Lecture Notes

# Chapter 14: Nonexperimental Quantitative Research

## Learning Objectives

* 1. State the definition of nonexperimental quantitative research.
  2. List categorical and quantitative independent variables that cannot be manipulated by a researcher.
  3. Evaluate evidence for cause and effect using the three required conditions for cause-and-effect relationships.
  4. Explain the “third-variable problem.”
  5. List and briefly describe the three major techniques of control that are used in nonexperimental research.
  6. Compare and contrast cross-sectional research, longitudinal research, and retrospective research.
  7. Compare and contrast the two types of longitudinal research.
  8. Identify descriptive research studies, predictive research studies, and explanatory research studies when examining published research.
  9. Explain the difference between a direct effect and an indirect effect in causal modeling.
  10. Draw the typology of nonexperimental quantitative research formed by crossing the time dimension with the research objective dimension.

## Chapter Summary

This chapter focuses on nonexperimental quantitative research. It presents information on independent variables, conditions for cause and effect, control techniques, and the multiple dimensions of nonexperimental quantitative designs.

## Annotated Chapter Outline

1. Introduction
   1. Recall that the defining characteristic of experimental research was manipulation of the independent variable. The defining characteristic of nonexperimental research is the lack of manipulation of the independent variable. In addition, there is not random assignment.
   2. Nonexperimental quantitative research designs allow researchers to investigate cause-and-effect relationships. There are control techniques specific to this type of research design. In addition, the dimensions of time and research objectives are important to nonexperimental quantitative research.
   3. **Nonexperimental research**: Research in which the independent variable is not manipulated and there is no random assignment to groups.
      1. Nonexperimental research is often needed because there are many independent variables that we cannot manipulate (e.g., for ethical reasons, for practical reasons, and for literal reasons such as it is impossible to manipulate some variables).
      2. Despite its limitations for studying cause and effect (compared to strong experimental research), nonexperimental research is very important in education.
      3. Discussion Question: Compare and contrast experimental and nonexperimental research. Discuss conditions that require the use of nonexperimental research designs.
2. Steps in Nonexperimental Research: Key point
   1. Determine the research problem and hypotheses to be tested.
   2. Select the variables to be used in the study
   3. Collect the data
   4. Analyze the data
   5. Interpret the results
   6. **Post hoc fallacy:** making the argument that because A preceded B, A must have caused B.
      1. This is a danger with this fallacy in nonexperimental research.
      2. Researchers must remember to empirically test any hypotheses developed after the fact.
      3. After generating a hypothesis from a nonexperimental research project, it must be tested.
      4. Discussion Question: Explain how the post hoc fallacy may impact a researcher’s conclusions about the study.
3. Independent Variables in Nonexperimental Research: These are variables that cannot be manipulated either because it is unethical or impossible to manipulate them.
   1. Both categorical and quantitative variables
      1. It is generally recommended that researchers should not categorize quantitative independent variables.
      2. Information is lost about the relationship.
      3. Discussion Question: Identify independent variables that cannot be manipulated either because it is unethical or impossible.
4. Simple Cases of Nonexperimental Quantitative Research: one independent or predictor variable and one dependent variable, no steps taken to control extraneous variables.
   1. **Simple case:** nonexperimental research design with one independent variable, one dependent variable, and no control for any extraneous variables.
   2. **First simple case of nonexperimental quantitative research:** design with one categorical independent variable and one quantitative dependent variable.
      1. The researcher checks to see whether the observed difference between the groups is statistically significant.
         1. Statistically significant: describes a research finding that is probably not attributable to chance alone; we believe it is a real relationship.
      2. If the difference is statistically significance means you probably are looking at a real relationship).
   3. **Second simple case of nonexperimental quantitative research:** design with one quantitative independent variable and one quantitative dependent variable
      1. The researcher checks to see whether the observed correlation is statistically significant (i.e., not due to chance).
   4. A conclusion about cause and effect cannot be drawn from these cases because observing a relationship between two variables is not enough evidence to conclude that the relationship is causal.
   5. Discussion Question: Compare and contrast the first and second simple cases of nonexperimental quantitative research.
5. Three Required Conditions for Cause-and-Effect Relationships: nonexperimental designs must meet these conditions to claim that the relationship is causal.
   1. **Three required conditions**: Three things that must be present to contend that causation has occurred (from Chapter 11, summarized in Table 14.1).
      1. Relationship condition: variable *A* and variable *B* are related.
      2. Time order: if changes in variable *A* cause changes in variable *B*, the changes in variable *A* must precede the changes in variable *B*.
      3. Rival explanations: the relationship between variable *A* and variable *B* is not due to a confounding extraneous or third variable.
         1. **Third-variable problem**: an observed relationship between two variables may be due to an extraneous variable.
         2. Confounding variables and third variables are synonyms.
         3. Alternative explanation, rival explanation, and rival hypothesis are synonyms.
         4. **Method of working multiple hypotheses** (attempting to identify rival explanations) is used when planning the study not after it has been completed.
      4. Discussion Question: Review the three required conditions for cause-and-effect relationships, and how the method of working multiple hypotheses is used in nonexperimental quantitative research.
6. Applying the Three Required Conditions for Causation in Nonexperimental Research: Key point
   1. It is easy to establish Condition 1 in nonexperimental research.
      1. Just see if the variables are related. Are the variables correlated? or Is there a difference between the means? (if yes, then the variables are related).
   2. When attempting to establish Condition 2, researchers use logic and theory and design approaches that are covered later.
   3. Condition 3 is a serious problem in nonexperimental research because it is always possible that an observed relationship is “spurious” (i.e., due to some confounding extraneous variable or “third variable”). A spurious relationship is a noncausal relationship.
      1. **Spurious relationship:** a relationship between two variables is due to a third variable.
      2. **Partially spurious relationship**: a relationship between two variables is partially due to a third variable.
      3. When attempting to establish Condition 3, researchers use logic and theory (e.g., make a list of extraneous variables that you want to measure in your research study), control techniques (such as statistical control and matching), and design approaches (such as using a longitudinal design rather than a cross-sectional design).
      4. Discussion Question: Explain how it is difficult to establish the three conditions of causality with nonexperimental quantitative research and how they can be addressed in nonexperimental quantitative research designs.
7. Techniques of Control in Nonexperimental Research (i.e., How to Design Strong Nonexperimental Research): These control techniques allow researchers to make causal attributions in nonexperimental quantitative research.
   1. Matching
      1. **Matching variable:** the variable the researcher matches on to eliminate it as an alternative explanation.
      2. Can match for categorical and quantitative variables
      3. Limitations of matching:
         1. It can be cumbersome finding individuals who meet the matching criteria and requires a large participant pool and access to information about them.
         2. Frequently matches cannot be found for potential participants so they are excluded or eliminated from the study.
         3. Usually there is more than one alternative explanation so matching needs to be done on more than one variable.
         4. The relevant extraneous variables must be known in order for matching to occur.
         5. The researcher never knows whether he or she has matched on all the appropriate variables.
         6. Matching can create an unrepresentative sample because people are chosen to be matches rather than being representative.
         7. If groups from different populations are matched, there is a threat to internal validity (regression to the mean) which can sometimes occur.
      4. Discussion Question: Discuss the strengths and weaknesses of using matching as a control strategy in nonexperimental quantitative research.
   2. Holding the Extraneous Variable Constant
      1. Only use study participants who are at the same constant level on the variable that you want to control for. If there is still a relationship between the independent and dependent variables, the relationship is not due to the matching variable because it was a constant in the study.
      2. There is a limitation on the external validity (i.e., generalizability) of this control technique.
      3. Discussion Question: Discuss how holding the extraneous variable constant impacts the external validity of the study.
   3. Statistical Control: most commonly used technique for controlling extraneous variables.
      1. Based on
         1. **General linear model:** a mathematical procedure that is the “parent” of many statistical analysis techniques.
         2. **Special case of the general linear model**: one of the “children” of a broader statistical procedure known as the general linear model (GLM)
      2. **Partial correlation**: used to examine the relationship between two quantitative variables, controlling for one or more quantitative extraneous variables.
         1. Variables should be quantitative.
         2. Weighted average of the correlations between the independent variable and dependent variable at each of the levels of the extraneous variable.
      3. **Analysis of covariance:** used to examine the relationship between one categorical independent variable and one quantitative dependent variable, controlling for one or more quantitative extraneous variables.
      4. Researchers can base research on samples of participants who are randomly selected from the population.
      5. Must collect data on the extraneous, independent, and dependent variables, thus extraneous variables are include in the study’s design. After data collection, the extraneous data are controlled for during data analysis.
      6. A limitation is that some statistical assumptions are frequently not met.
      7. Discussion Question: Discuss the pros and cons of using statistical control in nonexperimental quantitative research.
8. Interlude (the Study of Causal Relationships in Epidemiology)
   1. How causation is established in epidemiology (Exhibit 14.1)
      1. Strength of Association: the stronger the relationship between the independent and dependent variables, the less likely the relationship is due to an extraneous variable.
      2. Temporality: it is necessary for a cause to precede and effect in time.
      3. Consistency: multiple observations of the relationship by different people under different circumstances and with different measurement instruments increase credibility.
      4. Theoretical Plausibility: It is easier to accept an association as causal when there is a rational and theoretical basis for the conclusion.
      5. Coherence: a cause-and-effect interpretation is clearest when it does not conflict it with previous knowledge about the variables and when there are not plausible competing theories or rival hypotheses.
      6. Specificity in the Causes: showing that an outcome is best predicted by one primary factor adds credibility to causal claim.
      7. Dose–Response Relationship: there should be a direct relationship between the risk factor/independent variable and one’s status on the disease variable/dependent variable.
      8. Experimental Evidence: any related research based on experiments will make causal inference more plausible.
      9. Analogy: sometimes a commonly accepted phenomenon in one area can be applied to another area.

10.Discussion Question: How do these ways of establishing causality in epidemiology relate to the three conditions for causality previously discussed.

1. Classifying Nonexperimental Research by Time and Research Objectives: These two objectives can be placed in a matrix and summarize how the data are collected in relation to time and the primary research objective. See Table 14.3.
   1. Discussion Question: Describe the matrix that results from crossing the time and research objectives dimensions of nonexperimental quantitative research.
2. The Time Dimension in Nonexperimental Research: time is important in terms of how variables change over time and establishing the proper time order for cause and effect.
   1. **Cross-Sectional Research:** data are collected at a single point in time.
      1. Advantage: Data can be collected on many different kinds of people in a relatively short period of time.
      2. Weaknesses:
         1. Difficult to establish time order.
         2. Studies of developmental trends can be misleading
      3. Discussion Question: Explain the advantages and disadvantages of cross-sectional research.
   2. **Longitudinal Research:** Data are collected at multiple time points, and comparisons are made across time.
      1. Require at least two distinct time periods.
      2. Two variations: trend and panel study.
      3. **Trend** **study:** independent samples are taken from a population over time, and the same questions are asked.
      4. **Panel study:** study in which the same individuals are studied at successive points over time.
         1. **Prospective study:** another term applied to a panel study
         2. **Cohort:** any group of people with a common classification or characteristic.
         3. As participants in panel study age, the ability to generalize to the current population decreases.
         4. **Differential attrition** (participants who drop out are different from those who stay) may also occur and reduce external validity.
         5. Panel studies are better than cross-sectional studies for studying cause and effect. They are also more powerful than trend study because change is measured in the same people over time.
         6. Medical researchers use prospective panel studies in which groups are matched on multiple extraneous variables and are followed over time. Sometimes a **dose–response relationship** (present when increased amounts, or greater strength, of the treatment results in increased amounts of response on the dependent variable) is also investigated.
      5. **Discussion Question:** Compare and contrast the different longitudinal research designs.
   3. **Retrospective Research:** The researcher starts with the dependent variable and moves back in time.
      1. Based on actual data collected in the past or through researchers’ use of **retrospective questions** (questions asking people to recall something from an earlier time).
      2. Researchers cannot always corroborate each finding but if they try to it is an asset.
      3. Discussion Question: Evaluate the strengths and weaknesses of the retrospective research design.
3. The Research Objective Dimension in Nonexperimental Research: Three types of research objectives can be addressed with nonexperimental quantitative research designs.
   1. Descriptive Nonexperimental Research
      1. **Descriptive research:** research focused on providing an accurate description or picture of the status or characteristics of a situation or phenomenon.
      2. Use survey method of data collection to find out about attitudes, opinions, believes, behaviors, and demographics.
      3. Test developers use descriptive studies of reliability and validity to develop and refine tests.
      4. Discussion Question: Develop research questions that could be answered using descriptive nonexperimental quantitative research.
   2. Predictive Nonexperimental Research
      1. **Predictive research:** research focused on predicting the future status of one or more dependent variables based on one or more independent variables.
      2. Discussion Question: Develop research questions that could be answered using predictive nonexperimental quantitative research.
   3. Explanatory Nonexperimental Research
      1. **Exploratory research:** testing hypotheses and theories that explain how and why a phenomenon operates as it does.
      2. Goals: understand phenomenon, establish evidence of cause-and-effect relationship.
      3. **Causal modeling:** a form of explanatory research in which the researcher hypothesizes a causal model and then empirically tests it. (See Figure 14.3.)
         1. Causal modeling is used to study **direct effect** (effect of one variable on another, in a causal model, the effect of the variable at the origin of an arrow on the variable at the receiving end of the arrow).
            1. **Path coefficient:** a quantitative index providing information about a direct effect
         2. Also used to study indirect effects (an effect occurring through an intervening variable).
            1. Intervening or mediating variable: a variable occurring between two other variables in a causal chain
         3. A strength of causal modeling in nonexperimental research is that the models develop detailed theories to test.
         4. A weakness of causal modeling in nonexperimental research is that the causal models are tested with nonexperimental data, which means there is no manipulation, and you will recall that experimental research is stronger for studying cause and effect than nonexperimental research.
         5. Also, causal models with longitudinal data are generally better than causal models with cross-sectional data.