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Articles

Types of Sampling Methods in Human Research: Why, When and How?

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Abstract

A sample is a representative portion of the larger population. In research, sampling is the process of acquiring this subset from a population. Due to the importance of sampling in research circles, there have been several debates over the usefulness of one method across disciplines and research methods. This paper focused primarily on illuminating the basic understanding of popular sampling techniques. We looked at the probability and non-probability types of sampling, the reasons for choosing them, and their advantages and disadvantages. Additionally, we raised some arguments concerning selecting a type of sampling technique and its usefulness. We hope this paper serves as an essential guide to researchers and students in making the right decisions about sampling techniques.

Keywords: probability, non-probability, research, sampling methods.

1. Introduction

Research is done to provide scientific evidence and solve problems. The usefulness of research findings is practically rooted in the data source and how they represent the population in context. Therefore, studying the entire population seems the best approach, although not always practical, due to constraints like time and funding (Acharya et al., 2013; Etikan, Bala, 2017). In research, it is preferable to select a representative portion of the larger population called a "sample" through a process called "sampling." Also, researchers seek a highly representative percentage of the population during sampling at the least possible error and bias (Tyrer, Heyman, 2016). Selecting the most appropriate sampling method for research should be based on several factors. Some of the factors include the specified research problem, the purpose of the study, the research approach, the study design, the nature of the population, time, and funding (Acharya et al., 2013; Elfil, Negida, 2017; Shorten, Moorley, 2014; Tyrer, Heyman, 2016).

There are two main sampling techniques; probability and non-probability (Acharya et al., 2013; Shorten, Moorley, 2014). Unlike non-probability sampling techniques, probability sampling techniques allow every member of the population a likelihood (greater than zero) to be selected. As a

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prerequisite, researchers who want to use probability sampling techniques effectively should seek a sampling frame (list of all members of the population and their characteristics) where they could identify actual or carefully estimated population size. Another important fact is that while qualitative researchers are restricted to non-probability sampling methods, quantitative researchers are permitted to use both probability and non-probability sampling methods (Acharya et al., 2013; Tyrer, Heyman, 2016). This paper briefly reviewed examples of probability and non-probability sampling techniques, reasons for choosing them, and their advantages and disadvantages.

2. Materials and Methods

Materials for this study came from scholarly papers and monographs by authors like Acharya, Elfil, Negida, Shorten, Moorley, Polit, Beck, Tyrer, etc. In addition, we looked up best practices for sample techniques on the official websites of various qualitative research professionals worldwide. Our review used several broad research procedures such as analysis, synthesis, comparison, etc. Several previous scholars have adopted this technique to provide insightful evidence (Bhardwaj, 2019; Elfil, Negida, 2017; Sarfo et al., 2021).

3. Probability Sampling Methods

3.1. Simple random sampling

Simple random sampling is a probability sampling method where participants within a target population are equally likely to be selected randomly (Bhardwaj, 2019). This technique implies that choosing one member from the population is independent of the others. There are two major types of simple random sampling; simple random sampling with replacement and simple random sampling without replacement. In simple random sampling with replacement, the researcher returns the selected participants to the sampling frame after their properties have been recorded, with the chance of the element being selected again. However, researchers using simple random sampling without replacement remove the chosen participants from the sampling frame to prevent selecting them more than once (Shorten, Moorley, 2014).

Furthermore, simple random sampling is practical when researchers have access to the sampling frame. Essentially, highly homogenous populations are best used in simple random sampling (Bhardwaj, 2019). This ensures that the quality of the sample is not compromised and sample representativeness is achieved (Shorten, Moorley, 2014). Adjustments may be made to the coverage of the sampling frame to correct for under, over, or multiple coverages before a unique number or code is assigned to elements listed in the sampling frame. The researcher then determines a sample size to guide the random selection of the target number. Randomly selecting the target number is made using the lottery method, a table of random numbers, or a computer-generated list. When using the lottery method, also called the hat model or blind draw method, numbers are inscribed on chips, mixed thoroughly in a container, and blindly picked until researchers select the desired sample size. For the table of random numbers method, a researcher blindly chooses a number from the table serving as a starting point, then systematically moves forward, backward, vertically, horizontally or diagonally to the column of numbers in the table of random numbers. Numbers generated by the computer list that correspond to elements in the population are then recruited as part of the sample (Elfil, Negida, 2017; Singh, 2003).

As a strength, simple random sampling allows easy assembling of the sample compared to other probability sampling techniques such as cluster and multi-stage sampling. Also, it provides a fair opportunity for selecting samples with a limited chance of sampling biases. Representativeness of the study population is assured using a simple random sampling technique. Thus, researchers can make sound generalisations from the sample to the entire population (Shorten, Moorley, 2014). On the contrary, researchers may require much time, effort, and money to obtain a thorough list of the target population to form their sampling frame. Getting a sampling frame can be challenging with hard-to-reach or geographically dispersed populations. Also, in the case of a small sample set, a representation of the entire population is more likely to be compromised (Bhardwaj, 2019; Sharma, 2017).

3.2. Systematic Sampling

Systematic sampling is another probability sampling strategy used when the population is heterogeneous (Parahoo, 2006). Systematic sampling involves a modified simple random approach where researchers systematically select samples from the population. Specifically, this technique enables the researcher to arrange the population consistent with some ordering pattern to select participants at regular intervals (Acharya et al., 2013). In practice, the researcher randomly selects a participant from the population list and then chooses every K^{th} number, meaning that the intervals between the listed numbers remain the same. It is noteworthy that the starting number is not automatically the first to be selected. Instead, the selected participant offers the starting point for every K^{th} number to be selected. The K^{th} number could be, for example, every 10th number. The key is to select every K^{th} subject from the list until a predetermined number has been reached. This is possible when the size of the population is divided by the size of the desired sample to obtain the sampling interval width (Polit, Beck, 2010).

The K^{th} number, also called the sampling interval, is the standard distance between the selected elements or participants. Assuming the researchers use an available students' register, they might choose every 10^{th} person from the list of students after randomly selecting the first student. The purpose is to avoid the simple human biases that creep into sampling.

Consequently, if the researcher wants a sample of 50 from a population of 500, the sampling interval will be (500/50=10). Thus, every 10^{th} case in the sampling frame would be sampled after the first case had been selected randomly using a table of random numbers. If the random number chosen is 7, those corresponding to numbers 7, 17, 27, and so forth would be included in the sample.

According to Singh (2007), the various steps to achieve a systematic sampling are:

- Number the units in the population from 1 to N (total population)
- Decide on the n (sample size) that you want or need, where k = N/n (i.e., the interval size)
- Randomly select an integer between 1 to k
- Select every K^{th} unit.

3.3. Stratified Sampling

Stratified sampling is one probability strategy that divides a population into specific homogenous groups, with each group having similar characteristics. This technique is helpful when the characteristics of the population units are quite different, i.e. heterogeneous (Parahoo, 2006). In a heterogeneous population, stratified sampling increases the likelihood of obtaining a representative sample. Also, stratified sampling can be used in getting homogenous groups for experimental research (groups with the same demographic or other relevant features). The sampling frame of stratified sampling is organised into different strata, where each stratum is composed of a distinct sub-population (Singh, 2007). If the strata are unevenly distributed, a proportional allocation for fair representation for each stratum must be considered. Strata could be based on sex, age, religion or geographical regions (Singh, 2007).

Researchers must identify and list the population to perform stratified sampling. It is essential to divide the population into strata based on a sample frame. Then the researcher draws a predetermined number from each group using a simple random sampling technique. Polit and Beck (2010) asserted that researchers could sample proportionately or disproportionately. Each stratum has the same sampling fraction in proportionate stratified sampling, while disproportionate stratified sampling has unequal numbers of subjects drawn from different strata (Singh, 2007). For example, if having equal numbers of men and women is vital for your study, it will be prudent to divide the population into two groups according to sex and then draw an equal number of respondents, each from male and female groups. At times, there might be unequal proportions in the groups. The probability of being selected is expressed in percentages that can be calculated for each group in the population to be randomly sampled.

The following procedure is required for selecting a stratified sampling.

- First, identify and define the population.
- Second, define the sample size to determine the allocation of each stratum in the sample.
- To select a sample of 10 students from a population of 100 students containing both females and males, we must first divide the population according to sex categories.
- Assuming there are 60 males and 40 females, the sampling is going to be:
- Number of females in the sample = (10/100) x 40 = 4
- Number of males in the sample = (10/100) x 60 = 6
- We then select 4 females and 6 males in the sample using either simple or systematic sampling random techniques.

According to Polit and Beck (2010), stratified sampling may be impossible if the information on the stratifying variables is unavailable.

3.4. Cluster (Area) Sampling

Cluster sampling is a type of probability sampling procedure whereby the selection of elements of the population is made randomly in a naturally occurring or already existing grouping, be it geographical or physical aggregates. Hence, the word "cluster" refers to an intact grouping of elements within a population. The clusters are, thus, sub-divisions of the population and are primarily selected based on geographic areas or districts (Dawson, Trapp, 2001). Cluster sampling is preferred when access to a sampling frame or creating one is nearly impossible due to the large population size (Elfil, Negida, 2017). It is worth noting that other probabilistic sampling methods, like simple random and stratified sampling techniques, require sampling frames of all the elements within the population. However, cluster sampling does not require a sampling frame at the beginning, but sometimes later. This requirement makes it useful for a researcher who intends to study a large population for which a sampling frame is unavailable. As such, this sampling method is mainly used in epidemiologic rather than clinical studies (Dawson, Trapp, 2001).

Conducting cluster sampling requires two main stages: obtaining a list of the clusters and randomly selecting subsets of the clusters using other probabilistic approaches, such as simple random sampling. To explain further with emphasis on the steps involved, cluster sampling begins with defining the target population to determine the desired sample size from the population size. The next is to obtain a list of all the clusters within the target population to form a sampling frame. This frame is then subjected to thorough evaluation to ascertain for under, over, or multiple coverages that may require adjustments. The number of clusters to be selected can then be determined by dividing the sample size by the estimated number of elements of a population in each cluster. Simple random or systematic sampling methods can then be applied to obtain the elements within each cluster (Bhardwaj, 2019).

An obvious advantage of using a cluster sampling method is that less expenditure is required in travelling and listing clusters with geographically defined clusters. Also, with a large population, the feasibility of using cluster sampling is high. Compared to simple random sampling, cluster sampling with a large sample size may yield less sampling error for the same cost level. This sampling method also allows for subsequent selection to dissolve the aggregates. However, issues of representativeness may be a disadvantage of using cluster sampling due to the use of various clusters from the target population. Also, a combined effect of the variance arising from two separate clusters may yield a higher variance in the sample than in simple random sampling. Cluster sampling may require complex data analysis, and sampling error is bound to occur with more cluster stages and dissimilarities (Sharma, 2017).

3.5. Multi-Stage Sampling

The multi-stage sampling technique, sometimes referred to as multi-stage cluster sampling, integrates different sampling strategies in selecting the sample units. It is an advanced form of cluster sampling. It ensures the splitting of significant groups or clusters of a population into sub-groups at various sampling stages, making the primary data collection simple (Sharma, 2017). Thus, multi-stage sampling allows the researcher to randomly group or cluster in stages (Elfil, Negida, 2017; Shorten, Moorley, 2014).

In conducting a study using a multi-stage sampling method, the researcher first obtains a sampling frame of the target population and numbers are allocated to every group [this group is known as the primary sampling unit (PSU)]. Then, the sample frame is further selected from sub-groups, known as the secondary sampling unit (SSU), and this is repeated based on the researchers' discretion. Further sampling is conducted by selecting members from each smaller cluster to form the tertiary sampling units (TSU) until the final sampling unit is obtained (Bhardwaj, 2019; Kuno, 1976).

To the researcher's advantage, a multi-stage sampling technique is easier to apply without restriction on using other random sampling techniques. It is useful in obtaining primary data from a geographically dispersed group. Furthermore, sampling preparation costs and time are reduced since the population can be obtained in smaller groups without requiring a complete sample frame of the target population (Bhardwaj, 2019; Elfil, Negida, 2017). However, if the groups obtained through the sample frame have a biased opinion, this opinion is inferred from the entire population. Also, the sampling errors in each of the sampling techniques used in the various stages may have an overall effect on the process of sampling (Sharma, 2017).

4. Non-Probability Sampling

4.1 Convenience sampling

Convenience sampling is also known as availability, accidental, opportunity, or grab sampling. Convenience sampling is a non-probability sampling method in which the selection of subjects is based on their availability, accessibility, proximity and suitability for providing data required for a study (Bhardwaj, 2019; Shorten, Moorley, 2014). Despite being a non-probability sampling, convenience sampling is one of the most used sampling techniques by researchers in clinical, social science and business research and beyond (Elfil, Negida, 2017). Convenient sampling is preferred chiefly when a researcher does not need additional inputs from subjects for principal research (Bhardwaj, 2019). Thus, data obtained by the researcher at the 'convenient' time of data collection is enough to make inferences about the responses provided by the subjects. This sampling method is therefore applied in conducting pilot studies more commonly (Bhardwaj, 2019). Sometimes, for principal research, convenience sampling may be the only appropriate and most useful sampling technique (Jager et al., 2017).

There is no strict method or pattern in selecting samples during convenience sampling. The researcher recruits subjects by merely seeking to know those present, whether on a street, social media platform, marketplace, workplace or anywhere else (Elfil, Negida, 2019). As such, this sampling method is sometimes considered accidental (Etikan, 2016). Advantages such as ease of data collection, readily available sample, no strict rules to follow, usefulness for a pilot study, time-saving nature and low cost involved in convenience sampling make it a preferred sampling technique by most researchers (Bhardwaj, 2019; Sharma, 2017). That notwithstanding, convenient sampling is prone to sampling biases, and the samples' representativeness of the population is mainly compromised.

4.2 Purposive Sampling

Purposive sampling is also known as judgmental, selective, or subjective sampling. It refers to a group of sampling techniques that rely on the researcher's judgment when selecting the participants (e.g. people, cases, organisations, events, pieces of data, etc.) that are to be studied (Sharma, 2017). Purposive sampling is based on the belief that researchers' knowledge about the population can be used to hand-pick sample members. Researchers often use purposive sampling when they want respondents who are judged to be typical of the population (i.e. meet the eligibility criteria) or may be knowledgeable about the issues under investigation (Apostolopoulos, Liargovas, 2016). To conduct purposive sampling, the researcher should first identify the target population. Next, the researcher must delimit the scope and focus of the study based on the research problem. Additionally, the sample size is determined based on the population size, research approach, and statistical test or technique for data analysis.

Some examples of purposive sampling include the following:

- Stakeholder sampling: This is beneficial in evaluation research and policy analysis. This strategy involves identifying the major stakeholders and those who were engaged in designing, giving, receiving, or administering the programme or service being evaluated and might otherwise be affected by it.
- Extreme/Deviant case sampling: This is used to select exceptional cases of interest representing the purest or most clear-cut instance of a phenomenon researchers are interested in.
- Typical case sampling: It allows researchers to look at a typical phenomenon or pattern in a population. For example, if a researcher is interested in university students' aggressive behaviours, then sampling should include individuals typical of the population or phenomenon of interest.
- Paradigmatic case sampling: This is a type of purposive sampling technique where people are selected because they represent an ideal for a specific concept or case. For example, if we want to study management in the mining industry, the paradigmatic case will be managers of a mining company.
- Maximum variation sampling: It is also called maximum diversity sampling or maximum heterogeneity sampling. With this type of purposive sampling, the researchers select individuals with the most comprehensive scope of perspectives concerning the phenomenon to be studied.
- Criterion sampling: This allows researchers to search for cases or individuals who meet certain criteria, i.e., if they have malaria or a specific life experience.

- Theory-guided sampling; It is a type of purposive sampling technique where researchers follow a more deductive or theory-testing approach to find individuals or cases that embody the theoretical constructs. Even though this could be considered a particular criterion sampling, it illustrates the overlaps between these categories.

- Critical case sampling: This helps researchers select a decisive case that would help decide which of several different explanations is most plausible or is one identified by experts as particularly useful because of its generalisations.

- Disconfirming or negative case sampling: It allows investigators to extend their analysis by looking for cases that disconfirm their observations. The principle remains that "*if you think your results are not generalisable or the existence of a particular kind of case will undermine all that you know to be true about a phenomenon, then look for that case.*"

The purposive sampling technique has several advantages. Qualitative researchers frequently use this sampling technique. It can be beneficial for situations where we need to reach a targeted sample quickly, but a random process of selection or proportionality is not possible. Also, newly developed instruments can be effectively pretested and evaluated with purposive sampling of diverse types of people. Aside from these advantages, this sampling method can be highly prone to researcher bias. The idea that this sampling is based on researchers' judgment increases researchers' subjectivity, especially when compared with probability sampling design. Sampling in this subjective manner also provides no external or objective method for assessing the typicalness of the selected respondents. Primarily, findings from the purposive sampling technique cannot be generalised.

4.3. Quota sampling

Quota sampling is a non-probability method in which subjects are selected in proportions according to specific characteristics they possess. The specific characteristics for which a sample is chosen are known as a quota (Martínez-Mesa et al., 2013). Using the quota sampling technique, the researcher aims to obtain a sample in which the studied groups are proportional to the target population (Guignard et al., 2013). Quota samplings could either be controlled, in which the researcher's choice is bound to limitations, or uncontrolled, where there are no limitations to the researcher's choice such that the selection of the sample is based on the researchers' convenience (Bhardwaj, 2019). This type of sampling method is preferred for use when access to a probability sample is impossible, but the researcher wishes to obtain a sample that is representative of the target population (Sharma, 2017).

As such, quota sampling, although a non-probability sampling technique, is likened to a stratified sampling technique which is a probability sampling technique, with the main difference being that the selection of elements in a stratified sampling technique is made randomly, unlike in quota sampling (Bhardwaj, 2019). To conduct a quota sampling, the researcher sets a quota by first classifying the population according to specific characteristics, such as gender, age, marital status or other key characteristics of interest. Subsequently, the members of each subgroup and their proportion in the target population are selected to complete each quota (Martínez-Mesa et al., 2016). Thus, in quota sampling, study subjects are selected according to specific categories that belong in a well-planned manner, for instance, 300 males and 300 females.

Arguably, quota sampling is quicker and easier than stratified sampling, its probability sampling comparison method. Unlike a stratified sampling technique, quota sampling is done without using a sampling frame and a random sampling approach (Setia, 2016). Also, quota sampling ensures that a target population being studied is divided into groups based on the researchers' discretion regarding the quota. As such, the researcher can compare the studied groups (Sharma, 2017). Additionally, quota sampling ensures that the sample is representative of the target population. As a disadvantage, quota sampling has sampling bias, as the unit selection is based on factors such as access and specific characteristics with which the quota is formed rather than using a random selection approach. As such, generalisation is impossible, and the desire to achieve external validation is compromised (Sharma, 2017).

4.4. Snowball sampling

Snowball sampling is a non-probability method in which the researcher accesses future samples through referrals from existing subjects (Johnson, 2014). Thus, the samples obtained at the beginning may not be the final sample because the initial sample serves as a link to access other subjects among their acquaintances in a chain-like manner, hence the name chain or chain-referral sampling (Bhardwaj, 2019). With time, the samples grow like a rolling snowball, which gives it the name snowball sampling. Snowball sampling is widely known for its application in studies that seek to recruit hidden or hard-to-access populations (Shaghaghi et al., 2011). For instance, in the medical field, snowball sampling may be applied in exploring rare diseases among a restricted number of subjects (Molster et al., 2016). Also, in criminal investigations, illicit drug use surveys, and cases of discord such as violence, terrorism and abuses, snowball sampling is applied to access a few witnesses who may serve as a guide to accessing the other population of interest to the researcher (Harker Burnhams et al., 2016; Samkange-Zeeb et al., 2019).

To conduct a snowball sampling, the researcher adopts special skills and thorough analysis in first accessing the initial group of individuals based on some characteristics they possess and their suitability to respond to the study (Martínez-Mesa et al., 2016). Subsequently, after obtaining data from the initial group of individuals, the researcher then adopts cajoling strategies on them to help in indicating other potential participants who also have similar characteristics and can speak up about the subject matter of the study (Martínez-Mesa et al., 2016; Shaghaghi et al., 2011).

Furthermore, the ability of the researchers to obtain access to future samples through the initial ones is to the advantage of helping in saving time for the researcher who would have otherwise found it difficult to access the required population (Bhardwaj, 2019; Sharma, 2017). Also, this sampling method is cost-effective since the referrals are obtained from primary sources. On the other hand, sample hesitance to participate due to various factors such as fear, shame, guilt, and sampling biases are well-known disadvantages of this method (Etikan et al., 2016).

4.5. Self-selection sampling

This is a non-probability sampling technique in which subjects willingly volunteer to participate in a study of their own accord (Lavrakas, 2013). Thus, in self-selection sampling, the researchers' inclusion or exclusion of a subject is based on whether or not the subjects themselves implicitly or explicitly decide to participate in a study (Lærd Dissertation, 2012). Self-selection sampling is applied in studies where the researcher does not want to approach study participants directly. It is used in some research designs, such as online surveys where questionnaires can be put online, and potential subjects among a defined population are invited to partake (Greenacre, 2016). Also, in conducting clinical trials, a researcher may advertise for people willing to participate, and volunteers present themselves as participants without being approached directly ((Lærd Dissertation, 2012).

The self-selection sampling technique benefits the researcher in terms of time required for sampling subjects since subjects enrol on the study by themselves (Khazaal et al., 2014). Also, considering that subjects volunteered to participate in the study, there is a likelihood of high commitment from them, which increases the response rate and improves their willingness to contribute insightfully to the subject area being studied (Khazaal et al., 2014). As a limitation, self-selection sampling increases the risks of sampling bias, over-representation, and under-representation of the sample (Sharma, 2017).

5. Conclusion

Sampling plays a major role in research. Choosing the most appropriate sampling method for research should be based on several factors. These factors include the research problem, the purpose of the study, the research approach, the study design, the nature of the population, time, and funding (Acharya et al., 2013; Elfil, Negida, 2017; Shorten, Moorley, 2014; Tyrer, Heyman, 2016). Furthermore, we reviewed common examples of the two main sampling techniques; probability and non-probability (Acharya et al., 2013; Shorten, Moorley, 2014). Probability sampling approaches enable every member of the population to be picked with a likelihood (higher than zero), in contrast to non-probability sampling methods. Also, a probability sample reduces the possibility of bias in sampling and ensures a more representative sample because the probability of each person in the population being selected is known (Wood, Ross-Kerr, 2011). In our paper, we discussed several issues regarding each sample technique type and the value of doing so. We believe that this article will be useful to researchers and students in selecting appropriate sampling procedures.

6. Declaration of Competing Interest

The authors of the manuscript declare that there is no interest in conflict, and all reference materials were dully acknowledged.

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