Sampling

5

What You Should Know!

Gathering data for a research study can be done in a variety of ways, which will be discussed in detail in a later chapter. When using the common method of a questionnaire, from whom the data are collected becomes an important consideration. Often data cannot be collected by every member of a target population due to logistical constraints, such as money and time. Therefore, it is necessary to select data from a subset of the population, also known as sampling. After completing this chapter, the reader should be able to:

1. Discuss the purpose of and need for sampling in research.
2. Define what is meant by the terms *population*, *sampling frame*, and *sample*, and provide examples of each term. Describe how these terms relate to each other.
3. Explain how probability theory enables the researcher to obtain representative samples.
4. Identify and describe the various types of probability samples, including simple random, stratified random, systematic, and cluster sampling.
5. Compare and contrast probability sampling with nonprobability sampling.
6. Identify and discuss the various types of nonprobability samples, including purposive, quota, snowball, and convenience sampling.

7. Explain the importance of sample size. Include confidence intervals, confidence levels, and sampling error in the discussion.
8. Determine how many observations are necessary to obtain a sample with an error tolerance of ±3 at the 95% confidence level. Explain how many more observations you would add to this number and why you would do so.

Sampling

Conducting research requires gathering information about a specific concept, phenomenon, event, or group. Gathering information about every element associated with the topic in the social sciences is neither feasible nor necessary. In conducting criminal justice and criminological research, the primary focus is typically on a specific population.

A *population* is the complete group or class from which information is to be gathered. Examples of populations are criminal justice system representatives (e.g., police, corrections, courts) or offenders (e.g., arrestees, convicts, parolees). Populations are not limited to individuals. Prisons in the United States or counties within a state are other examples of populations for studies at the aggregate rather than individual level. Although it would be great if every member of a population could provide the information sought, it is just not practical. Therefore, sampling the population is a necessity. A *sample* is a smaller group subset chosen from within a target population. Before one can begin to sample, the first step is to identify the population. Once the population has been identified, then the next step is to acquire a sampling frame. A *sampling frame* is a list of all units within the population (Bachman & Schutt, 2008; Creswell, 2008; Maxfield & Babbie, 2009). For example, if your population consists of New York City police officers, then the sampling frame would be a list of all officers. Each officer is one unit.

Having identified the sampling frame, the next decision is to choose the type of sample to be used. However, it is often the case that a full sampling frame is not available. A researcher may want to examine the reasons that some individuals are working as prostitutes. However, there is not a list of working prostitutes as there would be of other populations, such as police officers. This scenario is not uncommon when dealing with offender populations in criminal justice and criminological research.

The lack of a full sampling frame will influence the selection of the sampling method because some methods require a full (or nearly full) sampling frame and other methods do not. Sampling methods are typically subdivided into probability or nonprobability methods. It is appropriate at this point to provide an overview of probability theory.

Probability Theory

A friend of yours frequently buys lottery tickets. On a number of occasions, individuals (usually whom he does not know) have taken it on themselves to inform him, "You are wasting your money. The odds of you being hit by lightning are higher than of you winning the lottery." To which he honestly replies, "Thank you for your concern. I have been hit by lightning. This is more fun." The individuals who are warning our friend are statistically correct: His chance of winning the lottery is extremely small. However, because he does not really care if he wins (he amuses himself by checking his tickets several days later, asserting that he is potentially a winner until he discovers otherwise) and because his investment only averages about $2 per week, statistical probabilities do not mean much to him.

Many people who wager far more than they can afford also disregard statistical probability. These individuals tend to believe either that "it is time for their luck to change" or that "God (or fate, depending on their religious orientation) will intervene in their lives." Although we do not question the benevolence of a Supreme Being, we do believe that if God or even luck preordained such an event, the purchase of one ticket would be adequate. If not preordained, the sincere gambler might want seriously to consider the statistical probability of success.

Probability theory is based on the concept that over time there is a statistical order in which things occur. If someone flips an unaltered coin 10 times, it is possible that it will land on heads five times and tails five times. However, it also might land on heads eight times and tails only two. This occurs because each time the coin is flipped it has an equal chance of being heads or tails. What happened previously has no influence on what happens in the future. One cannot accurately predict what will happen on the next coin toss. Yet, one can accurately assume that over a lengthy period of time the number of heads and the number of tails will be about the same. This occurrence is the

FROM THE REAL WORLD

Let us continue with Dantzker's dissertation examining whether there were any differences between two types of psychologists who performed pre-employment psychologic examinations of police recruits regarding the instruments they used to conduct the evaluations and the reason for their choice. Because there is no one source identifying all licensed psychologists in the United States, the sampling frame for this study included all clinical psychologists with memberships in the American Psychological Association (APA) and the Psychology Section of the International Association of Chiefs of Police.

basis of statistical probability. Anything can happen, but over the long run there is a statistical order.

The knowledge that over time things tend to adhere to a statistical order allows one to choose samples that are representative of a population in general. Although a researcher cannot say in advance that a sample is representative, the researcher can follow a procedure that should lead to a representative sample being selected. Because every number (representing people, items, or events) has a known chance of being chosen, then most of the time the sample drawn is representative. However, on occasion it is not representative.

Probability Sampling

The general goal when choosing a sample is to obtain one that is representative of the target population. Representation requires that every member in the population or the sampling frame have a known chance of being selected for the sample. If the sample is representative of the population, then the results from the sample can be applied or generalized to the whole population, which is also known as generalizability. Four types of probability samples include: (1) simple random, (2) stratified random, (3) systematic, and (4) cluster.

Simple Random Samples

A *simple random sample* is one in which all members of a given population have an equal chance of being selected. Furthermore, the selection of each member must be independent from the selection of any other member. In other words, the selection of each member does not impact the likelihood that another member of the sampling frame will be selected. To assist in selecting a random sample, a device known as a random numbers table is often used, which contains numbers that have been randomly generated and can be found in almost every statistics book as well as being readily available on the Internet. To use the random numbers tables, an individual selects a number at random as a starting point and then chooses a pattern, such as moving down or across the table, to select the subsequent random numbers provided within the table until the appropriate number of population members needed has been selected. Today, computers are commonly used to select a random sample. In either case, the researcher must have a complete list of every member of the sampling frame, which is one of the disadvantages of random sampling. Yet, even with this obstacle, random sampling is very popular, partly because it has become easier for researchers to obtain random samples with the use of computers.

Stratified Random Samples

A *stratified random sample* is a random sample that has been chosen from a population subdivided into groups called *strata*. These strata are homogeneous

FROM THE REAL WORLD

Examining the shadow of sexual assault hypothesis among college and university students across temporal situations and victim-offender relationships, Hilinski (2009) used a simple random sample. The sample was of 375 undergraduate and graduate students enrolled at a medium-sized public university during the fall 2006 and spring 2007 semesters. She obtained her sample by sending an e-mail invitation to a random selection of 3,500 (approximately 25% of the university's population) graduate and undergraduate students enrolled during the spring 2007 semester.

groups selected based on specified characteristics (Adler & Clark, 2007; Dunn, 2009; Frankfort-Nachmias & Leon-Guerrero, 2008). This type of sample requires the researcher to have knowledge of the sampling frame's characteristics. These characteristics (selected variables) are then used to create the strata from which the sample is chosen. If you wanted to sample students at a high school, you may group them into strata based on their class (freshman, sophomore, junior, or senior) and then select a random sample from within each stratum. Depending on the interests or needs of the researcher, a proportionate stratified random sample may be selected in which the proportions of the strata are similar to the proportions in the population. For example, if freshman represented 20% of the population from the example above, then the sample stratum for freshman would represent 20% of the sample. Disproportionate stratified random sampling incorporates oversampling of specific stratum and may be used if one or more of the stratum is particularly small.

Systematic Samples

There is some debate over this type of sampling. It has been discussed as both probability and nonprobability sampling. It is offered here as a type of probability sample because it includes random selection and initially allows inclusion of every member of the sampling frame. With a systematic sample, every nth item (e.g., 3rd, 5th, 100th) in the sampling frame is included in the sample. A warning should be given when using systematic sampling. When sampling an organization with a rank or hierarchical structure, one must be sure the selection procedure does not result in a rhythm consistent with the organization's bureaucratic structure that would cause a particular type of individual to be selected each time. For example, if you are studying employee satisfaction and are sampling a company with 24 employees in each unit and the 25th individual is a supervisor, then you would need to mix up the sampling frame so that if you choose the 25th person each time, you will not always be selecting a supervisor. This situation negates the purpose of such a sample. To begin systematic

FROM THE REAL WORLD

Dantzker used a combination of sampling techniques for his study. He began with a stratified, systematic random sample drawn from the membership of the American Psychological Association Division 12 (Clinical Psychologists). After removing students, non–United States members, and retirees, a population of 3,609 members was left. A random sample of 1,000 was selected through stratification by state. Because 1,000 individuals was the sample goal, which was 28% of the population, approximately 28% of each state's members were randomly chosen using a random numbers table.

sampling, determine the nth unit by dividing the total number of units within the sampling frame by the number of units wanted in the sample, then make sure the sampling frame does not have an existing order, and finally choose a random starting place in the sampling frame.

Cluster Samples

The last of the probability sampling methods is the cluster sample. *Cluster sampling is a multistage random sample (sampling occurs two or more times) in which groups (clusters) are sampled initially and then individuals are sampled within each cluster* (Adler & Clark, 2007). Clusters are groups within the population (e.g., police precincts, prisons). For example, a sampling frame of correctional institutions nationwide may be created, and then a random sample of correctional institutions is selected from this frame. Employee information from each of the sampled institutions might then be obtained. From these lists, a random sample of correctional employees from each institution may be drawn. This method is popular for national victimization studies or other national interest topics (e.g., politics), which may be begin with clusters of counties or census tracts.

Usually, researchers want to make use of probability samples primarily because they are often more statistically stable and the results can be generalized from the sample to the population. However, random sampling can be expensive and logistically difficult to complete. Therefore, it is common to find nonprobability sampling in criminal justice and criminological research.

Nonprobability Sampling

The major difference between probability and nonprobability sampling is that one provides the opportunity for all members of the sampling frame to be selected, whereas the other does not. This shortcoming of nonprobability sampling often leads to questions and concern over the representativeness of the sample. However, when the sample produces the requisite information, representativeness is often not as much of a concern, although its limitations must still be noted. Furthermore, a nonprobability sample could be perceived as representative if enough characteristics of the target population exist in the sample. There are four types of nonprobability samples: (1) purposive, (2) quota, (3) snowball, and (4) convenience.

Purposive Samples

Among the nonprobability samples, the purposive sample seems to be the most popular. The sampling process is based on the researcher's skill, judgment, and needs to select an appropriate sample (Dunn, 2009). When the subjects are selected based on the researcher's view that they reflect normal or average scores, this process is sometimes referred to as *typical-case sampling*. For example, a researcher may select an "average" student for a sample of high school students. If subgroups are sampled to permit comparisons among them, this technique is known as *stratified purposeful sampling* (Adler & Clark, 2007). A major factor of purposive sampling is accessibility to units or individuals that are part of the target population.

In all of the studies from the preceding **From the Real World**, the researchers chose their samples because they believed they best fit the needs of the study. The selection was based on their knowledge of the topic, the target populations, and accessibility. Although the samples may not have been representative, they did provide the requisite data to complete the studies. In most cases, because the purposive sample is not representative, findings cannot be generalized to complete populations. Despite statistical concerns about the sample, purposive sampling can offer researchers a legitimate and acceptable means of collecting data.

FROM THE REAL WORLD

Monto and Julka (2009), in framing prostitution as an economic exchange, evaluated some of the consequences of conceiving of sex as a commodity rather than as an aspect of an intimate interpersonal relationship among the customers of prostitutes. Their data were collected from a purposive sample of 700 men arrested while trying to hire street prostitutes. DeMatteo, Marlowe, Festinger, and Arabia (2009) used a purposive sample of 28 individuals assigned to a drug treatment program to study what effect the program may have had on the participants' continued drug use. To gather opinions of police officers with many years of experience responding to emergency calls and pursuing fleeing suspects, Schultz, Hudak, and Alpert (2009) used data collected from participants of In-Service Training in Emergency Vehicle Operations and Police Pursuits.

Quota Samples

Sometimes a study simply needs data collected from a set amount of participants fitting the sampling needs. These types of research efforts often rely on quota sampling. For this type of sample, the proportions (or percentages) may be based on the researcher's judgment for inclusion. Does the individual or unit fit the needs of the survey? Selection continues until enough individuals have been chosen to fill out the sample. For example, assume one is required to conduct a study of high school drug use with a sample size of 100 first-semester college freshman at a given university. Because there is no means of identifying these individuals, a booth is set up in the student union where students are stopped as they come by and inquiry is made as to their status at the university. Only those who advise that they are first-semester freshman students are surveyed, and this approach is continued until the desired sample size or quota is reached. To ensure some level of representativeness by gender and race, the quota is set at a percentage equivalent to what the university claims to have in its population. For example, by gender, the university is 45% female and 55% male, whereas racially it is 43% white, 37% African American, and 20% other. Reaching some minimal level of representativeness requires one to continue selecting students until the quota sample seems to be comprised in similar fashion to the university. Obviously, this can be a painstakingly long method and does not guarantee representation.

One way to visualize this process is to use a table. Continuing with the example of high school drug use reported by first-semester college students, a table could be created using more than one factor based on the characteristics of the population. Based on the following table, 24% of the population consists of white males; thus, once 24% of the total sample is white males, then no more white males would be sampled.

		Race		
		White	African-American	Other
Sex	Male	24%	20%	11%
	Female	19%	17%	9%

Snowball Samples

Snowball sampling is commonly used as a qualitative technique. The snowball sample begins with a person or persons who provide names of other persons for the sample. This sample type is most often seen used in exploratory studies where an appropriate target population is not readily identifiable, making a sampling frame more difficult to select (Senese, 1997). Additionally, despite the issue of representation, snowball sampling requires the researcher to rely on the expertise of others to identify prospective units for the sample. Snowball sampling is frequently used in field research when the researcher must rely on introductions from group members to access other group members. Using the previous prostitution sample, you may interview one person working as a prostitute who in turn introduces you to others. The sample may represent a small geographic area or the acquaintances of an individual and not be representative of the population of prostitutes in the metropolitan area. Thus snowball sampling may lead to a sample that has no representative or generalizable attributes. However, if the data address the research question, then these shortcomings are acceptable.

Convenience Sample

The last choice for a sample is the convenience sample or a sample of available subjects. Here there is no attempt to ensure any type of representativeness. Usually this sample is an abstract representation of the population. Units or individuals are chosen simply because they were in the right place at the right time.

Analysis of data from a convenience sample is extremely limited. The sample selected may or may not represent the population that is being studied. Therefore, generalizations that are made about the population cannot be considered to be valid (Adler & Clark, 2007). For example, if you wanted to research the study habits of college students, you may stand outside of the college library to collect the convenience sample. But keep in mind that students who are visiting the library may differ in their study habits compared to the population of college students as a whole. Because of this limitation, convenience samples are not useful for explanation or even for description beyond the sample surveyed. They are often useful as explorations on which future research may be based.

The quality and quantity of the data are dependent on the sampling technique. Statistical support is stronger for probability samples. However, there are times when nonprobability samples are fruitful. Regardless of which type is used, an important element of each is the sample size.

FROM THE REAL WORLD

Flanyak (1999), conducting a qualitative, exploratory research study, used both snowball and convenience sampling methods. Through this method she obtained 22 subjects for the study. Although her sampling frame consisted of lists of sociology and criminal justice department faculty members in several universities in Illinois, it was the result of initial interviews during a pilot study with respondents at her academic institution that other potential subjects were identified. Furthermore, other subjects were chosen from the faculty of her undergraduate [illegible]onse rate.

FROM THE REAL WORLD

To study officer opinions on police misconduct, Hunter (1999) developed a survey instrument based on the findings of prior research on police ethics and misconduct. Before administering this survey to a sample of several hundred officers in the southeastern United States, he sought feedback from a convenience sampling of currently serving officers. One group consisted of officers on a patrol shift from a mid-sized metropolitan police agency. A second group was composed of officers taking college courses at a regional college. A third group was made up of officers in their final phase of training at a regional police academy. Findings from this convenience sample not only permitted Hunter to refine the questionnaire, but he was also able to gain insights as to how officers felt about different forms of police misconduct and a variety of proposed solutions aimed at curbing such behaviors. The results were only indicative of the opinions of the subjects within this sample and could not be construed to be representative of the opinions of officers outside the sample. However, as an exploratory study it was quite useful.

Sample Size

The quality of a sample is largely dependent on its size (Banyard & Grayson, 2009; Creswell, 2008; Frankfort-Nachmias & Leon-Guerrero, 2008). The belief is that the larger the sample, the more likely the data will more truly reflect the population. An interesting aspect about sample size seems to be that there is no ideal set size. Usually, the sample size is the result of several elements: (1) requirements for sample accuracy; (2) economic feasibility (how much does one have to spend); (3) the availability of requisite variables (including any subcategories); and (4) accessibility to the target population. Furthermore, confidence level is important.

Confidence Levels

Deciding how large the sample should be requires an understanding of confidence intervals, which indicates a range of numbers (e.g., ±15). Because a sample is merely an estimated reflection of the target population, a confidence interval suggests the accuracy of the estimate; the smaller the confidence interval, the more accurate the estimated sample. The estimated probability that a population parameter will fall within a given confidence interval is known as the *confidence level* (Adler & Clark, 2007). Levels of 0.05 (95%) and 0.01 (99%) are most readily acceptable in most research (Gillham, 2009; Shaughnessy, Zechmeister, & Zechmeister, 2008). To reduce sampling error, the researcher desires a smaller confidence interval. To do so, he or she selects a smaller confidence level. For example, Dantzker (2010) sought to meet an alpha or confidence level of 0.05, which required a sample size of 385 (the process of arriving at this number is explained below).

In social science research, confidence levels are important, although they are rarely explained or identified. In many cases readers are expected to accept that samples are statistically acceptable as an accurate estimate of the target population. A confidence level outside the expected range does not mean that the findings should be ignored. It simply means that their application must be more conservative and judicious.

Sampling Formulas

The key aspect to selecting appropriate confidence levels is the sample size. As previously suggested, the larger the sample, the more accurate the estimate. Therefore, it is beneficial to know just how large a sample is needed to attain the best confidence level. There are several mathematical formulas to assist in determining sample size. Unless one is a good mathematician, it is suggested that preexisting tables or computer statistical packages be used to make that determination. Should those means not be available, the following paragraphs demonstrate how such a formula may be used.

A Commonly Used Sampling Formula

In selecting a sample size, one is seeking to draw a large enough number of observations from the target population to ensure that the sample accurately represents that population. As was discussed previously, the larger the sample size, the more likely that it is representative. However, because the costs in time and money of sampling large numbers are prohibitive, probability theory is relied on to estimate the proper sample size. One is guided in the selection by knowledge of acceptable sample sizes. Generally, in social science research, one seeks a sample size that 95 times out of 100 varies by 5% or less from the population. In some cases one may use less stringent requirements and in others one may wish to have (and be able to afford) a higher level of accuracy.

Assuming that one wishes to have a sample of a large population that is at the 95% confidence level and has a sample error within 5% of the population, one could use the following formula:

$$n = (1.96)^2[p\,(1 - p)] / se$$

where n = sample size needed,
p = assumed population variance,
se = standard error, and
1.96 represents a normal curve z score value at a confidence level of 95%.

For an error tolerance of 5% at the 95% confidence level, one would use 0.05 as the sample error. The formula then becomes:

$$n = (1.96)^2[.5\ (1 - 0.5)] / 0.05$$

$$n = 384.16 \text{ which rounds up to } n = 385$$

Thus, a sample size of 385 provides a sample that had an error tolerance of +5% at the 95% confidence level. If one wished to change confidence levels or error tolerance, one would then adapt the formula. For example, if one wanted to ensure that the sample was representative and had the money and time to do so, an error tolerance of +1% at the 99% confidence level would result in the following:

$$n = (4.2930175)^2[0.1\ (1 - 0.1)] / 01$$

$$n = 16586.99 \text{ or } = 16{,}587$$

A Sampling Size Selection Chart

Having read how the previous formula was used to obtain the desired sample size, you may decide that you have no desire to ever perform these calculations. To save you from such an exercise, a simple chart is included that makes sample size selection much easier. Simply determine the confidence level and error tolerance desired in the survey sample and look it up in **Table 5-1**. The number indicated is how many observations from the study population are needed to select randomly to have a representative sample.

Table 5-1 provides the sample size needed based on the error tolerance and confidence level desired. However, those are the numbers of observations needed in the sample. To ensure that those numbers are obtained, it is recommended that one always oversample by 20% because not everyone selected will agree to

TABLE 5-1

Sample Size Selection Chart

Error tolerance (percent)	Confidence levels	
	95%	99%
1	9604	16,587
2	2401	4147
3	1068	1843
4	601	1037
5	385	664

Source: Modified from Cole, R. L. *Introduction to Political Science and Policy Research*. St. Martin's Press, 1996.

participate in the research study. If this is not enough, one can always add more observations as long as they are randomly selected from the same population and any time differences do not affect responses.

Summary

Gaining data from a complete population is usually impossible. In most cases, research data are best obtainable through a sample. Before a sample is chosen, identifying the sampling frame is necessary. An identifiable sampling frame leads to a decision as to what type of sample to select: probability or nonprobability. Probability samples include simple random, stratified random, strata, and cluster sampling. Purposive, quota, snowball, and convenience are forms of nonprobability sampling.

Regardless of the type of sampling, there is a question of sample size. Although no magical number exists, confidence levels provide a statistical means for establishing legitimacy of the sample. The smaller the confidence level, the more representative is the sample. As can be seen, careful thought should be given before choosing a sample type and a sample size.

APPLICATION EXERCISES

1. You are working for a large, private research firm that has been hired by the comprehensive University and College System (UCS) of a large state to study the issue of violence on college campuses. How would you explain to the UCS officials the difference between a sample and a population and why sampling would be appropriate for this study?
2. What is a sampling frame? What would be an appropriate sampling frame of individual students for this study? Describe how you would collect the data for sampling frame.
3. Describe probability sampling to the USC officials, including the advantages and disadvantages of probability sampling.

3a. Describe how you would collect a simple random sample.

3b. Describe how you would collect a stratified random sample. Describe at least two factors that you could use to identify strata.

3c. Describe how you would collect a systematic sample.

3d. The system includes 130 four-year universities, four-year colleges, two-year community colleges, and two-year technical colleges. Describe how you would collect a cluster sample using two levels (institution and individual) and three levels (institution, major, and individual).

4. Describe nonprobability sampling to the USC officials, including the advantages and disadvantages of nonprobability sampling.

4a. Describe how you would collect a purpose sample, including the specific factors that would be used to select the "normal" or "average" student.