Introduction to Nursing Research

As per the Revised INC Syllabus for BSc Nursing





Semester VII

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Contents

Chapter 1: Introduction **1**

- Introduction to Research *1*
- Methods of Acquiring Knowledge *1*
- Definition of Research *3*
- Characteristics of Research *3*
- Purpose of Research *4*
- Scope of Nursing Research *9*
- Health Research *10*
- Historical Evolution of Research in Nursing *12*
- Social Research *12*
- Concept of Evidence-based Practice *14*
- Steps Involved in Evidence-based Practice *15*
- Ethics in Research *16*
- Overview of Research Process *19*

Chapter 2: Research Problem **21**

- Factors to be Considered in Selecting a Research Problem *21*
- Identification or Selection of Research Problem *22*
- Formulation of Problem Statement and Research Objectives *23*
- Definition of Terms or Concepts *24*
- Assumptions *25*
- Limitations and Delimitations of a Study *28*
- Identification of Variables *28*
- Hypothesis *29*
- Testing of Hypothesis *31*

Chapter 3: Developing Theoretical/Conceptual Framework **34**

- Components of Theoretical Ideas *35*
- Characteristic Features of a Theory *35*
- Purposes of a Theory *36*
- Conceptual/Theoretical Framework *36*

Chapter 4: Review of Literature **39**

- Importance of Literature Review *39*
- Purpose of Literature Review *40*
- Principles of Literature Review *41*
- Sources of Literature Review *41*
- Types of Reviews *43*
- Methodology and Tools for Critical Literature Review in Academic Research *45*
- Steps in Reviewing Literature *45*
- Key Components of Literature Review *48*
- Criteria for Writing a Good Literature Review *48*
- Traps Involved in Writing a Good Literature Review *49*
- Key Ways by which Researchers Problematize the Literature *49*
- Strategies for Writing the Literature Review *50*
- Common Misconceptions About Literature Review *52*
- Plagiarism *52*

JAYPEE BROTHERS

Chapter 5: Research Approaches and Designs **55**
- Components of Research Design *55*
- Characteristics of a Good Research Design *55*
- Classification of Research Design *56*
- True Experimental *59*
- Quasi-Experimental *64*
- Pre-Experimental *68*
- Ethics Concerns in Experimental Research *70*
- Nonexperimental Research Design *71*
- Qualitative Research Design *72*

Chapter 6: Sampling **85**
- Population *85*
- Characteristics of a Good Sampling Design *85*
- Criteria for Sample Selection *86*
- Factors Influencing Sampling *86*
- Sampling Design Process *86*
- Classification or Types of Sampling Technique *92*
- Sampling Errors and Nonsampling Errors *100*
- Types of Error *100*

Chapter 7: Tools and Methods of Data Collection **103**
- Concepts of Data Collection *103*
- Sources of Data *104*
- Tools for Data Collection *104*
- Types *104*
- Characteristics of a Good Schedule/Questionnaire *108*
- Steps Involved in Tool Construction *108*
- Measurement and Scaling *109*
- Comparison of Scaling Techniques *110*
- Item Analysis *112*
- Item Analysis Guidelines *113*
- Reliability of the Tool *114*
- Factors Affecting Reliability *120*
- Validity of the Tool *121*
- Pilot Study *124*
- Procedure for Data Collection *126*

Chapter 8: Implementing Research Plan **128**
- Research Plan (Design) *128*
- Plan for Data Collection *129*

Chapter 9: Analysis and Interpretation of Data **133**
- Plan for Data Analysis *133*
- Computer Analysis *134*
- Statistical Analysis *135*
- Interpretation of Data *137*
- Strategies or Steps Used in Data Interpretation *137*

Chapter 10: Reporting and Utilizing Research Findings **139**
- Purpose *139*
- Types *139*
- Communicating Research Findings *140*

JAYPEE BROTHERS

- Types of Presenting Research Reports (Orally and Written) *140*
- Form and Style of Writing Research Report *145*
- Description of the Contents of the Report *146*
- Chapter–I *148*
- Chapter–II *149*
- Chapter–III *150*
- Chapter–IV *151*
- Chapter–V *152*
- Chapter–VI *153*
- General Suggestions for Preparation of Dissertation Report *154*
- Methods of Writing Research Report *156*
- Research Utilization (or) Utilization of Research Findings *163*

Chapter 11: Critical Analysis of Research Reports and Articles **167**

- Purpose of Critiquing a Research Article *167*
- Steps Involved in Critiquing a Research Article *167*
- Guidelines for Critiquing a Research Article *169*

Chapter 12: Developing and Presenting a Research Proposal **172**

- Purpose of Report Writing and Presentation *172*
- Report Preparation and Presentation Process of a Proposal *173*

Model Research Proposal-1: Based on Experimental Design *175*

- Need for the Study *175*
- Review of Literature *175*
- Statement of the Problem *175*
- Objectives of the Study *176*
- Hypothesis of the Study *176*
- Operational Definitions *176*
- Assumptions *176*
- Delimitations *177*
- Methodology *177*

Model Research Proposal-2: Based on Descriptive Design *178*

- Need for the Study *178*
- Review of Literature *178*
- Statement of the Problem *179*
- Objectives of the Study *179*
- Hypotheses of the Study *179*
- Operational Definitions *179*
- Assumptions *180*
- Delimitations *180*
- Methodology *180*

Model Research Proposal-3: Based On Comparative Design *182*

- Need for the Study *182*
- Review of Literature *182*
- Statement of the Problem *183*
- Objectives of the Study *183*
- Hypothesis of the Study *183*
- Operational Definitions *183*

JAYPEE BROTHERS

- Assumptions *184*
- Delimitations *184*
- Methodology *184*

Model Research Proposal-4: Based on Case Study Design ***185***

- Need for the Study *185*
- Review of Literature *185*
- Statement of the Problem *186*
- Objectives of the Study *186*
- Hypotheses of the Study *186*
- Operational Definitions *186*
- Assumptions *186*
- Delimitations *187*
- Methodology *187*

Model Research Proposal-5: Based On Correlational Design ***188***

- Need for the Study *188*
- Review of Literature *188*
- Statement of the Problem *188*
- Objectives of the Study *189*
- Hypothesis of the Study *189*
- Operational Definitions *189*
- Assumptions *189*
- Delimitations *190*
- Methodology *190*

Glossary 191

Bibliography 205

Index ***207***

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6

CHAPTER

Sampling

Sampling is one of the components of a research design. For example, a house wife examines only 2–3 grains of boiling rice to know whether the pot of rice is ready or not. A doctor examines a few drops of blood and draws the conclusions about blood constitution of the whole body. The sampling design process includes five steps and they are closely inter-related and relevant to all aspects of the research, from problem definition to the presentation of the results. Therefore, sample should be integrated with all other decisions in a research process.

DEFINITION

According to Hurlock: "Sampling is the process of selecting, representing units of a population for the study or research."

According to Chris Jordan: "Sampling is the process of selecting a subset of a population in order to obtain information regarding phenomena in a way that represents the entire population."

POPULATION

According to Chris Jordan: Population is an aggregate of elements showing some common set of criteria.

Accessible Population

Accessible population refers to the aggregate of cases, which confirm to the designated criteria and which is accessible to the researchers as a pool of subjects for the study.

Target Population

Target population refers to the population that the researcher wishes to study and wishes to make a generalizations.

CHARACTERISTICS OF A GOOD SAMPLING DESIGN

The characteristics of a good sampling design are as follows:

- A good sample is one, which within restrictions imposed by its size, will reproduce the characteristics of the population with the greatest possible accuracy.

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- It should be free from error due to bias or due to deliberate selection of the unit of the sample.
- It should be free from random sampling error.
- There should not be any substitution of originally selected unit by some other more convenient way.
- It should not suffer from incomplete coverage of the units selected for the study, i.e., it should not ignore the failure in the sample in responding to the study.
- In the sample, only such units should be included, which as far as possible, are independent.
- While constructing a sample, it is important that measurable or known probability sample technique is used; this will substantially reduce the likely discrepancies.
- Relatively small samples properly selected may be much more reliable than large samples poorly selected. But at the same time, it is very essential that the sample is adequate in size, so that it can become more really reliable.

CRITERIA FOR SAMPLE SELECTION

The criteria for sample selection are as follows:

- The sample must be chosen well so as to be representative of the parent population.
- The sample must be sufficiently large.
- There must be adequate coverage of the sample.
- The sample that is badly chosen or inadequately covered remains a biased one.

FACTORS INFLUENCING SAMPLING

The following are the factors, which influences sampling:

- The size of the universe
- Availability of resources
- Desired degree of accuracy
- Homogeneity or heterogeneity of the universe
- Nature of study
- Sampling method adopted.

SAMPLING DESIGN PROCESS

The sampling design process includes the following five steps as follows:

1. Define the Target Population

Sampling design begins by specifying the target population. The target population is the collection of elements or objects that process the information sought by the researcher and about which inferences are to be made. The target population must be defined precisely. Imprecise definition of the target

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population will result in research that is ineffective at best and misleading at worst. Defining the target population involves translating the problem defining into a precise statement of who should and should not be included in the sample.

The target population should be defined in terms of elements, sampling units extent and time. An element is the object about which or from which the information is desired. In survey research, the element is usually the respondent. A sampling unit is an element or a unit containing the element, that is available for selection at some stage of the sampling process.

For example, coffee drinkers is (element) household that have (sampling unit) brought coffee (extent) in the last 3 months (time).

2. Determine the Sampling Frame

A sampling frame is a representation of the elements of the target population. It consists of a list or set of directions for identifying the target population.

For example, telephone book, map or city directory, etc.

3. Select a Sampling Technique

Selecting a sampling technique involves several decisions of a broader nature. The researcher must decide whether to use a Bayesian or traditional sampling approach, to sample with or without replacement, and to use nonprobability or probability sampling.

In the Bayesian approach, the elements are selected sequentially. After each element is added to the sample, the data are collected, sample statistics computed and sampling costs determined. The Bayesian approach explicitly incorporates prior information about population parameters as well as the costs and probabilities associated with making wrong decisions.

In sampling with replacement, an element is selected from the sampling frame and appropriate data are obtained. Then the element is placed back in the sampling frame. As a result, it is possible for an element to be included in the sample more than once. In sampling without replacement, once an element is selected for inclusion in the sample, it is removed from the sampling frame and therefore, cannot be selected again. The calculation of statistics is done somewhat differently for the two approaches, but statistical inference is not very different if the sampling frame is large relative to the ultimate sample size. Thus, the distinction is important only when the sampling frame is not large compared to the sample size. The most important decision about the choice of sampling technique is whether to use probability or nonprobability sampling.

4. Determine the Sample Size

Sample size refers to the number of elements to be included in the study. Calculation of exact sample size is an important part of research design. It is

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very important to understand that different study design need different method of sample size calculation and one formula cannot be used in all designs. Determining the sample size is complex and involves several qualitative and quantitative considerations.

Sample Size Calculation for Cross-sectional Studies/Surveys

Cross-sectional studies, or cross-sectional survey are done to estimate a population parameter like prevalence of some disease in a community or finding the average value of some quantitative variable in a population.

Formula for calculating base sample size	$n = (t^2 \times p\ (1-p)/m^2$
Definition of components	n = sample size t = confidence level at 95% (standard value of 1.96) p = estimated prevalence of desired/practice in the program area m = margin of error at 5% (standard value of 0.05)
Example	The estimated prevalence of anemia in community is 15% (0.15) $n = (t^2 \times p\ (1-p)/m^2$ t = 1.96, p = 0.15, m = 0.05) $n = (1.96^2 \times 0.15\ (1-0.15)/0.05^2$ $n = 3.842 \times 0.1275/0.0025$ n = 195.942 **n = 196 (approximately)** **So, the researchers will have to take the blood hemoglobin sample of at least 196 children in a community to now average anemic children** **Sample size is = 216 (Considering 10% drop out or attrition).**

Sample Size Calculation for Case Control Studies

In case control studies cases (the group with disease) are compared with controls (the group without disease) regarding exposure to the risk factor under question.

Formula for calculating base sample size	$n = \frac{(r+1)}{r} \frac{(p0)\ (1-p_0)\ (Z_\beta + Z_{\alpha/2})}{(p_1-p_2)^2}$ where $P_{\text{cases exposed}}(p_1) = \frac{\text{Odds Ratio}\ (P_{\text{controls exposed}})}{(P_{\text{controls exposed}})\ (\text{Odds Ratio} - 1) + 1}$
Definition of components	n = sample size $Z_{1-\alpha/2}$ = confidence level at 95% (standard value of 1.96) $Z_{1-\beta}$ = sample proportion for 80% power (standard value of 0.842) Odds ratio, r = 2 (there is a 100% increase in the odds of an outcome with a given exposure) p_1 = no of cases exposed p_2 = no of controls exposed p_0 = average proportion exposed = $\frac{(p_1 + p_2)}{2}$

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Example

In a **case-control** study of the association between smoking and lung cancer the inclusion of **controls** being treated for a condition related to smoking (e.g., chronic bronchitis) may result in an underestimate of the strength of the association between exposure (smoking) and outcome. Available information indicates that the proportion exposed in the control group is 20% and an odds ratio of 2.
Here,
The proportion exposed in the control group is 20%
To get proportion of cases exposed

$$P_{\text{cases exposed}} = \frac{\text{Odds Ratio } (P_{\text{controls exposed}})}{(P_{\text{controls exposed}})\ (\text{Odds Ratio} - 1) + 1}$$

$$P_{\text{cases exposed}} = \frac{2\ (0.20)}{(0.20)\ (2.0-1) + 1}$$

$$P_{\text{cases exposed}} = \frac{0.40}{1.20} = 0.33$$

$$\text{Average proportion exposed } (p_0) = \frac{(0.33 + 0.20)}{2} = 0.265$$

$$n = \frac{(r+1)}{r} \frac{(p_0)\ (1-p_0)\ (Z_\beta + Z_{\alpha/2})}{(p_1 - p_2)^2}$$

$$n = \frac{(1+1)}{1} \frac{(0.265)\ (1-0.265)\ (0.842 + 1.96)}{(0.33 - 0.20)^2} = 181$$

n = 181 (approximately)
So the researchers will have to take a sample of at least 362 (181 cases and 181 controls)
Sample size is = 398 (Considering 10% drop out or attrition.

Sample Size Calculation for Comparative Studies

In a comparative study comparison is done between two or more groups on the basis of selected attributes such as knowledge, attitude and perception.

Formula for calculating base sample size

$$n = \frac{p_1\ (1-p_1) + p_2\ (1-p_2)}{(p_1 - p_2)^2}$$

Definition of components

n = sample size
p_1 = proportion of group 1
p_2 = proportion of group 2
C = standard value for the corresponding level of α and β selected for the study

Example

$$n = \frac{p_1\ (1-p_1) + p_2\ (1-p_2)}{(p_1 - p_2)^2}$$

p_1 = proportion of group 1 (From the previous study it was 40%)
p_2 = proportion of group 2 (From the previous study it was 20%)
C = 7.85 [at 95% Confidence Interval (CI) and 80% power]

$$n = \frac{0.4\ (1-0.4) + 0.2\ (1-0.2)}{(0.4 - 0.2)^2}$$

$$n = \frac{0.4\ (0.6) + 0.2\ (0.8)}{(0.2)^2}$$

$$n = \frac{0.24 + 0.16}{0.04}$$

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$$n = \frac{0.40}{0.04}$$

$n = 10$

n = 10 (approximately)

So the researchers will have to take a sample of at least 10

Sample size is = 11 (Considering 10% drop out or attrition).

Sample Size Calculation of Cohort Studies

In cohort studies healthy subjects with or without exposure to some risk factor are observed over a time period to see the event rate in both groups.

Formula for calculating base sample size

$$n = \frac{[Z_{1-\alpha/2}\sqrt{\{(1 + 1/m)\ p\ (1 - p)\}} + Z_{1-\beta}\sqrt{p_0(1-p_0/m)\ p\ (1-p)}\}]^2}{(p_0 - p_1)^2}$$

Definition of components

n = sample size (case) to identify true relative risk with two-sided type-I error

m = number of subjects (control) per experimental subject

$Z_{1-\alpha/2}$ = confidence level at 95% (standard value of 1.96)

$Z_{1-\beta}$ = sample proportion for 80% power (standard value of 0.842)

P_0 = possibility of events in control

P_1 = possibility of event in experimental

$P = p_1 + mp_0/m+1$

Example

If a researcher wants to see the impact of weight reduction program on cardiovascular mortality then they will select two groups, one consisting of subjects who participate in weight reduction program whereas the other group don't participate. These groups will be followed up for a specific time period to see cardiovascular mortality in both groups. At the end of the study period both groups will be compared for cardiovascular mortality.

$$n = \frac{[Z_{1-\alpha/2}\sqrt{\{(1 + 1/m)\ p\ (1 - p)\}} + Z_{1-\beta}\sqrt{p_0(1-p_0/m)\ p\ (1-p)}\}]^2}{(p_0 - p_1)^2}$$

$m = 1$

$Z_{1-\alpha/2}$ = confidence level at 95% (standard value of 1.96)

$Z_{1-\beta}$ = sample proportion for 80% power (standard value of 0.842)

$P_0 = 0.2$

$P_1 = 0.3$

$$P = \frac{0.3 + 1 \times 0.2 = 0.25}{1 + 1}$$

$$n = \frac{[1.96\sqrt{\{(1 + 1/1)\ 0.25\ (1-0.25)\}} + 0.842\sqrt{0.2\ (1-0.2/1)\ 0.25\ (1-0.25)}\}]^2}{(0.2-0.3)^2}$$

$$n = \frac{[1.96\sqrt{\{(2)\ 0.25\ (0.75)\}} + 0.842\sqrt{0.2\ (0.8)\ 0.25\ (0.75)}\}]^2}{(0.2-0.3)^2}$$

$$n = \frac{[1.96\sqrt{0.375} + 0.842\sqrt{0.03}]^2}{0.01}$$

$$n = \frac{[1.96\ (0.61) + 0.842\ (0.61)]^2}{0.01}$$

$$n = \frac{[1.20 + 0.842\ (0.61)]^2}{0.01}$$

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$$n = \frac{[1.20 + 0.51]^2}{0.01}$$

$$n = \frac{2.92}{0.01}$$

n = 292 (approximately)
So the researchers will have to take a sample of at least 292
Sample size is = 321 (Considering 10% drop out or attrition).

Sample Size Calculation for Testing a Hypothesis (Clinical Trials or Clinical Interventional Studies)

An experimental study is a type of evaluation that seeks to determine whether a program or intervention had the intended causal effect. Out of the various components of experimental studies, we focus mainly on studies/designs comparing a treatment group and a control group.

Formula for calculating base sample size	$n = \frac{[Z_{1-\alpha}/2\sqrt{2}\,P(1-P) + Z_{1-\beta}\sqrt{\{P_1(1-P_1) + P_2(1-P_2)\}}]^2}{(p_1 - p_2)^2}$ where $P = \frac{P_1 + P_2}{2}$
Definition of components	n = sample size $Z_{1-\alpha/2}$ = confidence level at 95% (standard value of 1.96) $Z_{1-\beta}$ = sample proportion for 80% power (standard value of 0.842) P1 – 0.6 [Approximate value of efficacy/cure rate for standard treatment (e.g., 60%)] P2 – 0.8 [Approximate value of efficacy/cure rate for new drug (e.g., 80%)] P1–P2 = 0.2 [Effect size (i.e., difference in efficacy of control and experimental group, e.g., 20%)]
Example	In the above example, the efficacy/cure rate on standard treatment is 60%. The new treatment would be considered superior if it offers at least 20% more over the standard treatment. It is desired to estimate the minimum number of patients required in each group in this study. The computation of sample size is as under: Here, $P_1 = 0.6$, $P_2 = 0.8$ $P = (0.6 + 0.8)/2 = 0.7$ $\alpha = 0.10$, $\beta = 0.20$ $n = \frac{[Z_{1-\alpha}/2\sqrt{2}\,P(1-P) + Z_{1-\beta}.\sqrt{\{P1(1-P_1) + P_2(1-P_2)\}}]^2}{(P_1 - P_2)}$ $n = \frac{[1.96\sqrt{2}(0.7)(1-0.7) + 0.842.\sqrt{\{(0.6)(1-0.6) + (0.8)(1-0.8)\}}]^2}{(0.6-0.8)^2}$ **n = 82 (approximately)** **The sample size to study the above claim with 95% confidence level and 80% power will be 82.** **Sample size is = 90 (Considering 10% drop out or attrition).**

The important factors that should be considered in determining the sample size include the following:

- The importance of the decision
- The nature of the research

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- The number of variables
- The nature of the analysis
- Sample sizes used in similar studies
- Incidence rates
- Completion rates
- Resource constraint.

5. Execute the Sampling Process

Execution of the sampling process requires a detailed specification of how the sampling design decisions with respect to the population, sampling frame, sampling unit, sampling technique and sample size are to be implemented.

CLASSIFICATION OR TYPES OF SAMPLING TECHNIQUE

Sampling technique may be broadly classified as nonprobability and probability sampling.

Sampling Techniques

- **Nonprobability sampling**
  1. Convenience sampling.
  2. Judgmental or purposive sampling.
  3. Quota sampling.
  4. Snowball sampling.
- **Probability sampling**
  1. Simple random sampling.
  2. Systematic sampling.
  3. Stratified sampling.
     a. Proportionate sampling.
     b. Disproportionate sampling.
  4. Cluster sampling.
  5. Multistage random sampling or multisampling.
  6. Other sampling techniques.

Nonprobability Sampling

Nonprobability sampling relies on the personal judgment of the researcher rather than chance to select sample elements. The researcher can arbitrarily or consciously decide what elements to include in the sample. Nonprobability samples may yield good estimates of the population characteristics. However, they do not allow for objective evaluation of the precision of the sample results. Because there is no way of determining the probability of selecting any particular element for inclusion in the sample, the estimates obtained are not statistically projectable to the population. Commonly used nonprobability sampling techniques include convenience sampling, judgmental sampling, quota sampling and snowball sampling.

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1. Convenience Sampling

It attempts to obtain a sample of convenient elements. The selection of sampling units is left primarily to the interviewer. Often, respondents are selected because they happen to be in the right place at the right time.

For example, use of students, church groups and members of social organizations.

Strengths

- It is the least expensive and least time consuming
- It is accessible, easy to measure and cooperative.

Weaknesses

- Many potential sources of selection bias are present.
- These are not proper representative of any definable population.
- These are not recommended for descriptive or causal research.

2. Judgmental or Purposive Sampling

It is a form of convenience sampling in which the population elements are selected based on the judgment of the researcher. The researcher, exercising judgment or expertise, chooses the elements to be included in the sample, because he or she believes that they are representative of the population of interest or are otherwise appropriate.

For example, the researcher has deliberately selected the sample units according to his/her personal opinion.

Strengths

- It is low cost, convenient and quick.
- It is subjective and its value depends entirely on the researcher's judgment, expertise and creativity.
- It is very simple to draw. People often use it in exploratory investigations, which precede major surveys.
- It is representative of 'typical' conditions than the random sample if the size of samples is small.

Weaknesses

- It does not allow direct generalizations to a specific population, usually because the population is not defined explicitly.
- It requires from the researcher considerable knowledge about the population, which he/she usually does not possess.
- It is not always reliable. The human mind has difficulty in recognizing typical items. This difficulty tends to distort purposive sampling.

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3. Quota Sampling

It is viewed as two-stage restricted judgmental sampling. The first-stage consists of developing control strategies or quotas of population elements. To develop these quotas, the researcher lists relevant control characteristics and determines the distribution of these characteristics in the target population. The relevant control characteristics, which may include sex, age and race, are identified on the basis of judgment. Often, the quotas are assigned, so that the proportion of the sample elements possessing the control characteristics is the same as the proportion of population elements with these characteristics. In other words, the quotas ensure that the composition of the sample is the same as the composition of the population with respect to the characteristics of interest. In the second stage, sample elements are selected based on convenience or judgment. Once the quotas have been assigned, there is considerable freedom in selecting the elements to be included in the sample. The only requirement is that the elements selected fit the control characteristics.

For example, Heterogeneous sample = BSc (N) students
Homogenous sample = I BSc, II BSc, etc.

Strengths

- ❖ Sample can be controlled for certain characteristics.
- ❖ It is less costly; there is no need to travel all over a town to tract down preselected respondents.
- ❖ It is administratively easy. The labor of random sample selection is avoided and so are the headaches of noncontacts and call backs.
- ❖ It is most suited in a situation where the field work has to be done quickly perhaps in order to reduce memory errors.

Weaknesses

- ❖ Selection bias is possible.
- ❖ No assurance of representativeness.
- ❖ It is possible to estimate sampling errors because quota sampling does not meet the basic requirement of randomness.
- ❖ In this type of sample, the investigator very often selects those respondents whom he knows.

4. Snowball Sampling

In snowball sampling, an initial group of respondents is selected, usually at random. After being interviewed, these respondents are asked to identify others who belong to the target population of interest. Subsequent respondents are selected based on the referrals. This process may be carried out in waves by obtaining referrals from referrals, thus leading to a snowballing effect. Even though probability sampling is used to select the initial respondents, the final sample is a nonprobability sample. The referrals will have demographic and psychographic characteristics that are more similar to the persons referring them than would occur by chance.

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For example, in this early sample members are asked to identify and refer other pupil to meet the same eligibility criteria who are alcoholics.

Strength

- Can estimate rare characteristics.

Weakness

- Time consuming.

Probability Sampling

Probability Sampling varies in terms of sampling efficiency. It is a concept that reflects a trade-off between sampling cost and precision. Precision refers to the level of uncertainty about the characteristic being measured. It is inversely related to sampling errors but positively related to cost.

1. Simple Random Sampling

In simple random sampling, each element in the population has a known and equal probability of selection. Furthermore, each possible sample of a given size (n) has a known and equal probability of being the sample actually selected. This implies that every element is selected independently of every other element. The sample is drawn by a random procedure from a sampling frame. This method is equivalent to a lottery system in which names are placed in a container, the container is shaken and the names of the winners are then drawn out in an unbiased manner.

For example, if we want to select 10 sample units from 100 population or patients from a hospital, first give serial numbers to all the patients starting from any point. Write all the 100 patient serial numbers in a uniform size cared separately and put it in a bowl, shuffle them well. Select one card suppose if the card number is 10, that means 10th patient is the first sample unit selected discard the card. Repeat the same process until the desired sample units required.

Strengths

- It is very easy to understand and its results are easily projectable.
- This method requires minimum knowledge about the population.
- This method is free from classification errors.
- Sampling errors can be easily computed and the accuracy of the estimate easily assessed.

Weaknesses

- It is difficult to construct sampling frame.
- It is expensive.
- The precision level is low.
- No assurance of representativeness.

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2. Systematic Sampling

In systemic sampling, the sample is chosen by selecting a random starting point and then picking every *i*th element in succession from the sampling frame. The sampling interval, *i,* is determined by dividing the population size N by the sampling size n and rounding to the nearest integer.

For example, if there are 1, 00,000 elements in the population and a sample of 1,000 are desired. In this case the sampling interval, *i*, is 100. A random number between 1 and 100 is selected. If, for example, this number is 23, the sample consists of elements 23, 123, 223 and so on.

Strengths

- This method is simple to follow
- This method distributes the sample more evenly over the entire listed population
- It increases the representativeness
- It is easier to implement than simple random sampling
- Construction of sampling frame is not needed.

Weaknesses

- It also can decrease the representativeness
- This method is not truly random. All items selected for the sample (except the first item) are predetermined by the constant interval.
- This method may sometimes result into a badly biased sample. For example, if by chance every 10th, 23rd, 25th or 50th expense voucher in the universe is one made out by an executive, the sample drawn would represent the expenses by executives, which may have certain special characteristics.

3. Stratified Sampling

It is a two-step process in which the population is partitioned into sub-populations or strata. The strata should be mutually exclusive and collectively exhaustive in that every population element should be assigned to one and only one stratum and no population element should be omitted. Next elements are selected from each stratum by a random procedure usually simple random sampling **(Table 6.1)**.

TABLE 6.1: Example of stratified sampling.

	Factor affecting		***10% sample proportionate***	***Disproportionate***
Total population 5,000	Epilepsy	1,500	150	100
	HTN*	1,250	125	100
	DM+	1,450	145	100
	Asthma	850	80	100

*HTN = Hypertension: +DM = Diabetes mellitus.

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Strengths

- It includes all important subpopulations.
- It is very precise.
- Characteristics of each stratum can be estimated and hence comparison can be made.

Weaknesses

- It is very expensive.
- It is difficult to select relevant stratification variables.
- It is not feasible to stratify on many variables.
- There is always a possibility of faulty classification and hence increase in variability.

4. Cluster Sampling

In cluster sampling, the target population is first divided into mutually exclusive and collectively exhaustive subpopulations or clusters. Then a random sample of clusters is selected, based on a probability sampling technique such as simple random sampling. For each selected cluster, either all the elements are included in the sample or a sample of elements is drawn probabilistically. If all the elements in each selected cluster are included in the sample, the procedure is called one-stage cluster sampling. If a sample of elements is drawn probabilistically from each selected cluster, the procedure is two-stage cluster sampling and further more, a cluster sample can have multiple (more than two) stages, as in multistage cluster sampling. A common form of cluster sampling is area sampling in which the clusters consist of geographic areas such as countries, housing tracts or blocks.

Strengths

- It is easy to implement.
- A cluster sample study is considerably less expensive and time consuming because the field work in this type of study gets localized. The investigator can obtain information about all elements of the cluster at one place.
- It does not require a complete frame of the whole population. It require list of members of the selected clusters only.
- The same sample of clusters can be used again and again for drawing random samples of elements from them in subsequent researches.

Weaknesses

- It is imprecise.
- It is difficult to compute and interpret results.
- This is because the requirement of heterogeneity of the element within a cluster is rarely fulfilled.
- Therefore, estimates about the parent population based on cluster sampling are often inaccurate.

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5. Multistage Random Sampling or Multisampling

Under this method sample is prepared by stages. The population is divided into a number of large sampling units, each of which in turn divided into smaller units and so on. A random sample is taken of the large units at the first-stage and from those selected a further random sample (i.e., second stage is collected of the smaller units).

For example, 1,500 sample from Tamil Nadu State
I step: State is divided into districts.
II step: Districts are subdivided into villages.
III step: From the subsample randomly sample is collected.

Strengths

- Sampling list, identification and numbering are required only for units selected in the sample at each stage and not for all the units of the population.
- If sampling units at each stage are geographically defined (such as district, village, etc.) this method cut down field costs (i.e., travel).

Weakness

- Errors increase as the number of sampling units selected decreases.

6. Other Sampling Techniques

In addition to the four basic probability sampling techniques, there are a variety of other sampling techniques are as follows:

a. Sequential Sampling

In this technique, the population elements are sampled sequentially, data collection and analysis are done at each stage and a decision is made as to whether additional population elements should be sampled. The sample size is not known in advance, but a decision rule is stated before sampling begins. At each stage, this rule indicates whether sampling should be continued or whether enough information has been obtained. Sequential sampling has been used to determine preferences for two competing alternatives. In one study, respondents were asked which of two alternatives they preferred and sampling was terminated when sufficient evidence was accumulated to validate a preference.

Strength

- It usually permits the use of a sample of smaller size than would be used in random sampling of the ordinary kind.

Weakness

- Sampling units must be capable of being observed in succession, e.g., if observations must be made at one point in time we cannot sample sequentially.

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b. Double or Replicated Sampling

It is also called two-phase sampling, certain population elements are sampled twice. In the first phase, a sample is selected and some information is collected from all the elements in the sample. In the second phase, a subsample is drawn from the original sample and additional information is obtained from the elements in the sub-sample. The process may be extended to three or more phases and the different phases may take place simultaneously or at different times. For example, a researcher wants to know the households consuming apple juice in a city. In applying double spacing, the researcher would obtain a sampling frame of all households in the first phase. This would be constructed from the city directory. Then a sample of households would be drawn, using systemic random sampling to determine the amount of apple juice consumed. In the second phase, households that consume apple juice would be selected and stratified according to the amount of apple juice consumed.

Strengths

- Findings of various subsamples can be compared with each other before arriving at the main conclusion. The consistency of findings from replica to replica is the strongest argument for the plausibility of findings.
- Replicated sampling provides insurance against several unforeseen mishaps that can befall a survey or some other method of research.

Weaknesses

- Replicated sampling is particularly useful when it is not possible to study the whole sample in the allotted time or when the preliminary results are required quickly.
- When different subsamples are assigned to different investigators for study, this acts as a check on their performances.

Advantages of Sampling

- Economy in expenditure
- Economy in time
- Greater scope
- Greater accuracy
- Organization of convenience
- Intensive and exhaustive date
- Suitable in limited resources
- Better report.

Disadvantages of Sampling

- Chances of bias
- Difficulty in getting representative sample
- Need for specialized knowledge
- Changeability of units
- Impossibility of sampling.

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SAMPLING ERRORS AND NONSAMPLING ERRORS

Two basic types of errors arise in research studies:
Sampling errors and non-sampling errors.

Sampling Errors

When we calculate a certain statistic from a sample and use it as an estimate of the population parameter, we subject ourselves to this type of error. Sampling error is the difference between the statistic and the parameter. It arises due to the fact that only a part of the population has been used to estimate the population parameter. As such, this error would not be present in a census study.

Nonsampling Errors

These errors arise due to factors other than the inductive process of interfering about the population from a sample. Some important factors, which give rise to these errors are as under:

- Defective frame and faulty sampling.
- Inappropriate methods of data collection, coding, tabulation, etc.
- Untrained investigators.
- Inadequate inspection and supervision.
- Incomplete converge.

Whereas sampling errors occur only in a sample study, nonsampling errors occur both in sample as well as census studies. Further, whereas sampling errors can be reduced by increasing the size of the sample, nonsampling errors can be reduced by suitably improving the collection and compiling techniques and streamlining the training and supervision of field staff.

It is not always enough to increase the sample sizes with the hope of reducing, sampling errors, which is just one type of error. By increasing the sample size there is no doubt that sampling errors are reduced, but this may increase nonsampling errors.

TYPES OF ERROR

1. Nonresponse Error

Nonresponse error arises when some of the respondents included in the sample do not respond.

2. Response Error

Response error arises when respondents give inaccurate answers or their answers are misrecorded or misanalyzed.

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3. Surrogate Information Error

Surrogate information error occurs when variation arises between the information needed for the research problem and the information sought by the researcher.

4. Measurement Error

Measurement error occurs when variation arises between the information sought and the information generated by the measurement process employed by the researcher.

5. Population Definition Error

Population definition error occurs when variation arises between the actual population relevant to the problem at hand and the population as defined by the researcher.

6. Sampling Frame Error

Sampling frame error occurs when variation arises between the population defined by the researcher and the population as implied by the sampling frame used.

7. Data Analysis Error

Data analysis error occurs when raw data from questionnaires are transformed into research findings.

8. Respondent Selection Error

Respondent selection error occurs when interviewers select respondents other than those specified by the sampling design or in a manner inconsistent with the sampling design.

9. Questioning Error

Questioning error denotes errors made in asking questions of the respondents or in not probing when more information is needed.

10. Recording Error

Recording error arises due to errors in hearing, interpreting and recording the answers given by the respondents.

11. Cheating Error

Cheating error arises when the interviewer fabricates answers to a part or the entire interview.

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12. Inability Error

Inability error results from the respondent's inability to provide accurate answers.

13. Unwillingness Error

Unwillingness error arises from the respondent's unwillingness to provide accurate information.

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