



# Quantitative Research: Types, Advantages, Generalizability & Limitations

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## Abstract

Quantitative research is a systematic investigation that utilizes numerical data and statistical techniques to determine relationships between variables and draw conclusions about the phenomena under study. It aims to quantify observations, measure variables, and generalize findings to wider populations through statistical, mathematical, or computational techniques. This paper, thus, discusses the various types of quantitative research, sampling techniques under quantitative research and the benefits and limitations of quantitative research. These fundamental concepts of quantitative research are explored following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol. Hence, from the analysis, the advantages of quantitative research include: generalizability of study findings to broader contexts, faster data collection and analysis, replicability of the studies and reliability and objectivity of the findings. On the other hand, the limitations of quantitative research include: the need for larger study samples, limited contextual understanding and interpretation of findings, rigidity and inflexibility of the research process, and inability to capture the depth of human behavior or social phenomena. Moreover, from this analysis, the types of quantitative research are experimental, correlational, descriptive and quasi-experimental/causal-comparative research, while the sampling technique is mainly probability (simple random sampling, stratified sampling, systematic and cluster sampling methods), with non-probability sampling used when practical limitations exist. Consequently, the goal of this synthesis is to provide scholars and practitioners with a consolidated view of how quantitative research functions within the broader landscape of academic inquiry. Recommendations for improving practice and future research directions are also presented.

## Subject Areas

Research & Quantitative Research

## Keywords

Quantitative Research, Methodology, Advantages, Correlation, Descriptive, Experimental, Quasi Experimental, Probability Sampling, Limitations

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## 1. Introduction

Quantitative research heavily relies on data that can be measured and analyzed numerically, as opposed to qualitative research that focuses on non-numerical data (Oranga, Njurai & Matere, 2025) [1]. Accordingly, it is a structured approach to investigating phenomena through numerical data collection and analysis (Polit & Beck, 2017) [2]. Its main aim is to establish relationships between variables, test hypotheses, and generalize findings to larger populations. Hence, it is characterized by statistical analyses, large sample sizes, an emphasis on objectivity and structured research instruments (Mujis, 2010) [3]. Gravetter and Forzano (2018) [4] also contend that quantitative research typically involves hypothesis testing, variable measurement, and data analysis using tools such as regression analysis, correlation, ANOVA, and t-tests. These features allow for strong internal validity and the ability to make inferences about causal relationships, particularly in experimental designs (Shadish, Cook, & Campbell, 2002) [5]. It emphasizes objectivity and statistical rigor and often leads to generalizable outcomes (Creswell & Creswell, 2018) [6].

Noteworthy, the growing demand for evidence-based practices in policy-making and program evaluation underscores the relevance of quantitative research methods. As a result, the methodology has been extensively documented as a dominant methodology used for investigating relationships, testing theories, and generating statistically generalizable findings. It emphasizes objectivity, reliability, and numerical precision, making it a cornerstone for empirical research across disciplines (Creswell & Creswell, 2018) [6]. Quantitative research is widely applied in fields such as health sciences, where randomized controlled trials (RCTs) are the gold standard for evaluating interventions (Polit & Beck, 2017) [2]; education, where standardized testing and longitudinal studies inform policy and pedagogy (Cohen, Manion, & Morrison, 2018) [7] and social sciences, where surveys, census data, and economic models provide critical insights into human behavior and societal trends (Bryman, 2016) [8].

## 2. Philosophical Foundations and Historical Development of Quantitative Research

Quantitative research is grounded in distinct philosophical paradigms that shape its assumptions about reality (ontology), knowledge (epistemology), values (axiology), and methodology. The foundations of quantitative research are deeply rooted in **positivism**, a philosophical approach that asserts knowledge should be derived from observable and measurable facts (Neuman, 2014) [9]. Developed in

the 19th century by thinkers such as Auguste Comte, positivism holds that authentic knowledge is based on empirical, observable phenomena (Neuman, 2014) [9]. Positivist principles advocate for the use of the scientific method in social inquiry, which led to the development of quantitative tools aimed at producing verifiable and generalizable data (Bryman, 2016) [8].

The positivistic paradigm, thus, informs how researchers utilizing the quantitative approach conceptualize problems, collect data, and interpret findings. An in-depth understanding of these foundations is essential for properly designing and critically evaluating quantitative studies. Furthermore, positivism is deductive, beginning with theory-driven hypotheses that are tested through structured data collection and statistical analysis. Measurement tools such as surveys, experiments, and structured observations are used to quantify variables (Muijs, 2010) [3]. In public health, for example, a positivist approach might test the effectiveness of a vaccine by conducting a randomized controlled trial and using statistical inference to generalize results to the broader population.

The philosophical foundations of quantitative research, positivism, provide the backbone for its methods, logic, and interpretation of results. Positivism emphasizes empirical observation, objectivity, and universal laws, and a commitment to empirical rigor, systematic inquiry, and the pursuit of generalizable knowledge which are the hallmarks of quantitative research.

### 3. Methodology

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol, a standardized approach for conducting systematic reviews and meta-analyses (Moher *et al.*, 2009) [10] as it ensures transparency, replicability, and minimizes bias in systematic reviews and meta-analyses. The protocol consists of a 27-item checklist and a four-phase flow diagram: identification, screening, eligibility, and inclusion.

- **Identification:** A comprehensive search was conducted using databases including PubMed, Scopus, and Google Scholar with keywords such as “quantitative research,” “sampling,” “survey research,” and “*experimental design*.”
- **Screening:** Duplicate *studies* and non-peer-reviewed articles were removed.
- **Eligibility:** Abstracts and full *texts* were assessed for relevance to quantitative research methodologies and applications.
- **Inclusion:** A final sample of 32 articles was selected for synthesis, representing various disciplines and methodological approaches.

## 4. Results

### 4.1. Types of Quantitative Research

Quantitative research can be categorized into several key types. Each type of quantitative research methodology serves a unique function within the research process. Descriptive research helps establish the “what,” while correlational research identifies relationships. Experimental research, on the other hand, establishes cau-

sality with high internal validity, while quasi-experimental research provides practical insights when randomization is not feasible. The choice of method should be based on the research question, ethical constraints, and the level of control the researcher can exercise over the variables involved. The different types of quantitative research are exhaustively discussed as follows.

#### 4.2. Descriptive Research (Can Be Both Quantitative or Qualitative)

*Descriptive Research* describes characteristics of a population or phenomenon without establishing cause-effect relationships and answers questions like “what are the characteristics?”, “What are the trends?”, or “What is the current situation?” rather than “why” questions, by observing and recording data without manipulating variables. Accordingly, this approach is often used to establish baselines, identify trends, and provide detailed accounts of a subject (Babbie, 2020 [11]; Creswell & Creswell, 2018 [6]). Oranga, Njurai and Matere (2025) [1] also emphasize that in descriptive studies, researchers observe and record data without attempting to control or manipulate the variables being studied. Noteworthy, descriptive research can utilize both numerical data (quantitative) and descriptive narratives (qualitative).

Fink (2013) [12] similarly contends that descriptive research is used to depict and systematically describe the characteristics of a population or phenomenon without manipulating variables (Fink, 2013) [12]. Consequently, its primary purpose is to “paint a picture” of a given situation through numeric data (Creswell & Creswell, 2018) [6]. Summarily, descriptive research is described as below:

- **Focus:** Answers the questions “what,” “where,” “when,” and “how many.”
- **Data Collection:** Surveys, observation, or analysis of existing records.
- **Design:** Cross-sectional or longitudinal (when studying changes over time).
- **Statistical Tools:** Frequencies, percentages, means, and standard deviations.

Example: A national health survey describing the prevalence of smoking among adolescents by age and gender.

The strengths of descriptive research include the fact that it provides a broad overview and establishes baseline data. While the main limitation is that it cannot determine causal relationships or explain underlying reasons (Babbie, 2020) [11].

#### 4.3. Correlational Research

Explores the strength and direction of relationships between two or more variables, but does not imply causation. Gravetter & Forzano, 2018 [4]; Gay, Mills, & Airasian, 2011 [13] examine the relationships between two or more variables without manipulating them. It aims to determine if a relationship exists and, if so, the strength and direction of that relationship. Correlational studies are useful for exploring potential connections and generating hypotheses, but they cannot establish cause-and-effect relationships. Researchers observe and measure existing variables as they naturally occur, without actively manipulating or changing them (Fink, 2013) [12]. The primary goal is to identify if and how variables are related,

including the direction (positive or negative) and strength of the relationship (Gravetter & Forzano, 2018) [4]. While correlational studies can reveal patterns, they cannot prove that one variable cause another. Correlational research ultimately identifies whether an association exists between variables. Under this methodology data are collected through Surveys or observational data. Statistical Tools such as Pearson's  $r$ , Spearman's  $\rho$ , regression analysis are utilized. An example could be an examining of the relationship between students' GPA and time spent studying per week. Notably, Results are typically presented with a correlation coefficient (ranging from  $-1$  to  $+1$ ), indicating the strength and direction of the relationship (Muijs, 2010) [3]. Correlational research is useful in identifying patterns and guiding further experimental research. Its limitations include the fact that third variables may influence the results (Gravetter & Forzano, 2018) [4].

Under correlational research, researchers select/identify two or more variables they want to investigate after which data is gathered through various methods, such as surveys, observations, or analysing existing records. Statistical techniques, like calculating correlation coefficients, are then used to determine the strength and direction of the relationship between variables (Gay, Mills, & Airasian, 2011) [13]. Ultimately, the findings indicate whether the variables are related and how strongly, but not necessarily why.

The types of relationships determined are:

**Positive Correlation:** As one variable increases, the other also increases (e.g., more study time, better grades).

**Negative Correlation:** As one variable increases, the other decreases (e.g., more absences, lower grades).

**No Correlation:** There is no apparent relationship between the variables.

**Examples:**

**Survey:** A researcher might survey students about their sleep habits and academic performance to see if there's a correlation.

**Naturalistic Observation:** A researcher might observe children playing in a park to see if there's a correlation between time spent playing and social interaction skills.

**Archival Research:** A researcher might analyse historical data on crime rates and unemployment to see if there's a correlation.

Ultimately, the strengths of correlational studies include the fact that correlational studies are cost-effective as they often require less resources than experimental studies. Furthermore, they are quite often ethical, implying that they can be used to study sensitive topics without manipulating variables (e.g., studying the effects of smoking without requiring people to smoke). Correlational studies also generate hypotheses and identify potential relationships that can be further investigated with other research methods.

The limitations on the other hand include the fact that correlation does not equal causation. Hence it would be crucial to remember that a correlation between variables does not necessarily mean one causes the other. Secondly, the correlation

may be due to a third, unmeasured variable problem influencing both of the observed variables.

#### 4.4. Experimental Research

Experimental research is the most rigorous quantitative method, involving manipulation of an independent variable and random assignment to control and experimental groups to determine causality. It involves the manipulation of variables to establish cause-effect relationships (test cause-effect hypotheses under controlled conditions (Campbell & Stanley, 2015) [14]. Designs under experimental research include:

- Randomized Controlled Trials (RCTs)
- Pre-test/Post-test Control Group Design
- Post-test Only Control Group Design

Furthermore, data collection is usually conducted in controlled environments (labs, classrooms) and makes use of statistical tools such as ANOVA, t-tests, regression, chi-square tests. An example of experimental study would be to test the impact of a new teaching method on student performance using an experimental and a control group randomly assigned. The Strengths of experimental research include the fact that they have High internal validity and the ability to establish causation (Shadish, Cook, & Campbell, 2002) [5]. On the other hand, the main limitations is that it may lack external validity due to artificial settings; ethical and practical constraints often limit use.

#### 4.5. Quasi-Experimental/Causal-Comparative Research

*Quasi-Experimental/Causal-comparative Research* is similar to experimental designs but lacks random assignment to groups. It is often used in real world settings like schools and hospitals (Shadish, Cook, & Campbell, 2002) [5]. It is used when randomization is not possible due to ethical, practical, or logistical reasons. Its main focus is attempting to infer causality under less controlled conditions. The designs under quasi- experimental research are: Non-equivalent control group designs, Interrupted time series and Regression discontinuity designs. Its statistical tools include ANCOVA, propensity score matching and difference-in-differences. An example of a quasi-experiment could be Evaluating the effectiveness of a new drug policy implemented in one city by comparing trends in that city to those in a similar city without the policy. Notably, quasi experiments are more practical and feasible in real-world settings but come with greater risk of selection bias, making causal inference more difficult (Campbell & Stanley, 2015) [14].

#### 4.6. Sampling in Quantitative Research

Sampling is a critical component of quantitative research. According to Creswell and Creswell (2018) [6], probability sampling methods (e.g., simple random sampling, stratified sampling, systematic and cluster sampling methods) increase the

likelihood of a representative sample, thereby enhancing generalizability. In contrast, non-probability sampling (e.g., convenience or purposive sampling) is often used when practical limitations exist, though it may introduce bias (Etikan, Musa, & Alkasim, 2016) [15]. Noteworthy, probability sampling ensures that each member of the population has a known chance of being selected (Bryman, 2016) [8]. The choice of sampling strategy directly influences the credibility and applicability of research findings. Sampling plays a critical role in ensuring that findings from a study are generalizable. Proper sampling enhances the internal and external validity of a study, directly influencing the credibility of its conclusions.

#### **4.7. Advantages of Quantitative Research**

Quantitative research offers several strengths, one of which is its generalizability, particularly when probability sampling techniques such as random sampling or stratified sampling are used (Etikan, Musa, & Alkassim, 2016) [15]. Results can often be generalized to a larger population if sampling is properly conducted. Additionally, the replicability of quantitative studies enhances the reliability of findings across different populations and contexts (Babbie, 2020) [11]. Further, quantitative research espouses objectivity realized through the use of standardized tools and procedures That minimize researcher bias (Creswell & Creswell, 2018) [6]. furthermore, enable s for hypothesis testing and predictive modeling (statistical analysis). moreover, large volumes of data can be collected and analyzed relatively quickly.

#### **4.8. Criticisms and Limitations of Quantitative Research**

Despite its advantages, quantitative research is not without criticism and limitation. Scholars argue that it reduces complex human experiences to numerical values, potentially overlooking the richness and context of the phenomena under study (Denzin & Lincoln, 2011) [16]. Accordingly, it does not capture the depth of human behavior or social phenomena. Rigid and inflexible designs and pre-structured instruments may also limit researchers' ability to adapt to evolving research settings and new or unexpected findings during data collection (Neuman, 2014) [9]. Furthermore, cultural and contextual variables may be difficult to quantify, thus affecting the external validity in diverse settings. Moreover, not all variables are quantifiable, especially in fields like psychology or anthropology. The need for a larger sample as compared to qualitative studies is another limiting aspect of quantitative research. These limitations often necessitate the integration of qualitative methods for a more comprehensive understanding.

#### **4.9. Generalizability in Quantitative Research**

Generalizability in quantitative research refers to the extent to which findings from a study can be applied or extended to populations, settings, or times beyond the specific conditions of the original study. It is a key criterion for evaluating the external validity of research results (Creswell & Creswell, 2018) [6].

In quantitative research, generalizability is often achieved through the use of **probability sampling techniques**, such as simple random sampling or stratified sampling, which aim to produce a representative sample of the target population (Fowler, 2014) [17]. The larger and more diverse the sample, the more likely it is that findings can be generalized (Bryman, 2016) [8]. However, limitations such as sampling bias, nonresponse, and contextual variability can restrict generalizability (Shadish, Cook, & Campbell, 2002) [5].

Moreover, researchers must consider **ecological validity**, which refers to how well the study settings and procedures reflect real-world conditions. Notably, even with a representative sample, results may not generalize well if the study context is artificial or overly controlled (Campbell & Stanley, 1963) [14].

## 5. Conclusion

Quantitative research is foundational to empirical inquiry across numerous disciplines. Its systematic, objective approach provides robust evidence for decision-making and theoretical advancement. When applied correctly, especially using protocols like PRISMA, quantitative studies yield replicable and impactful results. However, researchers must be cautious about its limitations and recognize when qualitative or mixed-methods approaches may be more appropriate.

## 6. Emerging Trends: Integration with Mixed Methods

In recent years, there has been growing interest in mixed-methods research, which combines quantitative and qualitative approaches to address the limitations of each (Tashakkori & Teddlie, 2010) [18]. This integrated approach allows for both the measurement of variables and the exploration of context, meaning, and experience, leading to more holistic insights (Creswell & Plano Clark, 2017) [19].

## 7. Recommendations

It is thus recommended that studies adopt standard protocols like PRISMA or similar frameworks to ensure methodological rigor in systematic reviews and also focus on probabilistic methods to improve generalizability and reduce bias in quantitative studies.

## Conflicts of Interest

The authors declare no conflicts of interest.

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