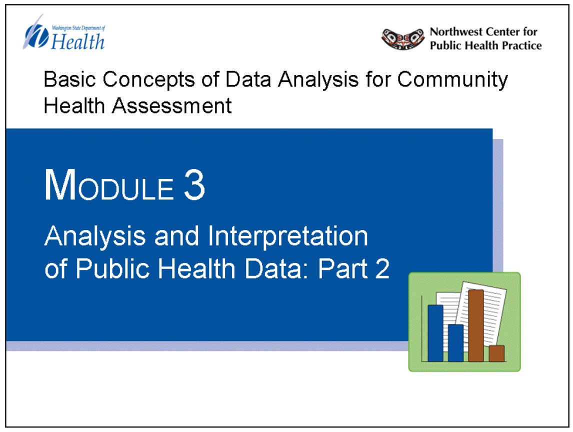
Module 3: Analysis and Interpretation of Public Health Data: Part 2

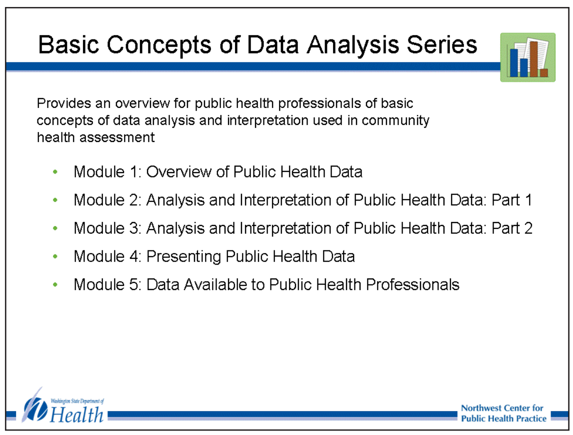
Transcript

Analysis and Interpretation of Public Health Data Part 2



Welcome to Analysis and Interpretation of Public Health Data: Part 2. This is the third module in the series on Basic Concepts of Data Analysis for Community Health Assessment in Washington State. I'm Jane Ballard. I helped create this course, along with a team of other community health assessment experts at both local and state health departments in Washington and Oregon. I have a doctorate in epidemiology and manage the Health Statistics and Assessment Program at Snohomish Health District. I have worked at Snohomish Health District since 2000.

Basic Concepts of Data Analysis Series



This series provides an overview for public health professionals of the basic concepts of data analysis and interpretation used in community health assessment. The training is intended to help professionals who work in public health practice at state and local agencies hone their assessment skills.

Module 1 provides an overview of public health data sources and uses. Module 2 introduces the analysis and interpretation of public health data. Module 3 continues the discussion of the analysis and interpretation of public health data. Module 4 provides information on how to present public health data, and module 5 describes data available to public health professionals.

This series was developed by Washington State Department of Health in partnership with the Northwest Center for Public Health Practice. Many of the examples use Washington State or county level data, but the concepts they illustrate are relevant to public health professionals in any location.

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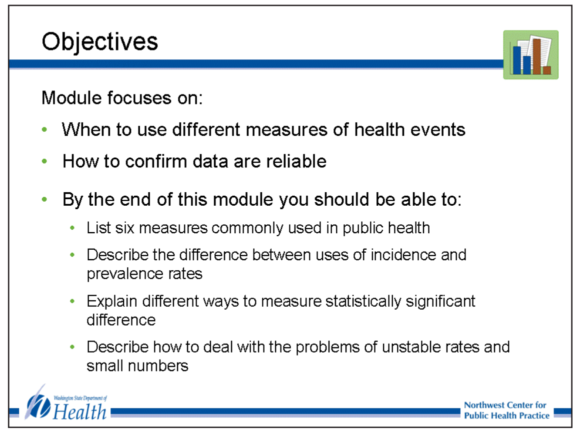
Objectives



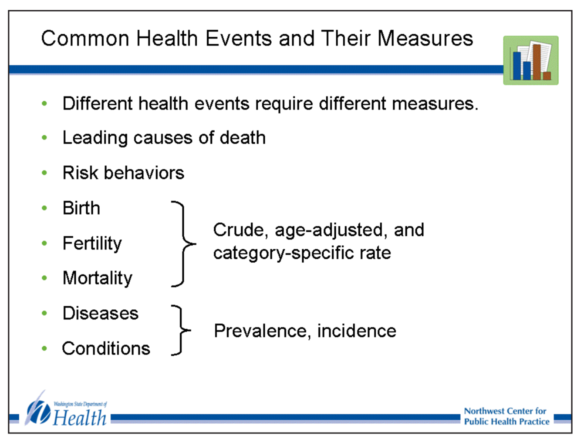
In this module we'll look at when to use different measures of health events for community health assessment, and we'll explore how to confirm that the data are reliable.

By the end of this module you should be able to:

- List six measures of health events commonly used in public health,
- Describe the difference between uses of incidence and prevalence rates,
- Explain different ways to measure statistically significant difference, and
- Describe how to deal with the problems of unstable rates and small numbers.

Please feel free to stop and replay sections of this module at any time, using the slider at the bottom of the screen.

Common Health Events and Their Measures



Public health measures a variety of health events such as health outcomes, deaths, births, disease, injury, and risk behaviors. Different health events require different measures. Some of the health events we'll look at in this module include the leading causes of death, risk behaviors, birth, fertility, and mortality. In addition, we'll introduce two new measures—prevalence and incidence—to measure diseases and conditions.

Leading causes of death use simple counts to rank causes of death in a population.

Risk behaviors, such as smoking tobacco, are commonly expressed as the percentage of those with the behavior in the population at risk.

Birth, fertility, and mortality are measured using the various types of rates covered in module 2, which include crude, age-adjusted, and category-specific rates. In this module, we'll look at how each of these health events are defined and what the specific components are that are needed to calculate the rates.

To measure diseases and conditions, we can use prevalence or incidence rates.

In the next few slides, we'll explore in more detail the measures used for various

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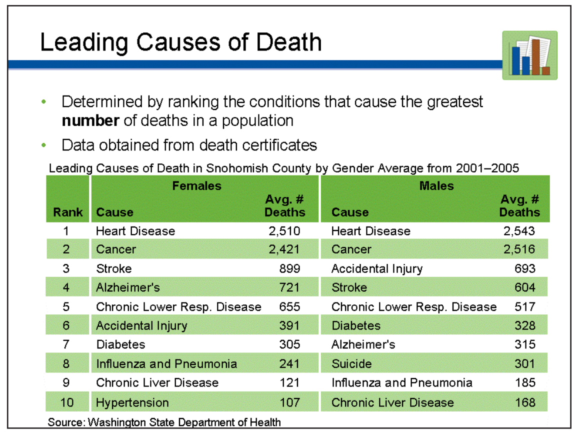
health events. After we discuss these measures, we'll look at some cautions when using them, as well as ways to test for significant differences and to assess changes in rates over time.

Let's first look at leading causes of death.

Leading Causes of Death

The leading causes of death in a population are determined by ranking the conditions that cause the greatest number of deaths. Data are obtained from death certificates.

For example, here are the leading causes of death in Snohomish County by gender from 2001 through 2005. We've ranked the average number of deaths by this five-year interval from the most frequent to the least frequent by gender. The leading causes of death can help guide health education and intervention programs. We can also look at the leading causes of death by race or age group to target specific groups in the population for health education or intervention.

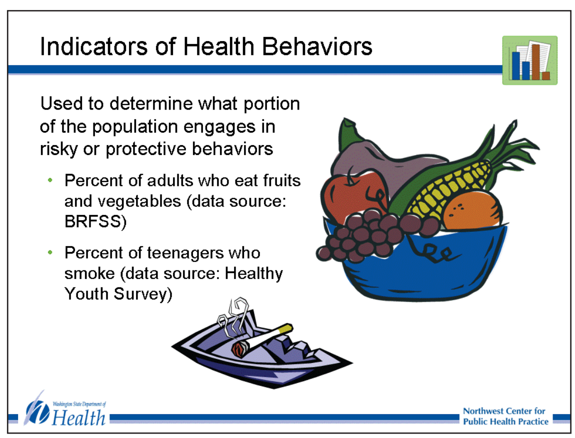


	Females		Males	
Rank	Cause	Avg. # Deaths	Cause	Avg. # Deaths
1	Heart Disease	2,510	Heart Disease	2,543
2	Cancer	2,421	Cancer	2,516
3	Stroke	899	Accidental Injury	693
4	Alzheimer's	721	Stroke	604
5	Chronic Lower Resp. Disease	655	Chronic Lower Resp. Disease	517
6	Accidental Injury	391	Diabetes	328
7	Diabetes	305	Alzheimer's	315
8	Influenza and Pneumonia	241	Suicide	301
9	Chronic Liver Disease	121	Influenza and Pneumonia	185
10	Hypertension	107	Chronic Liver Disease	168

Source: Washington State Department of Health

Indicators of Health Behaviors

Among the measures public health professionals frequently use are indicators of risk or protective health behaviors. The indicators can help you determine what portion of the population engages in those behaviors. For example, if data from the Behavioral Risk Factor Surveillance System, or BRFSS, shows us that only 10 percent of the adult population eats the recommended servings of fruits and vegetables, we might want to focus intervention efforts on improving the percent of adults who eat these healthy foods.



An example of a risky behavior would be the percentage of teenagers who smoke. Data on teenagers are available from the Healthy Youth Survey.

Module 5 delves into available data sources in more depth.

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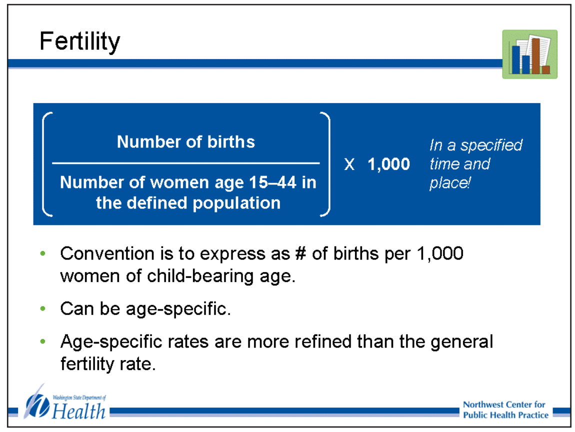
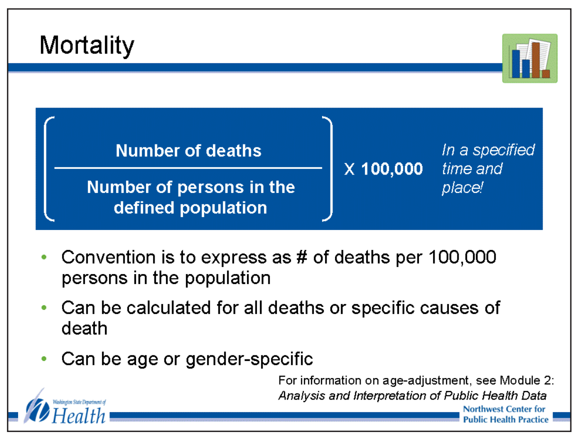
Fertility



Fertility rates are calculated as the number of births divided by the number of women of childbearing age. By convention, fertility rates are expressed per 1,000 women of childbearing age. Both the number of births and the defined population need to be for the same time period and place, for example, the year 2005 in Snohomish County. Childbearing age is defined as 15 to 44.

You may also want to look at age-specific fertility rates, such as those of young women aged 15 to 19. Age-specific rates are more refined than the general fertility rate.

Mortality



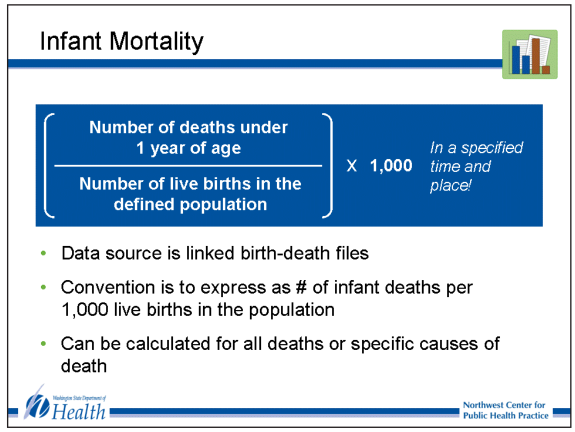
Mortality rates measure the deaths in a population in a specific period of time. We calculate them by dividing the number of deaths by the total population. By convention mortality rates are expressed per 100,000 persons. We can calculate mortality rates for specific causes of death, as well as for specific ages or categories such as gender. For chronic diseases, such as heart disease, mortality rates are usually age-adjusted. (For more information about age-adjustment, see Module 2 in this series.)

The age range of a population is an important characteristic governing the distribution of disease. We need to know what people are dying of in our communities so we can identify where to target prevention and screening.

Infant Mortality

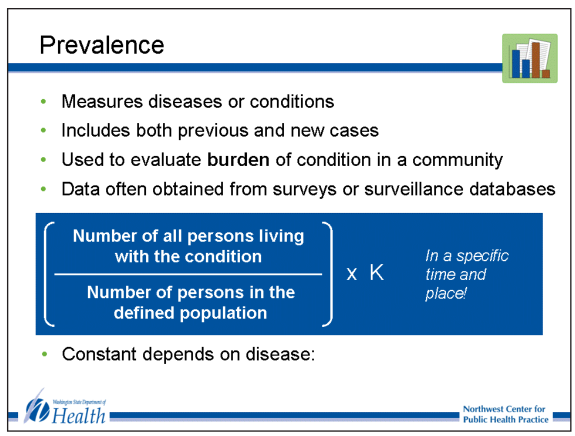
Infant mortality rates are a special case of age-specific mortality rates. Infant mortality rates use the number of deaths in children under one year of age divided by the number of live births in the defined population in a specific time and place. Unlike other mortality rates, which require only death data, infant mortality rates are calculated from linked birth and death files. By convention, they are expressed as the number of infant deaths per 1,000 live births in the population. These rates may be for either the total number of all causes of infant deaths or for the infant-specific causes of death.

Let's pause now while you answer a question on what you have just learned.



Practice: Mortality and Fertility

Prevalence



In the previous slide we talked about several measures related to births and deaths, such as leading causes of death, infant mortality, and fertility rates. To measure diseases or conditions, such as influenza or heart disease, we use prevalence and incidence rates. Let's look first at prevalence.

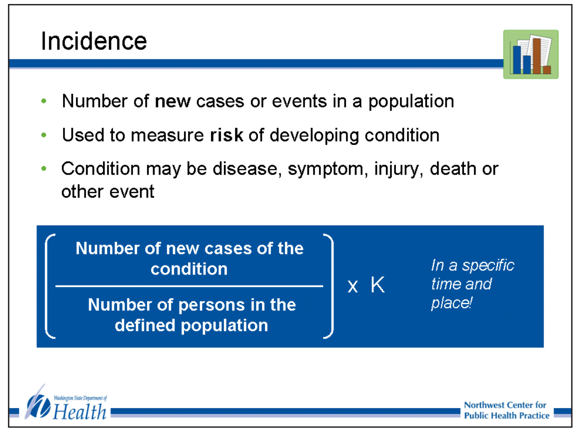
Prevalence is the total number of events or cases in a population at a specific time and place, so it includes both previously and newly diagnosed cases.

Public health professionals use prevalence to evaluate the burden, or amount, of a health condition in a community. Prevalence depends on two factors—the incidence and the duration of the disease. Prevalence data are often obtained from surveys, such as the BRFSS survey, or surveillance databases.

We calculate prevalence by dividing the number of all persons with the condition during a specified time and place by the number of persons in the population of concern and then multiplying the result by a constant, such as 100 or 100,000, in order to end up with a rate that we can compare to other rates. The constant used will depend on the disease. For example, for a more common disease such as diabetes, we'd use per 100, but for a neurological disease such as Multiple Sclerosis, which is not as common, we'd use per 100,000.

Remember that data for both the persons with the condition and the population of concern must be drawn from the same specific time and place.

Incidence

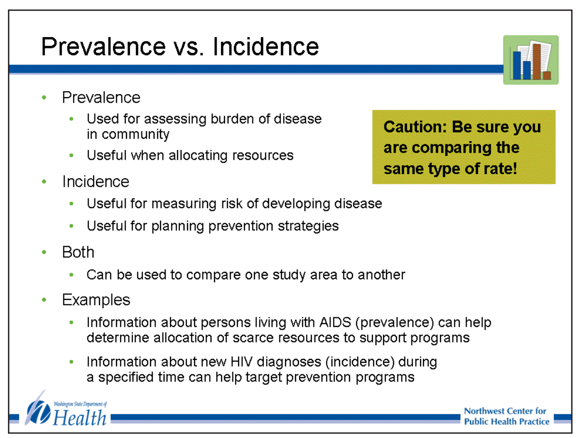


In contrast to prevalence, which measures the total amount of disease at a point in time, incidence gives us the number of new cases or events in a population during a specific period of time.

Incidence is used to measure the risk of developing a condition or the rate of occurrence. A condition may be a disease, symptom, injury, or other event. For example, we might want to know the incidence rate of chlamydia or of motor vehicle injuries in year.

We calculate incidence by dividing the number of new cases by the total number of persons in the population of concern and then multiplying the result by a constant. As with prevalence, the data for both the cases and the population of concern must be drawn from the same specific time and place.

Prevalence vs. Incidence



Incidence and prevalence are used for different purposes. Prevalence rates are used for assessing the burden of disease in a community and are useful when allocating resources. Incidence rates are useful for measuring risk of developing disease and for planning prevention strategies.

Both types of rates can be used to compare one study area to another. However, be sure you are comparing the same type of rate.

For example, information on all cases (in other words, prevalence rates) for persons living with AIDS or diabetes can aid in the allocation of scarce resources to psycho-social support programs.

On the other hand, information on new cases (or in other words, incidence rates) for HIV diagnoses or newly diagnosed diabetes cases during a specific time period, can help in developing strategies for how and where to target preventions programs.

We can also look at age- or gender-specific rates for both prevalence and incidence if we want to know if the rates vary by these categories.

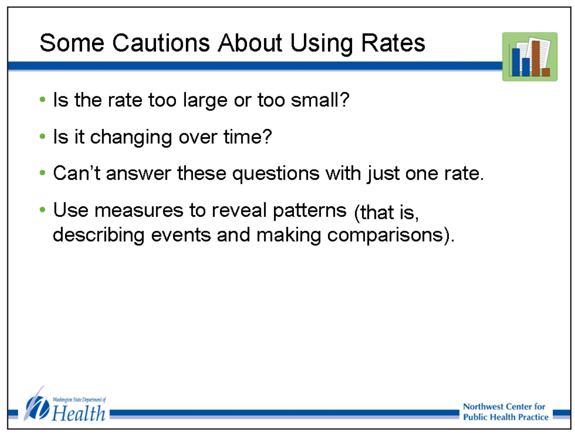
Let's pause now so you can answer some questions on what you've just learned.

Practice: Prevalence and Incidence

Practice: Calculating Prevalence

Practice: Calculating Incidence

Some Cautions About Using Rates

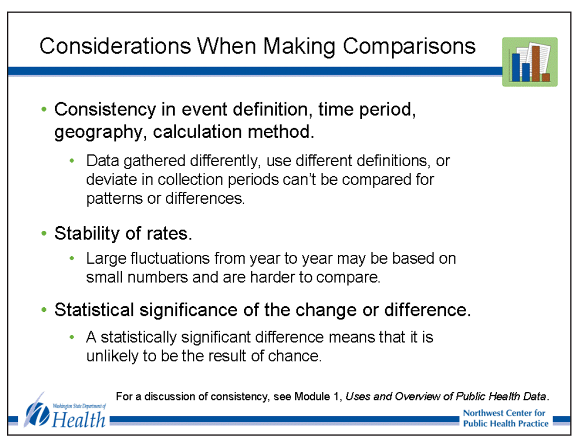


Now that we've looked at these common measures for various health events, let's look at some cautions about using and interpreting these measures.

Is the rate too large or too small? And, is the rate changing over time? We can't answer these questions with just one rate. We need more information so we can identify patterns in health events. Fortunately we have several measures to reveal patterns in health events relative to person, place, and time. (Module 2 introduces two useful measures for looking at patterns, those of central tendency and of frequency.)

When we say, patterns, we're really talking about describing the events and making comparisons.

Considerations When Making Comparisons



When making comparisons using rates, we need to address three issues.

- First, consistency in event definition, time period, geography, and calculation method,
- Second, stability (or, variability) of the rates and
- Third, statistical significance of the change or difference.

Consistency in the data is extremely important. Data can't be compared if they are gathered differently, or use different definitions for similar outcomes and measures, or if collection periods deviate from year to year. I discuss consistency in Module 1.

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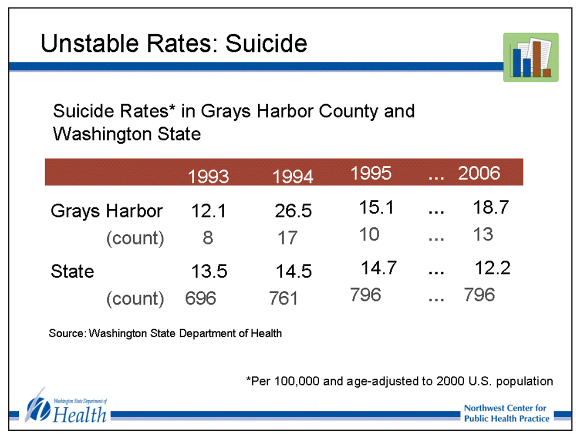
Another problem to be aware of with measurements of rates is instability. Rates that are not stable or tend to fluctuate greatly from year to year may be based on small numbers and thus, be less reliable and more difficult to compare.

Statistical significance gives us an objective measure of when a difference is real or just due to chance. If a difference is statistically significant, it means the difference is unlikely to be the result of chance.

In the next slides, we'll look at how to assess rates for stability. Before we look at the measures we use to assess stability, let's look for a moment at the issue of stability of rates.

Unstable Rates: Suicide



Unstable Rates: Suicide

Suicide Rates* in Grays Harbor County and Washington State

	1993	1994	1995	...	2006
Grays Harbor	12.1	26.5	15.1	...	18.7
(count)	8	17	10	...	13
State	13.5	14.5	14.7	...	12.2
(count)	696	761	796	...	796

Source: Washington State Department of Health

*Per 100,000 and age-adjusted to 2000 U.S. population

Imagine that you are in Grays Harbor County and are faced with this staggering rate of suicide for 1994 compared with that of 1993. You feel compelled to take action and implement a major suicide prevention initiative.

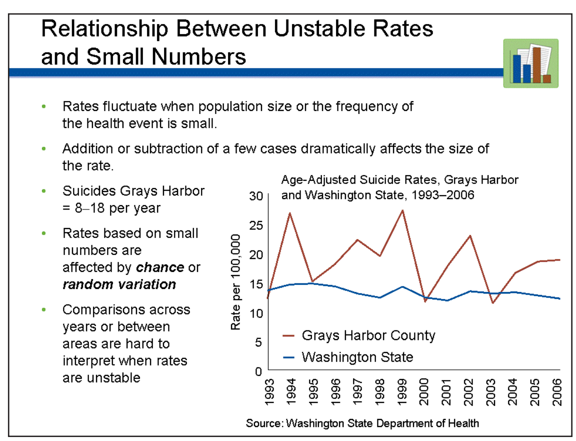
The 1995 mortality figures are released, and you're a hero! The suicide rate has dropped almost to the level it was in 1993. The suicide prevention campaign is lauded as a huge success and might even be replicated nationwide.

A few years go by, and despite your intervention initiative, suicide rates are rising again.

What's going on here? Why are the rates bouncing around like this? Are rates in Grays Harbor County really that much bigger than in Washington State as a whole?

What you see here is what we refer to in epidemiology as "unstable rates."

Relationship Between Unstable Rates and Small Numbers



The Grays Harbor suicide rate we just looked at underscores the problem of unstable rates. Rates often fluctuate widely when the size of the population—or the frequency of the health event—is small. The addition or subtraction of a few cases dramatically affects the size of the rate.

In this situation, the number of suicides per year in Grays Harbor County is very small—ranging from

8 to 18 a year for the years shown here. But in Washington State the range is 696 to 796. In addition to the small number of suicides in Grays Harbor, the population is less than 70,000, while Washington State has a much larger population of nearly 6.4 million.

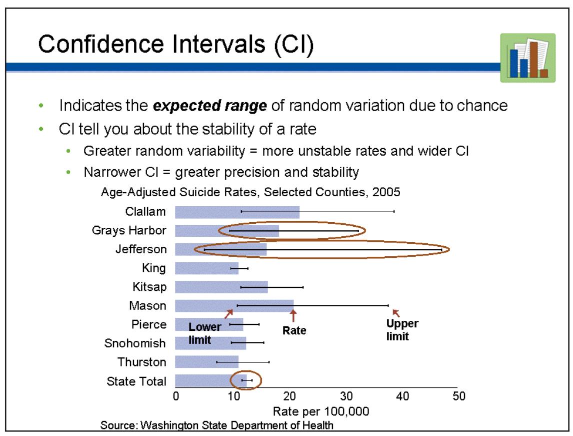
Rates based on small numbers of events are affected by chance, or random variation, as it's called in statistics. Although the change in the number of events is real, the wide variation in the rate doesn't necessarily indicate any actual, underlying change in the population's health.

Comparisons across years or between populations are hard to interpret when rates are unstable. We need a way of assessing the stability of rates. In other words, we need a way to measure the size of the random variation.

Let's pause now so you can answer some questions on what you have just learned.

Practice: Unstable Rates

Confidence Intervals (CI)



We use confidence intervals to help identify the variability in rates. The confidence intervals measure the expected range of random variation in a rate that is due to chance. We use confidence intervals to quantify, or measure, the randomness, or statistical "noise," associated with the rate. It is the range that we believe the true value will fall within.

Confidence intervals tell us about the stability of a rate. Greater random variability leads to more unstable rates and to wider confidence intervals. Narrower confidence intervals indicate greater precision and stability.

The limits (or bounds) of the confidence interval tell you how high and how low the observed rate could have been simply as a result of chance. Let's look at how confidence intervals work, using suicide rates for several counties. Here is the range of variability around the rates. You can see that for larger population groups such as the state, the range is fairly small. For smaller population groups, such as Jefferson County, the range is quite large. And you can see that Grays Harbor falls somewhere in the middle.

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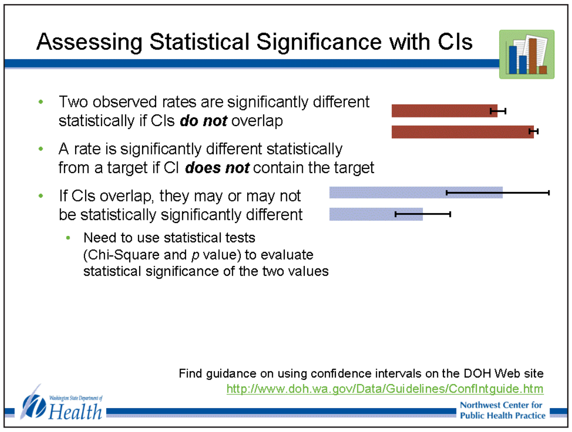
Assessing Statistical Significance with CIs

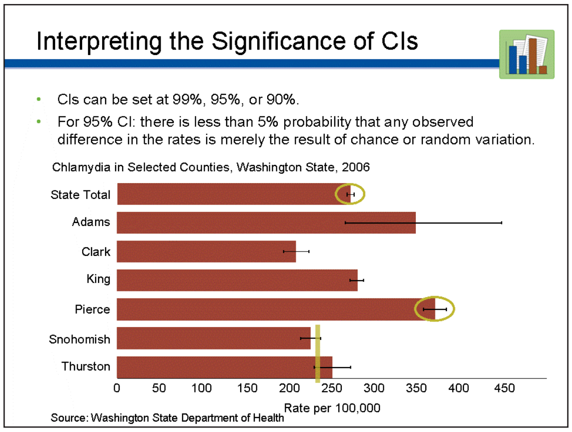


As I said, we use confidence intervals to assess the stability of a rate. We can also use confidence intervals to assess statistical significance when we compare two rates. Two observed rates are said to be significantly different statistically if their confidence intervals do not overlap. A rate is significantly different statistically from a target value—such as a Healthy People 2010 goal—if its confidence interval does not contain the target value.

However, if the confidence intervals of the two rates do overlap, we cannot say for sure whether they are, or are not, statistically significantly different. We would need to use statistical tests (for example Chi-square and the *p* value) to evaluate if there is a statistically significant difference. I'll discuss Chi-square tests and *p* values later in this module.

For more guidance on using confidence intervals, see the Guidelines for Using Confidence Intervals for Public Health Assessment on the DOH Web site.

Interpreting the Significance of CIs



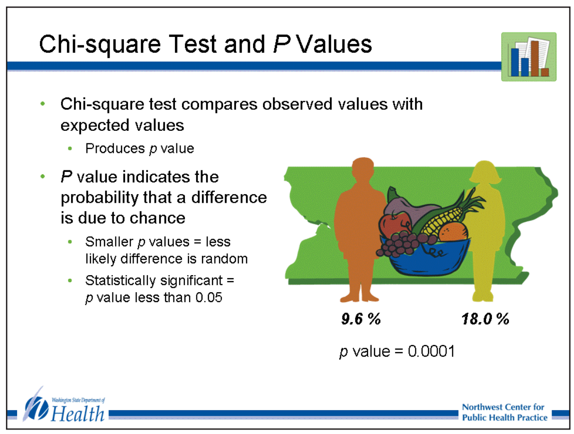
In epidemiology, we use different levels of confidence intervals depending on the precision we need in our analysis. A confidence interval can be set, for instance, at 99%, 95%, or 90%. For most circumstances, we use a 95% confidence interval. The 95% confidence interval means that there is less than a 5% probability that any observed difference in the rate is merely the result of chance or random variation. In other words, 95 times out of 100, we believe that the true value will be within the low and the high value.

Let's look at a graph of chlamydia rates, and use the 95% confidence intervals to help answer the question: Is the chlamydia rate in Pierce County significantly higher than the state rate? You can see that the confidence intervals do not overlap, and so we can say that the Pierce County rate is significantly higher than the state's rate. You can also see that the rate in Snohomish County is probably not statistically different from the Thurston County rate, because the confidence intervals overlap. However, we cannot say for sure that they are not statistically different. We will have to use another test.

Let's pause now so you can answer some questions on what you have just learned.

Practice: Statistical Significance

Chi-square Test and *P* Values



A test used to determine statistical differences in proportions or rates is the chi-square test for comparisons. The chi-square test compares observed values with the expected values. The chi-square test will produce a value called the *p* value. I won't cover how to calculate the chi-square test in this module, but most analytic software programs will calculate the chi-square and the associated *p* value for you.

The *p* value indicates the probability that a difference between two values is due to chance. The smaller the *p* value, the less likely that the difference is random, or in other words, the more likely that it is "statistically significant." The conventional definition of "statistically significant" is a *p* value less than 0.05. This means there is less than a 5% chance that the difference is due to random variation.

So let's say we want to know if there is a statistically significant difference between the fruit and vegetable consumption of men and women in Snohomish County. The percent of men who eat two servings of fruit and three servings of vegetables is 9.6 and for women it's 18.0. The *p* value for the chi-square test is less than 0.0001. Since a *p* value of 0.0001 is much smaller then the statistically significant 0.05, we can say that females are statistically more likely to eat fruits and vegetables.

Testing for Trend in Rates

Just as we use confidence intervals or the chi-square test to make comparisons between groups and places, we can use trend tests to determine if there are statistically significant changes in our data over time. When rates vary or differ over time, we may want to know whether things are actually getting better or worse—and rule out the possibility of random variation in the data.

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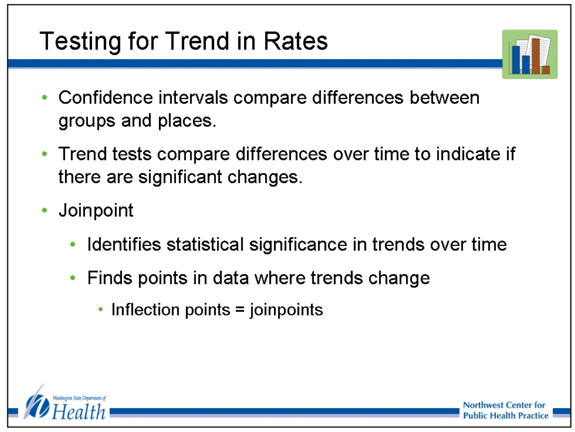
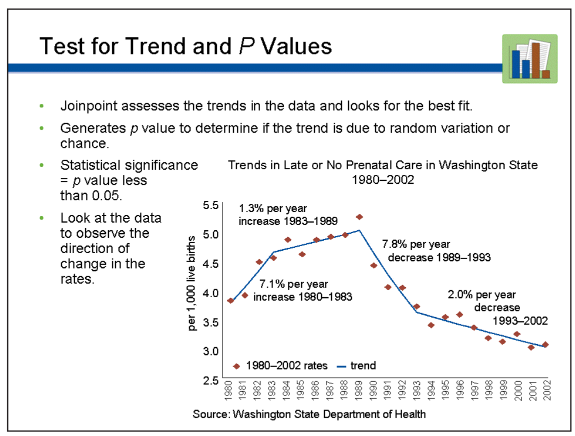
Washington Department of Health recommends using the Joinpoint Regression Program from the National Cancer Institute to test for statistical significance in trends. This program will examine rates over a time period to identify significant trends and find points in the data where the trends change slope or direction. These points where trends change are called inflection points or "join points." Since rates for health outcomes may increase for several years and then begin to level off or decrease, the ability to identify these changes, or join points, is essential to public health assessment.



Test for Trend and *P* Values

Joinpoint assesses trends by finding the best fit of straight lines through the data. The program then tests for how different the slopes of these lines are from flat lines. (Flat lines indicate no trend.) Joinpoint generates *p* values, which tell us whether these trend lines are statistically significant. If the *p* value is less than the conventional value of 0.05, this provides evidence that the trend may be real and not due to chance. The *p* value will not tell you whether the trend is going up or down—for that, you need to look at your data.



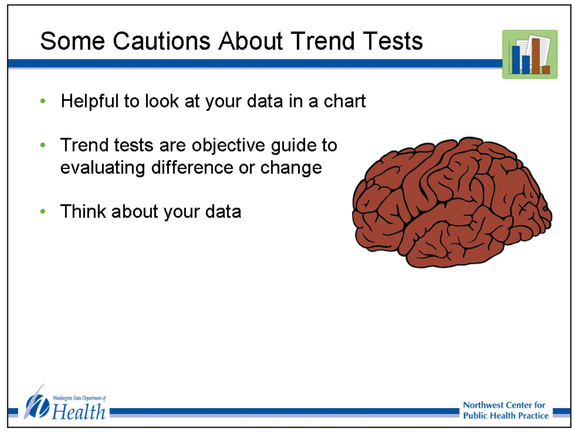
Let's look at an example of Joinpoint using prenatal care data. Late or no prenatal care shows a sharp increase from 1980 to 1983, and a slower increase from 1983 to 1989. Then the trend changes direction, and from 1989 to 1993 we see a sharp decrease in the trend—nearly 8% per year—which tapers off to a 2% per year decline from 1993 to 2002. Each of these trends is statistically significant.

To learn more about Joinpoint, use the link to the NCI Web site in the Resources section at the end of this module.

Some Cautions About Trend Tests

I want to make a couple of final points about trend tests.

It's always helpful to look at your data in a chart, so you can observe what's happening in the rates over time. Creating a line chart can help you see possible



upward and downward trends in the data that you can then test with a tool such as Joinpoint.

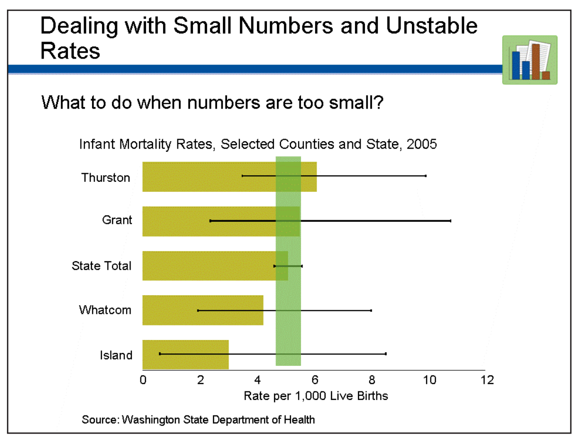
As we've discussed, trend tests are an objective guide to evaluating statistical difference or change. But keep in mind that the data can tell an important story even when trends are not statistically significant. For instance, if rates of a health outcome are continuously declining over time, the change may be real even if the numbers are too small to detect a statistically significant trend.

The bottom line is that these statistical tests are powerful tools, but they're no substitute for the most important tool: your brain. You always have to think, really think, about your data.

Let's pause now so you can answer some questions on what you have just learned.

Practice: Testing Trends

Dealing with Small Numbers and Unstable Rates



So, what do we do when our numbers are so small that there's too much statistical "noise," or variation, to reliably tell whether there's any meaningful difference between the rates? Fortunately we have ways of dealing with small numbers and unstable rates.

This chart shows rates for infant mortality—a relatively rare occurrence—for several counties and the state in 2005. The confidence intervals represented by the lines on the bars show the wide variation in the measures. The wider the confidence interval, the more unstable the rates are. The state rate, which is based on larger numbers, is more stable and so has a narrow confidence interval. You can see by looking at the confidence intervals that these rates are not likely to be statistically significantly different. We would still need to use additional statistical tests to determine if there was a statistically significant difference in the rates.

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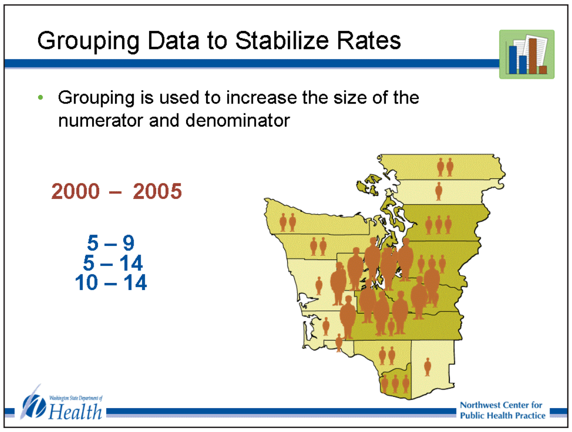
Grouping Data to Stabilize Rates

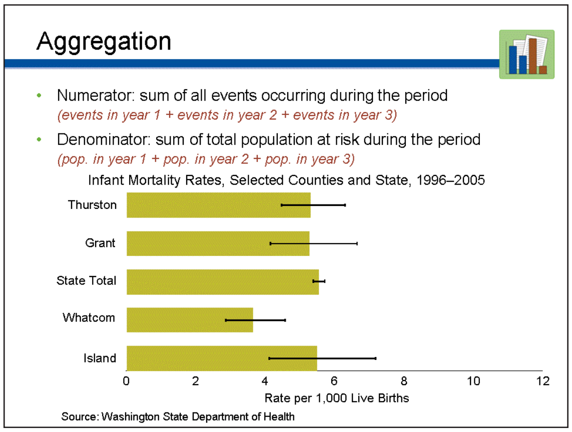


Our primary strategy for dealing with this problem is to aggregate—or group—data to stabilize rates. Grouping allows us to increase the size of the numerator and denominator. For example, you can:

- Combine across multiple years of data,
- Combine across geographic areas (such as counties), or
- Combine across groups of people (for example, aggregating 5 to 9 and 10 to 14 age groups into one 5 to 14 age group).

The purpose in grouping data in these ways is to create a larger population and, thus, more opportunity for the event of interest to occur in large enough numbers to analyze meaningfully.

Aggregation



When we aggregate data, the numerator is the sum of all events occurring during the period, and the denominator is the sum of the total population at risk during the period.

In our example of infant mortality rates for 2005, both the numerators and denominators are fairly small, especially in the smaller counties.

Here, we've aggregated three years of data to give us an average rate. You can see that the confidence intervals for these rates are smaller. But there are still no statistically significant differences.

And here's the same data averaged over five years. Now the confidence intervals are even smaller, but we can see that the differences in the rates are still not statistically significant because the confidence intervals have a large overlap. However, notice that the confidence interval for Whatcom County only slightly overlaps that of the state; thus, we cannot say for sure if they are statistically different.

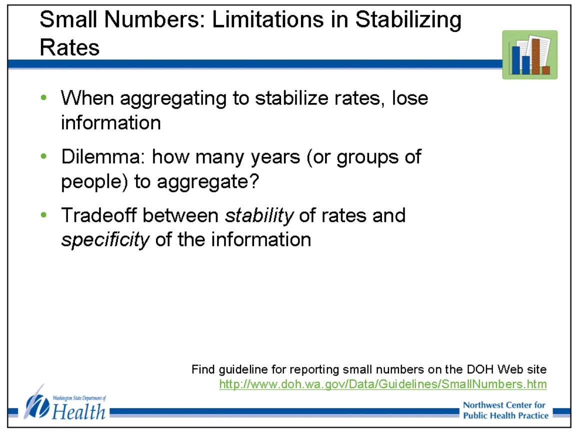
Finally, with a ten-year average rate, we can see a statistically significant difference between the state and Whatcom County, which has a lower rate. These examples clearly demonstrate that the larger numbers result in more stable rates.

For a more common event—such as teen births—you may need to aggregate only three years to stabilize the rates.

Module 3: Analysis and Interpretation of Public Health Data: Part 2

Transcript

Small Numbers: Limitations in Stabilizing Rates



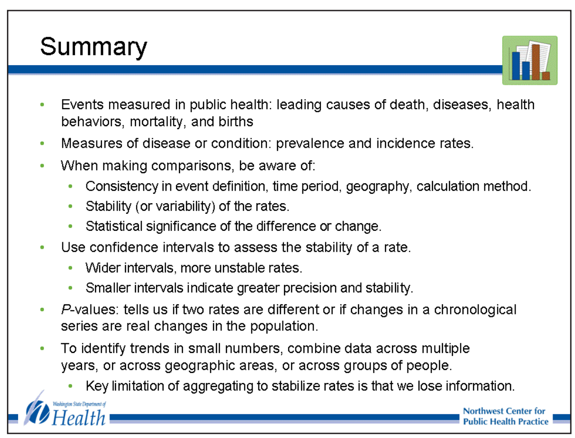
As you might guess, there are limitations to aggregating data. The key limitation is that in aggregating to stabilize rates, we lose information. As you saw with infant mortality rates, we had to combine ten years of data into one rate. But, significant changes may have occurred over that time period that are obscured in our average rate. So, the dilemma is knowing how many years—or groups of people—to aggregate. Often this comes down to a tradeoff between stability of rates and specificity of the information.

You can find more guidelines for reporting small numbers on the DOH Web site.

Let's pause now so you can answer some questions on what you have just learned.

Practice: Aggregating Rates

Summary



To summarize, we looked at a variety of health events, such as leading causes of death, diseases, health behaviors, mortality, and births, and the measures used to assess them. Two important measures of disease are prevalence and incidence rates.

Prevalence rates measure the total number of cases of a condition in a population.

Incidence rates measure the number of new cases of a condition in a population during a given time period.

When we make comparisons between populations or events, we must be aware of three issues: consistency in event definition, time period, geography, and calculation method; stability (or variability) of the rates; and statistical significance of differences of changes.

Statistical significance gives us an objective gauge of when a difference between groups or places is real.

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Transcript

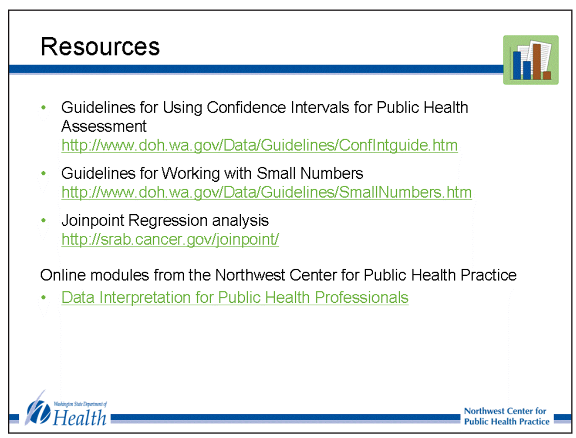
We use confidence intervals to assess the stability of a rate. Wider confidence intervals indicate more unstable rates. Narrower confidence intervals indicate greater precision and stability. For most circumstances, we use a 95% confidence interval.

We can also use confidence intervals to determine if there is a statistically significant difference when comparing two rates or proportions.

P values tell us the probability that a value is real or due to chance. The *p* value helps us determine whether two rates are different or if the increases or decreases in a chronologic series of rates indicate real changes in the population. The conventional definition of "statistically significant" is a *p* value less than 0.05.

Public health often works with rates that have very small numbers, such as infant mortality. In order to identify trends in small numbers, we can combine, or aggregate, data across multiple years, or across geographic areas, or across groups of people. A key limitation of aggregating to stabilize rates is the loss of specificity.

Resources



If you would like to learn more about the concepts in this module, you might want to explore some of the resources listed here.

Guidelines for Using Confidence Intervals for Public Health Assessment
www.doh.wa.gov/Data/Guidelines/ConfIntguide.htm

Guidelines for Working with Small Numbers
www.doh.wa.gov/Data/Guidelines/SmallNumbers.htm

Joinpoint Regression analysis
http://srab.cancer.gov/joinpoint

Online modules from the Northwest Center for Public Health Practice

Data Interpretation for Public Health Professionals
www.nwcphp.org/data

Now, if you're ready, please go on to the final test.