Measures of Dispersion: Range and Standard Deviation

EXERCISE 9

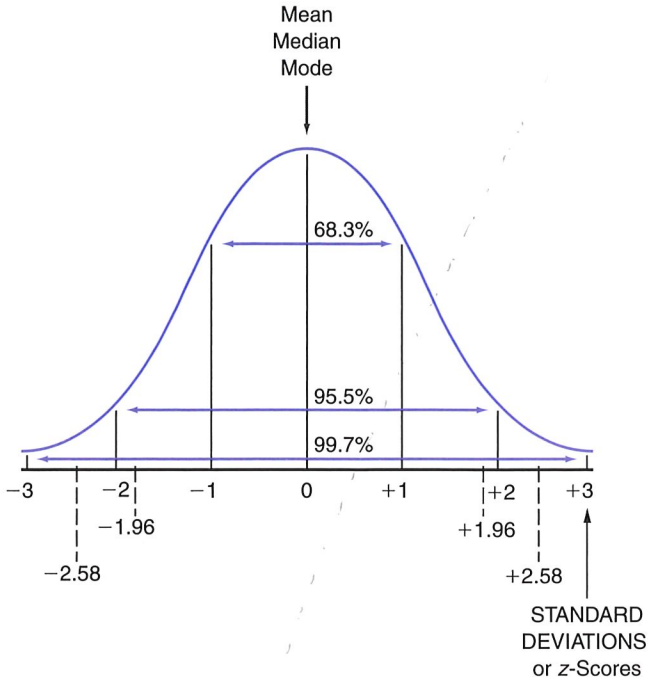
STATISTICAL TECHNIQUE IN REVIEW

Measures of dispersion, or measures of variability, are descriptive statistical techniques conducted to identify individual differences of the scores or values in a sample. These techniques give some indication of how values in a sample are dispersed, or spread, around the mean. The measures of dispersion indicate how different the scores on a particular scale are or the extent that individual scores deviate from one another. If the individual scores are similar, dispersion or variability values are small and the sample is relatively **homogeneous**, or similar, in terms of these scores or values. A **heterogeneous** sample has a wide variation in the scores, resulting in increased values for the measures of dispersion. Range and standard deviation are the most common measures of dispersion included in research reports (Gray, Grove, & Sutherland, 2017).

The simplest measure of dispersion is the **range**. In published studies, range is presented in two ways: (1) the range includes the lowest and highest values obtained for a variable, or (2) the range is calculated by subtracting the lowest score from the highest score. For example, the range for the following scores, 8, 9, 9, 10, 11, 11, might be reported as 8 to 11 (8–11), which identifies outliers or extreme values for a variable. The range can also be calculated as follows: $11 - 8 = 3$. In this form, the range is a difference score that uses only the two extreme values in a sample for the comparison. The range is generally reported in published studies but is not used in further analyses (Grove & Gray, 2019; Kim & Mallory, 2017).

The **standard deviation** (*SD*) is a measure of dispersion that is the average number of points by which the scores or values of a distribution vary from the mean. It indicates the degree of error that would result if the mean alone were used to interpret the data for a variable in a study. The *SD* indicates the variability of values in the normals curve. Figure 9-1 presents the normal curve, where the mean is zero (0) and each $SD = 1$. Values that are greater than +1.96 or −1.96 *SD* from the mean are significantly different from the mean at $p = 0.05$ when alpha = 0.05. Values that are greater than +2.58 or −2.58 are significant at $p = 0.01$.

The *SD* is an important statistic, both for understanding dispersion within a distribution and for interpreting the relationship of a particular value to the distribution. When the scores of a distribution deviate from the mean considerably, the *SD* or spread of scores is large. When the degree of deviation of scores from the mean is small, the *SD* or spread of the scores is small. *SD* is a measure of dispersion that is the square root of the variance (Grove & Gray, 2019; King & Eckersley, 2019). The equation and steps for calculating the standard deviation are presented in Exercise 27, which is focused on calculating descriptive statistics.



RESEARCH ARTICLE

Source

Roch, G., Dubois, C. A., & Clarke, S. P. (2014). Organizational climate and hospital nurses' caring practices: A mixed-methods study. *Research in Nursing & Health, 37*(3), 229–240.

Introduction

Roch and colleagues (2014) conducted a two-phase mixed methods study (Creswell & Clark, 2018) to describe the elements of the organizational climate of hospitals that directly affect nursing practice. The first phase of the study was quantitative and involved surveying nurses ($N = 292$), who described their hospital organizational climate and their caring practices. The second phase was qualitative and involved a study of 15 direct-care registered nurses (RNs), nursing personnel, and managers. The researchers found the following: "Workload intensity and role ambiguity led RNs to leave many caring practices to practical nurses and assistive personnel. Systemic interventions are needed to improve organizational climate and to support RNs' involvement in a full range of caring practices" (Roch et al., 2014, p. 229).

Relevant Study Results

The survey data were collected using the Psychological Climate Questionnaire (PCQ) and the Caring Nurse-Patient Interaction Short Scale (CNPISS). The PCQ included a five-point Likert-type scale that ranged from *strongly disagree* to *strongly agree*, with the high scores corresponding to positive perceptions of the organizational climate. The CNPISS included a five-point Likert scale ranging from *almost never* to *almost always,* with the higher scores indicating higher frequency of performing caring practices. The return rate for the surveys was 45%. The survey results indicated that "[n]urses generally assessed overall organizational climate as moderately positive (Table 2). The job dimension relating to autonomy, respondents' perceptions of the importance of their work, and the feeling of being challenged at work was rated positively. Role perceptions (personal workload, role clarity, and role-related conflict), ratings of manager leadership, and work groups were significantly more negative, hovering around the midpoint of the scale, with organization ratings slightly below this midpoint of 2.5.

Caring practices were regularly performed; mean scores were either slightly above or well above the 2.5 midpoint of a 5-point scale. The subscale scores clearly indicated, however, that although relational care elements were often carried out, they were less frequent than clinical or comfort care" (Roch et al., 2014, p. 233).

TABLE 2 NURSES' RESPONSES TO ORGANIZATIONAL CLIMATE SCALE AND SELF-RATED FREQUENCY OF PERFORMANCE OF CARING PRACTICES ($N = 292$)

Scale and Subscales (Possible Range)	*M*	*SD*	Observed Range
Organizational Climate			
Overall rating (1–5)	3.13	0.56	1.75–4.67
Job (1–5)	4.01	0.49	1.94–5.00
Role (1–5)	2.99	0.66	1.17–4.67
Leadership (1–5)	2.93	0.89	1.00–5.00
Work group (1–5)	3.36	0.88	1.08–5.00
Organization (1–5)	2.36	0.74	1.00–4.67
Caring Practices			
Overall rating (1–5)	3.62	0.66	1.95–5.00
Clinical care (1–5)	4.02	0.57	2.44–5.00
Relational care (1–5)	2.90	1.01	1.00–5.00
Comforting care (1–5)	4.08	0.72	1.67–5.00

Roch, G., Dubois, C., & Clarke, S. P. (2014). *Research in Nursing & Health, 37*(3), p. 234.

STUDY QUESTIONS

1. Organizational climate was measured with which type of scale? What level of measurement was achieved with this scale? Provide a rationale for your answer.

2. The mean ($\bar{X}$) is a measure of _____ _____ of a distribution, while the standard deviation (*SD*) is a measure of _____ of its scores. Both $\bar{X}$ and *SD* are _____ statistics.

3. What is the purpose of the range, and how is it determined in a distribution of scores?

4. What subscales were included in the description of organizational climate? Do these seem relevant? Provide a rationale for your answer with documentation.

5. Which organizational climate subscale had the lowest mean? What is your interpretation of this result?

6. What were the dispersion results for the organization subscale in Table 2? What do these results indicate?

7. Which aspect or subscale of organizational climate has the lowest dispersion or variation of scores? Provide a rationale for your answer.

8. Is the dispersion or variation of the ratings on jobs more homogeneous or heterogeneous than the other subscales? Provide a rationale for your answer.

9. Which subscale of organization climate had the greatest dispersion of scores? Provide a rationale for your answer.

10. Ledoux, Forchuk, Higgins, and Rudnick (2018, p. 17) conducted a predictive correlational study to "examine how structural empowerment, psychological empowerment, and inter-professional collaboration affect nurse compassion." These variables were measured with 5-point Likert scales, and Table 1 includes the mean, *SD*, range, and reliability alphas for these variables. Which scale's scores or values had the smallest dispersion? Provide a rationale for your answer.

TABLE 1 MEAN, STANDARD DEVIATION (SD), RANGE, RELIABILITY (α) OF VARIABLES

Variable	Mean	*SD*	Range	α
Structural empowerment	3.09	0.58	1.75-4.68	0.89
Psychological empowerment	3.80	0.51	2.25-5	0.84
Interprofessional collaboration	3.51	0.53	1.97-4.94	0.96
Compassion	4.20	0.43	3-5	0.84

From Ledoux, K., Forchuk, C., Higgins, C., & Rudnick, A. (2018). The effect of organizational and personal variables on the ability to practice compassionately. *Applied Nursing Research, 41*(1), 15–20.

Answers to Study Questions

1. Organizational climate was measured with the Psychological Climate Questionnaire (PCQ), which is a 5-point Likert scale. This scale has multiple items, and the participants mark their responses to each item using a scale of 1 = *strongly disagree* to 5 = *strongly agree*. The data obtained from multiple-item Likert scales are combined and usually analyzed as though they are interval-level data as in this study (Gray et al., 2017). Some sources might describe Likert scale data as ordinal because the 5-point rating scale used in a Likert scale lacks continuous values. However, most nursing and healthcare researchers analyze data from multiple-item Likert scales as interval-level data (see Exercise 1; Waltz, Strickland, & Lenz, 2017).

2. The $\bar{X}$ is a measure of central tendency, and the *SD* is a measure of dispersion. Both $\bar{X}$ and *SD* are descriptive or summary statistics.

3. Range is the simplest measure of dispersion or variability, obtained by identifying the lowest and highest scores in a distribution or by subtracting the lowest score from the highest score in the distribution of scores (Grove & Gray, 2019).

4. The subscales included in organizational climate were job, role, leadership, work group, and organization (see Table 2). Yes, these subscales seem relevant because the items used to measure job were related to perceived autonomy, importance of work, and being challenged. The role subscale included personal workload, role clarity, and role-related conflict (see narrative of results). Thus, the items of these five subscales are important in understanding the organizational climate in a hospital. The American Hospital Association (AHA) promotes research to improve the climates in hospitals. For more information on AHA, review their website at http://www.aha.org/research/index.shtml. A subsidiary of AHA is the American Organization of Nurses Executives, which is focused on improving nursing leadership in the current healthcare system (AONE; http://www.aone.org/). You might document with other research articles, texts, and websites.

5. Organization had the lowest mean at 2.36, indicating this is the most negatively perceived of the subscales included in the PCQ scale. The lower the mean the more negative the nurses' perception of their organization. The results identified a problem area that requires additional investigation and management to improve the relationships between the nurses and their organization.

6. The dispersion results for the organization subscale included range = 1.00–4.67 and *SD* = 0.74. The score for each item on the organization subscale could range from 1.00–5.00 based on the Likert scale used in the PCQ. Both the range and *SD* seemed similar to the other subscales, indicating the dispersion of scores was similar for the organization subscale (King & Eckersley, 2019).

7. The job subscale had the lowest dispersion with range = 1.94–5.00 or, when calculating the range by subtracting the lowest score from the highest score, 5.00 – 1.94 = 3.06. The *SD* = 0.49 was also the lowest for organizational climate, indicating the scores for job had the lowest variation of the subscales. Focusing on the subscales' results rather than just on the overall organizational climate rating provides readers with a richer understanding of the nurses' perceptions of their organization.

8. Job scores were the most homogeneous or had the least variation of the organization climate subscales as indicated by the lowest range and *SD* results discussed in Question 7 (Grove & Gray, 2019).

9. When compared with the other subscales, leadership scores had the greatest dispersion or variation among the subscales as indicated by the largest *SD* (*SD* = 0.89) and range (1.00–5.00 or 5.00 – 1.00 = 4).

10. The compassion variable has the lowest dispersion or variation of values in this study. The *SD* (0.43) and the range (3–5) were the lowest values of the four scales indicating the lowest dispersion (Grove & Gray, 2019; Kim & Mallory, 2017)

Questions to Be Graded

EXERCISE 9

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 submit your answers online.

1. What were the name and type of measurement method used to measure caring practices in the Roch, Dubois, and Clarke (2014) study?

2. The data collected with the scale identified in Questions 1 were at what level of measurement? Provide a rationale for your answer.

3. What were the subscales included in the CNPISS used to measure RNs' perceptions of their caring practices? Do these subscales seem relevant? Document your answer.

4. What were the dispersion results for the relational care subscale of the caring practices in Table 2? What do these results indicate?

5. Which subscale of caring practices has the lowest dispersion or variation of scores? Provide a rationale for your answer.

6. Which subscale of caring practices had the highest mean? What do these results indicate?

7. Compare the overall rating for organizational climate with the overall rating of caring practices. What do these results indicate?

8. The response rate for the survey in this study was 45%. Is this a study strength or limitation? Provide a rationale for your answer.

9. What conclusions did the researchers make regarding the caring practices of the nurses in this study? How might these results affect your practice?

10. What additional research is needed in the areas of organizational climate and caring practices?