

# Quantitative Research Design and Sample Trends: A Systematic Examination of Emerging Paradigms and Best Practices

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**Abstract:** *Research design and sampling are pivotal in scientific research, shaping methodology and ensuring the credibility and validity of findings, necessitating clear and focused attention from researchers. Based on the above statement the study was focused on underlining the research design's basic terms and sample in order for researchers to be reliable in their research. The study used PRISMA to select the sample of documents. 30 major studies were used to explain the research objectives. The study covers only four types of research design i.e. Descriptive, Developmental, Experimental, and Casual Comparative. Results highlight the four research designs that aim to answer, words to be concerned with during objective setting, statistical tools, data visualization, words to be selected during hypothesis setting based on tools, and the minimum number of samples required depending on various tools. The research concludes that the choice of effective research design terms is pivotal. In statistical analysis, hypothesis wording directs research, with terminology so depending on the tools appropriate words need to be selected. Researchers need to make sure that the minimum sample size is right. However, larger samples improve the stability and accuracy of results. This study contributes by explaining essential research design terminology on sample selection, and their influence on statistical analysis, providing researchers with a clear guide to improve credibility and validity in their work.*

**Keywords:** *Casual Comparative, Descriptive, Developmental, Experimental, Sample*

## I. INTRODUCTION

The function of research design is crucial in the area of research, as it acts as the fundamental framework for every step of the investigative process (Khanday & Khanam, 2019). The relevance of this tool is in its capacity to assist researchers in defining the scope, objectives, and methodologies of their investigation, so ensuring that their research is systematic, reliable, and capable of producing substantial results (Rashid, Rashid, Warraich, Sabir, & Waseem, 2019). A properly designed research framework supports the formation of research questions, the selection of suitable collection methods, and the establishment of the study's overall structure (Sileyew, 2019). Additionally, it serves to reduce bias, enhance the reliability and trustworthiness of the results, and promote the consistency of the research (Stahl & King, 2020). In addition, a well-designed research methodology enhances the efficiency of resource allocation, so maximizing the use of limited time and resources (Kothari, 2004). This aspect has special significance in the fields of academia, industry, and policymaking. Research design is a fundamental component of scientific and academic studies, functioning as the basis for rigorous and insightful research (Pawar, 2020).

Research design and sampling are fundamental components of the research process, with an inverse connection that positively influences and influences one another (Cash, Isaksson, Maier, & Summers, 2021). The term "research design" encompasses the whole approach and framework of a research investigation, encompassing the choice of research methodologies, processes for data collecting, and the overall blueprint for exploring a particular research question or hypothesis (Almalki, 2016). Conversely, the concept of sampling refers to the systematic procedure of choosing a subset of individuals or products from a more extensive

population for the purpose of investigation. This technique is sometimes employed when studying a whole population is either impractical or impossible (Taherdoost, 2016).

However, many studies fail to meet the fundamental standards when it comes to establishing how to organize the study and determining the number of participants or components required based on the research methods used (Mohajan, 2017). Researchers frequently get into an issue in which the design of their study is different from the technique they use when choosing the participants or products to be studied. This mismatch often results in study findings that are unreliable, making it difficult to draw accurate conclusions from the data. This research issue underlines the need to address these concerns in order to make sure that research develops reliable and insightful findings that may successfully contribute to the researcher's understanding of different phenomena.

## II. STUDY METHODS

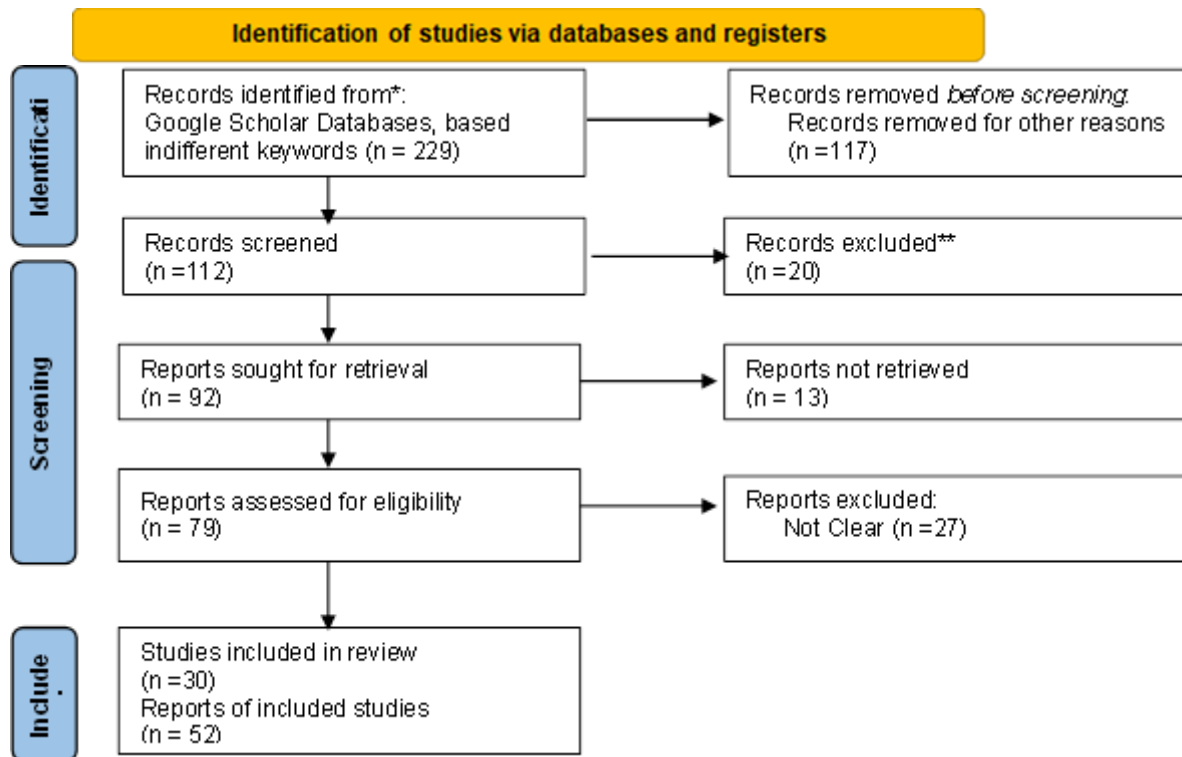


Figure1: PRISMA

### A. *Databases and search procedures*

The research employed Google Scholar as a tool for conducting document searches. The search engine limited the study to "Title" only; the article was searched using the following keywords: "Research" "Descriptive Research" "Developmental Research Design" "Experimental Research Design" "Casual Comparative" "Chi-square" "ANOVA" "ANCOVA" "MANOVA" "t-test" "Correlation" "Regression" "Words to be select during Hypothesis base on tools" and "Minimum Number of sample". These limitations reduced the study while maintaining its quality. There was no restriction enforced on the publication date. The search was carried out in July 2023.

### B. *Inclusion and exclusion criteria*

The documents chosen had been peer-reviewed, were full text, books, and book reviews, and were all in English. This study covers all Fields of Research related to the title.

There were no notes, or unclear studies included, preprint and there were no restrictions on the year or geographical area of the studies under review.

**C. Tools and Data Analysis**

In the study, MS Excel was used to manage data in tabular form, to detect percentage and frequency. Similarly, thematic analysis was employed to reveal the sequence of research design and sampling. To make the results more trustworthy, the researcher concentrated on citing books and articles to back up the findings.

**III. RESULTS AND DISCUSSION**

The study looked at three main types of publications. The majority (46%) of the total documents were articles. Second, 50% of the documents were books, which constituted the majority of the collection. Conferences were the last category, accounting for 4% of the documents. This study's time frame was from 1999 to 2023. 13% of the total records for the years 2019 and 2018 were included, making up the majority of the study's focus. On the other hand, the least number of documents were covered in 1999, which suggests that less of the research's focus was on that year.

TABLE I RESEARCH DESIGN BASIC TERMS

Research Design				
Types	Aim to answer	Objective	Statistical Tools	Data Visualization
<b>Descriptive Research</b>	who, what, where, how and when	To describe To determine To identify To explore	Frequency, Percentile, Mean, Median, Mode, Range, Variance, Standard deviation	Bar Chart, Histogram, Pie chart, Box plots, Scatter plots, Table
<b>Developmental research Design</b>	How, why	To examine To investigate To explore	Regression, ANOVA, Longitudinal data analysis	Line graph, scatter plots, bar charts, development milestone chart
<b>Experimental research Design</b>	Does A & B? How, does A & B?	To determine To explore To investigate To compare	ANOVA, t-test, Regression, Chi-square, ANCOVA, MANOVA	Line chart, Bar charts, Box plots, Scatterplots, Control charts, Heat maps
<b>Casual Comparative</b>	Why, which, When	To investigate To examine To determine	ANOVA, t-test, chi-square	Bar-chart, Box plots, Scatter plots, Histogram

Source: Research Scholar

Descriptive research is a fundamental kind of research method that attempts to answer the "who, what, where, how, and when" questions about a particular event or topic of interest (Tracy, 2019; King, 2023). The key aims of this study involve the description, determination, identification, and exploration of several facets that relate to the research subject (Hancock, Ockleford, & Windridge, 2009; Vaismoradi, Turunen, & Bondas, 2013; Mohajan, 2018). Descriptive research offers significant value in situations when researchers seek to acquire an initial knowledge of a particular issue, provide a foundational basis point of view, or provide a comprehensive overview without performing any form of variable manipulation. In order to accomplish these aims, descriptive research utilizes several statistical tools and approaches for data visualization. These tools assist researchers in efficiently summarizing and presenting data. Frequently applied statistical measures in descriptive research encompass frequency, percentile, mean, median, mode, range, variance, and standard deviation (Marshall & Jonker, 2010; Bhattacharjee, 2012; Hesse & Ofosu, 2017). These measurements offer useful insights into the major structure and variation present within the dataset. Descriptive research commonly employs various data visualization techniques that are bar charts, histograms, pie charts, box plots, scatter plots, and tables (Kiernan, 2007; Cooksey, 2020). Visual representations allow researchers to accurately represent data distributions, patterns, and trends, hence facilitating the comprehension of key results.

Developmental study design is a special method used to figure out "how" and "why" people, groups, or places change and grow over time (Thomas, 2010; Rejab, Chuprat, & Azm, 2018; Ismaila, Ishakb, & Yuetc, 2020). The basic objective of developmental research is to examine, investigate, and explore the processes,

determinants, and trends linked to the advancement and transformation in several areas including (Richey, Klein, & Nelson, 2004). In order to attain these aims, developmental research utilizes specialized statistical methodologies designed for the examination of longitudinal data, which enables the observation and study of changes that occur over a period of time. Regression analysis and analysis of variance (ANOVA) are often employed as statistical techniques in developmental research (Green, Camilli, Elmore, Skukauskaiti, & Grace, 2023). These techniques assist researchers in identifying trends, relationships, and significant differences that can provide insights into the fundamental steps of development. Data visualization is an essential component of developmental research, alongside statistical methods. Visual representations, such as line graphs, scatter plots, and bar charts, are frequently employed to show stages of development and trends (Zacks & BarbaraTversky, 1999; Friendly & Denis, 2005; Srivastava, 2023). These visuals facilitate the comprehension of the complex procedures of transformation and development for both researchers and audiences, increasing their intuitive understanding. One alternative visualization technique that can be employed is a development milestone chart, used to show significant developmental milestones and their periodic progression.

The utilization of experimental research design is a consistent and systematic methodology within the domain of research (Wuest, Tinscher, Porzel, & Thoben, 2014; Creswell & Creswell, 2018). This design directed to provide answers to concerns about causality and the consequences of changing one or more variables. The experimental research is focused on finding out (aim to answer) "does A and B?" and "how do A and B interact?" by carefully controlling and changing factors to see how they affect the result of interest (Buchanan & Bryman, 2009; Imai, Tingley, & Yamamoto, 2013). The major objectives of experimental research include the determination, exploration, investigation, and comparison of various aspects related to the study issue (Apuke, 2017; Seltman, 2018). Researcher's aim is to determine causal correlations, study or investigate these relationships, explore differences within various groups or situations, and determine the impact of different interventions through comparison. In order to accomplish these aims, experimental research employs a variety of statistical techniques specifically designed for hypothesis testing and group or condition comparisons. Experimental research commonly utilizes several statistical approaches, such as analysis of variance (ANOVA), t-tests, regression analysis, chi-square tests, analysis of covariance (ANCOVA), and multivariate analysis of variance (MANOVA) (Ross & Morrison, 2003; Zubair, 2022). The above-mentioned statistical techniques aid researchers in evaluating the statistical significance of stated differences, associations, or impacts. To display experimental results representations like line charts, bar charts, box plots, scatterplots, control charts, and heat maps are widely employed. These illustrations aid researchers and audiences in understanding the influence of factors and circumstances on the result variables (Somisetty, Songa, Raavi, Tetali, Edara, & Madireddy, 2021).

Causal-comparative research design, often known as *ex post facto* research, is a methodological strategy used in the area of research to discover causal links between variables, especially when it is not possible to conduct a true experimental study (Kothari, 2004; Williams, 2007; Asenahabi, 2019). This sort of study is aimed at answering questions about "why," "which," and "when" specific results occur by evaluating variations across groups that have already been subjected to certain situations or factors (Kothari, 2004). The primary objectives of causal-comparative research are the investigation, examination, and determination of the causative elements that contribute to observed differences or effects (Schenker & Jr, 2004). In order to accomplish these aims, statistical methodologies are utilized to evaluate and compare the data collected from various groups or situations. Causal-comparative research commonly uses statistical techniques that consist of analysis of variance (ANOVA), t-tests, and chi-square tests (Larson, 2015; Kumar & Reddy, 2023). Statistical tests are utilized by researchers to evaluate the statistical significance of observed differences and discover relationships between variables. Data visualization is a crucial element within the context of causal-comparative research. Visual representations, which consist of bar charts, box plots, scatter plots, and histograms, are commonly employed to show and communicate the differences and variations in the data among distinct groups or situations (Sailem, Cooper, & Bakal, 2016; Yalim & Handley, 2023).

TABLE III WORDS NEED TO DENOTE DURING HYPOTHESIS

Words to be selected during Hypothesis based on tools	
Tools	Denote
Chi-square	Association
ANOVA, ANCOVA, MANOVA, t-test	Different
Correlation	Relationship
Regression	Impact

Source: Research Scholar

The wording of hypotheses is critically important in statistical analysis; since it assists as the guide for research. Researchers that utilize the Chi-square test frequently include terminology like "association" to describe the kind of relationship being studied between two category variables (McHugh, 2013; Gonzalez-Chica, Bastos, Duquia, Bonamigo, & Martínez-Mesa, 2015). ANOVA (Analysis of Variance) and ANCOVA (Analysis of Covariance) are frequently related to the concept of "difference" since their application to analyzing mean differences across several groups while including variables (Jamieson, 2004; Sungaur & Ankarali, 2018). When examining differences between several dependent variables, MANOVA (Multivariate Analysis of Variance) is used. On the other hand, the t-test is used to find changes between two groups, so the word "difference" is often used in the hypothesis statement (Kim, 2015; Xu, Fralick, Zheng, Wang, Tu, & Feng, 2017). Correlation analysis usually includes the word "relationship" in its hypotheses as it looks at the size and direction of relationships (Bujan & Baharum, 2016; Schober, Boer, & Schwarte, 2018). When doing regression analysis, the word "impact" is often used due to the fact that it shows how the independent variables affect the dependent variable (Alexopoulos, 2010; Shepherd, Doytchinova, & Kravchenko, 2019).

TABLE IIIII MINIMUM NUMBER OF SAMPLE

Sample	
Tools	Minimum Number of sample
Chi-square	+30
ANOVA, ANCOVA, MANOVA, t-test	+250 or 30 participants per cell
Correlation	+50
Regression	Base on ANOVA or +300 or (10 participants per predictor variable)
Factor analysis	+300

Source: Research Scholar

Selecting and maintaining to a minimal sample size is essential in research and data analysis. Basic minimum levels that researchers should consider when determining their sample sizes were highlighted. In order to conduct a chi-square analysis, it is generally recommended to have a minimum sample size of 30 or greater (Delice, 2005; McHugh, 2013; Turhan, 2020). When designing studies that use ANOVA, ANCOVA, MANOVA, or t-test, it is recommended that researchers go for a minimum sample size of 250 in order to enhance the credibility and reliability of their statistical analyses (Delice, 2005; Mishra, Singh, Pandey, Mishra, & Pandey, 2019). In order to have confidence that the correlation coefficient is a true representation of the relationship, at least 50 Sample size is recommended (Delice, 2005; VanVoorhis & Morgan, 2007). A minimum sample size of at least 300 can be used as a simple rule of thumb to provide an adequate sample size for Multiple Linear Regression (Bujang, Sa'at, & Sidik, 2017). There should be a minimum of 10 participants per predictor variable in regression equations with six or more variables (VanVoorhis & Morgan, 2007). Regression analysis sample sizes should be determined by a number of criteria, including model complexity and the required statistical power. Parameter estimates and inferences about links between variables benefit from larger samples because of the increased stability they provide. Factor analysis is a method for reducing a large number of variables to smaller factors. Usually, a sample size of 300 or more is needed to get relevant and accurate results (Delice, 2005; VanVoorhis & Morgan, 2007). Many researchers focused that if parametric tests are to be utilized, a sample size of 30-500 people is recommended; otherwise, non-parametric analytic approaches should be used (Delice, 2005).

#### IV. RESULTS AND DISCUSSION

The selection of an appropriate research design and sample size is crucial for ensuring the effectiveness of a research study. Developmental research involves the examination of changes that occur through time, utilizing longitudinal data analytic techniques and visual representations. Experimental research is a methodological approach that aims to demonstrate causal correlations by employing hypothesis testing and doing group comparisons. The approach of causal-comparative research is used to determine the cause-effect relationship among a dependent and independent variable. In statistical analysis, hypothesis wording directs research, with terminology such as "association," "difference," "relationship," or "impact" depending on the test or analysis being performed. For reliable research and data analysis using different statistical methods, it is important to make sure that the minimum sample size is right. The recommended sizes vary depending on factors like the type of analysis, its complexity, and the need for statistical power. In general, larger samples improve the

stability and accuracy of results. The accuracy and practicality of study findings are improved by careful consideration of research design and sample size. Future researchers can focus on the research design impact the quality and validity of research findings in different fields of study.

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