**Epidemiologia**

disciplina che studia la frequenza e la distribuzione delle malattie nelle popolazioni, le cause ed i fattori di rischio ad esse associati, al fine di attuarne il controllo

**Epidemiologia delle MTA**

- **osservare l'andamento delle MTA (A)**

- individuare le cause ed i fattori di rischio che ne inducono l'insorgenza e ne condizionano la diffusione (B)

- studiare gli interventi atti a rendere maggiormente efficace il loro controllo (C)

Food- and waterborne diseases

https://www.ecdc.europa.eu/en/food-and-waterborne-diseases-and-zoonoses

An official website of the European Union How do you know?

Other sites: ECDC European Antibiotic Awareness Day ESCAIDE - Scientific conference Eurosurveillance journal EVIP - Vaccination portal

**European Centre for Disease Prevention and Control**

An agency of the European Union

All sections Enter your keyword

Infectious disease topics Data Analysis and guidance Training and tools About ECDC

Home > Infectious disease topics > A-Z disease list > Food- and waterborne diseases and zoonoses

# Food- and waterborne diseases and zoonoses

Most human foodborne diseases are caused by *Campylobacter*, *Salmonella*, *Yersinia*, *E. coli* and *Listeria* bacteria. The most frequent way of getting infected is through the consumption of contaminated food or water.

## Surveillance and disease data

- EU Summary Reports on AMR
- EU summary reports on trends and sources of zoonoses

## Threats and outbreaks

Rapid outbreaks assessment aim at supporting the countries and the European Commission in their preparedness and response to a public health threat.

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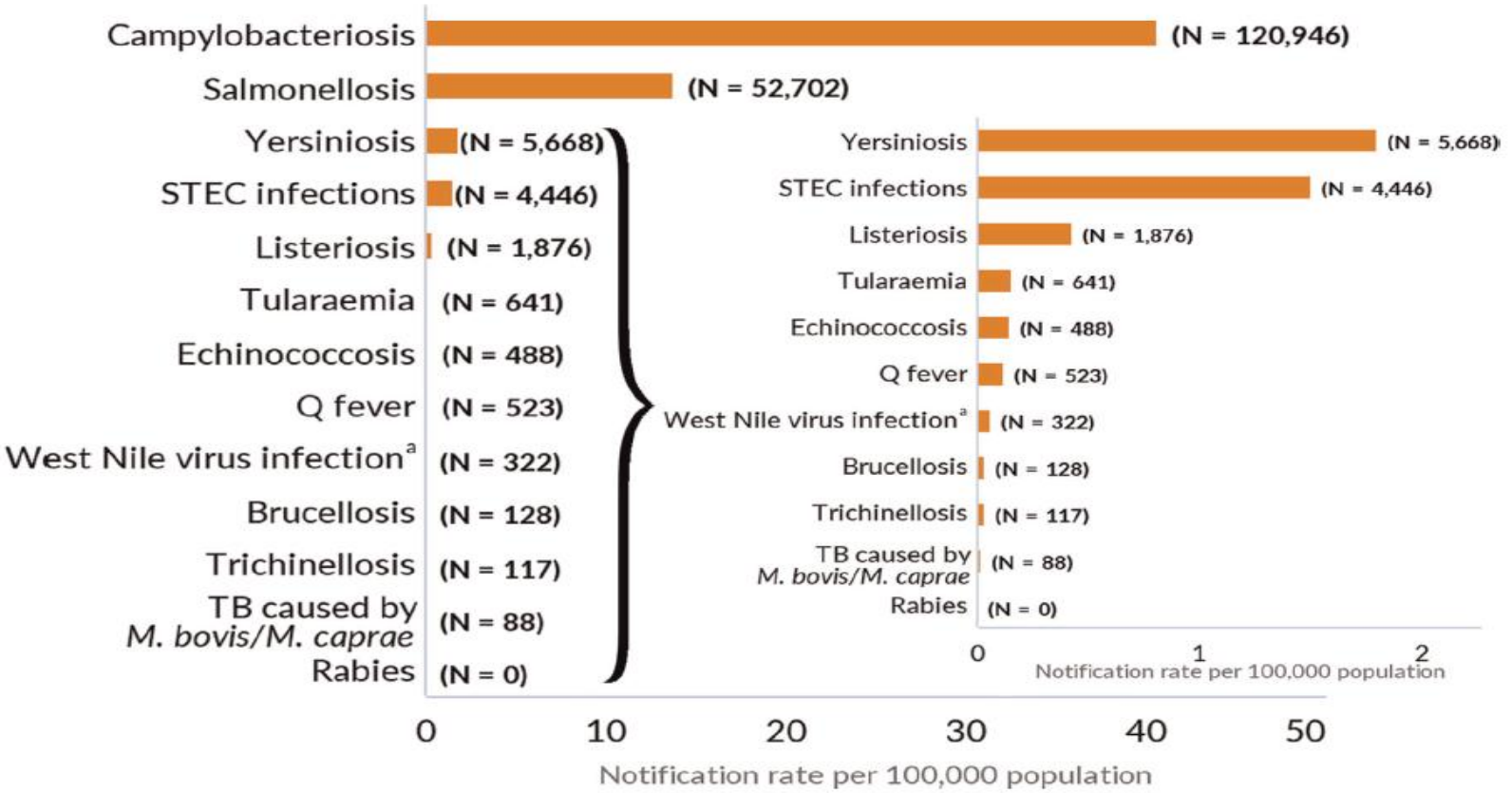



Note: The total number of confirmed cases is indicated in parentheses at the end of each bar.
(a): Regarding West Nile virus infection, the total number of cases was used (includes probable and confirmed cases).

**Figure 1:** Reported numbers of cases and notification rates of confirmed human zoonoses in the EU, 2020

**Keywords:** *Campylobacter*, foodborne outbreaks, *Listeria*, monitoring, parasites, *Salmonella*, zoonoses

**Table 2:** Reported hospitalisations and case fatalities due to zoonoses in confirmed human cases in the EU, 2020

| Disease | Number of confirmed human cases | Hospitalisation | | | | | Deaths | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Status available (N) | Status available (%) | Number of reporting MS[(b)] | Reported hospitalised cases | Proportion hospitalised (%) | Outcome available (N) | Outcome available (%) | Number of reporting MS[(b)] | Reported deaths | Case fatality (%) |
| Campylobacteriosis | 120,946 | 41,037 | 33.9 | 14 | 8,605 | 21.0 | 83,744 | 69.2 | 15 | 45 | 0.05 |
| Salmonellosis | 52,702 | 20,562 | 39.0 | 13 | 6,149 | 29.9 | 30,355 | 57.6 | 15 | 57 | 0.19 |
| Yersiniosis | 5,668 | 1,214 | 21.4 | 12 | 353 | 29.1 | 3,072 | 54.2 | 13 | 2 | 0.07 |
| STEC infections | 4,446 | 1,593 | 35.8 | 16 | 652 | 40.9 | 3,094 | 69.6 | 19 | 13 | 0.42 |
| Listeriosis | 1,876 | 803 | 42.8 | 18 | 780 | 97.1 | 1,283 | 68.4 | 18 | 167 | 13.0 |
| Tularaemia | 641 | 123 | 19.2 | 9 | 64 | 52.0 | 200 | 31.2 | 10 | 0 | 0 |
| Echinococcosis | 488 | 73 | 15.0 | 12 | 44 | 60.3 | 204 | 41.8 | 14 | 0 | 0 |
| Q fever | 523 | NA | NA | NA | NA | NA | 235 | 44.9 | 14 | 5 | 2.1 |
| West Nile virus infection[(a)] | 322 | 239 | 74.2 | 8 | 219 | 91.6 | 322 | 100 | 8 | 39 | 12.1 |
| Brucellosis | 128 | 56 | 43.8 | 8 | 36 | 64.3 | 55 | 43.0 | 9 | 2 | 3.6 |
| Trichinellosis | 117 | 22 | 18.8 | 5 | 16 | 72.7 | 24 | 20.5 | 6 | 0 | 0 |
| Rabies | 0 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

MS: Member State(s); NA: Not applicable, as information is not collected for this disease.
(a): Locally acquired infections – for West Nile virus infection, the total number of cases was used (includes probable and confirmed cases).
(b): Not all countries observed cases for all diseases.

# *Campylobacter*

## Human cases

Notification rate (per 100,000 population) 40.35

Trend (2016–2020)

120,946 Cases of illness

70,769 Infections acquired in the EU

8,605 Hospitalisations

1,586 Infections acquired outside the EU

45 Deaths

48,591 Unknown travel status or unknown country of infection

## Human cases in foodborne outbreaks

317 Foodborne outbreaks

11 Strong-evidence outbreaks

306 Weak-evidence outbreaks

1,319 Cases of illness

112 Hospitalisations

0 Deaths

## Foodborne outbreaks in the EU


Top food vehicles causing strong-evidence outbreaks

4 Outbreaks

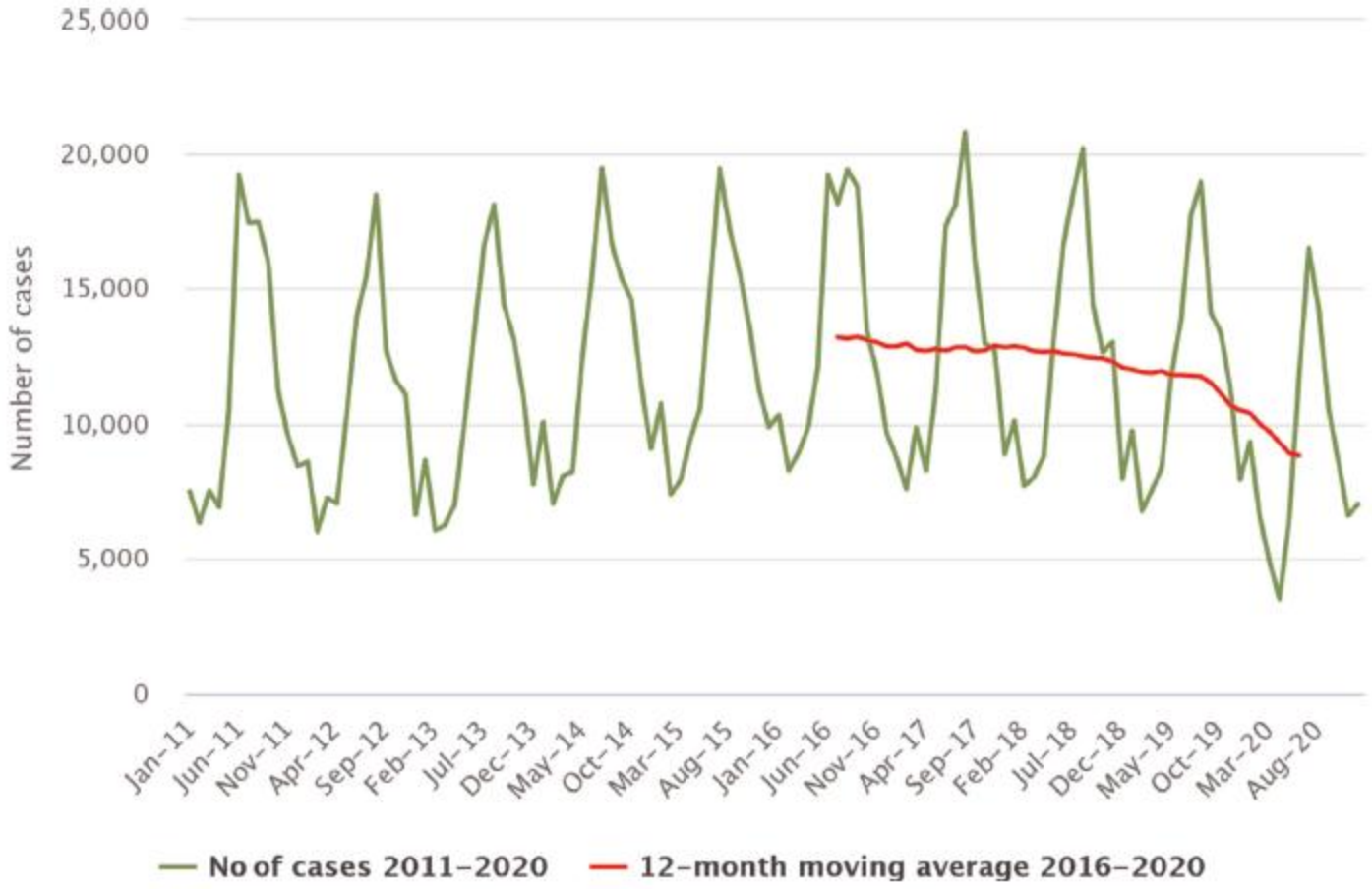
Broiler meat (*Gallus gallus*) and products thereof

4 Outbreaks

Milk

ECDC data EFSA data

* Differences among countries shall be interpreted with caution as this indicator depends on several factors including the type of outbreaks under surveillance and does not necessarily reflect the level of food safety in each country.




Source: Austria, Czechia, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Poland, Romania, Slovakia, Slovenia and Sweden.

**Figure 2:** Trends in reported confirmed human cases of campylobacteriosis in the EU, by month, 2016–2020

# Salmonellosis

## Human cases

Notification rate (per 100,000 population) 13.71

Trend (2016–2020) —

52,702 Cases of illness

33,309 Infections acquired in the EU

967 Infections acquired outside the EU

18,426 Unknown travel status or unknown country of infection

6,149 Hospitalisations

57 Deaths

## Human cases in foodborne outbreaks

694 Foodborne outbreaks

84 Strong-evidence outbreaks

610 Weak-evidence outbreaks

3,686 Cases of illness

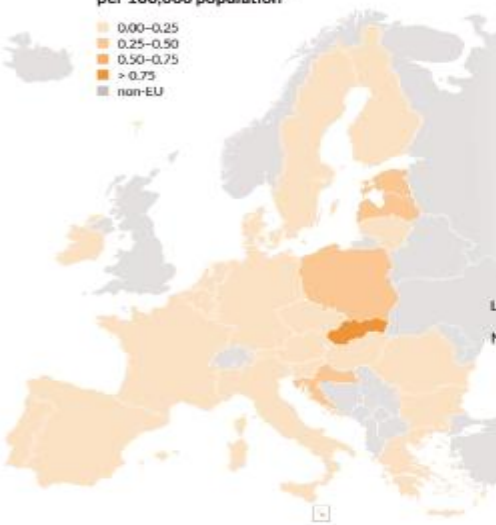
812 Hospitalisations

7 Deaths

## Foodborne outbreaks in the EU

Outbreak reporting rate per 100,000 population *

0.00–0.25
0.25–0.50
0.50–0.75
> 0.75
non-EU



| No. of salmonellosis outbreaks | |
|---|---|
| Austria | 7 |
| Belgium | 1 |
| Bulgaria | 0 |
| Croatia | 12 |
| Cyprus | 0 |
| Czechia | 7 |
| Denmark | 10 |
| Estonia | 7 |
| Finland | 3 |
| France | 138 |
| Germany | 48 |
| Greece | 0 |
| Hungary | 3 |
| Ireland | 2 |
| Italy | 32 |
| Latvia | 14 |
| Lithuania | 5 |
| Luxembourg | 1 |
| Malta | 13 |
| Netherlands | 5 |
| Poland | 111 |
| Portugal | 0 |
| Romania | 1 |
| Slovakia | 216 |
| Slovenia | 0 |
| Spain | 56 |
| Sweden | 2 |

Top food vehicles causing strong-evidence outbreaks



37 Outbreaks

Eggs and egg products



11 Outbreaks

Pig meat and products thereof

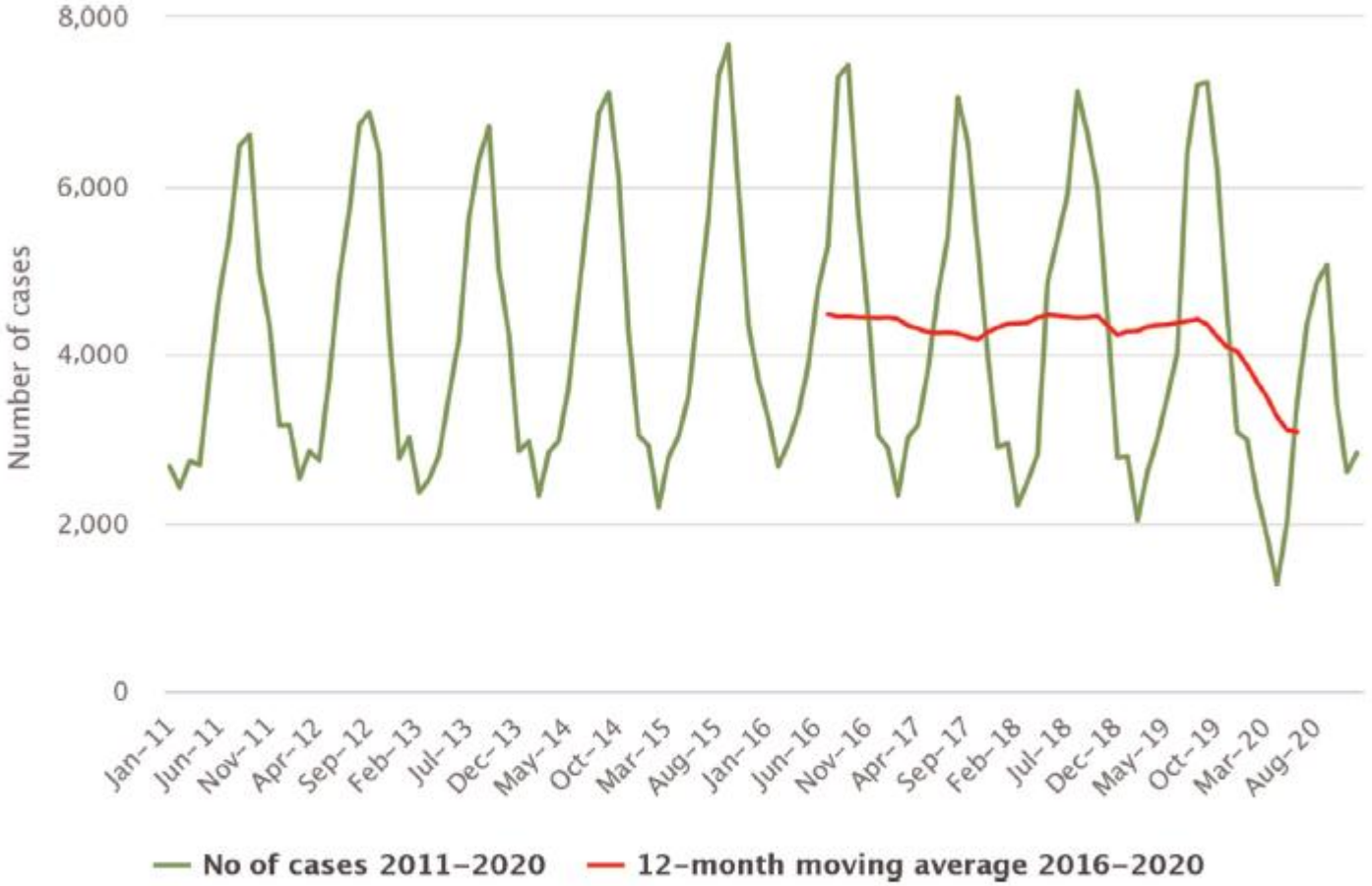


9 Outbreaks

Bakery products

ECDC data EFSA data

* Differences among countries shall be interpreted with caution as this indicator depends on several factors including the type of outbreaks under surveillance and does not necessarily reflects the level of food safety in each country.




Source: Austria, Belgium, Czechia, Denmark, Estonia, Greece, Finland, France, Ireland, Italy, Luxembourg, Latvia, Malta, the Netherlands, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia.

**Figure 3:** Trend in reported confirmed human cases of non-typhoidal salmonellosis in the EU by month, 2016–2020

# *Listeria*

## Human cases

Notification rate (per 100,000 population) 0.42

Trend (2016–2020) — Increasing, Decreasing, Stable

**1,876** Cases of illness

- 1,285 Infections acquired in the EU
- 5 Infections acquired outside the EU
- 586 Unknown travel status or unknown country of infection
- 780 Hospitalisations
- 167 Deaths

## Human cases in foodborne outbreaks

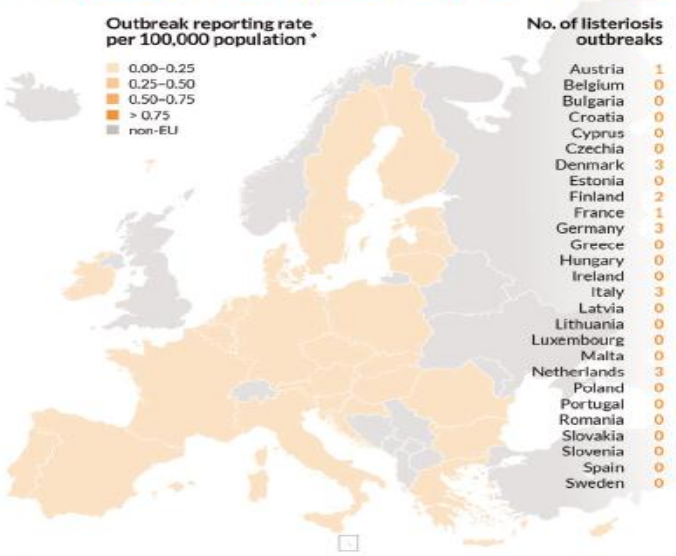
**16** Foodborne outbreaks

- 9 Strong-evidence outbreaks
- 7 Weak-evidence outbreaks

**120** Cases of illness

- 83 Hospitalisations
- 17 Deaths

## Foodborne outbreaks in the EU

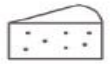



| No. of listeriosis outbreaks | |
|---|---|
| Austria | 1 |
| Belgium | 0 |
| Bulgaria | 0 |
| Croatia | 0 |
| Cyprus | 0 |
| Czechia | 0 |
| Denmark | 3 |
| Estonia | 0 |
| Finland | 2 |
| France | 1 |
| Germany | 3 |
| Greece | 0 |
| Hungary | 0 |
| Ireland | 0 |
| Italy | 3 |
| Latvia | 0 |
| Lithuania | 0 |
| Luxembourg | 0 |
| Malta | 0 |
| Netherlands | 3 |
| Poland | 0 |
| Portugal | 0 |
| Romania | 0 |
| Slovakia | 0 |
| Slovenia | 0 |
| Spain | 0 |
| Sweden | 0 |

Top food vehicles causing strong-evidence outbreaks


6 Outbreaks
Fish and fish products


2 Outbreaks
Other or mixed red meat and products thereof

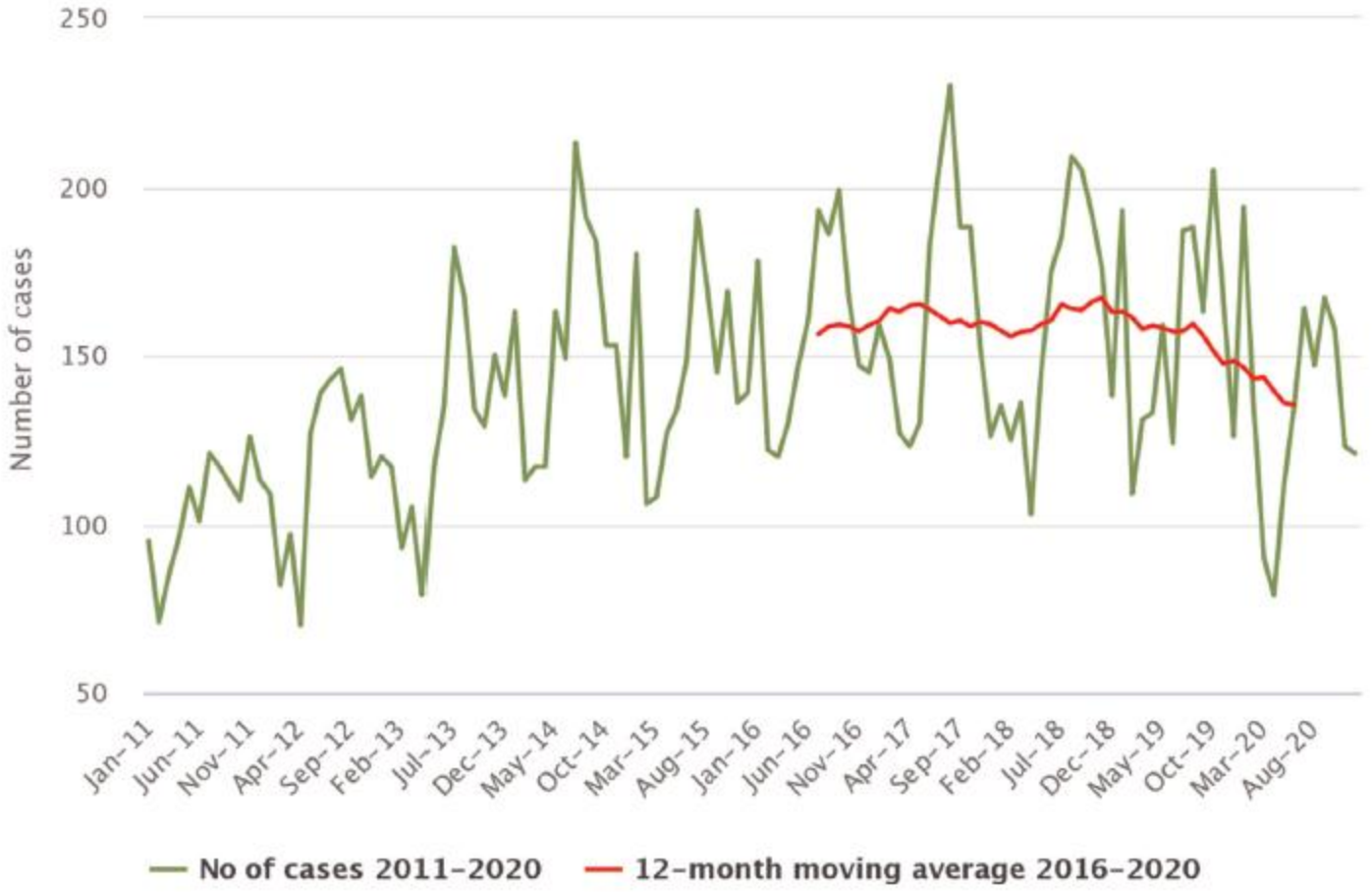

1 Outbreak
Cheese

ECDC data EFSA data

* Differences among countries shall be interpreted with caution as this indicator depends on several factors including the type of outbreaks under surveillance and does not necessarily reflects the level of food safety in each country.



IA (LBIA) Fea 23-24




Source: Austria, Belgium, Czechia, Cyprus, Denmark, Estonia, Germany, Greece, Finland, France, Hungary, Ireland, Italy, Latvia, Lithuania, Malta, the Netherlands, Poland, Romania, Sweden, Slovakia, Slovenia.

**Figure 19:** Trends in reported confirmed human cases of listeriosis in the EU by month, 2016–2020

# Shiga toxin-producing *Escherichia coli* (STEC)

## Human cases

**Notification rate** (per 100,000 population) **1.49**

**Trend** (2016–2020) — Increasing / Decreasing / Stable

**4,446** Cases of illness

- 3,327 Infections acquired in the EU
- 148 Infections acquired outside the EU
- 971 Unknown travel status or unknown country of infection
- 652 Hospitalisations
- 13 Deaths

## Human cases in foodborne outbreaks

**34** Foodborne outbreaks

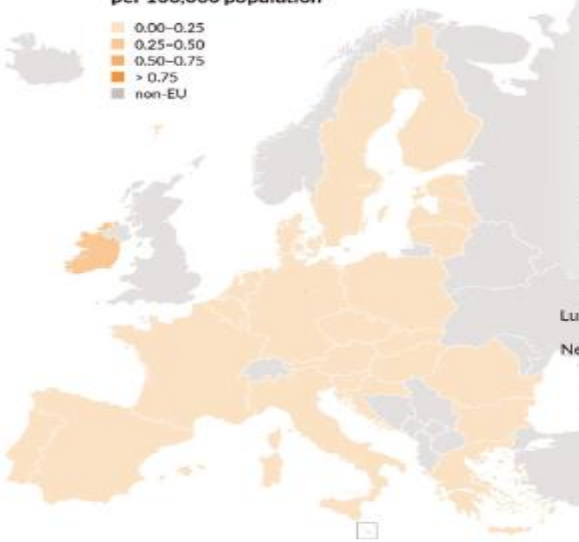
- 5 Strong-evidence outbreaks
- 29 Weak-evidence outbreaks

**208** Cases of illness

- 30 Hospitalisations
- 1 Death

## Foodborne outbreaks in the EU

**Outbreak reporting rate per 100,000 population ***




**No. of STEC outbreaks**

| | |
|---|---|
| Austria | 1 |
| Belgium | 3 |
| Bulgaria | 0 |
| Croatia | 0 |
| Cyprus | 0 |
| Czechia | 0 |
| Denmark | 1 |
| Estonia | 0 |
| Finland | 1 |
| France | 6 |
| Germany | 4 |
| Greece | 1 |
| Hungary | 0 |
| Ireland | 16 |
| Italy | 1 |
| Latvia | 0 |
| Lithuania | 0 |
| Luxembourg | 0 |
| Malta | 0 |
| Netherlands | 0 |
| Poland | 0 |
| Portugal | 0 |
| Romania | 0 |
| Slovakia | 0 |
| Slovenia | 0 |
| Spain | 0 |
| Sweden | 0 |

**Top food vehicles causing strong-evidence outbreaks**

2 Outbreaks

Tap water, including well water

2 Outbreaks

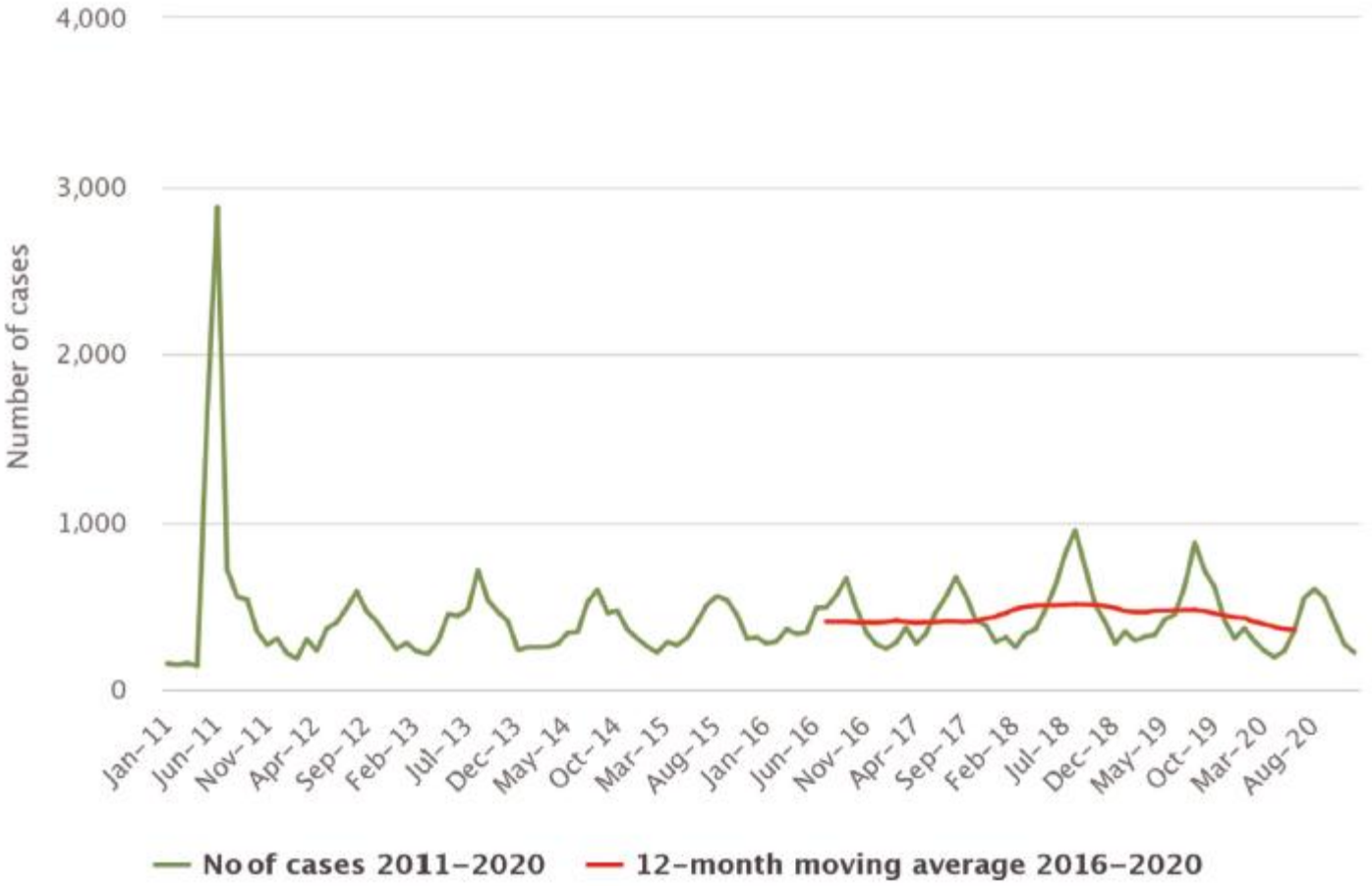
Cheese and dairies other than cheese

1 Outbreak

Other or mixed red meat and products thereof

ECDC data  EFSA data

* Differences among countries shall be interpreted with caution as this indicator depends on several factors including the type of outbreaks under surveillance and does not necessarily reflects the level of food safety in each country.




Source: Austria, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, the Netherlands, Poland, Romania, Slovakia, Slovenia, Sweden.

**Figure 24:** Trends in reported confirmed human cases of STEC infection in the EU by month, 2016–2020

**Epidemiologia**

disciplina che studia la frequenza e la distribuzione delle malattie nelle popolazioni, le cause ed i fattori di rischio ad esse associati, al fine di attuarne il controllo

## Epidemiologia delle MTA

- osservare l'andamento delle MTA (A)

- **individuare le cause ed i fattori di rischio che ne inducono l'insorgenza e ne condizionano la diffusione (B)**

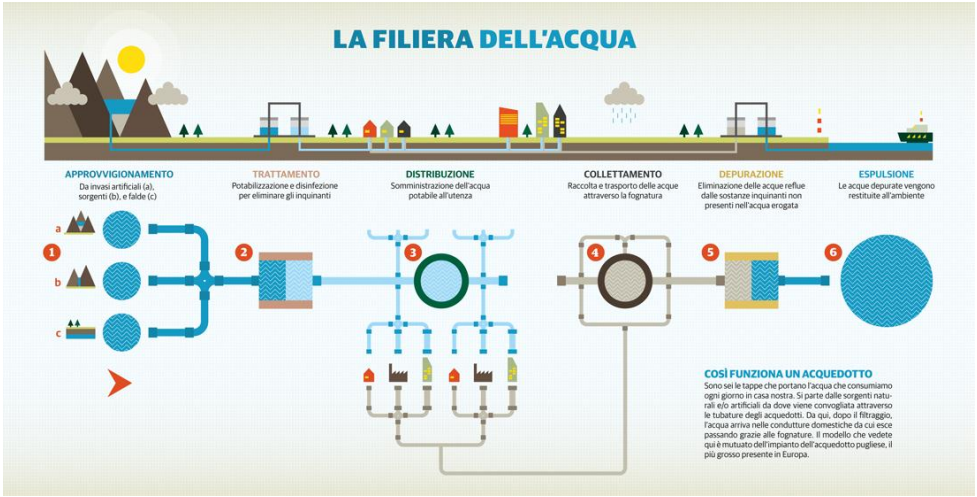
- studiare gli interventi atti a rendere maggiormente efficace il loro controllo (C)

# FATTORI FAVORENTI LA DIFFUSIONE DELLE MTA (FD) NEI PAESI INDUSTRIALIZZATI

- **danneggiamento o assenza di infrastrutture* in insediamenti urbani**
  **[eventi bellici, sismici o meteorologici** (inondazioni o alluvioni)**]**

  ***(impianti di depurazione dei reflui civili o di potabilizzazione delle acque destinate al consumo umano)**

Impianto di depurazione e riuso SMAT
Società Metropolitana Acque Torino a Collegno (TO)

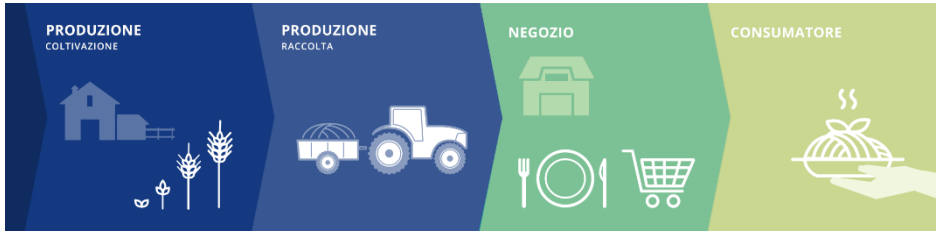


# FATTORI FAVORENTI LA DIFFUSIONE DELLE MTA (FD) NEI PAESI INDUSTRIALIZZATI

- **comportamenti della popolazione**
  - **incremento consumi alimenti non trattati**
    (pesce crudo, carne cruda, latte crudo,)
  - **incremento consumi vegetali crudi** (frutta e verdure)
    **senza un accurato lavaggio**
  - **incremento del movimento/turismo**
    (viaggi in paesi con standard igienici più bassi)
  - **incremento del consumo di cibi pronti al consumo**
    (ristorazione collettiva, gastronomie, venditori ambulanti)

# FATTORI FAVORENTI LA DIFFUSIONE DELLE MTA (FD) NEI PAESI INDUSTRIALIZZATI

- **globalizzazione della produzione alimentare**
  - **filiera alimentare corta** (produzione locale, trattamento casalingo e consumo familiare)




  - **filiera alimentare lunga** (produzione centralizzata, distribuzione su vaste aree)


  - **trasporto del mo da aree endemiche ad aree non endemiche**

# FATTORI FAVORENTI LA DIFFUSIONE DELLE MTA (FD) NEI PAESI INDUSTRIALIZZATI

- **tecnologie alimentari che favoriscono alcuni mo**
  - sottovuoto → botulismo
  - refrigerazione → listeriosi

- **fattori demografici**
  - aumento della suscettibilità alle infezioni a causa dell'aumento di alcuni gruppi della popolazione (anziani, soggetti diabetici, sottoposti a trapianti, a chemioterapie, a radioterapie, a terapie con cortisonici)

- **negazione dell'esistenza di epidemie**
  - per non bloccare le esportazioni ed il turismo

- **limiti della reale azione preventiva**
  - carenze nell'educazione degli addetti (OSA)e dei consumatori

- **variabilità genetica dei mo**
  - sviluppo naturale di ceppi virulenti (*E. coli patogeni,* ) o resistenti agli antibiotici (*S. typhimurium*)

- **fattori climatici e ambientali**

https://doi.org/10.1038/s41579-019-0222-5

CONSENSUS STATEMENT

OPEN

# Scientists' warning to humanity: microorganisms and climate change

*Ricardo Cavicchioli[1]*, William J. Ripple[2], Kenneth N. Timmis[3], Farooq Azam[4], Lars R. Bakken[5], Matthew Baylis[6], Michael J. Behrenfeld[7], Antje Boetius[8,9], Philip W. Boyd[10], Aimée T. Classen[11], Thomas W. Crowther[12], Roberto Danovaro[13,14], Christine M. Foreman[15], Jef Huisman[16], David A. Hutchins[17], Janet K. Jansson[18], David M. Karl[19], Britt Koskella[20], David B. Mark Welch[21], Jennifer B. H. Martiny[22], Mary Ann Moran[23], Victoria J. Orphan[24], David S. Reay[25], Justin V. Remais[26], Virginia I. Rich[27], Brajesh K. Singh[28], Lisa Y. Stein[29], Frank J. Stewart[30], Matthew B. Sullivan[31], Madeleine J. H. van Oppen[32,33], Scott C. Weaver[34], Eric A. Webb[17] and Nicole S. Webster[33,35]*

Abstract | In the Anthropocene, in which we now live, climate change is impacting most life on Earth. Microorganisms support the existence of all higher trophic life forms. To understand how humans and other life forms on Earth (including those we are yet to discover) can withstand anthropogenic climate change, it is vital to incorporate knowledge of the microbial 'unseen majority'. We must learn not just how microorganisms affect climate change (including production and consumption of greenhouse gases) but also how they will be affected by climate change and other human activities. This Consensus Statement documents the central role and global importance of microorganisms in climate change biology. It also puts humanity on notice that the impact of climate change will depend heavily on responses of microorganisms, which are essential for achieving an environmentally sustainable future.

https://doi.org/10.1038/s41579-019-0222-5

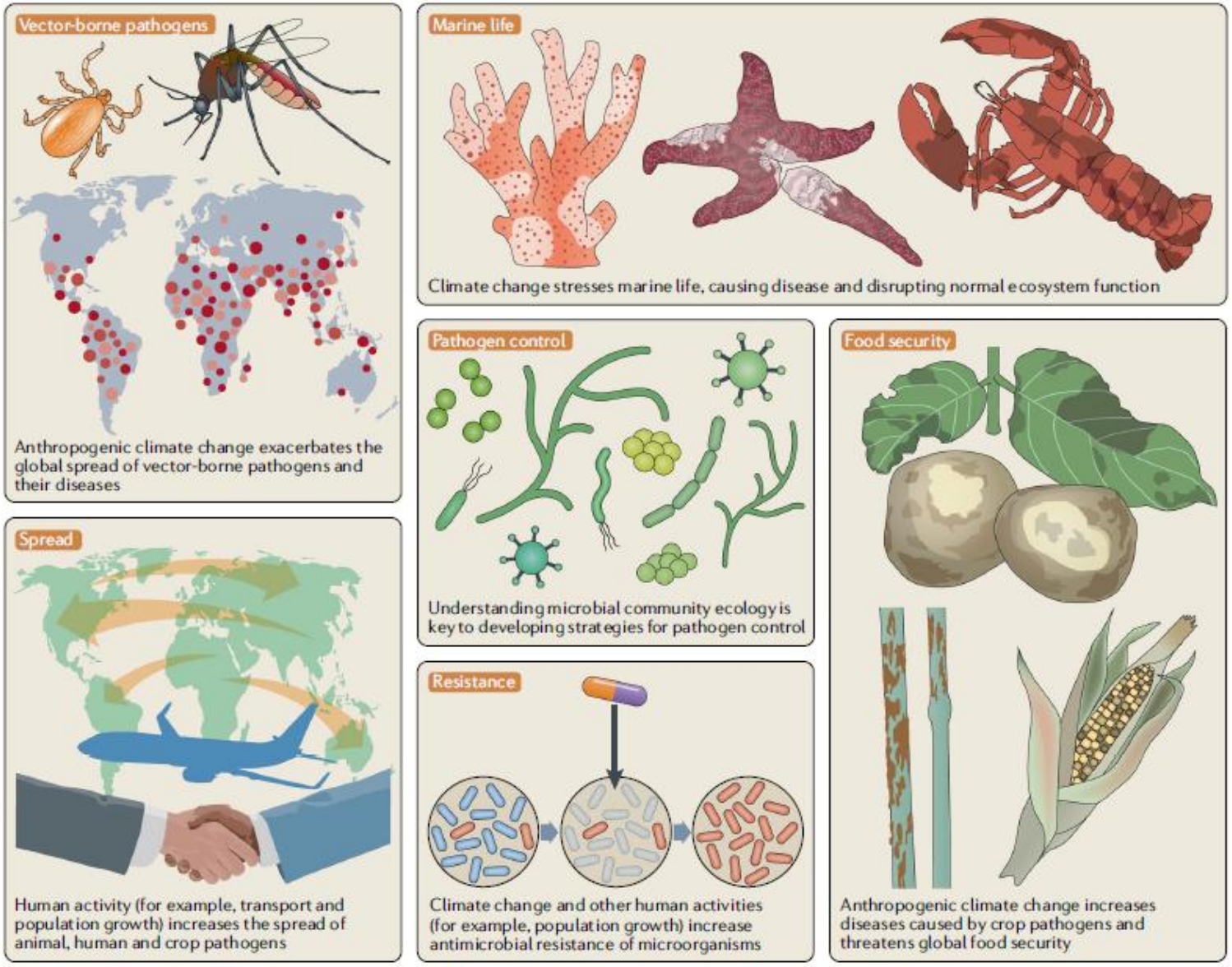
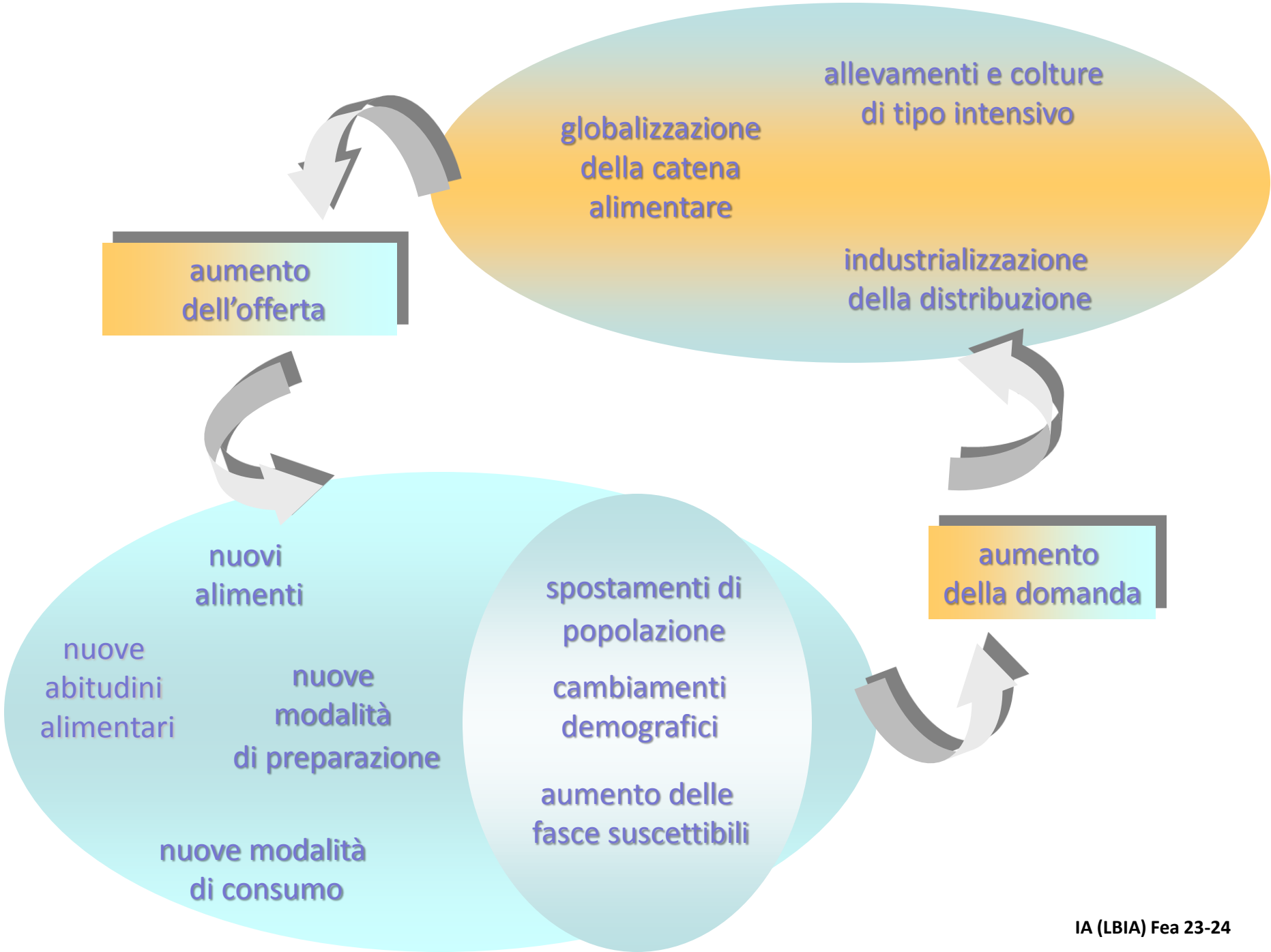



Fig. 3 | **Climate change exacerbates the impact of pathogens.** Anthropogenic climate change stresses native life, thereby enabling pathogens to increasingly cause disease. The impact on aquaculture, food-producing animals and crops threatens global food supply. Human activities, such as population growth and transport, combined with climate change increase antibiotic resistance of pathogens and the spread of waterborne and vector-borne pathogens, thereby increasing diseases of humans, other animals and plants.

https://doi.org/10.1038/s41579-019-0222-5

Table 1 | **Transmission response of pathogens to climatic and environmental factors**

| Example pathogens or diseases | Climatic and environmental factors | Transmission parameters |
|---|---|---|
| ***Vector-borne*** | | |
| West Nile virus | Precipitation, relative humidity, temperature, El Niño Southern Oscillation | Vector abundance, longevity and biting rate, pathogen replication rate in vector[273–276] |
| Malaria | | |
| Dengue fever | | |
| Lyme disease | | |
| ***Waterborne*** | | |
| Cholera | Temperature, precipitation variability, salinity, El Niño Southern Oscillation | Pathogen survival, pathogen replication in environment, pathogen transport[244,277–279] |
| Non-cholera *Vibrio* spp. | | |
| *Cryptosporidium* spp. | | |
| Rotavirus | | |
| ***Airborne*** | | |
| Influenza | Relative humidity, temperature, wind | Pathogen survival, pathogen and/or host dispersal[280–284] |
| Hantavirus | | |
| Coccidioidomycosis | | |
| ***Foodborne*** | | |
| *Salmonella* spp. | Temperature, precipitation | Pathogen replication, human behaviour[239,240] |
| *Campylobacter* spp. | | |


globalizzazione della catena alimentare
allevamenti e colture di tipo intensivo
industrializzazione della distribuzione
aumento dell'offerta
aumento della domanda
spostamenti di popolazione
cambiamenti demografici
aumento delle fasce suscettibili
nuovi alimenti
nuove abitudini alimentari
nuove modalità di preparazione
nuove modalità di consumo

# Patologie e mo trasmessi attraverso gli alimenti (1)

**inizio 1900**

- febbre tifoide (*Salmonella typhi e paratyphi*)
- colera (*Vibrio cholerae*)
- tubercolosi trasmessa attraverso il latte crudo (*Mycobacterium **bovis***)**Mycobacterium **tubercolosis*** è quello trasmesso per via aerea

**anni 1990 - oggi**

- *Campylobacter* spp (sorgente animale - intestino di volatili, pollame in particolare)
- *Salmonella* spp (sorgente animale - intestino di volatili, rettili e mammiferi)
- *E. coli* O157:H7 (sorgente animale - intestino bovini ed erbivori)
- Norovirus - NoV (sorgente umana - intestino umano - si diffonde principalmente attraverso una persona contagiosa/malata che manipola i cibi)

# Patologie e mo trasmessi attraverso gli alimenti (2)

- **patogeni occasionalmente di origine alimentare, possono essere trasmessi attraverso altre vie (acqua, ecc)**
  - virus dell'epatite A (HAV) ed E (HEV)
  - *Giardia lamblia*
  - *Cryptosporidium parvum*

- **patogeni che producono tossine dopo aver contaminato ed essersi moltiplicate sull'alimento**
  - *Staphylococcus aureus*
  - *Clostridium botulinum*

# Agenti patogeni responsabili MTA

**range di microrganismi responsabili MTA:**
**circa 20 specie sono coinvolte nel 90% dei casi**

**patogeni considerati "emergenti" in ambito alimentare**

- **patogeni opportunisti** microrganismi che si sono spostati in nuove nicchie determinate dai cambiamenti della produzione alimentare e delle tecnologie della manipolazione (*Listeria* → refrigerazione)

- **agenti non rilevabili** microrganismi "nascosti" fino allo sviluppo di appropriate tecniche di coltivazione (*Campylobacter* ambiente microaerofilo)

- **nuovi microrganismi** nuovi ceppi virulenti emersi attraverso variazioni genetiche (*E. coli* O157 e *Vibrio cholerae* O139)

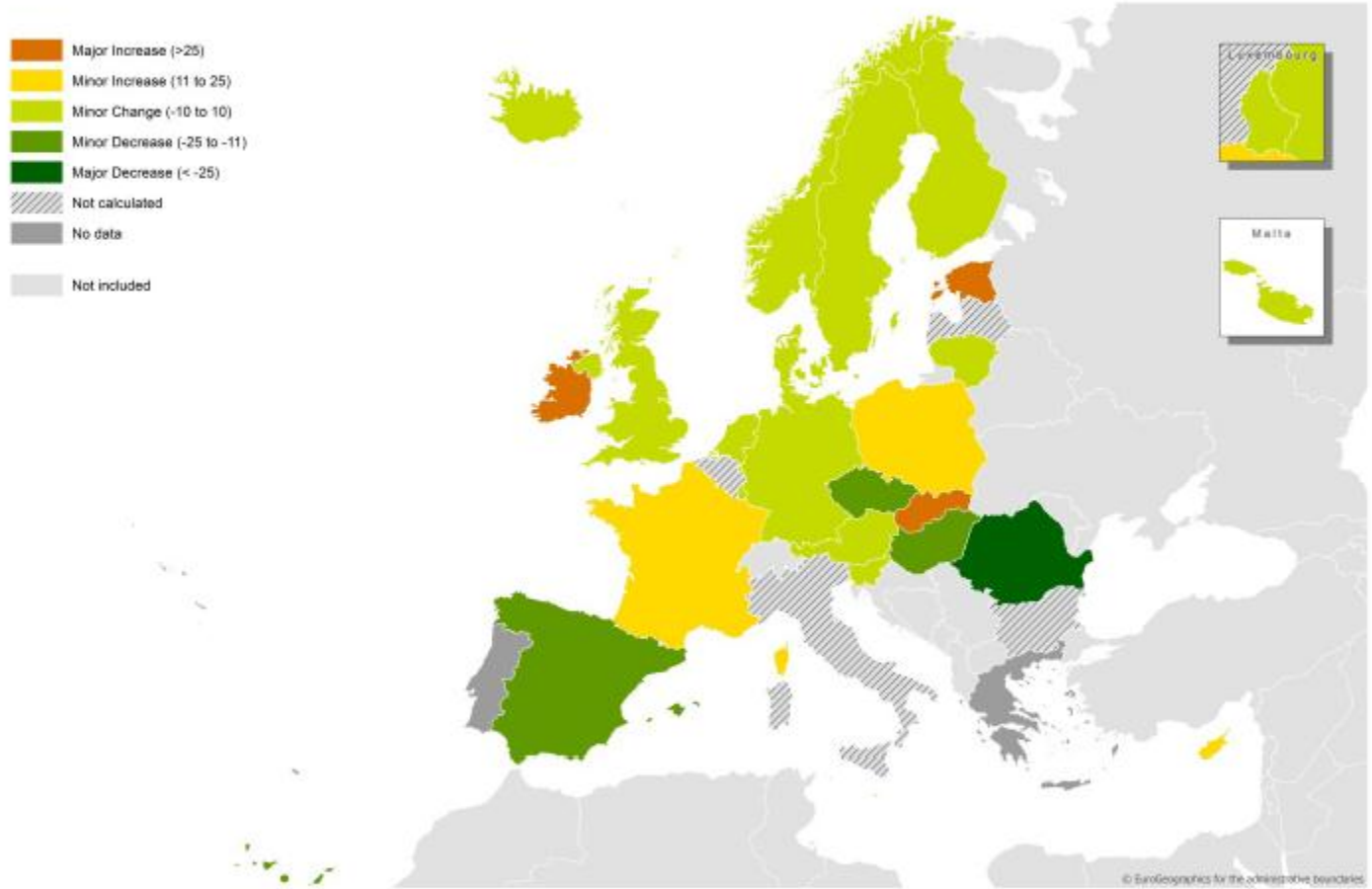
# Differenze nell'incidenza delle MTA nei diversi paesi

- variabilità nella distribuzione geografica dei patogeni
- diversa suscettibilità genetica del bestiame
- influenza delle condizioni climatiche
- fattore ospite (suscettibilità)
- abitudini culturali della popolazione
- educazione soggettiva

# Difficoltà nell'acquisizione delle informazioni su MTA

- differenza nelle modalità di notifica dei dati nei Paesi
- solo il colera è notificato a livello internazionale
- differenza di notifica a livello nazionale ed anche regionale
- problematiche legate alla diagnosi di laboratorio
- bassa percezione della popolazione nei confronti delle MTA
- indagini inconcludenti: le autorità non hanno i mezzi e l'organizzazione per fare delle indagini corrette sulle epidemie

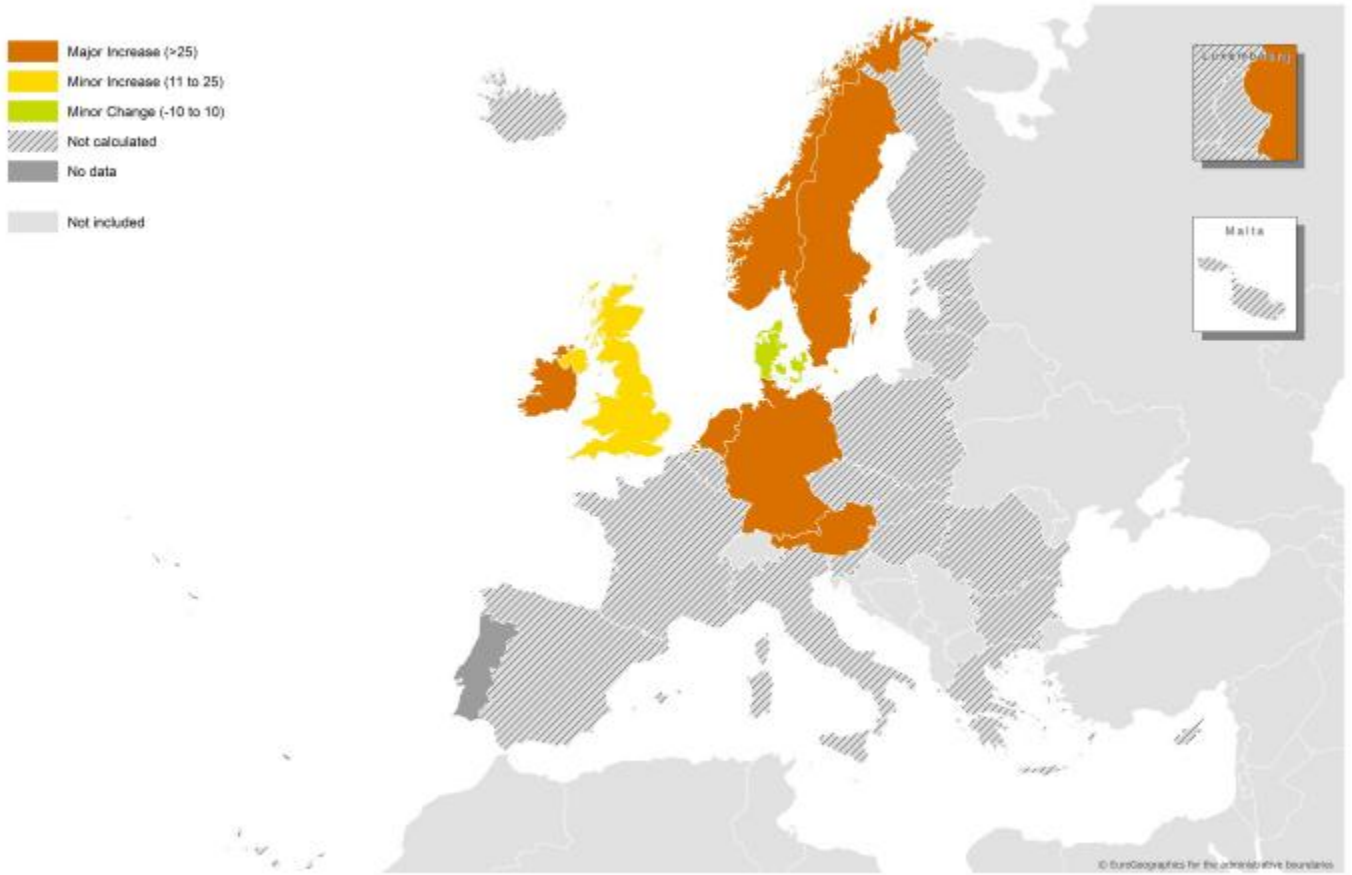
**Figure 1.2. Percentage change in notification rates of campylobacteriosis cases in EU/EEA countries, 2010–2012**




*Not calculated: Country-specific percentage changes in notification rates were not calculated if the number of confirmed cases reported for one or more years during 2010–2012 was lower than 25, if sentinel surveillance systems had unknown population coverage, or if there was incomplete reporting for one of the reporting years.*

*Source: The European Surveillance System (TESSy) data, 2010–2012*

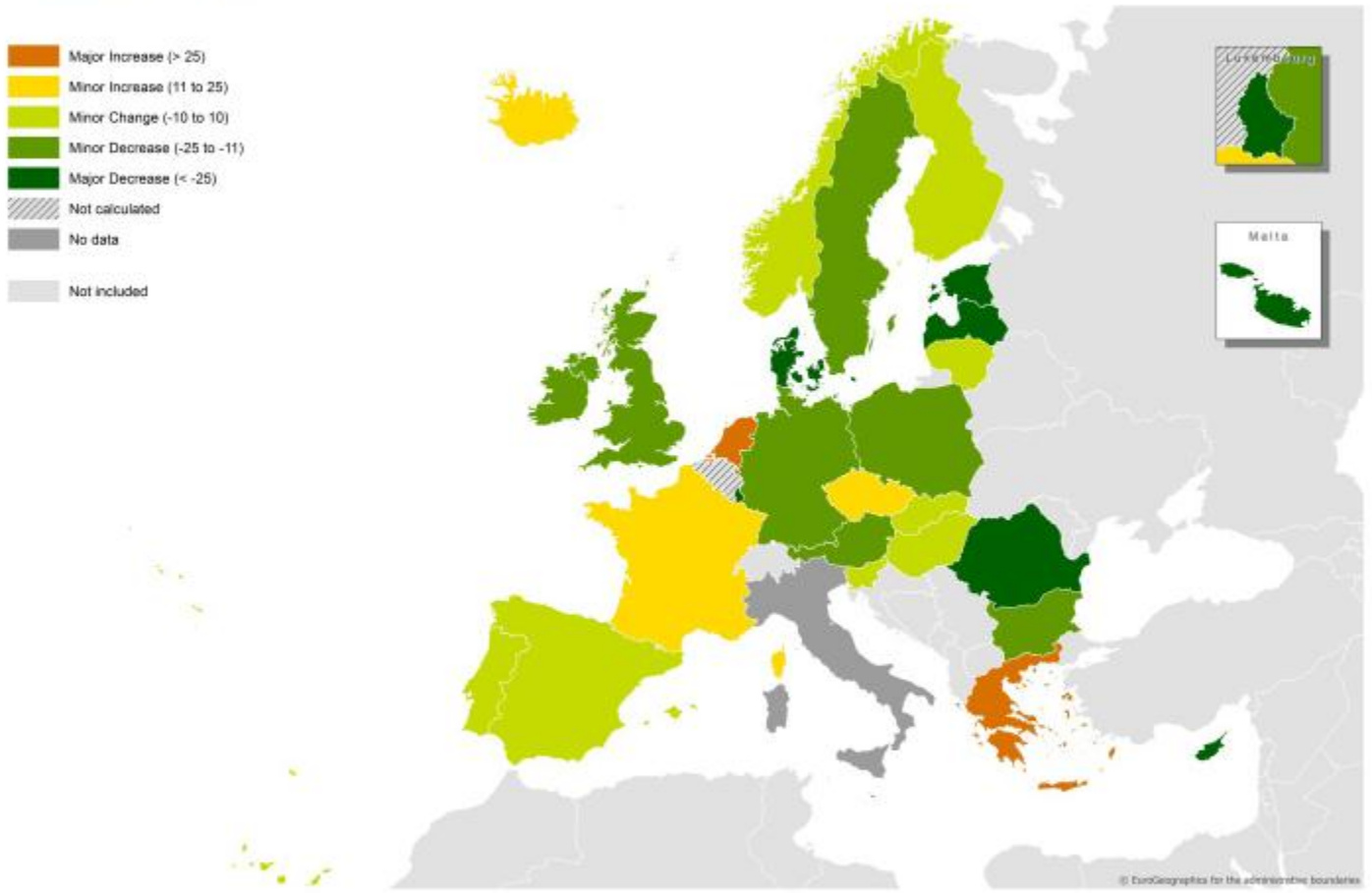
**Figure 5.2. Percentage change in notification rates of STEC/VTEC cases in EU/EEA countries, 2010–2012**




*Not calculated: Country-specific percentage changes in notification rates were not calculated if the number of confirmed cases reported for one or more years during 2010–2012 was lower than 25, if sentinel surveillance systems had unknown population coverage, or if there was incomplete reporting for one of the reporting years.*

*Source: The European Surveillance System (TESSy) data, 2010–2012*

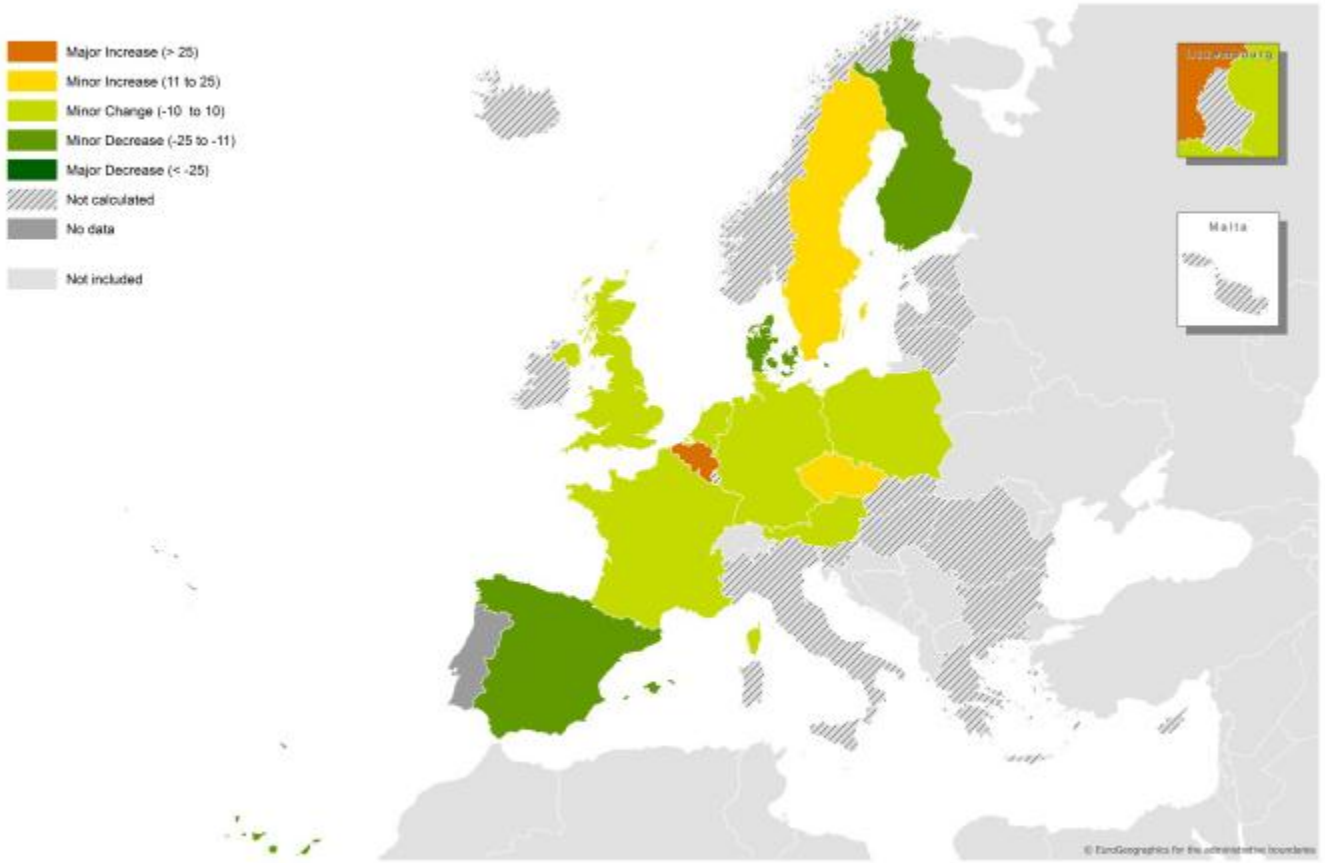
**Figure 3.2. Percentage change in notification rates of non-typhoidal salmonellosis cases in EU/EEA countries, 2010–2012**




*Not calculated: Country-specific percentage changes in notification rates were not calculated if the number of confirmed cases reported for one or more years during 2010–2012 was lower than 25, if sentinel surveillance systems had unknown population coverage, or if there was incomplete reporting for one of the reporting years.*

*Source: The European Surveillance System (TESSy) data, 2010–2012*

**Figure 2.2. Percentage change in notification rates of listeriosis cases in EU/EEA countries, 2010–2012**

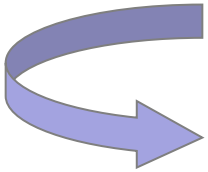



*Not calculated: Country-specific percentage changes in notification rates were not calculated if the number of confirmed cases reported for one or more years during 2010–2012 was lower than 25, if sentinel surveillance systems had unknown population coverage, or if there was incomplete reporting for one of the reporting years.*

*Source: The European Surveillance System (TESSy) data, 2010–2012*

# FATTORI DI CONTAMINAZIONE DEGLI ALIMENTI
# biologici – chimici – fisici

(tipologia di contaminazione)



## contaminanti di natura biologica

microrganismi vitali e/o loro tossine
(batteri, virus, lieviti, miceti, protozoi)

risulta necessario che il microrganismo si moltiplichi e/o superi una certa quantità e/o produca tossine per determinare la patologia

- **contaminazione primaria:** presenza del microrganismo nell'alimento in origine o durante la produzione primaria degli alimenti di origine animale (allevamento) e vegetale (coltivazione in campo)
- **contaminazione secondaria:** penetrazione del microrganismo nelle diverse fasi di lavorazione (es macellazione), distribuzione, commercializzazione e somministrazione dell'alimento (produzione secondaria)

# Fattori che determinano una MTA

1. la presenza di un microrganismo (mo)
2. la presenza di un alimento (adatto)
3. la contaminazione dell'alimento da parte del mo
4. la presenza di un numero adeguato di mo

   dose minima infettante (DMI) necessaria per determinare la patologia

   4a batteri, miceti, lieviti → tempo e temperatura di conservazione dell'alimento

   4b virus e protozoi

5. l'ingestione dell'alimento contaminato (4) da un numero di mo pari alla DMI

azione di prevenzione primaria **3**

**→ evitare la contaminazione mo-alimento**

azione di prevenzione primaria **4**

**→ evitare la moltiplicazione del mo**