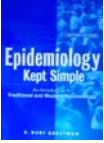


## Epidemiology Kept Simple



Chapter 6  
Incidence and Prevalence

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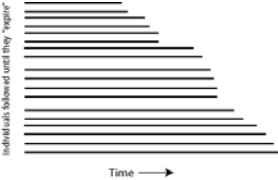
## Disease Frequency

- Common epi measures of disease frequency:
  - **Incidence proportion** (“average risk”)
  - **Incidence rate** (“density”)
  - **Prevalence**
- All *loosely* called “rates” (usage technically *incorrect*)
- “Rates” are studied in closed and open populations

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## Closed Populations (Cohorts)

- Fixed number of people
- Individuals followed over time
- Outflow occurs only by death or onset of disease condition being studied
- “Loss to follow-up” must be compensated (e.g., life-table adjustment technique)



Individuals followed until they “drop”

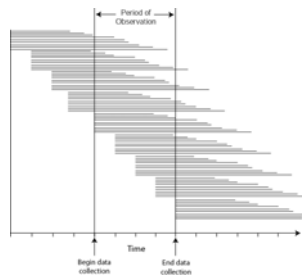
Time →

*Once you are a member of a cohort, you are a member for life. – Olli Miettinen*

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## Open Populations


- Inflow (immigration, births) and outflow (emigration, death)
- An open population in “steady state” (constant size and age distribution) is said to be **stationary**



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## Numerators & Denominators


- “Rates” have numerators and denominators
- **Numerator** ⇒ case count
  - Incidence count** ⇒ onsets
  - Prevalence count** ⇒ old + new cases
- Numerators without **denominators** are seldom useful (p. 120)



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## Numerators & Denominators (cont.)

- **Denominators** ⇒ reflect something about population size



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## Incidence Proportion (IP)

$$\text{Incidence Proportion} = \frac{\text{no. of onsets}}{\text{no. @ risk}}$$

- Synonyms: average risk, “risk”, cumulative incidence
- Can be calculated *only* in cohorts
- Interpretation: average risk

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## Example

- Study uterine cancer risk
- Recruit 1000 women
- Discover 100 recruits had hysterectomies
- 900 *at risk*
- Follow for 10 years
- 10 onsets of uterine cancer

$$\text{IP} = \frac{\text{no. of onsets}}{\text{no. @ risk}} = \frac{10 \text{ women}}{900 \text{ women}} = 0.0111$$

10-year average risk is .011 or 1.1%.

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## “per *m* people”

- “Rates” are often reported with a population multiplier of “per *m* people”
- To report “per *m*,” simply multiply by *m*
- Example: An incidence proportion of 0.011 can be reported as 11 per 1000

$$.011 \times \frac{1000}{1000} = \frac{1.1}{1000}$$

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## “per *m* people”

- Use a large multiplier for rare diseases
- Example: An incidence proportion of 0.000001 can be reported as 1 per million

$$.000001 \times \frac{1,000,000}{1,000,000} = \frac{1}{1,000,000}$$

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## Incidence Rate (IR)

$$\text{Incidence Rate} = \frac{\text{no. onsets}}{\text{Sum of person - time}}$$

- Synonyms: incidence density, person-time rate
- Interpretation A: “Speed” at which events develop
- Interpretation B: When disease is rare (risk ≤ 5%), rate per person-year ≈ one-year average risk

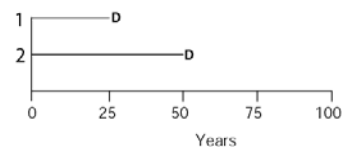
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## Incidence Rate in a Cohort

Schematic: line ≡ follow-up; D ≡ “disease onset”



$$\text{IR} = \frac{\text{onsets}}{\sum \text{person - time}} = \frac{2 \text{ onsets}}{25 \text{ years} + 50 \text{ years}} = \frac{2}{75 \text{ years}}$$

$$= 0.0267 \text{ person per years} = 2.67 \text{ per } 100 \text{ person - years}$$

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### Incidence Rate, Open Population

$$IR \approx \frac{\text{onsets}}{\text{Avg population size} \times \text{time}}$$

- Average U.S. population, 1999: 272,705,815
- 2,391,630 deaths in 1999

$$IR \approx \frac{2,391,630 \text{ deaths}}{272,705,815 \text{ persons} \times 1 \text{ year}}$$

$$= 0.008770 \text{ deaths year}^{-1}$$

$$= 877 \text{ per } 100,000 \text{ person - years}$$

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### Counting Person-Time

- $\sum \text{person-time} \approx (\text{pop. size}) \times (\text{time})$
- Example  
52 people observed for one week  
= (52 persons)  $\times$  (1 week)  
= 52 person-weeks  
= 1 person-year
- More sophisticated methods of estimating person-time are discussed in the text (but that is the general idea)

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### Wait Time

In cohorts without truncation and in stationary populations, rate = inverse of "wait time"

$$\text{Wait time} = \frac{1}{\text{Rate}}$$

In looking at mortality, wait time = life expectancy

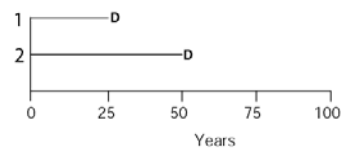
Example: Mortality rate of .0267 per year = life expectancy of  $1 / 0.0267 \text{ year}^{-1} = 37.5 \text{ years}$

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### Rate and Wait Time



This cohort has a mortality rate of  $\frac{2 \text{ events}}{(25 + 50) \text{ years}} = 0.0267 \text{ year}^{-1}$

This cohort has life expectancy  $\frac{(25 + 50) \text{ years}}{2 \text{ events}} = 37.5 \text{ years}$

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### Prevalence

$$\text{Prevalence} = \frac{\text{no. cases}}{\text{no. of people}}$$

- Point prevalence = prevalence at a point in time
- Period prevalence = prevalence over a period of time (misleading concept??)
- Interpretation A: proportion with condition
- Interpretation B: probability a person selected at random will have the condition

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### Example

- Recruit 1000 women, 55+ years of age or older
- Ascertain: 100 with hysterectomies

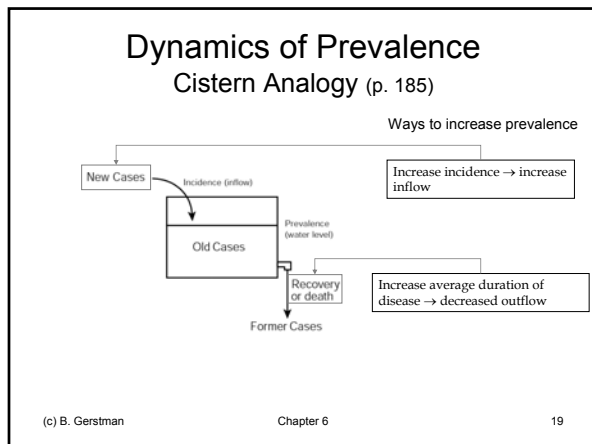
$$\text{Prevalence} = \frac{\text{no. cases}}{\text{no. of people}} = \frac{100 \text{ people}}{1000 \text{ people}} = 0.10$$

10% of sample or population has the condition

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### Relation Between Incidence and Prevalence

When disease rare & population stationary

$$\text{prevalence} \approx (\text{incidence rate}) \times (\text{average duration})$$

Example:

Incidence rate = 0.01 / year

Average duration of the illness = 2 years.

Thus, Prevalence  $\approx 0.01 / \text{year} \times 2 \text{ years} = 0.02$

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