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Evaluating the Mediators for Self-Efficacy: Two Parallel Mediator Models

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Abstract- The aim of this study is to identify mediator variables for self-efficacy and to introduce parallel multiple mediator model. If there is more than one mediator variable describing the relationship between the variables, a multiple mediator model is used to explain the causal effects. In this study it was aimed to examine the mediators affecting the self-efficacy via two parallel multiple mediator model and to explain the statistical relationship between the variables.

Keywords- *Multiple Mediator, Self-Efficacy, Mediator*

I. INTRODUCTION

The purpose of the mediation analysis is to investigate the relationship between an independent and dependent variables. It is a statistical approach that explores the direct and indirect effects of an independent variable on a dependent variable [1]. Analysis searches to go beyond the question of whether an independent variable causes a change in a dependent variable and the question of whether or not mediator is present. If there is the role of the third variable in the relationship between two variables, there is a mediator in the model. The model takes the name of the simple mediation model when there is only one mediator that describes the relationship between the variables.

A number of studies have been conducted on the relationships of the mediating variables with the dependent and independent variables. These studies have been used especially in psychological researches and changes in the structure of the model have been observed in the presence of the mediator variable. Most of the applied psychological researchers usually conduct studies requiring application of advanced mediation models, such as multiple mediator models [2].

II. PARALLEL MEDIATOR MODEL

In the parallel multiple mediator model, independent variable X is modeled as effecting dependent Y directly as well as indirectly through two or more mediators [3] and it was first introduced by Bollen (1987). In the multiple mediator model there is a condition about the mediator: no mediator causally influences the another. The model described on the basis of structural equation models (SEM) has defined multiple mediator variables based on total and indirect effect definition.

In this study, equations will be given on parallel model with two mediator variables. A statistical diagram of two mediator model can be shown as in Figure 1.

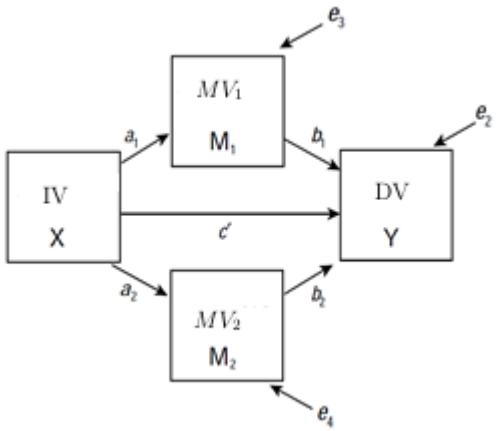

Figure 1. Parallel Mediator Model

In the multiple model if there are two mediator, there are three equations have to solve. These equations are:

$$Y = i_2 + c'X + b_1M_1 + b_2M_2 + e_2 \quad (1)$$

$$M_1 = i_3 + a_1X + e_3 \quad (2)$$

$$M_2 = i_4 + a_2X + e_4 \quad (3)$$

In the equations; Y is dependent variable; X is independent variable; M_1 is first mediator ; M_2 is second mediator; c' is the parameter relating the independent to the dependent variable adjusted for two mediators; b_1 is the parameter relating the first mediator to dependent variable adjusted for the independent variable and second variable; b_2 is the parameter relating the second mediator to dependent variable adjusted for the independent variable and first variable; a_1 is the parameter relating independent variable to the first mediating variable; a_2 is the parameter relating

independent variable to the second mediating variable; $e_2; e_3$ *and* e_4 are error variability and $i_2; i_3$ *and* i_4 are intercepts [1] .

The product of the a_1 and b_1 parameters, a_1b_1 and the product of the a_2 and b_2 parameters, a_2b_2 are the two mediated effects in the model. The effect of X on Y after adjustment for the two mediators; c', is the direct effect just as it was for the single mediator model; thus, $a_1b_1 + a_2b_2 = c - c'$. The total mediated effect, a_1b_1 plus a_2b_2 equals the difference between the *c* and *c′* coefficients, where *c* is the total effect of X on Y, thus $c = c' + a_1b_1 + a_2b_2$. As a result, the total effect *c* can be decomposed into a direct effect, *c′*, and two mediated effects, a_1b_1 and a_2b_2. The causal steps approach can be used to determine whether or not c - c′ represents a mediation effect in the multiple mediation context. Using this approach, the investigator asks whether the paths defining a specific indirect effect are significant [4]. The effects of multiple mediator variables can be tested simultaneously using structural equation models. As a result, different models were introduced. These are moderated mediation [5], sequential multiple mediation [6], nonlinear mediation [7], mediation with categorical X [8], multilevel mediation [9].

A. Confidence Limits for the Two Mediator Model

The confidence limits for the mediated effect can be construct as follows:

$$mediated\ \ effect \pm z_{type\,1error} s_{\hat{a}_1\hat{b}_1 + \hat{a}_2\hat{b}_2} \tag{4}$$

where *z* Type I error is the critical value from the *z* distribution. For 95% confidence limits, the *z* is equal to 1.96. Because the distribution of the product is not always symmetric and is often skewed, these confidence limits can be inaccurate. A more accurate method takes the shape of the distribution of the product into account when the confidence limits are calculated.

The multivariate delta solution for the standard error of the total mediated effect $a_1b_1 + a_2b_2$, is equal to:

$$s_{\hat{a}_1\hat{b}_1 + \hat{a}_2\hat{b}_2} = \sqrt{s^2_{\hat{a}_1^2\hat{b}_1^2} + s^2_{\hat{b}_1^2\hat{a}_1^2} + s^2_{\hat{a}_2^2\hat{b}_2^2} + s^2_{\hat{b}_2^2\hat{a}_2^2} + 2\hat{a}_1\hat{a}_2 s_{\hat{b}_1\hat{b}_2}} \tag{5}$$

where $s_{\hat{b}_1\hat{b}_2}$ the covariance between the $\hat{b}_1$ and $\hat{b}_2$ regression estimates. The standard error of the total mediated effect, $\hat{c} - \hat{c}'$, for the multiple mediator case is equal to the following formula:

$$s_{\hat{c}-\hat{c}'} = \sqrt{s^2_{\hat{c}^2} + s^2_{\hat{c}'^2} - 2r s_{\hat{c}}\, s_{\hat{c}'}} \tag{6}$$

where the covariance between $\hat{c}$ and $\hat{c}'$, $r s_{\hat{c}}\, s_{\hat{c}'}$ is the mean square error divided by the product of the variance of the independent variable and sample size.

Bootstrap method can be used in situations where the observed data were not normally distributed [10]. The large number of estimates of the indirect effect generates a bootstrap distribution. The percentile bootstrap test takes the bootstrap estimates of the indirect effect that subtend to the $\propto/2$ and $(1-\propto/2)$ percentiles of the bootstrap sample distribution to form a $100(1-\propto)\%$ confidence interval. If this confidence interval does not contain zero, mediation is considered to be present.

B. Testing Significance

Indirect (i.e., mediated) effects are distributed normally, we refer to it as the normal theory approach. However, Frazier et al. cited a comparison of methods reporting that the normal theory approach lacks statistical power relative to other methods [11].

The mediated effect can be tested for statistical significance by dividing the estimate of the mediated effect by its standard error. This value compared against a standard normal distribution to test for significance. If the z-score is greater than 1.96 we conclude that the effect is larger than would be expected by chance and calls the effect significant. The standard error can be used to obtain confidence intervals around the mediated effect. On the other hand the confidence interval of the mediated effect does not contain zero, consequently it is said that effect is considered to be significant.

III. MULTIPLE MEDIATORS FOR SELF-EFFICACY

Self efficacy is the extend or strength of one's own ability to complete tasks and reach goals. Psychologists have studied self-efficacy from sevaral perspectives. By this way different models can be established by including psychological variables that affect the self-efficacy. In this study mental-health, stress, depression and anxiety variables were used to evaluate of self-efficacy via multiple mediator model.

In this study the data set collected from the participants living in Istanbul via the questionnaire form of Self-efficacy, the Mental Health and DASS-42 (depression, anxiety and stress scale). Data were obtained from 316 participants. A pen and paper version of the Self-Efficacy Mental Health and DASS-42 were conducted to the each participant who has equal chance to participate in the survey and simple random sampling was used in the sample selection.

All the questionnaires have been tested and the Cronbach alpha values were found 0.92, 0.90 and 0.87 for Self-Efficacy Mental Health and DASS-42 respectively, which exceeded the acceptable level of 0.8 [12]. For all subscales, it can be said that the Cronbah's alpha values were large enough.

The self-efficacy questionnaire has 23 questions. Each question has scored on 5-point Likert scale ranging from 1 to 5. "1" indicates strongly disagree, "2" indicates disagree, "3" indicates undecided, "4" indicates agree and "5" indicates strongly agree. Total scores on the self-efficacy scale are obtained by summing the scores for each item of the scale. The mental health has 14 questions. Each question has rated on 5-point Likert scale. Likert scale type is same as in the self-efficacy questionnaire. Total scores on the mental health scale are obtained by summing the scores for each item of the scale.

DASS questionnaire is composed of three 14-item for each subscales: depression-anxiety and stress. DASS was originally developed for the aim of measuring the distinctive features of depression, anxiety and stress. DASS was advanced to measure the general psychological properties between the three seperate structures. Each item scored on a 4-point Likert scale, ranging from 0 to 3. "0" indicates the symptom "did not apply to me at all" and "3" indicates the symptom "applied to me very much or most of the time" in the questionnaire. Total scores on the DASS-42 are obtained by summing the scores for each item of the scale.

Using the variables two different models were constructed. In the first model; stress is an independent variable; depression and mental health are mediators and self-efficacy is dependent variable. The models were created using "PROCESS" macros in SPSS and "Mediation Package" in R Project. The parallel mediator model for self-efficacy can be visualized as in Figure 2.

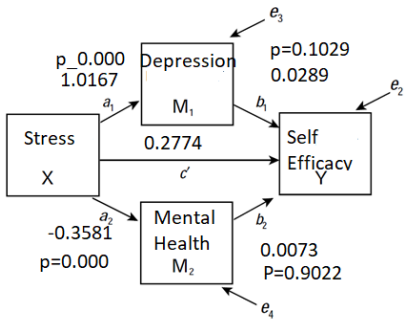

Figure 2. Model 1 for Self-efficacy

Equations for this model can be expressed as follows:

$$\hat{Y} = 55.899 + 0.2774X + 0.0289M_1 + 0.0073M_2$$

$$\hat{M}_1 = 0.062 + 1.0167X$$

$$\hat{M}_2 = 58.859 - 0.3581X$$

In this model the direct effect was obtained as $c' = 0.2774$ with significance $p = 0.000$. As a result of these values, self-efficacy is significantly related to stress. In another words there is a statistically significant relation between the independent and dependent variable. When the positive coefficient of the direct effect is taken into consideration, it is stated that the direction of the relationship is the same. In addition the significance of the relationship between the independent variable and the mediator variables can be evaluated by looking at the "p" values of the coefficients a_1 and a_2. $a_1 = 1.0167$ with $p = 0.000$ and $a_2 = -0.3581$ with $p = 0.000$ are statistically significant. On the other hand the relationship between the mediators and the dependent variable should also be evaluated. When $b_1 = 0.0289$ and $b_2 = 0.0073$ coefficients with significance $p = 0.000$ are evaluated, the relationship between the mediator variables and the dependent variable was also statistically significant. As a result the effects of depression and mental health mediator variables on self-efficacy were statistically significant in this Model l.

The second model has been established in order to evaluate the mediators and independent variable of self-efficacy dependent variable. In the second model; anxiety is an independent variable; depression and mental health are mediators and self-efficacy is dependent variable. The second parallel mediator model for self-efficacy can be visualized as in Figure 3.

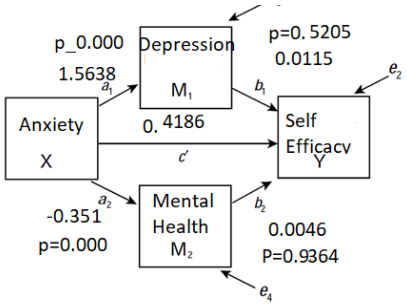

Figure 3. Model 2 for Self-efficacy

For the Model 2, the equations can be expressed as follows:

$$\hat{Y} = 56.899 + 0.4186X + 0.0115M_1 + 0.0046M_2$$

$$\hat{M}_1 = 0.918 + 1.5638X$$

$$\hat{M}_2 = 56.941 - 0.351X$$

Direct effect of X on Y is $c' = 0.4186$ with significance $p = 0.000$. Anxiety is significantly related to the self-efficacy. On the other hand $a_1 = 1.5638$ with $p = 0.000$ and $a_2 = -0.351$ with $p = 0.000$ are statistically significant. But in this model the relationship between depression and self-efficacy was significant whereas the relationship between mental health and self-efficacy was not statistically significant. This can be easily seen by looking at the coefficients and significance values, $b_1 = 0.0115$ with $p = 0.000$ and $b_2 = 0.0046$ with. As a result of the second model the effect of the mental health mediator variable on self-efficacy was not significant. It can be said that it is unnecessary for the model to be included as an mediator variable.

Two models were established in order to evaluate the significance of mediator variables for self-efficacy. It was observed that the first model was a meaningful model and the mental health variable in the second model did not have any effect. Therefore, a confidence interval for the mediated effect will only be created for the first model. If the observed data set is not distributed normally, it was stated that the bootstrap confidence intervals should be calculated for the tool effect. However, this study was not used the bootstrap confidence

intervals because the distribution of the data set was observed to be normal. The normal confidence interval for the mediated effect $a_1b_1 + a_2b_2$ can be calculated with the help of the calculated z value. The mediated effect divided by its standard error yields a z-score of the effect. This value compared against a standard normal distribution to test for significance. If the z-score is greater than 1.96 we conclude that the effect is larger than would be expected by chance and calls the effect significant. The standard deviation of the mediated effect calculated by Eq. 5 was 0.00086. Here, the confidence interval of the mediated effect is obtained by the help of Eq. 4 as follows for the Model 1:

$$mediated\ effect \pm z_{type1error} s_{\hat{a}_1\hat{b}_1+\hat{a}_2\hat{b}_2} =$$

$$\left[(1.0167)(0.0289) + (-0.3581)(0.0073)\right] \pm (1.96)(0.00086)$$

The confidence interval for the mediated effect was found $(0.00155; 0.00049)$. This confidence interval does not contain zero, consequently it is said that mediated effect is significant.

IV. CONCLUSION

Mediation analysis is a method that is used to investigate the effect of independent variable on dependent variable with the help of mediator variable and is very popular in recent years. In particular, the method used in psychological research is a member of the family of structural equation models.

The most common issues in scientific research are the leading relationship. In this study, the variables that have the nature of reason for self-sufficiency dependent variable are determined while the mediating variables that act together with the cause are also observed. Two parallel mediation models were established for this purpose. In the first model where stress was independent variable the effects of depression and mental health mediator variables on self-efficacy were statistically significant. In the second model where the anxiety was independent variable the effect of the mental health mediator variable on self-efficacy was not significant. It can be said that it is unnecessary for the model to be included as an mediator variable. Model 1 is better than Model 2 and it helps to explain with two mediator variables for self-efficacy.

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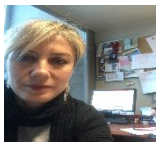

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