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Mediation analysis in nursing research: a methodological review

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Abstract

Mediation statistical models help clarify the relationship between independent predictor variables and dependent outcomes of interest by assessing the impact of third variables. This type of statistical analysis is applicable for many clinical nursing research questions, yet its use within nursing remains low. Indeed, mediational analyses may help nurse researchers develop more effective and accurate prevention and treatment programs as well as help bridge the gap between scientific knowledge and clinical practice. In addition, this statistical approach allows nurse researchers to ask – and answer – more meaningful and nuanced questions that extend beyond merely determining whether an outcome occurs. Therefore, the goal of this paper is to provide a brief tutorial on the use of mediational analyses in clinical nursing research by briefly introducing the technique and, through selected empirical examples from the nursing literature, demonstrating its applicability in advancing nursing science.

Keywords

mediation; mediator; methodological review

Introduction

Nursing research is multifaceted and includes understanding of both biological and psychosocial processes. For instance, among the goals of the National Institute of Nursing Research is to facilitate better understanding of health promotion, disease prevention, enhancement of quality of life and interrelationships between biological and behavioural processes (NINR, 2010). To achieve these goals, however, advanced statistical methods such as mediation analysis may help nurse researchers clarify important relationships between and among variables and outcomes of importance to patient care. In fact, Krause et al. (2010) recently noted that use of mediation as statistical methods in the nursing literature has been fairly low.

Mediation models are particularly important for understanding underlying mechanisms accounting for the relationship between a predictor on an outcome. These approaches allow researchers to ask – and answer – more meaningful and nuanced questions that extend

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beyond merely determining whether an outcome occurs. Moreover, mediation allows us to understand how and why it occurs (Liu, 2011). The goal of this paper is to help readers better understand what mediation analysis is and how it has been used in nursing research. Mediation has been described in the nursing literature by several authors (Bennett, 2000; Jasti, Dudley, & Goldwater, 2008; Krause et al., 2010; Levy, Landerman, & Davis, 2011; Lindley & Walker, 1993; Mahon, Yarcheski, & Yarcheski, 1998), but this article provides a slightly expanded tutorial by including a description of how mediation differs from other commonly used statistical approaches. Second, while the previously published papers include important discussions of mediation from a theoretical and conceptual perspective, the current paper takes a different approach by focusing more on its application and demonstrating the use of mediation in a variety of research designs. To accomplish this, we included selection of articles published in several notable journals related to the field of nursing to further illustrate application of mediation. It is important to note that this paper is not a systematic review of all databases and relevant publications and systematic literature search of all databases was not conducted. Rather, these articles were included based on their relevancy and specifically for the purpose of illustrating examples of how mediation analyses have been used in nursing research. Thus, the goal of this paper is to provide basic education on the use of mediation in order to stimulate greater use of these techniques by nursing researchers.

What are mediator variables?

A mediating variable is a qualitative or quantitative variable that accounts for the relationship between a predictor and an outcome. It is sometimes termed an intervening variable. A mediator may fully account for this relationship (full mediation), or it may only account for the relationship to a limited degree (partial mediation). Therefore, a mediator helps explain why the relationship between the two variables is present (Liu, 2004a, 2011). Assuming a three-variable system, the role of a mediating variable can be shown in Figure 1. This model demonstrates the causal chain involved with a mediating variable. There are two paths that lead to the outcome (dependent) variable: the direct effect of the independent variable on the dependent variable (Path C) and the effect on the dependent variable from the mediating variable (Path B). Also involved is the path connecting the independent variable to the mediator variable (Path A). For example, a previous publication (Liu, Raine, Venables, & Mednick, 2004b) found that low IQ mediated the link between malnutrition assessed at three years of age (predictor) and externalising behaviour at ages eight, 11 and 17 years (outcome). Specifically, the degree of malnutrition in children at age three years positively correlated with the degree of externalising behaviour problems at age 11 years (Path C), and the relationship was mediated by cognitive ability, indicating that malnutrition predisposes children to a lower IQ (Path A), which in turn predisposes them to externalising behaviour problems (Path B). Another example in our longitudinal study involves the link between birth complications and behavioural problems in childhood. In these two cases, cognitive deficit serves as the mediator factor between earlier health risk factors (malnutrition and birth complications) and later outcomes (childhood behaviour problems) (Liu, Raine, Wuerker, Venables, & Mednick, 2009).

According to the pioneering work in mediation models by Baron and Kenny (1986), a variable serves as a mediator variable if the following conditions hold: (1) changes in the independent variable significantly affect the mediating variable (Path A) (e.g., relationship between malnutrition and low IQ); (2) changes in the mediator variable account for variations in the outcome (dependent) variable (Path B) (e.g., relationship between low IQ and externalising behaviour); and (3) a previously significant connection between the independent and dependent variables becomes insignificant when Paths A and B are controlled (e.g., relationship between malnutrition and externalising behaviour). This last condition describes the strength of the mediator variable. If Path C disappears when controlling for Paths A and B, this is a strong indication that the mediator variable is a single and dominant mediator. If Path C is retained, this suggests that there may be multiple mediating factors.

Furthermore, MacKinnon, Fairchild, and Fritz (2007) pointed out that although knowledge of the significance of the relationship between the independent (predictor) and dependent variable (outcome) is vital for the mediation model, it is possible that an overall independent-dependent relationship may not always be significant; however, mediation can exist. Such inconsistent mediation can be found in multiple mediator models where counter-mediation effects exist. Examples for such models can be found in MacKinnon et al. works in 2007.

Why are mediator variables important?

As discussed in the definitions above, mediation models are particularly important for understanding underlying mechanisms accounting for the relationship between a predictor on an outcome. In fact, mediation plays a key role in causal and structural modelling (Baron & Kenny, 1986), which makes understanding mediation a central first step in a researcher's ability to draw inferences about why two variables are related or *how* they are related. In terms of treatment studies, this allows researchers to identify mechanisms of change that explain why an intervention is efficacious. This is especially relevant in intervention studies, where understanding if a given treatment is efficacious is less informative than understanding for which groups or under which conditions it may be effective (Frazier, Tix, & Barron, 2004).

Within biomedicine, including clinical nursing research, mediation analyses are both important for the identification and study of health risk factors for a variety of diseases and conditions. Looking at potential mediator variables allows for the examination of three variables simultaneously. Health risk factors generally do not pose a singular, direct effect on health; rather, they tend to interact with other factors and conditions in multiple ways. For instance, in the Early Health Risk Factor for Violence Model (Liu, 2011), it was argued that while biological and social risk factors may directly predispose to childhood behaviour problems, teenage delinquency and adult violent acts, it is more critical that the mediation effect of brain mechanism account for the relationship between early health factors (biosocial risk factors) and behavioural outcomes. More specifically, malnutrition may not directly affect a patient's mental health but may do so only in the presence of other factors, such as a lack of family support or poor community environment. These other factors must

be fully detailed and examined before the origins of physical and mental health disorders can be completely understood and effective treatment options can be thoroughly designed and implemented. For example, lead exposure, even at low blood lead levels has been associated with decreased cognitive function (e.g., Bellinger, 2008; Liu, Li, Wang, Yan, & Liu, 2013) and increased childhood behaviour problems (e.g., Liu et al., 2014), and it is possible that brain dysfunction reflected by cognitive deficit serves as the mediator for the lead exposure–behaviour relationship.

Given the relevance of mediator variables to biomedical and psychological research, they are also arguably highly relevant to the profession of nursing. Nurses are both physical health professionals as well as psychosocial health professionals. Nursing research covers a vast area that includes the study of biomedicine, pathophysiology and disease treatment, as well as non-physical arenas of quality of life, psychosocial health and patient adjustment. These are nuanced and complex topics, and as nursing researchers are better equipped to disentangle the relationships between important variables of study, they and other healthcare professionals will be better able to develop successful prevention and intervention plans to mitigate the effects of given disorders and outcomes.

How does mediation differ from other commonly used statistical approaches?

One of the most basic and commonly used statistical approaches is the chi-square (χ^2) test. This is used to examine frequencies of discrete (i.e., a limited number) outcomes among two variables. For instance, χ^2 analyses could help answer questions about whether there were significant differences in gender (male vs. female) among a group of children with and without a diagnosis of depression (yes vs. no). Analysis of variance (ANOVA) similarly answers questions about differences between groups, but rather than being limited to discrete variables, ANOVA is used to examine differences between groups (independent variables) based on continuous outcomes (dependent variables). For example, ANOVA could be used to examine whether two groups of children with and without depression differed in scores on an IQ assessment. If the IQ assessment was performed repeatedly on each child at different time points (e.g., once every two years for 10 years), a repeated-measures ANOVA could be utilised to look at differences in multiple outcomes (the repeated IQ test scores) across groups. An even more complex version of ANOVA – the multivariate ANOVA or MANOVA – allows for the examination of several dependent variables at the same time. For instance, depressed and non-depressed children might be compared on IQ test scores as well as family household income.

Like ANOVAs, mediation is interested in the relationship between independent and dependent variables. However, Baron and Kenny (1986) describe mediation as causal analyses; that is, by clarifying the relationships between variables, mediation indicate whether a variable is in fact causing the relationship between an independent variable and dependent variable.

Regression analyses are another type of commonly used statistical analysis that is interested in whether a predictive relationship exists between an independent variable and dependent

variable. When there is more than one independent variable of interest, multiple linear regression is utilised; when there is only one independent variable, simple linear regression is used. When there is one independent variable, but numerous dependent variables, multivariate regression is used. Further, in linear regression, the dependent variable, or outcome, is continuous, whereas a dichotomous outcome uses logistic regression. Continuous dependent variables are those in which the value isn't restricted to a certain limit, such as blood pressure, weight, or age. Dichotomous variables are restricted to a predefined set – such as gender (male or female) or whether a test result is positive or negative. While mediation uses basic regression analyses, it moves beyond the straightforward approach of determining whether an independent variable predicts a dependent variable by including outside variables (i.e., third variables) and assessing the predictive relationship in the context of the third variable.

Conducting mediation analyses

Baron and Kenny's (1986) four-step approach to mediation is among the most widely used and is easily implemented through basic regression analyses. Their approach requires the following:

Step 1: Conduct a simple regression analysis to predict the outcome (Y) from the predictor (X);

Step 2: Conduct a simple regression analysis to predict the mediator (M) from the predictor (X);

Step 3: Conduct a simple regression analysis to predict the outcome (Y) from the mediator (M);

Step 4: Conduct a multiple regression analysis to predict the outcome (Y) from both the predictor (X) and the mediator (M).

Most statistical software can be used to test mediation effect; For example, both SPSS macros and SAS macros are capable of doing this by using syntax. When the data analysis involves more than one independent variable or dependent variable, we can also use Structural Equation Modelling (SEM). There are multiple programs for conducting SEM, for example, Mplus, EQS and Amos, etc.

It is important to note that while Baron and Kenny's four-step method laid the foundation for implementing mediation analysis in regression models, over the years, many researchers have made contributions to improve the method above (which was presented to provide an elementary statistical context of mediation analysis). Most recently, Gelfand, Mensinger, and Tenhave (2009) discusses problems of the Baron and Kenny method regarding association, temporal precedence, the no omitted variables assumption, measurement reliability, and the confirmatory–exploratory distinction. Kraemer, Kiernan, Essex, and Kupfer (2008) discusses the methods by which mediators are defined and assesses the rationale for favouring the MacArthur approach (which modified the Baron and Kenny criteria). For example, the MacArthur definition of a mediator requires that the mediating variable must precede the predictor variable and that the mediator and predictor variable must be independent. Other

discussions which point out problems and alternatives to the Baron and Kenny method can also be found in Hayes (2009) and Zhao, Lynch, and Chen (2010). More comprehensive discussions about the most recent methods to assess mediation effects in statistical analysis can be found in Little, Bovaird, and Card (2007) and MacKinnon (2008). In addition, a recent article by Levy et al. (2011) describes the use of computation of bootstrap sampling distributions in tests of mediation effects and a recently refined method for testing hypotheses about moderated mediation.

The empirical application of mediation models in nursing research

Mediation models can be used for a variety of methodologies and study designs in nursing research. Although some authors suggest that the use of mediation in cross-sectional samples can lead to biased results, others note that these models may be particularly useful for experimental designs and intervention studies, and there is also support for their application in both linear as well as non-parametric designs (Breitborde, Srihari, Pollard, Addington, & Woods, 2010; Cole & Maxwell, 2003; Kraemer, 2008). A selection of nursing-specific studies that have utilised mediation models and can be found in Table 1. This is not an exhaustive list of nursing research using mediation analyses but rather is a reference for readers interested in reviewing further examples. Please note that while this paper only focuses on the discussion of mediation models in nursing research, some of the references in Table 1 also include some discussions of moderation models. While mediation models provide additional information about factors that explain the association between a predictor and an outcome, moderation models provide even more specific information – namely, they describe *the conditions under which* the predictor is associated with an outcome. Moderators explain the strength of the relationship between the predictor variable and the outcome. For instance, the correlation between colon cancer screening and age might be negative only for men but positive for women. Thus, gender is a moderator that influences the strength and direction of effect between age (the predictor) and outcome (undergoing screening). These models are useful when a researcher hypothesises that a third variable is influencing the relationship between a predictor and an outcome in a specific manner (e.g., by strengthening the outcome, weakening the outcome). While moderators affect the nature of the relationship between predictors and outcomes, mediators explain why the relationship between predictors and outcome exists in the first place. In other words, removal of a mediator causes the relationship between the predictor and an outcome to disappear. Thus, in the example above, if removing gender makes the correlation between age and screening no longer significant, gender can be considered a mediator.

In addition to Table 1, below are brief descriptions of other studies (not included in Table 1) specific to both nursing and the biobehavioural literature. These examples are intended to serve as teaching aids to facilitate understanding of how other researchers have used mediation in different research designs. As such, they are intended to give readers a better understanding of the potentially complex relationships between predictors and outcomes and for identifying areas of focus for future interventions in the development of treatment and prevention programs. Utilisation of descriptions from varied methodologies and study designs is especially beneficial for demonstrating the flexibility of mediation models in addressing a wide range of study questions. These summaries should also guide nurse

researchers in developing a more concrete understanding of this statistical approach and its potential utility in future endeavours. Below are examples of mediation analyses using cross-sectional, longitudinal and experimental designs as well as a meta-analysis.

Cross-sectional designs

Riegel and Dickson (2008) studied the mechanism of how social support contributes to success in managing chronic illness. They conducted a secondary data analysis from a cross-sectional study to assess whether self-care confidence mediates the relationship between social support and self-care management. In this study, the sample included 117 patients with heart failure recruited from the heart failure clinic of a large medical centre. The authors hypothesised that there was an association between social support and self-care management in patients with heart failure and this relationship was mediated by self-care confidence.

In order to examine the mediating effect, a linear regression model was used to test the hypothesis. Social support was a significant predictor of self-care confidence. In addition, social support was a significant predictor of self-care management outcomes. Social support and self-care confidence were both statistically significant predictors of self-care management outcomes when entered simultaneously into the same model. Both variables significantly explained 17.8% of the variance in self-care management outcomes ($p = .02$). However, the direct relationship between support and self-care management was no longer significant ($p = .29$) once confidence was removed from the equation, which suggested evidence of confidence providing a mediating effect. As hypothesised, self-care confidence mediated the relationship between social support and self-care management outcomes in patients with heart-failure, which suggested social support influences self-care confidence and therefore improved self-care management outcomes. The authors concluded that social support improves self-care management through improving patients' confidence in their abilities when performing heart failure self-care.

Giurgescu, Penckofer, Maurer, and Bryant (2006) report that women with greater reported levels of psychological distress are at higher risk for pregnancy-related health problems such as preterm delivery, neurodevelopmental delays in children, chronic illness and other negative outcomes. Psychological distress includes feelings of uncertainty regarding the outcomes of the pregnancy, and previous research has found uncertainty is associated with greater risk of pregnancy-related health problems. Social support has been found to positively influence psychological wellbeing and mental health and has demonstrated an effect of reducing psychological distress in high-risk pregnancy populations. Giurgescu et al. (2006) examined whether prenatal coping strategies (e.g., preparing for motherhood, avoidance, using positive interpretations and prayer) mediate the relationship between uncertainty and social support on psychological wellbeing in high-risk pregnant women. The authors hypothesised that uncertainty and social support would both be associated with psychological wellbeing, but that coping strategy would mediate these relationships. They used SEM path analysis to examine responses among 105 women at risk for pregnancy-related health problems.

As hypothesised, women with greater levels of uncertainty were more likely to cope using avoidance and less likely to use positive interpretation. They also reported lower levels of social support and lower psychological wellbeing. Social support was associated with greater use of preparation and positive interpretation and lower use of avoidance as coping mechanisms, and with greater levels of psychological wellbeing. Positive interpretation was related to less distress, less use of avoidance and greater use of preparation. Use of prayer was unrelated to any of the variables in the model. The SEM analyses revealed that the significance of the direct effect of uncertainty on psychological wellbeing was significantly reduced when the indirect effect of avoidance was entered into the model ($p < .01$). In fact, avoidance accounted for 94% of the relationship between uncertainty and psychological distress. Therefore, avoidance was confirmed to be a mediator between the two. However, no other mediator relationships (i.e., between uncertainty or social support and the other coping mechanisms) were found. Implications from these findings concern the development of cognitive and behavioural interventions that specifically target avoidance as a strategy being used by women at risk for pregnancy-related health problems. While these findings do not imply that other coping strategies should be ignored, the fact that avoidance was such a significant mediator among the women with feelings of uncertainty about their pregnancy and impending motherhood can allow nurses to target intervention strategies and specifically focus on teaching these women how to use mechanisms other than avoidance (and perhaps educating them on why avoidance may be counter-productive).

Longitudinal design – one sample cohort

He et al. (2010) utilised a prospective study of two independent cohort samples (i.e., younger and older women) to clarify the relationship among a complex set of health factors. More specifically, they sought to understand the relationship between age of menarche and future risk of developing non-insulin dependent diabetes mellitus (NIDDM). The samples were from two large-scale studies of women (i.e., Nurses Health Study and Nurses Health Study II). Women were enrolled at ages 30 to 55 and 24 to 44, respectively, and have completed questionnaires on a wide variety of health indices every two years. For the purposes of these analyses, He and colleagues examined data collected between 1980 and 2006 for one sample and between 1991 and 2005 for the second. A large number of covariates were examined as possible third variables (i.e., mediators or moderators influencing the relationship between age of menarche and risk of future NIDDM), including dietary factors (e.g., fat intake, glycaemic score), age, weight, smoking status, menopause status, use of oral contraceptives, history of cardiovascular disease and cancer, body mass index, hypertension, cholesterol, level of physical activity, and more.

Regression models with Cox proportional hazards (to estimate relative risk of developing NIDDM) were employed. Results indicated that early menarche (i.e., beginning at or before age 11 years) was associated with a significant increase risk of NIDDM in both older and younger women. However, after adjusting for adult BMI (over the course of the follow-up period), the trend of decreasing relative risk of NIDDM with greater age of menarche ($p < .0001$) was no longer significant ($p = .42$), suggesting that current adult weight may mediate the relationship between early menarche and diabetes risk. These analyses provide important data to help researchers and health practitioners better understand the impact of adult

adiposity on development of diabetes and whether hormonal factors related to onset of menses (e.g., oestrogen) are implicated in the development of NIDDM.

Meta-analysis

Meta-analysis is not a research design but rather a statistical approach. However, the 2009 review article by Dunst and Trivette provides a sound example of how mediation can be used in advanced statistics. The authors conducted a meta-analysis of 15 studies examining the impact of a family-centred healthcare approach and self-efficacy beliefs on parent and child psychological health. Family-centred care is defined as an approach to health care for children and adolescents specifically in which families and providers actively collaborate. The authors report that previous studies have found such an approach is associated with positive health outcomes in families but that its impact on parents and children separately has not been thoroughly examined. The authors hypothesised that family-centred care would impact parent psychological health and child psychological health through self-efficacy.

As hypothesised, Dunst and Trivette (2009) found that family-centred care was indirectly related to parent and child health, family-centred care was directly related to self-efficacy, and that self-efficacy was related directly to parent psychological health and child psychological health. That is, the more family-centred care was used as an approach to health care, the more positive outcomes were documented in both parents and children that reported greater self-efficacy beliefs. The role of belief appraisals as a mediator provides better understanding of previous findings that suggest the family-centred approach to health care can yield positive psychological benefits for families.

Experimental designs

Kotz, Huibers, West, Wesseling, and van Schayck (2009) provides a straightforward, concrete description of their use of mediation methods to better understand the effects of a smoking cessation intervention for patients with chronic obstructive pulmonary disease (COPD). In their study, 228 COPD smokers were assigned to one of two behavioural treatments – confrontational counselling with spirometry versus a conventional health education intervention. The authors sought to specifically examine how confrontation counselling, which uses methods to confront patients with the consequences of their smoking behaviour and challenge erroneous beliefs about their smoking, was effective. They hypothesised that confrontation counselling was related to cessation of smoking due to cognitive factors, such as increased perception of risk for harm, increased health concerns, and decreased use of self-exempting beliefs. Using methods from Baron and Kenny, they tested whether the intervention predicted cessation, whether the intervention predicted the mediators (e.g., the cognitive beliefs), whether the mediator predicted cessation, and the impact of both the intervention and the mediators in predicting cessation. After entering the three mediators in a logistic regression model to predict cessation, they found that the predictive effect of confrontation counselling disappeared (from $p = .06$ to $p = .70$), thus demonstrating ‘perfect mediation’. That is, the mediators (i.e., self-efficacy for successful cessation, expectation of developing a serious disease within 10 years, and self-exempting beliefs) accounted for the entire effect of the intervention on the outcome, and this persisted even after controlling for covariates such as age, sex, education background, previous

attempts at cessation and quality of life. Understanding how components of an intervention contribute to its success can inform the creation of future interventions and ensure that implementation and design of the intervention are carried out to optimise outcomes.

A related, quasi-experimental, repeated measures study (Andrews et al., 2007) examined the impact of a smoking cessation program for women in subsidised housing on smoking cessation for a six-month period. The intervention included group counselling, nicotine replacement therapy and contact with a community health worker to increase social support, self-efficacy, and spiritual wellbeing. The authors hypothesised that these variables (i.e., social support, self-efficacy and spiritual wellbeing) would mediate the effects of the intervention on smoking abstinence. Use of Baron and Kenny methods revealed that use of the intervention was associated with greater reported levels of social support and abstinence at six months. Furthermore, when entered into the model together, social support independently predicted smoking cessation, but the effects of the intervention in predicting cessation were not reduced. Therefore, social support was not found to mediate the effect of the intervention on smoking cessation. Regarding the mediator of smoking self-efficacy, when entered into the predictor model along with the intervention, the independent effects of the intervention became non-significant ($p = .13$), suggesting that self-efficacy did mediate the effects of the intervention on smoking cessation. Finally, spiritual wellbeing was not significantly correlated with the outcome of smoking abstinence at six months; therefore, mediation failed at Step 2 in Baron and Kenny's approach.

Summary: implications for nursing research

Mediating variables are prominent in psychological theory and research (MacKinnon et al., 2007) but also relevant to biomedicine and nursing, as the use of advanced statistical approaches is becoming increasingly important to help answer complex, multi-factorial hypotheses in nursing research (Bennett, 2000; Krause et al., 2010). Included among this is elucidating the presence of third variables that may inform the relationship between a predictor and an outcome. Mediation models can help provide initial insight into the nature of causal relationships, which holds great potential for its application in clinical nursing research in particular. Specifically, mediation analysis is highly informative in the design of intervention trials for assessing whether a treatment affected the outcome it was intended to affect, or whether a third variable (i.e., a mediating or moderating variable) was responsible for the outcome (MacKinnon et al., 2007). This approach would be considerably useful in the design and testing of primary and secondary prevention programs, as mediation also helps clarify why an intervention produced an effect as well as the strength of its effect (Bennett, 2000). While Baron and Kenny's (1986) seminal framework of mediation and moderation have been widely applied in the psychological, social and biomedical sciences, flaws in their approach underscore the need for nursing researchers to extend their knowledge to that of more robust models to improve power and reduce type I error rates (Krause et al., 2010).

Cause-and-effect questions are vital for understanding and developing patient interventions, risk factor and causal risk factor identification, and disease outcomes – alternatively, understanding brain mechanism accounting for the relationship between early health risk

factors (e.g., environmental toxicity or nutrition deficit) and negative behaviour outcomes (Liu, 2011), all of which are highly relevant to healthcare research, patient clinical care, and public health initiatives. MacKinnon and Luecken (2008) opine that among health psychology research – which utilises a biobehavioural approach of concurrently examining biological, psychological, social and behavioural contributors – use of mediation is warranted though still poorly understood and inappropriately applied. Kotz et al. (2009) aptly state in their examination of a smoking cessation treatment that ‘mediation analysis allows us to open up the “black box” that conceals the mechanisms of change in [an] intervention’ (p. 17), underscoring its relevance to experimental designs. And, as Emsley and colleagues further elaborate (Emsley, Dunn, & White, 2010), these methods are particularly useful for complex designs and multiple group data collection that is popular in psychosocial research, where studies focus on more than just learning whether an intervention works but how and why it is effective, and how specific components can be applied to specific populations to maximise effects. By better understanding how mediation is pertinent to these and similar study questions, nursing researchers are primed to develop more meaningful hypotheses, determine more precise answers to those hypotheses, and help bridge the gap between scientific knowledge and clinical practice.

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Figure 1.

Pathways demonstrating mediator effects. The outcome variable results from the direct effect of the predictor variable (Path C) as well as the mediating variable (Path B). Variables mediating the independent variable can also be involved (Path A).

Table 1

Additional references for nursing research demonstrating the use of mediation models.

Reference	Hypothesis/Aims	Variables/Mediators	Statistical analysis	Key findings
Cross-sectional design Mahon, Yarcheski, and Hanks (2007)	To examine the mediating effect of depression and optimism on the relationship between social support and positive health practices in early adolescents	IV: Social support DV: Positive health outcomes Mediator: Depression and optimism	<ul style="list-style-type: none"> - Two mediation models constructed from theory and previous research were tested using regression analysis - Pearson correlations were used to test the hypotheses 	<ul style="list-style-type: none"> - Depression and optimism were partial mediators between social support and positive health practices in early adolescents
Carlson, Pozehl, Hertzog, Zimmerman, and Riegel (2012)	To determine the key predictors of overall perceived health in persons with heart failure and to examine any mediating relationships	IV: Perceived sufficiency of income, social functioning, comorbid burden, symptom stability, race, the interaction of gender and social functioning DV: Overall perceived health Mediator: physical and social functioning	<ul style="list-style-type: none"> - Hierarchical regression analysis was performed to determine the predictors of overall perceived health - Multiple mediation models were constructed to determine the mediating effects of physical and social functioning on the relationship between predictors and overall perceived health 	<ul style="list-style-type: none"> - Perceived sufficiency of income, social functioning, comorbid burden, symptom stability, race, the interaction of gender and social functioning were significant independent predictors of overall perceived health - The effects of shortness of breath and fatigue on overall perceived health were mediated by physical and social functioning
Peters, De Rijk, and Boumans (2009)	To determine if satisfaction with irregular working hours operates as a mediator between work and home characteristics and health problems	IV: Work characteristics, home characteristics, DV: Satisfaction with irregular working hours, health variables Mediator: Satisfaction with irregular working hours	<ul style="list-style-type: none"> - Multiple regression analyses were performed to investigate the relationships between work characteristics, home characteristics, satisfaction with irregular working hours, and health 	<ul style="list-style-type: none"> - Satisfaction with irregular working hours did not mediate work/home characteristics and health - All work characteristics, but not home characteristics, were associated with satisfaction with irregular working hours
Plach, Heidrich, and Waite (2003)	To examine the mediating effects of women's social role quality on the psychological wellbeing of women with rheumatoid arthritis (RA)	IV: Physical health DV: Psychological wellbeing Mediator: Women's social role quality	<ul style="list-style-type: none"> - Functional status and pain were assessed the Arthritis Impact Measurement Scale 2 (AIMS2) - Wellbeing was assessed with two scales measuring distress (anxiety and depression) and three scales assessing psychological wellbeing (self-acceptance, purpose in life and positive relations) 	<ul style="list-style-type: none"> - Women's social role quality mediated the effects of physical health on depression and purpose in life: women in poor health with high role quality were significantly less depressed than women in poor health with poor role quality
Yarcheski, Mahon, and Yarcheski (2001)	To examine the relationship between perceived social support and general wellbeing in early adolescents and to test whether hopefulness and self-	IV: perceived social support DV: general wellbeing Mediator: Hopefulness and self-esteem	<ul style="list-style-type: none"> - Pearson correlations were used to test the hypothesized relationships 	<ul style="list-style-type: none"> - Hopefulness and self-esteem were mediators of the relationship between social support and wellbeing

Reference	Hypothesis/Aims	Variables/Mediators	Statistical analysis	Key findings
Longitudinal design	esteem mediate this relationship		<ul style="list-style-type: none"> Three regression analyses (Baron & Kenny, 1986) were performed for each model 	
	To investigate whether intensive care nurses' efficacy beliefs predict future collaborative practice and whether team commitment is a mediator of this relationship	IV: Efficacy beliefs DV: Future collaborative practice Mediator: Team commitment	Analyses were carried out using SEM to examine pathways between variables over time	<ul style="list-style-type: none"> Baseline self-efficacy predicted follow-up team commitment, and baseline team commitment predicted follow-up collaborative practices Team commitment mediated the relationship between professional efficacy and collaborative practice
	To investigate the relationship between transformational leadership behaviours and employees' sleep quality, and to test whether self-efficacy mediates this relationship	IV: transformational leadership behaviours DV: employees' sleep quality Mediator: self-efficacy	Path models were used to examine the mediating effect of self-efficacy on the relationship between transformational leadership behaviours and employees' sleep quality	<ul style="list-style-type: none"> Training managers in transformational leadership behaviours may have a positive effect on healthcare workers' health over time self-efficacy did not mediate the relationship between employees' sleep quality and transformational leadership behaviours
Experimental design	To investigate the effectiveness of a multi-component smoking cessation intervention in African American women residing in public housing	IV: smoking cessation interventions DV: smoking cessation (whether quit smoking) Mediator: social support, self-efficacy and spiritual wellbeing	Logistic regression was used to determine whether differences in abstinence existed between the intervention and comparison group Modelling methods were used to assess the mediating effects of social support, self-efficacy and spiritual wellbeing	<p>Women who received the Sister to Sister intervention were six times more likely to quit smoking than women who received group attention and minimum self-help written materials</p> <ul style="list-style-type: none"> Self-efficacy mediated the relationship between smoking interventions and intervention
	To estimate relationships between receiving personal knowledge of bone mineral density (gained through DXA scan), general knowledge of osteoporosis, health beliefs, and calcium intake and weight-bearing exercise in healthy postmenopausal women 50 to 65 years	IV: receiving personal knowledge of bone mineral density (gained through DXA scan), general knowledge of osteoporosis, health beliefs DV: calcium intake and weight-bearing exercise Mediator: Susceptibility beliefs	<ul style="list-style-type: none"> Measurement models were performed to assess the relationship between the predictors and calcium intake/weight-bearing exercise and the mediating effect of susceptibility beliefs 	<ul style="list-style-type: none"> Women in the experimental group who were informed they had osteopenia or osteoporosis had a greater change in daily calcium intake than those with normal bone density Susceptibility beliefs partially mediate between DXA results and change in calcium intake

Notes: IV = independent variable; DV = dependent variable.