Description of a Study Sample

EXERCISE 10

STATISTICAL TECHNIQUE IN REVIEW

Most research reports describe the subjects or participants who comprise the study sample. This description of the sample is called the **sample characteristics**, which may be presented in a table and/or the narrative of the article. The sample characteristics are often presented for each of the groups in a study (i.e., intervention and control groups). Descriptive statistics are calculated to generate sample characteristics, and the type of statistic conducted depends on the level of measurement of the demographic variables included in a study (Grove, Burns, & Gray, 2013). For example, data collected on gender is nominal level and can be described using frequencies, percentages, and mode. Measuring educational level usually produces ordinal data that can be described using frequencies, percentages, mode, median, and range. Obtaining each subject's specific age is an example of ratio data that can be described using mean, range, and standard deviation. Interval and ratio data are analyzed with the same statistical techniques and are sometimes referred to as interval/ratio-level data in this text.

RESEARCH ARTICLE

Source

Oh, E. G., Yoo, J. Y., Lee, J. E., Hyun, S. S., Ko, I. S., & Chu, S. H. (2014). Effects of a three-month therapeutic lifestyle modification program to improve bone health in postmenopausal Korean women in a rural community: A randomized controlled trial. *Research in Nursing & Health, 37*(4), 292–301.

Introduction

Oh and colleagues (2014) conducted a randomized controlled trial (RCT) to examine the effects of a therapeutic lifestyle modification (TLM) intervention on the knowledge, self-efficacy, and behaviors related to bone health in postmenopausal women in a rural community. The study was conducted using a pretest-posttest control group design with a sample of 41 women randomly assigned to either the intervention (n = 21) or control group (n = 20). "The intervention group completed a 12-week, 24-session TLM program of individualized health monitoring, group health education, exercise, and calcium–vitamin D supplementation. Compared with the control group, the intervention group showed significant increases in knowledge and self-efficacy and improvement in diet and exercise after 12 weeks, providing evidence that a comprehensive TLM program can be effective in improving health behaviors to maintain bone health in women at high risk of osteoporosis" (Oh et al., 2014, p. 292).

Relevant Study Results

"Bone mineral density (BMD; g/cm^2) was measured by dual energy x-ray absorptiometry (DXA) with the use of a DEXXUM T machine.... A daily calibration inspection was performed. The error rate for these scans is less than 1%. Based on the BMD data, the participants were classified into three groups: osteoporosis (a BMD *T*-score less than −2.5); osteopenia (a BMD *T*-score between −2.5 and −1.0); and normal bone density (a BMD *T*-score higher than −1.0)" (Oh et al. 2014, p. 295).

"Characteristics of Participants

The study participants were 51–83 years old, and the mean age was 66.2 years ($SD = 8.2$). The mean BMI was 23.8 kg/m^2 ($SD = 3.2$). Most participants did not consume alcoholic drinks, and all were nonsmokers. Antihypertensives and analgesics such as aspirin and acetaminophen were the most common medications taken by the participants. Less than 20% of participants had a regular routine of exercise at least three times per week. Daily calcium- and vitamin D-rich food intake (e.g., dairy products, fish oil, meat, and eggs) was low. Seventy-five percent ($n = 31$) of the participants had osteoporosis or osteopenia. There were no differences in the baseline characteristics of the groups (Table 2). The adherence rate to the TLM program was 99.6%" (Oh et al., 2014, p. 296).

TABLE 2 BASELINE CHARACTERISTICS AND HOMOGENEITY OF THE TREATMENT AND CONTROL GROUPS

Characteristic	Intervention (n = 21) Mean ± SD	Control (n = 20) Mean ± SD	t or χ^{2a}
Anthropometric			
Age (years)	65.95 ± 8.59	66.35 ± 7.94	0.154
Height (cm)	152.33 ± 6.53	150.57 ± 6.01	0.896
Weight (kg)	57.90 ± 10.85	54.66 ± 9.48	1.016
BMI (kg/m²)	24.17 ± 3.14	23.38 ± 3.32	0.782
Lifestyle			
Years since menopause	20.21 ± 10.44	17.5 ± 11.05	0.767
Calcium-rich food intake (times/week)	27.3 ± 11.4	23.8 ± 8.8	1.110
Vitamin D-rich food intake (times/week)	2.4 ± 2.5	3.1 ± 3.1	0.705

Characteristic	Intervention (n = 21)		Control (n = 20)		t or χ^{2a}
	n	%	n	%	
History of fracture	8	38	5	25	1.026
Regular exercise (≥3 times/week)	4	19	4	20	0.006
Non-drinker (alcohol)	20	95	20	100	0.024
Non-smoker	21	100	20	100	0.024
Bone status[b]					
Normal (T ≥ −1.0)	6	29	4	20	1.995
Osteopenia (−1.0 > T > −2.5)	8	38	12	60	
Osteoporosis (T ≤ −2.5)	7	33	4	20	

Characteristic	Intervention (n = 21) Mean ± SD	Control (n = 20) Mean ± SD	t or χ^{2a}
BMD			
Lumbar 2–4	0.83 ± 0.12	0.85 ± 0.20	0.526
Femur neck	0.67 ± 0.15	0.67 ± 0.13	0.055
Bone biomarkers			
Serum osteocalcin (ng/ml)	13.97 ± 4.90	15.85 ± 5.64	1.135
Serum calcium (mg/dl)	9.47 ± 0.40	9.54 ± 0.59	0.405
Serum phosphorus (mg/dl)	3.68 ± 0.44	3.70 ± 0.50	0.165
Serum alkaline phosphatase (IU/L)	68.43 ± 21.52	66.70 ± 13.24	0.308
Serum 25-OH-Vitamin D (ng/ml)	14.03 ± 4.34	12.38 ± 4.65	1.177
Urine deoxypyridinoline (nM/mM creatinine)	5.70 ± 1.70	5.95 ± 1.12	0.555

Note. SD, standard deviation; BMD, bone mineral density (g/cm²).
[a]All group differences $p > 0.05$.
[b]Defined from *T*-score of femur neck site based on World Health Organization criteria.

Oh, E. G., Yoo, J. Y., Lee, J. E., Hyun, S. S., Ko, I. S., & Chu, S. H. (2014). Effects of a three-month therapeutic lifestyle modification program to improve bone health in postmenopausal Korean women in a rural community: A randomized controlled trial. *Research in Nursing & Health, 37*(4), p. 297.

STUDY QUESTIONS

1. What demographic variables were described in this study?

2. Which variable was measured at the ordinal level? Provide a rationale for your answer.

3. What level of measurement is the data for history of fracture? Provide a rationale for your answer.

4. What statistics were calculated to describe history of fracture? Were these appropriate? Provide a rationale for your answer.

5. Could a mean be calculated on the history of fracture data? Provide a rationale for your answer.

6. What statistics were calculated to describe the regular exercise (≥3 times per week) for the intervention and control groups? Calculate the frequency and percentage of the total sample who exercised regularly. Round your answer to the nearest tenth of a percent.

7. What statistics were calculated to describe age in this study? Were these appropriate? Provide a rationale for your answer.

8. Were the intervention and control groups significantly different for age? Provide a rationale for your answer.

9. What was the mode for bone status for the total sample ($N = 41$)? Determine the frequency and percentage for the bone status mode for the sample. Round your answer to the nearest whole percent. Why is this clinically important?

10. Based on the bone status of the study participants, discuss the clinical importance of this study. Document your response.

Answers to Study Questions

1. Demographic variables described in the study were age, height, weight, body mass index (BMI), lifestyle (years since menopause, calcium-rich food intake, vitamin D-rich food intake), history of fracture, regular exercise, alcohol consumption, and smoking. You might have identified the bone status, bone mineral density (BMD), and bone biomarkers but these are dependent variables for this study (Grove et al., 2013).

2. The variable bone status provided ordinal-level data. The researchers classified the participants into three groups, normal (*T*-score higher than −1.0), osteopenia (*T*-score between −1.0 and −2.5), and osteoporosis (*T*-score less than −2.5), based on their BMD scores. These categories are exhaustive, mutually exclusive, and can be ranked from greatest or normal BMD to osteoporosis or least BMD.

3. The data collected for history of fracture are nominal level, including the two categories of no history of fracture and yes history of fracture. These categories are exhaustive and mutually exclusive, since all study participants will fit into only one category. These yes and no categories of history of fracture cannot be ranked so the data are nominal versus ordinal level (see Exercise 1).

4. Frequencies and percentages were used to describe history of fracture for the intervention and control groups. Since the data are nominal, frequencies and percentages were appropriate. The researchers might have also identified the mode, which was no history of fracture since 13 participants had a history of fracture and 28 had no history of fracture.

5. No, a mean cannot be calculated on the history of fracture data, which are nominal-level data that can only be organized into categories (see Exercise 1). A mean can only be calculated on interval- and ratio-level data that are continuous and have numerically equal distances between intervals.

6. Regular exercise was described for both the intervention and control groups using frequencies and percentages. A total of 8 or 19.5% of the participants exercised regularly. Eight of the participants (4 in the intervention and 4 in the control groups) were involved in regular exercise of the sample ($N = 41$). Percentage $= (8 \div 41) \times 100\% = 0.1951 \times 100\% = 19.51\% = 19.5\%$. Researchers also indicated in the narrative that less than 20% of the participants were involved in regular exercise, supporting the importance of providing these individuals with an exercise program.

7. Age was described with means and *SD*s for the intervention and control groups (see Table 2). In the narrative, the range of ages for the participants was identified as 51–83 years, and the mean age for the total sample was 66.2 years ($SD = 8.2$). The statistics were appropriate since age was measured in years, which are ratio-level data that are analyzed with mean, *SD*, and range (Grove et al., 2013).

8. No, the groups were not significantly different for age. The results from the *t*-test ($t = 0.154$) indicated that the groups were not significantly different for age. In addition, the bottom of Table 2 states that all group differences were $p > 0.05$. The level of significance (alpha) in nursing studies is usually set at $\alpha = 0.05$, and since all differences were $p > 0.05$, then no significant differences were found for the baseline characteristics between the intervention and control groups.

9. The mode was osteopenia for the intervention and the control groups. The number and percentage of participants with osteopenia for the sample was $(8 + 12) \div 41 \times 100\% = (20 \div 41) \times 100\% = 0.488 \times 100\% = 48.8\% = 49\%$. It is clinically important that 49% of the women in the study had osteopenia or thinning bones and needed assistance in managing their bone health problem. Also 11 participants had osteoporosis or holes in their bones, an even more serious condition, requiring immediate and aggressive management to prevent fractures.

10. Oh et al. (2014) indicated that 75% ($n = 31$) of the study participants had osteopenia or osteoporosis. So it is important for these individuals to have their bone health problem diagnosed and managed. The TLM program is multifaceted and has the potential to reduce these women's bone health problems (osteopenia and osteoporosis). Additional research is needed to determine the effect of this intervention with larger samples and over extended time periods. National guidelines and important information about the assessment, diagnosis, and management of osteoporosis and osteopenia might be found at the following website: http://www.guideline.gov/search/search.aspx?term=osteoporosis or the National Osteoporosis Foundation (NOF) website at http://www.nof.org. You might use a variety of resources for documentation including research articles, websites, and textbooks.

Questions to Be Graded

EXERCISE 10

Name: ______________________ Class: ____________

Date: ______________________

Follow your instructor's directions to submit your answers to the following questions for grading. Your instructor may ask you to write your answers below and submit them as a hard copy for grading. Alternatively, your instructor may ask you to use the space below for notes and submit your answers online at http://evolve.elsevier.com/Grove/statistics/ under "Questions to Be Graded."

1. What demographic variables were measured at the nominal level of measurement in the Oh et al. (2014) study? Provide a rationale for your answer.

2. What statistics were calculated to describe body mass index (BMI) in this study? Were these appropriate? Provide a rationale for your answer.

3. Were the distributions of scores for BMI similar for the intervention and control groups? Provide a rationale for your answer.

4. Was there a significant difference in BMI between the intervention and control groups? Provide a rationale for your answer.

5. Based on the sample size of $N = 41$, what frequency and percentage of the sample smoked? What frequency and percentage of the sample were non-drinkers (alcohol)? Show your calculations and round to the nearest whole percent.

6. What measurement method was used to measure the bone mineral density (BMD) for the study participants? Discuss the quality of this measurement method and document your response.

7. What statistic was calculated to determine differences between the intervention and control groups for the lumbar and femur neck BMDs? Were the groups significantly different for BMDs?

8. The researchers stated that there were no significant differences in the baseline characteristics of the intervention and control groups (see Table 2). Are these groups heterogeneous or homogeneous at the beginning of the study? Why is this important in testing the effectiveness of the therapeutic lifestyle modification (TLM) program?

9. Oh et al. (2014, p. 296) stated that "the adherence rate to the TLM program was 99.6%." Discuss the importance of intervention adherence, and document your response.

10. Was the sample for this study adequately described? Provide a rationale for your answer.

Determining the Normality of a Distribution

EXERCISE 26

Most parametric statistics require that the variables being studied are normally distributed. The normal curve has a symmetrical or equal distribution of scores around the mean with a small number of outliers in the two tails. The first step to determining normality is to create a frequency distribution of the variable(s) being studied. A frequency distribution can be displayed in a table or figure. A line graph figure can be created whereby the x axis consists of the possible values of that variable, and the y axis is the tally of each value. The frequency distributions presented in this Exercise focus on values of continuous variables. With a continuous variable, higher numbers represent more of that variable and the lower numbers represent less of that variable, or vice versa. Common examples of continuous variables are age, income, blood pressure, weight, height, pain levels, and health status (see Exercise 1).

The frequency distribution of a variable can be presented in a **frequency table,** which is a way of organizing the data by listing every possible value in the first column of numbers, and the frequency (tally) of each value as the second column of numbers. For example, consider the following hypothetical age data for patients from a primary care clinic. The ages of 20 patients were: 45, 26, 59, 51, 42, 28, 26, 32, 31, 55, 43, 47, 67, 39, 52, 48, 36, 42, 61, and 57.

First, we must sort the patients' ages from lowest to highest values:

26
26
28
31
32
36
39
42
42
43
45
47
48
51
52
55
57
59
61
67

Next, each age value is tallied to create the frequency. This is an example of an ungrouped frequency distribution. In an **ungrouped frequency distribution**, researchers list all categories of the variable on which they have data and tally each datum on the listing. In this example, all the different ages of the 20 patients are listed and then tallied for each age.

Age	Frequency
26	2
28	1
31	1
32	1
36	1
39	1
42	2
43	1
45	1
47	1
48	1
51	1
52	1
55	1
57	1
59	1
61	1
67	1

Because most of the ages in this dataset have frequencies of "1," it is better to group the ages into ranges of values. These ranges must be mutually exclusive (i.e., a patient's age can only be classified into one of the ranges). In addition, the ranges must be exhaustive, meaning that each patient's age will fit into at least one of the categories. For example, we may choose to have ranges of 10, so that the age ranges are 20 to 29, 30 to 39, 40 to 49, 50 to 59, and 60 to 69. We may choose to have ranges of 5, so that the age ranges are 20 to 24, 25 to 29, 30 to 34, etc. The grouping should be devised to provide the greatest possible meaning to the purpose of the study. If the data are to be compared with data in other studies, groupings should be similar to those of other studies in this field of research. Classifying data into groups results in the development of a grouped frequency distribution. Table 26-1 presents a grouped frequency distribution of patient ages classified by ranges of 10 years. Note that the range starts at "20" because there are no patient ages lower than 20, nor are there ages higher than 69.

Table 26-1 also includes percentages of patients with an age in each range; the cumulative percentages for the sample should add up to 100%. This table provides an example of a percentage distribution that indicates the percentage of the sample with scores falling into a specific group. Percentage distributions are particularly useful in comparing this study's data with results from other studies.

TABLE 26-1 GROUPED FREQUENCY DISTRIBUTION OF PATIENT AGES WITH PERCENTAGES

Adult Age Range	Frequency (f)	Percentage (%)	Cumulative Percentage
20–29	3	15%	15%
30–39	4	20%	35%
40–49	6	30%	65%
50–59	5	25%	90%
60–69	2	10%	100%
Total	20	100%	

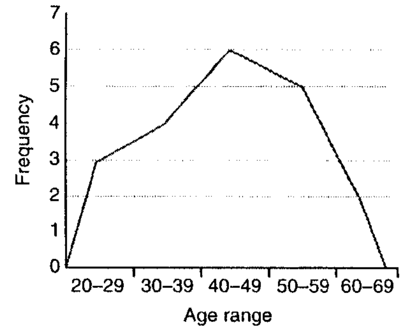


FIGURE 26-1 ■ FREQUENCY DISTRIBUTION OF PATIENT AGE RANGES.

As discussed earlier, frequency distributions can be presented in figures. The common figures used to present frequencies include graphs, charts, histograms, and frequency polygons. Figure 26-1 is a line graph of the frequency distribution for age ranges, where the x axis represents the different age ranges and the y axis represents the frequencies (tallies) of patients with ages in each of the ranges.

THE NORMAL CURVE

The theoretical normal curve is an expression of statistical theory. It is a theoretical frequency distribution of all *possible* scores (see Figure 26-2). However, no real distribution exactly fits the normal curve. This theoretical normal curve is symmetrical, unimodal, and has continuous values. The mean, median, and mode are equal (see Figure 26-2). The distribution is completely defined by the mean and standard deviation, which are calculated and discussed in Exercises 8 and 27.

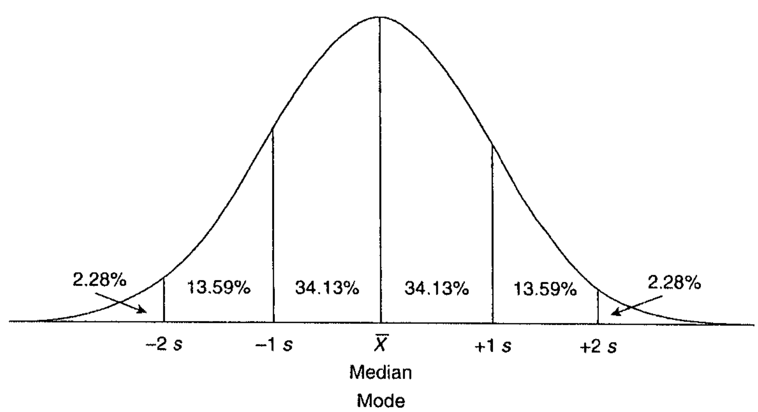


FIGURE 26-2 ■ THE NORMAL CURVE.

SKEWNESS

Any frequency distribution that is not symmetrical is referred to as **skewed** or **asymmetrical**. Skewness may be exhibited in the curve in a variety of ways. A distribution may be **positively skewed**, which means that the largest portion of data is below the mean. For example, data on length of enrollment in hospice are positively skewed because most of

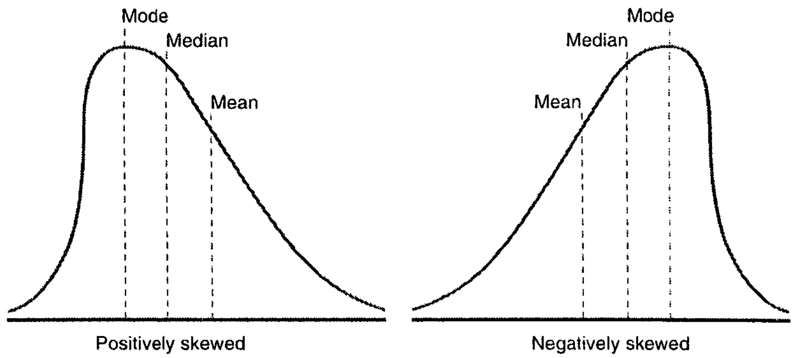


FIGURE 26-3 ▪ EXAMPLES OF POSITIVELY AND NEGATIVELY SKEWED DISTRIBUTIONS.

the people die within the first 3 weeks of enrollment, whereas increasingly smaller numbers of people survive as time increases. A distribution can also be **negatively skewed**, which means that the largest portion of data is above the mean. For example, data on the occurrence of chronic illness in an older age group are negatively skewed, because more chronic illnesses occur in seniors. Figure 26-3 includes both a positively skewed distribution and a negatively skewed distribution.

In a skewed distribution, the mean, median, and mode are not equal. Skewness interferes with the validity of many statistical analyses; therefore, statistical procedures have been developed to measure the skewness of the distribution of the sample being studied. Few samples will be perfectly symmetrical; however, as the deviation from symmetry increases, the seriousness of the impact on statistical analysis increases. In a positively skewed distribution, the mean is greater than the median, which is greater than the mode. In a negatively skewed distribution, the mean is less than the median, which is less than the mode (see Figure 26-3). The effects of skewness on the types of statistical analyses conducted in a study are discussed later in this exercise.

KURTOSIS

Another term used to describe the shape of the distribution curve is kurtosis. **Kurtosis** explains the degree of peakedness of the frequency distribution, which is related to the spread or variance of scores. An extremely peaked distribution is referred to as **leptokurtic**, an intermediate degree of kurtosis as **mesokurtic**, and a relatively flat distribution as **platykurtic** (see Figure 26-4). Extreme kurtosis can affect the validity of statistical analysis because the scores have little variation. Many computer programs analyze kurtosis before conducting statistical analyses. A kurtosis of zero indicates that the curve is mesokurtic, kurtosis values above zero indicate that the curve is leptokurtic, and values below zero that are negative indicate a platykurtic curve (Grove, Burns, & Gray, 2013).

TESTS OF NORMALITY

Skewness and kurtosis should be assessed prior to statistical analysis, and the importance of such non-normality needs to be determined by both the researcher and the statistician. Skewness and kurtosis statistic values of $\geq +1$ or ≥ -1 are fairly severe and could impact the outcomes from parametric analysis techniques. Because the severity of the deviation from symmetry compromises the validity of the parametric tests, nonparametric analysis

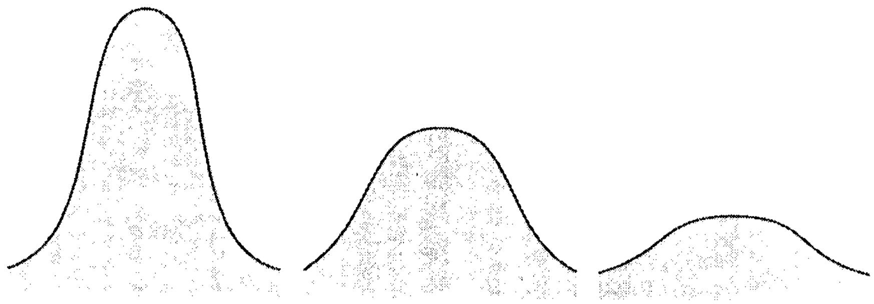


FIGURE 26-4 ■ EXAMPLES OF KURTOTIC DISTRIBUTIONS.

techniques should be computed instead. Nonparametric statistics have no assumption that the distribution of scores be normally distributed (Daniel, 2000).

There are statistics that obtain an indication of *both* the skewness and kurtosis of a given frequency distribution. The Shapiro-Wilk's W test is a formal test of normality that assesses whether a variable's distribution is skewed and/or kurtotic. Thus this test has the ability to calculate both skewness and kurtosis by comparing the shape of the variable's frequency distribution to that of a perfect normal curve. For large samples ($n > 2000$) the Kolmogorov-Smirnov D test is an alternative test of normality for large samples.

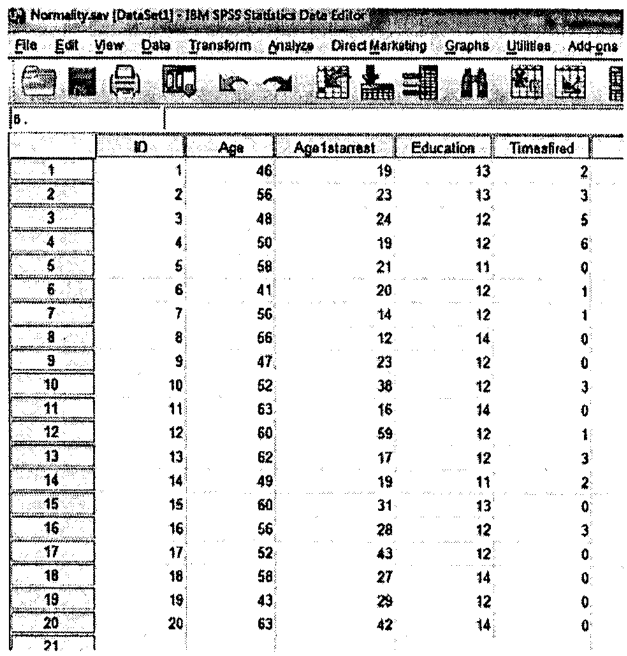
SPSS COMPUTATION

A randomized experimental study examined the impact of a special type of vocational rehabilitation on employment among veterans with felony histories (LePage, Bradshaw, Cipher, & Hooshyar, 2014). Age at study enrollment, age at first arrest, years of education, and number of times fired were among the study variables examined. A simulated subset of the study data is presented in Table 26-2.

TABLE 26-2 AGE, EDUCATION, AND TERMINATION HISTORY AMONG VETERANS WITH FELONIES

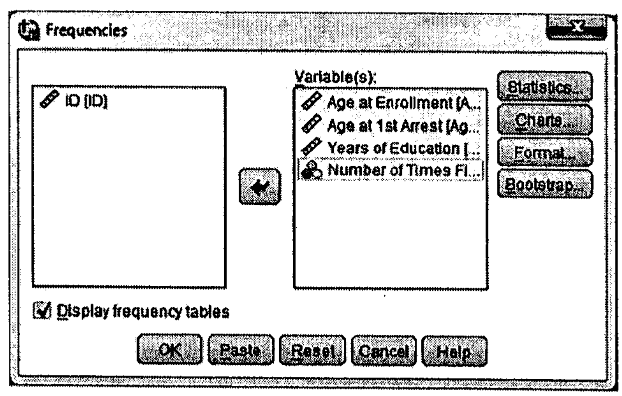
ID	Age	Age at 1st Arrest	Education	Number Times Fired
1	46	19	13	2
2	56	23	13	3
3	48	24	12	5
4	50	19	12	6
5	58	21	11	0
6	41	20	12	1
7	56	14	12	1
8	56	12	14	0
9	47	23	12	0
10	52	38	12	3
11	63	16	14	0
12	60	59	12	1
13	62	17	12	3
14	49	19	11	2
15	60	31	13	0
16	56	28	12	3
17	52	43	12	0
18	58	27	14	0
19	43	29	12	0
20	63	42	14	0

This is how our dataset looks in SPSS.

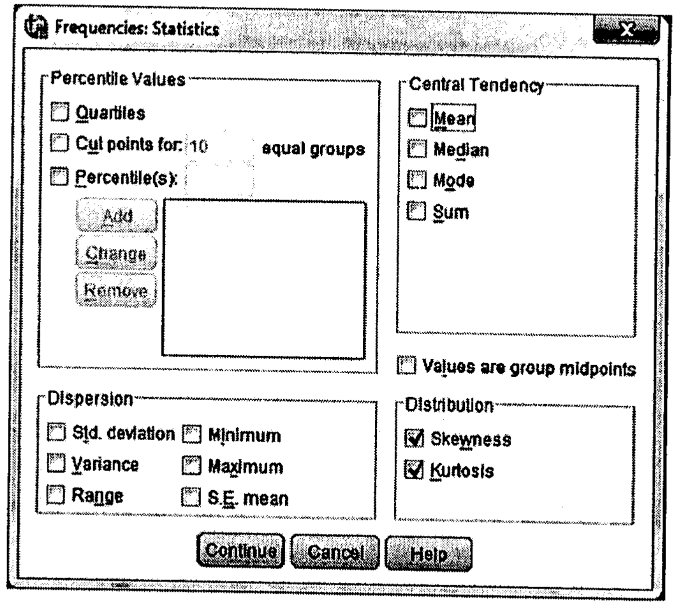


	ID	Age	Age1starrest	Education	Timesfired
1	1	46	19	13	2
2	2	56	23	13	3
3	3	48	24	12	5
4	4	50	19	12	6
5	5	58	21	11	0
6	6	41	20	12	1
7	7	56	14	12	1
8	8	66	12	14	0
9	9	47	23	12	0
10	10	52	38	12	3
11	11	63	16	14	0
12	12	60	59	12	1
13	13	62	17	12	3
14	14	49	19	11	2
15	15	60	31	13	0
16	16	56	28	12	3
17	17	52	43	12	0
18	18	58	27	14	0
19	19	43	29	12	0
20	20	63	42	14	0
21					

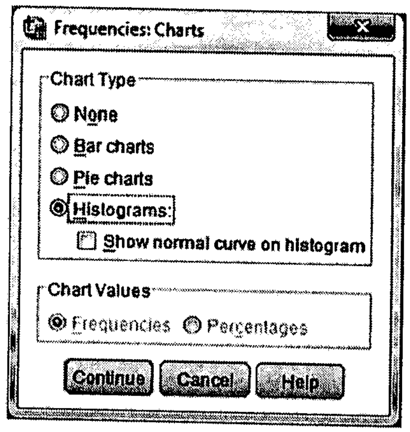
Step 1: From the "Analyze" menu, choose "Descriptive Statistics" and "Frequencies." Move the four study variables over to the right.



Step 2: Click "Statistics." Check "Skewness" and "Kurtosis." Click "Continue."



Step 3: Click "Charts." Check "Histograms." Click "Continue" and then "OK."



INTERPRETATION OF SPSS OUTPUT

The following tables are generated from SPSS. The first table contains the skewness and kurtosis statistics for the four variables.

Frequencies

Statistics

		Age at Enrollment	Age at 1st Arrest	Years of Education	Number of Times Fired from Job
N	Valid	20	20	20	20
	Missing	0	0	0	0
Skewness		-.351	1.402	.576	1.133
Std. Error of Skewness		.512	.512	.512	.512
Kurtosis		-.883	2.043	-.575	.576
Std. Error of Kurtosis		.992	.992	.992	.992

The next four tables contain the frequencies, or tallies, of the variable values. The last four tables contain the frequency distributions of the four variables.

Frequency Table

Age at Enrollment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	41	1	5.0	5.0	5.0
	43	1	5.0	5.0	10.0
	46	1	5.0	5.0	15.0
	47	1	5.0	5.0	20.0
	48	1	5.0	5.0	25.0
	49	1	5.0	5.0	30.0
	50	1	5.0	5.0	35.0
	52	2	10.0	10.0	45.0
	56	4	20.0	20.0	65.0
	58	2	10.0	10.0	75.0
	60	2	10.0	10.0	85.0
	62	1	5.0	5.0	90.0
	63	2	10.0	10.0	100.0
	Total	20	100.0	100.0	

Age at 1st Arrest

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	12	1	5.0	5.0	5.0
	14	1	5.0	5.0	10.0
	16	1	5.0	5.0	15.0
	17	1	5.0	5.0	20.0
	19	3	15.0	15.0	35.0
	20	1	5.0	5.0	40.0
	21	1	5.0	5.0	45.0
	23	2	10.0	10.0	55.0
	24	1	5.0	5.0	60.0
	27	1	5.0	5.0	65.0
	28	1	5.0	5.0	70.0
	29	1	5.0	5.0	75.0
	31	1	5.0	5.0	80.0
	38	1	5.0	5.0	85.0
	42	1	5.0	5.0	90.0
	43	1	5.0	5.0	95.0
	59	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

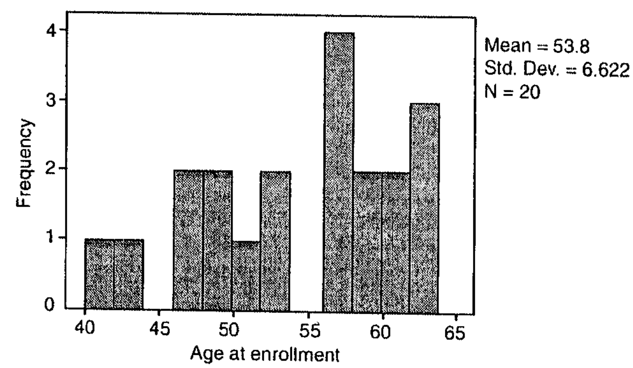
Years of Education

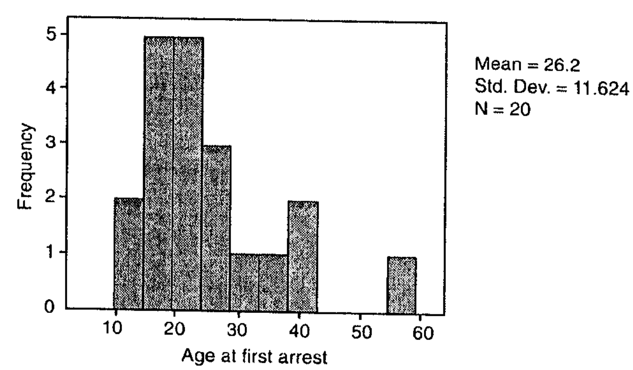
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	11	2	10.0	10.0	10.0
	12	11	55.0	55.0	65.0
	13	3	15.0	15.0	80.0
	14	4	20.0	20.0	100.0
	Total	20	100.0	100.0	

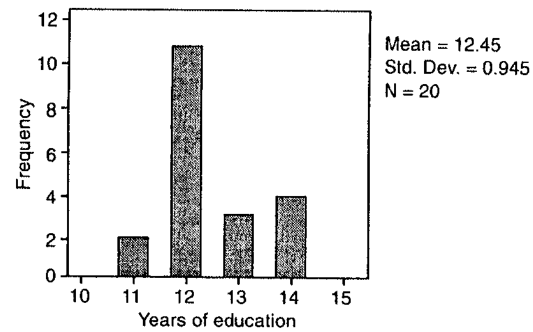
Number of Times Fired from Job

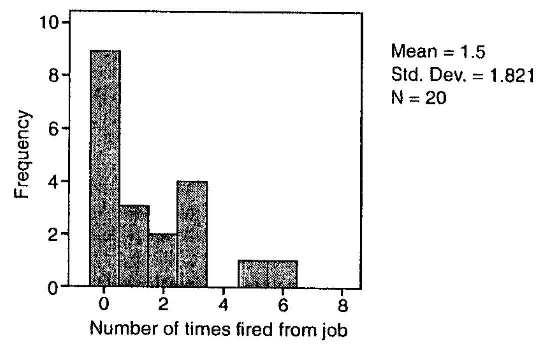
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	9	45.0	45.0	45.0
	1	3	15.0	15.0	60.0
	2	2	10.0	10.0	70.0
	3	4	20.0	20.0	90.0
	5	1	5.0	5.0	95.0
	6	1	5.0	5.0	100.0
	Total	20	100.0	100.0	

Histogram





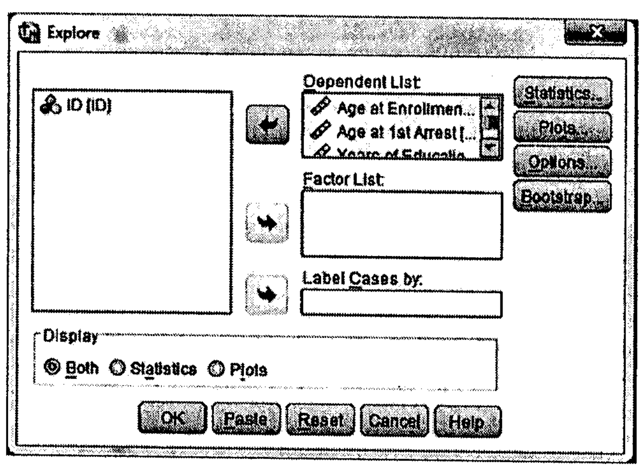




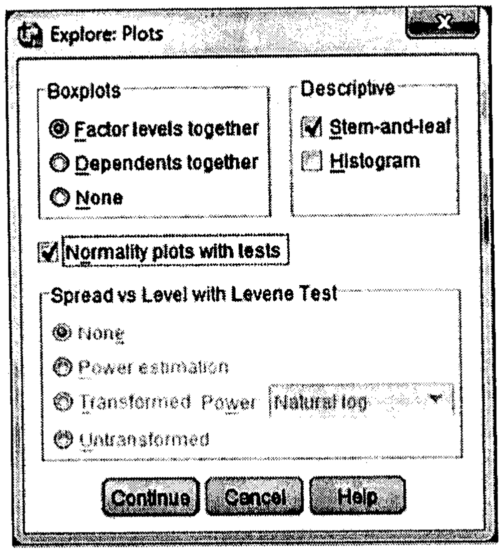
In terms of skewness, the frequency distribution for "Age at enrollment" appears to be negatively skewed, and the other three variables' frequency distributions appear to be positively skewed. The absolute values of the skewness statistics for "Age at first arrest" and "Number of times fired" are greater than 1.0. The kurtosis statistic for "Age at first arrest" is also greater than 1.0. No other skewness or kurtosis statistics were greater than 1.0.

In order to obtain a comparison of the study variables' deviation from normality (and thereby assessing skewness and kurtosis simultaneously), we must compute a Shapiro-Wilk test of normality.

Step 1: From the "Analyze" menu, choose "Descriptive Statistics" and "Explore." Move the four study variables over to the box labeled "Dependent List."



Step 2: Click "Plots." Check "Normality plots with tests." Click "Continue" and "OK."



SPSS yields many tables and figures—for this example, SPSS produces over 20 tables and figures. In the interest of saving space, we will focus on the table of interest, titled "Tests of Normality." This table contains the Shapiro-Wilk tests of normality for the four study variables. The last column contains the p values of the Shapiro-Wilk statistics. Of the four p values, three are significant at $p < 0.05$. "Age at enrollment" is the only variable that did not significantly deviate from normality ($p = 0.373$).

Explore

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Age at Enrollment	.180	20	.088	.950	20	.373
Age at 1st Arrest	.175	20	.110	.879	20	.017
Years of Education	.333	20	.000	.815	20	.001
Number of Times Fired from Job	.245	20	.003	.808	20	.001

a. Lilliefors Significance Correction

In summary, the skewness statistics as well as the Shapiro-Wilk values for "Age at first arrest" and "Number of times fired from a job" indicated significant deviations from normality. "Age at enrollment," while appearing to be slightly negatively skewed, did not yield skewness, kurtosis, or Shapiro-Wilk values that indicated deviations from normality. Years of education appeared to be positively skewed but did not have an extreme skewness or kurtosis value. However, the Shapiro-Wilk p value was significant at $p = 0.001$. It is common for Shapiro-Wilk values to conflict with skewness and kurtosis statistics, because the Shapiro-Wilk test examines the entire shape of the distribution while skewness and kurtosis statistics examine only skewness and kurtosis, respectively. When a Shapiro-Wilk value is significant *and* visual inspection of the frequency distribution indicates non-normality, the researcher must consider a nonparametric statistical alternative. See Exercise 23 for a review of nonparametric statistics that would be appropriate when the normality assumption for a parametric statistic is not met.

STUDY QUESTIONS

1. Define skewness.

2. Define kurtosis.

3. Given this set of numbers, plot the frequency distribution:
   1, 2, 9, 9, 11, 11, 11, 12, 12, 12, 12, 13, 13, 13, 14, 14.

4. How would you characterize the skewness of the distribution in Question 3: positively skewed, negatively skewed, or approximately normal? Provide a rationale for your answer.

5. Given this set of numbers, plot the frequency distribution:
   1, 2, 2, 2, 3, 3, 3, 3, 3, 4, 4, 4, 5, 5, 10, 11.

6. How would you characterize the skewness of the distribution in Question 5: positively skewed, negatively skewed, or approximately normal? Provide a rationale for your answer.

7. Given this set of numbers, plot the frequency distribution:
   4, 4, 4, 5, 5, 5, 5, 5, 5, 5, 5, 5, 6, 6, 6, 6.

8. How would you characterize the kurtosis of the distribution in Question 7: leptokurtic, mesokurtic, or platykurtic? Provide a rationale for your answer.

9. When looking at the frequency distribution for "Age at first arrest" in the example data, where is the mean in relation to the median?

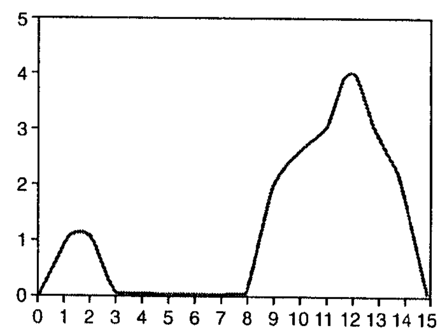
10. What is the mode for "Years of Education"?

Answers to Study Questions

1. Skewness is defined as a frequency distribution that is not symmetrical.

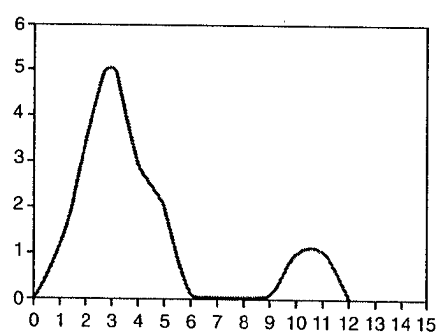
2. Kurtosis is defined as the degree of peakedness of the frequency distribution.

3. The frequency distribution approximates the following plot:



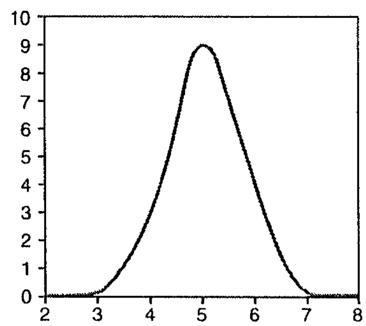
4. The skewness of the distribution in Question 3 is negatively skewed, as evidenced by the "tail" of the distribution appearing below the mean.

5. The frequency distribution approximates the following plot:



6. The skewness of the distribution in Question 5 is positively skewed, as evidenced by the "tail" of the distribution appearing above the mean.

7. The frequency distribution approximates the following plot:



8. The kurtosis of the distribution in Question 7 is leptokurtic, as evidenced by the peakedness of the distribution and the limited variance of the values.

9. The mean, for "Age at First Arrest" is above, or higher than the median due to its positively skewed distribution.

10. The mode for "Years of Education" is 12.

DATA FOR ADDITIONAL COMPUTATIONAL PRACTICE FOR QUESTIONS TO BE GRADED

Using the same example from LePage and colleagues (2014), the following data include only the last 15 observations (the first 5 were deleted). The data are presented in Table 26-3.

TABLE 26-3 AGE, EDUCATION, AND TERMINATION HISTORY AMONG VETERANS WITH FELONIES

ID	Age at Enrollment	Age at 1st Arrest	Education	Number Times Fired
6	41	20	12	1
7	56	14	12	1
8	56	12	14	0
9	47	23	12	0
10	52	38	12	3
11	63	16	14	0
12	60	59	12	1
13	62	17	12	3
14	49	19	11	2
15	60	31	13	0
16	56	28	12	3
17	52	43	12	0
18	58	27	14	0
19	43	29	12	0
20	63	42	14	0

5. How would you characterize the kurtosis of the distribution in Question 4—leptokurtic, mesokurtic, or platykurtic? Provide a rationale for your answer.

6. What is the skewness statistic for "Age at Enrollment"? How would you characterize the magnitude of the skewness statistic for "Age at Enrollment"?

7. What is the kurtosis statistic for "Years of Education"? How would you characterize the magnitude of the kurtosis statistic for "Years of Education"?

8. Using SPSS, compute the Shapiro-Wilk statistic for "Number of Times Fired from Job." What would you conclude from the results?

9. In the SPSS output table titled "Tests of Normality," the Shapiro-Wilk statistic is reported along with the Kolmogorov-Smirnov statistic. Why is the Kolmogorov-Smirnov statistic inappropriate to report for these example data?

10. How would you explain the skewness statistic for a particular frequency distribution being low and the Shapiro-Wilk statistic still being significant at $p < 0.05$?