

Epidemiologic Inference in Public Health I

340.721.81

LiveTalk
February 7, 2018

Overview of LiveTalk

1. Announcements
2. Review of Activity: Measuring Disease Frequency
3. Question and Answer session
 - Please post to General Chat

Announcements

- PRE-Activity (Validity and Reliability) due to Courseplus on **Wed, Feb 14** by **4:00PM** Eastern time
- We will discuss the Activity on Validity and Reliability at the LiveTalk Wed, Feb 14 4:00-5:30PM Eastern time
- Thank you to everyone who has identified a Proctor for the midterm exam!
 - You can change your Proctor for the final exam
 - Email to go to proctors on Friday**

Announcements (continued)

- Midterm Exam
 - Opens Thursday, February 15
 - Closes Saturday, February 17
 - The exam must be completed sometime during that time

Midterm Exam

- 20 multiple choice questions
- Closed book/closed note
- To be completed individually in keeping with the Academic Ethics code
- Covers material through Lecture 12 (Analytic Studies and Clinical Trials) and PRE-Activity/Activity 3 on Validity and Reliability
- 2 hours to complete the exam

Proctor for the Midterm Exam

- Proctored exam
- Identify a proctor in Courseplus if you have not already done so

Midterm and Final Examinations

Both the mid-term and final examinations will consist of 25 multiple choice questions. Both examinations are closed book/closed note and are to be completed individually in keeping with the Academic Ethics code. The mid-term examination will cover material through the online lecture on clinical trials and Activity 3: Assessing the Validity of Diagnostic and Screening Tests. The final examination will be cumulative. You will have 2 hours to complete each exam.

We utilize the proctor system to administer both the midterm and final examinations. Please identify a proctor in Courseplus for your midterm and final exams by the dates provided in the Course Schedule. Details on how to access the exam will be emailed to your proctor prior to the exam period. He or she will administer the exam to you as in a classroom setting. When you complete the exam, you will transcribe the answers to an online answer page. Proctors will then return all exam materials back to the course instructors. If you do not have access to a computer and Internet access at the proctor location, please contact the course instructors before the exam.

Detailed instructions for identifying a proctor are in the first LiveTalk

Midterm Exam

- Proctored exam
- Passwords to access the Midterm will be emailed to Proctors on Monday (Feb 12)
- If you have not identified a Proctor in Courseplus, you will not be able to take the exam
- It is your responsibility to arrange with your proctor the date and location of the exam

Midterm Exam

- Bring to the exam:
 - Blank paper (for scrap paper)
 - Pen or pencil
 - Calculator
 - You are not allowed to use the calculator function on your cellphone or tablet. You cannot use Excel or any other computer software
 - Laptop computer
 - If there is not a computer at the testing site
- At the beginning of the exam, the proctor will use the password to access the exam for you

Midterm Exam

- During the exam:
 - The only application that should be open on your computer is an Internet browser, and the only tab that should be open on that browser is the examination in Courseplus
 - In addition to recording your answers in Courseplus, you should record your answers on scrap paper during the exam, as a precaution in case of technical difficulties
 - Should you experience technical difficulties (e.g., loss of power, loss of internet connectivity), the proctor will need to re-enter the password

Tracking Online Activity during the Exam

- From the course syllabus:

Tracking of Your Activity When Taking Online Quizzes/Exams in CoursePlus

CoursePlus tracks your browsing activity any time you are logged into CoursePlus. This includes when you take quizzes or exams. While you take quizzes or exams, CoursePlus tracks any time you switch away from or back to the quiz or exam page. It also tracks your access of other web pages or content in the course website while taking the quiz or exam. Faculty have access to per-student logs which show all this information. Switching away from the exam page, whether or not to access other course content, while taking a closed-book, online exam (i.e., a quiz/exam which does not allow use of course materials or any other outside sources to complete the quiz/exam) may constitute an academic ethics violation, even if you do not intend to access materials relevant to completing the exam or quiz.

Some students ask if they may copy answers into a Word document in case they lose Internet connectivity during an exam. There is no need to do this. Your answers are automatically saved in the background as you work. If you are logged out from CoursePlus during an exam, all your answers will be saved as soon as you log back in. So do NOT do this – the log of your activity may record this as impermissibly leaving a closed-book exam.

Midterm Exam

- At the end of the exam:
 - All exam materials (including scrap paper) must be given to the proctor
 - The proctor must watch you submit your final answers prior to leaving the testing site
- Grades will be distributed by email once all exams (including make-up exams) have been completed

Review for the Midterm Exam

Additional Resources (Optional)

Self-assessments for each Lecture: [Self-assessments](#) are provided for you to check your understanding of the material covered in each lecture. These questions can be completed and reviewed at your convenience, and you can access them as often as you like. Self-assessments are not graded and answers are provided.

Practice Problems for the Exams: [Practice Problems for the Midterm I and II](#) and [Practice Problems for the Final I and II](#) are taken from past exams in order to help you prepare for the midterm and final examinations. These questions can be completed and reviewed at your convenience, and you can access them as often as you like. These problems are not graded and answers are provided.

Reviews for the Midterm and the Final Examinations: PowerPoint slides and accompanying audio files that were recorded for another section of this course this academic year are available in the [Online Library](#) to help you review for the midterm and final examinations.

Practice Problems in the Textbook. Practice problems are available at the end of each chapter of the textbook and answers are provided at the back of the book. These problems may be accessed using the electronic version of the book, as well as the hardcopy. Additionally, the website for the book that is maintained by the publisher has additional practice problems. Access to this website requires purchase of the book and is not required for this course.

Review for the Midterm Exam

- Slides and audio recording of a review for the Midterm Exam presented during another section of this course are available in the Online Library on Courseplus
- Material covered in this course and in that course is very similar
 - Ignore slides 1-21 (announcements for the prior course)
 - Relevant audio starts at ~15:50

Practice Problems for the Midterm Exam

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Practice Problems for the Midterm Exam

Content

Available	Assignment		Due	Completed?
Important Links and Assessments				
Mon, Jan 22	Proctor	Identify a Proctor in CoursePlus	Mon, Feb 5, 11:59 PM	<input type="checkbox"/>
Mon, Jan 22 to Sat, Mar 17	Lecture Self-Assessments	Use this link to reach the self-assessments for all lectures	Sat, Mar 17,	<input type="checkbox"/>
Mon, Jan 22	LiveTalks and Archived LiveTalk Recordings			<input type="checkbox"/>

Practice Problems for the Exams can be accessed using this link

Midterm Exam

Additional Resources (Optional)

Self-assessments for each Lecture: [Self-assessments](#) are provided for you to check your understanding of the material covered in each lecture. These questions can be completed and reviewed at your convenience, and you can access them as often as you like. Self-assessments are not graded and answers are provided.

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Activity

Measuring Disease Frequency

Plan for the LiveTalk Today

- We will review the answers to the Activity question by question
- Questions were assigned to Groups last week
- When it's time for your group to present, if you are the spokesperson for your group, please raise your hand and we will call on you to answer your assigned questions

Activity:

Measuring Disease Frequency


- **Concepts covered:**
 - Mortality
 - Crude rates of disease incidence
 - Adjustment for extraneous factors (e.g., age)
 - Direct adjustment method
 - Indirect adjustment method
 - Standardized Mortality Ratios (SMRs)
 - Stratification

Activity:

Measuring Disease Frequency


- This Activity focuses on measures used to summarize the frequency of disease occurring in a population, measures of association employed to assess risk factors for diseases, and measures of survival, and introduces methods to account for the influence of extraneous factors on measures of association

This Activity corresponds to:


JOHNS HOPKINS
BLOOMBERG SCHOOL
of PUBLIC HEALTH

Measures of Morbidity and Mortality, Part 2

Jennifer Deal, PhD
Johns Hopkins University




Building on concepts
covered in:

JOHNS HOPKINS
BLOOMBERG SCHOOL
of PUBLIC HEALTH

Measures of Morbidity and Mortality, Part 1

Jennifer Deal, PhD
Johns Hopkins University



This Activity corresponds to:

 **JOHNS HOPKINS**
BLOOMBERG SCHOOL
of PUBLIC HEALTH

Measures of Morbidity and Mortality, Part 2

Jennifer Deal, PhD
Johns Hopkins University



Building on concepts
covered in:

Including:

- Prevalence
- Incidence
 - Cumulative incidence
 - Incidence rate
- Mortality rates
- Case-fatality

Jennifer Deal, PhD
Johns Hopkins University



Activity:

Measuring Disease Frequency

- As epidemiologists, we often wish to compare measures of disease frequency (e.g., incidence rate, mortality rate) in two populations.
- One issue we face when we make these comparisons is that differences we observe may be due, in whole or in part, to factors other than our primary exposure of interest.
- In this Activity, we will discuss ways in which we can compare these measures in 2 populations, independent of those other factors

Learning Objectives

In the PRE-Activity & Activity, we will:

1. Calculate and interpret crude rates of mortality
2. Perform direct and indirect adjustment of incidence rates and interpret adjusted rates.
3. Calculate and interpret Standardized Mortality Ratios (SMRs).
4. Describe advantages, limitations, and appropriate use of adjusted rates.

Comparison of Rates across Populations

Recall...from the Activity

Presented below are statistics for breast cancer for white and black females in the United States for the five-year period 1998-2002, taken from the Surveillance, Epidemiology and End Results (SEER) program of the National Cancer Institute (2005). Refer to the appendix for a description of SEER.



Cancer Statistics

Statistical Summaries

Interactive Tools

Publications

For Researchers

Datasets and Software

For Cancer Registrars

Coding Rules, Training and Support

About SEER

Our Registries and Research



WE ARE A PREMIER SOURCE FOR CANCER STATISTICS IN THE UNITED STATES.

The Surveillance, Epidemiology, and End Results (SEER) Program of the National Cancer Institute works to provide information on cancer statistics in an effort to reduce the burden of cancer among the U.S. population.

Did You Know? Video Series

Did you know that endometrial cancer is the most common cancer of the female reproductive system?

[Endometrial Cancer](#)

Cancer Stat Fact Sheets

Population statistics for common types of cancer:

All Cancers

View

Fast Stats

Get a customized graph or table by selecting a category:

Cancer Site

View

Latest Releases & Highlights

[Cancer Statistics Review \(CSR\), 1975–2013](#)

Updated 9/12/16



[Information about SEER 2018 Renewal](#)

Updated 8/26/16



[Funding Opportunity: New Informatics Tools and Methods to Enhance U.S. Cancer Surveillance and Research](#)

Released 7/8/16



[SEER Data, 1973–2013](#)

Released 4/15/16



Overview of the SEER Program

- *The Surveillance, Epidemiology, and End Results (SEER) Program of the National Cancer Institute (NCI) is an authoritative source of information on cancer incidence and survival in the United States. SEER currently collects and publishes cancer incidence and survival data from population-based cancer registries covering approximately 30 percent¹ of the US population... SEER coverage includes 26 percent of African Americans, 38 percent of Hispanics, 44 percent of American Indians and Alaska Natives, 50 percent of Asians, and 67 percent of Hawaiian/Pacific Islanders.*

Overview of the SEER Program

- *The SEER Program registries routinely collect data on patient demographics, primary tumor site, tumor morphology and stage at diagnosis, first course of treatment, and follow-up for vital status. The SEER Program is the only comprehensive source of population-based information in the United States that includes stage of cancer at the time of diagnosis and patient survival data... Updated annually and provided as a public service in print and electronic formats, SEER data are used by thousands of researchers, clinicians, public health officials, legislators, policymakers, community groups, and the public.*

SEER Registries



Question 1a. (Group 40)

The table below summarizes results from the PRE-Activity:

Crude and Age-Adjusted* Breast Cancer Incidence Rates by Race

	White Females	Black Females	Ratio
Crude Rates	29.8	19.8	1.51
Age-Adjusted Rates	28.7	25.4	1.13

*Using direct standardization methods using the total population of white and black females as the standard population.

- a. The ratio of crude breast cancer incidence rates comparing white women to black women is **1.51**. This ratio is called the relative risk. Interpret that relative risk. Discuss possible reasons for the difference in crude breast cancer incidence rates.

Question 1b. (Group 40)

The table below summarizes results from the PRE-Activity:

Crude and Age-Adjusted* Breast Cancer Incidence Rates by Race

	White Females	Black Females	Ratio
Crude Rates	29.8	19.8	1.51
Age-Adjusted Rates	28.7	25.4	1.13

*Using direct standardization methods using the total population of white and black females as the standard population.

- b. The ratio of age-adjusted breast cancer incidence rates comparing white women to black women is **1.13**. Interpret this ratio.

Question 2 (Group 40)

How do the crude relative risk and the age-adjusted relative risk compare? Do they differ? If so, how do you explain the difference?

The table below summarizes results from the PRE-Activity:

Crude and Age-Adjusted* Breast Cancer Incidence Rates by Race

	White Females	Black Females	Ratio
Crude Rates	29.8	19.8	1.51
Age-Adjusted Rates	28.7	25.4	1.13

*Using direct standardization methods using the total population of white and black females as the standard population.

Question 2 (Group 40)

How do the crude relative risk and the age-adjusted relative risk compare? Do they differ? If so, how do you explain the difference?

(HINT: Look again at the information in Table 3 from the PRE-Activity.)

TABLE 3:

**Invasive Breast Cancer Incidence Rates in White and Black Females by Age,
United States, SEER, 1998-2002**

Age Group (years)	White Females				Black Females			
	Average Number of Cases per year ¹	Population (In 1,000's) ²	Percent of Total Population	Average annual incidence rate per 100,000 women at risk	Average Number of Cases per year ³	Population (In 1,000's) ⁴	Percent of Total Population	Average annual incidence rate per 100,000 women at risk
0 – 19	0	30,057	26	0	0	6,147	33	0
20 – 29	118	14,081	12	0.8	30	2,722	15	1.1
30 – 39	1,525	16,848	15	9.0	281	2,917	16	9.6
40 – 49	5,630	17,627	15	31.9	795	2,737	15	29.0
50 – 59	8,081	13,334	12	60.6	872	1,740	9	50.1
60 – 69	5,488	9,123	8	60.2	792	1,156	6	68.5
70 – 79	8,300	8,137	7	102.0	615	778	4	79.0
80+	5,023	5,527	5	90.9	316	448	2	70.5
All ages	34,165	114,734	100		3,701	18,645	100	
Average annual incidence rate per 100,000 women at risk (from Table 2):				29.8	19.8			

TABLE 3:

**Invasive Breast Cancer Incidence Rates in White and Black Females by Age,
United States, SEER, 1998-2002**

Age Group (years)	White Females				Black Females			
	Average Number of Cases per year ¹	Population (In 1,000's) ²	Percent of Total Population	Average annual incidence rate per 100,000 women at risk	Average Number of Cases per year ³	Population (In 1,000's) ⁴	Percent of Total Population	Average annual incidence rate per 100,000 women at risk
0 – 19	0	30,057	26	0	0	6,147	33	0
20 – 29	118	14,081	12	0.8	30	2,722	15	1.1
30 – 39	1,525	16,848	15	9.0	281	2,917	16	9.6
40 – 49	5,630	17,627	15	31.9	795	2,737	15	29.0
50 – 59	8,081	13,334	12	60.6	872	1,740	9	50.1
60 – 69	5,488	9,123	8	60.2	792	1,156	6	68.5
70 – 79	8,300	8,137	7	102.0	615	778	4	79.0
80+	5,023	5,527	5	90.9	316	448	2	70.5
All ages	34,165	114,734	100		3,701	18,645	100	
Average annual incidence rate per 100,000 women at risk (from Table 2):				29.8				
					19.8			

Question 3 (Group 26)

Why adjust?

[HINT: which incidence rates (crude or adjusted) are more appropriate for inter-population comparisons – why?] Is it ever inappropriate to adjust? In what circumstances, if any, might you choose to present crude (unadjusted) rates?

Why do we adjust?

- The distribution of age in white and black women is different: there are more older white women than older black women.
- Because older age is a risk factor for breast cancer, the difference we observe in mortality rates between white and black women may not be due to race, but due to the fact that there are more older white women.
- Adjusting for age will allow us to compare breast cancer mortality rates in white and black women *independent* of age.

Choice of Standard Population

In the PRE-Activity, we created a hypothetical standard population by combining (summing) the populations of white and black females.

Other standard populations can be used for direct adjustment. The choice of a standard population for the age adjustment is somewhat arbitrary, although it is usually based on previous studies and desired comparison groups.

Question 4 (Group 26)

Compare the WHO World Standard Population (last column in Table 4) to the Standard Population in Table 3. How do they compare? Given what you learned about direct standardization in the PRE-Activity, how do you expect the age-adjusted breast cancer incidence rates that were adjusted using the combined population (calculated as part of the PRE-Activity) to compare to the age-adjusted breast cancer incidence rates that are adjusted using the WHO World Standard Population? Why?

(To make the comparison easier, data on the two standard populations is summarized for you in the table below).

Age Group (years)	Combined Population Standard (In 1,000's) (%)	WHO World Standard (Million) (%)
0 – 19	36,204 (27%)	346,150 (34%)
20 – 29	16,803 (13%)	161,450 (16%)
30 – 39	19,765 (15%)	147,550 (15%)
40 – 49	20,364 (15%)	126,250 (13%)
50 – 59	15,074 (11%)	99,150 (10%)
60 – 69	10,279 (8%)	66,750 (7%)
70 – 79	8,915 (7%)	37,250 (4%)
80+	5,975 (4%)	15,450 (1%)
Total	133,379	1,000,000

Question 5 (Group 26)

What issues should one consider in selecting a standard population?

Poll

- Pertussis (also known as whooping cough) is a disease that is most likely to occur in children.
- The United States population has proportionately fewer children than the World population.
- *If the crude death rate from pertussis in the United States were age standardized to the World population, what would you expect to happen?*

AGE STANDARDIZATION OF RATES:

A NEW WHO STANDARD

A recent WHO analysis has revealed the need for a new world standard population (see attached table). This has become particularly pertinent given the rapid and continued declines in age-specific mortality rates among the oldest old, and the increasing availability of epidemiological data for higher age groups. There is clearly no conceptual justification for choosing one standard over another, hence the choice is arbitrary. However, choosing a standard population with higher proportions in the younger age groups tends to weight events at these ages disproportionately. Similarly, choosing an older standard does the opposite. Hence, rather than selecting a standard to match the current age-structure of some population(s), the WHO adopted a standard based on the average age-structure of those populations to be compared (the world) over the likely period of time that a new standard will be used (some 25-30 years)

It is important to note, however, that the age standardized death rates based on the new standard are not comparable to previous estimates that are based on some earlier standard(s). However, to facilitate comparative analyses, WHO will disseminate trend analyses of the “complete” historical mortality data using on the new WHO World Standard Population in future editions of the World Health Statistics Annual.

Indirect Standardization

Overview of indirect adjustment

Indirect adjustment enables the calculation of a relative measure of association when the outcome incidence rate is available for an exposed group, but not for a suitable comparison group. The relative measure of mortality calculated when death is the outcome of interest is the standardized mortality ratio (SMR).

The SMR is defined as:

$$\frac{\text{Observed number of deaths over a specified time period}}{\text{Expected number of deaths over a specified time period}} \times 100$$

Recall...from the PRE-Activity...

Table 6:
Standardized Mortality Ratio (SMR) among a hypothetical cohort of miners

Age Category	U.S. All-cause annual mortality rate per 100,000 population		Miner population (number of exposed subjects)		Expected number of deaths	Observed number of deaths among workers
25-34 years	138.6	X	2297	=	3.18	
35-44 years	255.2	X	1723	=	4.40	
45-54 years	542.8	X	1148	=	6.23	
55-64 years	1230.7	X	574	=	7.06	
Total					20.87	26

***World Health Organization (WHO) mortality database)**

Table 6:
Standardized Mortality Ratio (SMR) among a hypothetical cohort of miners

Age Category	U.S. All-cause annual mortality rate per 100,000 population	Miner population (number of exposed subjects)	Expected number of deaths	Observed number of deaths among workers
25-34	1097	197	3.18	
35-44	1223	223	4.40	
45-54 years	1348	48	6.23	
55-64 years	1230.7	574	7.06	
Total			20.87	26

Total expected number of deaths

*World Health Organization (WHO) mortality database)

$$\text{SMR} = \frac{26 \text{ (observed)}}{20.87 \text{ (expected)}} \times 100 = 125$$

Question 6 (Group 02)

Suppose that the SMR for mortality from all causes among former mercury miners is 1.40. Interpret this SMR.

Question 7 (Group 02)

Why calculate an SMR? When might you choose to calculate an SMR instead of use direct adjustment? (HINT: Consider the real example in the following abstract.)

A real example of the SMR

Statin Drugs and Risk of Advanced Prostate Cancer

Elizabeth A. Platz, Michael F. Leitzmann, Kala Visvanathan, Eric B. Rimm, Meir J. Stampfer, Walter C. Willett, Edward Giovannucci

Background: Statins are commonly used cholesterol-lowering drugs that have proapoptotic and antimetastatic activities that could affect cancer risk or progression. Results from previous epidemiologic studies of the association between statin use and cancer have been inconsistent. We investigated the association of statin use with total and advanced prostate cancer, the latter being the most important endpoint to prevent. ***Methods:*** We analyzed data from an ongoing prospec-

A real example of the SMR

Table 3. Relative risk of prostate cancer by duration of use of statin drugs among 34 989 male health professionals, 1990–2002

	Duration of use of statin drugs*			
Prostate cancer	Never†	<5 y	≥5 y	P _{trend} ‡
Total				
No. of cases	2212	241	126	
Person-years at risk	329 357	29 159	18 423	
RR _{age-adjusted} (95% CI)§	1.00 (reference)	1.02 (0.89 to 1.17)	0.83 (0.69 to 1.00)	.30
RR _{multivariable} (95% CI)	1.00 (reference)	1.04 (0.91 to 1.19)	0.85 (0.71 to 1.03)	.49
Organ-confined				
No. of cases	1439	174	101	
Person-years at risk	330 100	29 227	18 448	
RR _{age-adjusted} (95% CI)	1.00 (reference)	1.04 (0.89 to 1.23)	0.85 (0.69 to 1.04)	.59
RR _{multivariable} (95% CI)	1.00 (reference)	1.06 (0.90 to 1.25)	0.87 (0.70 to 1.07)	.82
Advanced				
No. of cases	298	15	3	
Person-years at risk	331 092	29 367	18 535	
RR _{age-adjusted} (95% CI)	1.00 (reference)	0.57 (0.34 to 0.96)	0.25 (0.08 to 0.78)	.002
RR _{multivariable} (95% CI)	1.00 (reference)	0.60 (0.35 to 1.03)	0.26 (0.08 to 0.83)	.003
Metastatic or fatal				
No. of cases	223	10	0¶	
Person-years at risk	331 161	29 372	18 537	
RR _{age-adjusted} (95% CI)	1.00 (reference)	0.49 (0.26 to 0.93)	0.00 (—)	.001
RR _{multivariable} (95% CI)	1.00 (reference)	0.52 (0.27 to 1.00)	0.00 (—)	.002

Zero incident cases of metastatic or fatal prostate cancer among men who had used a statin for ≥5 years

A real example of the SMR

disease decreased with increasing duration of ever use ($P_{\text{trend}} = .003$; Table 3). The relative risk of metastatic and fatal disease combined for fewer than 5 years of ever use compared with never use was 0.52 (95% CI = 0.27 to 1.00); no cases were observed for 5 or more years of ever use ($P_{\text{trend}} = .002$), although eight cases were expected based on the incidence rate of metastatic and fatal disease combined in the never users.

Current use of statin drugs was not associated with risk of

Question 8 (Group 16)

Complete the following table, comparing the direct and indirect methods of adjustment.

	Direct Adjustment	Indirect Adjustment
From what population are the age-specific incidence rates drawn?		
From what population are the age-specific weights drawn?		
What useful comparisons can be made with each method of standardization?		
Under what circumstances are each method of adjustment applied?		
What is an advantage of each method of adjustment?		
What is a limitation of each method of adjustment?		

Complete the following table, comparing the direct and indirect methods of adjustment

	Direct Adjustment	Indirect Adjustment
From what population are the age-specific incidence rates drawn?	<u>Study</u> population	<u>Standard</u> (reference) population
From what population are the age-specific weights drawn?	<u>Standard</u> population	<u>Study</u> population

Complete the following table, comparing the direct and indirect methods of adjustment

	Direct Adjustment	Indirect Adjustment
What useful comparisons can be made with each method of standardization?	Compare trends over time in a given population Compare differences between populations	Compare observed outcome (study population) with expected outcome (standard population) with SMR
Under what circumstances are each method of adjustment applied?	When an imbalance of a risk factor (for the outcome) exists between populations being compared (e.g., age distribution of the populations is different)	When you are interested in how a study group's mortality experience compares to a general population's mortality experience When lacking information on stratum-specific incidence rates in study population

Complete the following table, comparing the direct and indirect methods of adjustment

	Direct Adjustment	Indirect Adjustment
What is an advantage of each method of adjustment?	Allows comparison of populations with different distributions (e.g., gender, age)	Allows calculation of a relative measure of mortality (SMR). If number in study population is small & therefore rates will be unstable
What is a limitation of each method of adjustment?	Cannot compare incidence rates calculated using different standard populations. NOT the true rates of the populations; should only be used for comparison	Relative mortality (SMR) often cannot be compared between study populations.

III. More Practice! (Optional – not required)

Isn't this fun? Want more practice? Need to prove to yourself how the age-adjusted rates compare when using the combined standard population vs. using the WHO standard population? Using the data from Table 5 (below), calculate age-adjusted incidence rates for both racial groups using **the WHO World Standard Population** as the standard population

TABLE 5:
Age-Adjustment of Invasive Breast Cancer Incidence in White and Black Females,
United States, SEER, 1998-2002 Using WHO World Standard Population

Standard Population
("Weights")

Age Group (years)	<i>WHO World Standard Population</i>	White Females		Black Females	
		Average annual incidence per 100,000 women at risk	Expected Number of Cases for White Females	Average annual incidence per 100,000 women at risk	Expected Number of Cases for Black Females
0 – 19	346,150 (34%)	0		0	
20 – 29	161,450 (16%)	0.8	1.29	1.1	1.78
30 – 39	147,550 (15%)	9.0		9.6	
40 – 49	126,250 (13%)	31.9		29.0	
50 – 59	99,150 (10%)	60.6		50.1	
60 – 69	66,750 (7%)	60.2		68.5	
70 – 79	37,250 (4%)	102.0		79.0	
80+	15,450 (1%)	90.9		70.6	
Total:	1,000,000				

Age-adjusted annual incidence rate per 100,000 population:

TABLE 5:
Age-Adjustment of Invasive Breast Cancer Incidence in White and Black Females,
United States, SEER, 1998-2002 Using WHO World Standard Population

**Observed (actual)
rates in white females
(per 100,000 populations)**

Age Group (years)	WHO World Standard Population	White Females		Black Females	
		Average annual incidence per 100,000 women at risk	Expected Number of Cases for White Females	Average annual incidence per 100,000 women at risk	Expected Number of Cases for Black Females
0 – 19	346,150 (34%)	0		0	
20 – 29	161,450 (16%)	0.8	1.29	1.1	1.78
30 – 39	147,550 (15%)	9.0		9.6	
40 – 49	126,250 (13%)	31.9		29.0	
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60 – 69	66,750 (7%)	60.2		68.5	
70 – 79	37,250 (4%)	102.0		79.0	
80+	15,450 (1%)	90.9		70.6	
Total:	1,000,000				

Age-adjusted annual incidence rate per 100,000 population:

TABLE 5:

Age-Adjustment of Invasive Breast Cancer Incidence in White and Black Females,
United States, SEER, 1998-2002 Using WHO World Standard Population

Expected number of cases
for white females when we
apply the observed age-specific
rate to the standard population

White females Aged 20-29 =

$$\frac{0.8}{100,000} \times 161,450 = 1.29$$

Age Group (years)	WHO World Standard Population	White Females		Black Females	
		Average annual incidence per 100,000 women at risk	Expected Number of Cases for White Females	Average annual incidence per 100,000 women at risk	Expected Number of Cases for Black Females
0 – 19	346,150 (34%)	0		0	
20 – 29	161,450 (16%)	0.8	1.29	1.1	1.78
30 – 39	147,550 (15%)	9.0		9.6	
40 – 49	126,250 (13%)	31.9		29.0	
50 – 59	99,150 (10%)	60.6		50.1	
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80+	15,450 (1%)	90.9		70.6	
Total:	1,000,000				

Age-adjusted annual incidence rate per 100,000 population:

TABLE 5:
Age-Adjustment of Invasive Breast Cancer Incidence in White and Black Females,
United States, SEER, 1998-2002 Using WHO World Standard Population

Age Group (years)	WHO World Standard Population	White Females		Black Females	
		Average annual incidence rate per 100,000 women at risk	Expected Number of Cases for White Females	Average annual incidence rate per 100,000 women at risk	Expected Number of Cases for Black Females
0 – 19	346,150	0	0.00	0	0.00
20 – 29	161,450	0.8	1.29	1.1	1.78
30 – 39	147,550	9.0	13.28	9.6	14.16
40 – 49	126,250	31.9	40.27	29.0	36.61
50 – 59	99,150	60.6	60.08	50.1	49.67
60 – 69	66,750	60.2	40.18	68.5	45.72
70 – 79	37,250	102.0	38.00	79.0	29.47
80+	15,450	90.9	14.04	70.6	10.89
Total	1,000,000				

TABLE 5:**Age-Adjustment of Invasive Breast Cancer Incidence in White and Black Females,
United States, SEER, 1998-2002 Using WHO World Standard Population**

Age Group (years)	WHO World Standard Population	White Females		Black Females	
		Average annual incidence rate per 100,000 women at risk	Expected Number of Cases for White Females	Average annual incidence rate per 100,000 women at risk	Expected Number of Cases for Black Females
0 – 19	346,150	0	0.00	0	0.00
20 – 29	161,450	0.8	1.29	1.1	1.78
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50 – 59	99,150	60.6	60.08	50.1	49.67
60 – 69	66,750	60.2	40.18	68.5	45.72
70 – 79	37,250	102.0	38.00	79.0	29.47
80+	15,450	90.9	+ <u>14.04</u>	70.6	+ <u>10.89</u>
Total	1,000,000		207.14		188.30

Total expected number of cases for white and black females

TABLE 5:

**Age-Adjustment of Invasive Breast Cancer Incidence in White and Black Females,
United States, SEER, 1998-2002 Using WHO World Standard Population**

Age Group (years)	WHO World Standard Population	White Females		Black Females	
		Average annual incidence rate per 100,000 women at risk	Expected Number of Cases for White Females	Average annual incidence rate per 100,000 women at risk	Expected Number of Cases for Black Females
0 – 19	346,150	0	0.00	0	0.00
20 – 29	161,450	0.8	1.29	1.1	1.78
30 – 39	147,550	9.0	13.28	9.6	14.16
40 – 49	126,250	31.9	40.27	29.0	36.61
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60 – 69	66,750	60.2	40.18	68.5	45.72
70 – 79	37,250	102.0	38.00	79.0	29.47
80+	15,450	90.9	<u>14.04</u>	70.6	<u>10.89</u>
Total	1,000,000		207.14		188.30

Now let's calculate the age-adjusted rate for each race group

TABLE 5:**Age-Adjustment of Invasive Breast Cancer Incidence in White and Black Females,
United States, SEER, 1998-2002 Using WHO World Standard Population**

Age Group (years)	WHO World Standard Population	White Females	
		Average annual incidence rate per 100,000 women at risk	Expected Number of Cases for White Females
0 – 19	346,150	0	0.00
20 – 29	161,450	0.8	1.29
30 – 39	147,550	9.0	13.28
40 – 49	126,250	31.9	40.27
50 – 59	99,150	60.6	60.08
60 – 69	66,750	60.2	40.18
70 – 79	37,250	102.0	38.00
80+	15,450	90.9	14.04
Total	1,000,000		207.14

Sum of expected # of cases
from each age strata

Total # of people in the
standard population

TABLE 5:

**Age-Adjustment of Invasive Breast Cancer Incidence in White and Black Females,
United States, SEER, 1998-2002 Using WHO World Standard Population**

Age Group (years)	WHO World Standard Population	White Females		
		Average annual incidence rate per 100,000 women at risk	Expected Number of Cases for White Females	
0 – 19	346,150	0	0.00	<p>Sum of expected # of cases from each age strata</p> <hr/> <p>Total # of people in the standard population</p> <p>$\frac{207.14}{1,000,000} = 0.000207$</p>
20 – 29	161,450	0.8	1.29	
30 – 39	147,550	9.0	13.28	
40 – 49	126,250	31.9	40.27	
50 – 59	99,150	60.6	60.08	
60 – 69	66,750	60.2	40.18	
70 – 79	37,250	102.0	38.00	
80+	15,450	90.9	14.04	
Total	1,000,000		207.14	

TABLE 5:
Age-Adjustment of Invasive Breast Cancer Incidence in White and Black Females,
United States, SEER, 1998-2002 Using WHO World Standard Population

Age Group (years)	WHO World Standard Population	White Females			
		Average annual incidence rate per 100,000 women at risk	Expected Number of Cases for White Females		
0 – 19	346,150	0	0.00	<div> <div> <div>207.14</div> <div>1,000,000</div> </div> <div>= 0.000207</div> <div> <div>To express in terms of 100,000 women at risk, multiply through by 100,000</div> <div>0.000207 x 100,000 =</div> <div>20.7 per 100,000 women at risk</div> </div> </div>	
20 – 29	161,450	0.8	1.29		
30 – 39	147,550	9.0	13.28		
40 – 49	126,250	31.9	40.27		
50 – 59	99,150	60.6	60.08		
60 – 69	66,750	60.2	40.18		
70 – 79	37,250	102.0	38.00		
80+	15,450	90.9	<u>14.04</u>		
Total	1,000,000		<u>207.14</u>		

TABLE 5:

**Age-Adjustment of Invasive Breast Cancer Incidence in White and Black Females,
United States, SEER, 1998-2002 Using WHO World Standard Population**

Age Group (years)	WHO World Standard Population	White Females	
		Average annual incidence rate per 100,000 women at risk	Expected Number of Cases for White Females
0 – 19	346,150	0	0.00
20 – 29	161,450	0.8	1.29
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50 – 59	99,150	60.6	60.08
60 – 69	66,750	60.2	40.18
70 – 79	37,250	102.0	38.00
80+	15,450	90.9	<u>14.04</u>
Total	1,000,000		207.14

$$\frac{207.14}{1,000,000} = 0.000207$$

To express in terms of 100,000 women at risk, multiply through by 100,000

$$0.000207 \times 100,000 =$$

20.7 per 100,000 women at risk

TABLE 5:
Age-Adjustment of Invasive Breast Cancer Incidence in White and Black Females,
United States, SEER, 1998-2002 Using WHO World Standard Population

Age Group (years)	WHO World Standard Population	White Females		Black Females	
		Average annual incidence rate per 100,000 women at risk	Expected Number of Cases for White Females	Average annual incidence rate per 100,000 women at risk	Expected Number of Cases for Black Females
0 – 19	346,150	0	0.00	0	0.00
20 – 29	161,450	0.8	1.29	1.1	1.78
30 – 39	147,550	9.0	13.28	9.6	14.16
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70 – 79	37,250	102.0	38.00	79.0	29.47
80+	15,450	90.9	14.04	70.6	10.89
Total	1,000,000		207.14		188.30
Age-adjusted rate per 100,000 women at risk:			<u>20.7</u>		<u>18.8</u>

TABLE 5:

**Age-Adjustment of Invasive Breast Cancer Incidence in White and Black Females,
United States, SEER, 1998-2002 Using WHO World Standard Population**

Age Group (years)	WHO World Standard Population	White Females		Black Females	
		Average annual incidence rate per 100,000 women at risk	Expected Number of Cases for White Females	Average annual incidence rate per 100,000 women at risk	Expected Number of Cases for Black Females
0 – 19	346,150	0	0.00	0	0.00
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70 – 79	37,250	102.0	38.00	79.0	29.47
80+	15,450	90.9	14.04	70.6	10.89
Total	1,000,000		207.14		188.30
			<u>20.7</u>		<u>18.8</u>

Ratio of age-adjusted incidence rates = 20.7 / 18.8 = 1.10

Rates using the standard population:

Crude and Age-Adjusted* Breast Cancer Incidence Rates by Race

	White Females	Black Females	Ratio
Crude Rates	29.8	19.8	1.51
Age-Adjusted Rates	28.7	25.4	1.13

*Using direct standardization methods using the total population of white and black females as the standard population.

Rates using the WHO World Standard Population:

	White Females	Black Females	Ratio
Age-Adjusted Rates	20.7	18.8	1.10

Key Points Direct Adjustment

- Direct adjustment useful for *comparison* of incidence or mortality rates in two populations *independent* of a given factor
- Factor can be age, race, sex, education, etc.
- Adjusted rates are a weighted average of factor-specific rates (where the weight is the number of people in each strata for that factor in a standard population)
- Adjusted rates are not the true (actual) rates in the population
- Adjusted rates vary based on the standard population used (so cannot directly compare rates when a different standard population was used)

2013 Cancer Types Grouped by Race and Ethnicity

Year

2013

▼

All Cancer Sites Combined

▼

Display

By Cancer Type & Race (crude)

▼

Go

For combined data, select '2009-2013' from Year.

Crude Invasive Cancer Incidence Rates and 95% Confidence Intervals by Primary Site and Race and Ethnicity, United States (Table 1.1.2.1MF)

★ Rates are per 100,000 persons.

Cancer Sites	All Races	White	Black
Male and Female Breast Data By Age	74.2	78.0	62.4

2013 Cancer Types Grouped by Race and Ethnicity

Year2013▼

All Cancer Sites Combined▼

Display

By Cancer Type & Race (crude)▼

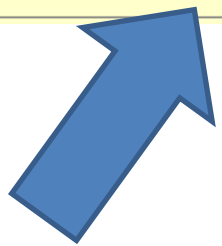
Go

For combined data, select '2009-2013' from Year.

Crude Invasive Cancer Incidence Rates and 95% Confidence Intervals by Primary Site and Race and Ethnicity, United States (Table 1.1.2.1MF)

★ Rates are per 100,000 persons.

Cancer Sites	All Races	White	Black
Male and Female Breast†† Data By Age	74.2	78.0	62.4



Female Breast. Invasive Cancer Incidence Rates and 95% Confidence Intervals by Age and Race and Ethnicity, United States (Table 3.7.1.1F)

★ Rates are per 100,000 persons.

Age	All Races	White	Black
<1	~	~	~
1-4	~	~	~
5-9	~	~	~
10-14	~	~	~
15-19	~	~	~
20-24	1.6	1.4	2.4
25-29	9.6	8.9	12.5
30-34	27.6	26.8	31.1
35-39	62.0	59.9	70.6
40-44	121.6	122.2	118.2
45-49	187.4	188.1	180.4
50-54	221.9	220.3	231.6
55-59	260.3	260.4	270.7
60-64	329.5	332.4	332.0
65-69	422.5	428.7	399.5
70-74	449.9	458.9	417.4
75-79	450.9	459.9	436.0
80-84	405.3	414.8	368.0
85+	325.9	323.7	358.0

<https://nccd.cdc.gov/uscs/cancersbyageandrace.aspx?Gender=Female&Count=false&Population=false&Data Type=Incidence&Rate Type=Crude Type&Cancer Site=Female%20Breast&Year=2013&Site=Female%20Breast&Survey InstanceID=1>

2013 Cancer Types Grouped by Race and Ethnicity

Year2013

All Cancer Sites Combined

DisplayBy Cancer Type & Race (age-adjusted)

Go

For combined data, select '2009-2013' from Year.

Age-Adjusted Invasive Cancer Incidence Rates and 95% Confidence Intervals by Primary Site and Race and Ethnicity, United States (Table 1.1.1.1MF)

★ Rates are per 100,000 persons and are age-adjusted to the 2000 U.S. standard population (19 age groups - Census P25-1130).

Cancer Sites	All Races	White	Black
Male and Female Breast Data By Age	66.3	66.0	70.1



CRUDE RATES:

Cancer Sites	All Races	White	Black
Male and Female Breast Data By Age	74.2	78.0	62.4

AGE-ADJUSTED RATES:

Cancer Sites	All Races	White	Black
Male and Female Breast Data By Age	66.3	66.0	70.1



CRUDE RATES:

Cancer Sites	All Races	White	Black
Male and Female Breast±± Data By Age	74.2	78.0	62.4

Crude rate ratio = $\frac{78}{62.4}$ = 1.25

AGE-ADJUSTED RATES:

Cancer Sites	All Races	White	Black
Male and Female Breast±± Data By Age	66.3	66.0	70.1

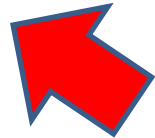
Age-adjusted rate ratio = $\frac{66}{70.1}$ = 0.94



CRUDE RATES:

Cancer Sites	All Races	White	Black
Male and Female Breast Data By Age	74.2	78.0	62.4

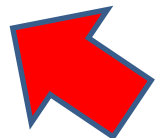
Crude rate ratio = $\frac{78}{62.4} = 1.25$

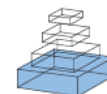


AGE-ADJUSTED RATES:

Cancer Sites	All Races	White	Black
Male and Female Breast Data By Age	66.3	66.0	70.1

Age-adjusted rate ratio = $\frac{66}{70.1} = 0.94$





Health disparities and cancer: racial disparities in cancer mortality in the United States, 2000–2010

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Declining cancer incidence and mortality rates in the United States (U.S.) have continued through the first decade of the twenty-first century. Reductions in tobacco use, greater uptake of prevention measures, adoption of early detection methods, and improved treatments have resulted in improved outcomes for both men and women. However, Black Americans continue to have the higher cancer mortality rates and shorter survival times. This review discusses and compares the cancer mortality rates and mortality trends for Blacks and Whites. The complex relationship between socioeconomic status and race and its contribution to racial cancer disparities is discussed. Based on current trends and the potential and limitations of the patient protection and affordable care act with its mandate to reduce health care inequities, future trends, and challenges in cancer mortality disparities in the U.S. are explored.

Keywords: cancer mortality, socioeconomic status, race/ethnicity, disparities, affordable care act

Wider Racial Gap Found in Cervical Cancer Deaths

By JAN HOFFMAN JAN. 23, 2017

Cervical cancer: Mortality rates underestimated, especially among black women

■ Taking into account hysterectomies in the analysis of cancer mortality has led to these rates being underestimated.



By Léa Surugue

January 23, 2017 05:00 GMT

International Business Times

HEALTHY LIVING

We've Been Seriously Underestimating Cervical Cancer Risks

And new research indicates that black women face an even higher risk than white women.

THE HUFFINGTON POST

https://www.nytimes.com/2017/01/23/health/cervical-cancer-united-states-death-toll.html?_r=0

<http://www.ibtimes.co.uk/cervical-cancer-mortality-rates-underestimated-especially-among-black-women-1602272>

http://www.huffingtonpost.com/entry/weve-been-seriously-underestimating-cervical-cancer-risks_us_58865888e4b096b4a233b9ca

Hysterectomy-Corrected Cervical Cancer Mortality Rates Reveal a Larger Racial Disparity in the United States

Anna L. Beavis, MD, MPH¹; Patti E. Gravitt, PhD²; and Anne F. Rositch, PhD, MSPH³



BACKGROUND: The objectives of this study were to determine the age-standardized and age-specific annual US cervical cancer mortality rates after correction for the prevalence of hysterectomy and to evaluate disparities by age and race. **METHODS:** Estimates for deaths due to cervical cancer stratified by age, state, year, and race were derived from the National Center for Health Statistics county mortality data (2000-2012). Equivalently stratified data on the prevalence of hysterectomy for women 20 years old or older from the Behavioral Risk Factor Surveillance System survey were used to remove women who were not at risk from the denominator. Age-specific and age-standardized mortality rates were computed, and trends in mortality rates were analyzed with Joinpoint regression. **RESULTS:** Age-standardized rates were higher for both races after correction. For black women, the corrected mortality rate was 10.1 per 100,000 (95% confidence interval [CI], 9.6-10.6), whereas the uncorrected rate was 5.7 per 100,000 (95% CI, 5.5-6.0). The corrected rate for white women was 4.7 per 100,000 (95% CI, 4.6-4.8), whereas the uncorrected rate was 3.2 per 100,000 (95% CI, 3.1-3.2). Without the correction, the disparity in mortality between races was underestimated by 44%. Black women who were 85 years old or older had the highest corrected rate: 37.2 deaths per 100,000. A trend analysis of corrected rates demonstrated that white women's rates decreased at 0.8% per year, whereas the annual decrease for black women was 3.6% ($P < .05$). **CONCLUSIONS:** A correction for hysterectomy has revealed that cervical cancer mortality rates are underestimated, particularly in black women. The highest rates are seen in the oldest black women, and public health efforts should focus on appropriate screening and adequate treatment in this population. *Cancer* 2017;000:000-000. © 2017 American Cancer Society.

KEYWORDS: Behavioral Risk Factor Surveillance System, cervical cancer, disparities, hysterectomy, mortality, Surveillance, Epidemiology, and End Results (SEER).

Key Concepts

In the PRE-Activity and Activity, we:

1. Calculated and interpreted crude rates of mortality
2. Performed direct and indirect adjustment of incidence rates and interpreted adjusted rates
3. Calculated and interpreted Standardized Mortality Ratios (SMRs)
4. Described advantages, limitations, and appropriate use of adjusted rates

Thank you to our presenters!

Questions?