Epidemiological Data for Diseases

STAT 244NF: Infectious Disease Modeling

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What is Epidemiology?

Epidemiology is defined as "the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems."

In this class, we will primarily focus on the distribution and determinants of infectious or disease events in populations that will change depending on the example and data we are considering.

Descriptive Epidemiology

Descriptive Epidemiology

Descriptive epidemiology is concerned with comprehensively characterizing an epidemiological event. In our case, this is going to be an infection or disease case. To do this, we want to know:

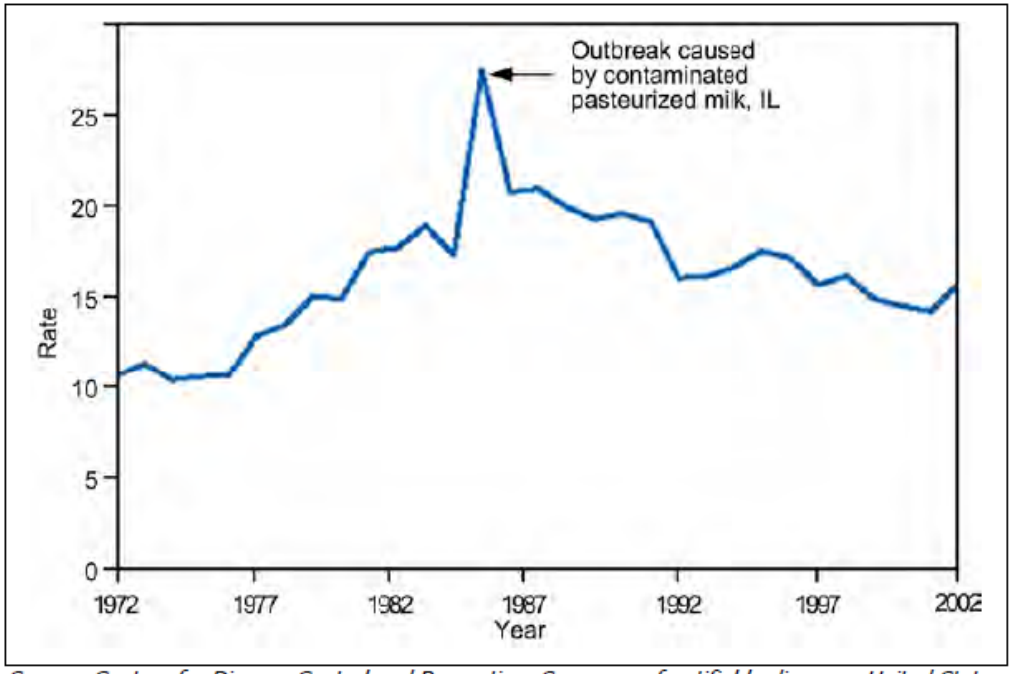
- Time
- Place
- Person

Descriptive Epidemiology: Time

- Long-term trends
  - Graph annual cases or rates over a period of years to show long-term trends
  - Used to assess overall direction of the disease (increasing? decreasing? no change?)
- Seasonality
  - Graph cases or rates by week or month over the course of a year to show any seasonal patterns
  - Seasonal patterns may lend insight into how the infection is spread (mode of transmission), behaviors associated with increased risk, or other contributors to disease
- Epidemic period
  - Time course of a disease outbreak/epidemic is graphed in an *epidemic curve*
  - Shape and other features can suggest information about exposure time/source, transmission mode, cause

Descriptive Epidemiology: Long-term trends (Time)

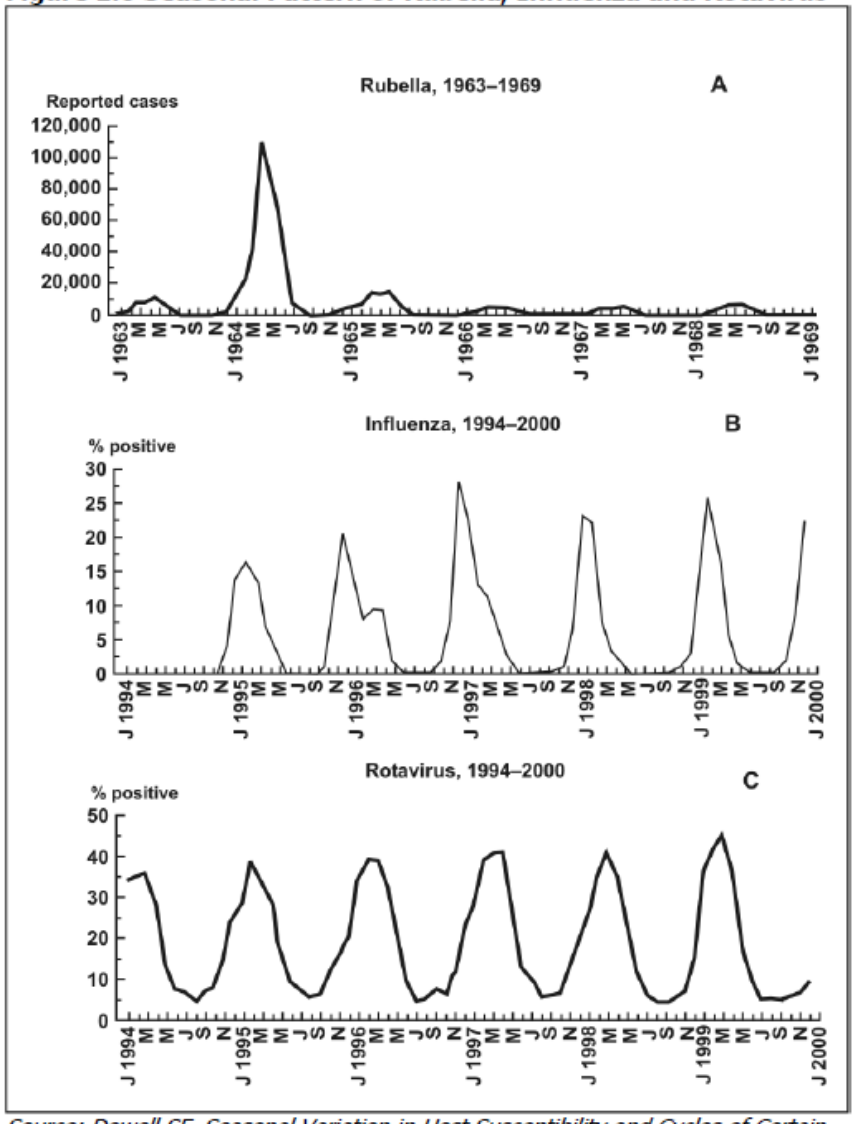
Figure 1.4 Reported Cases of Salmonellosis per 100,000 Population, by Year — United States, 1972–2002



Source: Centers for Disease Control and Prevention. Summary of notifiable diseases–United States, 2002. Published April 30, 2004, for MMWR 2002;51(No. 53): p. 59.

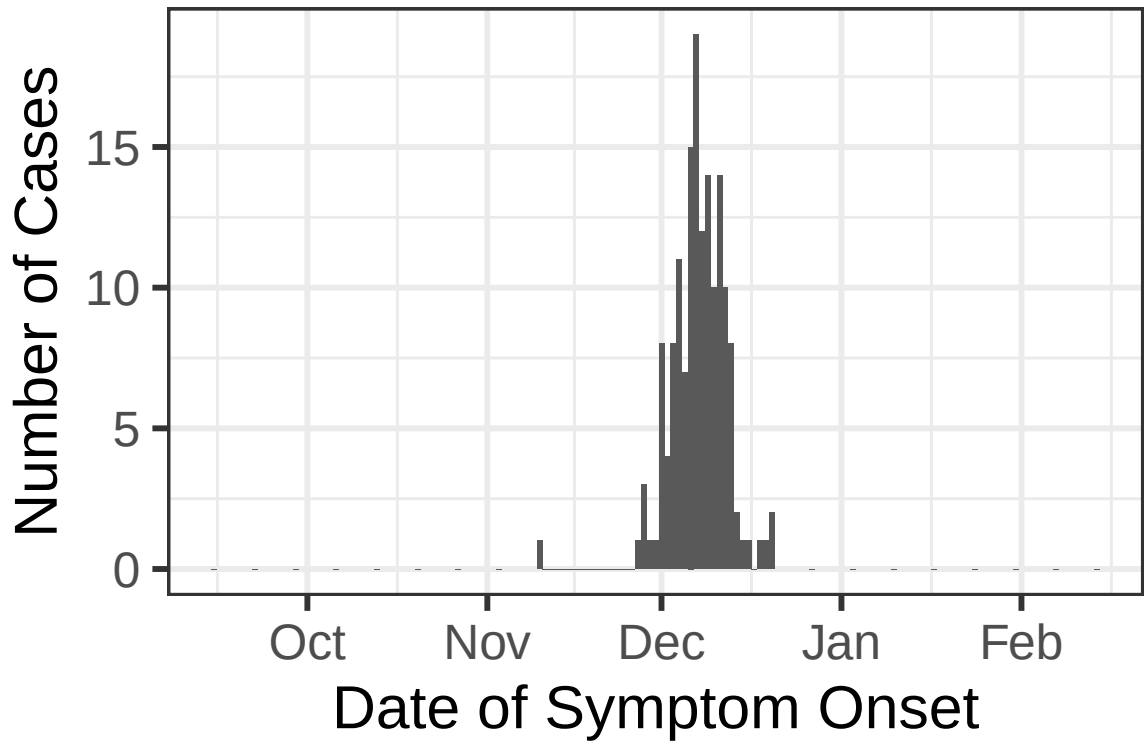
Descriptive Epidemiology: Seasonality (Time)

Figure 1.6 Seasonal Pattern of Rubella, Influenza and Rotavirus



Source: Dowell SF. Seasonal Variation in Host Susceptibility and Cycles of Certain Infectious Diseases. Emerg Infect Dis. 2001;5:369–74.

Descriptive Epidemiology: Epidemic Period (Time)



Descriptive Epidemiology: Place

- Disease incidence location information provides insight into the extent of the problem and variation over space
- Place may mean residence, or other relevant information, like employment site, school, hospital, travel destinations
- Place may be large, like country or state, or small, like street address
- Place may be more vague, like urban/rural, domestic/foreign, etc.

Descriptive Epidemiology: Place

Cholera (addresses)

Figure 1.1 Spot map of deaths from cholera in Golden Square area, London, 1854 (redrawn from original)

Source: Snow J. Snow on cholera. London: Humphrey Milford: Oxford University Press; 1936.

COVID-19 (US county-level)

Descriptive Epidemiology: Person

- **Age**
- **Sex** (historically a binary variable)
  - Used as a proxy for genetic, hormonal, and anatomic factors
- Biologic factors like immune status
- Race/ethnicity; nationality; religion; other social groups
  - Used as proxy for susceptibility and exposure
- Socioeconomic status
  - Hard to quantify
  - May be described by occupation, family income, educational level, census track

Epidemiological Studies

Types of Studies

- Experimental Studies (Experiments)
- **Observational Studies**

Experimental Studies (Experiments)

An investigator randomly assigns individuals or communities exposure to some agent (e.g., a vaccine) and tracks the individuals or communities over time to determine the effects of the exposure.

- Clinical trial: individual exposure is determined in a controlled and randomized way and tracked over time to detect effects of exposure (e.g., vaccine trial); control group is included (think placebo group)
- Community trial: like a clinical trial, but using a community rather than an individual

Note, we will not spend that much time with experimental studies in this class – *most data will be from observational studies*

Observational Studies

- Cohort study
  - Follow-up/Prospective
  - **Retrospective**
- Case-control study
- Cross-sectional study

Observational Studies: Cohort study

- An investigator records whether each participant is exposed and tracks the individual to see if they develop the disease/infection of interest.
- Similar to an experimental design, but an investigator *does not* control the exposure (no one is randomly assigned to exposure/control).
- Disease rate in each group is compared after some set time, and if there is a substantial difference in disease in one group versus another, we can conclude that there is an exposure effect.
- Cohorts will be chosen to be similar in some way so they are comparable.

Prospective versus Retrospective

- *Prospective*: participants enrolled as study begins and followed forward in time to see if and when a particular event occurs
- *Retrospective*: participants have already been exposed and outcomes of interest have occurred; disease rates are

Observational Studies: Case-control study

- Case-patients (people with disease) and controls (people without disease) are enrolled in a study
- Then previous exposures between the two groups are compared
- The control group provides an idea of how much exposure exists in the population already
- If the case group has substantially higher exposure than the control group, then illness is said to be associated with exposure
- Identifying an appropriate control group is key here and must be comparable to the case group in most respects

Observational Studies: Cross-sectional study

- Participants are enrolled and health outcomes and exposures are simultaneously measured.
- Study used to assess the prevalence of a particular disease at that time without worrying about the duration of the event
- Weaker than cohort or case-control studies because risk factors and disease occurrence cannot be separated.
- Helpful for descriptive purposes; routinely used to document prevalence of vaccination (e.g., against measles) and prevalence of chronic health conditions (e.g., diabetes), among others

Exercise 1

_____ 1. Representative sample of residents were telephoned and asked how much they exercise each week and whether they currently have (have ever been diagnosed with) heart disease.

- A. Experimental
- B. Observational cohort
- C. Observational case-control
- D. Observational cross-sectional
- E. Not an analytical or epidemiologic study

Exercise 2

_____ 2. Occurrence of cancer was identified between April 1991 and July 2002 for 50,000 troops who served in the first Gulf War (ended April 1991) and 50,000 troops who served elsewhere during the same period.

- A. Experimental
- B. Observational cohort
- C. Observational case-control
- D. Observational cross-sectional
- E. Not an analytical or epidemiologic study

Exercise 3

_____ 3. Persons diagnosed with new-onset Lyme disease were asked how often they walk through woods, use insect repellant, wear short sleeves and pants, etc. Twice as many patients without Lyme disease from the same physician's practice were asked the same questions, and the responses in the two groups were compared.

- A. Experimental
- B. Observational cohort
- C. Observational case-control
- D. Observational cross-sectional
- E. Not an analytical or epidemiologic study

Exercise 4

_____ 4. Subjects were children enrolled in a health maintenance organization. At 2 months, each child was randomly given one of two types of a new vaccine against rotavirus infection. Parents were called by a nurse two weeks later and asked whether the children had experienced any of a list of side-effects.

- A. Experimental
- B. Observational cohort
- C. Observational case-control
- D. Observational cross-sectional
- E. Not an analytical or epidemiologic study

References

- Principles of Epidemiology in Public Health Practice, 3rd Edition. https://www.cdc.gov/csels/dsepd/ss1978/SS1978.pdf