PARTICIPANT WORKBOOK

analysis

Descriptive analysis

univariable

bivariable

design

justify

stratify

confounding

statistical

software

variables

Measures of association

assess

calculate

confidence intervals

plan

table

shells

testing

Analyzing and Interpreting Large Datasets

Created: 2013

Analyzing and Interpreting Large Datasets. Atlanta, GA: Centers for Disease Control and Prevention (CDC), 2013.

Table Of Contents

Introduction

LEARNING OBJECTIVES

At the end of this module, you will be able to:
- conduct and interpret descriptive analysis and analytic epidemiology,
- summarize your findings, and
- prepare a report.

ESTIMATED COMPLETION TIME

The workbook should take approximately 18 hours to complete.

TARGET AUDIENCE

The workbook is designed for FETP fellows who specialize in NCDs; however, you can also complete the module if you are working in infectious disease.

PRE-WORK AND PREREQUISITES

Before participating in this training module, you must complete training in:
- Basic epidemiology and surveillance
- Basic analysis
- Statistical software program (your country is using)
- Creating an analysis plan
- Managing data (creating a data dictionary and cleaning data)

ABOUT THIS WORKBOOK AND THE ACTIVITY WORKBOOK

The format of the **Participant Workbook** consists of one overview section and three additional sections. You will read information about analyzing and interpreting large datasets and complete six exercises to practice the skills and knowledge learned. At the end of the training module, you will complete a skill assessment which combines all skills taught.

ICON GLOSSARY

The following icons will be used in this workbook:

Image Type	Image Meaning
Activity Icon	**Pencil** - an activity, exercise, assessment or case study that participants complete
Stop Icon	**Stop** - a point at which you should consult a mentor or wait for the facilitator for further locally relevant information about the topic
Tip Icon	**Tip –** key idea to note and remember
Resource Icon	**Resource / Website Icon**- a resource or website that may provide further information on a given topic

ACKNOWLEDGEMENTS

Many thanks to the following colleagues from the Centers for Disease Control and Prevention for providing detailed feedback and guidance:

- Fleetwood Loustalot, PhD, FNP, Andrea Neiman, MPH, PhD (Division for Heart Disease and Stroke Prevention) and Edward Gregg, PhD (Division of Diabetes Translation), for creating the hypertension case study.

- Lina Balluz, Sc.D., MPH, from the Office of Surveillance, Epidemiology and Laboratory, Division of Behavioral Surveillance

- Richard Dicker, MD, MS, from the Centers for Global Health, Division of Public Health Systems Workforce Development

- Italia Rolle, PhD, RD, Office on Smoking and Health, Global Tobacco Control Branch

- Roberto (Felipe) Lobelo, MD, PhD, Division of Diabetes Translation

Section 1: Overview

INTRODUCTION TO DATA ANALYSIS

In the *Creating an Analysis Plan* module, you learned how to create table shells to use when you analyze data. The *Managing Data* module explained how to create a data dictionary to use during data analysis and how to clean the data. In this module, you will learn how to conduct descriptive analysis and analytic epidemiology and how to interpret the findings.

Creating an Analysis Plan	Managing Data	Analyzing and Interpreting Large Datasets	→	Data into Action

If you look at the "five W's of journalism" below, descriptive and analytic epidemiology can help answer the following:

- What → Clinical
- Who → Person
- Where → Place
- When → Time

Descriptive Epidemiology (Distribution)

- Why/How → Cause, mode of transmission, risk factors

Analytic Epidemiology (Determinants)

STEPS IN ANALYZING NCD DATA

When analyzing data, you will begin with simple analysis (descriptive) and move to the complex.

As you recall, the main steps in analyzing large datasets is as follows:

1. **Conduct basic descriptive analysis**:
   Describe the sample population by person, place, and time characteristics. Summarize variables using population-level frequencies, and calculate stratified frequencies across important sub-groups (if any).

   The purpose of descriptive analysis is to characterize the study participants by age and sex distribution, where they are from, by distribution of risk factors, etc. You will calculate frequency-of-disease measures, such as prevalence.

2. **Compute and interpret measures of association:**
   Determine the strength of association between an exposure variable and an outcome variable. If there are two or more populations, consider comparing their demographic data to determine whether they were different before the study/analysis was conducted.

3. **Conduct confidence intervals and/or statistical significance testing:**
   Use t-tests for continuous data and chi-square for non-continuous data.

4. **Assess for effect measure modifcation:**
   A situation in which a third variable exhibiting statistical interaction by virtue of its being antecedent in the causal process under study.

5. **Assess the effect of potential confounders:**
   A situation in which a measure of the effect of an exposure on risk is distorted because of the association of exposure with other factors that influencethe oucome under study

KEY CONCEPTS

In non-communicable diseases, we tend to use large datasets and conduct secondary data analysis. The size of the database depends on the number of records (persons) and variables. Commonly used datasets include:

- Vital registration (number of deaths, cause of death for a country)
- Demographic health surveys (DHS) used in low and middle income countries
- WHO STEPS survey
- The National Health and Nutritional Examination survey (NHANES -U.S.)

- The Behavioral Risk Factor Surveillance System (BRFSS - U.S., Jordan)

The databases typically are representative of a population either through a census (all persons included) or a sample (number of people selected to represent the population). For example, NHANES 1999-2000 interviewed 9,965 persons in the United States and the database includes hundreds of variables. Before attempting data analysis for large datasets, it is very important you locate the survey sampling methodology, questionnaire, data variable dictionary and any other supporting documentation.

Activity

Activity #1:
Go to the NHANES links below and describe what key information they provide. Write your response in the space below. Then check your response with Appendix A.

1. http://www.cdc.gov/nchs/nhanes/nhanes1999-2000/questexam99_00.htm;
2. http://www.cdc.gov/nchs/data/nhanes/nhanes_03_04/nhanes_analytic _guidelines_dec_2005.pdf

Once you have your data, determine if the data include:

- All persons in the population of interest (census)
- A sample representative of the population (e.g. probability simple random sample, random sample or cluster sampling)
- A sample not representative of the population (e.g. non-probability convenience sampling or purposive sampling)

Knowing this information will inform the statistics you will use during data analysis.

Survey Commands

For samples that are from complex survey designs, you must use the appropriate survey commands and not the regular commands in your statistical survey software.

Before setting these commands, always look at the raw data before applying the survey commands using the non-survey commands. This would be the first step before performing univariable analysis to view the data. In addition, for complex survey designs, you must set the weight command, strata, and psu (primary sampling unit) commands when computing representative estimates of the variables.

After examining the data and finalizing your data analysis plan, proceed with using the survey commands to obtain estimates that account for the complex survey design and weighting. These estimates, although from a sample, are now representative of the population that was sampled.

Population Parameters and Sample Statistics

The following table is helpful when we talk about population parameters and sample statistics. The measures you use depend on the type of data you are analyzing.

Table 1: Population Parameters and Sample Statistics[1]

Population parameter	Sample statistic
N: Number of observations in the population	n: Number of observations in the sample
N_i: Number of observations in population i	n_i: Number of observations in sample i
P: Proportion of successes in population	p: Proportion of successes in sample
P_i: Proportion of successes in population i	p_i: Proportion of successes in sample i
μ: Population mean	x: Sample estimate of population mean
$μ_i$: Mean of population i	x_i: Sample estimate of $μ_i$
σ: Population standard deviation	s: Sample estimate of σ
$σ_p$: Standard deviation of p	SE_p: Standard error of p
$σ_x$: Standard deviation of x	SE_x: Standard error of x

Let us examine standard error and standard deviation in more detail.

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[1] *Taken from: http://stattrek.com/estimation/standard-error.aspx.*

Standard Deviation

The standard deviation reflects the variability of the distribution of a continuous variable. To estimate the standard deviation:

1. Calculate the **weighted** sum of the squares of the differences of the observations in a simple random sample from the sample mean

2. Divide the result obtained in #1 by an **estimate of the population size** minus 1

3. Take the square root of the result obtained in #2

Standard Error of the Mean

The standard error of the mean is an indication of how well the mean of a sample estimates the mean of a population. To estimate the standard error, divide the estimated standard deviation by the square root of the sample size.

@

Resource

For an example of standard error:
http://www.bmj.com/content/343/bmj.d8010


Application of Weights

In addition to population parameters and survey statistics, another important concept you need to know when using complex survey data is the **use of weights**.

Use weights to account for complex survey design (including oversampling), survey non-response, and post-stratification. When a sample is weighted, it is representative of the population. A sample weight is assigned to each sample person. It is a measure of the number of people in the population represented by that sample person. Fortunately, there are several software packages for survey analysis that compute sampling errors correctly for weighted survey estimates from complex sample designs.

It is important to use weighted data when you need to generalize the findings from your study to the whole population. . Weighting is a technique usually done by statistician to assure representation of cetain groups in the sample. It is a process that removes non-response and non -coverage bias.

If you look at the graph below, you will see that the unweighted interview sample from NHANES 1999-2002 is composed of 47% non-Hispanic white and Other participants, 25% non-Hispanic Black participants, and 28% Mexican American participants. The US population in 2000, in contrast, was 78% non-Hispanic white and Other, 13% non-Hispanic black, and 9% Mexican American. Therefore, unweighted estimates for any survey item associated with race/ethnicity would be biased if weights were not used, because estimates would not be representative of the actual U.S. civilian noninstitutionalized population.

Figure 1: NHANES 1999-2002, Race-Ethnicity Distribution
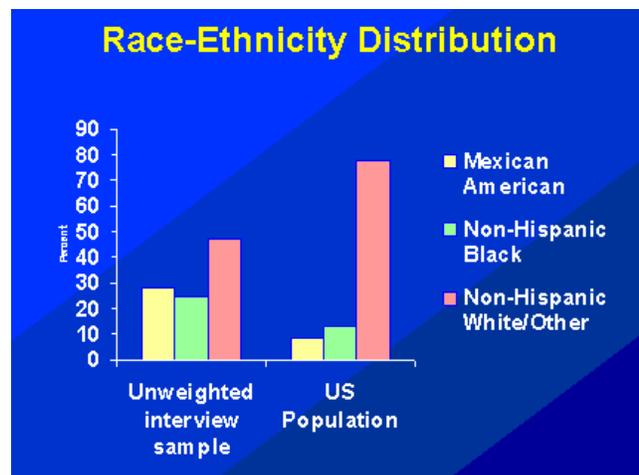
Stop

Let the facilitator or mentor know you are ready for the group discussion.

Section 2: Descriptive Analysis

OVERVIEW OF DESCRIPTIVE ANALYSIS

Descriptive analysis involves computing frequency distributions (also known as univariable analysis) and simple cross-tabulations (bivariable analysis). This helps you characterize the population under study and understand the occurrence of outcomes and exposures by person, place, and time characteristics.

The objectives of descriptive analysis are to:
- Describe and assess the health status of a population
- Evaluate patterns of disease and allow comparisons over time and place
- Provide a basis for planning and evaluation of services
- Identify problems to be studied by analytic methods, including testing hypotheses related to those problems

Conducting univariable data analysis involves analyzing one variable at a time in a dataset, such as sex, age, or education. You can assess the range, mean, median and mode of each continuous variable and the range and frequency distribution of discrete variables. You will then examine the prevalence by demographics (e.g., age, marital status, location).

Conducting bivariable analysis involves analyzing the relationship between two variables. You will compare the outcome populations of interest in terms of demographic characteristics (e.g., comparing differences in age, gender, ethnicity, income, or location between cases and controls).

Depending on the questions you need answered, descriptive analysis can reveal information related to the factors of person, place, and time in the population of interest such as:
- The characteristics of the population, such as age, gender, where they live (e.g., urban or rural)
- The prevalence of the population affected by the disease, outcomes, or exposures
- The prevalence of risk factors among the population
- When the events of interest occurred, such as monthly or yearly

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Tip

Remember to use the table shells you created in your analysis plan when describing the characteristics from descriptive analysis.

For this section of the module, you will practice conducting descriptive analysis for the hypertension case study and your own country data.

UNIVARIABLE ANALYSIS

When you cleaned your dataset, you looked at key descriptive variables (such as age, sex, marital status, education level, and occupation). Now you will examine the results and organize them into tables and graphs so that you can compare the variables.

Run Frequencies

A frequency distribution shows the number of observations located in each category of a categorical variable (e.g., sex, level of education, marital status). For continuous variables, such as age, frequencies are displayed for values that appear at least one time in the dataset.

Frequency distributions provide an organized picture of the data, and allow you to see how individual scores are distributed on a specified scale of measurement. For instance, a frequency distribution shows whether the data values are generally high or low, and whether they are concentrated in one area or spread out across the entire measurement scale.

You can structure frequency distributions as tables or graphs, but either should show the original measurement scale and the frequencies associated with each category. Datasets with very large sample sizes can potentially have a long list of different values for continuous variables; therefore, it is recommended that you use a graphic format to check the distribution for continuous variables, and either frequency tables or graphic forms for nominal or interval variables.

For large datasets, analyze continuous variables (such as age) by determining the mean, median, standard deviation and interquartile range (IQR). Analyze nominal variables (such as gender) by using percentages.

Table 1 has been adapted from the Jordan BRFSS, 2004 to show frequency distribution by education level:

Table 2: Distribution by Education (Jordan BRFSS, 2004)

Education	All Participants N = 3342	
	F	%
Never attended school	491	14.7
Primary school	936	28.0
Secondary or technical school	1481	44.3
University or more	434	13.0

Activity

Activity #2:
Discuss with a colleague the conclusions you would make based on Table 2. Check your answers with those in Appendix A.

Creating Intervals or Categories

The mean and median of continuous variables provide useful information; however, there are times when you may want to group the continuous variable data into logical intervals or categories. You will then compare the frequency distributions of the new categories.

Consider these guidelines when creating intervals:
- Create intervals that are mutually exclusive and include all of the data
- Use a relatively large number of narrow intervals initially. You can combine intervals again after you look carefully at the distributions.
- Use natural or biologically meaningful intervals when possible. For example, look at standard or frequently used age groupings when considering age.
- Create a category for unknowns if relevant

In the example below (table 3), the frequency distribution yielded a long list of values.

Table 3: Distribution by Age (Sample Data)[2]

Age	F	%
18	84	18.3
19	113	24.6
20	88	19.1
21	45	9.8
22	42	9.1
23	13	2.8
24	17	3.7
25	13	2.8
26	5	1.1
27	3	0.7
28	5	1.1
29	6	1.3
30	3	0.7
31	3	0.7
32	5	1.1
33	4	0.9

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[2] *Blaikie, N.(2003). Analyzing Quantitative Data. London: Sage.*

Age	F	%
34	3	0.7
36	1	0.2
37	3	0.7
38	2	0.4
42	1	0.2
46	1	0.2
N	460	100.0

If there is no clear natural or standard interval, you can:
- Divide the data into groups of equal size
- Base the intervals on mean and standard deviation
- Divide the range into equal class intervals

The example in table 4 shows how the data was grouped in five categories of relatively even distribution.

Table 4: Distribution by Age in Five Categories (Students)[3]

Age	F	%
18	84	18.3
19	113	24.6
20	88	19.1
21-22	87	18.9
23+	88	19.1
N	460	100.0

Eliminating Responses
Sometimes, you have to eliminate certain responses in your analysis to create a two-part response. For example, a question originally coded to include "Yes", "No", and "Don't Know" responses is a three-part response. If you have very few "Don't Know" responses, you may choose to eliminate them. You should be very careful when eliminating responses because you will lose information. If there are a large number of a certain response (such as "Don't Know"), then it would not be appropriate to eliminate that information.

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[3] *Blaikie, N.(2003). Analyzing Quantitative Data. London: Sage.*

Tip

If there is only a very small number of responses, then eliminating the information can be an appropriate choice to improve your interpretation of the variable.

Prevalence

Recall that **prevalence** is a proportion that expresses the presence of a disease or other characteristic at a specific point in time. To calculate the prevalence of a disease or other health outcome, divide the number of cases in a population at a specific time by the total population at that period of time. Similarly, to calculate the prevalence of a risk factor such as smoking or other characteristic, divide the number of people with that risk factor at a specific time by the total population at that period of time.

For example, one of the research questions for the 2004 Jordan Behavioral Risk Factor Survey was: **To determine prevalence of frequent mental distress (FMD) (a proxy for mental illness), using number of mentally unhealthy days among adult Jordanians.**

- Health Related Quality of Life question:
  "Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?"

- Frequent Mental Distress was defined as $\geq$14 days of mental health not good.
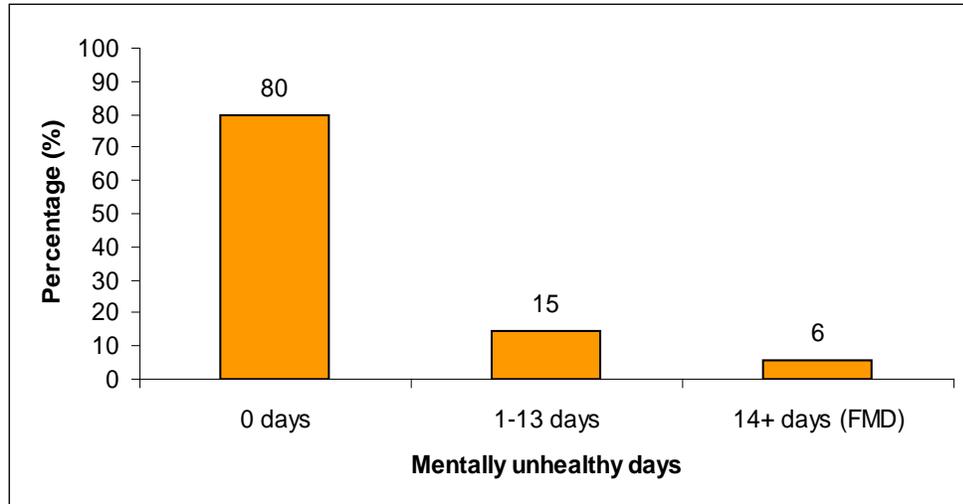
Activity

Activity #3:
Discuss with a colleague the conclusions you would make based on Figure 2 below. Then check your responses with those in Appendix A.

Figure 2: Percent Mentally Unhealthy Days (out of the past 30 days): Jordan 2004

To analyze the data by certain demographics, such as age, education and income, you will conduct bivariable analysis (discussed in the next section).

Stop

Let the facilitator or mentor know you are ready for a group discussion. He or she will review key concepts of conducting univariable analysis before you complete Exercise 1.

KEY POINTS TO REMEMBER

Use the space below to record any key points from the facilitator-led discussion:

Practice Exercise #1 (Estimated time: 1 hour)

Background:
For this exercise, you will work individually, in pairs or in a small group to compute univariable analysis.

Instructions:
1. Read figure 3

2. Answer the questions that follow

3. Ask a facilitator to review your work

Figure 3: Hypertension case study

The initial analysis should provide you with a general description of the sample characteristics. Exploring the data may include assessing mean, median, range, minimum and maximum values, and other descriptive characteristics. As the data are from a complex design, you would want to assess crude estimates and weighted estimates. Revisiting the research questions are appropriate. If you are describing the distribution and burden of hypertension in County X, consider the variables to select, and what variables may influence your outcome of interest.

1. Assess the variables in the tables below using descriptive statistics (e.g., frequency, mean, median, standard deviation, minimum, maximum). Consider assessing variables graphically (e.g., histogram, scatterplot, etc).

Variable:	Age (years)
Frequency	
Mean	
Median	
Standard deviation	
Minimum	
Maximum	

Variable:	Systolic blood pressure (mmHg) (1st measure)
Frequency	
Mean	
Median	
Standard deviation	
Minimum	
Maximum	

Variable:	Body Mass Index (kg/m2)
Frequency	
Mean	
Median	
Standard deviation	
Minimum	
Maximum	

2. The dataset that you are using was derived using a complex design, and the data are nationally representative of the civilian population in Country X. Sample weights and sample design variables are frequently needed when analyzing data from a complex design survey. Compare crude (i.e., unweighted) and weighted estimates. **Examine the crude (i.e., unweighted) and weighted estimates for variables in the table below and fill in the answers.**

	Unweighted estimate	Standard Deviation	Weighted estimate (95% CI)	Standard Error
Age (mean)				
Male (%)				
Non-Hispanic white				
Systolic blood pressure (mmHg)				
Body Mass Index (kg/m2) (mean)				

Hypertension (%)				

Optional Question:

3. After you have explored the data, you can set up the first table using adjusted data. It is important to provide an adequate description of your sample and include relevant health and health outcome variables. Consider what variables would be presented in a descriptive table in a manuscript. (*Note*: Review questionnaire for available variables).

   What variables would you include in the table below? After you have selected the variables, perform the descriptive analysis and add the information to the table.

	N	Percent	Standard Error

BIVARIABLE ANALYSIS

As you recall, bivariable analysis involves either:

- Establishing similarities or differences of the demographic characteristics (e.g., age, gender, ethnicity, income, or location) and/or exposure characteristics (e.g., drug use, environmental exposure, diet, exposure to other ill persons, family history of disease)
- Describing patterns or connections between such characteristics

Simple Cross-Tabulations

A cross-tabulation (cross-tab) is a two or more dimensional table that records the number (frequency) of respondents that have the specific characteristics described in the cells of the table. You can use cross-tabs to visually assess whether independent and dependent variables might be related. You can also use cross-tabs to find out if demographic variables such as sex and age are related to the second variable.

Use cross-tabs when you want:

- To look at relationships among two or three variables

- A descriptive statistical measure to determine whether differences among groups are large enough to indicate some sort of relationship among variables

Refer to an example of cross-tabs in Table 5 below.

Table 5: (Adapted from) Chronic Disease Risk Factors Among Participants in Medical Examination, by Selected Demographic Characteristics, Behavioral Risk factor Surveillance System, Jordan, 2004.

	Sex		Total % (SE)
	Male % (SE)	Female % (SE)	
Diabetes			
Self-reported	9.8 (1.95)	8.6 (1.36)	9.0 (1.16)
Measured	17.7 (2.38)	16.5 (1.38)	16.9 (1.24)

Activity

Activity #4:
Discuss with a colleague the conclusions you would make based on Table 5. Then check your responses to the possible answers in Appendix A.

Let's look at another example from the same Jordan BRFSS from 2004. In table 6 below, we are examining the relationship between age groups and high blood pressure (self-reported and measured).

Table 6. (Adapted from) Chronic Disease Risk Factors Among Participants in Medical Examination, by Selected Demographic Characteristics, Behavioral Risk Factor Surveillance System, Jordan, 2004.

	Age Groups				
	18-34 % (SE)	**35-49 % (SE)**	**50-64 % (SE)**	**≥ 65 % (SE)**	**Total**
High Blood Pressure					
Self-reported	2.5 (.095)	11.3 (1.87)	35.9 (4.05)	34.1 (6.82)	15.2 (1.52)
Measured	9.4 (2.30)	28.3 (3.53)	55.2 (3.78)	61.4 (5.52)	30.2 (1.83)

Activity

Activity #5:

Discuss with a colleague the conclusions you would make based on table 6. For example, which age group was more likely to self-report high blood pressure? What is the percentage of participants in the medical evaluation with undiagnosed high blood pressure? How does the total prevalence of high blood pressure based on measurements compare with the prevalence of self-reported cases? Then check your responses to the possible answers in Appendix A.

Tip

Cross tabs are **not** sufficient to:
- Show the strength or actual size of the relationship among two or more variables
- Test a hypothesis about the relationship between two or more variables

Instead, use analytic epidemiology (explained in the section 4).

Analyzing Demographic Characteristics

Using bivariable analysis allows you to detect similarities or differences of the demographic characteristics (e.g., age, gender, ethnicity, income, or location).

In the Jordan study of the prevalence of frequent mental distress, it was found that 6% of Jordanian adults would be classified as experiencing frequent mental distress. The next few graphs show the prevalence of frequent mental distress by age, education, and income.
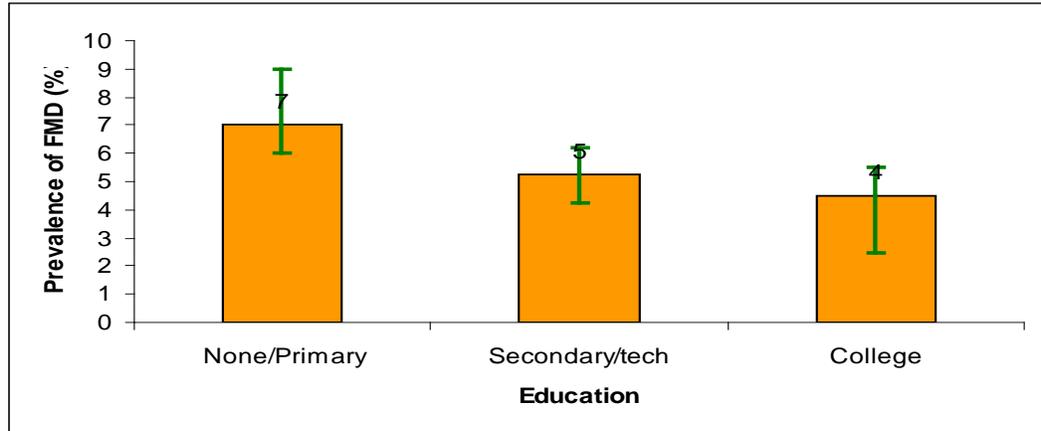
Figure 4. Prevalence of Frequent Mental Distress by Age: Jordan 2004
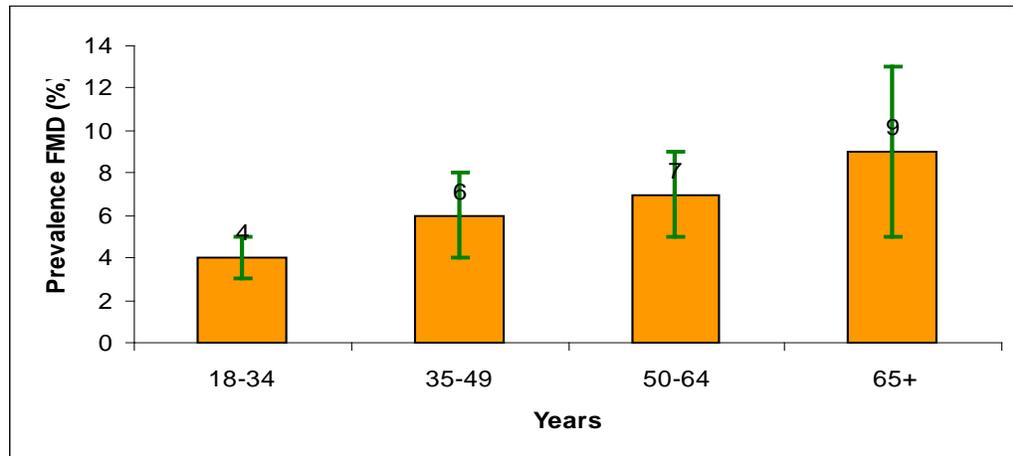
Activity

Activity #6:

Discuss with a colleague what figure 4 shows about the relationship between frequent mental distress and age. Then check your responses to the possible answers in Appendix A. To further analyze the data by demographics, the data was analyzed to determine the prevalence by **education**, as shown in the figure 5 below.

Figure 5. Prevalence of Frequent Mental Distress by Education: Jordan 2004
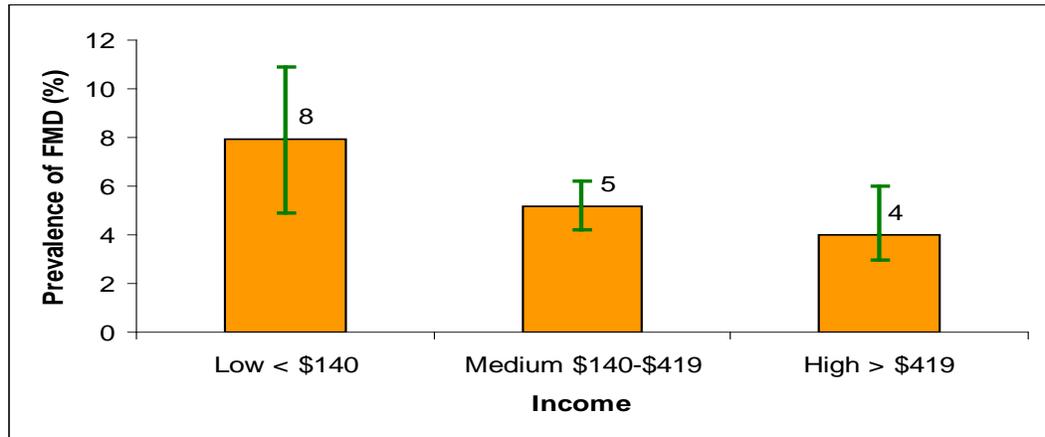

Activity

Activity #7:
Discuss with a colleague what figure 5 shows about the relationship between frequent mental distress and education. Then check your responses to the possible answers in Appendix A.

Figure 6: Prevalence of Frequent Mental Distress by Income: Jordan 2004

Activity

Activity #8:
Discuss with a colleague what figure 6 shows about the relationship between frequent mental distress and income. Then check your responses to the possible answers in Appendix A.

Let the facilitator or mentor know you are ready for a group discussion. He or she will review key concepts of conducting bivariable analysis before you complete Exercise 2.

Use the space below to record any key points from the facilitator-led discussion:

Activity

Practice Exercise #2 (Estimated Time: 45 Minutes)

Background:
For this exercise, you will work individually, in pairs or in a small group to compute bivariable analysis.

Instructions:
1. Read figure 7

2. Answer the questions that follow

3. Ask a facilitator to review your work

Figure 7: Hypertension case study

The prior exercise explored the distribution of the data. Next, you will assess comparisons among variables of interest. Consider assessing hypertension status by descriptive characteristics. Does hypertension status vary among different demographic groups? Identified

differences in descriptive comparisons will inform decisions in later analyses and may eventually aid in the direction of public health resources.

1. How would you compare your health outcome of interest (hypertension) by descriptive characteristics to assess for patterns in the data.

Hypertension by Sex

	Hypertension					
Sex	Yes			No		
	N*	%	95% CI	N*	%	95% CI
Male						
Female						

*Unweighted N

Hypertension by Racial/Ethnic Group

	Hypertension					
Race	Yes			No		
	N*	%	95% CI	N*	%	95% CI
Non-Hispanic White						
Non-Hispanic Black						
Hispanic						

*Unweighted N

**Hypertension by Age Group
(Alternate table view)**

	Hypertension		
Age (group)	Yes		
	N*	%	95% CI
≤34 years			
35-54 years			
55-64 years			
>65 years			

*Unweighted N

Section 3: Analytic Epidemiology

OVERVIEW

In the last section, you learned that one primary purpose of conducting descriptive analysis is to *generate* hypotheses by revealing the burden and distribution of health events by person, place and time. In contrast, you will conduct analytic epidemiology to *test* hypotheses by quantifying the strength of association between a suspected risk factor and the health event.

CONCEPTS OF ASSOCIATION

A measure of association quantifies the degree of statistical connection between two variables (the "exposure" and the outcome). In this context, "exposure" refers to an external exposure such as radiation or medication, and also behavior, genetic make-up or any other characteristic of a person. In this section, we assume that the health outcome of interest is measured as a binary variable, i.e., present or absent.

When we measure the health outcome in terms of incidence (new cases), measures of association in epidemiology include the risk ratio[4], rate ratio[5], odds ratio (OR), risk difference, and rate difference. You should already be familiar with these measures of association and their applications from your introductory epidemiology courses. You can use these measures to evaluate associations between exposures and non-communicable health outcomes for which incidence can be measured, such as acute myocardial infarction.

For many chronic diseases, date of onset is unknown and burden of disease is important. Therefore, you are more likely to measure prevalence rather than incidence. If you measure the outcome in terms of prevalence, the corresponding measures of association are the **prevalence ratio** and the **prevalence odds ratio**.

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[4] *Risk ratio is also known as the relative risk or cumulative incidence ratio.*
[5] *Rate ratio is also known as incidence density ratio*

Prevalence ratio (PR)

The prevalence ratio (PR), usually from a cross-sectional study, is similar to the risk (cumulative incidence) ratio from a cohort study. The prevalence ratio reflects how much more or less common (prevalent) is the health outcome among people with the exposure than among those without the exposure. Refer to the example below.

	With disease	**Without disease**	
Exposed	A	B	a+b
Unexposed	C	D	c+d
	a+c	b+d	

$$PR = \frac{\text{Prevalence of disease in exposed}}{\text{Prevalence of disease in unexposed}} = \frac{a/(a+b)}{c/(c+d)}$$

Table 7: Example of PR Calculation: Case-control Study of Alcohol Use and Coronary Heart Disease (CHD)

	CHD	**No CHD**	
>3 drinks/day	84	64	148
≤3 drinks/day	87	107	194

$$PR = \frac{84/148}{87/194} = \frac{.57}{.45} = 1.26$$

Interpreting prevalence ratio

The following rules apply when interpreting PR:

PR > 1: the prevalence of disease in the exposed group is greater than the prevalence in the unexposed group

PR = 1: the prevalence of disease in the exposed group is the same as the prevalence in the unexposed group

PR < 1: the prevalence of disease in the exposed group is less than the prevalence in the unexposed group

---

Activity

Activity #9:
Refer back to Table 7 showing PR for alcohol use and CHD. Discuss with a colleague what a PR of 1.26 means? Check your response with Appendix A.

Prevalence odds ratio

The prevalence odds ratio (POR) from a cross-sectional study is equivalent to the odds ratio, usually from a case-control study. You calculate it the same way as any other odds ratio:

$$POR = \frac{a * d}{c * b}$$

Table 8: Example of POR Calculation: Case-control Study of Alcohol Use and Coronary Heart Disease (CHD)

	CHD	**No CHD**	
>3 drinks/day	84	64	148
<3 drinks/day	87	107	194

$$POR = \frac{84 * 107}{87 * 64} = 1.6$$

Interpreting prevalence odds ratio

The following rules apply when interpreting POR:

POR > 1: the odds of disease in the exposed group is greater than the odds in the unexposed group

POR = 1: the odds of disease is the same in the exposed and unexposed (no association)

POR < 1: the odds of disease in the exposed group is less than the odds in the unexposed

Activity

Activity #10:
Refer to Table 8 above.
Discuss with a colleague what a POR of 1.6 means? Check your response with Appendix A.

Using PR or POR

For acute disease studies, PR is the preferred measure of association. for cross-sectional studies, POR is the preferred measure of association. Cross-sectional studies are useful for investigating chronic diseases (such as lung cancer) where the onset of disease is difficult to determine. They are also useful for studying long lasting risk factors (such as smoking).

Tip

If the prevalence of the outcome is rare (less than 10%), then the prevalence ratio and the prevalence odds ratio will be approximately equal.
(PR≈POR)
Thus, for rare diseases, it does not matter which measure you use.

Stop

> Let the facilitator or mentor know you are ready for a group discussion. He or she will review key concepts of computing and interpreting PR and POR before you complete Exercise 3.

KEY POINTS TO REMEMBER

Use the space below to record any key points from the facilitator-led discussion:

Activity

Practice Exercise #3 (Estimated time: 1 hour)

Background:
For this exercise, you will work individually, in pairs or in a small group to compute and interpret prevalence ratio and prevalence odds ratio.

Instructions:
1. Read figure 8
2. Answer the questions that follow
3. Ask a facilitator to review your work

Figure 8: Hypertension case study
Up to this point in the case study, you have assessed the data using descriptive statistics. Additional steps are taken to assess statistical associations in the data. Based on your literature review and initial descriptive analysis, you have found differences in hypertension status among demographic characteristics. Additional analytic analysis are needed using measures of association.

1. How would you additionally assess associations between hypertension and descriptive characteristics? (Consider: Is hypertension more frequent in male compared to females?) You may wish to create additional derived variables for these analyses to simplify the associations. (*Note:* Statistical significance testing is included in the next exercise).   Refer to the example table below. Then create two more.

Example 1

Exposure Variable: *Sex*	Outcome Variable: *Hypertension*	
	Yes	No
Male		
Female		

PR =

POR =

Hypertension by _____

	Hypertension					
	Yes			No		
	N*	%	95% CI	N*	%	95% CI

*Unweighted N

PR = _____

POR = _____

Hypertension by _____

	Hypertension					
	Yes			No		
	N*	%	95% CI	N*	%	95% CI

*Unweighted N

PR = _____

POR = _____

2. Interpret your findings. For example, if the prevalence of hypertension is greater in females than males, how would you describe your findings?.

Interpretation:

STATISTICAL SIGNIFICANCE TESTING

You have calculated an appropriate measure of association from your study, such as the POR = 1.6 for alcohol consumption and CHD. Now you will consider the possibility that the POR in the population is actually 1.0, and the POR of 1.6 calculated from a small sample of that population is simply the result of chance. Statistical significance testing is the process of evaluating whether chance is a reasonable explanation for the observed association in a study.

To test statistical significance, you will calculate the probability of finding an association as strong as (or stronger than) the one you would have observed by chance if the null hypothesis (no association) were really true. This probability is called a *p-value*.

A very small p-value means that you would be unlikely to observe such an association if the null hypothesis were true. A small p-value indicates that the null hypothesis is implausible given the data. If this p-value is smaller than some predetermined cutoff (usually 0.05 or 5%), you can reject the null hypothesis and accept the alternative hypothesis that exposure and disease are associated. The association is then said to be "statistically significant".

For this module, we will briefly discuss two types of statistical tests: **t-test** and **chi-square.**

Chi-square
Use **chi-square** test:
- To compare two proportions

- When you have at least 30 subjects
- The expected value in each cell of the 2x2 table[6] is at least five

The chi-square test provides a test statistic that corresponds to a two-tailed p-value. For the alcohol-CHD data in Table 7, the chi-square statistic is 4.765, which corresponds to a 2-tailed p-value of 0.029. This p-value indicates that, if the null hypothesis were true, i.e., if alcohol consumption was not related to CHD in the general population, then only 2.9% of samples taken from that population would have a POR as high as 1.6 or higher. Because 0.029 is less than the traditional cut-off of 0.05, we conclude that the null hypothesis is implausible (we "reject the null hypothesis"). We conclude that consuming more than 3 alcohol drinks per day is indeed associated with having coronary heart disease. In statistical jargon, we conclude that the association between consumption of more than 3 alcohol drinks per day and coronary heart disease is "statistically significant."

T-test

Use a **t-test** to compare means from two continuous distributions. For example, a t-test can help determine whether the mean systolic blood pressure among a group of hypertensive men is lower after they started taking an experimental antihypertensive medication than before. This illustrates the use of a t-test to compare means of paired samples (before versus after in the same individuals).

You can also use t-tests to compare an observed distribution to an independent standard. For example, you may want to determine if the distribution of serum cholesterol levels is statistically significantly different from the accepted standard. You can also compare the means of two independent samples. For example, you can use t-tests to determine if the mean BMI of women is statistically significantly different from the mean BMI of men in this population.

Similar to the chi-square test and chi-square statistic, the t-test produces a t statistic that corresponds to a p-value.

---

[6] *The chi-square statistic can also be calculated for tables other than 2x2 tables.*

CONFIDENCE INTERVALS

Another measure of statistical variability of association is the confidence interval. Statisticians define a 95% confidence interval as the interval that, given repeated sampling of the source population, will include the true association value 95% of the time. Epidemiologists regard a confidence interval as the range of values consistent with the data in the study.

The chi-square test and the confidence interval are closely related. The *chi-square test* uses the observed data to determine the probability (p-value) under the null hypothesis; you reject the null hypothesis if the probability is less than the pre-selected alpha (α) value. Usually this value is 5% (0.05) or 1% (0.01) Similarly, a *confidence interval* uses a pre-selected probability value, also called alpha (α), to determine the limits of the interval. An alpha of 0.05 results in a 95% confidence interval; an alpha of 0.01 results in a 99% confidence interval..

Unlike the chi-square, the calculation of the confidence interval is a function of the particular measure of association. That is, each association measure, such as the prevalence ratio or prevalence odds ratio, has its own formula for calculating confidence intervals.

Use of confidence intervals is now preferred over statistical testing by most journals, because confidence intervals better reflect the precision or variability with which the measure of association value is estimated. Because a confidence interval reflects the values with which the data are consistent, a confidence interval that does not include the null value (1.0 for a prevalence ratio or odds ratio) can be used to "reject" the null hypothesis. A confidence interval can be used in place of a statistical test to determine whether you can reject the null hypothesis.

Interpreting the Confidence Interval

Calculating a measure of association, such as prevalence odds ratio, and calculating a confidence interval provides the "best guess" of the true association as well as an index of how precise or variable that "best guess" is. The width of a confidence interval (i.e.,

the values included) reflects the precision with which a study can pinpoint an association.

A wide confidence interval reflects a large amount of variability or imprecision. A narrow confidence interval reflects little variability and high precision. Usually, given a larger number of subjects or observations in a study, the narrower the confidence interval, the greater the precision.

A confidence interval reflects the range of values consistent with the data in a Study. You can use the confidence interval to determine whether the data are consistent with the null hypothesis. Because the null hypothesis specifies that the relative risk (or odds ratio) equals 1.0, a confidence interval that includes 1 is consistent with the null hypothesis. A confidence interval that does not include 1.0 indicates that the null hypothesis should be rejected.
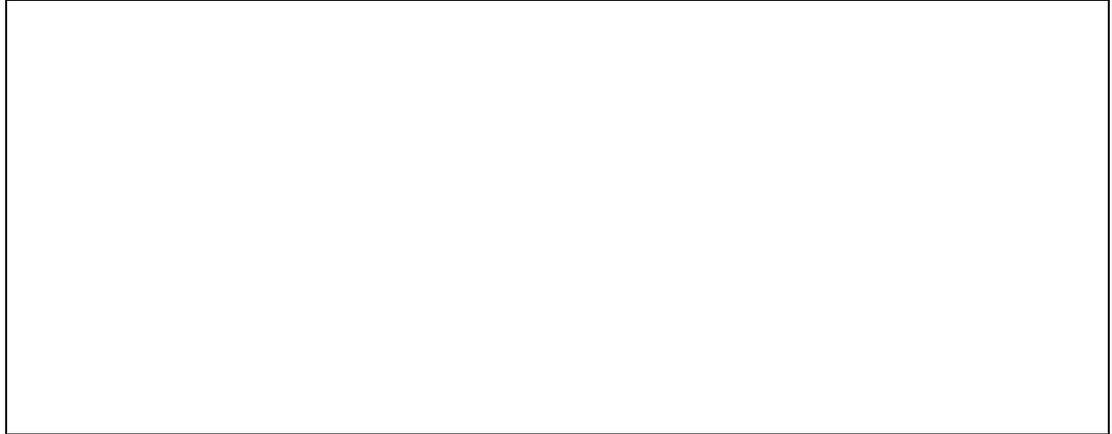

Stop

Let the facilitator or mentor know you are ready for a group discussion. He or she will review key concepts of computing and interpreting statistical tests and confidence intervals before you complete Exercise 4.

KEY POINTS TO REMEMBER

Use the space below to record any key points from the facilitator-led discussion:

STRATIFIED ANALYSIS

Conduct a stratified analysis to evaluate the association between the outcome and main exposure of interest according to levels of a third variable (i.e., suspected confounders or effect measure modifiers). It is useful for removing the effect of a confounder, as well as for identifying effect measure modifiers.

If you think that the association between the outcome and the main factor of interest (or exposure) may differ by some other factor, like gender or race, use stratified analysis to evaluate confounding and effect measure modification.

Stratification involves creating separate 2x2 tables according to the different categories of the variable that you are stratifying. For example, stratification based on sex would result in the two 2x2 tables below:

Male	Disease - Yes	Disease - No	
Exposed	a_m	b_m	$POR_{male} = a_m \times d_m / b_m \times c_m$
Unexposed	c_m	d_m	

Female	Disease - Yes	Disease - No	
Exposed	a_f	b_f	$POR_{female} = a_f \times d_f / b_f \times c_f$
Unexposed	c_f	d_f	

EFFECT MEASURE MODIFICATION

Recall that effect measure modification, or EMM, occurs when the values of the measure of association differ between subgroups of a third variable. The effect of the exposure on the outcome is different at each level of the third variable (e.g., between males and females, different age groups, different races).

For example, in the older age group, hip fracture is more common among females than males. However, in the younger age group, hip fracture is more common among males than females. In this example, age is the effect modifier for the association between gender and hip fracture. When EMM is present, you would present the different effects that you see in each group rather than calculating an "average" effect that does not describe the observed effect in either group.

You can assess effect measure modification by stratifying the analysis by a third variable. EMM is present when the stratum-specific measures of association are different from each other.

If EMM is found, report the stratum-specific effect measures separately, rather than a combined (averaged) effect measure (as you would do in the case of confounding). An averaged measure of effect would obscure the important finding of different risks among subgroups. This would prevent the targeting of prevention efforts at the high-risk group(s).

Tip

EMM is not a common occurrence in NCD large datasets.

Example:

Using the data from the 2004 Jordan BRFSS survey, investigators looked at the relationship between body mass index (BMI) and diabetes. They categorized BMIs under 25 as "Normal", and BMIs 25-29 as "Overweight". From their data, they created the following 2x2 table:

		Diabetes	No Diabetes
BMI	Overweight	87	920
	Normal	49	1230

They calculated the crude prevalence odds ratio.
cOR=87 × 1230 / 920 × 49 = 2.37 (95% CI = 1.66, 3.40)

Tip

You can use **http://www.openepi.com** for calculating crude prevalence odds ratios.

The investigators were curious to know whether sex might modify the effect of BMI on the odds of getting diabetes, so they stratified the 2x2 table above by sex. The age-specific strata are below. For each stratum, they calculated the prevalence odds ratio as shown below:

Males

	Diabetes	No Diabetes
Overweight	43	423
Normal	36	554

Females

	Diabetes	No Diabetes
Overweight	44	497
Normal	13	676

POR_m= 43 × 554 / (423 × 36) = 1.56
95% CI=(0.99, 2.48)

POR_f = 44 × 676 / 497 × 13 = 4.60
 95% CI = (2.45, 8.64)

The investigator's interpretation of the PORs for each stratum was as follows:

The odds of having diabetes among males who are overweight is 1.6 times higher than among males with normal BMI. In contrast, the odds of having diabetes among overweight women was 4.6 times higher than among women with normal BMI.

Are the stratum-specific PORs different from each other?

In the example shown above, 4.6 is a much higher ratio measure of effect than 1.6; therefore, it would seem that the PORs are different. However, there are two more rigorous ways to evaluate whether or not there is a difference between the PORs:

1. Use a statistical test to determine whether or not the strata are different from each other. For this test, the null hypothesis is that the strata are equal (H_0: POR_m=POR_f). In OpenEpi and Epi Info, the programs will show the results of the Breslow-Day test for Heterogeneity, a statistical test that determines whether the strata are different. A p-value of <0.05 is usually considered to indicate that the strata are different.

   Using OpenEpi, the p-value of the Breslow-Day test for Heterogeneity (or "Interaction") is 0.006678. Since the p-value is <0.05, we would conclude that the strata are indeed different. This difference suggests that there may be a biological difference between men and women which augments the effect of being overweight on the risk of developing diabetes among women.

2. A less formal way of assessing EMM is to look at the confidence intervals around each stratum-specific measure. If the confidence intervals overlap, you could conclude that the stratum-specific measures are not different from each other. There is no EMM present.

   In the example shown above, the confidence intervals around the POR for males is from 0.99 to 2.48. The confidence intervals around the POR for females is from 2.45 to 8.64. Do they overlap? The upper CI for males (2.48) is slightly greater than the lower CI for females (2.45).

Because they overlap slightly, it may be a matter of personal judgment as to whether the strata are different.

CONFOUNDING

Confounding is a "mixing" of effects that occurs when a third factor distorts the true association between the exposure and disease. This is a type of bias. We need to control for it in our analysis, if it exists. Like other types of bias, confounding results in a mistaken estimate of an exposure's effect on the risk of the outcome (e.g. disease). However, unlike most types of bias, we can sometimes control for it in our analysis.

To be a confounder, three criteria must be met.
1. A variable must be a *risk factor for the outcome*
2. A variable must be *associated with the exposure*
3. A variable must *not* be *in the causal pathway* between the exposure and outcome

As an example, look at the effect of alcohol (the exposure) on developing lung cancer
(the outcome). This relationship could be confounded by smoking. Let's see if smoking fits the three requirements to be a confounder:
1. Smoking is a *risk factor* for lung cancer even in the absence of alcohol
2. Smoking is *associated* with alcohol use (i.e. drinkers are more likely to smoke than the general population)

3. Smoking is not caused by use of alcohol (i.e., smoking is *not in the causal pathway* between use of alcohol and lung cancer)

Thus, smoking meets the criteria for being a possible confounder.

Controlling for Confounding
Removing the distortion caused by a confounding factor is called *"controlling."* Controlling for confounding will result in a better, more valid measure of effect.

As discussed previously, stratification—as with modeling–allows you to compare like with like. By stratifying on sex, for example, you will compare the effect of an exposure exclusively among men and exclusively among women. If the effects are similar in the two groups, then techniques are

available to calculate a summary or adjusted or "pooled" effect measure that eliminates confounding.

Assessing for Confounding

The steps to assess for confounding are as follows:

1. Compute the stratum-specific measures of association
2. Calculate the measures of effect stratified by levels of the potential confounder
3. Compare the stratum-specific measures to each other.
   a. If the stratum-specific measures are different from each other, as described in the EMM section, the covariate is an effect measure modifier. Report the stratum-specific measures of association.
   b. If the stratum-specific measures are not substantially different from each other, compare the crude measure to the stratified measures.
      i. If the crude measure and the stratified measures are close in value, the covariate has no impact on the exposure-outcome relationship. Report the crude measure.
   c. If the stratified measures are close in value, but the crude is different, then the covariate *is* a confounder. Take steps to control confounding by using one of two approaches:
      i. Calculate the adjusted measure of association that controls for confounding. If the crude measure differs from the adjusted measure by more than 10%, then confounding is present. Use the adjusted measure.
      ii. Look at the range of stratum-specific measures. If the crude measure is outside the range of the stratum-specific measures, then confounding is present. Calculate and use the adjusted measure.

Example[7]

In a hypothetical case-control study, the relationship between smoking and ovarian cancer among nulliparous women[8] was studied. The results are below.

Step 1: Compute measures of association

Table 9. Results of a case-control study on smoking cancer: hypothetical data

	Ovarian Cancer	Control	Total
Smoker	24	58	82
Non-smoker	36	40	98
Total	60	98	158

Crude odds ratio = (24 × 40) / (58 × 60) = 0.46
95% confidence interval = 0.24-0.89
$\chi^2 = 5.45$; p = 0.02

Activity

Activity #11:
Discuss with a colleague what conclusions you would make based on table 9. For example, do the findings suggest that smoking protects against ovarian cancer? Check your responses with Appendix A.

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[7] *Adapted from http://www.iarc.fr/en/publications/pdfs-online/epi/cancerepi/CancerEpi-14.pdf*
[8] *Nulliparous - a **woman** who has never given birth to a viable, or live, infant.*

Step 2. Calculate the measures of effect stratified by levels of the potential confounder

In table 9, it is possible that the association between smoking and ovarian cancer is due to the confounding effect of other factors, such as oral contraceptive use? To assess the oral contraceptive use as a potential confounder, we can stratify by oral contraceptive "users" and "never-users", as shown in table 10.

Table 10. Hypothetical case-control study on smoking and ovarian cancer: results presented separately for never-users and users of oral contraceptives (OCs).

Never-Users of OCs	Ovarian Cancer	Control	Total
Smoker	9	8	17
Non-smoker	32	28	60
Total	41	36	77

Crude odds ratio = (9 × 28) / (8 × 32) = 0.99
95% confidence interval = 0.60–1.65
$\chi^2 =0.0008$; p = 0.977

Ever Users of OCs	Ovarian Cancer	Control	Total
Smoker	15	50	65
Non-smoker	4	12	16
Total	19	62	81

Crude odds ratio = (15 × 12) / (50 × 4) = 0.90
95% confidence interval = 0.25-3.21
$\chi^2 =0.026$; p = 0.872

Step 3. Compare the <u>crude</u> measure to the <u>stratified</u> measures

Activity

<u>Activity #12:</u>
Discuss with a colleague the following question: Given an odds ratio of 0.90 in non-OC users and 0.99 in OC users, what value would be a reasonable summary of the two stratum specific effects? Check your responses with Appendix A.

The crude odds ratio was 0.46. The stratum-specific odds ratios were 0.99 and 0.90. Obviously, 0.46 is not within the range of 0.90 to 0.99, and hence the crude is not a reasonable summary of the relationship between smoking and ovarian cancer. The adjusted (Mantel-Haenszel) odds ratio is 0.95, with a 95% confidence interval of 0.42–2.16). Thus, the adjusted odds ratio is just what we expected. The confidence interval includes 1.0, indicating that we cannot exclude the null hypothesis; we cannot reject the assertion that smoking is not associated with ovarian cancer at all.

SUMMARY OF EMM AND CONFOUNDING

The following flow chart summarizes the steps to assess for EMM and confounding. It is often advised to assess for EMM before assessing for confounding, because if EMM is found, it is inappropriate to present an adjusted measure of association; therefore, it would not be necessary to assess whether confounding is present.

However, in practice, because EMM is very rare and confounding is extremely common, many epidemiologists will look for confounding without first checking to see if effect modification is present.
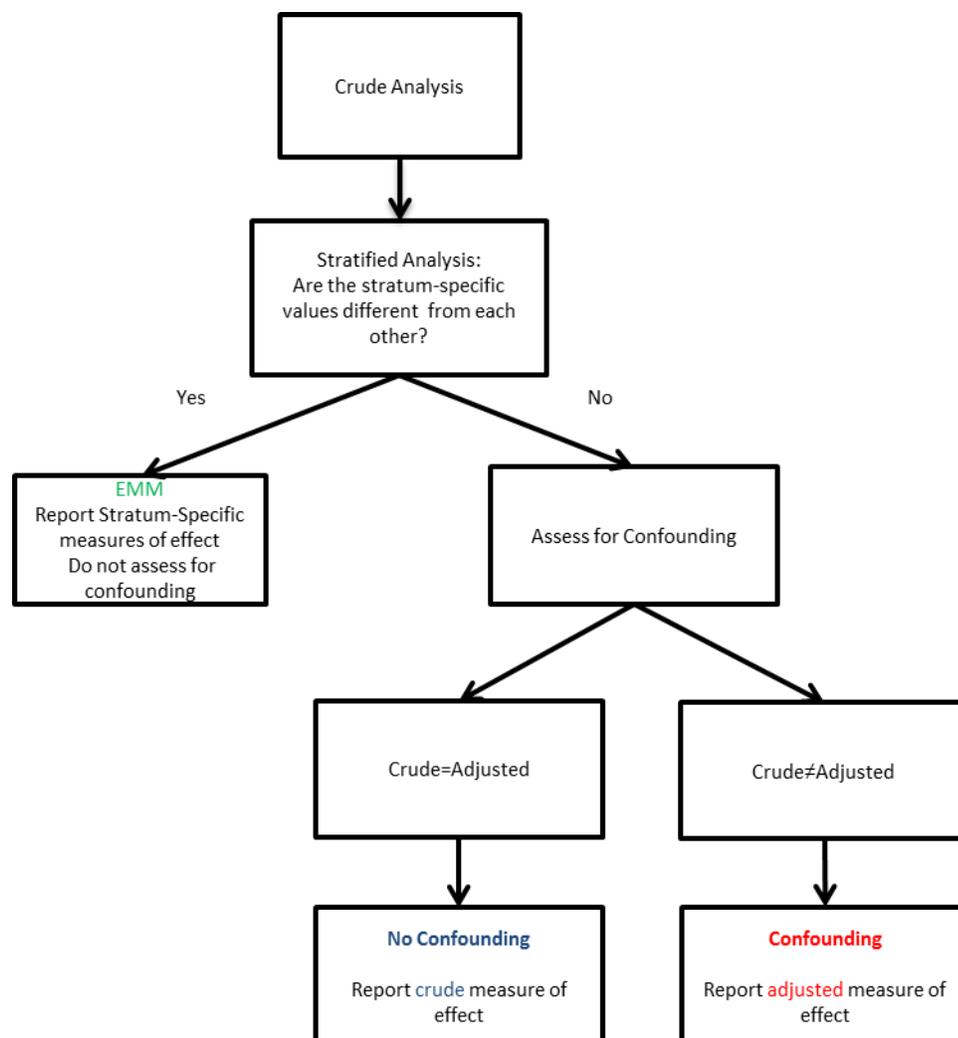
Stop

> Let the facilitator or mentor know you are ready for a group discussion. He or she will review key concepts of assessing for potential confounders and EMM before you complete Exercise 4.

KEY POINTS TO REMEMBER

Use the space below to record any key points from the facilitator-led discussion:

Activity

Practice Exercise #4 (Estimated Time: 1 Hour)

Background:
For this exercise, you will work individually, in pairs or in a small group to **assess for EMM and potential confounders.**

Instructions:
1. Read figure 10

2. Answer the questions that follow

3. Ask a facilitator to review your work

Figure 10: Hypertension case study
Differences in demographic and descriptive characteristics and hypertension status were likely found in previous exercises. In addition to providing estimates of the burden of hypertension in Country X, and describing the distribution of hypertension prevalence among subgroups, you have also been asked by the Minster of Health to assess the relationship between obesity and hypertension.

Questions that you may process: Is there a relationship between obesity and hypertension in Country X? Are there potential confounding variables that have been assessed in the recent survey that could help explore this relationship? (Consider: Demographic and descriptive variables are frequently assessed as potential confounders or in EMM).

Note: When assessing confounding and EMM consider stratification of variables (e.g., age group, gender, etc.) to assess the primary relationship (i.e., obesity and hypertension). Stratification allows you to observe relationships beyond the crude association.

1. What is the first step in assessing the relationship between obesity and hypertension?

2. Fill in the table below.

Hypertension by Weight Classification

	Hypertension					
Weight Classification	Yes			No		
	N*	%	95% CI	N*	%	95% CI

*Unweighted N

PR =_____ (95% CI:_____-_____)

POR = _____(95% CI: _____-_____)

χ^2 =_____ , df=_____, p=_____

3. Your findings indicate a signficant relationship between obesity and hypertension. Are there variables that have been collected in the survey that may distort the relationship between obesity and hypertension? Would you expect gender to confound the relationship? Fill in the tables below:

Hypertension by _____

Gender: Males

	Hypertension					
Gender	Yes			No		
	N*	%	95% CI	N*	%	95% CI

*Unweighted N

PR =_____ (95% CI:_____-_____)

POR = _____(95% CI: _____-_____)

Hypertension by   _____

Gender: Females

	Hypertension					
Weight Classification	Yes			No		
	N*	%	95% CI	N*	%	95% CI

*Unweighted N

PR =_____ (95% CI:_____-_____)

POR = _____(95% CI: _____-_____)

4. Are there differences among the demographic variables that you assessed? How do you interpret the findings?

Section 4: Interpreting and Reporting Your Findings

The final step in data analysis is interpreting and reporting your results. Interpretation means translating your raw findings (measures of association, results of statistical tests) into words that explain what each result means and how it helps to answer your research question. Throughout this module, you have been asked to interpret your findings.

Let us practice interpreting the results of the case-control study to evaluate whether or not alcohol is a risk factor for coronary heart disease. Recall that in this study, the researchers compared people who drank more than three alcoholic drinks a day to people who drank three or fewer drinks a day. The results yielded an OR of 1.61, with a 95% confidence interval of (1.03, 2.54) and a $\chi2$ value of 4.75, with a corresponding p-value of 0.029.

Activity

Activity #13:
Discuss with a colleague the following question: How would you interpret these findings? Use the space below to record your response. Check your response with Appendix A.

@

Information

When interpreting your results, remember that an association does not equal causation. Finding that an exposure is statistically associated with an outcome does not mean that the exposure *caused* the outcome, merely that the two are related in some way. Additional evidence or information is generally required to conclude that an exposure led to the outcome. See below to review the criteria for causality:

Criteria for Causality (Bradford-Hill Criteria):
1. **Strength of the association**
2. **Consistency**
3. **Specificity (possibly the weakest criterion, especially for chronic diseases)**
4. **Temporality**
5. **Biological Gradient (Dose Response)**
6. **Plausibility**
7. **Cohorence**
8. **Experiment**
9. **Analogy**

Report Your Findings

After interpreting your data, report your findings to the appropriate persons so that action can be taken. You will also want to share your work with other scientists to add to the collective knowledge on your study subject. This is this final step that allows your research to have a purpose.

To effectively convey your findings, carefully consider your audience. For example, you might need to report to decision makers at the Ministry of Health the study results and evidence-based interventions to address the public health problem. You may also share your methods and results with peers at an international conference. Or, you may have your study results

published in a scientific journal. If you have received funding from a donor to conduct your study, they will surely be interested in your findings, too!

The way in which you report your findings will depend on your audience. If the audience is other epidemiologists, you can generally communicate your findings using technical terminology. However, many ministers and ministry of health staff are not epidemiologists or statisticians; they may not know what an odds ratio or risk ratio is or how to interpret one. They will still be knowledgeable about public health matters and will want to know how your findings can help to protect the population's health. Translate your findings into language that they will understand.

Similarly, there will be times when it is necessary to share your findings with non-scientific audiences such as the media, law enforcement, and the community. These groups will need to know and understand the results of your study in order to make certain decisions. Use simple messages and non-technical language.

Regardless of who the audience is, simply telling people what you found is not enough; you must also provide them actionable recommendations for what to do.

Consider how you might report the results to your minister of health and other public health decision makers with regards to the CHD and alcohol study.

Activity

Activity #14:
Write a short synopsis of the findings, along with a recommendation, in the space below. Check your responses with Appendix A.

Activity

Activity #15

Write a short summary of your findings and recommendations
that will be disseminated to the public via the media Check your
responses with Appendix A.

> **@**
>
> Information
>
> You should have completed training on scientific writing; therefore, this module will not teach the topic.
>
> See Appendix B for a sample report of an analysis.

In summary, analyzing and interpreting data and presenting findings to key stakeholders is critical to ensure data is turned into action. It provides the science to support your recommendations for interventions and policy change to address health issues within a community.

Creating an Analysis Plan → **Managing Data** → **Analyzing and Interpreting Large Datasets** → **Data into Action**

Stop

> Let the facilitator or mentor know you are ready for a group discussion. He or she will review key concepts of interpreting and reporting your findings before you complete Exercise 6.

Activity

Practice Exercise #5 (Estimated Time: 45 Minutes)

Background:
For this exercise, you will work individually to summarize your findings and prepare a report based on the hypertension analysis.

Instructions:

1. Read Figure 11

2. Answer the questions below

3. Ask a facilitator to review your work

Figure 11.
As you recall, the Minister has asked you to report the findings of the national health survey data. The Minister wants to provide the report to the national and provincial decision-makers to better understand the magnitude of the burden of disease and the key determinants and underlying factors that are affecting this public health burden. The Minister is hoping use your findings to target resources and support evidence-based actions and policies to improve the health of the population.

Questions:

1. Based on the results of your analyses, use the space below to

summarize your key key findings.

2. What main sections would you include in the report? List in the space below.

3. Which of the tables you created would you include in the report to support your findings? Describe them in the space below.

4. Would you recommend changes to the national survey to better

assess hypertension in Country X?

Stop

Activity

Complete the Skill Assessment.

Resources

For more information on component/item nonresponse adjustment and re-weighting the data for analyses:

Lohr, Sharon L. *Sampling: Design and Analysis*, pp.265-272. Duxbury Press, 1999; and

Examples of papers with re-weighted NHANES data

Gregg E, Sorlie P, Paulose-Ram R, Gu Q, Wolz M, Eberhardt MS, Burt VL, Engelgau MM, and Geiss LS. Prevalence of lower extremity disease among persons 40 years and older in the US with and without diabetes. Diabetes Care. 2004 Jul;27(7):1591-7.

Ostchega Y, Dillon CF, Lindle R, Carroll M, Hurley BF. Isokinetic leg muscle strength in older americans and its relationship to a standardized walk test: data from the national health and nutrition examination survey 1999-2000. J Am Geriatr Soc. 2004 Jun;52(6):977-82.

Other references:

Dicker, RC. Analyzing and interpreting data. In: GreggMB, editor. Field Epidemiology. 2nd ed. 2002, New York: Oxford University Press;. P. 132-172.

Elliott, A. Statistical Analysis Quick Reference Guidebook: With SPSS Examples.1st Ed. California: Sage; 2006.

Kleinbaum DG, Kupper LL, Morgenstern H. Epidemiologic research: Principles and quanitative methods. New York: Van Nostrand Reinhold; 1982.

Rothman, K. Greenland, S. Lash, T. Modern Epidemiology. 3rd Ed. Pennsylvania: Lippincott Williams & Wilkins; 2008

Jekel, J. Katz, D. Wild, D. Elmore, J. Epidemiology, Biostatistics and Preventive Medicine. 3rd Ed. Pennsylvania: Saunders; 2007.

Appendices

Appendix A

Review the possible answers to the small group activities:

Activity #	Possible Answers
1	The first website provides links to NHANES questionnaires, datasets and related documentation. The second website provides reporting guidelines.
2	The largest percentage of participants (44.3%), attended secondary or technical school; Only 13% of partipants attended University or more; 28% of participants attended Primary School and 14.7% never attended school.
3	The results of univariable analysis showed that 6% of Jordanian adults would be classified as experiencing frequent mental distress.
4	The percentage of participants in the medical evaluation with undiagnosed diabetes was high Nine percent of participants reported that they had been diagnosed with diabetes compared with 16.9% diagnosed by laboratory testing.
5	The percentage of participants in the medical evaluation with undiagnosed high blood pressure levels was very high. The total prevalence of high blood pressure based on measurements was 30.2% compared with 15.2% based on self-reported data. The age group that was most likely to self-report high blood pressure was 50-64.
6	With increasing age, frequent mental distress also increases.
7	The more educated one becomes, the likelihood of experiencing frequent mental distress is decreased.
8	The more money one makes, the lower the prevalence of frequent mental distress.
9	The prevalence of coronary heart disease (CHD) is 1.26 times as high (e.g., 26% higher) among persons who consume more than 3 alcoholic drinks per day than among persons who consume 3 or fewer drinks per day.
10	The odds of having CHD for people who drink more than 3 drinks a day is 1. 6 as great as the odds of having CHD for people who drink less than or equal to 3 drinks a day.

11	Women with ovarian cancer were less likely to be smokers (24/60 = 40%) than were controls (58/98 = 59%).The odds ratio for smoking and ovarian cancer was 0.46. The confidence interval indicates that this estimate is relatively precise (ranging from 0.24 to 0.89), and is satistically significant (does not include 1.0). This finding suggests that smoking protects against ovarian cancer.
12	Both odds ratios are slightly less than 1.0 (i.e., close to no effect at all or perhaps a slightly protective effect). Most investigators would say that a reasonable summary odds ratio should be some value between 0.90 and 0.99, perhaps 0.94 or 0.95 or 0.96.
13	This case-control study found a statistically significant association between alcohol consumption and coronary heart disease. The odds of coronary heart disease were 1.61 times higher (or 61% higher) among individuals who drank more than three alcoholic drinks a day compared to the odds among individuals who drank three of fewer alcoholic drinks a day. Thus, high alcohol consumption may be a risk factor for CHD.
14	The present study adds to the growing body of evidence that there is an increased risk of coronary heart disease (CHD) among individuals who consume high quantities of alcohol on a daily basis. Specifically, our study found that in the studied population, persons who drank more than three alcoholic beverages a day were more than 50% more likely to develop CHD than those who drank 3 or fewer alcoholic beverages. Based on this finding, we recommend that the ministry undertake to communicate with the public that they should limit their daily alcohol consumption to three or fewer drinks per day in order to reduce their risk of CHD. The ministry may want to consider targeting this message at consumers of alcohol, for example, by placing notices prominently where alcohol is sold (e.g, bars, restaurants, liquor stores.)
15	A new study has shown that people who drink more than three alcoholic beverages a day may be at greater risk for heart disease. This study supports other, similar studies that have also shown that high alcohol use can lead to heart problems, including heart attack. Public health officials recommend consuming no more than three alcoholic drinks a day to reduce risk of heart disease, in addition to a healthy diet, exercising regularly, and not smoking.

Appendix B

Globalization and Health

Short report

A surveillance summary of smoking and review of tobacco control in Jordan

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Abstract

The burden of smoking-related diseases in Jordan is increasingly evident. During 2006, chronic, noncommunicable diseases (NCDs) accounted for more than 50% of all deaths in Jordan. With this evidence in hand, we highlight the prevalence of smoking in Jordan among youth and adults and briefly review legislation that governs tobacco control in Jordan. The prevalence of smoking in Jordan remains unacceptably high with smoking and use of tobacco prevalences ranging from 15% to 30% among students aged 13-15 years and a current smoking prevalence near 50% among men. Opportunities exist to further reduce smoking among both youth and adults; however, combating tobacco use in Jordan will require partnerships and long-term commitments between both private and public institutions as well as within local communities.

Findings

The negative health consequences of smoking and second hand smoke exposure are well documented [1-3]. The World Health Organization (WHO) estimates that there are more than one billion current smokers worldwide and that more than 80% of the world's smokers live in low- and middle-income countries [1]. An estimated 5.4 million people die from diseases directly related to cigarette smoking worldwide each year [1] and millions more are affected by the nonfatal consequences of tobacco use. Unabated, tobacco-related deaths are estimated to increase to more than eight million a year by 2030, and 80% of those deaths will occur in the developing world [1].

The burden of smoking-related diseases in Jordan is increasingly evident [4-6]. During 2006, chronic, non-

communicable diseases (NCDs) accounted for more than 50% of all deaths in Jordan [7]. Deaths from heart disease and stroke (ICD-10 codes I00-I99) accounted for a third of all deaths, and malignant neoplasms (C00-C97) were responsible for about 13% of deaths, with lung cancer being the leading cause of cancer death. Nearly 60% of deaths from malignant neoplasms occurred among people younger than 65 years, and approximately one-third of those who died from heart disease and stroke were aged 65 or younger. Moreover, the economic consequences of smoking-related morbidity and mortality are profound [1]. In addition, according to national estimates, smokers in Jordan spend an estimated JD 250 million annually on tobacco products [8]. With this evidence in hand, we provide an update of the prevalence of smoking in Jordan among youth and adults. Because legislation is central to

effective tobacco control [9], we briefly review legislation that governs tobacco control in Jordan.

For this report, data were derived from national health surveys conducted by the Jordan Ministry of Health (MOH) as well as surveys conducted by the MOH in collaboration with the WHO and the United States Centers for Disease Control and Prevention (CDC).

Smoking among Youth

The prevalence of tobacco smoking among youth was obtained from two sources, the Global Youth Tobacco Survey (GYTS) and the Global School-based Student Health Survey (GSHS). The GYTS, conducted in Jordan during 1999, is a school-based survey of students aged 13-15 years in public or private schools. The GSHS, also a self-administered, school-based survey conducted primarily among students 13-15 years of age, was conducted in Jordan during 2004 and 2007.

Both surveys employ a multistage sample design with schools selected proportional to enrollment size and classrooms chosen randomly within selected schools. All students in selected classes are eligible for participation, and surveys can be administered during one regular class period. During 1999, a total of 3912 students participated in the Jordan GYTS with an overall response rate of 83.9% [10]. A detailed description of the GTYS and its methodology is provided elsewhere [11]. For the 2004 Jordan GSHS, 2457 questionnaires were completed in 26 schools with an overall response rate of 95%. For the 2007 Jordan GSHS, 2197 questionnaires were completed in 25 schools with an overall response rate of 99.8%. Further details of the GSHS can be obtained at http://www.who.int/chp/gshs and http://www.cdc.gov/gshs.

The estimated prevalence of ever smoking among youth is shown in Tables 1 and 2. Current smoking prevalence ranged from 18% in 1999 to about 13% in 2004 and 16% in 2007. The prevalence of current smoking was substantially greater among boys than girls, with approximately 1 in 5 boys reporting that they currently smoke compared to 7 to 10% of girls. Use of other forms of tobacco was also high among both boys and girls. Nearly 1 in 3 boys reported current use of other forms of tobacco during 2007 and roughly 17% of girls reporting current use of other forms.

Smoking among Adults

The prevalence of tobacco smoking among adults was obtained from behavioral risk factor surveys (BRFS) conducted by the Jordan MOH during 2002, 2004 and 2007. A detailed description of the Jordan BRFS is provided elsewhere [4,5,12]. Briefly, during 2002 questions about behavioral risk factors and NCD prevalence were added to the Jordan Department of Statistics' quarterly, multistage,

Table 1: Prevalence of ever smoking, current smoking and current tobacco use among youth (aged 13-15 years) in Jordan, Global Youth Tobacco Survey (GYTS), 1999

	Boys	Girls	Overall
Ever smoked cigarettes	44.1%	25.8%	36.4%
Currently smoke cigarettes	22.6%	11.4%	18.3%
Currently use any form of tobacco	27.5%	15.2%	22.9%

* GYTS sample size, 3912
Source: GYTS data obtained online from: http://www.cdc.gov/tobacco/global/GYTS/factsheets/emr/1999/jordan_factsheet.htm Accessed 11 June 2009.
Notes. Lifetime prevalence of smoking was obtained from an affirmative response to the question, "Have you ever tried or experimented with cigarette smoking, even one or two puffs?". Youth were also asked the question "During the past 30 days (one month), on how many days did you smoke cigarettes?". Those who responded one ore more days were considered current smokers. Similarly, youth were asked about use of smoked tobacco products other than cigarettes (e.g. cigars, water pipe, cigarillos, little cigars, pipe) and use of any form of smokeless tobacco products (e.g. chewing tobacco, snuff, dip) during the previous 30 days. Those responding affirmatively were considered to currently use other forms of tobacco.

cross-sectional employment and unemployment survey. During 2004 and 2007, the Jordan MOH conducted its second and third BRFS, respectively, among a nationally representative sample of adults aged $\geq$ 18 years. Similar to 2002, a multistage sampling design was used to select households using the master sampling frame of census enumeration blocks from the 2004 Jordan census to select the sample of blocks, or primary sampling areas, from which households were selected. In each household, one adult aged 18 years or older was randomly selected and interviewed in person in Arabic. During 2004, a total of 3520 households were selected and 3334 adults were interviewed; a response rate of 94.7%. During 2007, a total of 3688 households were selected and 3654 adults were successfully interviewed; a response rate of 99.1%. Smokers were classified as "ever smokers" (i.e., smokers who had smoked $\geq$ 100 cigarettes during their lifetime) or "current smokers" (i.e., smokers who had ever smoked 100 cigarettes and currently smoke every day or some days).

During, 2007, nearly 40% of all adults aged 25 years or older reported having smoked at least 100 cigarettes during their lifetime (Table 2). Overall during 2007, the age-standardized prevalence of current smoking was 28% (standard error [SE], 0.86) with nearly half of men reporting current smoking behaviour compared to 5% of women (Table 3). Men aged 25-34 years had the highest (63%) prevalence of current smoking and women aged 18-24 years had the lowest (<1%) prevalence (Figure 1). By governorate in 2007, the age-standardized prevalence of current smoking ranged from 23% in Irbid and Tafela to 33% in Balqa and Zarqa (Figure 2).

Table 2: Prevalence of current smoking and current tobacco use on one or more days during the 30 days preceding the survey among youth (aged 13-15 years) in Jordan, Global School-based Student Health Survey (GSHS), 2004 and 2007

	2004 (n = 2457)	2007 (n = 2197)
Smoked cigarettes on one or more days during the 30 days preceding the survey		
Boys	19.2% (14.9-23.5)	22.7% (18.1-27.2)
Girls	6.6% (3.8-9.4)	8.7% (6.1-11.2)
Overall	12.6% (10.1-15.1)	15.6% (11.0-20.2)
Used any form of tobacco on one or more days during the 30 days preceding the survey		
Boys	28.4% (25.5-31.3)	33.5% (29.2-37.9)
Girls	12.2% (9.9-14.5)	16.5% (11.6-21.5)
Overall	19.9% (17.7-22.1)	24.9% (19.4-30.3)

95% confidence interval reported in parentheses
Source: GSHS data obtained online from http://www.who.int/chp/gshs/jordan/en Accessed 11 June 2009.
Notes. As part of the survey, youth are asked the number of days during the 30 days preceding the survey that they smoked cigarettes. Those reporting that they smoked cigarettes on one or more days were considered current smokers. Similarly, youth were asked the number of days they used any other form of tobacco during the 30 days preceding the survey.

The prevalence of current smoking was 22.8% (SE, 2.84) among adults with physician-diagnosed heart disease, 26.8% (6.81) among those with diagnosed high blood pressure, 21.3% (2.46) among those with diagnosed high blood cholesterol and 20.5% (2.56) among those with diagnosed diabetes mellitus.

Comment and note on tobacco legislation, control policies, programmes in Jordan

The well-known adverse effects of smoking and the documented benefits of quitting [13] notwithstanding, the prevalence of smoking among Jordanian youth and adults remains high. Smoking behavior among women may be higher than that reported here as women may deny their smoking behavior and/or underestimate their frequency of smoking. As a result of second-hand smoking, women's smoking exposure almost certainly exceeds that reflected in their own smoking behaviour. The prevalence of smoking among young and middle aged Jordanian men is similar to that of the US adult population during the late 1960s/early 1970s [14]. In Egypt the prevalence of lifetime smoking was 20% among boys and 5% among girls according to data from the 2005 GYTS while the prevalence among men (aged 15-65 years) was 34% according

Table 3: Survey participant characteristics and age-specific and age-standardized smoking prevalences among adults aged 18 years or older by participant characteristics, Behavioral Risk Factor Surveillance System, Jordan, 2007

Characteristic	Survey Participant Characteristics n = 3654 % (SE)	Prevalence of Lifetime Smoking n = 1409 % (SE)	Prevalence of Current Smoking n = 1080 % (SE)
Age, yrs			
18-24	14.9 (0.64)	25.0 (1.96)	23.4 (1.95)
25-34	19.6 (0.76)	41.0 (2.13)	37.2 (2.06)
35-44	26.7 (0.80)	40.7 (1.60)	32.9 (1.57)
45-54	15.4 (0.62)	38.6 (2.16)	28.5 (2.02)
55-64	12.7 (0.58)	39.6 (2.61)	23.6 (2.29)
≥65	10.8 (0.58)	40.3 (2.97)	19.4 (2.39)
Gender*			
Men	53.1 (0.87)	61.8 (1.21)	48.2 (1.27)
Women	46.9 (0.87)	7.8 (0.67)	5.1 (0.54)
Education*			
Never attended school	11.4 (0.58)	24.7 (4.98)	18.6 (4.83)
Primary school	32.0 (0.87)	44.1 (1.74)	35.3 (1.90)
Secondary or technical school[a]	42.7 (0.87)	36.5 (1.56)	26.8 (1.47)
University or more	13.9 (0.75)	44.7 (2.30)	29.8 (2.18)

SE, standard error
Note: Current smoker defined as having ever smoked >100 cigarettes in lifetime and currently smoke every day or some days; former smoker defined as having ever smoked >100 cigarettes in lifetime but not currently smoking
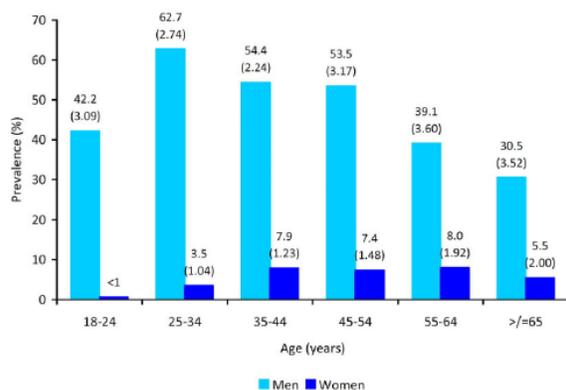* Prevalence of smoking is age-standardized

Figure 1
Age-specific current smoking prevalence among adults aged 18 years or older by gender, Behavioral Risk Factor Surveillance System, Jordan, 2007.

to data from the WHO's Global Infobase https://apps.who.int/infobase/report.aspx. Similarly high prevalences have been observed among boys (45% ever smoked, 25% currently smoke, 2006 GYTS) and men (20%-42% currently smoke, 2006/7 Iraq Family Health Survey; men aged 19-64 years) in Iraq.
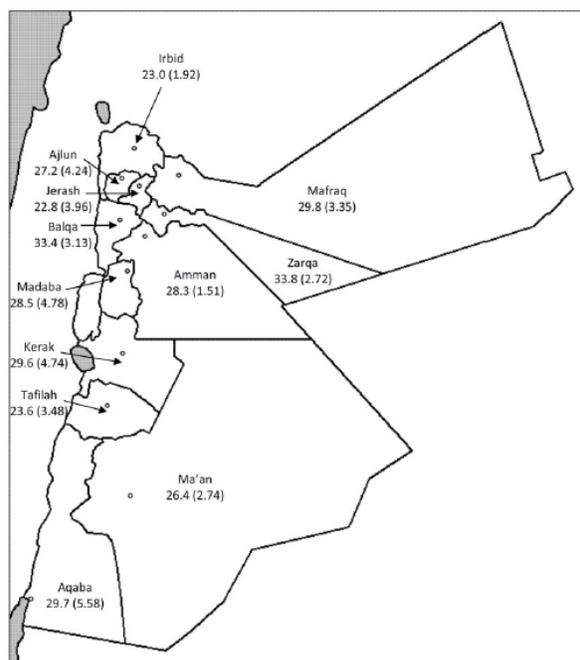

Figure 2
Age-standardized current smoking prevalence among adults aged 18 years or older by governorate, Behavioral Risk Factor Surveillance System, Jordan, 2007.

The relatively lower prevalence rate of current smoking in patients with prevalent heart disease and heart disease risk factors in Jordan is easy to explain on the basis of patients quitting the habit after diagnosis with these conditions. In addition, poor survival of smokers suffering from heart disease and its risk factors may, in part, provide another explanation. Smoking cessation is essential for patients with CHD. However, current smoking remained unacceptably high in these patients. Current guidelines recommend that clinicians ask about tobacco use and provide counseling about quitting within the context of a comprehensive plan for secondary prevention [15,16]. Available strategies include identifying and documenting smoking status in all patients, referral for consultation and counseling, prescription of appropriate drugs in accordance with clinical guidelines, and the provision of quit lines and community support services [17]. In addition, initiatives to promote cessation at the work site are needed, as is enforcement of smoke-free legislation in schools and public places.

Jordan has an extensive history with tobacco control policies and programmes that have shaped its current tobacco control infrastructure. Jordan's initial anti-smoking regulation was part of a public health law issued in 1971. This initial legislation established jail sentences not exceed four months or fines (ranging from JD 25 to JD 500, or both penalties, [1 Jordanian Dinar (JD) = 1.41 US dollars]) but was challenged by the absence of enforcement mechanisms and application of penalties for those who smoked in public places and on public transport or promoted tobacco use through advertisements. In November 2001, legislation, included as part of Juvenile Monitoring Legislation, was put in place to restrict tobacco sales to minors with penalties for minors (e.g., a JD 20 fine for a first-time violation; fine doubled if the offence were to be repeated) and for the vendor (e.g., a JD 100 fine and a jail sentence of up to one year). In May 2003, Jordan adopted the Framework Convention on Tobacco Control (FCTC) with a tobacco control strategy that included a general ban on tobacco advertising, raising of public awareness on the hazards of tobacco use, enforcement of legislation, and encouragement of smoking cessation, among others. (*N.B.* The 2003 tobacco control country profile can be found online at http://www.who.int/tobacco/media/en/Jordan.pdf.) For example, a picture warning that covers 50% of the package size is now required on all cigarette packages in Jordan.

More recently (in 2008), Jordan's public health law was amended to prohibit smoking in public and private institutions and all public facilities including hospitals, healthcare centres, schools, cinemas, theatres, libraries, museums, public and nongovernmental buildings, public transport vehicles, airports, closed playgrounds, lecture

halls and any other location at the discretion of the Minister of Health. Smoking is also prohibited inside Amman's shopping malls, and in addition to posted warning signs, the MOH has required five star restaurants in Amman to identify smoke-free places for non-smokers. Beginning June 2009, smoking was banned inside Amman's fast-food outlets. 'No smoking' signs were widely distributed and posted in every MOH facility, other major health facilities (hospitals, large health centres, etc), airports, and other venues. Penalties were established in this section in more formative way compared with prior legislation. In addition, the new legislation provided clear mechanisms for organizing the supervision and monitoring of the smoking ban. For example, the prohibition of smoking among staff in health facilities in the country was accompanied by a decision by the Minister of Health to penalize Ministry staff who smoked in health facilities both administratively and monetarily through reductions in wages and benefits. At the international airport, where smoking is now prohibited with the exception of designated smoking areas, focal points for monitoring adherence were also assigned. Effectiveness of these policies, however, remains to be measured.

In conclusion, while the current infrastructure for tobacco control is a beginning, opportunities remain to improve anti-smoking policies and programmes particularly in areas of enforcement. The prevalence of smoking in Jordan, particularly among men, remains unacceptably high, and opportunities exist to further reduce smoking among both youth and adults and particularly among patients with smoking-related diseases. Of course, it is hoped that the tobacco control policies will, in part, result in a reduction in smoking prevalence; however, such policies cannot work in isolation. Socio-cultural norms, whereby smoking among men is a common and accepted part of daily life with little or no societal perception of smoking as a negative behaviour, present a challenge to tobacco control. Ultimately, smokers must decide that they need to quit smoking. Smoking cessation programmes that offer free-of-charge counseling and nicotine replacement medication for those who wish to quit smoking as well as quit hotlines have been implemented in Jordan in the past, but their widespread use has not been sustained and some suggest that additional effort is needed to educate and counsel health professionals as well as provide them the necessary behavioral intervention skills for smoking cessation [18]. Effective tobacco-related awareness programmes, particularly anti-tobacco peer education programmes targeting youth, must be implemented more widely across the country. Combating tobacco use in Jordan will require partnerships and long-term commitments between both private and public institutions as well as within local communities.

Competing interests
The authors declare that they have no competing interests.

Authors' contributions
Study conception and design: AB, MAN, DWB. Acquisition of data: AB, MAN. Analysis and interpretation of data: MAN, DWB. Drafting of manuscript: AB, MAN, AB, DWB, HTW. Critical revision: AB, MAN, AB, DWB, HTW. All authors read and approved the final manuscript.

Acknowledgements

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