

RATIOS, PROPORTIONS, PERCENTAGES, AND RATES

1. **Ratios:** ratios are one number expressed in relation to another by dividing the one number by the other. For example, the sex ratio of Delaware in 1990 was:

343,200 females to 322,968 males or 1.06

This can easily be expressed in terms of males to females, .94. There is really no way other than tradition and practice or your specific purpose to determine which figure is the numerator and which is the denominator. The interpretation of the sex ratio is that for every male there are 1.06 females. Sometimes we express this as the ratio per 100, 1,000, or 100,000 persons. So, we could say 106 females for every 100 males.

Other ratios commonly used are:

Population Density -- the number of people per square mile. In 1990 in Delaware, the population density was:

$666,168 \text{ persons} / 1955 \text{ sq. miles} = 341 \text{ persons per square mile}$

In New Castle County, the population density was:

$441,946/426 = 1,037 \text{ persons per square mile}$

The Dependency Ratio -- the number of people under age 15 plus the number 65 and over divided by the number of people 15 to 64. It is a crude measure of dependency that assumes age defines your economic contribution. :

In 1994 in Delaware, the dependency ratio was estimated as:

$(152,869 + 90,329)/462,396 = .53$

For every 100 workers there are 53 dependents, or

For every dependent, there are 1.9 workers

2. **Proportions:** proportions are special kinds of ratios where the denominator is the total while the numerator is a subpart of the total. This tells us what part the numerator is of the total. Thus, while the ratio of females to males in Delaware is 1.06, females represent .515 proportion of the total. Percentages are just a form of the proportion based on 100 people. To calculate a percentage we simply multiply a proportion by 100 (females are 51.5% of the total).
3. **Rates:** rates are a special form of a ratio which represents the probability of a certain event. The numerator is the number of occurrences of an event during a time period, and the denominator is the number of persons exposed to that event in the time period. To be a true rate we must try to have only those at risk in the denominator. Sometimes this is difficult to do so we use approximations or use the total population. In the latter case we generally call it a *crude rate*. Let's use fertility rates as examples:

The Crude Birth Rate is given by the number of live births per 1,000 population in a given year. In 1994 the crude birth rate for Delaware was estimated as:

$(10,390/705,594) \times 1,000 = 14.7$

HOW TO PERCENTAGE A TABLE

Often people are confused as to the correct way to percentage a table. In fact, the correct percentage depends upon the purpose of the user. Suppose we have a simple table of labor force participation by sex (see Table 1). The Percentage of males in the labor force could be expressed as:

- a. The # of males in the labor force over the total # of persons 16 years and over:
 $(188,631/518,946) \times 100 = 36.35\%$
- b. The # of males in the labor force over the total # in the labor force:
 $(188,631/354,474) \times 100 = 53.21\%$
- c. The # of males in the labor force over the total # of males 16 years and over:
 $(188,631/247,566) \times 100 = 76.19\%$

Table 1: Labor Force Participation of Males and Females 16 Years and Over in Delaware, 1990

Labor Force Participation	Males	Females	Total
	N	N	N
In the Labor Force	188,631	165,843	354,474
Not in the Labor Force	58,935	105,537	164,472
TOTAL	247,566	271,380	518,946

Table 2 shows the table using all three percentages, which is often given by a computer statistical package such as SAS. We have three numbers, but which one is right? The simple answer is that all three are right, but they tell different stories. Calculation (a) tells what percent of the total possible labor force (persons 16 years and over) are males in the labor force. Most times this is not all that interesting. Calculation (b) gives an indication of the percentage of those in the labor force who are male. This is analogous to saying: *Given a person is in the labor force, what is the probability that this person is a male?* The answer is that 53.21 percent of the those in the labor force are males. This may be of interest, but in a causal sense we don't think that being in the labor force causes (or influences) a person to be male.

Table 2: Labor Force Participation of Males and Females 16 Years and Over, in Delaware, 1990, with Row, Column, and Total Percentages

Labor Force Participation	Males	Females	Total
	N	N	N
In the Labor Force	188,631	165,843	354,474
	53.21%	46.79%	68.31%
	76.19%	61.11%	
	36.35%	31.96%	
Not in the Labor Force	58,935	105,537	164,472
	35.83%	64.17%	31.69%
	23.81%	38.89%	
	11.36%	20.34%	
TOTAL	247,566	271,380	518,946
	47.71%	52.29%	

On the other hand, calculation (c) gives the percentage of all males 16 years and older who are in the labor force. This is analogous to saying: **Given a person is male, what is the probability of being in the labor force?** The latter calculation is a labor force participation rate and is generally what we want to report. Table 2 shows the full labor force participation rates for males and females.

The Rule of Thumb is:

*If you can specify one variable as causing or influencing a second variable, the first variable is called the **independent variable** and the latter is called the **dependent variable**. You should percentage in the direction of your independent variable.*

For example, consider the following table.

Table 2: Labor Force Participation Rates of Males and Females 16 Years and Over, in Delaware, 1990

Labor Force Participation	Males	Females	Total
	N (Percent)	N (Percent)	N (Percent)
In the Labor Force	188,631 (76.19%)	165,843 (61.11%)	354,474 (68.31%)
Not in the Labor Force	58,935 (23.81%)	105,537 (38.89%)	164,472 (31.69%)
TOTAL	247,566	271,380	518,946

In this case, **the independent variable is the total number of males. The dependent variable is the number in the labor force.** "In the direction of..." means that the independent variable should be used as the denominator or the point of comparison.

HOW TO CALCULATE AN ODDS RATIO

Odds ratios have become popular ways of displaying data. Whenever you hear an expression such as, "One group is 3 times more likely to suffer from chronic disease", this is an odds ratio. It expresses the likelihood of one group experiencing a situation relative to another group. Here's how it works. Table 1 shows the labor force participation of males and females 16 years and over in Delaware.

Table 1: Labor Force Participation of Males and Females 16 Years and Over in Delaware, 1990

Labor Force Participation	Males	Females	Total
	N	N	N
In the Labor Force	188,631	165,843	354,474
Not in the Labor Force	58,935	105,537	164,472
TOTAL	247,566	271,380	518,946

The odds of males being in the labor force is the ratio of males in the labor force to males not in the labor force:

$$\text{Odds}_{\text{males in LF}} = 188,631/58,935 = 3.20$$

This means males are 3.2 times more likely to be in the labor force rather than not be in the labor force.

The odds of females being in the labor force is the ratio of females in the labor force to females not in the labor force:

$$\text{Odds}_{\text{females in LF}} = 165,843/105,537 = 1.57$$

This means that females are 1.57 times more likely to be in the labor force rather than not be in the labor force.

The **Odds Ratio** of males in the labor force to females in the labor force is the ratio of the two odds:

$$\text{Odds Ratio}_{\text{Males to Females}} = 3.20/1.57 = 2.04$$

This means that males are twice as likely to be in the labor force than are females.

Odds ratios take some getting used to before feeling comfortable. Notice that an odds ratio of two does not mean the percentage or proportion for males is twice that for females. It just means that males are twice as likely to be in the labor force when compared to females (the odds for males is twice that for females).

Odds ratios are very useful when comparing subgroups to each other. For example, labor force participation rates for women with children is much higher than those without children. Part of the difference is due to age - women with children are younger, and younger persons are more likely to be in the labor force. However, part of the difference reflects real social change as over time more women in families with children are working to make ends meet. In 1990, 73.64 percent of women with children under 18 were in the labor force. Consider the following analysis using odds and odds ratios:

The odds of females with children under 18 being in the labor force is the ratio of females with children in the labor force to females with children not in the labor force:

$$\text{Odds}_{\text{females with children}} = 62,390/22,338 = 2.79$$

This means that females with children under 18 are 2.79 times more likely to be in the labor force rather than not be in the labor force.

The odds of females without children under 18 being in the labor force is the ratio of females without children in the labor force to females without children not in the labor force:

$$\text{Odds}_{\text{females without children}} = 103,453/83,199 = 1.24$$

This means that females without children under 18 are only 1.24 times more likely to be in the labor force rather than not be in the labor force.

The **Odds Ratio** of females with children under 18 in the labor force to females without children under 18 in the labor force is the ratio of the two odds:

$$\text{Odds Ratio}_{\text{Females W/C to Females Wo/C}} = 2.79/1.24 = 2.25$$

This means that women with children are over twice as likely to be in the labor force than are women without children under 18.