Epidemiologic Measures in Policy Briefs

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Learning Objectives

At the end of this module, you will be able to:

- **Use basic and complex health measures to describe individual populations**
- **Use basic and complex health measures to compare two or more populations**
- **Determine which measures are most useful to tell which stories**
- **Explain measures from the public health literature**

Basic Measures of Disease in Policy Briefs

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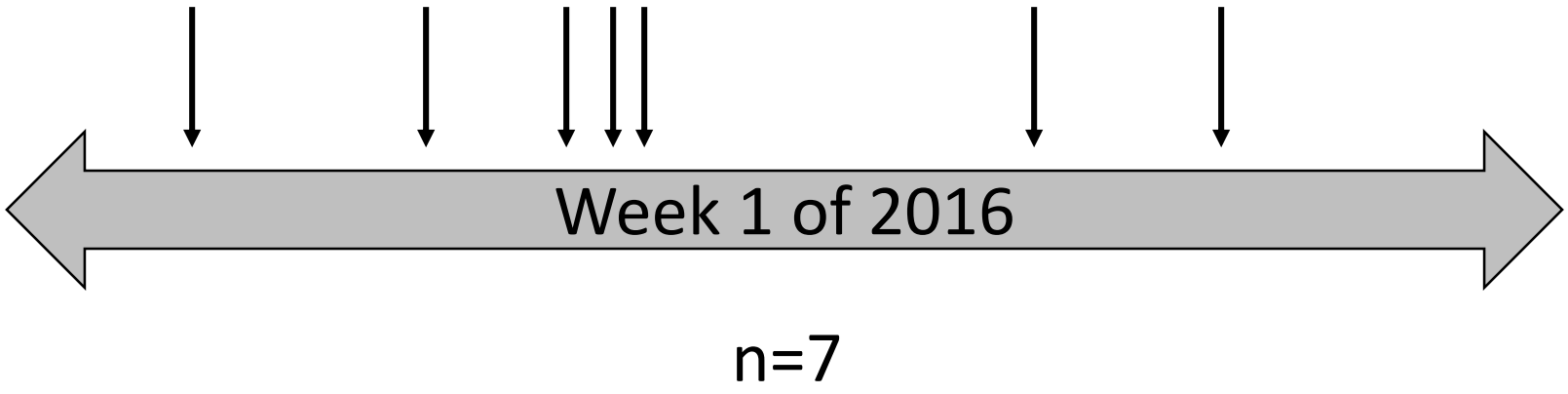
Basic Measures of Disease for One Group

- **Counts**
- **Risk**
- **Odds**
- **Prevalence**
- **Incidence**

Counts

- **The number of events that occur (or persons who develop disease) in a defined period of time**
  - E.g., The total number of persons in City X injured in motor vehicle crashes during Week 1 of 2016



When to Use (and Not Use) Count Data

- To show overall burden
- Emphasize the number of people affected
- Indicate demands on the health system
- Do NOT use when comparing different population groups (they do not take into account population size)

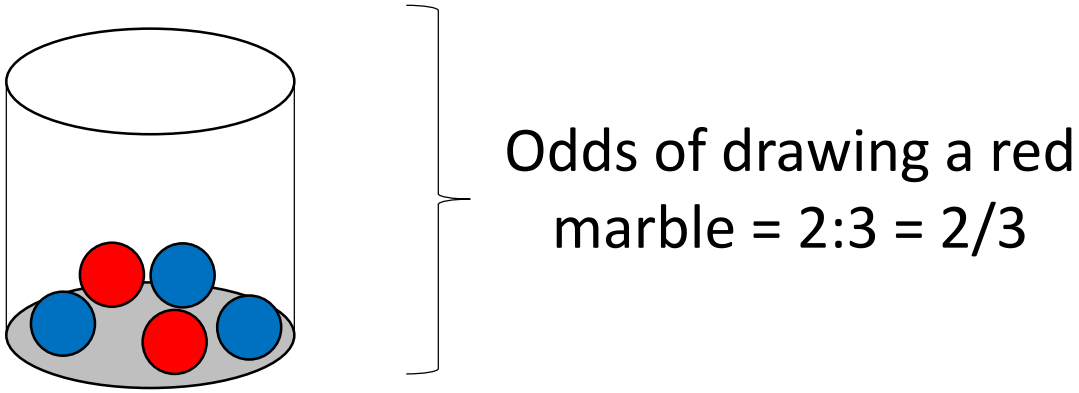
Risk

- **The probability of an event occurring over a specified period of time**
  - E.g., “70-year-old men have a 10% risk of dying from heart disease over the next 12 months.”
  - If you are a 70-year-old man, your risk of dying from heart disease sometime in the next 12 months is 1 in 10

Note that without the time component, risk statements don’t make sense

Odds

- **The ratio of ways that an event could happen, to the ways that it could not happen**



Odds of drawing a red marble = 2:3 = 2/3

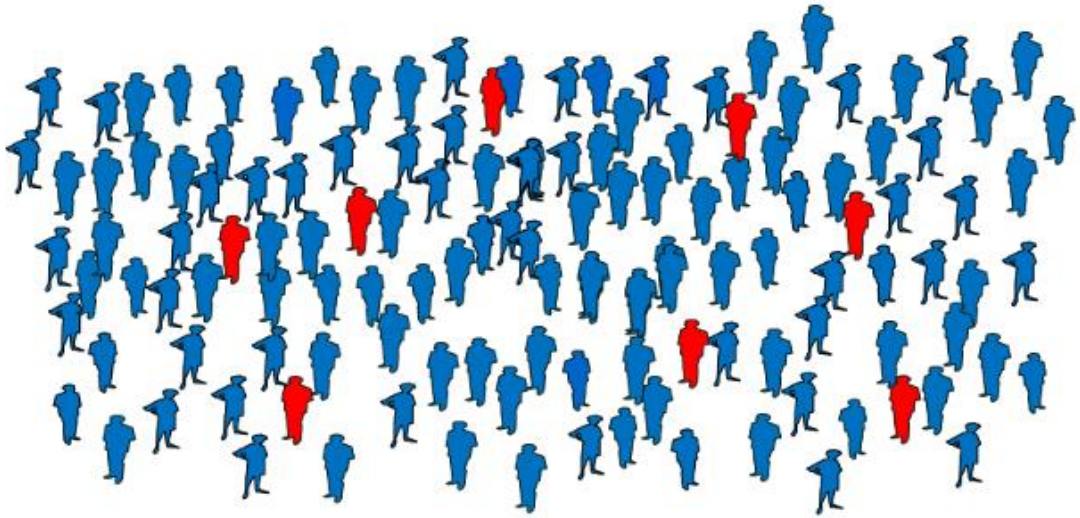
Odds

- **If we know that three in ten people will develop cancer at some point in their lives, the lifetime odds of cancer are:**
  - Three (for the ways it could happen), divided by
  - Seven (for the ways it could not happen)

$$\text{Lifetime odds of cancer} = \frac{3}{7}$$

Prevalence

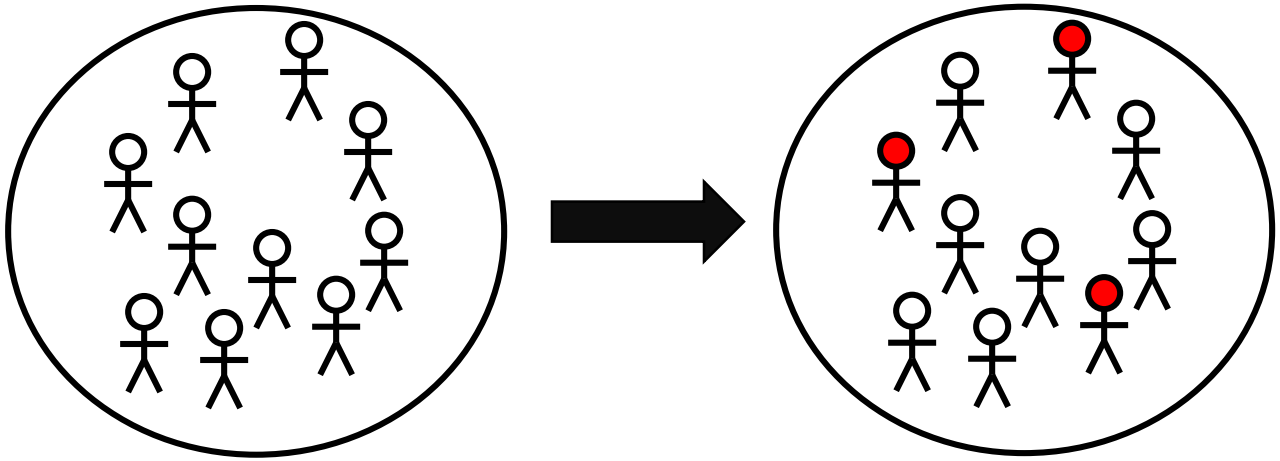
- **The proportion of a given population with a disease, condition, or risk factor *at a specific time***



$$\frac{\text{8 persons with condition}}{\text{120 persons total}} = \textbf{prevalence of 6.7\%}$$

Incidence Rate

- **Number of new events or cases of disease occurring *during a defined period* in a defined population**

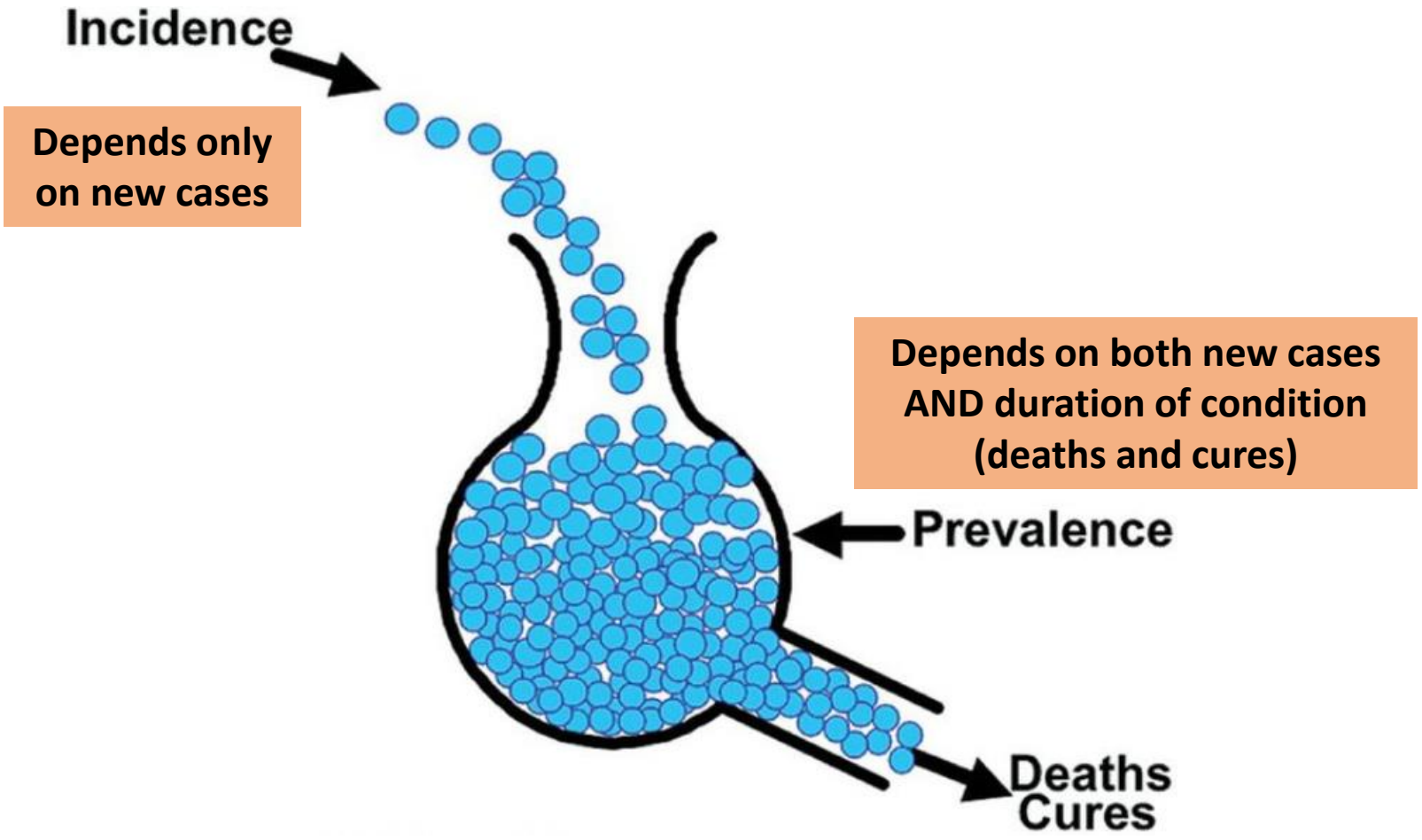


January 1
No cases

By Dec 31:
Three new cases

$$\frac{\text{3 new cases}}{\text{10 persons total}} = \textbf{incidence of 30\% per year}$$

Incidence Rate vs Prevalence



When to Use Incidence vs Prevalence

- **Incidence Rate**
  - Used primarily for diseases of short duration, often during outbreaks of communicable diseases
  - For non-communicable diseases: To emphasize the new cases that could be prevented with an intervention

- **Prevalence**
  - To describe the proportion of the population with a chronic disease (e.g., diabetes)
  - To describe the proportion of the population with a risk factor (e.g., smoking)

Review Question: Incidence or Prevalence?

- **If you were writing a policy brief about:**
  - Heart disease PREVALENCE
  - Automobile crashes INCIDENCE
  - Salmonellosis INCIDENCE
  - Teenage pregnancy ??
  - HIV infections ??

Comparative Measures of Disease for >1 Group

- **Relative risk**
- **Risk difference (Excess risk)**
- **Prevalence ratio**
- **Odds ratio**

Relative measures

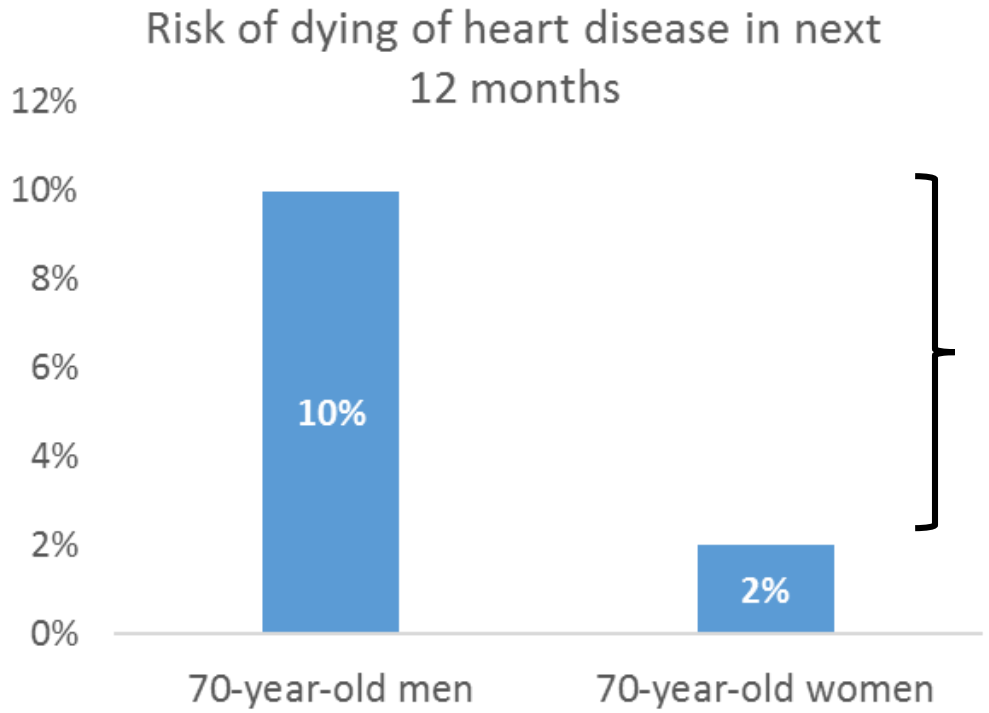
Why Compare Across Groups?

- **Comparisons can highlight:**
  - Health disparities
  - Underserved communities
- **To show that intervention or action is necessary, often need to compare health outcomes across:**
  - Time
  - Place
  - Person

Relative Risk & Risk Difference

- **Relative risk:**
  - Risk in one group, divided by risk in another group
  - Tells you *how many times more likely* an outcome is in one group (or time period, or location) compared with another
- **Risk difference:**
  - Risk in one group, subtracted from risk in another group
  - Tells you *how many more (or fewer)* cases in one group vs another
  - Conveys the size of the difference in absolute terms

Relative Risk & Risk Difference



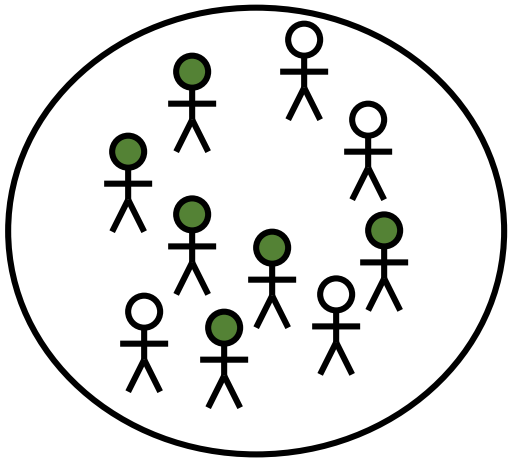
Risk difference:

(10% - 2%) = 8%

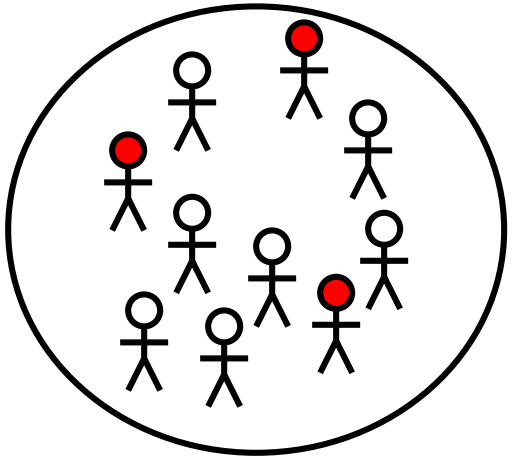
Relative risk of dying of heart disease in next 12 months, comparing men to women = $\frac{10\%}{2\%}$ = 5.0

Prevalence Ratio

- **Prevalence in one group, divided by prevalence in another group**
  - Tells you *how much more common* an outcome or risk factor is in one group compared with another



Group A:
Prevalence = 60%

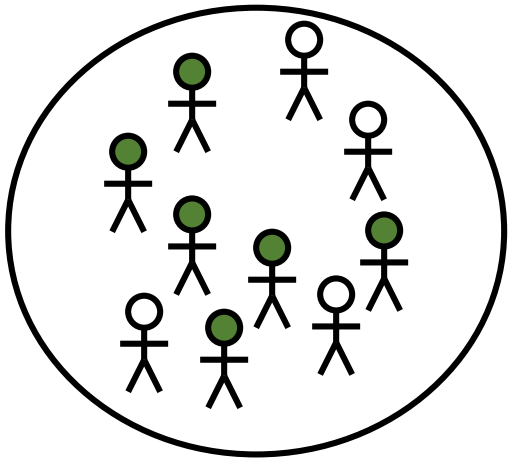


Group B:
Prevalence = 30%

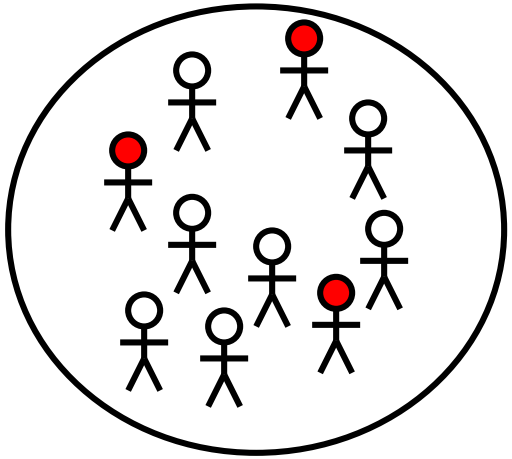
$$\frac{60\%}{30\%} = \textbf{prevalence ratio of 2.0}$$

Odds Ratio

- **Odds in one group, divided by odds in another group**
  - Similar to the relative risk when the risk is low



Group A:
Odds = 6:4



Group B:
Odds = 3:7

$$\frac{6/4}{3/7}$$ **= odds ratio of 3.5**

Notes about Relative Risk, Prevalence Ratio, and Odds Ratio

- **Often used interchangeably and called 'relative risk'**
  - However, they are not the same thing
  - Correct reporting is important, in a scientific manuscript or in a policy brief

Example	How to report
An odds ratio of 2.0, comparing Group B to A	People in Group B had twice the odds of disease as people in Group A
A relative risk of 2.0, comparing Group B to A	People in Group B had twice the risk of disease as people in Group A
A prevalence ratio of 2.0, comparing Group B to A	Disease was twice as common among people in Group B, compared with Group A

Continuous Data are Useful Too!

- **Counts, incidence, and prevalence are all measures of health that are based on categorical data**
  - E.g., sick / not sick; exposed / unexposed
- **Continuous measures of data: <u>mean</u>, <u>median</u>, <u>range</u>**
  - Can quantify the *extent* of exposure or illness, e.g.:
    - **20% of teenagers smoked cigarettes.**
    - **Within that 20%, the average number of cigarettes / day was 15**
    - **Number of cigarettes smoked per day ranged from 1 – 30**

Review Question: What Measure Should I Use…

- **…to show the current number of people affected by a disease**
- **…to show how many new cases we have/how an epidemic is changing over time**
- **…to compare the burden of disease in one population to another**

COUNTS

INCIDENCE RATE

PREVALENCE RATIO

Data in Policy Briefs: Telling Stories with Data

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Data Story 1: Description

Today

Where are we now?

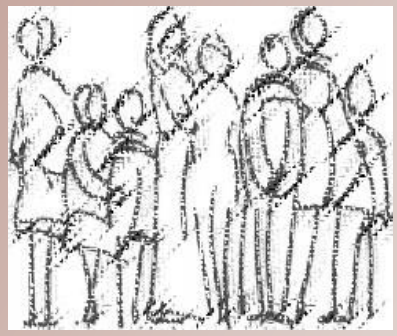
Data Story 2: Description w/ Comparison

Today

Where are we compared with others?

Data Story 3: Change

Yesterday



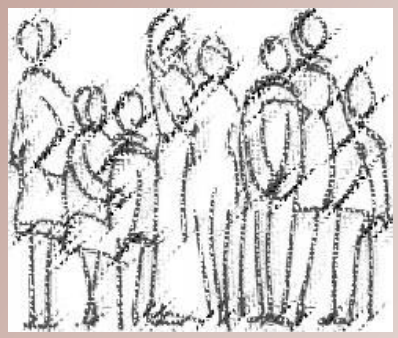
Where were we?

Today

Where are we now?

Data Story 4: Explanation

Yesterday



Today

Where were we?

Where are we now?

Why did we change?

Measures of Disease in Policy Briefs

Smoking in Kentucky—We're Number 1!

A 2007 assessment of Kentuckians' health by the Institute of Medicine at the University of Kentucky confirmed a grim statistic—Kentucky leads the nation in smoking:

- **Kentucky ranks first in the nation in the percent of adults who smoke.** More than 29% of adult Kentuckians smoke (876,000 people) compared to 21% nationally.
- An estimated **25% of high school students (53,000 students) also smoke** compared to 23% nationally.
- **Pregnant women in Kentucky smoke at twice the national rate**—one out of four pregnant women (26%) smoke in Kentucky.
- Almost **half of smokers, 47.7%, have tried to quit.**
- **Over 45% of Kentucky children live in a household where someone smokes**, compared to a national average of 29.5%.

Measures of Disease in Policy Briefs

COUNTS

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Measures of Disease in Policy Briefs

Prevalence

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Measures of Disease in Policy Briefs

Leading the nation in smoking exacts a high price for Kentucky, in both lives and dollars:

- The U. S. Centers for Disease Control and Prevention (CDC) reports that, with an **average of 7,700 smoking-related deaths each year, Kentucky has the country's highest rate of deaths attributable to smoking.**
- The UK study found that more than **half of all smokers will die of a smoking-related illness.**
- UK researchers also report that **23% of all deaths in Kentucky are attributed to smoking.**

Measures of Disease in Policy Briefs

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Incidence

Data Story 2: Description w/ Comparison

Today

Where are we compared with others?

Comparisons in Policy Briefs

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Comparing Across Groups in Policy Briefs

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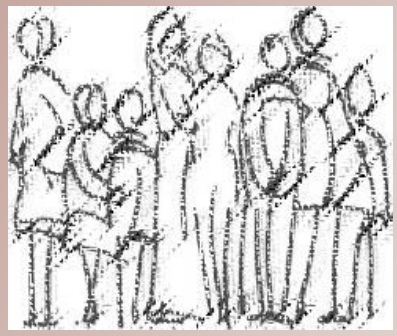
Data Story 3: Change

Yesterday

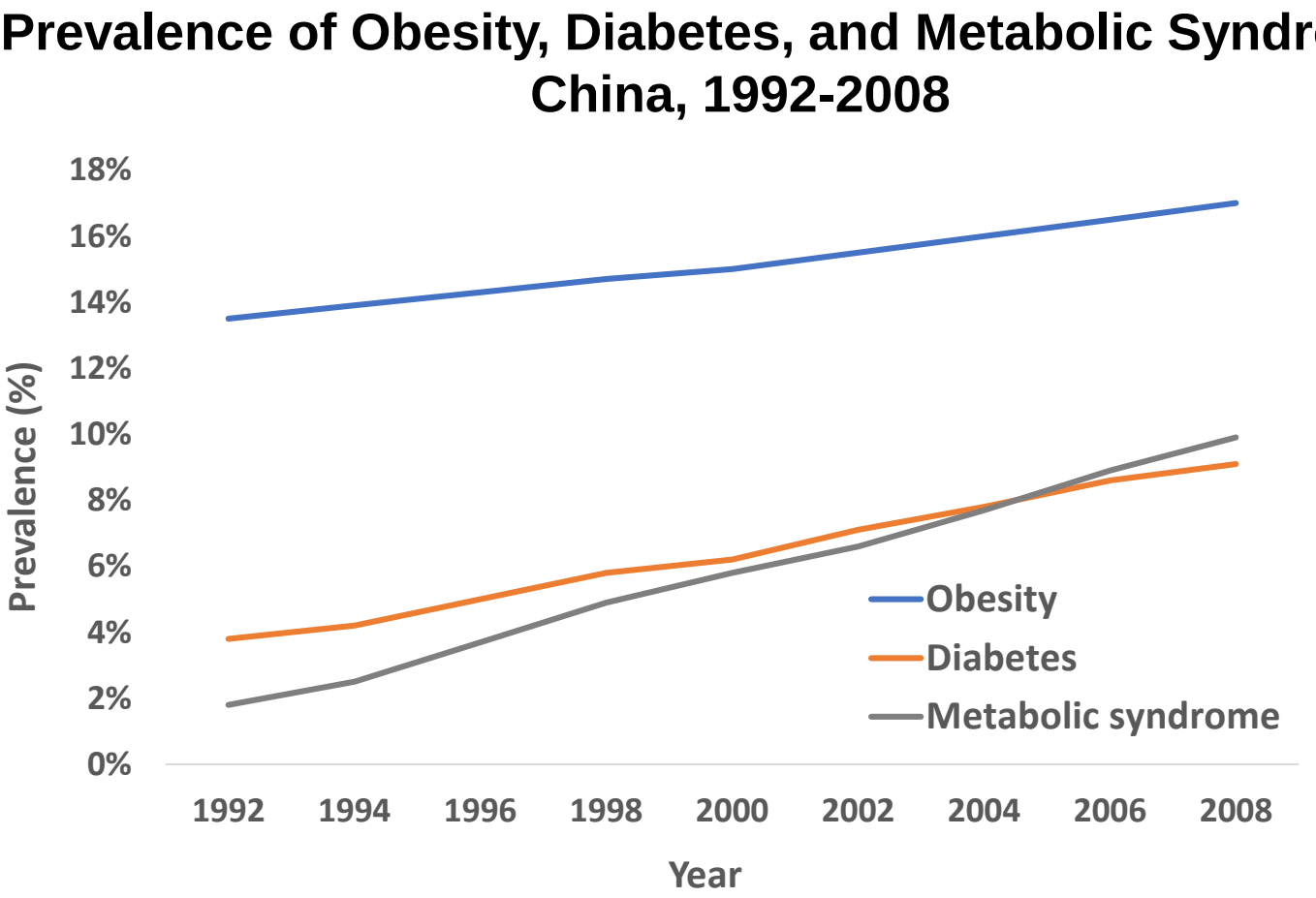


Today

Where were we?

Where are we now?

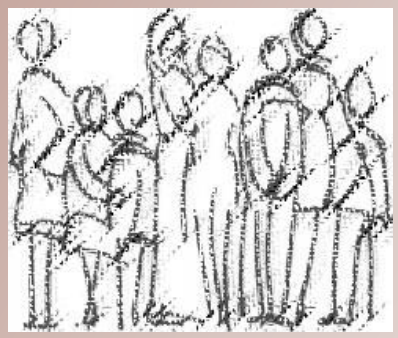
Why Compare Across Time?



Adapted from: Shen J, Goyal A, and Sperling L. The emerging epidemic of obesity, diabetes, and the metabolic syndrome in China. Cardiol Res Pract 2012; 2012.

Data Story 4: Explanation

Yesterday



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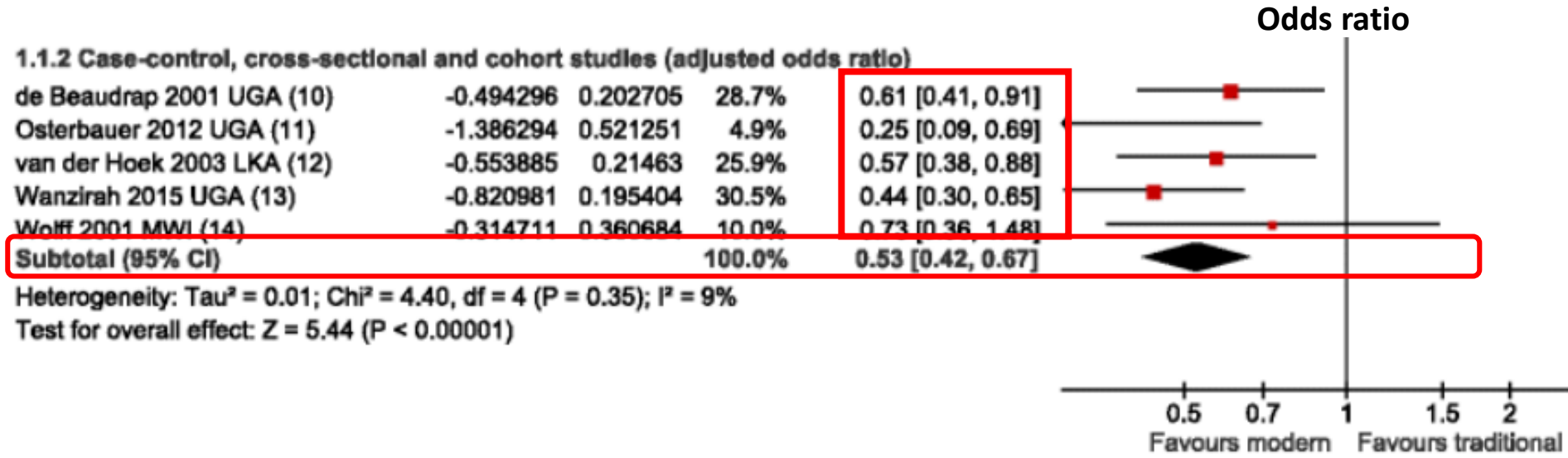
Where are we now?

Why did we change?

Analytic Epidemiology

Fig. 3. Meta-analysis of association between modern housing and malaria.



The odds of malaria among persons living in modern housing was 0.53 times the odds of malaria among persons living in traditional housing.

Modern housing, compared with traditional housing, reduced the odds of malaria by 47%.

Tusting et al (2017) Malaria Journal (2015) **14**:209. **DOI:** 10.1186/s12936-015-0724-1

Age Adjustment

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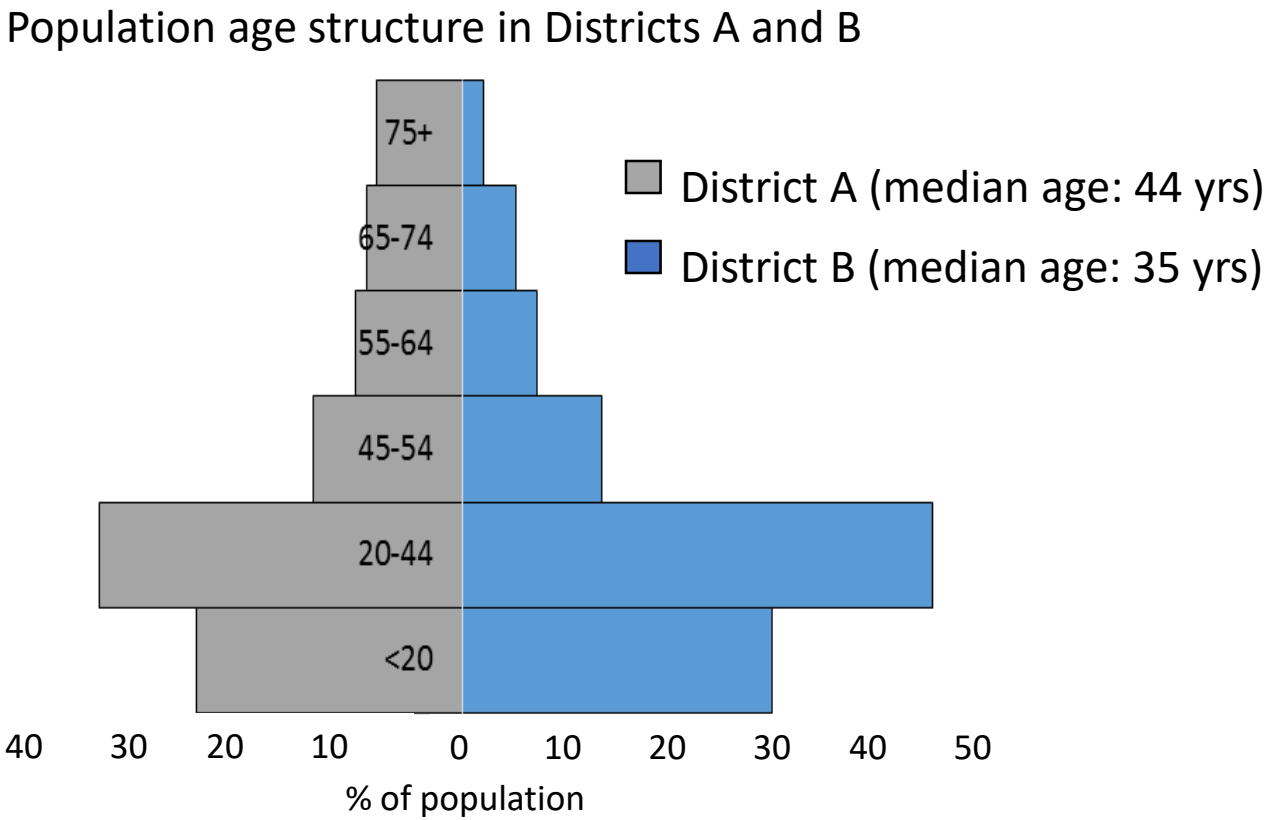
Before You Compare

- **Imagine two districts (District A and District B) which have two different crude death rates**
- **Example: Crude death rates**
  - District A = 11/1000
  - District B = 8/1000
- **At first glance, it seems like District A is a riskier place to live than District B!**

Before You Compare

- **What if District A and District B have different age compositions?**



Age Adjustment

- **Age is the biggest predictor of mortality as well as the onset of many diseases**
- **Comparing crude mortality rates or the rates of age-related diseases across populations with different age structures can be misleading**
- **Common to use direct age-standardization (age adjustment) to eliminate the age differences between populations**

- **Excel tool in your flash drive – your mentor can help you age-adjust if needed!**

Statistical Significance

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Statistical Significance

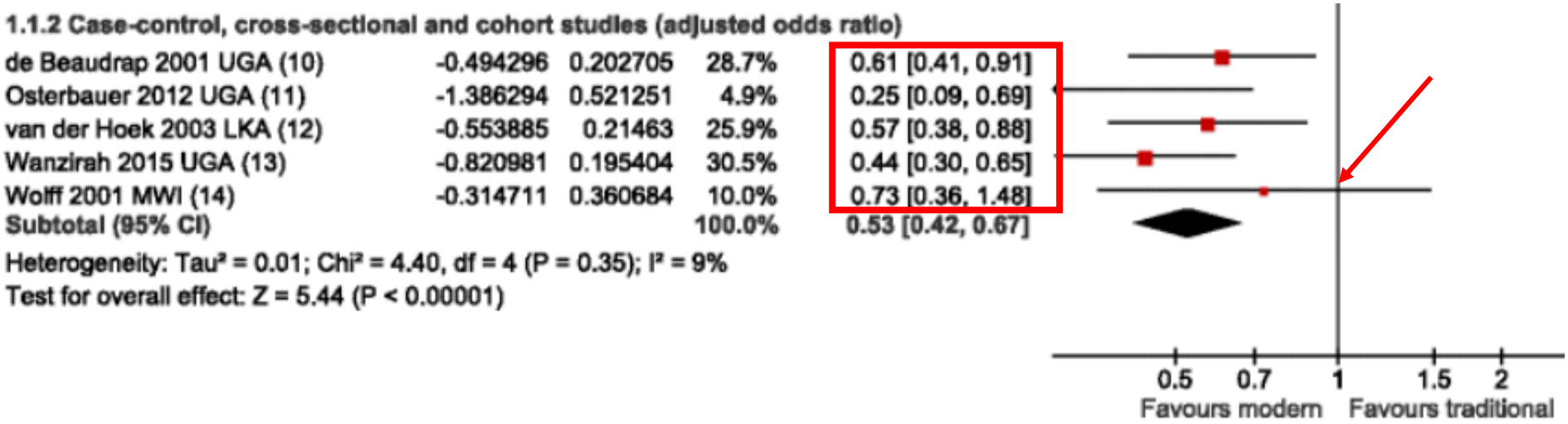
- **P-value**
  - Probability that results you get are due to chance
  - p≤0.05 means there is <5% probability that the effect you see in your results (or a larger effect) is due to chance alone (p<0.05)
- **95% Confidence interval**
  - Interval over which you are 95% confident that the true result is contained
  - Significant if:
    - Relative measures: does not contain 1
    - Difference measures: does not contain 0

Example

- **RR of lung cancer among smokers, compared with nonsmokers = 9.8 (95% CI = 6.4-15.4), p=0.03**
  - Interpretation for RR: The risk of lung cancer is 9.8 times greater among smokers than nonsmokers
  - Interpretation for 95% CI: We are 95% confident that the true risk of lung cancer is between 6.4 and 15.4 times greater for smokers than nonsmokers
  - Interpretation of p-value: There is a 3 in 100 chance that the RR result we obtained is due to chance alone

Review question: Which of the five studies have statistically significant results?

Fig. 3. Meta-analysis of association between modern housing and malaria.



Modern housing was shown to reduce the risk of malaria by 47%.

Tusting et al (2017) Malaria Journal (2015) **14**:209. **DOI:** 10.1186/s12936-015-0724-1

Part II: Advanced Measures of Disease in Policy Briefs

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Different ways to rank diseases…and risk factors!

- **Scenario 1: In your city, in one year:**
  - 500 five-year-olds die of pediatric cancers
  - 5,000 60-year-olds die of adult cancers
  - How can you compare the burdens of childhood and adult cancer?

- **Scenario 2: In your city, in one year:**
  - 500 people develop Type II diabetes
  - 25 people become quadriplegic (paralyzed)
  - How can you compare these in terms of burden?

- **Scenario 3: You have $5 million to spend, and your goal is to avert as much premature death as possible in your city**
  - Should you target vaccines? Tobacco? High blood pressure? Or something else? How do you know what to target?

Different ways to rank diseases…and risk factors!

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Years of Life Lost (YLL)

- **Scenario 2: In your city, in one year:**
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  - How can you compare these in terms of burden?

Disability-Adjusted Life-Years (DALY)

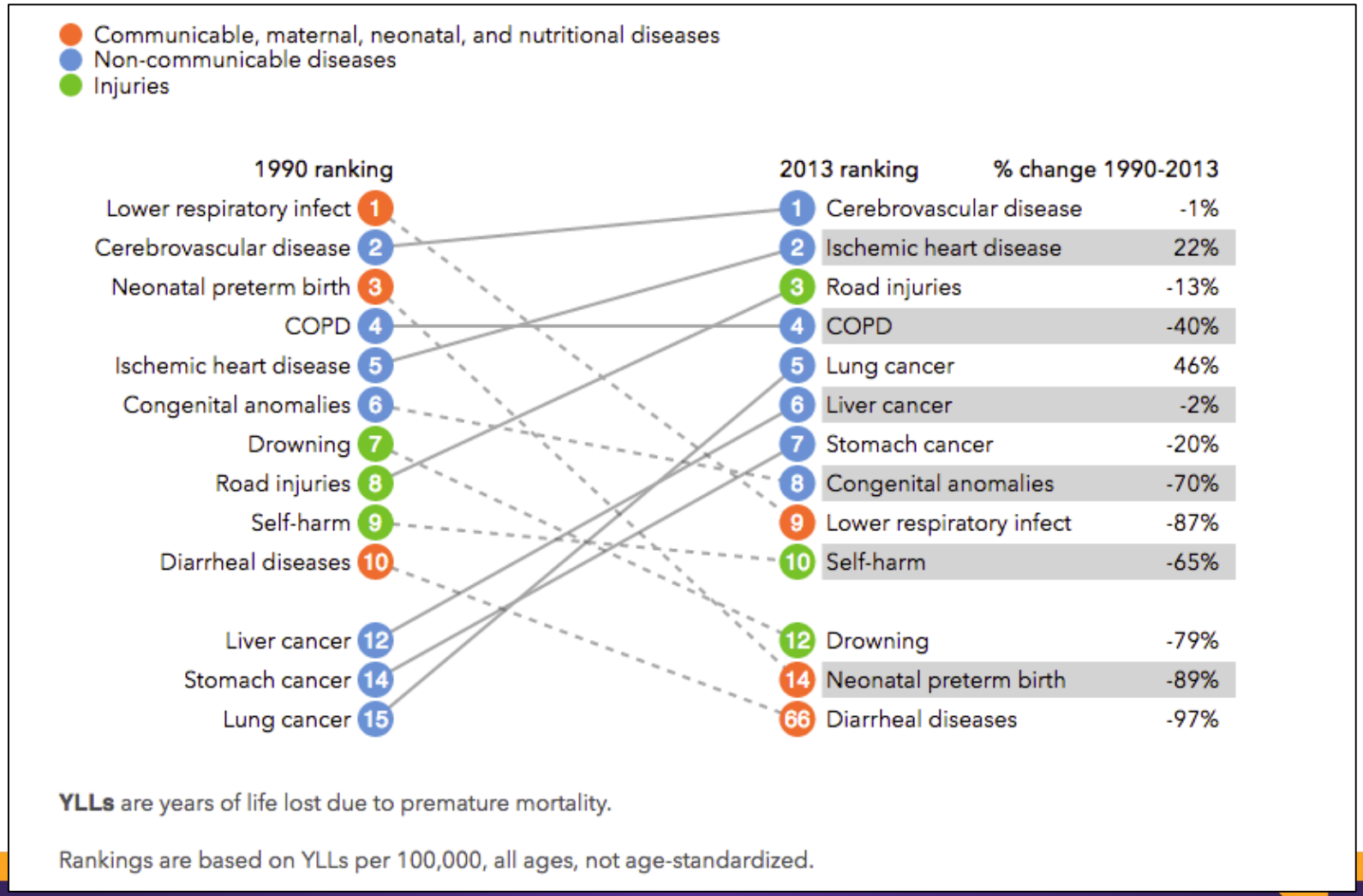
- **Scenario 3: You have $5 million to spend, and your goal is to avert as much premature death as possib**
  - Should you target vaccines? Tobacco? High blood
    something else? How do you know what to target?

Population Attributable Risk (PAR)

Years of Life Lost (YLL)

- **What is YLL?**
  - Measure of premature mortality
  - Years of potential life lost due to premature deaths
  - Single measure that sums up age at death and number of deaths from a specific disease
- **Why is it useful?**
  - Weights deaths that occur at younger ages more than those that occur at older ages
  - Often used to rank different causes of death (% of total YLLs calculated)
- **Calculated by subtracting age at death from potential life expectancy**

Leading causes of premature mortality (YLLs) in China, 1990 and 2013



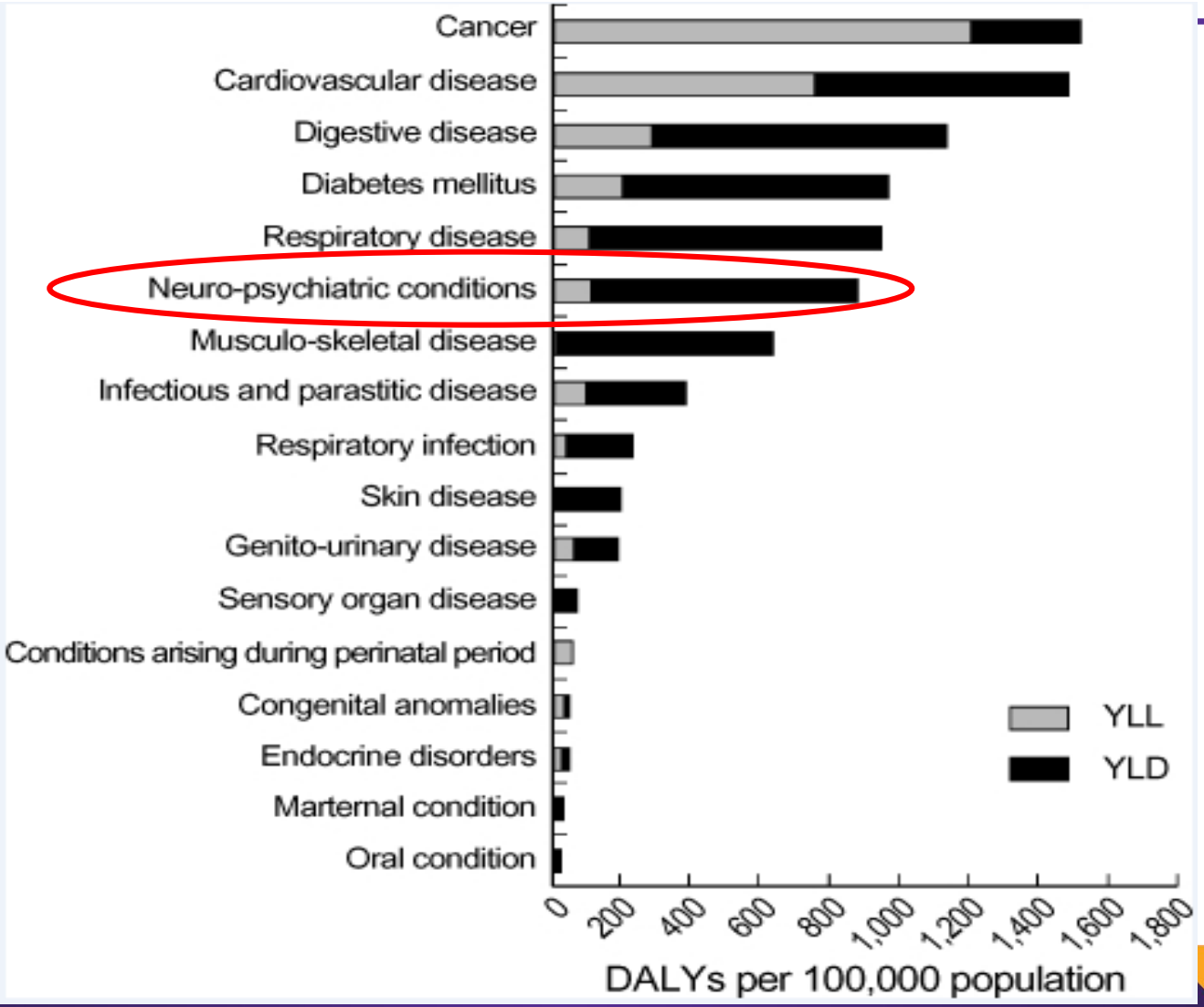
Source: IHME, 2013 Global burden of disease

Disability Adjusted Life Year (DALY)

- **Total burden of disease = morbidity + mortality**
- **Years lost due to disability (YLD):**
  - Weighted count of years lived with disability
  - Assumes:
    - Year lived in less than perfect health worth <1 year
    - The more severe the disease/disability, the less it's worth

DALY = YLL + YLD

DALYs v. YLLs (Korea, 2012)



Source: Lee et al, Translation of Korean Medicine Use to ICD-Codes Using National Health Insurance Service-National Sample Cohort. Evidence-Based Complementary and Alternative Medicine (2016) 9963:1-12.

DALY Example

- **In Vietnam, people are expected to live to age 75**
- **Bing is injured in a motorcycle accident at age 35 resulting in paralysis from the waist down**
- **A committee decided that each year lived as a paraplegic is worth 0.5 years of healthy life**
- **Bing dies at 65**
- **In total, Bing lost**
  - YLLs: 10 years of life due to dying at 65 rather than 75
  - YLDs: 15 years of life due to being injured at 35 (30 years of injury * 0.5 years)
  - DALYs: 25

Leading causes of death in Kenya (DALYs)

Causes of Death		
Rank	**Disease or injury**	**% total**
1	HIV/AIDS	29.3
2	Perinatal conditions	9.0
3	Lower respiratory infections	8.1
4	Tuberculosis	6.3
5	Diarrhoeal diseases	6.0
6	Malaria	5.8
7	Cerebrovascular disease	3.3
8	Ischaemic heart disease	2.8
9	Road traffic accidents	1.9
10	Violence	1.6

From: Miles and Misses in HIV Prevention <Treatment, and Support: Progress towards Zero AIDS, Dr. Martin Sirengo, MD, Head, National AIDS and STI Control Program (NASCOP), MOH 18 June 2014 – KICC Nairobi

Sources of DALYs and YLLs

- **Calculating DALYs for populations outside of the scope of a policy brief**
  - Useful if a burden of disease study has already been conducted in country
- **Main sources of DALYs**
  - World Health Organization (WHO)
  - Institute on Health Metrics and Evaluation (IHME) (http://www.healthdata.org/)
  - Scientific literature
  - Your own calculations (YLLs)
- **Other similar measures exist (QALYs, HALE)**

Population Attributable Risk

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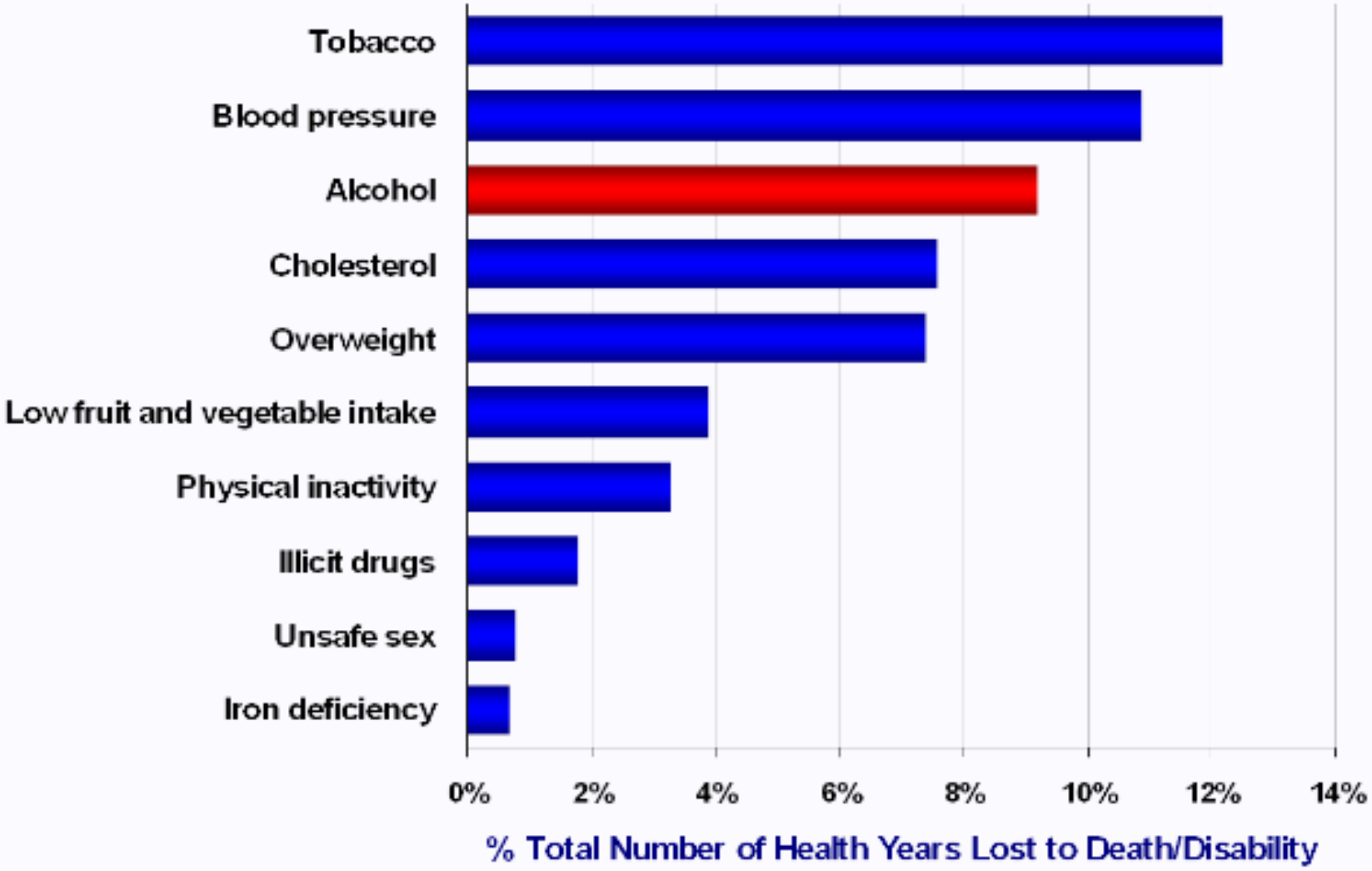
Vital Strategies

Burden of Disease Attributable to Alcohol Among 10 Leading Risk Factors for Disease in Developed Countries



The World Health Report 2002: http://www.who.int/whr/2002/en/whr2002_annex14_16.pdf

Smoking Attributable Mortality, China

Table 3. Relative Risk, Prevalence of Smoking, Population Attributable Risk, and the Absolute Number of Deaths Attributable to Smoking in China in 2005.

Age Group	Relative Risk (95% CI)		Prevalence of Smoking*	Population Attributable Risk	Absolute No. of Deaths Attributable to Smoking (95% CI)
	Age-Adjusted	Multivariable-Adjusted†			
			percent		*thousands*
Men					
40–54 yr	1.33 (1.20–1.48)	1.20 (1.07–1.34)	72.1	12.7	55.6 (17.3–93.8)
55–64 yr	1.26 (1.16–1.36)	1.25 (1.15–1.36)	70.6	15.0	82.4 (51.3–113.6)
≥65 yr	1.17 (1.11–1.23)	1.19 (1.12–1.26)	67.8	11.2	400.2 (315.8–484.6)
Total	1.28 (1.23–1.33)	1.21 (1.16–1.26)	71.1	12.9	538.2 (455.8–620.6)
Women					
40–54 yr	1.50 (1.26–1.80)	1.36 (1.13–1.63)	7.8	2.7	7.6 (0–15.7)
55–64 yr	1.33 (1.19–1.49)	1.31 (1.17–1.47)	11.4	3.4	12.7 (3.3–22.1)
≥65 yr	1.28 (1.18–1.37)	1.27 (1.18–1.37)	15.3	4.0	114.6 (79.4–149.8)
Total	1.41 (1.33–1.49)	1.33 (1.25–1.41)	9.9	3.1	134.8 (108.9–160.8)

Source: Gu et al. Mortality Attributable to Smoking in China, NEJM. 2009.

Population Attributable Risk

- **Definition:**
  - Expected reduction in disease occurrence if harmful exposure could be eliminated, OR
  - Actual reduction in disease occurrence attributable to beneficial protective exposure
- **Puts the association between exposure and disease (RR) in a public health context**

Note: You can only use a PAR if you KNOW there is a causal relationship between exposure and disease!

Source: FETP – Measures of Impact

Population Attributable Risk Calculation

- **2 possible equations can be used calculate**
- **Both rely on the relative risk and the prevalence of the risk factor in question**

Equation 1: $P_e*(RR - 1)/[P_e*(RR - 1) + 1]$

P = proportion of population exposed

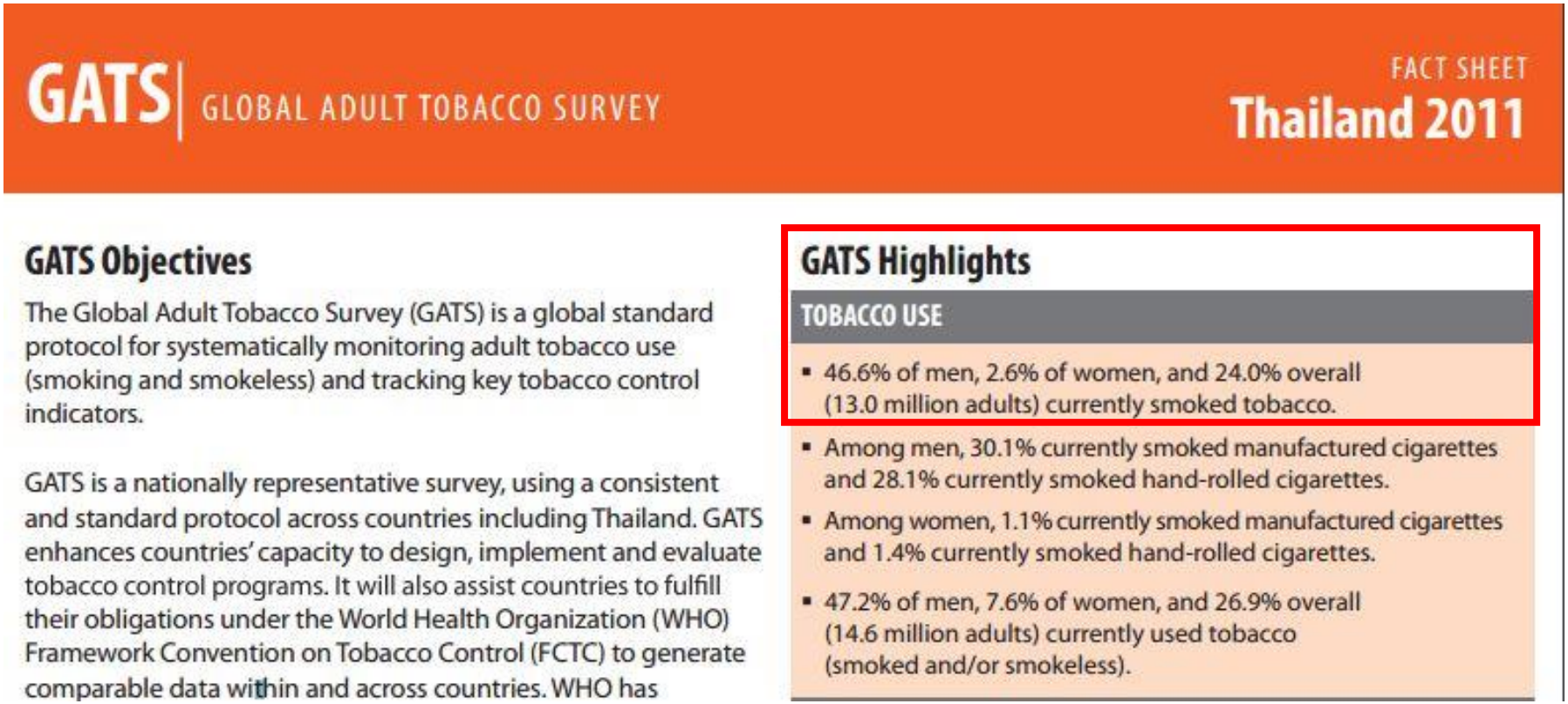
Equation 2: $P_c * (RR - 1)/RR$

P = proportion of cases (events) exposed

Example: Smoking and Lung Cancer Risk

- **Imagine: Thailand, concerned about lung cancer in men, is considering a new tobacco control law**
  - You want to provide data to show the potential impact
- **Question: In Thailand, how many lung cancer cases in men are caused by smoking?**
  1. Gather data
  2. Calculate the population attributable risk (PAR)
  3. Apply the PAR to the actual number of lung cancer cases in men to get the total cases caused by smoking
- **Data needed:**
  - Prevalence of male smoking in Thailand
  - RR of lung cancer comparing male smokers to non-smokers
  - Number of lung cancer cases in men in Thailand

Step 1: Gather Data: Smoking Prevalence



GATS | GLOBAL ADULT TOBACCO SURVEY

FACT SHEET
Thailand 2011

GATS Objectives

The Global Adult Tobacco Survey (GATS) is a global standard protocol for systematically monitoring adult tobacco use (smoking and smokeless) and tracking key tobacco control indicators.

GATS is a nationally representative survey, using a consistent and standard protocol across countries including Thailand. GATS enhances countries' capacity to design, implement and evaluate tobacco control programs. It will also assist countries to fulfill their obligations under the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) to generate comparable data within and across countries. WHO has

GATS Highlights

TOBACCO USE

- 46.6% of men, 2.6% of women, and 24.0% overall (13.0 million adults) currently smoked tobacco.
- Among men, 30.1% currently smoked manufactured cigarettes and 28.1% currently smoked hand-rolled cigarettes.
- Among women, 1.1% currently smoked manufactured cigarettes and 1.4% currently smoked hand-rolled cigarettes.
- 47.2% of men, 7.6% of women, and 26.9% overall (14.6 million adults) currently used tobacco (smoked and/or smokeless).

Source: Global Adult Tobacco Survey, Thailand 2011

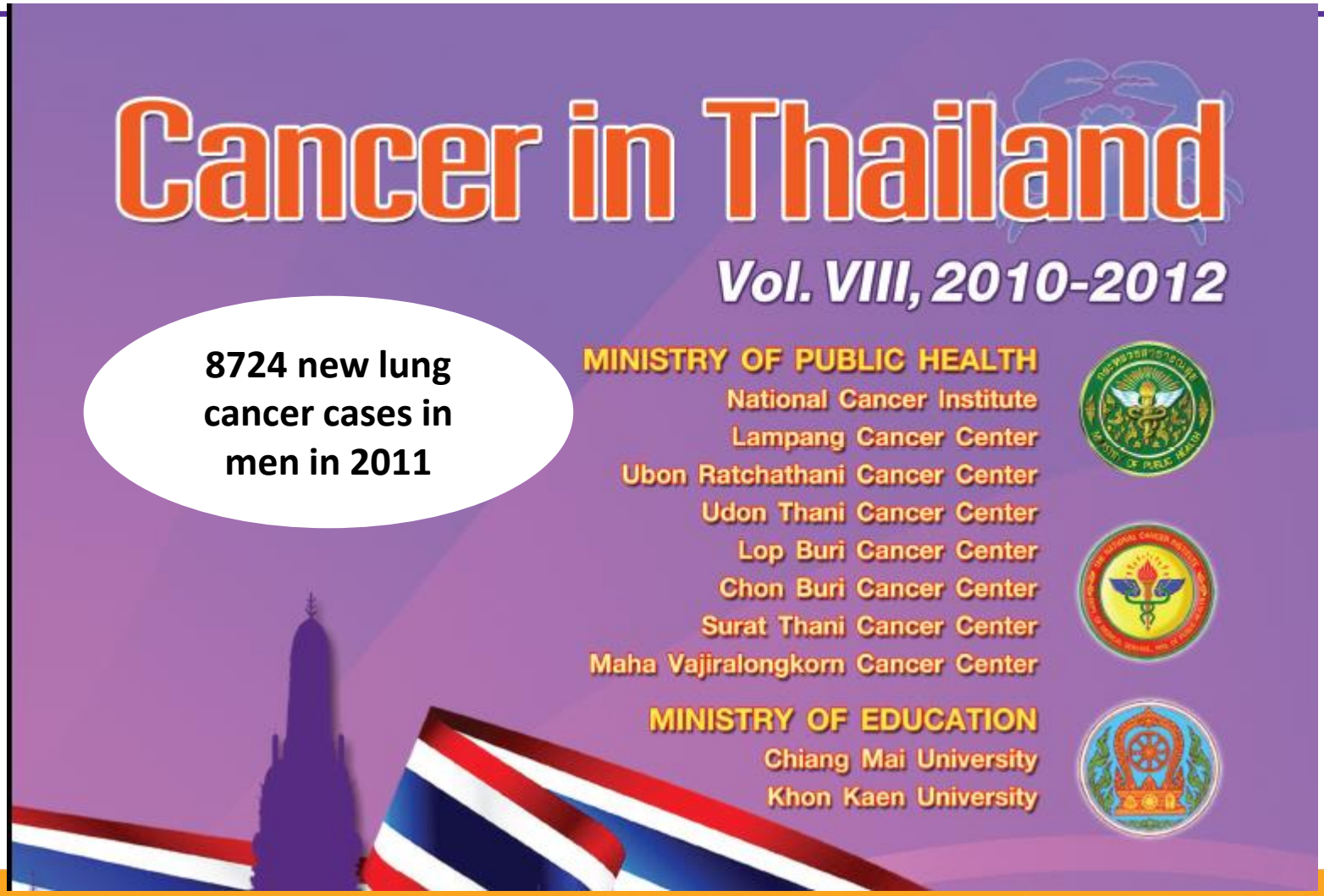
Step 1: Gather Data: Relative Risk

Table 3. Combined estimates of relative risk of lung cancer according to smoking status and gender

	No. of studies	Ever smoker		Current smoker		Ex-smoker	
		OR	95% CI	OR	95% CI	OR	95% CI
Men	18	9.90	7.72–12.7	20.3	12.1–34.2	8.17	6.54–10.2
Women	12	25.5	13.5–48.2	79.9	37.4–170.5	29.9	22.4–39.8

Adapted From: Sadik A. Khuder. **Effect of cigarette smoking on major histological types of lung cancer: a meta-analysis. Lung Cancer** Volume 31, Issues 2–3, March 2001, Pages 139-148

Step 1: Gather Data: Lung Cancer Incidence



Step 2: Calculate PAR

Equation 1: $P_e*(RR - 1)/[P_e*(RR - 1) + 1]$

PAR =

Interpretation

- 90% of lung cancer cases in men are due to smoking
- 90% of lung cancer cases in men could be avoided if smoking was eliminated

Step 3: Calculate Number of Lung Cancer Cases Attributable to Smoking

- **Apply the PAR to the number of cases of lung cancer in men**
- **Number of lung cancer cases in men attributable to smoking**

  = PAR * total number of cases

  = 8,724 * 0.9

  = 7,852 cases of lung cancer attributable to smoking

What if the Relative Risk Was Lower?

- **If the RR had been 10?**
  - PAR = 81%
  - 7,044 cases attributable to smoking
- **If the RR had been 2?**
  - PAR = 32%
  - 2,773 cases attributable to smoking
- **If the RR had been 1.2**
  - PAR = 9%
  - 744 cases attributable to smoking

PAR in Sample Policy Brief

Leading the nation in smoking exacts a high price for Kentucky, in both lives and dollars:

- The U. S. Centers for Disease Control and Prevention (CDC) reports that, with an **average of 7,700 smoking-related deaths each year, Kentucky has the country's highest rate of deaths attributable to smoking.**
- The UK study found that more than **half of all smokers will die of a smoking-related illness.**
- UK researchers also report that **23% of all deaths in Kentucky are attributed to smoking.**

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Using Data from the Literature to Tell Your Story

Bloomberg Philanthropies | DATA FOR HEALTH INITIATIVE

D2P Data to Policy

CDC Foundation
Together our impact is greater

Vital Strategies

Telling Your Story

- **Remember: writing a policy brief is about telling a story!**
  - If your story isn't *clear* and *interesting*, the impact you want it to have
  - You need to modify scientific language to make it easy to understand

Example

- **"We conducted longitudinal analyses during 2013–2015 in an 853-bed hospital and observed a significantly increased hand hygiene compliance rate ($p<0.001$) and a significantly decreased healthcare-associated infection rate ($p = 0.0066$)."**

- **Translate:**

  Handwashing among healthcare workers reduces infections acquired in the hospital.

Source: Sickbert-Bennett EE, DiBiase LM, Schade Willis TM, Wolak ES, Weber DJ, Rutala WA. Reduction in healthcare-associated infections by exceeding high compliance with hand hygiene practices. Emerg Infect Dis. 2016 Sep [*date cited*]. http://dx.doi.org/10.3201/eid2209.151440

Example

- **“We found no difference in favorable treatment outcomes among HIV-positive patients who initiated ARV treatment before or after start of XDR TB treatment (p = 0.59).”**

- **Translate:**

People with HIV and TB co-infections can start their ARV treatment before or after their TB treatment

Source: Kvasnovsky CL, Cegielski P, van der Walt ML. Treatment outcomes for patients with extensively drug-resistant tuberculosis, KwaZulu-Natal and Eastern Cape provinces, South Africa. Emerg Infect Dis. 2016 Sep. http://dx.doi.org/10.3201/eid2209.160084

Example

- **"The odds of a child being anemic at 9 years of age was 1.81 (95% CI 1.07, 3.05; P = 0.027) and 2.34 (1.37, 4.00; P = 0.002) fold higher if their mothers were anemic during pregnancy, compared to non-anemic mothers."**
- **Translate:**

Nine-year-old children were about twice as likely to be anemic if their mothers were anemic during pregnancy.

Source: Mannan, Ahmed, and Akhtar et al. **Maternal Micronutrient Supplementation and Long Term Health Impact in Children in Rural Bangladesh, PLoS One, Aug 2016. Available at http://journals.plos.org/plosone/article?id=10.1371%2Fjournal.pone.0161294.**

Deliverable 3:
Draft Problem Statement (with Data!)

Draft your problem statement by answering the questions below.

1. What is the problem?
   - Health issue
   - Primary cause
2. Qualify the problem:
   - Who is affected by the problem?
   - Where is the problem present?
3. Quantify the problem
   - How much?
   - When?
4. What are the root cause(s) of the problem?

You will need to do more data searching. Don't forget to add those to your list of data sources in Deliverable 1!

Output: Problem Statement Outline

END

Bloomberg Philanthropies | DATA FOR HEALTH INITIATIVE | D2P Data to Policy | CDC Foundation Together our impact is greater | Vital Strategies