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ORIGINAL ARTICLE

RESEARCH SAMPLING

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Abstract:

No aspect of the research plan is more critical for assuring the usefulness of a study than the sampling strategy. It will determine if the results of the study can be applied as evidence and contributes to the trustworthiness of the results. The sampling strategy is a critical part of research design. An appropriate sampling plan is vital for drawing the right conclusions from a study. Good sampling is critical for the confident application of the study findings to other people, settings, or time periods.

KEYWORDS:

Sampling, Population, Researchers.

1.INTRODUCTION:

Samples are drawn to represent populations in a research study. A population, sometimes called the target population, is the entire set of subjects that are of interest to the researcher. It is rarely possible or even necessary, to study the entire population of interest. It is more likely that the researcher will study a subset of the population called a sample. Samples, if selected carefully, represent the population. When samples are selected using objective criteria, they help control bias

SAMPLING THEORY

Sampling theory was developed to determine mathematically the most effective way to acquire a sample that would accurately reflect the population under study. The theoretical, mathematical rationale for decisions related to sampling emerged from survey research. The techniques were first applied to experimental research by agricultural scientists. One of the most important surveys that stimulated improvements in survey techniques was the national census. The assumptions of sampling theory have been adopted by researchers and incorporated within the research process.

Key concepts of sampling theory include elements, populations, sampling criteria, representativeness, sampling errors, randomization, sampling frames, and sampling plans. The following sections explain the meaning of these concepts. In later sections, these concepts will be used to explain a variety of sampling technique.

ELEMENTS AND POPULATIONS

The individual units of a population are called elements. An element can be a person, event, behavior, or any other single unit of a study. When elements are persons, they are referred to as subjects

The population, sometimes referred to as the target population, is the entire set of individuals or elements who meet the sampling criteria. An accessible population is the portion of the target population to which the researcher has reasonable access. The accessible population might be elements within a state, city, hospital, or nursing unit. In this case, the sample is obtained from the accessible population, and findings are generalized first to the accessible population and then, more abstractly, to the target population.

Generalizing means that the findings can be applied more generally than just to the sample under study. Because of the importance of generalizing, there are risks to defining the accessible population too narrow. For example, a narrow definition of the accessible population reduces the ability to generalize from the study and thus reduces the meaningfulness of the findings. Biases may be introduced that make generalization to the broader target population difficult to defend. If the accessible population is defined as individuals in a white upper middle class setting, one cannot generalize to nonwhite or lower income populations. These biases are similar to those that may be encountered in a nonrandom sample.

SAMPLING CRITERIA

sampling criteria list the characteristics essential for membership in the target population. The sample is selected from the population that meets the sampling criteria. When the study is completed, the findings are generalized to this population.The researcher needs to provide logical reasons for the characteristics selected) For example, the sampling criteria may be designed to make the population as homogeneous as possible or to control for extraneous variables. However, in a descriptive or correlational study, the sampling criteria may be defined to insure a heterogeneous population with a broad range of values on the variables being studied. Narrow and restrictive sampling criteria will reduce the sample size or make obtaining a sample difficult. Defining the criteria too broadly may make interpreting results difficult

REPRESENTATIVNESS

Representativness means that the sample must he like thc population in as many ways as possible. It is especially important that the sample bc representative in relation to the variables heing studied and to other factors that may influence thc study variahley For example. if the study examined attitudes toward AIDS. the sample should be representative of the distribution of attitudes toward AIDS that exists in the specified population. In addition. a sample needs to be representative of such characteristics as age. gender, ethnicity. income, and education, which often influence study variables.

The accessible population must be representative of the target population. If the accessible population is limited to a particular setting or type of setting, the individuals seeking care at that setting may be different than those who would seek care for the same problem at other settings, or from those who choose to use selfcare to manage their problems. Studies conducted in private hospitals usually exclude the poor. Other settings could exclude the elderly or the undereducated. Those who do not have access to care are usually excluded from studies. Representativness is usually evaluated by comparing sample means with target population means

SAMPLING ERROR

The difference between a sample statistic and a population parameter is called the sampling error. A large sampling error means that the sample is not providing a precise picture of the population; it is not representative) In most nursing studies the extent of sampling error is not known(However. sampling error is usually larger with small samples and decreases as the sample size increases. Sampling error decreases the power to detect differences between groups or accurately describe the relationships between or among variables. Sampling error occurs as a result of random variation and systematic "variation.

RANDOM VARIATION

Random variation is the expected difference in values that occurs when one examines different subjects from the same sample. If the mean is used to describe the sample, the values of individuals in that sample will not all be exactly the same as the sample mean. Individual subject's values will vary from the value of the sample mean. The difference is random because the value of each subject is likely to vary in a different direction. Some values will be higher and others will be lower than the sample mean. Thus, the values will be randomly scattered around the mean. As the sample size becomes larger, overall variation in sample values decreases, with more values being close to the sample mean. As the sample size increases, the sample mean is also more likely to have a value similar to that of the population mean.

SYSTEMATIC VARIATION

Systematic variation, or systematic bias, is a consequence of selecting subjects whose measurement values are different, or vary, in some specific way from the population. Because the subjects have something in common. their values tend to be similar to others in the sample but different in some way from those of the population as a whole. These values do not vary randomly around the population mean. Most of the variation from the mean is in the same direction; it is systematic. All the "alues in the sample may tend to be higher or lower than the population mean)!or example. if all the subjects in a study examining some type of knowledge have an intelligence quotient (IQ) above 120, their scores will likely all be higher than the mean of a population that includes individuals with a wide variation in lQ. The IQs of the subjects have introduced a systematic bias. Because of systematic variance, the sample mean is different from the population mean. The extent of the difference is the sampling error

RANDOM SAMPLING

From a sampling theory point of view, each individual in the population should have an equal opportunity to be selected for the sample. The method of achieving this equal opportunity is referred to as random sampling. In experimental studies in which a control group is used, subjects are randomly selected for placement in the control group and the experimental group as well as being randomly selected for participation in the study. The use of the term control group is limited to those studies using random sampling methods. If nonrandom methods are used for sample selection, the group not receiving a treatment is referred to as a comparison group since there is an increased possibility of pre-existing differences in the experimental and the comparison groups. The purpose of random sampling is to increase the extent to which the sample is representative of the target population.

SAMPLING FRAMES

In order for each person in the target or accessible population to have an opportunity for selection in the sample, each person in the population must be identified. To accomplish this, a listing of every member of the population must be acquired, using the sampling criteria to define membership. This listing is referred to as the sampling frame. Subjects are then selected from the sampling frame using a sampling plan.

SAMPLING PLANS

A sampling plan describes the strategies that will be used to obtain a sample for a study. It is developed to increase representativness, decrease systematic bias, and decrease the sampling error. To accomplish this task, sampling theory has devised strategies for optimal sample selection. The sampling plan may use probability (random) sampling methods or nonprobability (nonrandom) sampling methods. A sampling method is similar to a design; it is not specific to a study. The sampling plan provides detail about the use of a sampling method in a specific study

PROPROBABILITY SAMPLING METHODS

Probability sampling methods have been developed to ensure some degree of precision in accurately estimating the population parameters. Thus, probability samples reduce sampling errorThe term probability sample refers to the fact that every member (element) of the population has a probability higher than zero of being selected for the sample. Inferential statistical analyses are based on the assumption that the sample from which data were derived have been obtained randomly. Thus, probability samples are often referred to as random samples. Such a sample is more likely to be representative of the population than a nonprobability sample. All the subsets of the population, which may differ from each other but contribute to the parameters of the population, have a chance to be represented in the sample. There is less opportunity for systematic bias if subjects are selected randomly although it is possible for a systematic bias to occur by chance. Using random sampling, the researcher cannot decide that person X will be a better subject for the study than person Y. In addition, researchers cannot exclude a subset of people from being selected as subjects because they do not agree with them, do not like them, or find them hard to deal with. Potential subjects cannot be excluded because they are too sick, not sick enough, coping too well, or not coping adequately. Researchers, who have a vested interest in their study, could tend (consciously or unconsciously) to select subjects whose conditions or behaviors are consistent with their hypothesis. It is tempting to exclude uncooperative or noncompliant individuals. Random sampling leaves the selection to chance and thus increases the validity of the study.

Theoretically, to obtain a probability sample, the researcher must identify every element ie population. A sampling frame must be developed, and the sample must be randomly selected from the sampling frame Thus, according to sampling theory, it is not possible to select a sample randomly from a population. that cannot be clearly defined. Five sampling designs have been developed to achieve probability sampling: simple random sampling, stratified random sampling, cluster sampling, systematic sampling, and .random assignment.

SIMPLE RANDOM SAMPLING

Simple random sampling is the most basic of the probability sampling methods. To achieve simple random sampling, elements are selected at random from the sampling frame. This can be accomplished in a varity of ways, limited only by the imagination of the researcher. If the sampling frame is small, names can be written on slips of paper. placed in a container, mixed well and then drawn out one at a time until the desired sample size has been reached. Another technique is assigning a number to each name in the sampling frame. In large population sets, elements may already have assigned numbers. For example, numbers are assigned to medical records, organizational memberships, and licenses. Numbers then are selected randomly to obtain a sample.

There can be some differences in the probability for the selection of each element, depending on whether the selected element's name or number is replaced before the next name or number is selected. Selection with replacement, the most conservative random sampling approach, provides exactly equal opportunities for each element to be selected. For example, if the researcher draws names out of a hat to obtain a sample, each name must be replaced prior to drawing the next name to ensure equal opportunities for each subject. Selection without replacement gives each element differing levels of probability of selection. For example, if the researcher is selecting 10 subjects from a population of 50, the first name has a 1 in 5 chance, or a .2 probability, of being selected. If the first name is not replaced, the second name has a 9 in 49 chance, or a .18 probability, of being selected. As further names are drawn, the probability of being selected decreases.

There are many ways of achieving random selection. For example, a computer, bingo wheel, or roulette and table of random numbers

STRATIFIED RANDOM SAMPLING

Stratified random sampling is used in situations in which the researcher knows some of the variables in the population that are critical to achieving representativeness. The variables used to stratify need to be correlated with the dependent

variables being examine in the study. I n order for stratification to be effective, the stratified layers of the sample must be more "homogeneous" in relation to the variable used for stratification than the population as a whole. Variables commonly use for stratification include age, gender, ethnicity. socio-economic status, diagnosis. geographic region, type of institution, type of care, and site of care. In stratified random sampling. the sample is divided into strata using the identified variables. The population is the~' classified into these strata, and samples of each strata are randomly selected. For example, age might be used to stratify the sample. The researcher would select age to stratify because subjects within each age group were expected to be more alike in relation to the study variables than they were to be like other age groups or the total sample. If a sample of 100 subjects was planned, the researcher might plan to obtain 25 subjects under the age of 20, 25 subjects in the age range of 20 to 39, 25 subjects in the age range of 40 to 59. and 25 subjects over the age of 60.

Stratification ensures that all levels of the identified variables will be adequately represented in the sample. Stratification allows the researcher to use a smaller sample size and achieve the same degree of representativeness as a large sample acquired through simple random sampling. Sampling error is decreased, power is increased, data collection time is reduced, and the cost of the study is lower using stratification.

LUSTER SAMPLING

Cluster sampling is used in two situations. The first situation is when a simple random sample would be prohibitive in terms of travel time and cost. Imagine trying to make personal contacts with 100 people, each in a different part of the United States. The second situation is in cases in which the individual elements making up the population are not known, thus preventing the development of a sampling frame. For example, there is no list of all the open-heart surgery patients in the United States. In these cases, it is often possible to obtain lists of institutions or organizations with which the elements of interest are associated)

In cluster sampling, a sampling frame is developed that includes a list of all the states, cities, institutions, or organizations with which elements of the identified population would be linked. A randomized sample of these states, cities, institutions, or organizations would then be used in the study. In some cases, this randomized selection continues through several stages and is then referred to as multistage sampling. For example, the researcher might first randomly select states, then randomly select cities within the sampled states. Then hospitals within the randomly selected cities might be randomly selected. Within the hospitals, nursing units might be randomly selected. At this level, all the patients on the nursing unit who fit the criteria for the study might be included, or patients could be randomly selected.

Cluster sampling provides a means for obtaining a larger sample at a lower cost. However, there are some disadvantages. Data from subjects associated with the same institution are likely to be correlated and, thus, not completely independent. This can lead to a decrease in precision and an increase in sampling error. However, these disadvantages can be offset to some extent by a larger sample.

SYSTEMATIC SAMPLING

sytematic sampling can be conducted when an ordered list of all members of the population is available. The process involves selecting every kth individual on the list, using a starting . point selected randomly. If the initial starting point is not random. it is not a probability sample. [n order to usc this design, the researcher must know the number of elements in the population and the size of the sample desired. The population size is divided by the desired sample size, giving "k." the size of the gap between elements selected from the list. For example. if the population size was N = 1200 and the desired sample size was n = SO, then k = 24. Every 24th person on the list would be included in the sample. This value is obtained by dividing 1200 by SO. There is argument that this procedure does not truly give each element an opportunity to be included in the sample; it provides a random but not equal chance for inclusion.

Care needs to be taken to determine that the original list has not been set up with any ordering that could be meaningful in relation to the study. The assumption is being made that the order of the list is random in relation to the variables being studied. If the order of the list is related to the study, it would introduce a systematic bias. In addition to this risk, computation of the sampling error using this design is difficult.~

RANDOM ASSIGNMENT TO GROUPS

Random assignment is a procedure used to assign subjects to treatment or control groups randomly. Random assignment can be either a probability or a non probability sampling technique. If the original group is selected randomly prior to random assignment, it is considered a probability sample. Otherwise. the result is a nonprobability sample. Random assignment without random selection lacks the strength of full randomization. As is true in selecting an accessible population, if the sample from which the random assignment to groups is made is biased, the groups will also be biased. However, random assignment used without random sampling decreases the risk Traditional approaches to random assignment involve the use of a random numbers table or flipping an unbiased coin to determine group assignment. However, these procedures can lead to unequal group sizes and thus a decrease in power of bias in the selection of groups.

NONPROBABILITY SAMPLING

Nonlprobabiliry sampling, not every element of the population has an opportunity for selection in the sample. Although this approach to sampling increases the possibilities of samples that are not representative. it has been commonly used in nursing studies. There are several types of non probability sampling designs. Each addresses a different research need. Tile four non probability designs included are convenience sampling. Quota sampling,-purposive sampling, and network sampling

CONVENIENCE SAMPLING.

Convenience sampling is considered a poor approach to sampling because it provides little opportunity to control for biases. In convenience sampling, subjects are included in the study because they happened to be in the right place at the right time. Available subjects are simply entered into the study until the desired sample size is reached. Multiple biases may exist in the sample, some of which may be subtle and unrecognized. However, serious biases are not always present in convenience samples.

The researcher needs to identify and describe known biases in the sample. Carefully thinking through the characteristics of the population, the researcher can identify biases likely to occur. Steps can then be taken to increase the representativeness of the sample. For example, if you are studying home care management of patients with complex health care needs, educational level will be an important extraneous variable. One solution would be to redefine the sampling criteria to include only those individuals with a high school education. This would limit the extent of generalization. Another option would be to select a population known 10 include individuals with a wide variety of educational levels. Data could be collected on educational level, so that the description of the sample would include information on educational level. With this information, one could judge the extent to which the sample was representative in respect to educational level.

Many strategies are available for selecting a convenience sample. A classroom of students might be used. Patients who attend a clinic on a specific day, subjects who attend a support group, patients currently admitted to a hospital with a specific diagnosis or nursing problem, and every fifth person who enters the emergency room are examples of types of frequently selected convenience samples .

Convenience samples are inexpensive, accessible, and usually require less time to acquire than other types of samples. Convenience samples provide means to conduct studies on topics that could not be examined using probability sampling They provide means to acquire information in unexplored areas.

QUOTA SAMPLING

Quota sampling uses a convenience sampling technique with an added feature, a strategy to ensure the inclusion of subject types that are likely to be underrepresented in the convenience sample, such as women, minority groups. the aged, the poor, the rich, and the undereducated. The goal of quota sampling is to replicate the proportions of subgroups present in the population. The technique is similar to that used in stratified random sampling. If necessary, mathematical weighting can be used to adjust sample values so that they are consistent with the proportion of subgroups found in the population. Quota sampling offers an improvement over convenience sampling and tends to decrease potential biases. In most studies in which convenience samples are used. quota sampling could be used and should be considered.

PURPOSIVE SAMPLING

Purposive sampling is sometimes referred to 'as judgmental sampling. Purposive sampling involves the conscious selection by the researcher of certain subjects or elements to include in the study. Efforts might be made to include "typical" subjects or typical situations. Examples of good care and poor care, good patients and bad patients might be used. This approach is often used in qualitative studies. using insights gained from initial data collection, the qualitative researcher may decide to seek subjects with particular characteristics in order to increase theoretical understanding of some facet of the phenomenon being studied. For example, the researcher might find through subject interviews that a few subjects differed strikingly from the views of the group. The researcher might intentionally seek interviews with those individuals who differed. The strategy has been criticized because there is no way to evaluate the precision of the researcher's judgment. How does one determine that the patient or element was typical. good, bad, effective, or ineffective? However, this sampling method may be a way to get some beginning ideas about an area not easily examined using other sampling techniques.

NETWORK SAMPLING

Network sampling, sometimes referred to as snowballing, holds promise for locating samples difficult or impossible to obtain in other ways. Network sampling takes advantage of social networks and the fact that friends tend to hold characteristics in common. When the researcher has found a few subjects with the needed criteria, the subjects are asked for their assistance in getting in touch with others with similar characteristics. This strategy is particularly useful for finding subjects in socially devalued populations such as alcoholics. prostitutes, child abusers, sex offenders, drug addicts, and criminals. These individuals arc seldom willing to make themselves known to others. Other groups such as widows, grieving siblings, or those successful at life style changes can be located using this strategy. These individuals are outside the existing health care system and are difficult to find. Obviously there are biases built into the sampling process. since the subjects are not independent of each other.

SAMPLE SIZE

One of the most frequent questions asked by beginning researchers is "What sample size size should I use?" Historically, the response to this question has been that a sample shouldould contain at least 30 subjects. However, in most cases, 30 subjects will be inadequate as a sample size. Currently, the deciding factor in determining sample size is power. Power is the capacity of the study to detect differences or relationships that actually exist in the population tion. Expressed another way, it is the capacity to correctly reject a null hypothesis.The minimum acceptable level of power for a study is .80 . This power level results in a 20% chance of a Type II error in which the study fails to detect existing effects .

Sample size is determined by performing power analyses for each group in the sample for which comparative data analysis will be performed. At a minimum, one power analysis should be performed for each hypothesis or research question in the study. The sample size obtained from the power analysis indicates the minimum number of subjects needed to complete the study. not the number initially enrolled in the study. Therefore, the initial samplesize will need to be larger than thecalculated number because of the expected attrition rate. data collection. Studies with inadequate sample sizes should not be approved for data

collection unless they are preliminary pilot studies conducted prior to a planned larger study. If it is not possible to obtain a larger sample because of time or numbers of available subjects. the study should be redesigned so that the available sample is adequate for the planned analyses. If it is not possible to obtain a sufficient sample size to achieve an acceptabll: risk of a Type 11 error. it is better not to conduct the study.Large sample sizes arc difficult to obtain in nursing studies, require long data collection periods, and are costly. Therefore, in developing the methodology for a study. it is important to evaluate the elements of the methodology that affect the required sample size. Kraemer and Thiemann identify the following factors that need to be taken into consideration in determining sample size:

I. The more stringent the significance level (e.g., .00 I vs. .05), the greater the necessary sample size.
2. Two-tailed statistical tests require larger sample sizes than one-tailed tests..
3. The smaller the effect size, the larger the necessary sample size.
4. The larger the power required, the larger the necessary sample size.
5. The smaller the sample size, the smaller the power. Other factors that need to be considered in making decisions about sample size (because they affect power) include the effect size, type of study, the number of variables. The sensitivity of the measurement tools, and the data analysis techniques

EFFECT SIZE

Effect size is the extent to which the null hypothesis is false. In a study. statistical procedures test for the presence or absence of a phenomenon in the population. Effect in this case is used in a broader sense than that of "cause and effect." "Effect" is the presence of the phenomenon. For example, you might examine the impact of gender on whether or not nausea occurred after chemotherapy. To examine this question, you might obtain a sample of subjects receiving chemotherapy and measure the occurrence of nausea. The null hypothesis would be that the same proportion of men and women would experience nausea. If this were so. you would say that the "effect" of gender on the occurrence of nausea was zero. In another study, you might be interested in using the Pearson product moment correlation "r" to examine the relationship between coping and anxiety. Your null hypothesis would be that the population "r" would be zero. Coping would have no "effect" (in terms of relationship) with anxiety.

Perform a power analysis for the purpose of determining sample size. If the ES is large, it is easy to detect and requires only a small sample; if the ES is small. Detecting it will be more difficult and require larger samples. Broadly, a small effect size would be about .2. a medium effect size .. 5. and a large effect size, .8. However, actually, the numerical value of these effect sizes varies depending on the statistical test that will be used . Extremely small effect sizes may not be clinically important. For example, an effect size of .10 F in oral temperature when comparing glass thermometers with electronic thermometers is probably not important enough to influence selection of a particular type of thermometer. Knowing the effect size that would be considered important clinically allows us to limit the sample to the size needed to detect that level of ES .Effect size is smaller with a small sample and is thus more difficult to detect. Increasing the

,ample size also increases the effect size, making it more likely that the effect will be detected. Setting the level of significance at a more stringent level makes the ES more difficult to detect since "detection" means that statistical analysis must find the "effect" to be "statistically significant."

Effect sizes vary based on the population being studied. Thus, we need to determine the ES for the particular effect being studied in a particular population. The most desirable source of this information is evidence from previous studies. Using such information as the mean and standard deviation, the ES can be calculated. This calculation, however, can be used only as an estimate of ES for your study. If you change the measure used, or the design or the population being studied, the ES will be altered. The best estimate of a population parameter of ES is obtained from a meta-analysis in which an estimated population effect size is calculated using statistical values from all studies included in the analysis.

TYPE STUDY

Qualitative studies and case studies tend to use very small samples. Comparisons between groups are not being performed, and problems related to sampling error and generalization has little relevance for these studies. A small sample size may better serve the researcher who is interested in examining the situation in depth from various perspectives. The qualitative researcher will stop seeking additional participants when theoretical saturation is achieved.

Descriptive studies, particularly those using survey questionnaires, and correlational studies often require very large samples. In these studies, multiple variables may be examined, and extraneous variables are likely to affect subject response(s) to the variables under study. Statistical comparisons are often made on multiple subgroups in the sample, requiring that an adequate sample be available for each subgroup being analyzed. In addition, subjects are likely to be heterogeneous in terms of demographic variables, and measurement tools are sometimes not adequately refined. Althoughtarget populations may have been identified, sampling frames may not be available,and parameters have not usually been well defined from previous studies. All of thesefactors lower the power of the study and require increases in sample size .

In the past. Quasi-experimental and experimental studies often used smaller samples than descriptive and correlational studies. As control in the study increases, the sample size can decrease and still approximate the population. Instruments in these studies tend to be refined, thus increasing precision. However, sample size must be sufficient to achieve an acceptable level of power to reduce the risk of a Type II error.

NUMBER OF VARIABLES

As the number of variables under stud: increases, the needed sample size may increase. Adding variables such as age. gender, ethnicity, and education to the analysis plan (just to be on the safe side) can increase the sample size by a factor of 5 to 10 if the selected variables are uncorrelated with the dependent variable. In this case. instead of a sample of 50, you may need a sample of 500 if you plan to use these variables in your statistical analyses. (Using them only to describe the sample does not cause a problem in terms of power.)However, if the variables are highly correlated with the dependent variable. the effect size will increase and the sample size can be reduced. Therefore, variables included in the data analysis need to be carefully selected. They should be essential to the research question or have a documented strong relationship to the dependent variable .. A number of the studies analyzed by Polit and Sherman (1990) had sufficient sample size for the primary analyses but failed to plan for analyses involving subgroups. Such as analyzing the data by age categories or by ethnic groups. The inclusion of multiple dependent variables also increases the sample size needed.

MEASUREMENT SENSITIVITY

Well-developed instruments measure phenomena with precision. A thermometer, for example, measures body temperature precisely. Tools measuring psychosocial variables tend to be less precise. However. a tool with strong reliability and validity tends to measure more precisely than a tool that is less well developed. Variance tends to be higher in a less well developed tool than in one that is well developed. An instrument with a smaller variance is preferred because the power of a test is always decreased by increased within-group variance (Kraemer & Thiemann, 1987). For example. It anxiety were being measured and the actual anxiety score of several subjects was 80. the subject-' score on a less well-developed tool might range from 70 to 90. Whereas a well-developed tool would tend to show a score closer to the actual score of 80 for each subject. .-\s variance in instrument scores increases. the sample size needed to gain an accurate understanding of the phenomenon under study increases.

The range of measured values influences power. For example. a variable might be measured in Hi equally spaced values, ranging from o to 9. Effect sizes will vary depending on how near the value is to the population mean. If the mean value is 5, effect sizes will be much larger in the extreme values and lower for values near the mean. If the researcher decides to use only subjects with values of 0 and 9. the effect size will be large and the sample could be small. However. the credibility of the study might be questionable since the values of most individuals would not be 0 or 9 but rather tend to be in the middle range of values. If a decision is made to include subjects who have values in the range of 3 to 6, excluding the extreme scores. the effect size would be small and a much larger sample would be required. The wider the range of values sampled. The larger the effect size . Each measure of response should be used in as sensitive a form as can be reliably measured. If measurement on a continuum is reliable. the measure should not be reduced to a scale or dichotomized since this will reduce the power. If an interval level measure is reduced to an ordinal or nominal level , a much larger sample size is required to achieve adequate power .

DATA ANALYSIS TECHNIQUES

Data analysis techniques vary in ability todetect differences in the data. Statisticians refer to this as the "power" of the statistical analysis. The most powerful statistical test appropriate to the data should be selected for data analysis. Overall, parametric statistical analyses arc more powerful in detecting differences than non parametric techniques if the data meet criteria for parametric analysis. However, in many cases. nonparametric techniques are more powerful if the assumptions of parametric techniques are not met. Parametric techniques vary widely in their capacity to distinguish fine differences in the data.

There is also an interaction between the measurement sensitivity and the power of the data analysis technique. The power of the analysis technique increases as precision in measurement increases. Larger samples need to be used when the power of the planned statistical analysis is weak.

For some statistical procedures, such as theT-test and ANOV A, equal group sizes will increase power because the effect size is maximized. The more unequal the group sizes are, the smaller the effect size. Therefore, in unequal groups. the total sample size needs to be larger .

Chi-square is the weakest of the statistical tests and requires very large sample sizes to achieve acceptable levels of power. As the number of categories increases, the sample size needed increases. Also. if there are small numbers in some of the categories, the sample size needs to be increased. Kraemer & Thiemann (1987) recommend that the chi-square (X2) test be used only when no other options are available. In addition, the number of categories should be limited to those essential to the study.

PERFORMING A POWER ANALYSIS

The statistical procedures to perform a power analysis have been described in detail by Cohen (1988). Kraemer and Thiemann (1987) offer a briefer explanation of the analysis process. The power analysis equation differs based on thestatistical procedure that will be used to analyze the data.

Computer programs designed to perform power analyses are beginning to appear. Borenstein and Cohen (1989) have developed Statistical Power Analysis, which will perform power analyses for t-test, correlation analysis. regression, proportions, and analysis of variance. Brent, Scott, and Spencer (1988) have developed a program called Ex-Sample that will perform power analysis and recommend a sample size. The program is user friendly and asks screening questions to make sure its procedures are appropriate. It generates a report that includes references for the mathematical calculations used in determining the power or the sample size. NCSS (Number Cruncher Statistical System) has a power analysis program called PASS (Power Analysis and Sample Size) for the IBM-compatible PC that is user friendly and is more comprehensive than the other programs. It can be purchased separately from the rest of NCSS.

Power tables have been developed to determine ES if you know the sample size, or to determine the sample size if you know the ES. Technically, there is a different calculation for each statistical procedure, and tables have been developed by Cohen (1988) for many of the statistical procedures. This means that you can look up the ES or the sample size on these tables rather than perform the calculation. However, Kraemer and Thiemann (1987) contend that the difference in calculations based on the type of statistical procedure is small. and they have developed a single table that can be used for this purpose . In order to use the tables, you need to know three of the four dimensions of the power equation. The four dimensions are (1) level of significance, (2) power, (3) sample size, and (4) effect size. This means that to determine sample size, you need to know the effect size, the level of significance, and the desired power level. Since level of significance is usually .05 and power is usually .8, only the effect size value is needed to determine the sample size.

RECRUITING AI\D RETAINING SUBJECTS

Once a decision has been made about the size of the sample. the next step is to develop a plan for recruiting subjects. Recruitment strategies differ depending on the type of study and the setting. Special attention needs to focus on recruiting subjects who tend to be under represented in studies, such as minorities and women. The sampling plan, initiated at the beginning of data collection, is almost always more difficult than was expected. Some researchers never obtain their planned sample size. Retaining acquired subjects is critical to the study and requires consideration of the effects of data collection strategies on subject mortality .Problems with retaining subjects increase as the data collection period lengthens.

RECRUITING SUBJECTS

The initial approach to a potential subject usually strongly affects his or her decision about participating in the study. Therefore, the approach needs to be pleasant and positive. The importance of the study is explained, and the researcher makes clear exactly what the subject will be asked to do, how much time will be involved for the subject, and what the time range of the study will be. Subjects are valuable resources. The recognition of this value needs to be communicated to the potential subject. High pressure techniques, such as insisting that the subject make an instant decision to participate in a study, usually lead to' resistance and increased refusals. The researcher accepts refusals to participate gracefully-in terms of body language as well as words. The actions of the researcher can influence the decision of other potential subjects who observe or who hear about the encounter. Studies in which a high proportion of individuals refuse to participate have a serious validity problem. The sample is likely to be biased, because usually only a certain type of individual has agreed to participate. Therefore, record,' are kept of the numbers of persons who refuse and, if possible, the reasons for refusal.

If data collectors are being used in the study, the researcher needs to verify that they are following the sampling plan, especially in random samples. When the data collectors encounter difficult subjects or are unable to make contact easily, they may simply shift to the next person without informing the principal investigator. This behavior could violate the rules of random sampling and bias the sample. If data collectors do not understand or believe in the importance of randomization. their decisions and actions can undermine the intent of the sampling plan. Thus, data collectors need to be carefully selected and thoroughly trained. A plan needs to be developed for the supervision and follow-up of data collectors, increasing their sense of accountability.

When surveys are used, the researcher may never have personal contact with the subjects. In this case, the researcher will have to rely on the use of attention-getting techniques, persuasively written material, and strategies for following up on individuals who do not respond to the initial written communication. Because of the serious problems of low response rates in survey studies, strategies to increase the response rate are critical.

We have received such things as a tea bag or packet of instant coffee with a questionnaire. with a statement in the letter to have a cup of coffee (or tea) on the researcher while you take a break from your work to complete the questionnaire Creativity is required in the use of such strategies since they will tend to lose their effect on groups who receive questionnaires frequently (such as faculty). In some cases, small amounts of money are included with the letter.

The letter may include a suggestion that you buy yourself a soft drink or that the money is a small offering for completing the questionnaire. This strategy imposes some sense of obligation on the recipient of the letter to complete the questionnaire but is not thought to be coercive (Baker, 1985). Avoid holidays or times of the year when workloads are high and the return rate might be reduced.

To reduce costs, nurse researchers are now using the mail to collect data far more extensive than that of the simple questionnaire. In some cases, multiple scales will be mailed to subjects to be completed at home and returned. Recruitment strategies for these subjects may require some form of personal contact prior to mailing the material as well as telephone contact during the data collection period.

An initial phase of recruitment may involve obtaining community and institutional support for the study. Support from other health professionals. Such as nurses and physicians. may be critical to successful recruitment of subjects. Studies may also benefit from endorsement by community leaders. This may include individuals such as city officials and key civic leaders, and social. Educational, religious, or labor groups. In some cases, these groups may be involved in planning the study, leading to a sense of community ownership of the project. Community groups may also assist in recruitment of subjects for the study. Sometimes, subjects who meet the sampling criteria will be found in the groups assisting with the study.

Endorsement may involve letters of support and, in some cases. funding. These activities add legitimacy to the study and make involvement in the study more attractive to potential subjects .

Media support can be helpful in recruiting subjects. Advertisements can be placed in local newspapers and church and neighborhood bulletins. Radio tations can make public service announcements. Members of the research team can speak at groups relevant to the study population. Posters can be placed in public places such as supermarkets, drugstores, and washaterias. With permission, tables can be placed in shopping malls with a member of the research team present to recruit subjects .

RETAINING SUBJECTS

One of the serious problems in many studies is subject retention. Often, subject loss cannot be Subjects move, die, or withdraw from treatment. If data" must be collected at

several points across time, subject mortality (loss of subjects from the study) can become a problem. Subjects who move frequently and those without telephones pose a particular problem. A number of strategies have been found to be effective in maintaining the sample. Names, addresses, and telephone numbers of at least two family members or friends need to be obtained when the subject is enrolled in the study. Consent may be sought from the subject to give the researcher access to unlisted phone numbers in the event that the subject changes the phone number. In some studies, the subject is reimbursed for participation. A bonus payment may be included for completing a certain phase of the study. Gifts can be used in place of money. Sending greeting cards for birthdays and holidays helps maintain contact. However, the researcher needs to carefully consider the point at which these activities cross the line into coercion.

Collecting data takes time. The researcher always keeps in mine that the subject's time is valuable and should be used frugally. During data collection, it is easy to begin taking the subject for granted. Taking time for social amenities with subjects may payoff. However. one needs to take care that these interactions do not influence the data being collected. Beyond that, nurturing subjects participating in the study is critical. In some situations, providing refreshments and pleasant surroundings is helpful. During the data collection phase, often there are others interacting with the subjects who also need to be nurtured. These may be volunteers, family, and staff. Students, or other professionals. It is important to maintain a pleasant climate for the data collection process, which will payoff in the quality of data collected and the retention of subjects.

SUMMARY

Sampling involve selecting a group of people, events, behaviors or other elements with which to conduct a study. Sampling defines the process of making these selections; sample defines the selected group of elements. Sampling theory "as developed to determine mathematically the most effective way of acquiring a sample that would accurately reflect the population under study. Important concept in sampling theory include target population,. elements of the population. randomizationsampling frame. accessible population. representativeness. Statistics parameters. precision, sampling errors and systematic bias. To obtain a probability (random) sample, the researcher must know every element in the population. A sampling frame must be developed and the sample randomly select" from the sampling frame. Five sampling designs have been developed to achive probability sampling: simple random sampling. stratified random sampling ,cluster sampling. systematic sampling, and random assignment to groups. I(. nonprobability)' (nonrandom) sampling. Not every element of the population has an opportunity for selection in the sample. There is no sampling frame. Four non probability designs are included in this text: convenience sampling, quota sampling;. Purposive sampling and network sampling.

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