Phylogenetic Analysis and Epidemiological Investigation of *Brucella* spp. in a One Health Context

Using epidemiological data in outbreak investigations

19 January 2026

Intended Learning Objectives

Specific objectives of this session:

1. Learn which main types of epidemiological analyses can be useful during an outbreak investigation

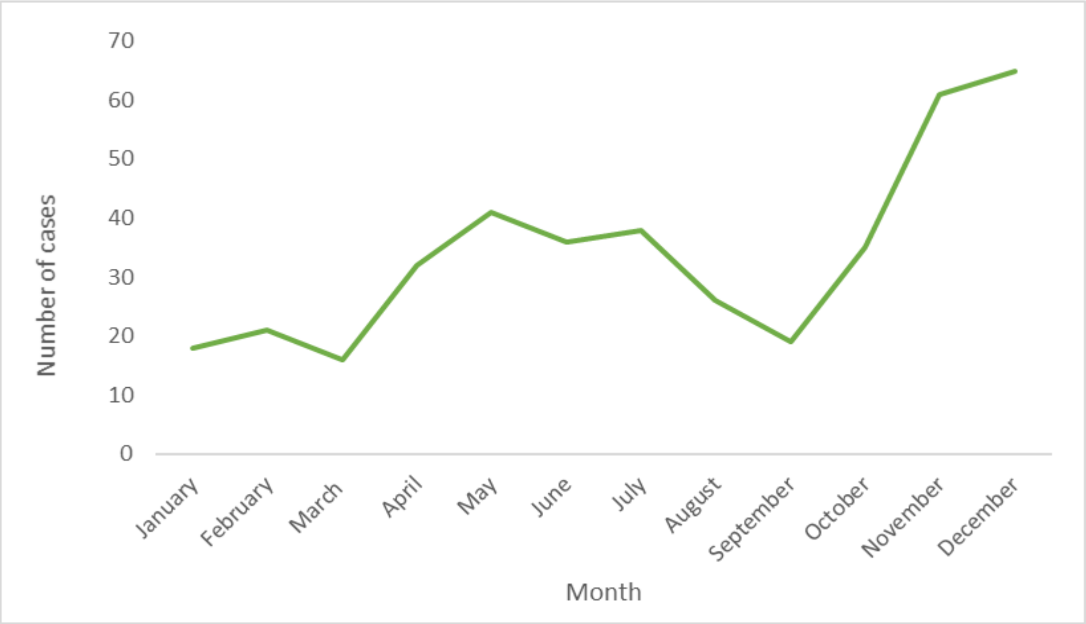
2. Understand how epidemiological data can complement microbiological analyses to strengthen outbreak investigations

Outline

This session consists of the following elements

1. Outbreak detection
2. How to draw and interpret an epidemic curve
3. Importance of case definition for outbreak investigations
4. How to use the epidemiological data to generate hypotheses

Is this an outbreak?



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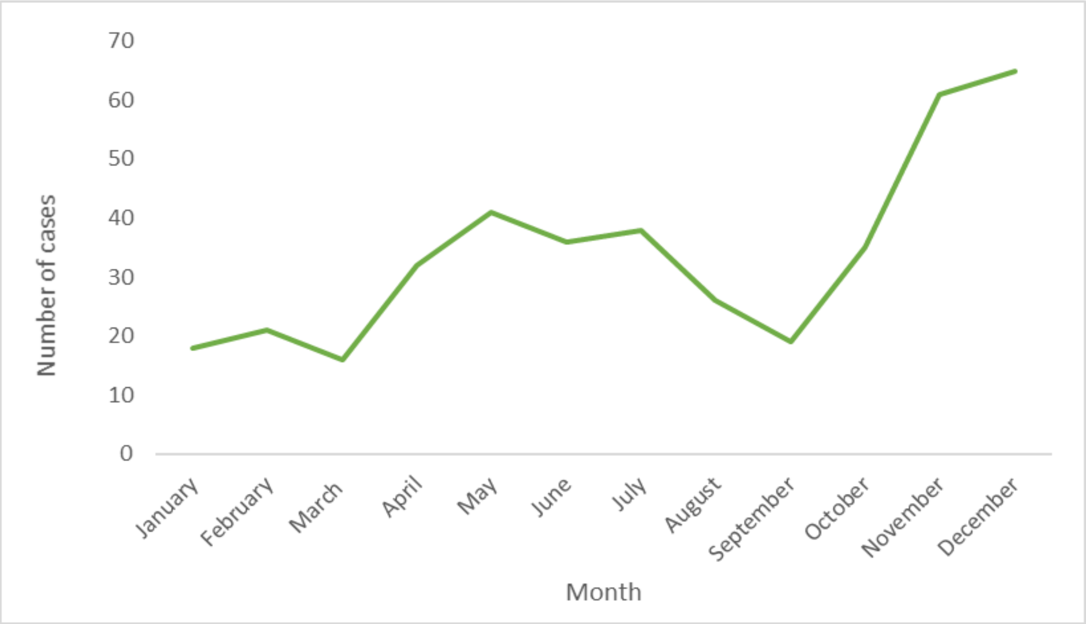
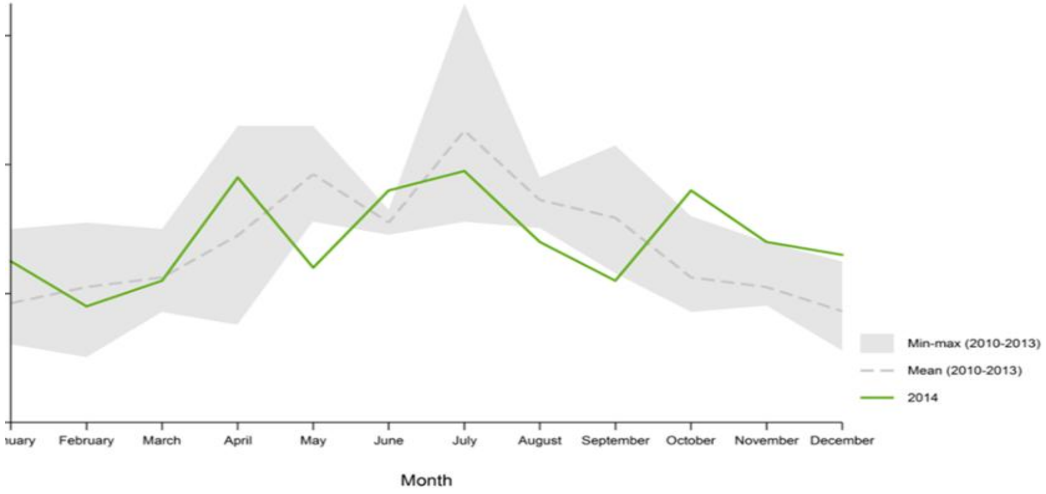


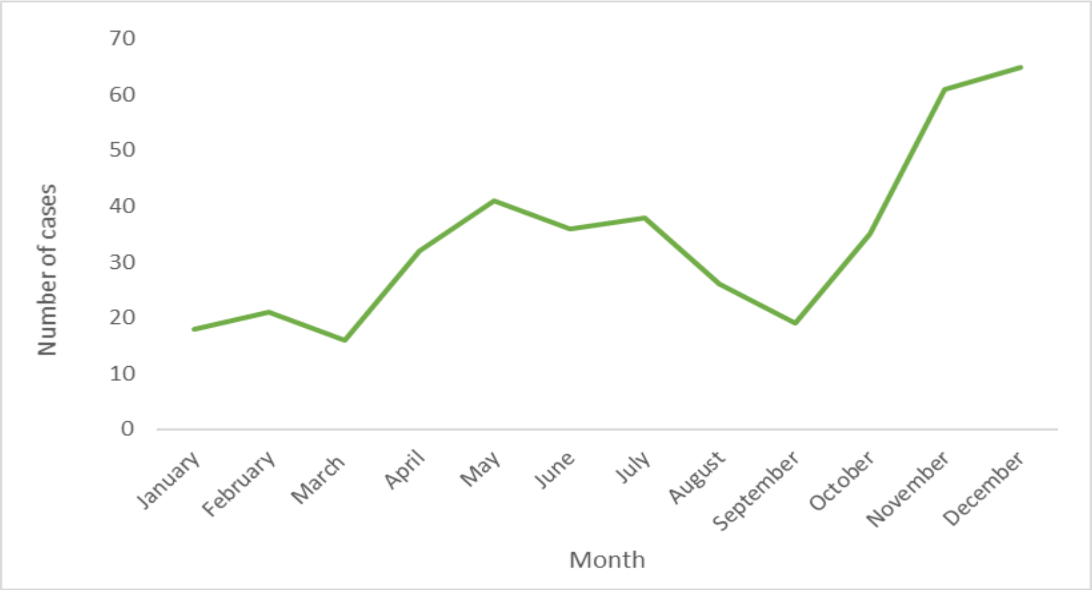


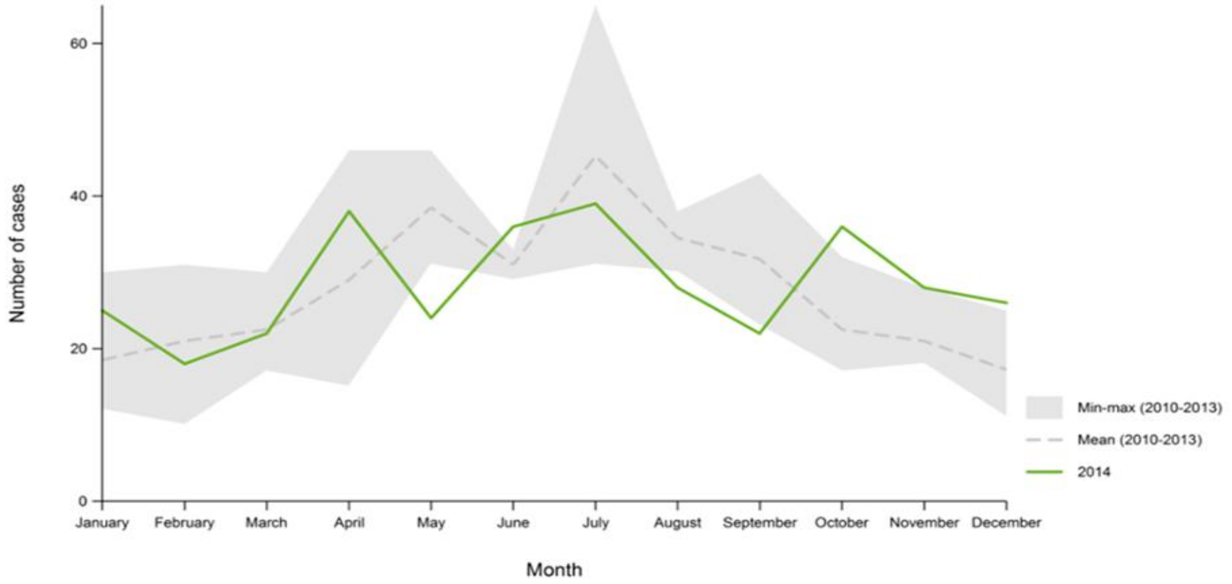
Graph from ECDC annual epidemiological report, brucellosis, 2015

Is this an outbreak?

The number of cases is higher than the expected background rate,

with no other apparent explanation for the increase in cases.





Detection of an outbreak

National surveillance system

- exceedance detection

Reported by clinicians/clinics/laboratories

Reported by schools etc

Others – eg WGS

* Notifiable/reportable disease?

Search for cases

- cases passively reported through surveillance
- stimulated passive surveillance, i.e. remind reporting units to notify cases
- active surveillance (eg active collection of information from reporting sites or laboratories through visits)
- active case finding (door-to-door search, media, health care providers office etc)

Importance of case definition

Case definition: Standard set of criteria for deciding if a person should be classified as a case or not

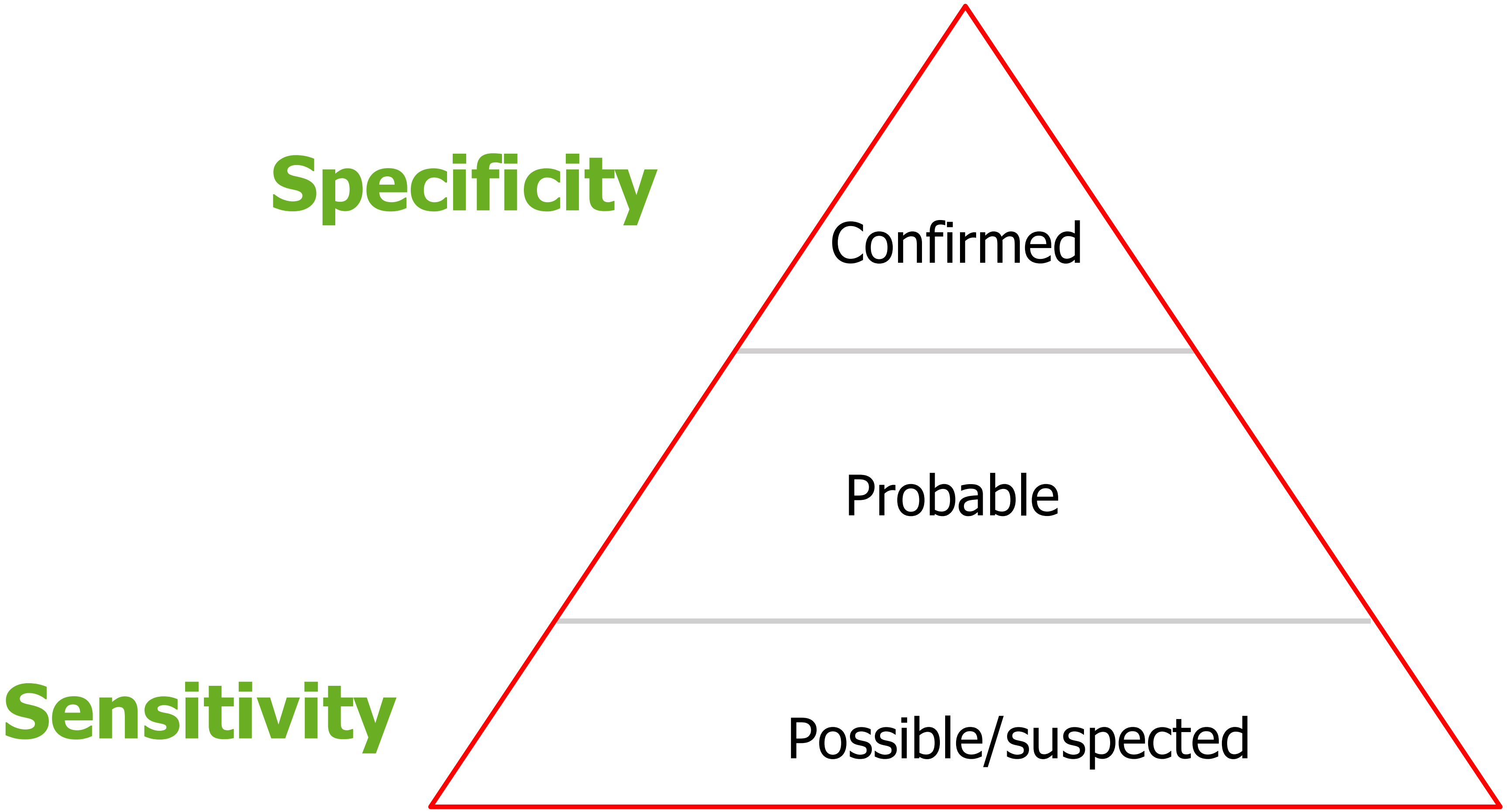
Criteria

- Person
- Place
- Time
- Clinical and/or laboratory and/or epi criteria

Building a case definition

- Person (who)
  - Aged 18 years or older
- Place (where)
  - Resident or visitor of Denmark
- Time (when)
  - Symptoms starting after 1st December 2025
- Clinical and/or laboratory (what)
  (and epidemiological) criteria
  - Laboratory-confirmed *Brucella abortus*

Case definitions may vary at different stages



Case definitions may vary at different stages

Different levels of a case definition (not all needed for all outbreaks)

Suspected/Possible case:

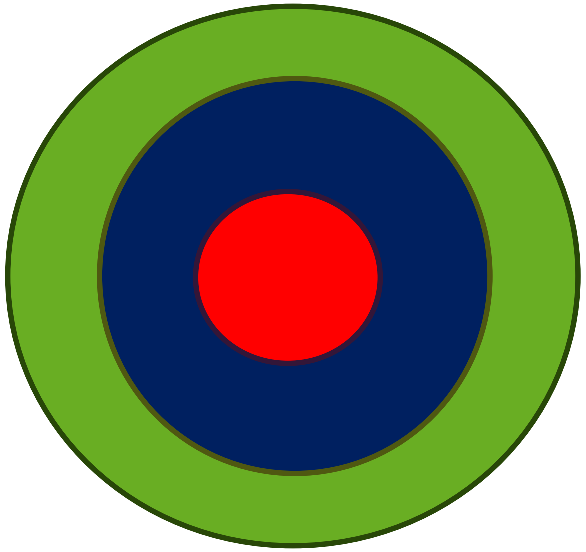
- Person living in Denmark with acute diarrhoea with onset of symptoms after 01/12/2025

Probable case:

- Suspected case with laboratory-confirmed brucellosis

Confirmed case:

- Laboratory diagnosis
- that consumed X product
- with the outbreak strain



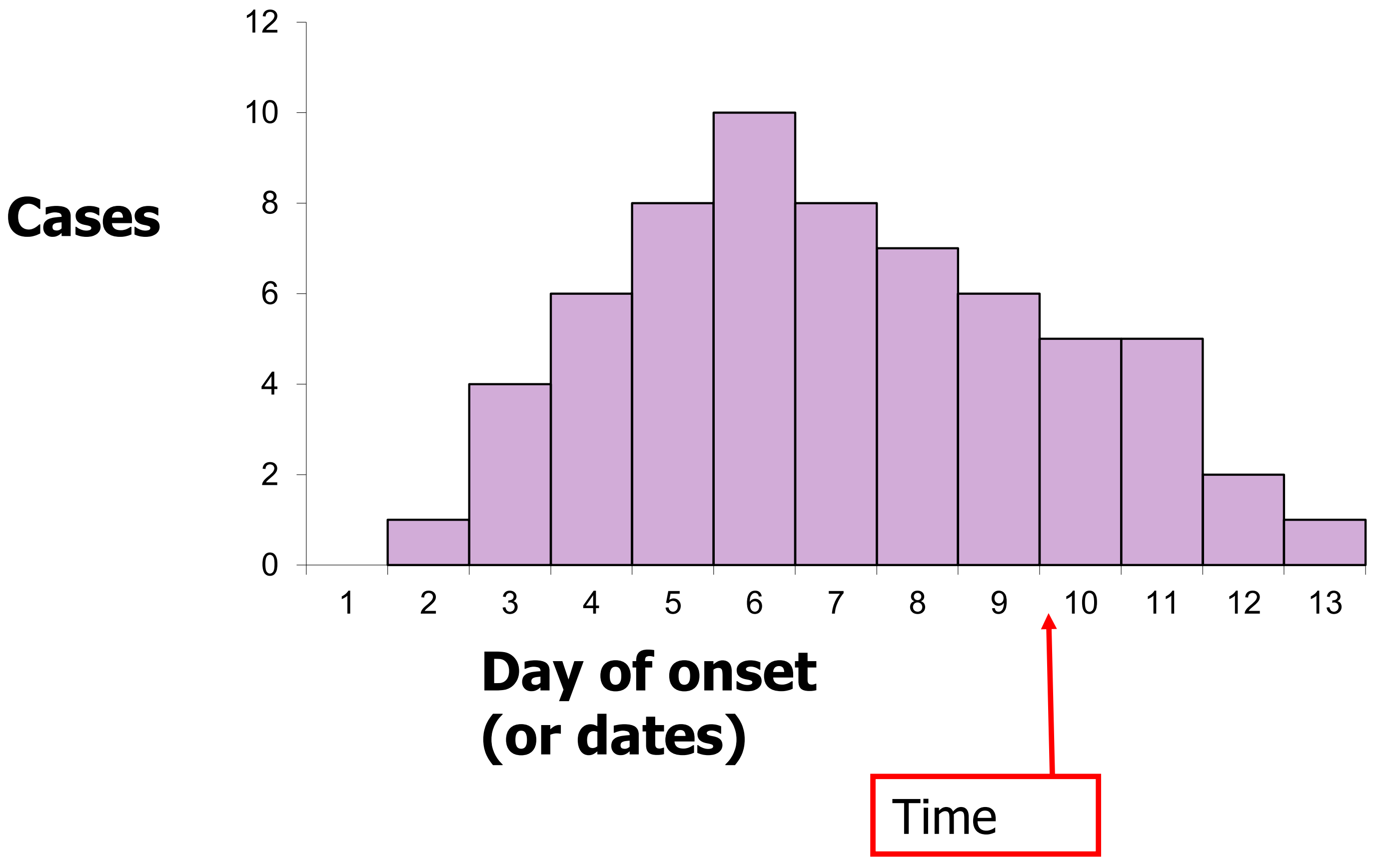
Epidemic (epi) curves

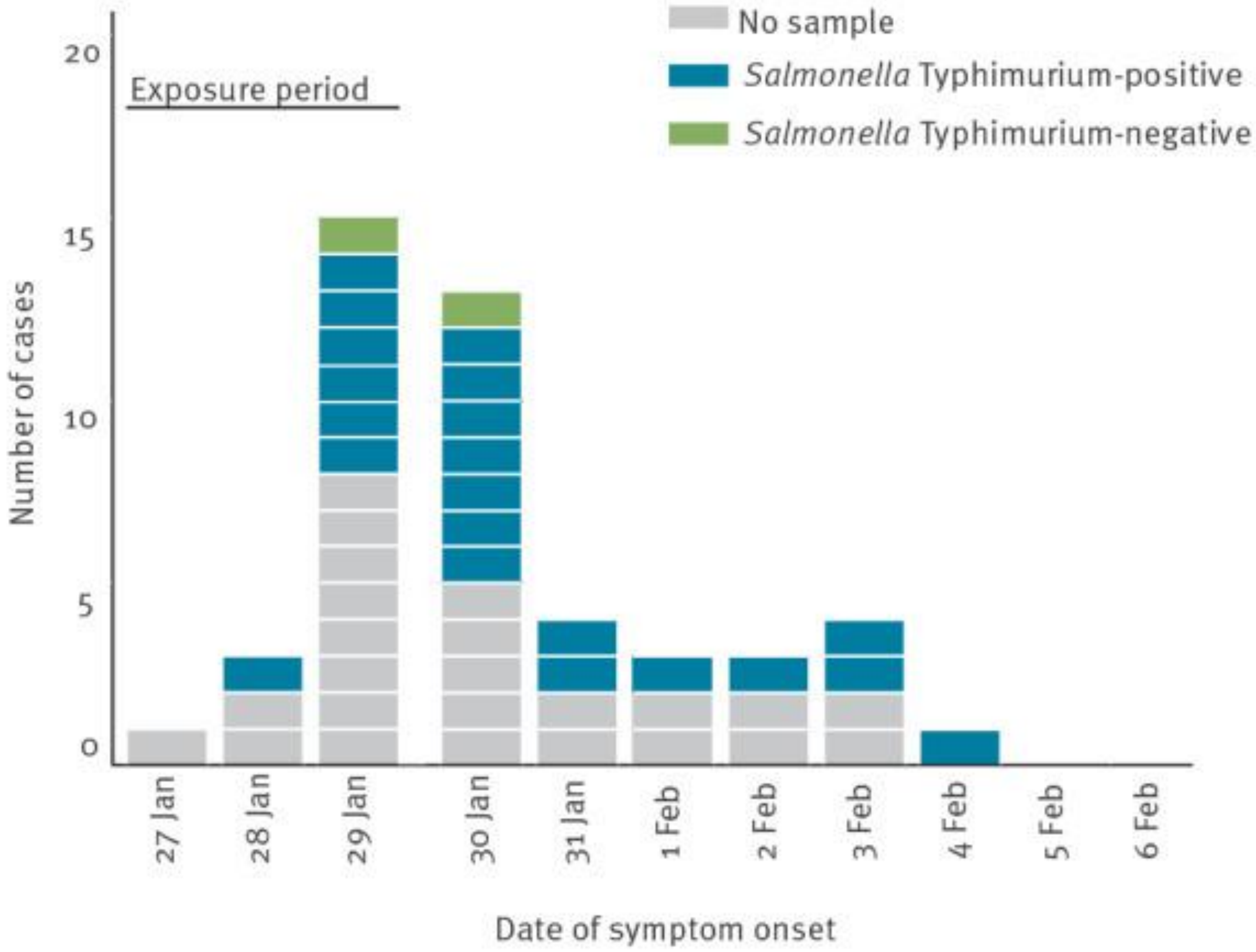
- To visually display the magnitude and time course of the outbreak
- **X axis: Time** (unit in hours, days, weeks, months etc, depending on the length of the outbreak and the incubation period of the pathogen) – day of symptom onset, day of reporting etc
- **Y axis:** absolute number of **cases**
- The curve is conventionally drawn as a histogram
- Many different software can be used, e.g. Excel, STATA, R, etc, even manual drawing

Epidemic (epi) curves

Provides clues on:

- Incubation period
- Aetiological agent
- Type of source
- Type of transmission
- Time of exposure

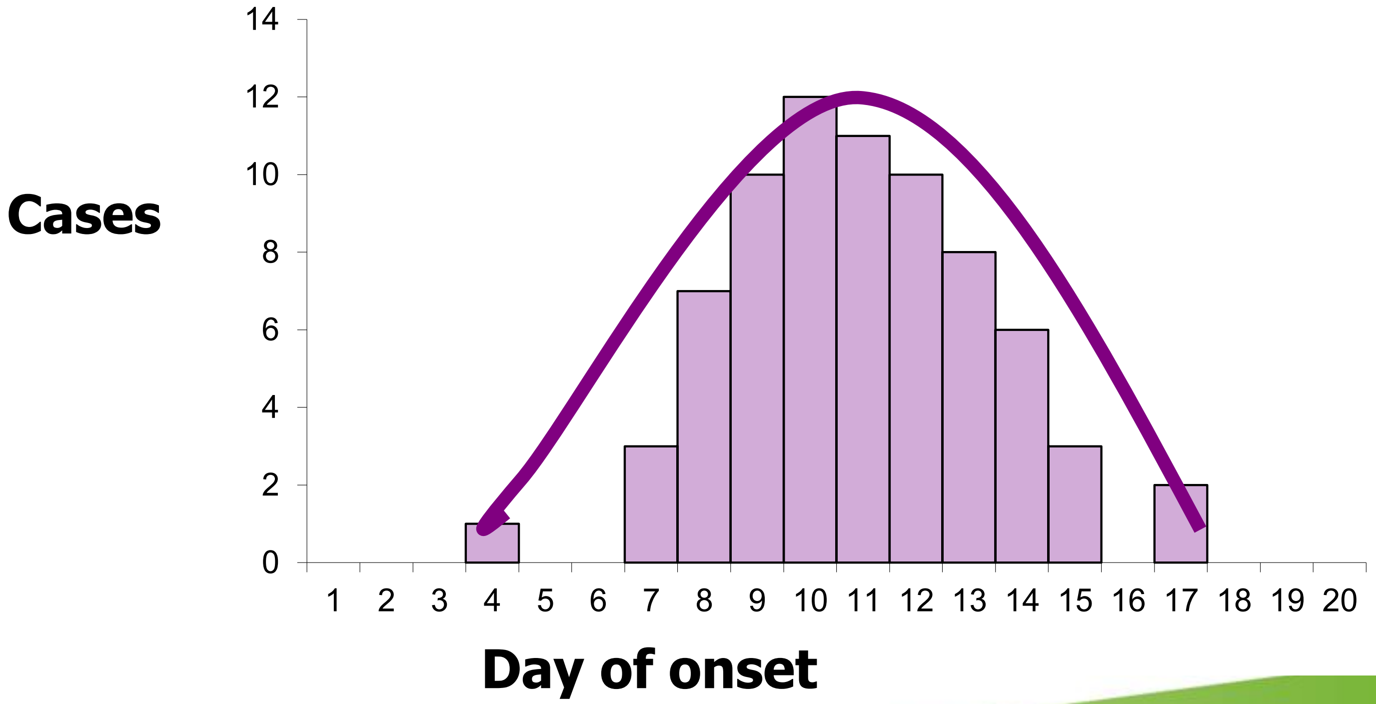




Kääriäinen *et al.*, 2022

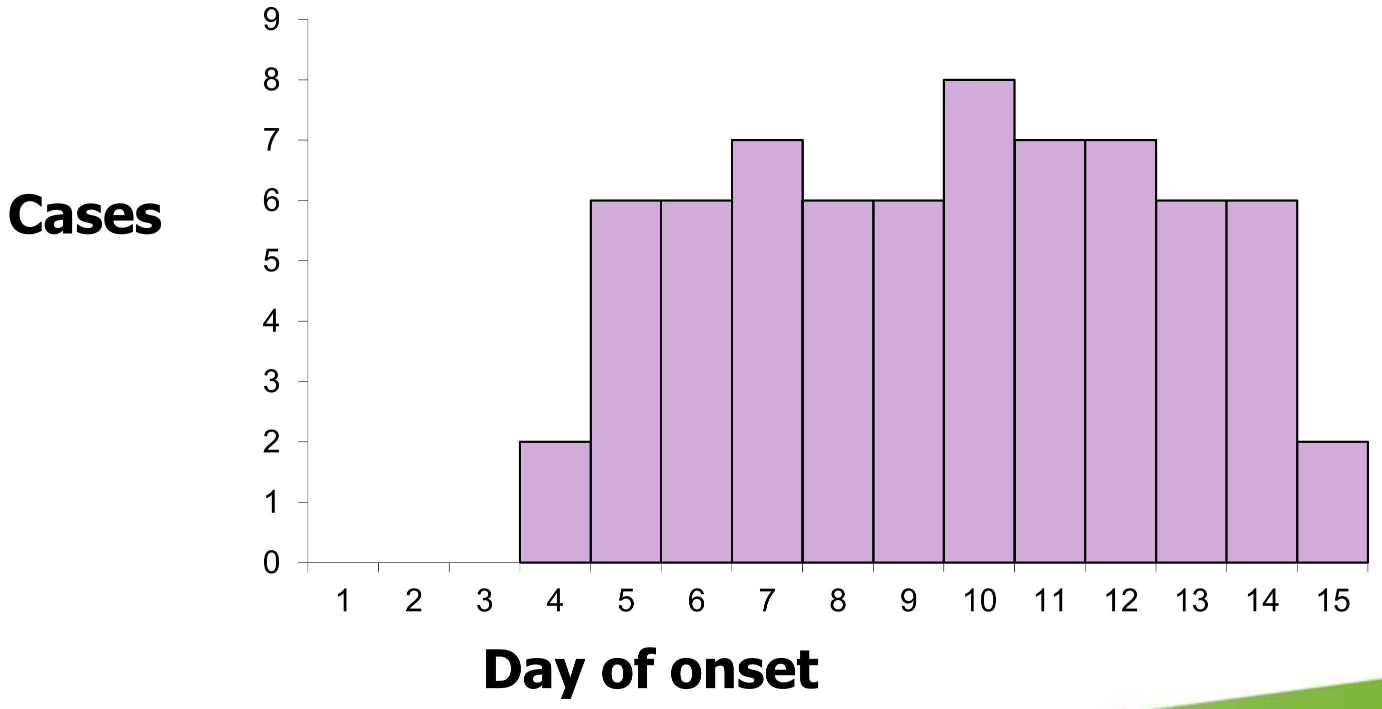
Epidemic (epi) curves

- Point source
  - One source of contamination
  - All persons exposed to same source
  - Shape of curve: sharp increase followed by rapid decline



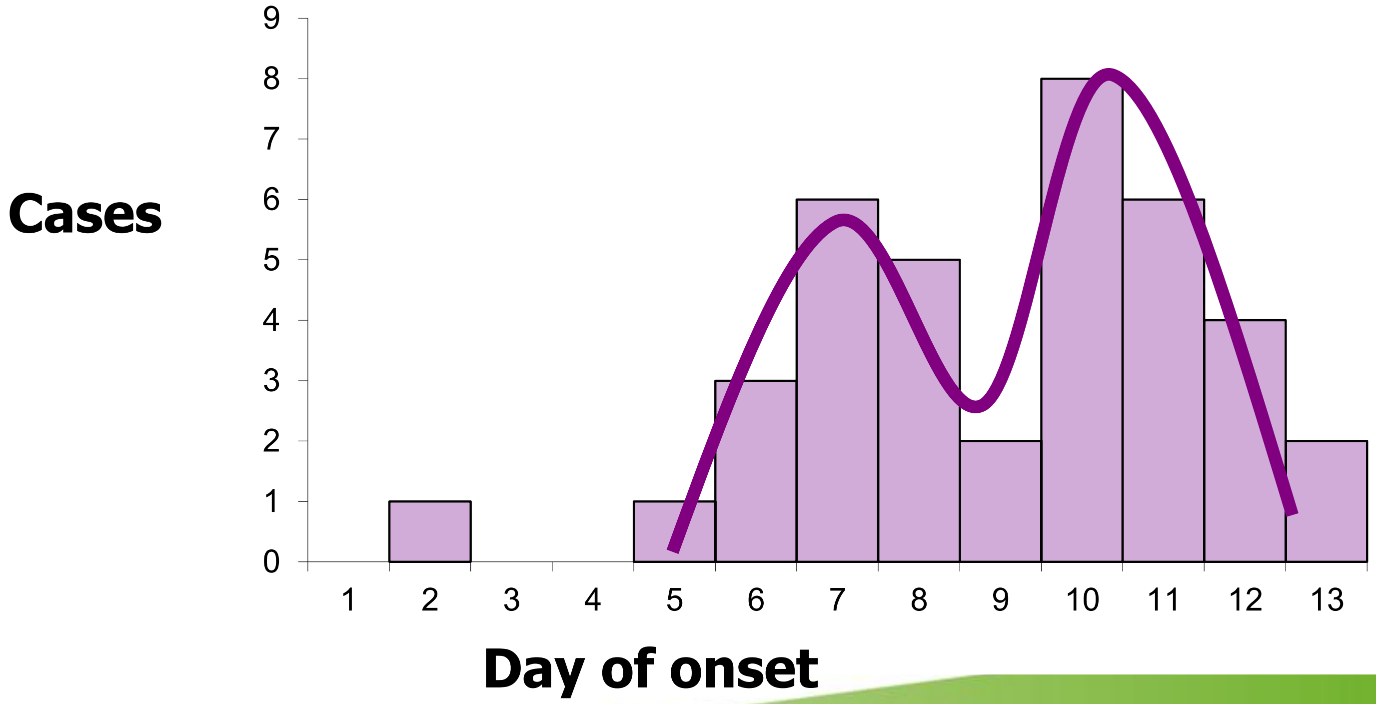
Epidemic (epi) curves

- Common continuous/persistent source
  - Continuous exposure over an extended period
  - Shape: sharp increase in cases, then flatter curve as new cases continue to occur as long as the source remains active.

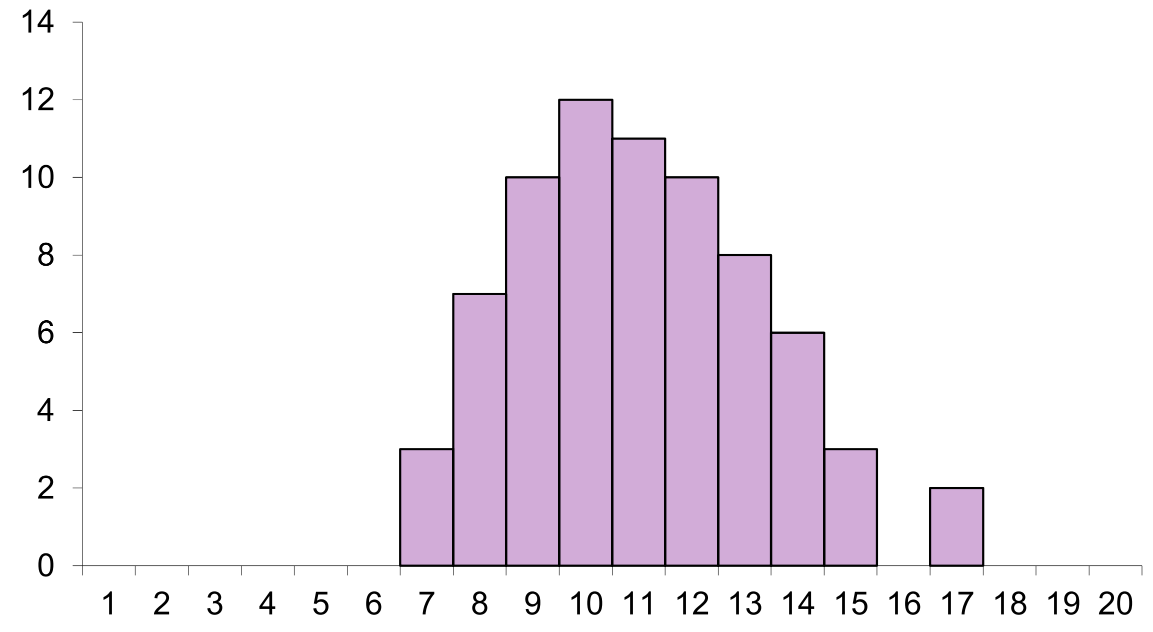


Epidemic (epi) curves

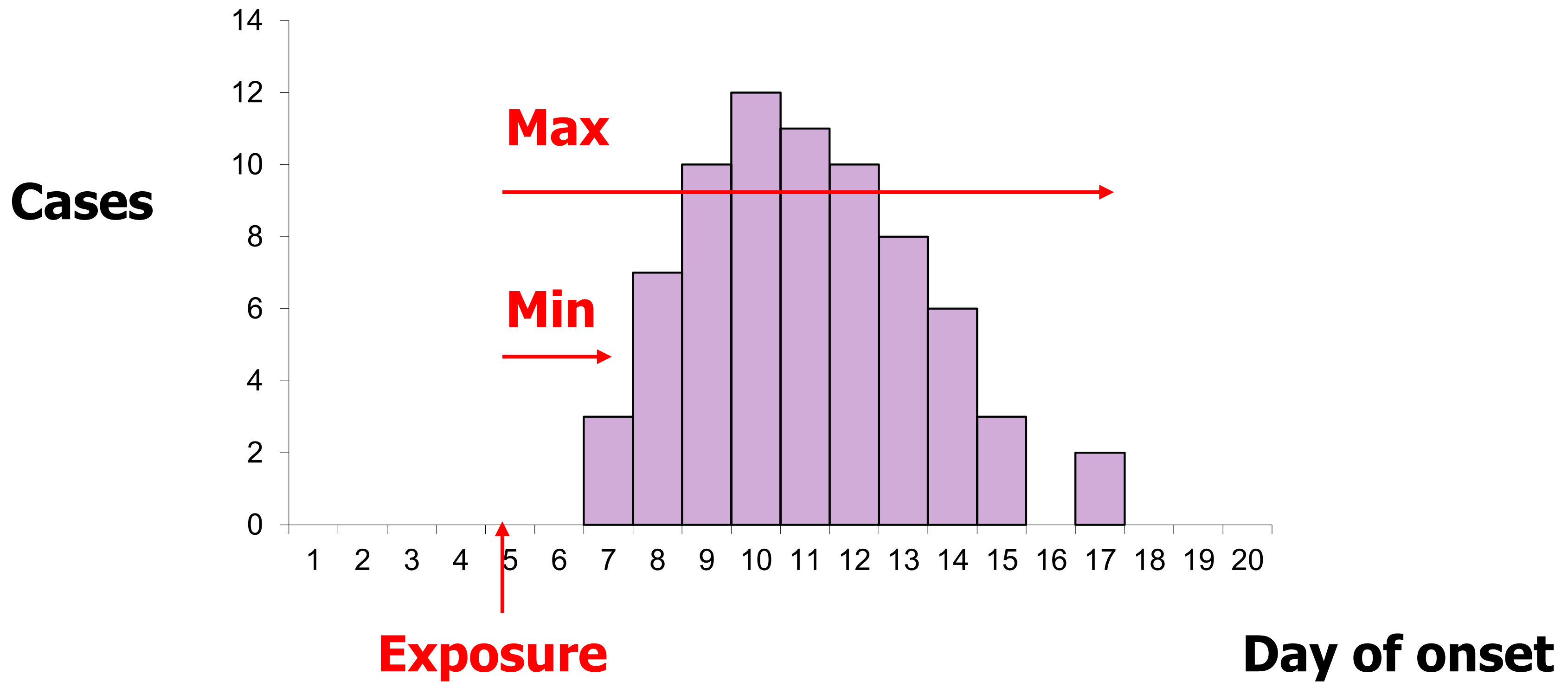
- Propagated outbreak
  - Person-to-person transmission
  - 1st wave of cases followed by 2nd wave etc
  - Each peak is a new generation of cases
  - Shape: multiple peaks, for different waves



Estimation of time of exposure, incubation period etc



Estimation of time of exposure, incubation period etc



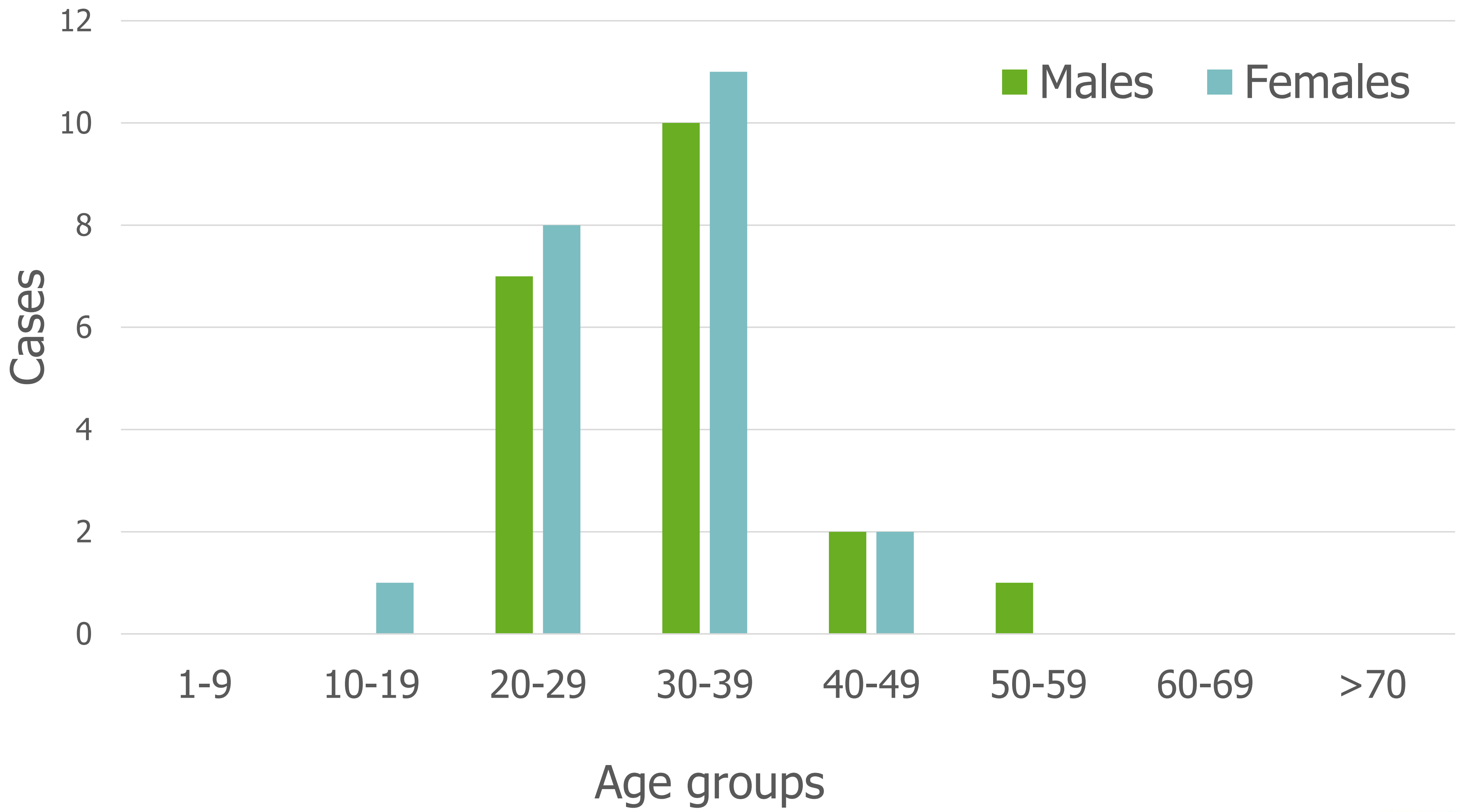
Other supporting graphs

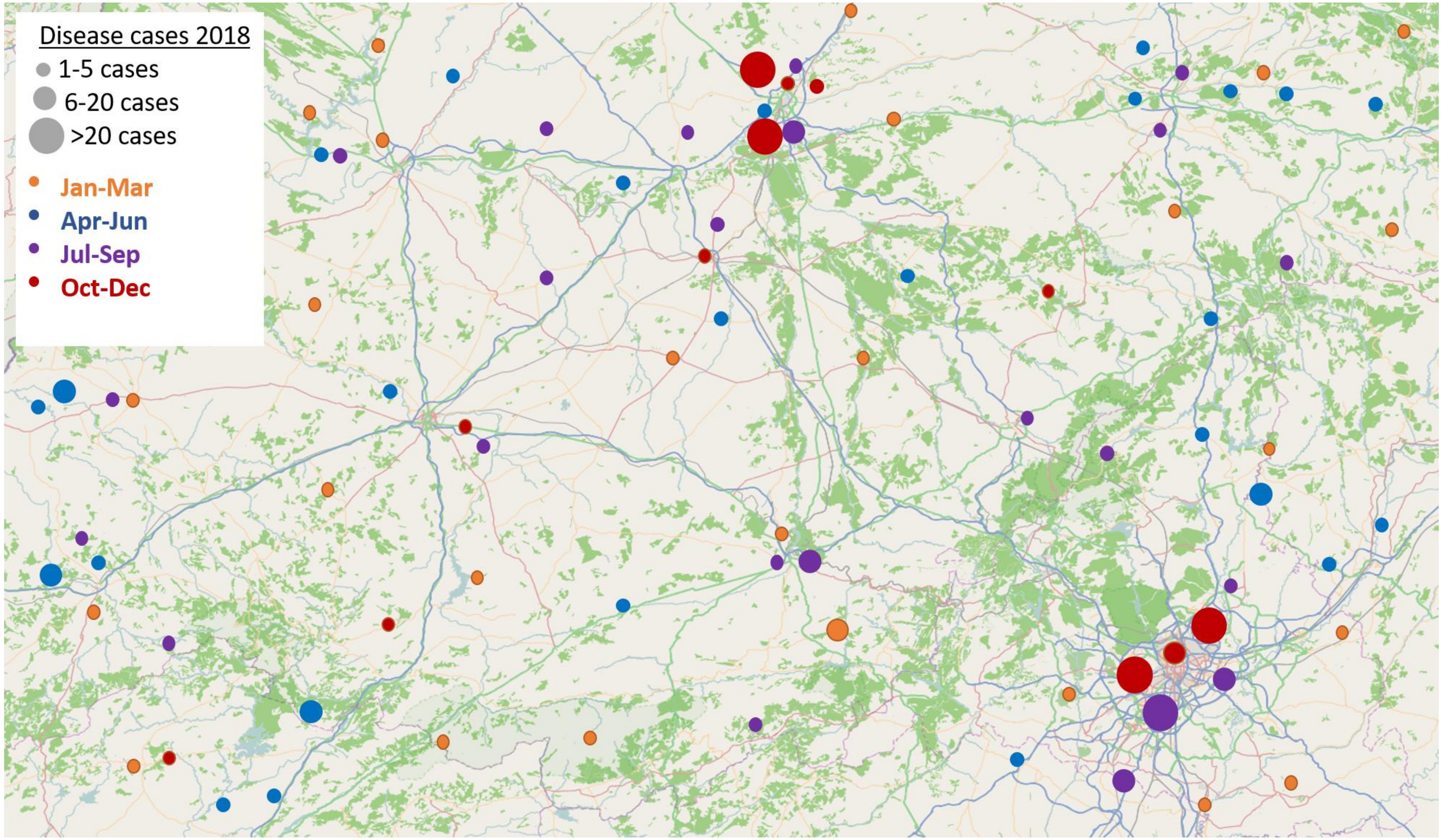
- Age and sex distribution curve: graphs with cases on one axis and age groups split by sex in x axis

- Maps, showing the distribution of cases across a geographical area and relevant possible outbreak sources

- And others…

Age and sex distributions




Disease cases 2018
1-5 cases
6-20 cases
>20 cases
Jan-Mar
Apr-Jun
Jul-Sep
Oct-Dec

How can we use epidemiological data to generate hypotheses?

- Point source, common source, human-to-human transmission …
- Estimation of incubation period
- Time of exposure
- Index case
- Case demographics
- Mapping: Jon Snow

Cholera outbreak, London, 1854

Additional investigations

Laboratory studies

- Microbiological typing
  - Closely related isolates among cases
  - Closely related isolates between source/vehicle and cases

Other investigations

- Environmental
  - (e.g., water, food items, kitchen samples)

- Anthropological
  - (understand a risk practice, e.g. burial rites)

- Veterinarian
  - (e.g., test animals in zoonotic disease outbreaks)

What kind of information will you need to collect for each specimen?

Type of specimen, patient/animal/food sample registration number, place and date of collection

Information on: date and time of onset, residence, demographic characteristics (age, sex), symptoms, what they ate, if they were in contact with animals, travel information

Trawling questionnaire with exposure routes

Trawling questionnaires to generate hypotheses

May be an extended structured questionnaire or open-ended questionnaires

Looking for common exposures

- Event they participated in?
- Place they visited? Foods they ate?
- Behaviour they have in common?
- Contact history?

In summary

Epi curves are an important tool for visualizing outbreak magnitude and time progression

Other analyses are also useful, including graphs visualizing sex-age distributions and maps

Case definitions are important and may change over the course of the outbreak

Epidemiological investigations and microbiological investigations are complementary and essential elements of outbreak investigations

References

Kääriäinen S, Obach D, Paspaliari DK, Tofferi M, Nieminen A, Pihlajasaari A, Kuronen H, Vainio A, Rimhanen-Finne R. *Salmonella* Typhimurium outbreak associated with frozen tomato cubes at a restaurant in western Finland, January to February 2021. Euro Surveill. 2022 Oct;27(41):2200316. doi: 10.2807/1560-7917.ES.2022.27.41.2200316. PMID: 36239170; PMCID: PMC9562807.

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Acknowledgements

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