AN OVERVIEW OF RESEARCH DESIGNS RELEVANT TO NURSING: PART 1: QUANTITATIVE RESEARCH DESIGNS

Valmi D. Sousa[1]
Martha Driessnack[2]
Isabel Amélia Costa Mendes[3]

This three part series of articles provides a brief overview of relevant research designs in nursing. The first article in the series presents the most frequently used quantitative research designs. Strategies for non-experimental and experimental research designs used to generate and refine nursing knowledge are described. In addition, the importance of quantitative designs and the role they play in developing evidence-based practice are discussed. Nursing care needs to be determined by the results of sound research rather than by clinical preferences or tradition.

DESCRIPTORS: *research; nursing research; quantitative analysis; methodology; nursing*

REVISIÓN DE DISEÑOS DE INVESTIGACIÓN RESALTANTES PARA ENFERMERÍA. PARTE 1: DISEÑOS DE INVESTIGACIÓN CUANTITATIVA

Esta serie de tres artículos muestra una breve revisión de los diseños de investigación resaltantes para Enfermería. En el primer artículo de la serie son revisados los diseños de investigación cuantitativa mas utilizados en la actualidad para las investigaciones en esta área del conocimiento. Son indicados los tipos de estrategias que tales diseños utilizan para generar y refinar conocimiento siendo descritos los diseños clasificados como no experimentales y experimentales. A modo de conclusión se resalta sobre la importancia de la práctica basada en evidencia para la profesión, de forma que el cuidado de enfermería sea determinado por resultados de investigación sólida y no de acuerdo con preferencias clínicas o tradicionales.

DESCRIPTORES: *investigación; investigación en enfermería; análisis cuantitativo; metodología; enfermería*

REVISÃO DOS DESENHOS DE PESQUISA RELEVANTES PARA ENFERMAGEM: PARTE 1: DESENHOS DE PESQUISA QUANTITATIVA

Esta série de três artigos apresenta uma breve revisão dos desenhos de pesquisa relevantes para a enfermagem. Neste primeiro artigo da série são revistos os desenhos de pesquisa quantitativa mais utilizados atualmente nas investigações desta área de conhecimento. São apontados os tipos de estratégia que tais desenhos utilizam para gerar e refinar conhecimento e são descritos os desenhos classificados como não-experimentais e experimentais. A guisa de conclusão ressalta-se a importância da prática baseada em evidência para a profissão, de modo que o cuidado de enfermagem seja determinado por resultados de pesquisa sólida e não por preferências clínicas ou por tradição.

DESCRITORES: *pesquisa; pesquisa em enfermagem; análise quantitativa; metodologia, enfermagem*

[1] PhD, APRN, BC, Assistant Professor, College of Health and Human Services, The University of North Carolina at Charlotte, United States of America, e-mail: vdsousa@uncc.edu; [2] PhD, APRN, BC, Postdoctoral Research Fellow in Clinical Genetics, College of Nursing, The University of Iowa, United States of America, e-mail: martha-driessnack@uiowa.edu; [3] PhD, RN, Full Professor, University of São Paulo at Ribeirão Preto College of Nursing, WHO Collaborating Centre for Nursing Research Development, Brazil, CNPq Researcher 1A, e-mail: iamendes@eerp.usp.br

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INTRODUCTION

A research design is the framework or guide used for the planning, implementation, and analysis of a study[1-2]. It is the plan for answering the research question or hypothesis. Different types of questions or hypotheses demand different types of research designs, so it is important to have a broad preparation and understanding of the different types of research designs available. Research designs are most often classified as either *quantitative* or *qualitative*. However, it is becoming more common for investigators to combine, or mix, multiple quantitative and/or qualitative designs in the same study[3].

Quantitative research designs most often reflect a deterministic philosophy that is rooted in the post-positivist paradigm, or school of thought. Post-positivists examine cause, and how different causes interact and/or influence outcomes. The post-positivist paradigm adopts the philosophy that reality can be discovered, however only imperfectly and in a probabilistic sense. The approach is typically deductive – where most ideas or concepts are reduced into variables and the relationship between or among them are tested[1,3]. The knowledge that results is based on careful observation and measurement and interpretation of objective reality.

In contrast, qualitative research designs are rooted in the naturalistic paradigm. The approach to study is inductive, rather than deductive, and begins with the assumption that reality is subjective, not objective, and that multiple realities exist, rather than just one[1,3]. When little is known about a particular phenomenon, experience, or concept, a qualitative design is often used first. Once concepts and/or themes are identified, or grouped into a theory, they can then be tested using a quantitative design or approach. Quantitative research designs primarily involve the *analysis of numbers* in order to answer the research question or hypothesis, while qualitative designs primarily involve the *analysis of words*.

RELEVANT QUANTITATIVE RESEARCH DESIGNS

Quantitative research designs adopt objective, rigorous, and systematic strategies for generating and refining knowledge[1-4]. They primarily use *deductive reasoning* and *generalization*. Deductive reasoning is the process in which the researcher begins with an established theory or framework, where concepts have already been reduced into variables, and then gathers evidence to assess, or test, whether the theory or framework is supported[1]. Generalization is the extent to which conclusions developed from evidence collected from a sample can be extended to the larger population[1].

Quantitative research is most often about quantifying relationships between or among variables – the *independent* or predictor variable (s) and the *dependent* or outcome variable (s). Broadly, quantitative research designs are classified as either *non-experimental* or *experimental* (Table 1). Non-experimental designs are used to describe, differentiate, or examine associations, as opposed to direct relationships, between or among variables, groups, or situations. There is no random assignment, control groups, or manipulation of variables, as these designs use observation only. The most common non-experimental designs are *descriptive* or *correlational* studies.

Non-experimental designs are often further classified according to timing of data collection, *cross-sectional* or *longitudinal*, or according to the timing of the experience or event being studied, *retrospective* or *prospective*[1,5]. In a *cross-sectional study*, variables are identified one point in time and the relationships between them are determined. In a *longitudinal study*, data are collected at different points over time. In a retrospective study, an event or phenomenon identified in the present is linked to factors or variables in the past. In a *prospective study*, or cohort study, potential factors and variables identified in the present are linked to potential outcomes in the future.

NON-EXPERIMENTAL RESEARCH DESIGNS

Non-experimental designs do not have random assignment, manipulation of variables, or comparison groups. The researcher observes what occurs naturally without intervening in any way. There are many reasons for undertaking non-experimental designs. First, a number of characteristics or variables are not subject or amenable to experimental manipulation or randomization. Further, some variables cannot or should not be manipulated for ethical reasons. In some instances, independent variables have already occurred, so no control over them is possible.

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Non-experimental designs may resemble the posttest-only experiment. However, there is a natural assignment to the condition or group being studied, as opposed to random assignment, and the intervention or condition (X) is something that has happened naturally, not imposed or manipulated. The most common methods used in non-experimental designs involve exploratory surveys and/or questionnaires. Non-experimental designs are typically classified as either *descriptive* or *correlational* (Table 1).

Descriptive Designs

Descriptive, or exploratory studies are used when little is known about a particular phenomenon[1,6]. The researcher observes, describes, and documents various aspects of a phenomenon. There is no manipulation of variables or search for cause and effect related to the phenomenon. Descriptive designs describe what actually exists, determine the frequency with which it occurs, and categorizes the information. Researchers pose Level I research questions[2,7-8] (Table 1). The results provide the knowledge base for potential hypotheses that direct subsequent correlational, quasi-experimental, and experimental studies. The two most common types of quantitative descriptive designs are: *case control* and *comparative*[1,6].

Case Control Studies. Case control studies involve a description of cases with and without a pre-existing condition or exposure. The cases, subjects, or units of study can be an individual, a family, or a group. Case control studies are more feasible than experiments in cases in which an outcome is rare or takes years to develop. This design is also known as a *case report* or *case study*.

Comparative Studies. Comparative studies are also called *ex post facto* or *causal-comparative studies*. These studies describe the differences in variables that occur naturally between two or more cases, subjects, or units of study. Researchers who use a comparative design normally pose hypotheses about the differences in variables between or among two or more units. The main difference between this approach and the quasi-experimental design is the lack of researcher control of the variables.

Correlational Designs

Correlational designs involve the systematic investigation of the nature of relationships, or associations between and among variables, rather than direct cause-effect relationships. Correlational designs are typically cross-sectional[1,6]. These designs are used to examine if changes in one or more variable are related to changes in another variable(s). This is referred to as *co-variance*. Correlations analyze direction, degree, magnitude, and strength of the relationships or associations. The results from correlational studies provide the means for generating hypotheses to be tested in quasi-experimental and experimental studies. Researchers may pose Level I or II research questions[2,7-8] (Table 1). Three of the most common correlational designs include: *descriptive*, *predictive*, and *model testing correlational design*[1,6].

Descriptive Correlational Designs. Descriptive correlational studies describe the variables and the relationships that occur naturally between and among them.

Predictive Correlational Designs. Predictive correlational studies predict the variance of one or more variables based on the variance of another variable (s). As with experimental designs, the study variables are classified as independent (predictor) and dependent (outcome). However, these variables are not manipulated, but occur naturally.

Model Testing Correlational Designs. Model testing correlational studies examine, or pilot test, proposed relationships for a model or theory. As with experimental designs, the study variables are classified as independent (predictor) and dependent (outcome). However, the variables are not manipulated, but occur naturally.

EXPERIMENTAL DESIGNS

Experimental designs typically use random assignment, manipulation of an independent variable(s), and strict controls[1,6,9]. These characteristics provide increased confidence of cause-and-effect relationships. *Random assignment* means that each subject had equal chance to be assigned to either the control or experimental group. The use of random assignment of subjects attempts to eliminate systematic bias. Random assignment is different from random sampling. *Random sampling* means that each subject had an equal chance of being selected from a larger group to participate in the study. This approach is often used in survey research to facilitate

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generalization. However, it is the random assignment to different conditions that distinguishes a true experimental design. To be classified as *true* experimental, there must be randomization, a control group, and manipulation of a variable when examining the direct causal or predicted relationship between variables. When any one of these requirements is not met, the design is no longer a *true* experiment and is classified as *quasi*-experimental. Researchers typically pose Level III research questions[2,7-8] (Table 1).

True-Experimental Designs

True experimental designs examine the cause and effect relationships between independent (predictor) and dependent (outcome) variables under highly controlled conditions. The simplest of all experimental designs is the *posttest-only control group*. Other common true-experimental designs include the *posttest only control group design*, *pretest-posttest control group design*, *Soloman four group design*, and *cross-over design*[1,6,9].

Posttest Only Control Group Design. In posttest only control group design, subjects are randomly assigned (R) to either a control or an experimental group. The groups are not pretested. One group is exposed to a treatment (X) or series of different treatments (X_1, X_2), and then both groups are posttested (O).

$$\begin{array}{ccc} R & X & O \\ R & & O \end{array}$$

Pretest-Posttest Control Group Design. In the pretest-posttest control group design, or classic experiment, subjects are randomly assigned (R) to either a control or experimental group. Both groups are pretested (O). The experimental group is exposed to a treatment (X) or different treatments (X_1, X_2), and then both groups are posttested (O).

$$\begin{array}{cccc} R & O & X & O \\ R & O & & O \end{array}$$

Solomon Four-Group Design. In Solomon four-group design, subjects are randomly assigned (R) to one of four different groups. Two of the groups are pretested (O) and two are not. Only one pretested and one not pretested group are then exposed to a treatment (X). All of the groups are postested (O).

$$\begin{array}{cccc} R & O & X & O \\ R & O & & O \\ R & & X & O \\ R & & & O \end{array}$$

Cross-over Design. In the cross-over, or counterbalanced, switchover, or rotation design, subjects are given two treatments, one being the experimental treatment (X_E), the other a control or reference treatment (X_C). The subjects are randomly assigned to one of two groups. One group receives the experimental treatment first and the other group receives the experimental group second. After a period of time, sufficient to allow for any treatment effect to *wash out* (W), the treatments are crossed over. Multiple cross-over designs involve several treatments.

$$\begin{array}{ccccccc} R & O & X_E & O & W & X_C & O \\ R & O & X_C & O & W & X_E & O \end{array}$$

Quasi-experimental Designs

Quasi-experimental, like true-experimental designs, examine cause-and-effect relationships between or among independent and dependent variables. However, one of the characteristics of true-experimental design is missing, typically the random assignment of subjects to groups. Although quasi-experimental designs are useful in testing the effectiveness of an intervention and are considered closer to natural settings, these research designs are exposed to a greater number of threats of internal and external validity, which may decrease confidence and generalization of study's findings. The most common used quasi-experimental designs are: *non-equivalent group pretest-posttest group design*, *control-group interrupted time series design*, *single-group interrupted time-series design*, and *counterbalanced design*[1,6,9].

Non-equivalent pretest-posttest control group design. The non-equivalent pretest-posttest control group design is identical in many ways to the pretest-posttest control group design except that subjects are not randomly (NR) assigned to groups. Both groups are pretested (O) and posttested (O). However, only the experimental group is exposed to a treatment (X).

$$\begin{array}{cccc} NR & O & X & O \\ NR & O & & O \end{array}$$

Control-group Interrupted Time Series Design. In the control-group interrupted time series design, groups are measured or tested repeatedly on the same variable over time. Again, there is no random assignment (NR) to groups. The experimental

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group is exposed to a treatment (X) at some point in the series while the control group is not.

NR O O O X O O O
NR O O O   O O O

Single-group Interrupted Time-Series Design. With the single-group interrupted time-series design, the researcher measures only one group repeatedly, both before and after exposure to a treatment (X).

NR O O O X O O O

Counterbalanced Design. The counterbalanced design is similar to the cross-over experimental design except that subjects are not randomly assigned (NR) to the different groups. All groups are exposed to all treatments. The most common counterbalanced design is the *Latin square*, where four different treatments are applied to four naturally assembled groups or individuals. Each of the groups or individuals is posttested after each treatment. The number of treatment and groups must be equal. The Latin square is shown here.

NR X1 O X2 O X3 O X4 O
NR X2 O X4 O X1 O X3 O
NR X3 O X1 O X4 O X2 O
NR X4 O X3 O X2 O X1 O

Table 1 - Quantitative research designs

Designs	Levels of Research Questions
Non-Experimental	
• Descriptive	• Level I - Descriptive in Nature
	- Little is known about the phenomenon
	- Descriptive questions include who, what, when, where, how many, how much?
	- Example: What are the characteristics of X?
• Correlational	• Level II - Exploratory and Explanatory in Nature
	- Build on existing knowledge
	- Proposes relationships
	- Exploratory and Explanatory questions include why and how?
	- Example: How factors …are related to X?
Experimental	
• True-Experimental	• Level III - Predictive in Nature
• Quasi-experimental	- Requires considerable prior knowledge
	- Test predictive hypotheses or theories
	- Predictive questions address the effectiveness or cause-and-effect of X on Y
	- Example: Is there a change in X when Y is manipulated?

SELECTION OF QUANTITATIVE RESEARCH DESIGN

The selection of a research design is based on the research question or hypothesis and the phenomena being studied. A true-experimental design is considered the strongest or most rigorous with regard to establishing causal effects and *internal validity*. Internal validity is the control of factors within the study that might influence the outcomes besides the experimental intervention or treatment. A non-experimental design is generally the weakest in this respect. However, this does not mean that non-experimental designs are weak designs overall. They are weak only with respect to assessing cause-effect relationships and the establishment of internal validity. In fact, the simplest form of non-experiment, the one-time survey design that consists of one single observation (O), is one of the most common forms of research and, for some research questions, especially descriptive ones, is clearly a strong and most appropriate design.

CONCLUSION

Research is important to the nursing profession. It is designed to provide new knowledge, improve health care, and challenge current nursing practice with new ideas. Evidence-based nursing practice comes from the idea that the care we provide be determined by sound research rather than by clinician preference or tradition. Understanding how to select the best design to answer a research question or test a hypothesis is the first step in conducting meaningful research. This process assists nurses as they read and critique original research articles. Nursing practice is seldom changed based on one study. It is the accumulation of results from several studies, often using different research designs that provide enough evidence for change.

In the first article of this series, we have presented an introduction and overview to different quantitative research designs, including descriptive, correlational, true-experimental, quasi-experimental designs. Each design offers a unique approach or plan for answering a nursing research question. In the next article, qualitative research designs will be presented and discussed, providing nurses with even more choices of design. Finally, in the third article, the combination, or mixing of designs within one study, will be introduced. At the completion of this series, nurses will have an overview of relevant research designs for nursing research and be able to select an appropriate design as a framework or guide for a potential study.

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