

Research in Surgery

Sampling

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Abstract:

The execution of scientific research necessitates the diligent collection of relevant information. Data collection methodologies can be broadly classified into two categories: a census, which entails gathering information from the entire population, and sampling, which involves selecting a subset from that population. Accessing the entirety of a population can often be challenging, costly, and time-consuming, prompting researchers to favor sampling methods. Within the realm of statistics, sampling plays a pivotal role in evaluating hypotheses regarding the characteristics of a population.

Introduction

Sampling constitutes a fundamental element of statistical analysis, facilitating the collection of essential data required for investigating hypotheses concerning population characteristics. By employing various sampling techniques, researchers can achieve considerable efficiencies in terms of both time and costs, thereby streamlining and enhancing the research process.^{1,2}

What is a Sampling Framework?

A sampling framework is a meticulously structured plan that delineates how samples will be selected from a population. This framework encompasses several critical components: the definition of the target population, the selection of an appropriate sampling method, the establishment of inclusion and exclusion criteria, the determination of sample size, the creation of a comprehensive list of population members, the detailing of the sampling process, and the identification of data collection methods. A well-defined sampling framework is vital for ensuring the validity and reliability of study findings, ultimately supporting accurate decision-making regarding sample selection and data gathering.⁶

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1- **Simple Random Sampling:** In this method, each individual in the population possesses an equal chance of being selected, akin to a lottery where names are drawn from a hat. While simple and cost-effective, this method lacks the researcher's control and may lead to a sample that does not accurately reflect the broader population.^{3,6}

2- **Systematic Sampling:** This method, while similar to simple random sampling, offers a more efficient means of data collection. Here, the sampling interval is predetermined based on the desired sample size. For instance, if the population (N) is numbered sequentially, every 10th individual may be selected, starting from the 5th position. Thus, the sample could include individuals numbered 5, 15, 25, 35, and so forth until the required sample size is achieved. However, this approach carries the risk of bias; for example, if patients who have undergone cholecystectomy are numbered sequentially without consideration of underlying health conditions such as diabetes or heart disease, significant groups may be omitted from the sample.^{3,6}

3- **Stratified Sampling:** This technique is particularly advantageous when simple random sampling may not yield a representative sample. The population is divided into strata based on relevant characteristics (e.g., age, gender, education level, underlying health conditions). Samples are then drawn from each stratum using either simple or systematic sampling methods. It is important to note that the number of samples collected from each stratum need not reflect the overall population ratio.

Non-Probability Sampling

Non-probability sampling is often favored for its efficiency in terms of time and cost. In this approach, individuals within the population do not possess an equal chance of selection, which may limit the ability to derive statistically reliable inferences applicable to the entire population. This method is commonly utilized in qualitative and exploratory research and is not intended for hypothesis testing at the population level. Nonetheless, it can yield valuable insights into the research population, particularly with smaller groups. Key methods include:

1- Convenience Sampling:

This cost-effective method utilizes easily accessible samples; however, the findings derived from this approach cannot be generalized to the larger population.

For example, if job satisfaction data is sourced exclusively from nurses in a specific department, these results would not be applicable to nurses in other departments within the hospital.

2- Consecutive Sampling:

This straightforward approach entails the researcher selecting readily available samples based on practical considerations such as time, cost, and resource availability, often without regard for the overall sample size. This method is frequently employed in student theses completed under tight deadlines.

3- Volunteer or Self-Selection Sampling:

This method invites participants to engage voluntarily in the research process. For instance, a questionnaire related to a study may be disseminated via social media, allowing interested individuals to respond. While cost-effective, the self-selection nature of this sampling method can introduce bias and limit the generalizability of results.

4- Purposive Sampling:

Purposive sampling is a technique frequently utilized in qualitative research methodologies. In this approach, the researcher intentionally selects samples based on the specific aims or objectives of the study. This may involve the selection of individuals or cases that are considered typical, validating specific hypotheses, or examining disconfirming instances to obtain a nuanced understanding of the phenomenon under investigation.

5- Snowball Sampling

Snowball sampling is employed when access to the target population presents notable challenges. This method relies on existing participants to refer new subjects. For example, when conducting a study on nurses' experiences with trauma patients, and there is uncertainty regarding individuals who have had significant exposure, the researcher may initially contact a few seasoned nurses. Subsequently, by requesting these initial participants to refer their colleagues, the researcher can effectively augment the sample size through their professional networks.

6- Quota Sampling

In quota sampling, researchers select participants according to predetermined quotas that reflect specific characteristics of the population. This method can be executed in two distinct forms: proportionate and disproportionate. In proportionate quota sampling, the objective is to maintain the same ratio of characteristics in the sample as they exist within the population. For instance, if the population exhibits a male-to-female ratio of 40:60 and the target sample size is 100, the researcher would aim to collect 40 male samples and 60 female samples. Upon reaching the designated quota for one gender, any additional qualified samples from that group would be excluded from further consideration.

Unlike stratified random sampling, quota sampling relies on conveniently available samples rather than a randomized selection process.

7- Model Instance Sampling

Model instance sampling involves the selection of individuals or cases that are particularly prevalent or relevant to the research topic. In statistical terms, this technique is associated with the concept of the mode, which denotes the most frequently occurring category within a dataset. For instance, if a particular clothing style is predominantly worn by young individuals, it may be referred to as the mode within that demographic. This sampling method is often employed in informal surveys, such as those assessing new product lines.

Accidental (or Haphazard) Sampling

Accidental sampling refers to the selection of cases at random with the intent to mimic random sampling methods. However, the resultant samples may not be truly random, which can lead to potential sampling bias and unpredictable errors that compromise the generalizability of the findings. Although this approach is both inexpensive and convenient, certain conditions can enhance the reliability of the results:

- 1- Samples should be independent of one another.
- 2- Each sample should possess an equal chance of being selected.
- 3- The sample size should be sufficiently large to yield meaningful insights.

8- Maximum Variation Sampling

Maximum variation sampling is characterized by its emphasis on diversity within the sample. This method seeks individuals with a broad range of characteristics to ensure that the sample effectively represents various dimensions relevant to the research topic. By capturing a wide spectrum of perspectives, researchers can acquire a deeper and more comprehensive understanding of the phenomenon under study.^{2,3,6}

Advanced Sampling Techniques

1- Cluster Sampling

Cluster sampling involves the division of the population into subgroups, or clusters, that exhibit internal homogeneity but external heterogeneity. This technique selects entire clusters rather than individual members, providing a practical solution for large populations where traditional sampling methods may prove cumbersome, costly, or logistically challenging. After identifying clusters, several are randomly selected, with all individuals within these chosen clusters included in the final sample. For example, when researching the prevalence of Irritable Bowel Syndrome (IBS) among medical students, individual medical schools can serve as clusters. By randomly selecting a few schools, researchers can generalize findings to the entire student population nationwide with a high degree of accuracy.

2- Double Sampling

Double sampling is a two-phase technique designed to enhance accuracy while minimizing costs. It comprises the following steps:

First Step: A random selection is made from the target population.

Data Analysis: A secondary variable that correlates with the primary variable of interest is analyzed.

Second Step: Based on the insights obtained, a final sample is selected, leveraging information from both phases to yield a more refined estimate. This method is particularly advantageous when research budgets are limited or when there exists significant variability within the population.^{3,4,6}

For instance, to assess average health indicators within a city, an initial random sample of 500 individuals may be selected. By analyzing the correlation between residential areas and household income, a more targeted sample can subsequently be drawn from neighborhoods exhibiting varying income levels, thereby refining the final analysis.

3- Multi-Stage Sampling

Multi-stage sampling integrates multiple sampling methods to establish a flexible and efficient sampling framework, particularly in the context of large populations. This technique may encompass various forms of random and non-random sampling at different stages.

For example, in a study investigating the average weight of first-grade students in a city, researchers might initially stratify the population according to municipal districts. Subsequently, schools within each district—considered as clusters—could be randomly selected. Within these selected schools, individual classes may again be treated as clusters, followed by a random selection of classes. Finally, a systematic approach can be applied to select the final sample from the attendance records of the chosen classes.

4- Probability Proportional to Size (PPS)

Probability proportional to size (PPS) sampling is a method in which the likelihood of selecting an individual member from the population corresponds to their significance or size in relation to the study objectives. This technique is particularly effective when population members exhibit notable variability in importance.

For instance, if the Ministry of Health seeks to evaluate the revenues of 100 hospitals in Tehran, the selection probability for each hospital can be established by calculating the ratio of each hospital's revenue to the total revenue of all hospitals. Consequently, hospitals with greater revenues will possess a higher probability of selection. A random sample can then be derived from these hospitals for further examination.

5- Randomized Response Technique (RRT)

The randomized response technique (RRT) is employed in survey sampling to elicit honest responses to sensitive or confidential inquiries. This method enables respondents to address sensitive questions while preserving their anonymity, particularly in contexts involving illegal activities or matters such as discrimination.

For example, in a study that poses a sensitive question, such as "Have you ever used drugs?" a follow-up inquiry could request information regarding the specific substances used in cases of affirmation.

By analyzing the randomized responses, researchers can estimate the prevalence of drug use within the population without compromising individual confidentiality. This technique significantly enhances the validity of efforts to collect sensitive data.⁶

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