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Mapping Measurement Scales to Statistical Techniques

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ABSTRACT

The selection of appropriate statistical procedures depends heavily on the type of measurement scale used in a study. This paper provides a structured overview linking nominal, ordinal, interval, and ratio scales with the statistical methods most suitable for analyzing each type of data. A qualitative review of methodological literature was conducted to classify common descriptive measures, inferential tests, and advanced statistical models according to measurement scale requirements. The results are summarized in a practical framework that guides researchers in choosing valid analytical techniques, thereby reducing the risk of methodological errors and improving the accuracy of statistical interpretation. The study contributes a clear reference tool that supports sound decision-making in quantitative research across disciplines.

Keywords: Measurement Scales; Statistical Procedures; Nominal; Ordinal; Interval; Ratio; Statistical Tests; Regression Models; Methodological Framework**.**

Introduction

In statistical analysis, the choice of measurement scale is a fundamental consideration that directly influences the selection of appropriate statistical procedures, tests, and estimators. Measurement scales categorize data into distinct types—nominal, ordinal, interval, and ratio—each with unique characteristics and analytical implications (Stevens, 1946). Correctly identifying the scale of measurement is crucial because it determines the validity and reliability of the statistical inferences drawn.

Nominal scales permit only classification into categories; ordinal scales introduce meaningful order; interval scales add equal distances between points but lack a true zero; and ratio scales incorporate an absolute zero, enabling multiplicative comparisons such as proportions and ratios. This structural progression governs the proper selection of descriptive statistics (e.g., mean, median, mode), hypothesis tests (e.g., chi-square, t-test, ANOVA), and multivariable models (e.g., linear regression,

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logistic regression, ordinal regression, Cox regression). Ensuring alignment between measurement scale and statistical method is not merely a procedural recommendation but a prerequisite for valid inference. Misclassification of variables—such as treating ordinal Likert data as interval or applying parametric models to inherently categorical data—has been shown to distort parameter estimates, inflate Type I and Type II error rates, and weaken replicability across studies. Recent methodological literature reinforces this concern. Selman (2024) demonstrates that respecting the ordinal nature of ranked data substantially improves model accuracy and interpretability compared with imposing inappropriate interval-based procedures.

Different scales permit the use of specific statistical techniques: nominal data can be analyzed using frequencies, proportions, chi-square tests, and odds ratios, whereas ordinal data allow for non-parametric tests, medians, and rank-based correlations. Interval and ratio scales support a wider range of analyses, including means, variances, parametric correlations, regression models, and advanced estimators such as logistic and Cox regressions (Field, 2018). Misapplication of statistical procedures due to improper scale identification may lead to inaccurate conclusions, affecting research quality and decision-making.

Literature Review

Measurement scales are the foundation of statistical analysis, providing a framework for organizing and interpreting data. Stevens (1946) classified measurement into four types: **nominal, ordinal, interval, and ratio**, each with distinct properties that determine the permissible mathematical operations and suitable statistical analyses. Proper identification of the measurement scale is critical for ensuring valid and reliable results (Field, 2018).

Nominal scales classify data into distinct categories without any inherent order. Common statistical procedures for nominal data include **frequencies, proportions, chi-square tests**, and **odds ratios** (Agresti, 2018). For example, the chi-square test is widely used to examine associations between categorical variables, while odds ratios quantify the strength of association in case-control studies.

Ordinal scales involve ordered categories, where the relative ranking is meaningful but the intervals between ranks are not necessarily equal. Analyses such as **median, mode, non-parametric correlation (Spearman's rho), Mann-Whitney U test, Kruskal-Wallis test**, and **ordinal logistic regression** are suitable for ordinal data (Pallant, 2020). Ordinal regression models allow researchers to predict ordered outcomes based on predictor variables while respecting the ordinal nature of the response.

Interval scales possess ordered values with equal intervals but lack a true zero point. Statistical measures such as **mean, variance, standard deviation, Pearson correlation**, and **linear regression** are appropriate for interval data (Field, 2018). Interval-level data permit arithmetic operations and parametric testing, enabling more precise estimations and predictions.

Ratio scales include all the properties of interval scales along with a meaningful zero, allowing for **geometric mean, harmonic mean, coefficients of variation**, and advanced models like **logistic regression, nominal logistic regression, and Cox regression** (Kleinbaum & Klein, 2012). Ratio scales enable computations of ratios,

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proportional comparisons, and time-to-event analyses, making them suitable for survival and biomedical research.

Several studies have emphasized the consequences of mismatching statistical procedures with inappropriate measurement scales. For instance, using a parametric test on ordinal data may violate underlying assumptions, leading to biased or invalid results (Agresti, 2018; Field, 2018). Therefore, a systematic mapping of measurement scales to suitable statistical procedures is essential for enhancing methodological rigor.

Despite the extensive literature on statistical methods, there remains a need for a comprehensive, scale-oriented guide that clearly links each measurement type to its appropriate statistical tools. This study aims to provide a systematic overview of which statistical procedures and estimators are suitable for different measurement scales, thereby enhancing methodological rigor and practical applicability in research.

This study builds upon the existing literature by providing a comprehensive overview of the linkage between measurement scales and statistical techniques, ranging from basic descriptive measures to complex regression models, thereby serving as a practical guide for researchers across disciplines.

Aim and objectives

This study aims to outline which measurement scale is suitable for each statistical procedure. The current study has three main objectives:

To categorize statistical tests according to measurement scales

To identify the correct procedures for nominal, ordinal, interval, and ratio data

To provide a brief reference guide for selecting appropriate statistical methods

Methodology

This study is based on a structured qualitative review of established statistical literature, adopts a qualitative, document-based research design aimed at mapping measurement scales to appropriate statistical procedures. The methodology consists of three main steps: literature identification, data extraction, and framework development.

First, a review of foundational statistical texts, methodological handbooks, and peer-reviewed research articles was conducted to gather established definitions, assumptions, and applications of measurement scales. Key sources included works on descriptive statistics, inferential statistics, regression modeling, and categorical data analysis.

Second, relevant statistical procedures—such as measures of central tendency, variability, association, and various regression models—were extracted and categorized according to the four primary measurement scales: nominal, ordinal, interval, and ratio. Each test was evaluated based on the mathematical operations it requires, its underlying assumptions, and the type of data it is designed to analyze.

Finally, the extracted information was synthesized into a structured reference framework. This framework organizes statistical procedures by scale type and highlights the most appropriate techniques for each category. To enhance clarity and practical usefulness, the study presents the framework using tables and simple illustrative figures. These visual elements help summarize complex information and

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allow researchers to quickly identify suitable methods for specific data types.
No primary data collection or statistical computations were performed; instead, this study relies entirely on synthesis of existing academic evidence to develop a clear and practical guide for researchers.

Results and Discussion

The findings of this study are presented in the form of a structured framework that maps each measurement scale to the statistical procedures most suitable for analyzing that type of data. The results are organized into descriptive methods, inferential tests, and advanced statistical models. This classification helps researchers quickly determine which analytical technique aligns with the nature of their data.

Table 1: Measurement Scales and Their Suitable Statistical Procedures

Measurement Scale	**Descriptive Methods**	**Inferential Tests / Estimators**	Advanced Models
Nominal	Frequencies, mode, proportions	Chi-square test, Fisher's exact test, odds ratio	Binary logistic regression, Multinomial logistic regression
Ordinal	Median, percentiles, rank-based summaries	Mann–Whitney U test, Wilcoxon test, Kruskal–Wallis, Spearman's rho	Ordinal logistic regression (proportional odds model)
Interval	Mean, standard deviation, variance	t-test, ANOVA, Pearson correlation	Multiple linear regression
Ratio	All interval methods + geometric mean, harmonic mean	Parametric tests (t-test, F-test), rate comparisons	Cox proportional hazards model, Poisson regression

Discussion

The results show that the appropriateness of a statistical procedure depends primarily on the level of measurement of the variable. Nominal scales—used for categorical classifications—support only nonparametric and frequency-based techniques, as they lack intrinsic ordering or numerical distance. Therefore, methods such as chi-square tests and odds ratios are well suited for analyzing relationships among nominal variables.
Ordinal data, which incorporate ranking, allow for more information than nominal scales but do not satisfy the assumptions required for parametric methods. This justifies the use of rank-based inferential tests such as Mann–Whitney U and Spearman correlation. The study's findings reinforce earlier literature emphasizing that ordinal logistic regression is the most appropriate modeling approach when the dependent variable is ordered but not interval-scaled.
Interval and ratio scales permit the application of more sophisticated statistical methods. Interval data, characterized by equal distances between values but a lack of

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true zero, support mean-based analyses and parametric tests under normality assumptions. Ratio scales extend these capabilities by adding a meaningful zero point, enabling techniques such as geometric and harmonic means, and advanced models like Cox regression used frequently in survival analysis.

Overall, the table and narrative collectively highlight how misclassification of measurement scales can mislead statistical interpretation. The framework developed in this study simplifies the process of choosing statistical methods by offering a direct and practical guide for researchers handling different types of data.

Conclusion

This study provides a structured overview of how measurement scales guide the selection of appropriate statistical procedures. By synthesizing established methodological literature, the research highlights the direct relationship between data type and analytical technique. The framework presented—linking nominal, ordinal, interval, and ratio scales with their suitable descriptive, inferential, and advanced methods—offers a practical reference for researchers and students.

Accurate identification of measurement scales is essential for maintaining the validity of statistical results and ensuring that interpretations are methodologically sound. The findings emphasize that choosing the wrong statistical test can lead to incorrect conclusions, while an informed selection enhances the quality and reliability of research.

Overall, this study contributes to methodological clarity by providing a simplified yet comprehensive guide that supports effective decision-making in statistical analysis across various disciplines.

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