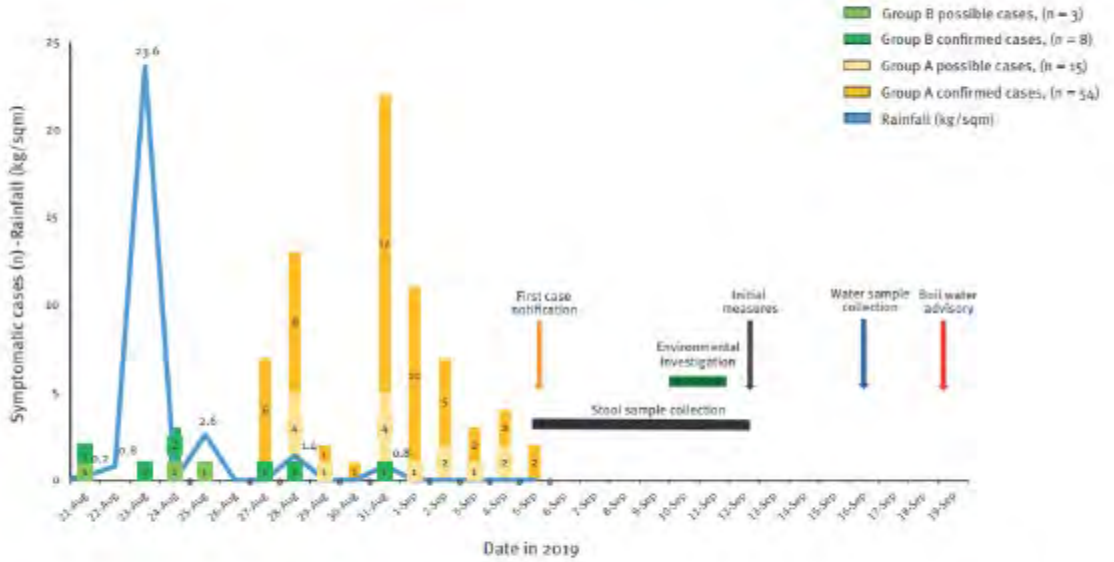
Cryptosporidium is a leading global cause of waterborne disease, with many reported outbreaks related to main water supplies. In August 2019, an outbreak of cryptosporidiosis involving 80 cases occurred among 114 vacationers in a small municipality located in the Tuscan-Emilian Apennines, north-eastern Italy. After excluding a potential food-borne outbreak, the epidemiological investigation focussed on the hypothesis of a waterborne outbreak. This was confirmed by the finding of *Cryptosporidium* oocysts in stools of the cases and in water samples from the municipal water network. Molecular characterisation revealed the zoonotic species *Cryptosporidium parvum* as the causative agent. A single subtype (IIdA25G1) was found among all cases, and in one of two positive water samples. The municipality's water supply used spring water that only received a disinfection treatment insufficient to inactivate the parasite. Possible entry means into the water mains were found through further environmental investigations. As these types of water supplies are particularly vulnerable to various environmental factors, a control system based on the risk assessment of each phase of the water supply chain is required to guarantee water safety. Effective methods for detection of protozoan pathogens, which are generally excluded from routine water supply anal-

FIGURE 1

Epidemic curve of cryptosporidiosis cases and local rainfall data, municipality of Tuscan-Emilian Apennines, Italy, August–September 2019 (n = 80)



Symptomatic cases from Group A and Group B, which include both possible (n = 18) and confirmed cases (n = 62, positive stool test), are represented. Cases are shown on the day of onset of symptoms. One confirmed case in Group B showed onset of symptoms on 18 August (the same day of the arrival; case with 8 h incubation) and is not visible in the figure but included in the total n.

Local rainfall data were gathered by the Regional Agency for Prevention, Environment and Energy.

Indirizzi di adattamento ai cambiamenti climatici in Italia

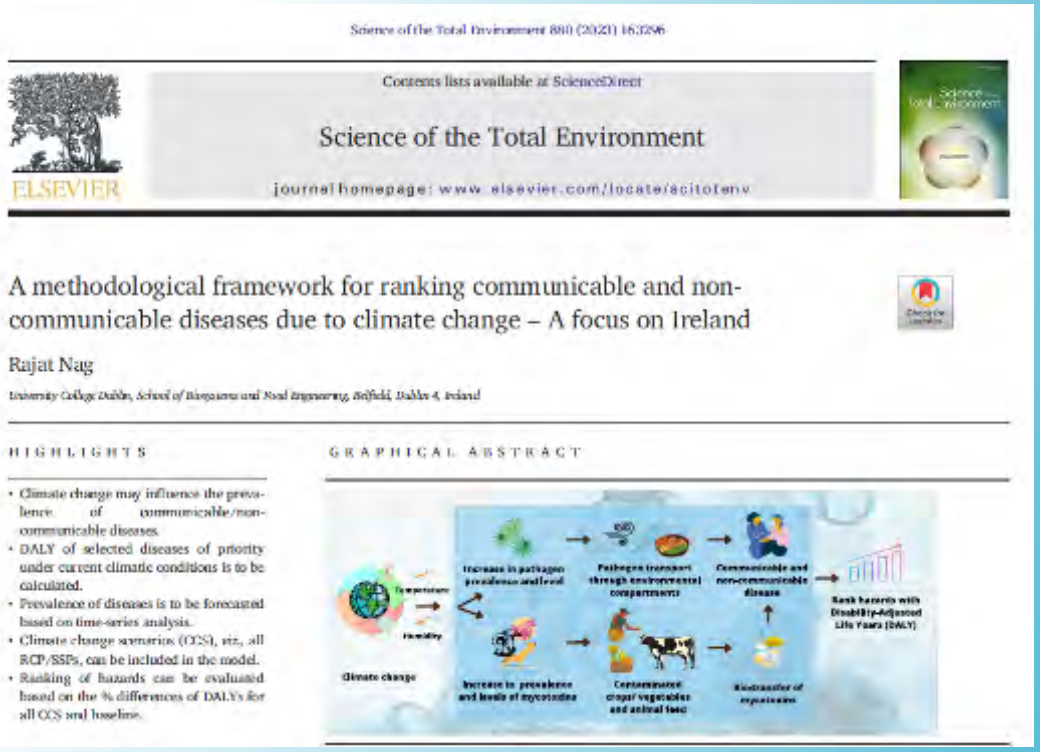
GAZZETTA UFFICIALE

DECRETO LEGISLATIVO 23 febbraio 2023, n. 18

Attuazione della direttiva (UE) 2020/2184 del Parlamento europeo e del Consiglio, del 16 dicembre 2020, concernente la qualita' delle acque destinate al consumo umano. (23G00025)

(GU n.55 del 6-3-2023)

Vigente al: 21-3-2023



- sostenere l'adozione e l'attuazione di un **approccio basato sui rischi** nel settore dell'acqua e dei servizi igienico-sanitari (piani di sicurezza dell'acqua), compresa la **raccolta dati su malattie idrodiffuse, sistemi di allerta precoce basati sulle previsioni, sulle distribuzioni di patogeni, di contaminanti chimici oggetto di ordinario controllo e emergenti**

My Working Group

Grazie per l'attenzione