THE ROLE OF USING IT FEATURES IN NURSING HOME MDS SYSTEMS
AN ANALYTICAL APPROACH OF MEDIATION AND MODERATION

by

Darren Liu

MBA, China Medical University, Taiwan, 1999

BS, Kaohsiung Medical College, Taiwan, 1997

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This thesis was presented

by

Darren Liu

It was defended on

December 8, 2008

and approved by

Nicholas G. Castle, Ph.D., Associate Professor, Department of Health Policy Management, School of Public Health, University of Pittsburgh

Joyce Chang, Ph.D., Associate Professor, School of Medicine, University of Pittsburgh

Thesis Advisor: Ada O. Youk, Ph.D., Research Assistant Professor, Biostatistics, School of Public Health, University of Pittsburgh

Ada O. Youk, Ph.D.

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Darren Liu, M.S.

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ABSTRACT

Mediation analyses are common in the field of psychology or social science research. Mediators are variables that explain the mechanism of action forming the observed relationships between independent and dependent variables. The advantage of testing models is that it helps the researcher to construct the conceptual framework regarding the intercorrelation of variables of interest because pure relationships between independent and dependent variables are usually unlikely.

This thesis was conducted to clarify whether the use of IT in MDS software would possibly influence the relationship between nurse staffing levels and quality of care in nursing homes. Literatures on the concepts of mediation and moderation effects were reviewed and analyses using STATA Sobel-Goodman tests were performed. Variables from three resources were used, including the use of IT in MDS software, three nurse staffing levels (RN, LPN, NA), and nursing home compare quality measures.

Results of the Sobel-Goodman test indicated the indirect path for the use of IT was statistically significant in all cases of nurse staffing levels, and the tests of moderation effects showed the use of IT was a statistically significant moderator.

Studies in this area can be further enhanced by taking into account more associated variables and by using extensive statistical mediation analysis. The public health importance for the present study is that it provides researchers with more information not only about the scientific evidences for exploring possible mediating variable effect from previous literatures but also about the statistical procedures for examining the statistical significance of an mediating effect.

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1.0 INTRODUCTION

While there is considerable information technology (IT) interest and quality relevance, little attention has been paid to the role of IT usage between nurse staffing levels and nursing home quality of care. To address this gap, we hypothesize three domains: IT, nurse staffing levels, and quality of care are correlated. Specifically, we expect that the relationship between nurse staffing levels and quality of care will be explained by including an additional variable (i.e., the use of IT). Although the identification of this relationship is obvious, the conceptualization or the association among each domain is not. The current literature addresses each of the three domains (i.e., quality of care, nurse staffing levels, the use of IT) individually. There are no studies to our knowledge that discuss the correlation among them.

1.1 STATEMENT OF THE PROBLEM

This study aims to determine the mechanism relating the use of IT in commercial Minimum Data Set (MDS) software, the nurse staffing levels, and the quality of nursing home care by using statistical mediation and moderation modeling. The specific objective is to estimate the effect of nurse staffing levels on nursing home quality of care that is mediated by the use of IT.

Data built on a previous work has recommended the use of IT in nursing homes for better quality of care. This study reported the results of quantitative data analyses based on the methods of testing mediation and moderation effects developed by Baron and Kenny (1986). The moderating and mediating effects were introduced following by the reviews of the methods. The results were also demonstrated using STATA procedures.

Specifically, this study was to address two research questions:

a) Does nurse staffing levels *mediate* "the use of IT" and "quality of care" relationship;

b) Does nurse staffing levels *moderate* "the use of IT" and "quality of care" relationship.

2.0 BACKGROUND

Many nursing homes have decided to use MDS software for resident assessments and electronically transmitting information as required by the states and federal government. Although the use of IT is still not ubiquitous throughout the U.S. health care system, many nursing homes have adopted some of the IT features in commercial MDS software. Some researchers have suggested that the uses of IT have potential to save time, improve quality of care, etc, while others have argued that the newly interested use of IT could have deleterious effects on nurse staffing levels and quality of care in nursing homes.

2.1 QUALITY OF CARE VS. NURSE STAFFING LEVELS

The quality of care is considered to be "something of a mystery" (Donabedian, 1988). It is being studied more frequently because the poor quality has long plagued the nursing home industry. Consequently, the literature on nursing home quality versus the factors to influence the quality is voluminous. To date, nurse-staffing levels have been of increasing concern because of the facilities' expenditures related to the quality they furnish. Some recent studies have demonstrated an association between nurse staffing levels and quality of care within nursing homes (Castle, 2008). A recent study from the General Accounting Office (GAO) found that nursing homes

providing more nursing hours per resident day were less likely to have had repeated serious or potentially life-threatening quality problems(GAO, 2002).

Other studies have also found an association between the higher level of nurse staffing and the better quality of care (Konetzska, Stearns, & Park, 2007; Schnelle et al., 2004), as well as the association between fewer registered nurse and nursing assistant hours and more nursing home deficiencies (Harrington, Zimmerman, Karon, Robinson, & Beutel, 2000). These findings have identified nurse staffing levels as one of many staff characteristics that may influence nursing home quality and should be taken into account in order to improve the quality of nursing homes (Castle & Engberg, 2007).

2.2 QUALITY OF CARE VS. IT

"Too Err Is Human", an often-cited report, has focused on many issues regarding health care quality and concluded that medical errors have became a vexing problem in health care (Institute of Medicine, 2000). More and more health care researchers have recommended the use of IT for reducing the frequency and consequences of these errors (Bates et al., 2001; Bates et al., 2003; Bates et al., 1999). For example, they advocated expanding the use of IT within the facility for achieving a better quality by reducing adverse drug events.

While some have suggested IT as having the potential to greatly improve the quality of health care (Ortiz & Clancy, 2003; Weiner et al., 2003), the evidence regarding the impact of IT on quality outcomes remains limited. Also, the degree to which IT affects quality of care in a nursing home is unknown.

2.3 IT VS. NURSE STAFFING LEVELS

A survey from the American Hospital Association found that about 50% of a nurses' hours were spent on routine paperwork in nursing homes, which has been a concern as the most serious problems in nursing homes (American Hospital Association, 2001). The use of IT in nursing homes could save nurse' hours while also improving the quality of care. For example, a recent study has found that the more use of advanced IT features in MDS software the better the quality of nursing home care as measured by nursing home compare quality measures (i.e., QMs). (Liu & Castle, 2008).

Increasing nurses staffing levels could minimize turnover rates by reducing burnout and job dissatisfaction, which are major precursors of job resignation. This in turn may induce more use of IT because the high nurse retention makes them more familiar with and willing to use the facility's IT. The impact of nurse staffing on nursing home quality suggests that by investing in nurse staffing, nursing home may increase both IT usage and quality of care.

2.4 CONCEPTUAL FRAMEWORK

Definitions, statistical reasons and a brief overview for mediation and moderation analyses are summarized in this section. The literature overview emphasized methods that are often used and discussed in studying psychological processes. The classic framework for mediation and moderation analysis was derived from the social/behavioral research methods by which psychologists often used to test whether and to what extent one variable affects another (Baron & Kenny, 1986).

2.4.1 Definitions

2.4.1.1 Mediation

Baron and Kenny (1986), which highlights the basic mediation modeling, has been used extensively to determine whether there is a variable (mediator) that mediates the effect of the relationship of an independent variable upon the dependent variable. A mediator is a variable that accounts for the relationship between the predictor and the criterion. It can also be referred to as a variable that occurs in a causal pathway from an independent variable to a dependent variable. A mediator causes variation in the dependent variable and itself is caused to vary by the independent variable (Last, 2000). Sobel (1990) defined a mediator to be a variable in a chain whereby an independent variable causes the mediator, which in turn causes the outcome variable. For example, Figure 1 shows the independent variable (IV) as described in this study, *nurses staffing levels,* and the dependent variable (DV) is *quality of care*. Mediator variable (i.e., *the use of IT*) is the factor mediating the effect of IV on DV.

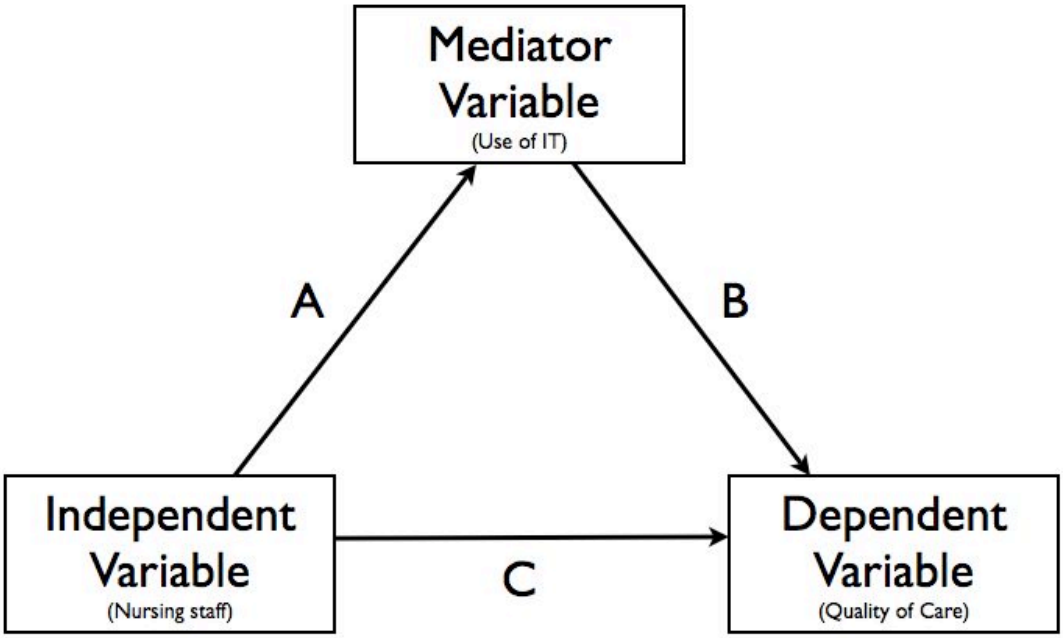

Figure 1. A conceptual model of mediation

In Figure 1, path C refers to a simple relationship between IV and DV, which is usually referred to as the *total effect* of IV on DV. However, the nature of the relationship can be more complicated then what we expect. For example, there may be more than one IV (e.g., IV_1 and IV_2) to predict DV, thus there are more ways to explain the nature of the underlying model. That is, we will need to answer the question: if one could use IV_1 and/ or IV_2 to predict DV, which pathway would yield the greatest potency? Would it be IV_1 alone, IV_2 alone, or the combinations of IV_1 and IV_2?

In order to answer these questions, many researchers have provided a variety of methods for testing these relationships. For example, Baron and Kenny (1986) outlined the procedures that guide the analyses of mediation. They suggested three assumptions to be held for using the

meditational model (Baron & Kenny, 1986), which has been one of the most popular approaches employed by many researchers. MacKinnon et al. (2002) indicated that the main purpose of using the causal steps methods was to establish the conditions for mediation rather than a statistical test of the indirect effect. To test these assumptions, one has to demonstrate that the correlation between the independent and dependent variable is significant then, demonstrate that the correlation between the independent variable and mediator is significant. In summary, all three statements in the following should be hold:

(1) The independent variable must affect the mediator.

(2) The independent variable must affect the outcome variable.

(3) The mediator must affect the dependent variable.

In addition, other methods are also available to test the mediation effects. MacKinnon et al. (2002) provided a comprehensive review of 14 different methods that have been proposed for testing these effects. They grouped the currently available methods into three general approaches according to the proposed methods to assess intervening variable effects. For example, *causal steps* refer to tests of different logical relations among the three variables involved. All three steps must be true for the basic mediating variable. *Differences in coefficients* were to comparing the relation between the independent variable and the dependent variable before and after adjustment for the mediating variable. *Product of coefficients* is an approach to test the significance of the mediating variable effect by dividing the estimate of the mediating variable effect by its standard error and comparing this value to a standard normal distribution.

In this study, the discussion is limited to the methods of *causal steps* and *product of coefficients* because these approaches are by far the most common type of mediation model discussed.

2.4.1.2 Moderation

In addition to mediation, researchers described moderation by arguing that the social support literature had underestimated the role of social support as a moderator of the adjustment to a stressful relationship(Cohen & Wills, 1985). This construct is shown in Figure 2. In general, a given variable may function as a moderator because it affects the strength of a relationship between two other variable. Thus, a moderator may be considered as "a variable exhibiting statistical interaction by virtue of its being antecedent or intermediate in the causal process under study"(Last, 2000). In regression modeling, such a model is said to have an *interaction* between two independent variables. That is, moderators are variables that cause interaction.

The concept of interaction can be addressed by including the product terms in the regression models. In Figure 2, the causal effect of independent variable (D) on the dependent variable differs according to the level of the interaction effect (F).

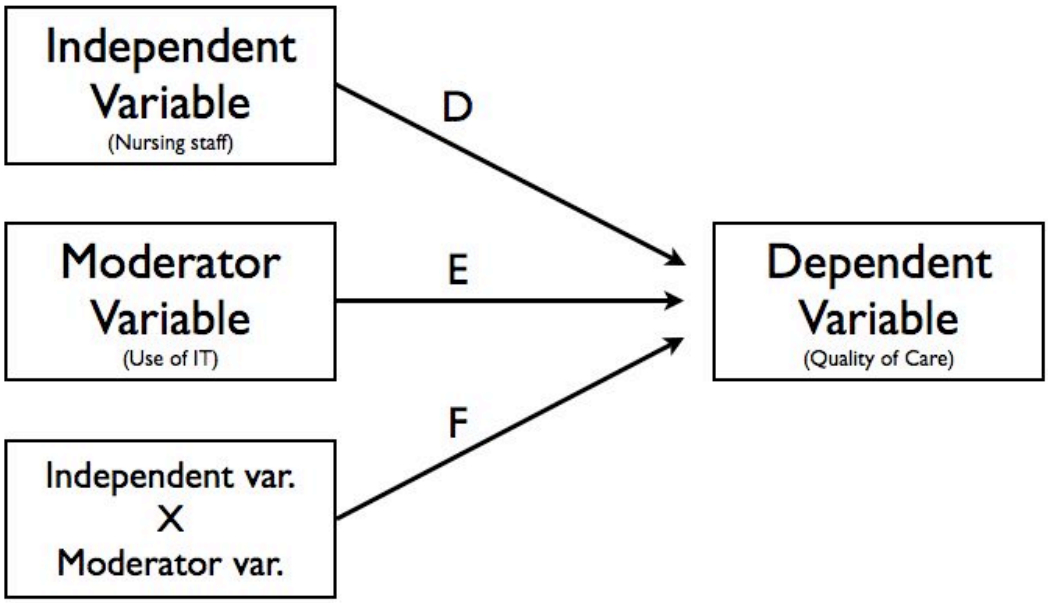

Figure 2. A conceptual model of moderation

2.4.2 Model Specification

This section describes the relationship among variables and uses general models to describe both mediate and moderate effects. Multivariate normal distributions are assumed and all error terms are normally distributed. Methods based on Baron & Kenny's approach (1986) are used. Similar methods can be found in MacKinnon et al. (1995).

2.4.2.1 Mediate & Moderate Effects

The mediated and moderated effects of this study can be expressed in the following functional equations:

$$QM = \lambda_0 + \lambda_1 \cdot STAF + \lambda_2 \cdot IT + \lambda_3 \cdot (IT \times STAF) + \varepsilon_1 \quad (1)$$

$$IT = \beta_0 + \beta_1 \cdot STAF + \varepsilon_2 \quad (2)$$

Where

QM	= summary score of nursing home quality of care
IT	= the use of information technology
STAF	= nurse staffing levels such as RN, LPN, and NA
IT×STAF	= the interaction of IT and nurse staffing levels
λ_0	= intercept of the regression model
λ_1 , λ_2 , λ_3	= slope of the regression model
β_0	= intercept of the regression model
β_1	= slope of the regression model
ε_1	= random error component of the regression model
ε_2	= random error component of the regression model

To solve the mediated function, both equations (1) and (2) are differentiated by STAF, which gives:

$$\frac{\partial QM}{\partial STAF} = \lambda_1 + \lambda_3 \cdot IT + \lambda_2 \cdot \left(\frac{\partial IT}{\partial STAF}\right)$$

$$= \lambda_1 + \lambda_3 \cdot IT + \lambda_2 \cdot \beta_1 \quad (3)$$

$$\frac{\partial IT}{\partial STAF} = \beta_1 \quad (4)$$

Both the mediated and moderated effects can be explained by specifying each component in Equation 3. That is:

For mediated effect:

$\lambda_2\beta_1 \neq 0, \lambda_3 = 0, \quad \lambda_1 = 0$ when direct effect is present.

$\lambda_2\beta_1 \neq 0, \lambda_3 = 0, \quad \lambda_1 \neq 0$ when indirect effect is present.

For moderated effect:

$\lambda_1 \neq 0,\ \lambda_2 \neq 0,\ \lambda_3 \neq 0,\ \beta_1 = 0$ when direct effect is present.

$\lambda_1 \neq 0,\ \lambda_2 \neq 0,\ \lambda_3 \neq 0,\ \beta_1 \neq 0$ when moderated-mediate effect is present.

It should be noted that this method involves the estimation of two regression equations. First, the coefficient in the model associated with the mediator and moderator to the outcome variable is estimated (i.e., $\lambda_2\beta_1$ and λ_3 in Equation 3, respectively). Second, the coefficient associated with the predictor to the mediating variable is β_1. In this study, Equation 2 shows that the nurse staffing levels are mediator outcome variable with β_0 as the intercept and IT is the predictor and ε_2 is the error term. In addition, the presented equations also show both direct and indirect associations on the effect of the use of IT. For example, the product of $\lambda_2\beta_1$ in Equation 3 is the mediated effect with $\lambda_1 = 0$ when the effect of the use of IT *directly mediated* the quality of care whereas the mediated effect with $\lambda_1 \neq 0$ when the effect *indirectly mediated (i.e., partially mediated)* the quality of care. Moreover, the moderated effects occur if λ_1 , λ_2 , $\lambda_3 \neq 0$. The effects can be presented in the form of *directly moderated* and *mediated-moderated*, with coefficient $\beta_1 = 0$ or $\beta_1 \neq 0$, respectively.

2.4.2.2 Tests for a mediating effect

To test the mediating effect in *causal steps*, one can compute a coefficient for the "indirect effect" of the independent variable on dependent variable through the mediator by

multiplying the coefficient for the path independent variable (IV) –mediator by the coefficient for path mediator—dependent variable (DV). According to the *causal steps* assumptions (Baron & Kenny, 1986), three regression equations were used to test for a mediating effect of the triad. In this study (Figure 1), the first step is to test whether staffing levels (IV) would influence the use of IT (Mediator). That is, demonstrate that the zero-order correlation between staffing levels and the use of IT (ignoring quality of care) is statistically significant. The second step is to test whether staffing levels (IV) would influence the quality of care (DV). That is, demonstrate that the zero-order correlation between staffing levels and quality of care (ignoring the use of IT) is significant. The third step is to test whether the use of IT (Mediator) would influence quality of care (DV). That is to conduct a multiple regression analysis, predicting quality of care from the use of IT and the staffing levels. In this case, the partial effect of *the use of IT* (controlling for staffing levels) must be significant.

There is one principal version of the "Sobel test" and two principal version of the "Goodman test" as computed in STATA. The differences among those three test are that: the Sobel test equation omits the third term of the variance estimate (i.e., $\sigma_a^2\sigma_b^2$) in the denominator while the other two either adds or subtracts the third term.

In Figure 3, let c denote the coefficient of the direct effect, and the path coefficients a, b, and c' are estimated by fitting two linear regression models as shown in Equation (6) and (7)

Model 1: $Y = c_0 + cX + \varepsilon_1$ (5)

Model 2: $M = a_0 + aX + \varepsilon_2$ (6)

Model 3: $Y = b_0 + c'X + bM + \varepsilon_3$ (7)

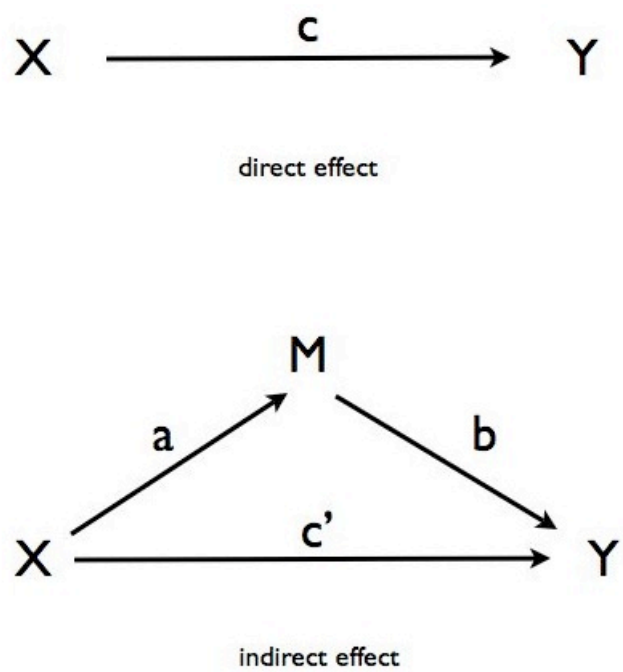

Figure 3. Mediation model

The *Sobel-Goodman test* in STATA involves dividing the effect of mediation by its standard error to arrive at a z-score that is used to compute the p value. The formulae for the tests are as follows (also refer to Figure 3):

The amount of mediation = $c - c' = ab$ (8)

Test statistic = $\dfrac{c - c'}{\sigma_{c-c'}} = \dfrac{ab}{\sigma_{ab}}$ = Z - statistic (9)

Where,

$$\sigma_{ab} = \sqrt{\sigma_b^2 a^2 + \sigma_a^2 b^2} \qquad \text{Sobel test} \qquad (10)$$

$$\sigma_{ab} = \sqrt{\sigma_b^2 a^2 + \sigma_a^2 b^2 + \sigma_b^2 \sigma_a^2} \qquad \text{Goodman I test} \qquad (11)$$

$$\sigma_{ab} = \sqrt{\sigma_b^2 a^2 + \sigma_a^2 b^2 - \sigma_b^2 \sigma_a^2} \qquad \text{Goodman II test} \qquad (12)$$

This approach is based on the *product of coefficients* (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). That is, test the significance of the mediating variable effect by dividing the estimate of the mediating variable effect (i.e., *ab*) by its standard error and compare this value to a standard normal distribution. The statistical techniques for testing a mediating effect were built on the works from Sobel (1982), Aroian (1944) and Goodman (1960).

The tests are computed when the mediator and outcome are measured on a *continuous level*. For a *binary outcome*, the test is more complicated since the scale in logistic regression is not constant across models as is the case with linear regression(MacKinnon & Dwyer, 1993). Thus, the coefficient estimates cannot be combined from different models as can be seen in Equation (8).

2.4.3 STATA procedures for the estimation

There is substantial literature providing SAS or SPSS procedures (Dudley, Benuzillo, & Carrico, 2004; Jasti, Dudley, & Goldwater, 2008; Preacher & Hayes, 2004) as well as online version easy-to-use calculator (e.g., http://www.danielsoper.com/statcalc/calc31.aspx) for estimating mediation. However, the literature for estimating mediation using STATA is sparse. In this study, the *Sobel-Goodman mediation tests* in Stata SE/10.1 (StataCorp, College Station, TX) were used to estimate indirect effects.

The *Sobel-Goodman tests* (i.e., **sgmediation**) found in STATA are based on the *causal steps estimation* and the *product of coefficients estimation*. These tests can be used to test the extent to which a mediator carries the influence of an independent variable to a dependent variable. The tests present three causal steps regression models as well as Sobel-Goodman

mediation tests with detailed information of percent of total effect that is mediated and ratio of indirect to direct effect.

3.0 METHODS

3.1 DATA SOURCES

The data for this study was drawn from three sources: (1) A nursing home IT survey conducted in early 2005 to collect information regarding the use of nursing home IT in 2004; (2) Nursing home compare quality measures (QMs) downloaded from Nursing Home Compare website (i.e., http://www.medicare.gov/NHCompare/); and (3) nursing home characteristics data from 2004 On-line Survey, Certification and Reporting (OSCAR) system.

Participants were nursing home administrators of the surveyed nursing homes. The original sample consisted of 4,000 nursing homes randomly sampled according to its market area (i.e., county) unemployment rates (Liu, 2008). We applied this approach as a sampling frame because the previous data-collection initiatives used staffing level variations (i.e., county unemployment rates) to select facilities. More complete details of this approach are provided by Liu *et al.*(2008). Nursing homes with small bed size (i.e., less than 30 beds) and those who did not have complete data on the relevant measures were eliminated, resulting in a sample of 2,397 (i.e., 72.5%) participants.

3.2 MEASURES

Use of IT. In this study, *Use of IT* served as the mediator variable. We focused on variables related to resident care and refined the variables into 12 explicit items (table 3). These features were selected because they were available to most commercial MDS software and were considered the most significant IT features for resident care. One feature relating to "financial management system" was included because the financial aspect has been considered an important concern in long-term care facilities (Poon et al., 2006). All items used a score of 1 to 10 to represent frequency of use, assigning 1 for minimum usage (i.e., not at all use) and 10 for maximum usage (i.e., use all of the time). Finally, an aggregate measure was created to indicate the complexity of use: *Number of features used all the time (0 to 12)*. This is a continuous variable by counting the number of features used all the time by a facility (i.e., rating 10 on the scale as described in the Data Source section).

Quality of Care. A summary score of 14 quality measures was used as a measure of quality of nursing home care. The 14 quality measures (QMs) were downloaded from 2004 Nursing Home Compare website (i.e., http://www.medicare.gov/NHCompare/). The QMs of a nursing home are numerous and reflect the quality of care among the residents such as decline in functional status or prevalence of severe pain and pressure ulcers.

Nurse Staffing levels. There have been multiple definitions of nursing staffing used for investigating the relationship of nurse staffing and quality of care. For example, Spector and Takada (Spector & Takada, 1991) used nurse hours (also called RN hours) to study facility quality measures. Harrington et al. (Harrington et al., 2000) used nursing staff hours per staff day for investigating nursing home deficiencies. Nyman (1988) utilized nurse hours per patient day to study its relationship to facility quality measures. Moreover, Schnelle and colleagues

(Schnelle et al., 2004) have measured nurse staffing as direct care hours per resident per day (hprd) to study the relationship between staffing and the implementation of daily care processes that reflect quality of care. Another study used number of registered nurse full-time equivalents (FTEs) to measuring staffing level such as (Castle, Engberg, & Men, 2007). FTE is a measure for a worker's involvement in work. FTE is defined as the number of total hours worked divided by the maximum number of compensable hours in a work year. This study used FTEs to measure nurses staffing levels. This measure is more comprehensive and commonly used by many studies in measuring nurse staffing. Three nurses staffing measures were calculated including the means of registered nurses (RN), licensed practical nurse (LPN), and nurse aides (NA).

3.3 ANALYTIC STRATEGY

In this study, we used *Sobel-Goodman tests* (**sgmediation** in STATA/SE 10.1) to test mediation effect of IT in the staffing levels-outcome relationship. These tests followed the procedures set forth by Baron and Kenny (1986) and the most commonly used standard errors in approximate formula based on methods derived by Sobel (1982), Aroian (1944), and Goodman (1960).

4.0 RESULTS

4.1 DESCRIPTIVE ANALYSES

Table 1 shows this sample consisted of 58.6% male and 41.4% female. The average age of participants was 49.5, and 3.9% of participants were minority (i.e., black or other races). The average year as an administrator at the current facility is 12.6 year. The distribution of the education background for the participants was as follows: 2.7% with high school, 9.9% with associate degree, 36.1% with bachelors, and 51.3% with masters or higher degree. 58.9% of them had professional membership.

Table 1. Demographic Characteristics of the Participants (n=2397)

Variables	Groups	Frequency	%
Age (years)	26 - 40	522	21.8
	41 - 50	673	28.1
	51 - 60	831	34.6
	60 and above	371	15.5
Gender	Female	1001	41.8
	Male	1396	58.2
Education	High school	65	2.7
	Associates degrees	238	9.9
	Bachelors	864	36.1
	Masters or higher	1230	51.3
Professional Membership	Yes	1411	58.9
	No	986	41.1
Tenure (years)	Less than 5	530	18.3
	5 - 9	491	16.9
	10 - 14	817	28.2
	15 - 19	495	17.1
	20 or more	566	19.5

Table 2 displays the demographic characteristics of the summary score of QMs, the number of IT used all the time, and nurse staffing levels. The mean QM was 92.69, with the range from 16.50 to 134.25. The mean number of IT used all the time was 4.17, with the range from 0 to 12. The mean FTE of registered nurses was 20.76, with the range from 5.25 to 38.14. The mean FTE of licensed practical nurses was 20.34, with the range from 5.50 to 30.48. The mean FTE of nurse aides was 31.51, with the range from 6.19 to 90.35.

Table 2. Demographic Characteristics of the Facilities (n=2397)

Variables	N	Mean	Std. Dev.	Min	Max
QMs	2397	92.69	20.32	16.50	134.25
IT_numall*	2397	4.17	4.75	0	12
FTEs RN staff	2397	20.76	6.02	5.25	38.14
FTEs LPN staff	2397	20.34	4.16	5.50	30.48
FTEs NA staff	2397	31.51	10.21	6.19	90.35

NOTE. *Number of IT use all the time

4.2 MEDIATING MODELS

The regression results in Table 3 show the total effect of staffing on QM. The total effect is 1.14 (Equation 5), which means that the quality measures are 1.14, 1.01, and .38 increments for each unit of FTE of RN, LPN, and NA, respectively. All three staffing levels in this step were statistically significant in the model and thus met the second assumption of Baron & Kenny (1986).

Table 3. Model with DV regressed on IV

$QM = \alpha_0 + \alpha_1 \bullet Staffing + \mathscr{E}_i$					
Types of Staffing	α_0	α_1	95% C.I. (α_1)	p-value (α_1)	Criteria met
RN Staff	68.85	1.14	1.01 – 1.27	***	Yes
LPN Staff	71.87	1.01	.82 – 1.21	***	Yes
NA Staff	80.41	0.38	.30 – .46	***	Yes

NOTE. *p<.05; **p<.005; ***p<.001

The regression results in Table 4 show the total effect of staffing on IT. The total effect is -.16, -.07, and -.04 for RN, LPN, and NA staffing levels, respectively (Equation 6), which means that the quality measures are .16, .07, and .04 reductions for each unit of FTE of RN, LPN, and NA, respectively. All three types of staffing level in this step were statistically significant in the model and thus met the second assumption of Baron & Kenny (1986).

Table 4. Model with mediator regressed on IV

$$IT = \beta_0 + \beta_1 \bullet \text{Staffing} + \mathscr{E}_i$$

Types of Staffing	β_0	β_1	95% C.I. (λ_1)	p-value (λ_1)	Criteria met
RN Staff	7.43	-0.16	-.19 — -.13	***	Yes
LPN Staff	5.53	-0.07	-.11 — -.02	**	Yes
NA Staff	5.57	-0.04	-.06 — -.03	***	Yes

NOTE. *p<.05; **p<.005; ***p<.001

Table 5 shows the effect of IT on QM controlling for staffing level. As noted previously this was to test the last step in Baron & Kenny's causal steps assumption, in which the mediator (i.e., IT) must affect the dependent variable while controlling for the independent variable (i.e., staffing). In this step, all three types of staffing level were statistically significant in the model and thus met the third assumption of Baron & Kenny (1986).

Table 5. Model with DV regressed on mediator and IV

$$QM = \lambda_0 + \lambda_1 \bullet IT + \lambda_2 \bullet Staffing + \mathscr{E}_i$$

Types of Staffing	λ_0	λ_1	λ_2	95% C.I. (λ_1)	p-value (λ_1)	Criteria met
RN Staff	76.99	-1.10	0.97	-1.26 – -.94	***	Yes
LPN Staff	79.04	-1.29	0.93	1.34 – 1.68	***	Yes
NA Staff	87.51	-1.27	0.33	-1.44 – -1.11	***	Yes

NOTE. *p<.05; **p<.005; ***p<.001

Table 6 presents the second part of Sobel-Goodman mediation test using **sgmediation** command in STATA 10/SE. The tests for mediation indicated that all three staffing levels (i.e., LPN, RN, NA) are statistically significantly mediated by the use of IT. In this example, it indicated that the mediation effect of IT was highly significant with approximately 8.6 to 15.2 % of the total effect (of staffing levels on quality of care) being mediated and that the ratios of indirect to direct effect were very small (less than 1).

Table 6. Sobel-Goodman Mediation Test

Staffing	tests	z-statistics	2-tail p-value	%*	Ratio^
RN	Sobel	7.975	0.000	15.15%	0.179
	Goodman-1	7.960	0.000		
	Goodman-2	7.989	0.000		
LPN	Sobel	2.814	0.005	8.59%	0.094
	Goodman-1	2.808	0.005		
	Goodman-2	2.819	0.005		
NA	Sobel	4.753	0.000	13.04%	0.15
	Goodman-1	4.750	0.000		
	Goodman-2	4.756	0.000		

NOTE. *Percent of total effect that is mediated; ^Ratio of indirect to direct effect

4.3 MODERATING MODELS

Table 7 presents results for testing for a moderator, a variable that changes the form of the relation between the independent variable (i.e., IT) and the dependent variable (i.e., QM). If the interaction (i.e., the product of IT and Staffing, ITxStaffing) is statistically significant, the moderating effects are present. If the moderator variable is also a significant predictor of the dependent variable, the moderator variable is called a quasi-moderator (MacKinnon, 2008). If not, it is called a pure moderator. In this study, IT is a quasi-moderator in all cases with each of three types of staffing levels.

Table 7. Model for Moderating effects

$$QM = \Upsilon_0 + \Upsilon_1 \bullet IT + \Upsilon_2 \bullet Staffing + \Upsilon_3 \bullet (IT \times Staffing) + \mathscr{E}_i$$

Types of Staffing	Υ_0	Υ_1	Υ_3	95% C.I. (Υ_3)	p-value (Υ_3)	Criteria met
RN Staff	90.42	-2.64	0.05	.03 ~ .06	***	Yes
LPN Staff	80.91	-3.36	0.11	.07 ~ .14	***	Yes
NA Staff	83.32	-3.93	0.17	.14 ~ .20	***	Yes

NOTE. *p<.05; **p<.005; ***p<.001

5.0 DISCUSSION

In this study, we have applied statistical methods to test a model in which an independent variable (IV) predicts a mediating variable (MV), which in turn predicts the dependent variable (DV). We used a data set built for previous work that has recommended the use of IT in nursing homes for better quality of care. To our knowledge, there is minimal published literature on linking the use of IT to nurses staffing and nursing home quality. This area is complicated because if the nursing staffs do not embrace the use of IT, the adoption of IT may consume more working hours even with higher staffing levels. That is, the higher nurse staffing levels the less IT being used (Table 4). Conventional experiences have indicated that preparing nursing staffs to use a system can be difficult because many of them are still accustomed to the old fashion paper work and the traditional ways to accomplish their task (Byrne, 2008).

The Sobel-Goodman test has the limitation of requiring a normal distribution. Various literatures have shown that the normality assumption is usually violated, especially in small samples, leading to lesser ability to detect true relationships among variables. Bootstraping, however, is a method that can be used to solve this issue by applying statistical methods that make assumptions about the shape of sampling distributions (Shrout & Bolger, 2002).

The results of this study indicated that the used of IT in MDS software might be one pathway whereby nurses staffing levels influence quality of nursing home care. Prospective evaluation of the use of IT, nurse staffing levels, and quality of care is warranted before drawing

conclusions about causal relationships among these variables. Also, the methods presented in this thesis apply only to the case of the simple mediation model as shown in Figure 1. Many extensions to the simple mediation model are possible.

6.0 IMPLICATION

Tests of the mediating effect are useful because they examine processes by which variables are related. In nursing home quality research, such tests are critical for clarification of how other factors correlate with quality of nursing home care. The finding for this study is imperative because it provides researchers with more information about both the conceptual background and the statistical performance of the available procedures for determining the statistical significance of a mediating effect. In addition, it also opens the possibility of the use of IT as a mediation effect to influence the nature of the relation between nurses staffing levels and quality of nursing home care.

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