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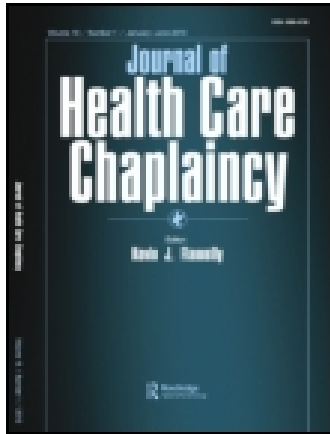
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### Independent, Dependent, and Other Variables in Healthcare and Chaplaincy Research

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## **Independent, Dependent, and Other Variables in Healthcare and Chaplaincy Research**

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*This article begins by defining the term variable and the terms independent variable and dependent variable, providing examples of each. It then proceeds to describe and discuss synonyms for the terms independent variable and dependent variable, including treatment, intervention, predictor, and risk factor, and synonyms for dependent variable, such as response variables and outcomes. The article explains that the terms extraneous, nuisance, and confounding variables refer to any variable that can interfere with the ability to establish relationships between independent variables and dependent variables, and it describes ways to control for such confounds. It further explains that even though intervening, mediating, and moderating variables explicitly alter the relationship between independent variables and dependent variables, they help to explain the causal relationship between them. In addition, the article links terminology about variables with the concept of levels of measurement in research.*

**KEYWORDS** *confounds, dependent variable, independent variable, levels of measurement, mediation, moderation, risk factors*

Anyone who wants to understand healthcare research should start by learning research terminology. The term *variable* is probably the most frequently used word in scientific research. However, people who have not been

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trained in research often find the word to be odd. The simplest definition of a variable is that it is something that takes on different values; it is something that varies (Bhopal, 2002; Kerlinger, 1973). Within the context of research, a variable may be defined as “an empirical phenomenon that takes on different values or intensities” (Ellis, 1998, p. 19).

A variable also may be thought of as a property of something (Kerlinger, 1973). The height, weight, and temperature of an object are three examples of its properties. Human research measures, among other things, the properties of people. These properties may include their height, weight, and temperature, as well as other properties (i.e., variables), such as, intelligence, personality, and health status.

Variables are generally divided into two broad categories in research, *independent* variables and *dependent* variables. However, researchers refer to them by many different names, and there are other types of variables, as well.

## INDEPENDENT AND DEPENDENT VARIABLES

Most healthcare professionals have heard the terms independent variable and dependent variable (Kleinbaum, Kupper, Muller, & Nizam, 1998; Polit, Beck, & Hungler, 2001), but they may not know what they mean or know the difference between them. Although the terms are similar, their meanings are very different, and the ability to distinguish between the two of them is essential for understanding and designing research studies.

One of the major aims of research is to understand the causes of phenomena. The presumed cause in a cause-effect relationship is called the independent variable, and the presumed effect is called the dependent variable (Polit et al., 2001; Vogt, 1993). In other words, an independent variable is a variable that is presumed to have an effect on another variable (a dependent variable). A dependent variable is, quite simply, dependent, in that it depends, in some sense, on an independent variable. It is the dependent variable that the researcher is usually most interested in understanding and possibly interested in predicting.

It is important to remember, however, that variables are not inherently independent or dependent variables. An independent variable in one study might be a dependent variable in another study. For example, one study might examine the effect of exercise (the independent variable) on osteoporosis (the dependent variable); another study might examine the effect of osteoporosis (the independent variable) on the occurrence of bone fractures (the dependent variable).

The use of the term independent variable arose in the context of experimentation, and the purpose of most experiments is to test whether an independent variable, in fact, does have an effect on one or more dependent

variables. A simple experiment might test whether exercise (the independent variable) has an effect on body weight (the dependent variable) by having people engage in physical exercise for different amounts of time. Many experiments in healthcare are referred to as randomized control trials (RCTs). An example of an RCT is a study in which individuals are randomly assigned to groups that exercise for different amounts of time to see if exercise has an effect on body weight. Another example of an RCT is a study that randomly assigns individuals to several groups that receive different doses of a diuretic (the independent variable) to test whether diuretics have an effect on blood pressure (the dependent variable). Many types of medical treatments have been examined as independent variables in RCTs to evaluate their effects on a predetermined health outcome (the dependent variable). An independent variable in an RCT can be as simple as a drug dosage, or as complex as a surgical procedure, or a series of medical treatments, such as chemotherapy.

An example that readers of the *Journal of Health Care Chaplaincy* will be familiar with is an RCT by Toussaint, Barry, Bornfriend, and Markman (2014), in which they randomly assigned patients to two conditions, or groups. The experimental group engaged in educational activities related to forgiveness (their independent variable), while the control group did not. The study tested whether the independent variable of educational activities had an effect on a number of dependent variables, including pessimism, self-acceptance, and self-forgiveness. The independent variable only had an effect on self-forgiveness. As often happens, the authors did not use the terms independent variable or dependent variable, and, therefore, readers had to figure them out for themselves.

Although the independent variable is not manipulated in nonexperimental research, the term independent variable is widely used in nonexperimental studies. For example, Galek et al. (2010) were explicit about what their independent and dependent variables were in a study of whether a chaplain's gender or religious affiliation influenced praying with patients. The independent variables were not limited to the gender and religious denomination of the chaplains; they also included whether the gender and denominations of the chaplains were the same as the gender and denominations of the patients they visited. The dependent variable was simply the percentage of visits in which chaplains prayed with patients. A key finding of the study was that chaplains were more likely to pray with patients from their own religion. It should be mentioned that personal or demographic characteristics are often treated as independent variables in experimental and nonexperimental studies.

## TREATMENTS, INTERVENTIONS, AND OUTCOMES

Some researchers only use the term independent variable in the context of experimental research, and some researchers do not use the term, even when

reporting an experiment or RCT. This is particularly true in healthcare research where the terms *treatment* and *intervention* often are used instead of independent variable. Likewise, many researchers prefer to use the term, *outcome* in favor of dependent variable. Montonye and Calderone (2009), for example, use the terms intervention and outcomes, instead of independent and dependent variables, in an observational study of specific chaplain interventions to address patients' feelings, attitudes, and issues.

One of the few experimental studies of chaplaincy used the words treatment and intervention, instead of independent variable, when referring to chaplain visits with patients. The study also used the word outcomes instead of dependent variables when referring to the effects of chaplain visits on patient anxiety, depression, hope, and coping (Bay, Beckman, Trippi, Gunderman, & Terry, 2008). The chaplain intervention only had an effect on negative religious coping. It is worth noting here that the term "effect" typically is used only when a causal relationship between an intervention and an outcome (i.e., independent variable and dependent variable) can be demonstrated experimentally. Therefore, the term effect typically is not used in reference to nonexperimental studies, as those studies only describe the associations or relationships between variables.

#### PREDICTOR, RESPONSE, AND MORE OUTCOME VARIABLES

The term *predictor* often is used in nonexperimental research (Kleinbaum et al., 1998) to refer to a variable that can predict another variable i.e., the magnitude of the predictor (independent variable) can predict the magnitude of another variable (dependent variable). The term predictor is useful because it does not imply that the predictor causes the change in the predicted variable, although it may. Grossoehme, Szczesniak, McPhail, and Seid (2013) examined the association between religious coping in adolescents with cystic fibrosis and the rate of change in their pulmonary function. Their *predictor* (or independent variable) was pulmonary functioning, which predicted the subsequent religious coping by the adolescents. The authors referred to religious coping as a *response variable*, which is another name for a dependent variable (Kleinbaum et al., 1998).

A cross-sectional survey by Gaudette and Jankowski (2013) on the associations of religious beliefs and spiritual practices with anxiety in palliative-care patients used the terms independent and predictor variable interchangeably when referring to beliefs and spiritual practices. The study found that both of the independent variables predicted anxiety. They also used the term outcomes when discussing the results of previous research, but described anxiety as their dependent variable.

A cross-sectional survey of physicians provides another example of the use of the terms predictors and outcomes (King, Dimmers, Langer & Murphy,

2013). One of the study's key findings was that greater knowledge of chaplains predicted the extent to which the physicians tried to address spirituality in their care of patients, and to refer patients to spiritual care providers.

## RISK FACTORS AND PROTECTIVE FACTORS

Many healthcare researchers, especially epidemiologists, use the term risk factor when referring to what otherwise would be called an independent variable (Kelsey, Thompson, & Evans, 1986; Kleinbaum, Kupper, & Morgenstern, 1982). There are at least two reasons for this. First, many diseases have multiple causes, as expressed in the notion of “the web of causation” (Kelsey et al., 1986, p. 33). Second, it is difficult to establish causality in nonexperimental research (see K. J. Flannelly & Jankowski, 2014). The use of the general term, risk factor, avoids the question of causality. The Framingham Heart Study, which introduced the term “risk factor” (Berridge, Gorsky, & Mold, 2011) found that high levels of blood cholesterol, high blood pressure, obesity, cigarette smoking, and age were key risk factors for coronary heart disease, in that they increased the risk of having the disease (Kannel, Dawber, Kagan, Revotskie, & Stokes, 1961).

Variables that reduce the risk of disease are called protective factors. Numerous studies, for example, have found that having a religious affiliation (i.e., belonging to a religious denomination) is a protective factor for heart disease (Koenig, McCullough, & Larson, 2001).

## EXTRANEOUS, NUISANCE, OR CONFOUNDING VARIABLES

Another type of variable to be aware of when reading or designing studies goes by many different names, including extraneous variable, nuisance variable, and confounding variable, or simply confound or confounder (Kleinbaum et al., 1982; 1998; Polit et al., 2001). Researchers are concerned about extraneous variables because they can alter or obscure the relationship between the independent variable and dependent variable, or indicate there is a causal relationship between them when none exists. Researchers try to control for extraneous variables in their experiments by controlling the conditions of the experimental environment to keep variables as constant as possible (Polit et al., 2001). In human research however, experimental control often is not sufficient because individuals vary in many ways that are extraneous to the purpose of a study. Such extraneous variables may include their age, gender, ethnicity, income, and education. If experimental control is not possible, the researcher has three options for dealing with extraneous variables (Polit et al., 2001). One way is to try to match the study participants on the possible confounds, such as matching experimental and control subjects, or cases and noncases, by age, gender, and other key possible confounding

variables. However, this can be difficult to do. Another way is to incorporate an extraneous variable as an independent variable in the study design. If age, for example, might have an effect on the relationship between the independent variable and dependent variable, the researcher can group participants into subgroups of different ages, say, 20 year-olds, 30 year-olds, 40 year-olds, and so forth. This method is called "stratification," and the "effects" of stratified variables are usually included in the statistical analyses (Mausner & Kramer, 1985). The third way is to use the person's age as an independent variable in the statistical analyses. It is a common practice to measure an extraneous variable and include the measure of it only in the statistical analysis as a way to control for variation in the levels of the variable among the study's participants. This practice is particularly common in survey studies. Regardless of the approach used to control extraneous variables, it is always important to see if the participants vary in ways that could affect the dependent variable.

When extraneous variables are used as independent variables in the statistical analyses, they are called covariates. Demographic and other personal characteristics are considered to be covariates (i.e., controls) or independent variables in statistical analyses contingent upon whether a researcher is specifically interested in the relationship between these variables and the dependent variable(s). Studies on the relationship between religion and health should, and usually do, statistically control for age, gender, and ethnicity because these variables are associated with variation in the level of religious involvement, practices, and other expressions of religious faith (Flannelly, Ellison, & Strock, 2004).

### INTERVENING, MEDIATING, AND MODERATING VARIABLES

There are three other terms that are used exclusively in reference to possible causal variables: intervening, mediating, and moderating variables. Tolman (1938) used the term intervening variable to refer to a variable or set of variables in a chain of causation in which the intervening variable is the causal link between the independent and dependent variable of interest. In his analysis of the concept, intervening variables are unobserved theoretical constructs, but the term can be applied just as well to observed variables. A major point of his paper is that the effect of an independent variable on a dependent variable can be demonstrated to occur through the causal chain of the independent, intervening, and dependent variables. Hence, an intervening variable is an independent variable in its own right. Today, such intervening variables are called mediating variables (Cohen, Cohen, West, & Aiken, 2003).

The well-established positive relationship between religion and health, often reflects, or at least implies, such a chain of causation. For example, numerous studies have found that people that have a religious affiliation



are less likely to have heart disease, and this is especially true for people who belong to The Seventh-Day Adventist Church and The Church of Jesus Christ of Latter-Day Saints (Koenig et al., 2001). A closer look at the association between religious affiliation and heart disease reveals that people who belong to The Seventh-Day Adventist Church and The Church of Jesus Christ of Latter-Day Saints also are less likely to have hypertension (i.e., high blood pressure), which can lead to heart disease (Koenig et al., 2001). Thus, hypertension appears to mediate the positive association between religious affiliation and heart disease. We can extend the chain of causation to identify intervening variables that may mediate the connection between religious affiliation and reduced blood pressure.

Ellison and Levin (1998) present a comprehensive review of why denominational differences and other aspects of religion mediate the effects of religion on health. Some of these entail proscriptions against certain kinds of behavior, such as prohibitions against drinking alcohol and coffee by the Latter-Day Saints and Seventh-Day Adventist Churches, which are risk factors for hypertension. Other aspects of religious affiliation also mediate the relationship between religion and health, including the salutary effects of social support provided by religious congregations that reduce the stress associated with illness and disease (Ellison & Levin, 1998).

Moderating variables alter the strength of association (and possibly the direction of association) between independent and dependent variables (Cohen et al., 2003). A comparison of two related studies will help to demonstrate this point. Both studies analyzed survey data from the same sample of American adults. The first study examined the relationship between mental health and spiritual struggles, that is, feeling alienated from God (McConnell, Pargament, Ellison, & Flannelly, 2006). After statistically controlling for age, education, gender, income, race, social support, strength of religious identity, and the frequency of praying and attending religious services, McConnell et al. (2006) found, as hypothesized, that the spiritual struggles were associated with higher levels of anxiety and depression. While prayer also was positively related to anxiety and depression, the strength of religious identity and attending services were unrelated to either anxiety or depression. The second study hypothesized that the association of spiritual struggles with anxiety and depression would be moderated by the strength of a person's religious identity (Ellison, Fang, Flannelly, & Steckler, 2013), and this proved to be the case. Controlling for the same variables analyzed in the first study (McConnell et al., 2006), the second study found that strength of religious identity moderated the association between spiritual struggles and both anxiety and depression. That is, symptoms of depression and anxiety among individuals with spiritual struggles were higher for individuals who were more religious than for individuals who were less religious. By itself, strength of religious identity had no association with anxiety or depression, yet it moderated (in this case, aggravated) the

adverse association between spiritual struggles and mental health (Ellison et al., 2013).

## CATEGORICAL, DISCRETE, AND CONTINUOUS VARIABLES

All of the previous terms we have discussed thus far have to do with the relationship among variables. These three terms are not about the relationship among variables, but the measurement of variables. The first term, categorical variable, was defined and discussed by Flannelly, Flannelly, and Jankowski (2014) in an earlier paper in this series of articles on *Research Methodology*. Categorical variables present a nominal level of measurement, in which objects or people are classified into categories based on certain characteristics. People, for example, are often classified into categories by their gender, ethnicity, occupation, religious denomination, and, in the healthcare context, as either cases or noncases of disease.

Discrete variables are variables that have two or more values (Ellis, 1998). Hence, categorical variables technically are also discrete variables. It should be noted that variables that only have two values are called dichotomous variables.

More specifically, however, the term discrete refers to the fact that a variable is measured in whole numbers, whereas continuous variables may take on a virtually infinite number of values (Bailey, 1987; Indrayan, 2013). Many discrete variables are measured at the interval level of measurement, in which the points on the scale are separated by equal intervals, but there is no true zero point (see Flannelly et al., 2014). However, discrete variables may also be measured on ratio scales, which have a true zero point. Frequency measures, such as frequency of attending religious services or frequency of visiting a physician are good examples. Many healthcare variables are measured on ratios scales and are continuous variables, for example, age, weight, and blood levels of enzymes.

It is often the case that a variable that has an underlying continuum, may be measured as a discrete variable. For example, age is usually measured as a discrete variable, that is, years of age. It is also common to measure age as a categorical variable for example, infant, child, adolescent, and adult (Ellis, 1998). It is even common in healthcare research to measure age as a dichotomous variable, such as, under 50 years of age, and 50 years of age and older.

## SUMMARY

The present article was written to help readers unfamiliar with research terms to navigate their way through the maze of terminology used to describe the relationships among variables, as well as those used with respect to

measuring variables. Anything that is measured in research is called a variable, and variables broadly fall into two categories: independent variables and dependent variables. The terms treatment, intervention, predictor, and risk factor are essentially synonyms for independent variable, and the terms response variable and outcomes are synonyms for dependent variable. As previously explained, extraneous, nuisance, and confounding variables are terms for a variable that can interfere with the ability to establish relationships between independent and dependent variables, and, therefore, different methods have been developed to control for them. On the other hand, although intervening, mediating, and moderating variables alter the relationship between independent and dependent variables, they help to explain the causal relationship between them. The final section tied together some terminology applied to the measurement of variables with the concept of levels of measurement in research.

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