Chapter 3: Quantifying the Extent of Disease

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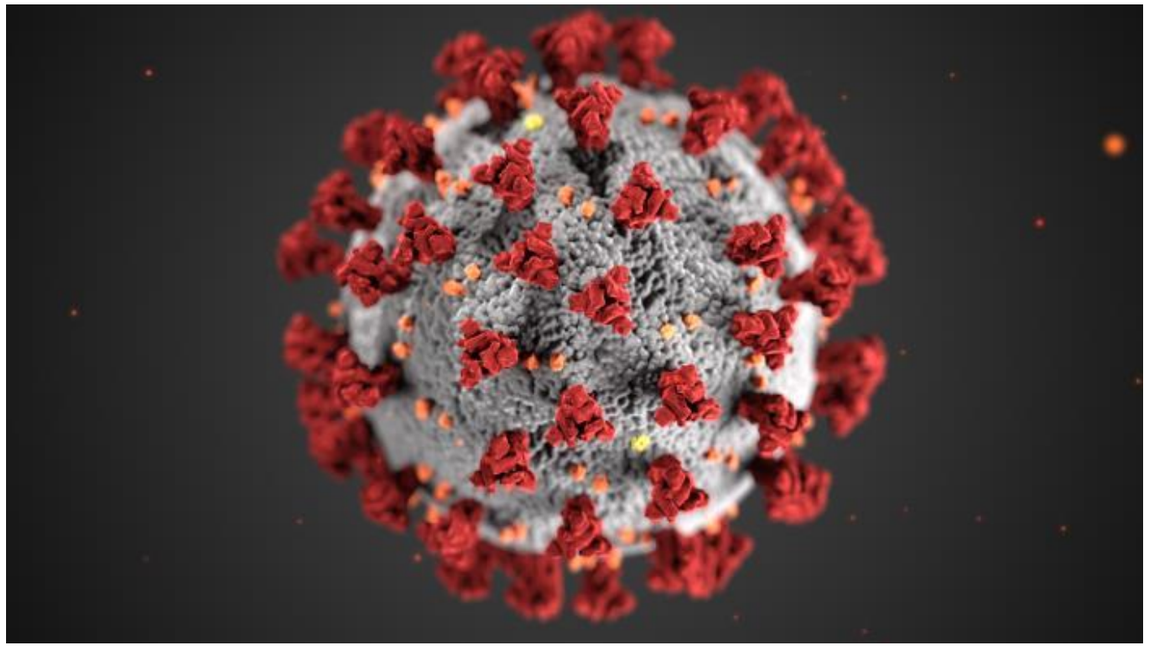
Quantifying

When a health-related agency report a disease, they use certain terms.

The objective of this chapter is to review and understand these terms.



https://phil.cdc.gov/Details.aspx?pid=23311

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

https://iphce.org/acadp_listings/public-health-image-library-phil-database/

3.1 Prevalence

Prevalence refers to the proportion of participants with disease at a particular point in time.

An estimate of the prevalence of disease at baseline is

$$\text{Point Prevalence} = \frac{\text{Number of persons with disease}}{\text{Number of persons examined at baseline}}$$

3.1 Prevalence

Example 3.1 Computing Prevalence of Cardiovascular Disease (CVD)

TABLE 3–1 Men and Women with Diagnosed CVD

	Free of CVD	History of CVD	Total
Men	1548	244	1792
Women	1872	135	2007
Total	3420	379	3799

$$\text{Prevalence} = \frac{\#\text{ with disease}}{\#\text{ examined at baseline}}$$

Prevalence of CVD = 379/3799 = 0.0998 → 9.98%

Prevalence of CVD in Men = 244/1792 = 0.1362 → 13.62%

Prevalence of CVD in Women = 135/2007 = 0.0673 → 6.73%

3.1 Prevalence

A question, we may like to ask is

What are the risk factors behind the disease?

In other words, what are the characteristics of the population within which the prevalence of the disease is high?

3.1 Prevalence

Data on H1N1 outbreak in La Gloria, Mexico: n = 1575 villagers (out of 2155) were surveyed to determine if they had influenza-like illness (ILI) between 2/15/09 and 4/27/09.

Age	No ILI	ILI	Total
≤ 44 years	703	522	1225
> 44 years	256	94	350
Total	959	616	1575

3.1 Prevalence

influenza-like illness

Age	No ILI	ILI	Total
≤ 44 years	703	522	1225
> 44 years	256	94	350
Total	959	616	1575

$$\text{Prevalence} = \frac{\text{\# with disease}}{\text{\# examined at baseline}}$$

Prevalence of ILI = 616/1575 = 0.3911 → 39.11%

Prevalence of ILI in ≤ 44 = 522/1225 = 0.4261 → 42.61%

Prevalence of ILI in > 44 = 94/350 = 0.2686 → 26.86%

3.2 Incidence

Incidence reflects the likelihood of developing disease among a group of participants free of the disease who are at risk of developing the disease over a specified observation period.

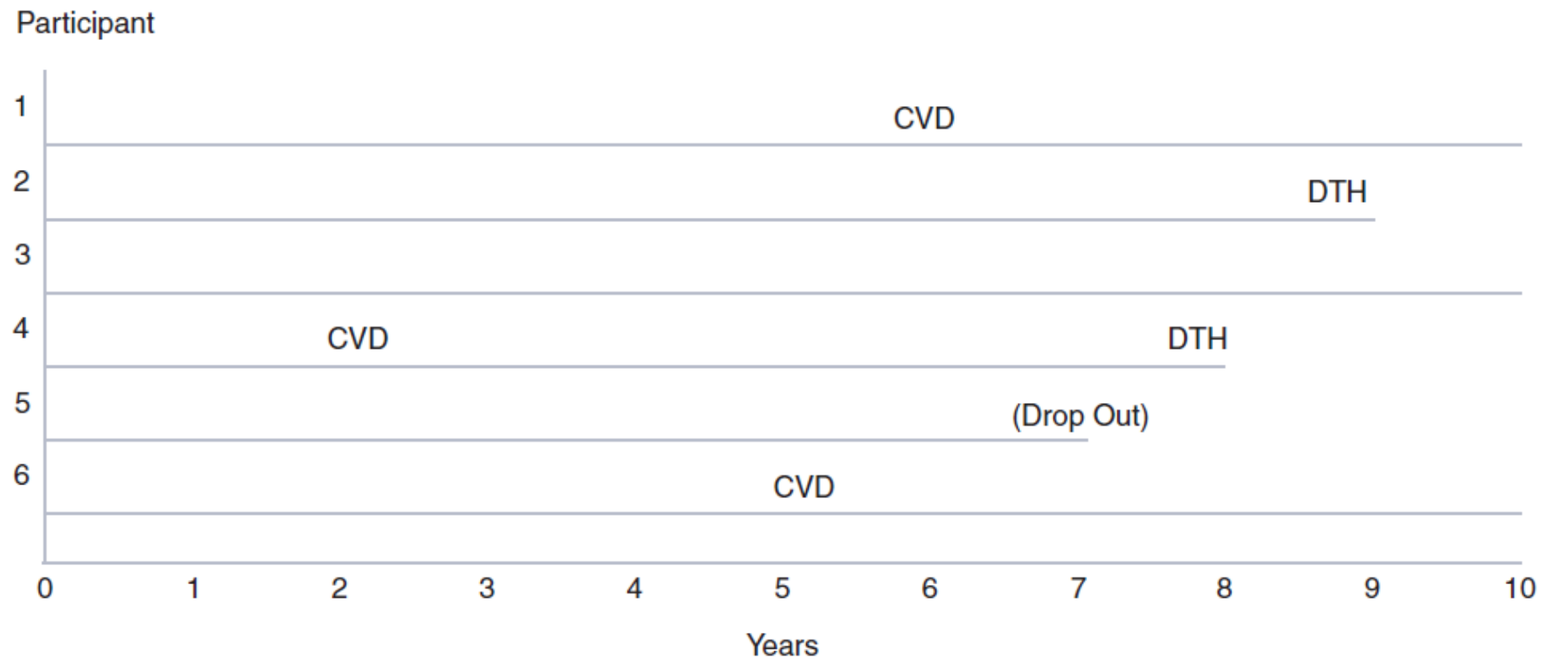
$$\text{Cumulative Incidence} = \frac{\text{Number of persons who develop disease during a specified period}}{\text{Number of persons at risk at baseline}}$$

$$\text{Incidence Rate} = \frac{\text{Number of persons who develop disease during a specified period}}{\text{Sum of the lengths of time during which persons are disease-free}}$$

3.2 Incidence

Incidence of CVD?

FIGURE 3–1 Course of Follow-up for 6 Participants



3.2 Incidence

Incidence Rate (IR) uses all available information and is computed by taking the ratio of the number of new cases to the total follow-up time.

$$\text{Incidence Rate} = \frac{\text{Number of persons who develop disease during a specified period}}{\text{Sum of the lengths of time during which persons are disease-free}}$$

3.2 Incidence

Cardiovascular Disease

Incidence of CVD?

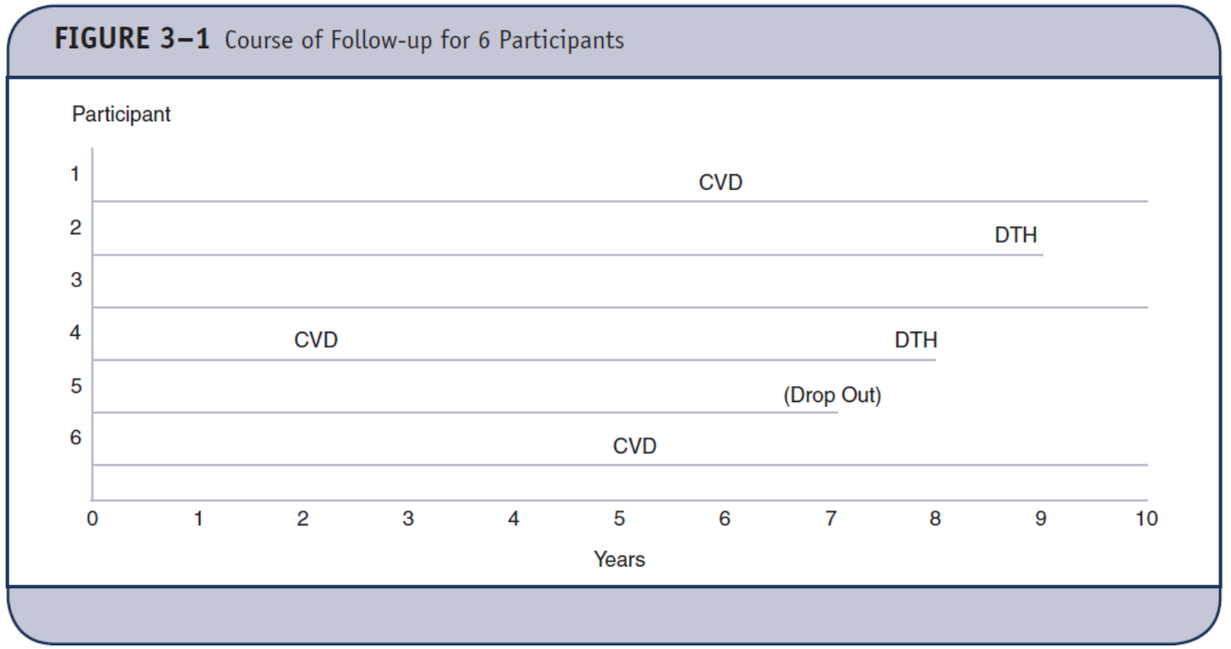
Incidence Rate of CVD

IR= 3/(6+9+10+2+7+5)

IR= 3/39

IR= 0.0769

7.7 per 100 person-years



3.2 Incidence

Cardiovascular Disease

Computing incidence

	Develop CVD	Total Follow-Up Time (years)
Men	190	9984
Women	119	12153
Total	309	22137

Incidence Rate of CVD in Men = 190/9984 = 0.01903

= 190 per 10,000 person-years

Incidence Rate of CVD in Women = 119/12153 = 0.00979

= 98 per 10,000 person-years

3.2 Incidence

influenza-like illness

Computing incidence

$$\text{Incidence Rate} = \frac{\text{Number of persons who develop disease during a specified period}}{\text{Sum of the lengths of time during which persons are disease-free}}$$

	Developed ILI	Total Follow-Up Time (years)
≤ 44 years	522	20,064
> 44 years	94	3,514
Total	616	23,578

Incidence Rate of ILI in ≤ 44 = 522/20064 = 0.0260

= 260 per 10,000 person-years

Incidence Rate of ILI in > 44 = 94/3514= 0.0268

= 268 per 10,000 person-years

3.4 Comparing Extent of Disease Between Groups

Risk Difference (excess risk)

$$RD = \text{Prevalence}_{\text{exposed}} - \text{Prevalence}_{\text{unexposed}}$$

$$RD = \text{Cumulative Incidence}_{\text{exposed}} - \text{Cumulative Incidence}_{\text{unexposed}}$$

$$RD = \text{Incidence Rate}_{\text{exposed}} - \text{Incidence Rate}_{\text{unexposed}}$$

$$\text{Prevalence} = \frac{\#\text{ with disease}}{\#\text{ examined at baseline}}$$

3.4 Comparing Extent of Disease Between Groups

Cardiovascular Disease

Risk Difference of prevalent CVD in smokers versus nonsmokers

$$RD = \text{Prevalence}_{\text{smokers}} - \text{Prevalence}_{\text{nonsmokers}}$$

TABLE 3–2 Smoking and Diagnosed CVD

	Free of CVD	History of CVD	Total
Nonsmoker	2757	298	3055
Current smoker	663	81	744
Total	3420	379	3799

$$\text{Prevalence} = \frac{\#\text{ with disease}}{\#\text{ examined at baseline}}$$

RD= 81/744 – 298/3055 = 0.1089 – 0.0975 = 0.0114

3.4 Comparing Extent of Disease Between Groups

Cardiovascular Disease

Population Attributable Risk (PAR) of CVD in Smokers vs. Nonsmokers

$$PAR = \frac{\text{Prevalence}_{\text{overall}} - \text{Prevalence}_{\text{nonsmokers}}}{\text{Prevalence}_{\text{overall}}}$$

TABLE 3–2 Smoking and Diagnosed CVD

	Free of CVD	History of CVD	Total
Nonsmoker	2757	298	3055
Current smoker	663	81	744
Total	3420	379	3799

$$\text{Prevalence} = \frac{\#\text{ with disease}}{\#\text{ examined at baseline}}$$

PAR= (0.0998 – 0.0975) / 0.0998 = 0.023 = 2.3%

3.4 Comparing Extent of Disease Between Groups

influenza-like illness

Risk Difference (RD) of history of ILI in males and females in La Gloria

$$RD = \text{Prevalence}_{\text{Females}} - \text{Prevalence}_{\text{Males}}$$

	No ILI	ILI	Total
Males	517	260	777
Females	442	356	798
Total	959	616	1575

$$\text{Prevalence} = \frac{\#\text{ with disease}}{\#\text{ examined at baseline}}$$

= 356/798 – 260/777 = 0.4461 – 0.3346 = 0.1115

3.4 Comparing Extent of Disease Between Groups

Relative Risk (RR)

$$RR = \frac{\text{Prevalence}_{\text{exposed}}}{\text{Prevalence}_{\text{unexposed}}}$$

$$\text{Prevalence} = \frac{\#\text{ with disease}}{\#\text{ examined at baseline}}$$

3.4 Comparing Extent of Disease Between Groups

Relative Risk (RR) of CVD in smokers versus nonsmokers

$$RR = \frac{\text{Prevalence}_{\text{smokers}}}{\text{Prevalence}_{\text{nonsmokers}}} = \frac{81/744}{298/3055} = \frac{0.1089}{0.0975} = 1.12$$

TABLE 3–2 Smoking and Diagnosed CVD

	Free of CVD	History of CVD	Total
Nonsmoker	2757	298	3055
Current smoker	663	81	744
Total	3420	379	3799

$$\text{Prevalence} = \frac{\#\text{ with disease}}{\#\text{ examined at baseline}}$$

3.4 Comparing Extent of Disease Between Groups

influenza-like illness

Relative Risk (RR) of ILI in females vs. males

$$RR = \frac{\text{Prevalence}_{females}}{\text{Prevalence}_{males}} = \frac{356/798}{260/777} = \frac{0.4461}{0.3346} = 1.33$$

	No ILI	ILI	Total
Males	517	260	777
Females	442	356	798
Total	959	616	1575

$$\text{Prevalence} = \frac{\#\text{ with disease}}{\#\text{ examined at baseline}}$$

3.4 Comparing Extent of Disease Between Groups

Odds Ratio (OR) is computed as a measure of effect.

$$OR = \frac{\text{Prevalence}_{\text{exposed}} \,/\, (1 - \text{Prevalence}_{\text{exposed}})}{\text{Prevalence}_{\text{unexposed}} \,/\, (1 - \text{Prevalence}_{\text{unexposed}})}$$

$$\text{Prevalence} = \frac{\text{\# with disease}}{\text{\# examined at baseline}}$$

3.4 Comparing Extent of Disease Between Groups

Odds Ratio of CVD in hypertensives vs. non-hypertensives.

$$OR = \frac{181/840 \,/\, (1-181/840)}{188/2942 \,/\, (1-188/2942)} = \frac{0.275 \,/\, 0.725}{0.068 \,/\, 0.932} = 4.04$$

TABLE 3–5 Prevalent Hypertension and Prevalent CVD

	No CVD	CVD	Total
No hypertension	2754	188	2942
Hypertension	659	181	840
Total	3413	369	3782

$$\text{Prevalence} = \frac{\text{\# with disease}}{\text{\# examined at baseline}}$$

$$OR = \frac{\text{Prevalence}_{\text{exposed}} \,/\, (1-\text{Prevalence}_{\text{exposed}})}{\text{Prevalence}_{\text{unexposed}} \,/\, (1-\text{Prevalence}_{\text{unexposed}})}$$

3.4 Comparing Extent of Disease Between Groups

influenza-like illness

Odds Ratio of ILI in younger group vs. older group.

Age	No ILI	ILI	Total
≤ 44 years	703	522	1225
> 44 years	256	94	350
Total	959	616	1575

$$OR = \frac{522/1225 \,/\, (1 - 522/1225)}{94/350 \,/\, (1 - 94/350)} = \frac{0.426 / 0.574}{0.269 / 0.731} = 2.02$$

$$\text{Prevalence} = \frac{\#\text{ with disease}}{\#\text{ examined at baseline}}$$

$$OR = \frac{\text{Prevalence}_{\text{exposed}} \,/\, (1 - \text{Prevalence}_{\text{exposed}})}{\text{Prevalence}_{\text{unexposed}} \,/\, (1 - \text{Prevalence}_{\text{unexposed}})}$$

3.4 Comparing Extent of Disease Between Groups

Relative Risks and Odds Ratios

Not possible to estimate relative risk in case-control studies.

Possible to estimate odds ratio because of its invariance property.

3.4 Comparing Extent of Disease Between Groups

Invariance Property of Odds Ratios

Case-control study to assess association between smoking and cancer.

TABLE 3–6 Smoking and Cancer

	Cancer (Case)	No Cancer (Control)	Total
Smoker	40	29	69
Nonsmoker	10	21	31
Total	50	50	100

3.4 Comparing Extent of Disease Between Groups

Invariance Property of Odds Ratios

Odds ratio for cancer in smokers versus nonsmokers

= (40/29) / (10/21) = 2.90

Odds of smoking in patients with cancer versus not

= (40/10) / (29/21) = 2.90(!)

TABLE 3–6 Smoking and Cancer

	Cancer (Case)	No Cancer (Control)	Total
Smoker	40	29	69
Nonsmoker	10	21	31
Total	50	50	100

Questions?

Homework 3

Read Chapter 3.

Problems # 1, 5, 7, 13