

> [Epidemiol Infect.](#) 2016 May;144(7):1445-54. doi: 10.1017/S0950268815002654.  
Epub 2015 Nov 11.

## Gastrointestinal, influenza-like illness and dermatological complaints following exposure to floodwater: a cross-sectional survey in The Netherlands

H DE Man <sup>1</sup>, L Mughini Gras <sup>2</sup>, B Schimmer <sup>2</sup>, I H M Friesema <sup>2</sup>, A M DE Roda Husman <sup>1</sup>, W VAN Pelt <sup>2</sup>

Affiliations + expand

PMID: 26554647 PMCID: [PMC9150532](#) DOI: [10.1017/S0950268815002654](#)

### Abstract

Extreme rainfall events may cause pluvial flooding, increasing the transmission of several waterborne pathogens. However, the risk of experiencing clinically overt infections following exposure to pluvial floodwater is poorly estimated. A retrospective cross-sectional survey was performed to quantify the occurrence of self-reported gastrointestinal, influenza-like illness (ILI) and dermatological complaints, and the frequency of visits to the general practitioner (GP), during a 4-week observation period following pluvial flooding at seven locations in The Netherlands. Questionnaires were sent to 817 flooded households, 149 (17%) of which returned the questionnaire reporting information for 199 participants. Contact with floodwater was significantly associated with increased occurrence of gastrointestinal [odds ratio (OR 4.44)], ILI (OR 2.75) and dermatological (OR 6.67) complaints, and GP visits (OR 2.72). Having hand contact with floodwater was associated with gastrointestinal and dermatological complaints, whereas ILI complaints were associated with being engaged in post-flooding cleaning operations and having walked/cycled through floodwater. This study shows that floodwater-associated diseases occur in urban settings following extreme rainfall events in a high-income country. As pluvial floods are expected to escalate in the future due to global climate change, further research is warranted to determine the disease burden of pluvial flooding and to assess the effect of different interventions, including raising awareness among stakeholders.

**Keywords:** Epidemiology; veterinary epidemiology; water (quality).

[PubMed Disclaimer](#)

### Figures



### Similar articles

["Sickenin' in the rain" - increased risk of gastrointestinal and respiratory infections after urban pluvial flooding in a population-based cross-sectional study in the Netherlands.](#)

Mulder AC, Piinacker R, de Man H, van de Kasstele J, van Pelt W, Mughini-Gras I, Franz F

#### FULL TEXT LINKS



#### ACTIONS



#### PAGE NAVIGATION

< Title & authors

Abstract

Figures

Similar articles

Cited by

References

MeSH terms

Related information

LinkOut - more resources

de Man H, van den Berg HH, Leenen EJ, Schijven JF, Schets FM, van der Vliet JC, van Knapen F, de Roda Husman AM. BMC Infect Dis. 2019 May 2;19(1):377. doi: 10.1186/s12879-019-3984-5. PMID: 31046688 [Free PMC article.](#)

### [Quantitative assessment of infection risk from exposure to waterborne pathogens in urban floodwater.](#)

de Man H, van den Berg HH, Leenen EJ, Schijven JF, Schets FM, van der Vliet JC, van Knapen F, de Roda Husman AM. Water Res. 2014 Jan 1;48:90-9. doi: 10.1016/j.watres.2013.09.022. Epub 2013 Sep 19. PMID: 24095592

### [Investigating the influence of urban morphology on pluvial flooding: Insights from urban catchments in England \(UK\).](#)

Zhu Y, Burlando P, Tan PY, Blagojevic J, Faticchi S. Sci Total Environ. 2024 Nov 25;953:176139. doi: 10.1016/j.scitotenv.2024.176139. Epub 2024 Sep 7. PMID: 39250969

### [Impact of climate change on dermatological conditions related to flooding: update from the International Society of Dermatology Climate Change Committee.](#)

Dayrit JF, Bintanjoyo L, Andersen LK, Davis MDP. Int J Dermatol. 2018 Aug;57(8):901-910. doi: 10.1111/ijd.13901. Epub 2018 Jan 29. PMID: 29377078 [Review.](#)

### [Real-Time Early Warning System Design for Pluvial Flash Floods-A Review.](#)

Acosta-Coll M, Ballester-Merelo F, Martinez-Peiró M, De la Hoz-Franco E. Sensors (Basel). 2018 Jul 12;18(7):2255. doi: 10.3390/s18072255. PMID: 30002358 [Free PMC article.](#) [Review.](#)

[See all similar articles](#)

## Cited by

### [Infectious Diseases Associated with Hydrometeorological Hazards in Europe: Disaster Risk Reduction in the Context of the Climate Crisis and the Ongoing COVID-19 Pandemic.](#)

Mavrouli M, Mavroulis S, Lekkas E, Tsakris A. Int J Environ Res Public Health. 2022 Aug 17;19(16):10206. doi: 10.3390/ijerph191610206. PMID: 36011854 [Free PMC article.](#)

### [Days of Flooding Associated with Increased Risk of Influenza.](#)

Kontowicz E, Brown G, Torner J, Carrel M, Baker KK, Petersen CA. J Environ Public Health. 2022 Jun 3;2022:8777594. doi: 10.1155/2022/8777594. eCollection 2022. PMID: 35692665 [Free PMC article.](#)

### [Natural disasters and infectious disease in Europe: a literature review to identify cascading risk pathways.](#)

Suk JE, Vaughan EC, Cook RG, Semenza JC. Eur J Public Health. 2020 Oct 1;30(5):928-935. doi: 10.1093/eurpub/ckz2111. PMID: 31169886 [Free PMC article.](#)

### [Risk factors for gastroenteritis associated with canal swimming in two cities in the Netherlands during the summer of 2015: A prospective study.](#)

Joosten R, Sonder G, Parkkali S, Brandwagt D, Fanoy E, Mughini-Gras L, Lodder W, Ruland E, Siedenburg E, Kliffen S, van Pelt W. PLoS One. 2017 Apr 3;12(4):e0174732. doi: 10.1371/journal.pone.0174732. eCollection 2017. PMID: 28369101 [Free PMC article.](#)

### [Viral respiratory infections in a rapidly changing climate: the need to prepare for the next pandemic.](#)

He Y, Liu WJ, Jia N, Richardson S, Huang C. EBioMedicine. 2023 Jul;93:104593. doi: 10.1016/j.ebiom.2023.104593. Epub 2023 May 9. PMID: 37169688 [Free PMC article.](#) [Review.](#)

[See all "Cited by" articles](#)

## References

1. Intergovernmental Panel on Climate Change. Fifth Assessment Report (<http://www.ipcc.ch/>), 2013. - [PubMed](#)
2. Semenza JC, Menne B. Climate change and infectious diseases in Europe. Lancet Infectious Diseases 2009; 9: 365–375. - [PubMed](#)
3. Cann KF, et al. Extreme water-related weather events and waterborne disease. Epidemiology and Infection 2013; 141: 671–686. - [PMC](#) - [PubMed](#)
4. Jacobs AFG, Heusinkveld BG, Holtslag AAM. Eighty years of meteorological observations at Wageningen, The Netherlands: precipitation and evapotranspiration. International Journal of Climatology 2010; 30: 1315–1321.
5. ten Veldhuis JAE, et al. Microbial risks associated with exposure to pathogens in

Show all 42 references

## MeSH terms

- > Adolescent
- > Adult
- > Aged
- > Cross-Sectional Studies
- > Female
- > Floods\*
- > Gastrointestinal Diseases / epidemiology\*
- > Gastrointestinal Diseases / etiology
- > General Practitioners / statistics & numerical data\*
- > Humans
- > Influenza, Human / epidemiology\*
- > Influenza, Human / virology
- > Male
- > Middle Aged
- > Netherlands / epidemiology
- > Retrospective Studies
- > Self Report
- > Skin Diseases / epidemiology\*
- > Skin Diseases / etiology
- > Young Adult

## Related information

MedGen

## LinkOut – more resources

### Full Text Sources

Cambridge University Press  
Europe PubMed Central  
Ovid Technologies, Inc.  
PubMed Central

### Medical

MedlinePlus Health Information

### Research Materials

NCI CPTC Antibody Characterization Program

[NCBI Literature Resources](#) [MeSH](#) [PMC](#) [Bookshelf](#) [Disclaimer](#)

The PubMed wordmark and PubMed logo are registered trademarks of the U.S. Department of Health and Human Services (HHS). Unauthorized use of these marks is strictly prohibited.

## FOLLOW NCBI



Connect with NLM



National Library of  
Medicine  
8600 Rockville Pike  
Bethesda, MD 20894

Web Policies  
FOIA  
HHS Vulnerability  
Disclosure

Help  
Accessibility  
Careers

NLM | NIH | HHS | USA.gov