ESTIMATION OF THE STANDARD ERROR AND CONFIDENCE INTERVAL OF THE INDIRECT EFFECT IN MULTIPLE MEDIATOR MODELS

DISSERTATION

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ABSTRACT

Mediation analysis seeks to go beyond the question whether an independent variable causes a change in a dependent variable. Mediation addresses the question of *how* that change occurs. Specifically, simple mediation occurs when the effect of a predictor variable on a dependent variable is transmitted through an intervening variable (the mediator). However, with the complicated relationships observed in the social sciences, including more than one mediating variable can provide a more complete picture of the change.

Researchers can test the statistical significance of the indirect effects in multiple mediation models. Researchers can obtain an estimate of the standard error of the indirect effects and use them to calculate a test statistic or confidence intervals. Typically, the standard error estimate derived from the multivariate delta method (MDM) is used. However, the distributional assumptions of this method are often violated, especially with small sample sizes. Bootstrapping the standard error and confidence interval has been suggested as a remedy.

This simulation study examined the performance of confidence intervals resulting from the MDM, the bootstrap estimate of the standard error, the bootstrap

percentile method, the bias-corrected method, and the bias-corrected and accelerated method. Simulations were performed to examine the performance of these standard error and confidence interval estimates in models with two mediating variables, varying the sample size, amount of mediation, the relative importance of the two indirect effects, and inclusion of correlated errors of the mediator variables. Results indicated that the MDM and bootstrap standard error estimates resulted in confidence intervals that showed inaccurate Type I error rates, failed to capture the known population value more often than the bootstrap percentile, bias-corrected bootstrap and bias-corrected and accelerated bootstrap methods, and showed lower power for small samples. In large samples, the performance for all methods was approximately equivalent.

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2. MacCallum, R. C., Tucker, L R, & Briggs, N. E. (2001). An alternative perspective on parameter estimation in factor analysis and related methods. In R. Cudeck, S. du Toit, & D. Sörbom (Eds.), *Structural equation modeling: Present and future* (pp. 39-57). Lincolnwood, IL: SSI.

3. Briggs, N. E., & Sheu, C. F. (1998). Using Java in introductory statistics. *Behavior, Research, Methods, Instruments and Computers*, *30*(2), 246-249.

AWARDS

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Major Field: Psychology

Minor Field: Health Psychology

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CHAPTER 1

INTRODUCTION

In the social sciences, researchers examine the relationships among variables. Sometimes, these relationships are straightforward; variable *X* directly influences variable *Y*. Often, though, these relationships are not so simple. Variable *X*'s influence on *Y* may be more complicated, occurring not only directly, but indirectly as well, through another variable or variables. Any number of models can be proposed that describe indirect relationships between two variables, but a particularly popular one is the simple mediation model. In this model, the relationship between *X* and *Y* is described as occurring at least partially through *X*'s influence on a third variable. Subsequently, that third variable affects *Y*.

Models proposing indirect relationships are prevalent in the behavioral sciences. From biopsychology to social psychology, researchers have used these models to help explain observed phenomenon and to develop theory. An examination of the published articles from January 2005 through December 2005 of three prominent journals in psychology – *Journal of Personality and Social Psychology*, *Journal of Consulting and Clinical Psychology*, and *Journal of Abnormal Psychology* – showed that mediation

models are commonly used. In the *Journal of Personality and Social Psychology*, 38 articles presented results involving at least one indirect effect. Most often the authors reported results of simple mediation models, but there were frequent instances of models with more than one mediator, multiple simple mediation models with different mediating variables, and few instances of models with latent variables. Similarly, there were 19 articles using models with indirect effects in the *Journal of Consulting and Clinical Psychology* and 17 articles in the *Journal of Abnormal Psychology* (see Preacher and Hayes (2004) for an informal content analysis). For the applied researcher, mediation models are a simple and useful way to examine the process of influence among a set of variables. As they are so popular, it is prudent to ensure that the inferences researchers make based on these models are accurate. This goal motivated the current study.

In examining the intervening variables that help explain the influence of *X* on *Y*, the researcher can move beyond a simple description of the relationship, leading to fuller understanding and closer to causal explanations. Assuming that *X* precedes *M* and *M* precedes *Y* in time, researchers can use the mediation model to posit causal explanations for the *X*-*Y* relationship. While statistical analysis and correct temporal ordering are not sufficient for establishing causation, researchers can use mediation analyses to move toward a plausible explanation for a relationship and provide guidance for subsequent experimental research. In addition, focusing on the possible mechanism of how one variable influences another can be helpful not only to the social researcher, but also to those in applied settings. For example, MacKinnon (1994) and Mackinnon

and Dwyer (1993) argued that identifying the important factors leading to health behavior change in a drug abuse prevention or intervention program can lead to more effective treatments. Assessing mediational relationship is a practical issue as well as an academic one, leading to increased theoretical knowledge and guiding applied practitioners by providing possible causal explanations for psychological phenomena.

Figure 1 presents the simple mediation model. Panel A shows the primary relationship to be explained; the predictor, *X*, influences the outcome, *Y*. This relationship is typically represented as *c*, and is termed the *total effect* of *X* on *Y*.

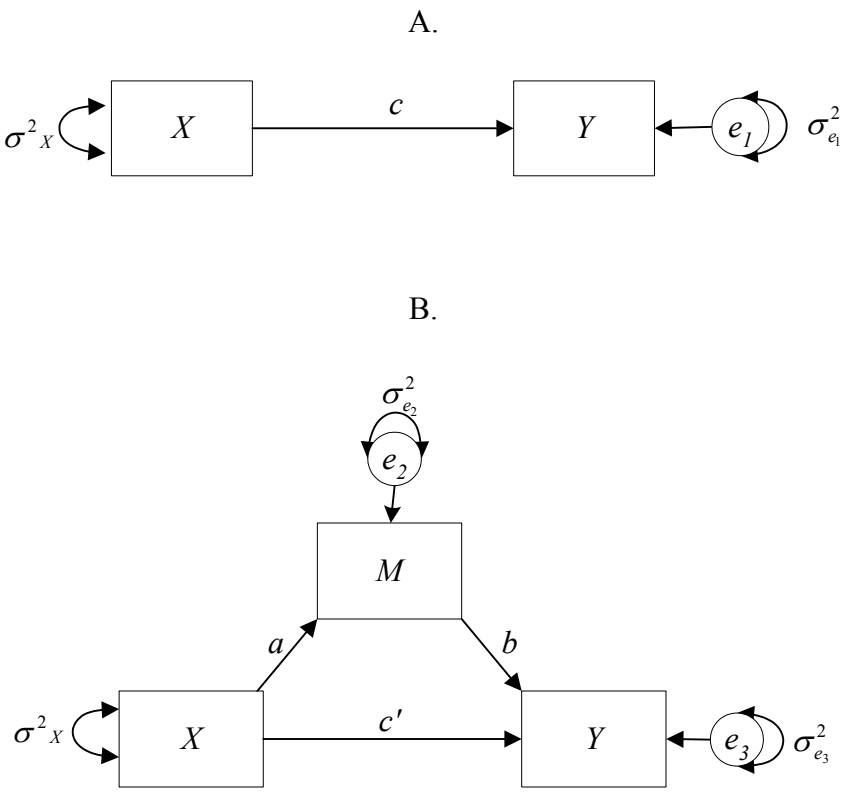


Figure 1: The formal simple mediation model

Mediation is typically examined using regression, so *c* is obtained from a simpleregression of *Y* on *X*. The variance of *X* is σ_X^2, and $\sigma_{e_1}^2$ is the error variance, namely the variance in *Y* not accounted for by *X*. Panel B shows the model in which the intervening variable is included. In this model, there are three relationships of interest. First, *X* influences the mediator, *M*, and is denoted by *a*, a regression coefficient obtained from a simple regression of *M* on *X*. The error variance for this regression is denoted $\sigma_{e_2}^2$. Second, the relationship between *X* and *Y* is examined again, this time with the mediator, *M*, also included as a predictor of *Y*. From this analysis, both the influence of *M* on *Y* (path *b*) and the influence of *X* and *Y* (path c', also called the *direct effect* of *X*) can be obtained.

As the preceding discussion indicates, the predictor, *X*, influences the outcome, *Y*, in two ways: directly, and indirectly through the mediator, *M*. If *M* accounts for the relationship between *X* and *Y*, at least in part, then it is a mediator of the *X*-*Y* relationship (Baron & Kenny, 1986). This effect of *X* on *Y* through *M* is the *mediation effect*, also called the *indirect effect*, and, mathematically, it is the product of the coefficients for the two paths involved, *a* and *b*. The *total effect* of *X* on *Y*, *c*, is equal to the sum of the direct and indirect effects, $ab + c'$ (MacKinnon, Warsi, & Dwyer, 1995).

Baron and Kenny (1986) provided a procedure to assess the presence of a mediator. In Figure 1, the estimates for *a*, *b*, *c* and c' ($\hat{a}$, $\hat{b}$, $\hat{c}$ and $\hat{c}'$, respectively), are obtained from a series of ordinary least squares regression analyses. In Baron and Kenny's approach, also called the causal hypothesis method, *M* can be considered a

mediator between *X* and *Y* if a series of conditions is satisfied. First, there should be a significant relationship between *X* and *Y*. In Figure 1, Panel A, this equates to the estimate of *c* being significantly different from zero. Similarly, there must a significant relationship between *X* and *M*; in Figure 1 Panel B, the estimate for *a,* $\hat{a}$, must be significantly different from zero. Third, in a multiple regression with both *X* and *M* predicting *Y*, the sample estimate of *b* ($\hat{b}$, the influence of *M* on *Y*) must be significantly different from zero. In all, parameter estimates from three equations are examined,

$$\hat{Y} = \hat{i}_1 + \hat{c}X + e_1 \tag{1}$$

$$\hat{M} = \hat{i}_2 + \hat{a}X + e_2 \tag{2}$$

$$\hat{Y} = \hat{i}_3 + \hat{c}'X + \hat{b}M + e_3 \tag{3}$$

with the intercepts represented in each equation by *i*. Centered scores can be used and all intercepts would then be zero. Complete mediation has occurred if $\hat{c}'$ (the influence of *X* on *Y* when *M* is included in the model as a predictor) is not significantly different from zero. In such a case, all of the influence of *X* on *Y* is indirect through *M*. Partial mediation is possible as well. If $\hat{c}'$ is smaller in magnitude than $\hat{c}$, but still statistically significant, then only part of the effect of *X* on *Y* is mediated by *M*. If $\hat{c}'$ is not substantially smaller than $\hat{c}$, then none of the influence of *X* on *Y* is transmitted indirectly through *M*; thus, *M* does not mediate the relationship between *X* and *Y*.

The causal hypothesis method is commonly used, but it is not a method devoid of problems. First, it is not a statistical test in itself. Baron and Kenny's approach simply requires that the coefficient $\hat{c}'$ be nonsignificant when *M* is included in the

model in order for complete mediation to have occurred. Holmbeck (2002) noted that simply observing that $\hat{c}'$ is smaller in magnitude than $\hat{c}$ is not rigorous enough. It is possible for the direct effect, $\hat{c}'$, to become nonsignificant with a very small decrease in magnitude from $\hat{c}$. In such a case, it would be misleading to conclude that mediation has occurred. Alternatively, $\hat{c}'$ could remain significant with a relatively large decrease. According to the Baron and Kenny approach, mediation would not have occurred in this situation. Reliance on the significance of $\hat{c}'$ is not a sufficient test when determining the presence of mediation. A test of the difference from $\hat{c}$ to $\hat{c}'$ would be a better test of whether mediation has occurred (Holmbeck, 2002; Preacher & Hayes, 2004).

In addition, MacKinnon, Lockwood, Hoffman, West and Sheets (2002) found that power for the Baron and Kenny approach can be low, especially for smaller sample sizes. The Baron and Kenny causal steps procedure requires that the relationship between *X* and *M* (coefficient $\hat{a}$), and the relationship between *M* and *Y* (coefficient $\hat{b}$), are statistically significant in order for mediation to have occurred. Because there are two coefficients to test for significance, $\hat{a}$ and $\hat{b}$, statistical power may be compromised (MacKinnon, et al., 2002). Rather than two separate tests of regression coefficients, one direct statistical test of the decrease in the effect of *X* on *Y* when *M* is included in the model would help alleviate the power issue.

The relationship between *X* and *Y* need not be significant in order for a mediation relationship to exist. For example, if the direct effect of *X* on *Y* ($\hat{c}'$) is

positive and the indirect effect ($\hat{a}\hat{b}$) through *M* is negative, the net influence of *X* on *Y* can be zero. However, mediation is still present. These models are called inconsistent models (Blalock, 1969; Davis, 1985). In addition, Shrout and Bolger (2002) argued that in correlational research, *X* and *Y* may be measured at very different points in time. Thus, the strength of the relationship can be diluted by competing variables or affected by additional variables in a causal chain or other random factors. In such a case, $\hat{c}$ is likely to be nonsignificant. However, the mediator, *M*, is more proximal in time to both *X* and *Y*. So, the individual paths from *X* to *M* and from *M* to *Y* are likely to be larger in magnitude than $\hat{c}$. Thus, mediation can be present, but the total effect of *X* on *Y* is zero.

Finally, this procedure does not test the mediation effect itself. The mediation effect is the indirect effect of *X* on *Y* ($\hat{a}\hat{b}$), and the Baron and Kenny method does not provide an estimate of that effect; only the magnitude of the direct effect ($\hat{c}'$) is examined. As an alternative, researchers can use a statistical test described by Sobel (1982). The Sobel test provides an expression for the standard error of the product of the estimates of *a* and *b*, the two paths comprising the mediation effect:

$$\hat{\sigma}_{ab} = \sqrt{\hat{a}^2\hat{\sigma}_{\hat{b}}^2 + \hat{b}^2\hat{\sigma}_{\hat{a}}^2} \tag{4}$$

where $\hat{\sigma}_{\hat{a}}^2$ is the variance of the regression coefficient $\hat{a}$ and $\hat{\sigma}_{\hat{b}}^2$ is the variance of the regression coefficient $\hat{b}$. Its derivation is explained later in this paper. A test statistic, calculated as

$$z = \frac{\hat{a}\hat{b}}{\hat{\sigma}_{ab}} \tag{5}$$

can be compared to a standard normal distribution for null hypothesis testing. In addition, this standard error estimate can be used to calculate confidence intervals for the population indirect effect:

$$\mathrm{CI}_{1-\alpha} = \hat{a}\hat{b} \pm z_{\alpha/2}\hat{\sigma}_{ab} \tag{6}$$

where α is the desired error level. While Sobel proposed the procedure for indirect effects in general, Baron and Kenny adapted it for use specifically with simple mediation.

The Sobel test is not the only statistical test for the significance of mediation. MacKinnon et al. (2002) examined 14 different methods to test the significance of a mediator. These methods are based on different assumptions, and not all test the product of $\hat{a}$ and $\hat{b}$ as the Sobel test does (see, for example, Olkin and Finn, 1995). However, when researchers wish to perform a statistical test for the presence of mediation, they do tend to use the Sobel test over other methods.

1.1 Multiple Mediators

In examining the process through which one variable influences another, it is possible that more than one intervening variable exists. A model with only one mediating variable would neglect potentially important and interesting relationships among predictor, mediator and outcome variables. In addition, with such focus on the Baron and Kenny approach and the Sobel test, other viable models, such as latent variable models, are often overlooked.

There are numerous examples in the recent literature of studies using several simple mediation models in which a series of mediators are examined with the same predictor and outcome variables. Haslam et al. (2005) examined five potential mediators of the relationship between self-ratings of humanness and ratings of others' humanness, all in separate mediation analyses. In an experimental setting, Seibt and Forster (2004) investigated the processes through which stereotype threat might operate. In one of their studies, they hypothesized that eagerness to perform well on a particular task and vigilance against mistakes mediated the relationship between stereotype threat and performance. Rather than examining a single model in which both eagerness and vigilance were included, Seibt and Forster performed two separate simple mediation analyses for the same independent and dependent variables, each with a different mediator.

Other studies have been published (e.g., Kling, Ryff, Love, & Essex, 2003; McGregor & Marigold, 2003) in which the investigators used this strategy as well. In restricting their analyses to simple mediation, these researchers are not only failing to examine the more complete process of how the predictor influences the outcome, they are also missing the opportunity to compare the relative strength of the individual indirect effects (MacKinnon, 2000). In addition, restricting a mediation model to a simple one (one mediator) when multiple mediators of the *X*-*Y* relationship exist may be a misspecification of the model (Shrout and Bolger, 2002). In such cases, the estimates of the *M*-*Y* relationship are biased, as they are not adjusted for the presence of the other mediators.

While much of the research in psychology that involves mediation models focuses on simple mediation, there are published articles that do examine more complex mediation models. For example, Samaniego and Gonzales (1999) found four variables that, together, totally mediated the effect of acculturation status on delinquency. A series of models with a single mediator each would likely have shown only partial mediation for each of the mediators. Bonnano, Rennicke and Dekel (2005) showed that of trauma exposure, positive affect and social constraints included in a multiple mediator model, only social constraints significantly mediated the relationship between self-enhancement and reported post-traumatic stress symptoms.

While many of the published studies using mediation analyses are correlational in nature, multiple mediation can be examined in experimental settings as well. Previously mentioned, Seibt and Forster (2004) studied stereotype threat in a controlled experimental design. Tauer and Harackiewicz (2004) examined the relationship between type of group competition (individual and group competition or cooperation) and performance on a task as mediated by enthusiasm, competence and challenge. While not specifically referring to their model as a "multiple mediator" model, their initial analyses included all three intervening variables. Likewise, Cohen (2003) examined the effect of three intervening variables using analysis of covariance.

Mediation analyses can also be tested using latent variable models. Indeed, one of the assumptions of the causal hypotheses approach is that the variables be measured without error (Baron & Kenny, 1986). This assumption oftentimes does not hold in psychology. Many of the constructs studied are in fact latent and can only be examined

using measured variables, which imperfectly reflect the latent construct. In such a case, latent variable model is indicated.

That said, researchers in psychology tend to assume that measured variables are without error and use the linear regression approach, and this preference is reflected in the literature. For example, during 2005, there were 38 articles published in the *Journal of Personality and Social Psychology* that used mediation analyses. Of these, only two studies presented results from a latent variable model (Martino, et al., 2005; Donnellan, Larsen-Rife & Conger, 2005); all others presented results from simple or multiple mediation analyses using measured variables only.

As this discussion indicates, researchers clearly test mediation models in their research, whether they employ simple mediation models or those that are more complicated. Yet, beyond the use of the Sobel test, there are few instances where significance tests or interval estimation were used to examine indirect effects in multiple mediator models. It seems that awareness of the methods available to test these models is low, and examination of the methods themselves is warranted.

Figure 2 formally presents the simplest multiple mediator model; one with two mediating variables, M_1 and M_2. Two *specific indirect effects* are shown, a_1b_1, which is the indirect effect of X on Y through M_1, and a_2b_2, the indirect effect of X on Y through M_2. The sum of these effects is the *total indirect effect*. The total effect of X on Y is c, and c' is the direct effect when both M_1 and M_2 are included in the model predicting Y. It should be noted that the total effect, c, is the sum of the direct effect and all indirect effects:

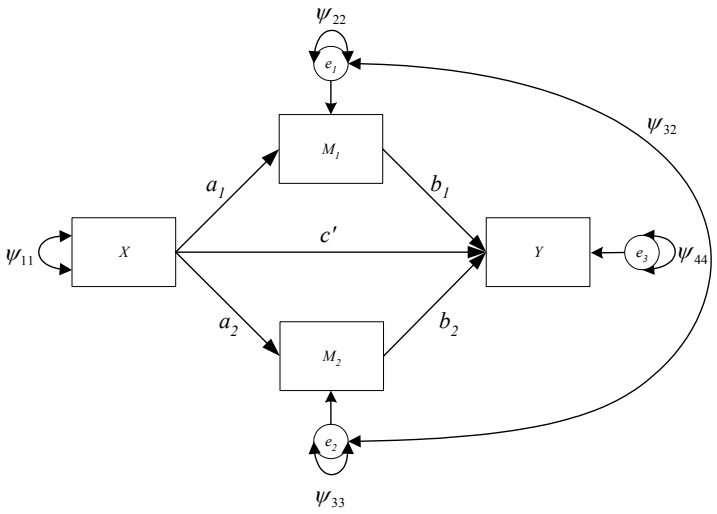


Figure 2: The multiple mediation model

$$c = c' + a_1 b_1 + a_2 b_2 \tag{7}$$

As in the simple mediation case, sample estimates of the paths are used to evaluate the presence of mediation. However, the calculation of the standard error estimates of the indirect effects can be more complicated.

Sobel (1986) described the decomposition of the total effect with the infinite sums approach. In a LISREL covariance structure model, the covariance matrix, Σ, can be partitioned as follows

$$\begin{aligned}\Sigma &= \begin{bmatrix} \Sigma_{yy} & \Sigma_{yx} \\ \Sigma_{xy} & \Sigma_{xx} \end{bmatrix} \\ &= \begin{bmatrix} \Lambda_y (\mathrm{I}-\mathrm{B})^{-1}(\Gamma\Phi\Gamma' + \Psi)(\mathrm{I}-\mathrm{B}')^{-1}\Lambda_y{}' + \Theta_\varepsilon & \Lambda_y \Phi\Gamma'(\mathrm{I}-\mathrm{B})^{-1}\Lambda_y{}' \\ \Lambda_x \Phi\Gamma'(\mathrm{I}-\mathrm{B})^{-1}\Lambda_x{}' & \Lambda_x \Phi\Lambda_x{}' + \Theta_\delta \end{bmatrix}\end{aligned} \tag{8}$$

The expressions in Equation 8 can be understood as follows. The population covariance matrix is denoted as Σ. Its components represent the covariance of endogenous

measured variables (Σ_{yy}); the covariance of exogenous measured variables[1] with endogenous measured variables (Σ_{xy}); and the covariance of exogenous measured variables (Σ_{xx}). The structure of the submatrices can be described by subsequent equations. A mediation model with measured variables only can be specified as a model with endogenous measured variables only. In such a case, the covariance structure becomes

$$\Sigma = \Sigma_{yy} = \Lambda_y (\mathrm{I} - \mathrm{B})^{-1} (\Gamma \Phi \Gamma' + \Psi)(\mathrm{I} - \mathrm{B}')^{-1} \Lambda_y{}' + \Theta_\varepsilon \qquad (9)$$

In this Equation 9, Λ_y contains the coefficients for a regression of the endogenous measured variables (*y*) on the endogenous latent variables (η). B contains the coefficients of the endogenous structural relationships of the model. Γ is the matrix containing the coefficients for the latent exogenous variables and the covariances of the latent exogenous variables are contained in Φ. The covariance matrix of the errors for the relationship between the exogenous and endogenous latent variables is Ψ, and for the measurement errors in *y*, the covariance matrix is Θ_ε. With no latent variables, both Γ and Θ_ε are **0** and Λ_y is an identity matrix. Thus

$$\Sigma = (\mathrm{I} - \mathrm{B})^{-1} \Psi (\mathrm{I} - \mathrm{B}')^{-1} \qquad (10)$$

In this formulation, the coefficients a_1, b_1, a_2, b_2 and c' are contained in the B matrix

[1] Endogenous variables are those variables in a model that are directly influenced be at least one other variable. Exogenous variables are variables that may influence other variables but are not themselves influenced by other variables.

In the mediation model (simple and multiple), *X* is an exogenous variable, and *M* and *Y* are endogenous variables.

$$\mathrm{B} = \begin{array}{c} \\ X \\ M_1 \\ M_2 \\ Y \end{array} \begin{array}{c} \begin{array}{cccc} X & M_1 & M_2 & Y \end{array} \\ \begin{bmatrix} 0 & 0 & 0 & 0 \\ a_1 & 0 & 0 & 0 \\ a_2 & 0 & 0 & 0 \\ c' & b_1 & b_2 & 0 \end{bmatrix} \end{array} \tag{11}$$

In this square matrix, the effect of the first variable, *X*, on the two mediators, M_1 and M_2, and *Y* are contained in the first column. The effects of M_1 and M_2 on *Y* are in the second and third columns, respectively. In the infinite sums approach described by Sobel (1986), the total effects are defined as

$$\mathrm{T} = \lim_{r=\infty} \sum_{k=1}^{r} \mathrm{B}^k \tag{12}$$

assuming the limit exists. In this example, it does exist, resulting in

$$\begin{aligned} \lim_{r=\infty} \sum_{k=1}^{r} \mathrm{B}^k &= \mathrm{B}^1 + \mathrm{B}^2 \\ &= \begin{bmatrix} 0 & 0 & 0 & 0 \\ a_1 & 0 & 0 & 0 \\ a_2 & 0 & 0 & 0 \\ c' & b_1 & b_2 & 0 \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ a_1 b_1 + a_2 b_2 & 0 & 0 & 0 \end{bmatrix} \\ &= \begin{bmatrix} 0 & 0 & 0 & 0 \\ a_1 & 0 & 0 & 0 \\ a_2 & 0 & 0 & 0 \\ c' + a_1 b_1 + a_2 b_2 & b_1 & b_2 & 0 \end{bmatrix} \end{aligned} \tag{13}$$

The total effect of *X* on *Y* is thus comprised of the sum of the two specific indirect effects ($a_1 b_1$ and $a_2 b_2$) and the direct effect (c'), as shown in Equation 7. As in the simple mediation case, the coefficients obtained from a sample are used as estimates of the population parameters.

To obtain the estimates for the coefficients for the multiple mediator model shown in Figure 2, the effect of X on each of the mediators is estimated:

$$\hat{M}_1 = \hat{i}_2 + \hat{a}_1 X + e_2 \tag{14}$$

$$\hat{M}_2 = \hat{i}_3 + \hat{a}_2 X + e_3 \tag{15}$$

A model examining the effect of all predictors, X, M_1, and M_2 on Y is tested:

$$\hat{Y} = \hat{i}_4 + \hat{c}' X + \hat{b}_1 M_1 + \hat{b}_2 M_2 + e_4 \tag{16}$$

As in the simple mediation case, the total effect of X on Y, $\hat{c}$, can be obtained as well (See Figure 1, Panel A and Equation 1).

The previously described methods for testing the significance of the mediated effect are not appropriate for models with more than one mediator. With two mediating variables in the model, the number of indirect effects that a researcher can statistically test increases to three (both specific indirect effects and the total indirect effect). The Sobel test was proposed to examine the significance of a product of two coefficients, not the sum of products, so it is not appropriate as the standard error of the estimated total indirect effect.

To address this problem, MacKinnon (2000) described an extension of the Sobel test for a single mediator to examine mediation in multiple mediator models. The multivariate delta method (MDM) can be used to derive the variance of the total indirect effect, as well as each specific indirect effect.

1.2 Multivariate Delta Method

The multivariate delta method is used to determine the variance of functions of random variables (Sobel, 1982, 1986), assuming the variables follow a multivariate normal distribution. This procedure consists of pre- and post-multiplying the covariance matrix of parameter estimates by the partial derivatives of the function. Since indirect effects are nonlinear functions of random variables, the MDM provides a method to calculate the standard error of the indirect effects, which can be used to test the significance of these effects.

Assume $\boldsymbol{\theta}$ is a vector of unknown parameters for which estimates are obtained from a sample of size *N*. The maximum likelihood and generalized least squares estimates have an asymptotically normal distribution, with a mean of $\boldsymbol{\theta}$ and variance-covariance matrix $N^{-1}\mathbf{V}(\boldsymbol{\theta})$ under appropriate assumptions (Browne, 1984; Jöreskog, 1978).

Define $\mathbf{f}(\boldsymbol{\theta})$ as a differentiable function of $\boldsymbol{\theta}$. The MDM states that the distribution of $\mathbf{f}(\hat{\boldsymbol{\theta}})$ is

$$\mathbf{f}(\hat{\boldsymbol{\theta}}) \sim N\left(\boldsymbol{\theta}, \left[\frac{\partial \mathbf{f}}{\partial \boldsymbol{\theta}}\right]' V(\boldsymbol{\theta}) \left[\frac{\partial \mathbf{f}}{\partial \boldsymbol{\theta}}\right]\right) \tag{17}$$

For a large samples, $\hat{\boldsymbol{\theta}}$ is substituted for $\boldsymbol{\theta}$, and the estimated variance-covariance matrix is

$$N^{-1}\left(\left[\frac{\partial \mathbf{f}}{\partial \hat{\boldsymbol{\theta}}}\right]' V(\hat{\boldsymbol{\theta}}) \left[\frac{\partial \mathbf{f}}{\partial \hat{\boldsymbol{\theta}}}\right]\right) \tag{18}$$

So, the variance-covariance matrix of the estimates of the functions contained in $\mathbf{f}(\hat{\boldsymbol{\theta}})$ can be obtained by pre- and post-multiplying the covariance matrix of the parameter estimates by the partial derivatives of $\mathbf{f}(\hat{\boldsymbol{\theta}})$.

For the simple mediation model, $\boldsymbol{\theta}$ contains the relevant parameters *a* and *b*, and the estimates from a sample of *N* are contained in $\hat{\boldsymbol{\theta}}$

$$\boldsymbol{\theta} = \begin{bmatrix} a \\ b \end{bmatrix} \text{ and } \hat{\boldsymbol{\theta}} = \begin{bmatrix} \hat{a} \\ \hat{b} \end{bmatrix} \tag{19, 20}$$

In this case, the indirect effect is the product of *a* and *b*, so

$$\mathbf{f}(\boldsymbol{\theta}) = [ab] \text{ and } \mathbf{f}(\hat{\boldsymbol{\theta}}) = [\hat{a}\hat{b}] \tag{21, 22}$$

The partial derivatives for $\mathbf{f}(\hat{\boldsymbol{\theta}})$ are easy to obtain

$$\left[\frac{\partial \mathbf{f}}{\partial \hat{\boldsymbol{\theta}}}\right] = \begin{bmatrix} \dfrac{\partial \hat{a}\hat{b}}{\partial \hat{a}} \\ \\ \dfrac{\partial \hat{a}\hat{b}}{\partial \hat{b}} \end{bmatrix} = \begin{bmatrix} \hat{b} \\ \hat{a} \end{bmatrix} \tag{23}$$

Therefore, for the simple mediation model, the variance of the indirect effect obtained from the sample, $\hat{a}\hat{b}$, is

$$\begin{aligned} \hat{\sigma}^2_{\hat{a}\hat{b}} &= N^{-1}\left(\left[\frac{\partial \hat{a}\hat{b}}{\partial \hat{\boldsymbol{\theta}}}\right]' V(\hat{\boldsymbol{\theta}}) \left[\frac{\partial \hat{a}\hat{b}}{\partial \hat{\boldsymbol{\theta}}}\right]\right) \\ &= N^{-1}\left(\begin{bmatrix} \hat{b} & \hat{a} \end{bmatrix} \begin{bmatrix} \hat{\sigma}^2_a & \hat{\sigma}_{ba} \\ \hat{\sigma}_{ab} & \hat{\sigma}^2_b \end{bmatrix} \begin{bmatrix} \hat{b} \\ \hat{a} \end{bmatrix}\right) \\ &= N^{-1}\left(\hat{b}^2\hat{\sigma}^2_a + 2\hat{a}\hat{b}\hat{\sigma}_{ab} + \hat{a}^2\hat{\sigma}^2_b\right) \end{aligned} \tag{24}$$

A test statistic can then be calculated

$$z = \frac{\hat{a}\hat{b}}{\sqrt{\hat{b}^2\hat{\sigma}_a^2 + 2\hat{a}\hat{b}\hat{\sigma}_{ab} + \hat{a}^2\hat{\sigma}_b^2}} \tag{25}$$

to evaluate hypotheses. Also, confidence intervals can be obtained as shown in Equation 6. This is equivalent to the standard error estimate in the Sobel method (Equation 4), assuming the covariance between $\hat{a}$ and $\hat{b}$ is zero.

Generally, the MDM can be used to calculate standard errors for indirect effects in models with more than one mediator, such as that in Figure 2. For example, for the multiple mediator model, the MDM can be used to calculate the standard errors for the total indirect effect of *X* on *Y*, as well as each specific indirect effect.

The total indirect effect is the sum of the two individual indirect effects, a_1b_1 and a_2b_2. Therefore, in the population

$$\mathbf{f}(\boldsymbol{\theta}) = (a_1b_1 + a_2b_2) \tag{26}$$

Using sample estimates

$$\mathbf{f}(\hat{\boldsymbol{\theta}}) = (\hat{a}_1\hat{b}_1 + \hat{a}_2\hat{b}_2) \tag{27}$$

The first partial derivative of $\mathbf{f}(\hat{\boldsymbol{\theta}})$ is

$$\frac{\partial \hat{a}_1\hat{b}_1 + \hat{a}_2\hat{b}_2}{\partial \hat{\boldsymbol{\theta}}} = \begin{bmatrix} \hat{b}_1 \\ \hat{a}_1 \\ \hat{b}_2 \\ \hat{a}_2 \end{bmatrix} \tag{28}$$

and the variance-covariance matrix for the estimated coefficients is

$$\Sigma\left(\hat{\boldsymbol{\theta}}\right)=\begin{bmatrix} \hat{\sigma}^2_{a_1} & \hat{\sigma}_{a_1b_1} & \hat{\sigma}_{a_1a_2} & \hat{\sigma}_{a_1b_2} \\ \hat{\sigma}_{a_1b_1} & \hat{\sigma}^2_{b_1} & \hat{\sigma}_{b_1a_2} & \hat{\sigma}_{b_1b_2} \\ \hat{\sigma}_{a_1a_2} & \hat{\sigma}_{b_1a_2} & \hat{\sigma}^2_{a_2} & \hat{\sigma}_{a_2b_2} \\ \hat{\sigma}_{a_1b_2} & \hat{\sigma}_{b_1b_2} & \hat{\sigma}_{a_2b_2} & \hat{\sigma}^2_{b_2} \end{bmatrix} \tag{29}$$

The variance of the estimate of the total indirect effect is

$$\hat{\sigma}^2_{\left(\hat{a}_1\hat{b}_1+\hat{a}_2\hat{b}_2\right)}=\begin{bmatrix}\hat{b}_1 & \hat{a}_1 & \hat{b}_2 & \hat{a}_2\end{bmatrix}\begin{bmatrix} \hat{\sigma}^2_{a_1} & \hat{\sigma}_{a_1b_1} & \hat{\sigma}_{a_1a_2} & \hat{\sigma}_{a_1b_2} \\ \hat{\sigma}_{a_1b_1} & \hat{\sigma}^2_{b_1} & \hat{\sigma}_{b_1a_2} & \hat{\sigma}_{b_1b_2} \\ \hat{\sigma}_{a_1a_2} & \hat{\sigma}_{b_1a_2} & \hat{\sigma}^2_{a_2} & \hat{\sigma}_{a_2b_2} \\ \hat{\sigma}_{a_1b_2} & \hat{\sigma}_{b_1b_2} & \hat{\sigma}_{a_2b_2} & \hat{\sigma}^2_{b_2} \end{bmatrix}\begin{bmatrix}\hat{b}_1 \\ \hat{a}_1 \\ \hat{b}_2 \\ \hat{a}_2\end{bmatrix} \tag{30}$$

$$\begin{aligned} &= \hat{b}_1^2\hat{\sigma}^2_{a_1} + \hat{a}_1^2\hat{\sigma}^2_{b_1} + \hat{b}_2^2\hat{\sigma}^2_{a_2} + \hat{a}_2^2\hat{\sigma}^2_{b_2} \\ &+ 2\hat{a}_1\hat{b}_1\hat{\sigma}_{a_1b_1} + 2\hat{b}_1\hat{b}_2\hat{\sigma}_{a_1a_2} + 2\hat{b}_1\hat{a}_2\hat{\sigma}_{a_1b_2} \\ &+ 2\hat{a}_1\hat{b}_2\hat{\sigma}_{b_1a_2} + 2\hat{a}_1\hat{a}_2\hat{\sigma}_{b_1b_2} + 2\hat{a}_1\hat{b}_2\hat{\sigma}_{a_2b_2} \end{aligned}$$

As this example illustrates, the standard error for indirect effects can involve numerous terms, but often the covariances involved are zero. The covariance matrix of the coefficient estimates are often available as output in software packages. So, in practice, many of the models researchers propose can be tested relatively easily with the MDM estimation of the standard error.

Using the MDM estimate of the standard error of the total and indirect effects has been shown to be problematic, however. If the standard error is being used to perform hypothesis tests or interval estimation, there are assumptions the MDM requires to be true for the standard error estimates and resulting statistical tests and confidence intervals to be accurate. Coefficients in the model must be asymptotically

normally distributed, consistent and efficient (Theil, 1971). The point estimate of an indirect effect is the product of normal random variables that are assumed to be asymptotically normally distributed (Hanushek & Jackson, 1977). As the function in question is a product of coefficients (in the specific indirect case) or the sum of products (in the total indirect effect case), the distribution in the population may violate this assumption, being non-normal (Lomnicki, 1967; Springer & Thompson, 1966), and skewed (Aroian, 1947; Aroian, Taneja & Cornwell, 1978; Craig, 1936; Meeker, Cornwell, & Aroian, 1981).

If it is true that the sampling distribution of an indirect effect is not normal, then hypothesis tests based on standard errors based on this assumption will show biased Type I error rates and inaccurate confidence intervals. This is a problem especially in research designs with small sample sizes. Sobel (1982) stated that in small samples, the properties of the MDM estimates are not well understood. A number of studies have been performed to examine the performance of the MDM estimates of the standard error of indirect effects, particularly in the range of sample sizes likely in psychological research.

Stone and Sobel (1990) investigated the performance of the MDM to estimate the standard error of total and specific indirect effects in covariance structure models. They generated sample covariance matrices and examined the distribution of total indirect effects generated from the sample matrices relative to the true population values. They found that for small sample sizes, the MDM provided estimates of the standard error of indirect effects that were biased for small samples and small indirect

effects. Of seven total indirect effects in one model tested, three showed standard error estimates with an absolute relative bias (bias relative to the known population value) of greater than 16% for a sample size of 50. For a sample of 100, the same three showed an absolute relative bias of more than 8%. These results led the authors to suggest that, for a model with measured variables only, the sample size should be at least 200 in order to avoid bias in the standard error estimate. In addition, the relative bias was more pronounced for indirect effects that were small in magnitude.

Recently, MacKinnon, Lockwood and Williams (2004) investigated the performance of estimates of standard errors obtained from multiple sources in simple mediation models, including the Sobel test. MacKinnon et al.'s simulation study revealed that the confidence intervals for a null indirect effect in the population calculated by the Sobel method contained the true value less often than those obtained with a method based on the distribution of products. For the conditions in which the population indirect effect was zero and a sample size of 25, the 95% confidence intervals calculated with the standard error estimated from the MDM failed to capture the true value of the indirect effect in less than 1% of cases. This indicated that, in general, the confidence intervals were too wide, and the standard error was too large. For a larger sample of 200, the intervals failed to capture the population value in 1.8% of cases. For indirect effects that were not zero in the population, the confidence intervals obtained from the MDM estimate of the standard error captured the true value at rates that were consistent with the nominal failure rate (5%). For a sample of 25, the intervals failed to capture the population value in 5.8% of cases. However, the majority

of intervals (5.5%) that failed were below the true value of the effect. Even with a large sample size, most of the intervals that failed to capture the population value were too low (4.8%). This study also showed that power for the confidence intervals obtained from the MDM method was low. For the 95% confidence intervals, power was .119 for a sample of 25; .544 for a sample of 100; and .674 for a sample of 200, the lowest power of the normal theory-based methods for estimating the standard error.

The results presented by MacKinnon et al. (2004) and Stone and Sobel (1990) demonstrate that the estimate of the standard error for an indirect effect provided by the MDM can be inaccurate, leading to incorrect conclusions based on hypothesis tests and confidence intervals. The resulting confidence intervals can be too wide or too narrow depending on the standard error estimate. In particular, standard error estimates obtained from small samples tend to show bias, especially for relatively small effects. Therefore, the use of the MDM to calculate the standard error estimate and confidence intervals may be inappropriate in situations that are common in behavioral research (relatively small samples, small effects).

The evidence these studies provide is compelling, but there are numerous research situations that merit further investigation. For example, the bulk of the studies examining the performance of the MDM in estimating the standard error have focused on the simple mediation case. While simple mediation designs are common in psychological research, other designs incorporating indirect effects are used as well. In fact, it could be argued that if more appropriate methods are proposed to examine mediation and indirect relationships, researchers will move toward more comprehensive

theories and research designs. For designs with more than one mediator, MDM has been the preferred method of estimating the standard error. There is little doubt that indirect effects with only one intervening variable are often not distributed normally; it seems likely that in a design with more than one mediating variable, the standard errors and confidence intervals calculated with MDM would also likely be inaccurate.

1.3 Bootstrapping as an Alternative

Since it seems the distributional assumptions for the MDM approach are often violated, bootstrapping is a plausible alternative to deriving the standard error when examining the indirect effect in a simple mediation model,. With no distributional assumptions about the population distribution of the indirect effects, any non-normality in the population or the sampling distribution should not adversely affect the estimate of the standard error.

In conventional parametric statistics, sample statistics such as the mean and standard deviation are used to estimate population parameters and to test hypotheses. Important to the validity and utility of these tests is the assumption of normality of the distribution of sampling distribution. Sometimes, though, the assumption of normality is not tenable. In such a case, using the bootstrap estimate of the parameter of interest can provide a more accurate estimate and inferential test.

Consider a population with a particular parameter θ, and its sample estimate *t*. For example, if the parameter of interest were the population mean, μ, the sample estimate would be $\bar{x}$. Researchers typically compare $\bar{x}$ to a hypothesized population

value using a statistical test such as the *t*-test. This test requires the assumption that the sampling distribution of the estimate has a particular distribution such as student's *t* or standard normal. However, there are situations in which this assumption may not be correct. Rather than relying on distributional assumptions of the statistic, the bootstrapping method instead actually creates a sampling distribution of *t*, using the sample data available.

Bootstrapping the distribution of *t* consists of drawing many samples, say *K* resamples, with replacement of size *n* from the single available sample and calculating the statistic of interest, *t*(k)*, for each of those resamples. The distribution of *t*(k)* then serves as a representation of the sampling distribution of *t*. The mean of the distribution of *t*(k)* serves as an estimate of the population parameter, θ. Likewise, the standard deviation of *t*(k)* serves as an estimate of the standard error. This standard error estimate can be used to calculate a test statistic for a hypothesis test and confidence limits for interval estimation using the standard normal *z* distribution, as shown in Equation 5.

In bootstrapping the distribution for the indirect effect in a mediation model, the unit being sampled is not a single variable, but a vector of variables. For a simple mediation model, there are three variables, *X*, *M* and *Y*. For a sample of size *n*, *n* cases are randomly sampled with replacement to obtain one resample. For each resample, the regression coefficients for each path in the mediation model are obtained, and the mediation effect for the bootstrap sample *k*, *ab*(k)*, is calculated. This process is repeated *K* times, producing the bootstrap distribution of the mediation effect, which

can be used as an approximation to sampling distribution of *ab* for a sample of size *n*. The process is similar for a multiple mediator model, resulting in the bootstrapped distributions of the specific indirect effects, a_1b_1, a_2b_2, and $\left(a_1b_1 + a_2b_2\right)$, the total indirect effect. The standard deviations of these distributions are estimates of the standard errors.

The problem with this approach, however, is similar to that of the MDM approach in terms of using the estimates for hypothesis testing and interval estimation. Using the bootstrapped estimate of the standard error and confidence intervals (see Equations 5 and 6) assumes that the sampling distribution is normal. Stone and Sobel (1990), and MacKinnon, Lockwood and Williams (2004) showed that this is not the case, especially in small samples. So, while the bootstrapped standard error estimate may be less biased than that obtained through the MDM method, any confidence intervals calculated using the bootstrapped estimate are likely to be inaccurate.

To address this problem, confidence intervals can be obtained directly through bootstrapping. Instead of using the bootstrapped standard error estimate and relying on the assumptions about the sampling distribution by the normal theory approach, "percentile-based" confidence limits can be obtained from the bootstrapped distribution of *t*. When the *K* values of *ab** are ordered, confidence limits for a particular Type I error level (α) correspond to the values at the $100\frac{\alpha}{2}^{\text{th}}$ and $100\left(1-\frac{\alpha}{2}\right)^{\text{th}}$ percentile. These are the bootstrap percentile (BP) confidence limits for θ. For example, consider the case of bootstrapping the mediation effect for a simple mediation model. If there

are 1,000 resamples, then the lower bound of the 95% confidence interval is the 25th ordered value of *ab*(k)*. Likewise, the upper bound is the 976th ordered value. It is possible, and even probable in the case of indirect effects, that the 25th and 976th ordered values are not equidistant from the mean of the bootstrapped distribution. Thus, the assumption that the confidence interval is symmetric is avoided.

BP estimates are sometimes inaccurate in that they can be over- or under-estimates of the population value. Efron and Tibshirani (1993) proposed a remedy to the problem. The bias-corrected (BC) and bias-corrected and accelerated (BCA) bootstrap estimates involve using a transformation of the distribution of the estimate, *t*. These methods can avoid inaccurate estimates provided by BP. Because BC is a special case of BCA, only BCA is described in detail.

The BCA interval limits are also percentile values taken from a bootstrap distribution, but not the distribution generated in the resampling process. Instead, the percentiles used are dependent upon two values obtained from the bootstrap distribution, $\hat{d}$ and $\hat{z}_0$. $\hat{z}_0$ is the *z*-score corresponding to the proportion of bootstrap replications of *t** that fall at or below the original estimate, *t*

$$\hat{z}_0 = \Phi^{-1}\left(\frac{\#_{k=1}^{K}\left(t_k^* \le t\right)}{K+1} \right) \tag{31}$$

with $\Phi^{-1}(\cdot)$ being the inverse function of a normal cumulative distribution function; *K* being the number of bootstrap replications; and # being a count function. For example, if the statistic of interest were the mediation effect in a simple mediation model, a

researcher may obtain a sample of 100 cases and calculate the indirect effect, $\hat{a}\hat{b}$. $\hat{a}\hat{b}$ is the original estimate of *ab*. If a bootstrap distribution of the indirect effect were obtained, and 60% of the resamples yielded ab^* values below $\hat{a}\hat{b}$, then $\hat{z}_0 = \Phi^{-1}(.60) = .253$. $\hat{z}_0$ is roughly the median bias of ab^* relative to $\hat{a}\hat{b}$. If there were no bias, the proportion of resamples resulting in a value below the original estimate would be .50, and $\hat{z}_0$ would be zero.

Acceleration refers to the rate of change of the standard error of $\hat{t}$ relative to the true parameter value, θ. To obtain the acceleration coefficient, $\hat{d}$, a jackknife procedure is used. In the jackknife, the statistic of concern is calculated *n* times, each time with one case removed. $\hat{d}$ is calculated by

$$\hat{d} = \frac{\sum_{i=1}^{n}\left(t_{(-i)} - \bar{t}\right)^3}{6\left[\sum_{i=1}^{n}\left(t_{(-i)} - \bar{t}\right)^2\right]^{\frac{3}{2}}} \tag{32}$$

where $t_{(-i)}$ is the estimate of *t* with case *i* removed. The calculation of $\hat{d}$ is very close to the calculation of skew in a distribution. In fact, the acceleration constant measures the skew of the distribution of the influence of each case on the parameter estimate. $\hat{d}$ will be positive if there are more cases that increase the estimate than decrease it.

Finally, the BCA limits for the $100\left(1-\frac{\alpha}{2}\right)$% confidence level are calculated.

First, *z*-scores corresponding to the lower and upper bounds are obtained:

$$\hat{z}_{lo} = \hat{z}_0 + \frac{\hat{z}_0 + z_{\frac{\alpha}{2}}}{1 - \hat{d}\left(\hat{z}_0 + z_{\frac{\alpha}{2}}\right)} \tag{33}$$

and

$$\hat{z}_{up} = \hat{z}_0 + \frac{\hat{z}_0 + z_{\left(1-\frac{\alpha}{2}\right)}}{1 - \hat{d}\left(\hat{z}_0 + z_{\left(1-\frac{\alpha}{2}\right)}\right)} \tag{34}$$

where $\hat{z}_0$ is the bias estimate; $z_{\frac{\alpha}{2}}$ is the *z*-score associated with the $\frac{\alpha}{2}$ percentile; and $\hat{d}$ is the acceleration estimate. To obtain the proportions of the normal distribution falling below the lower and upper *z*-scores, the cumulative normal distribution function is used:

$$l_1 = \Phi\left(\hat{z}_0 + \frac{\hat{z}_0 + z_{\frac{\alpha}{2}}}{1 - \hat{d}\left(\hat{z}_0 + z_{\frac{\alpha}{2}}\right)}\right) \tag{35}$$

and

$$l_2 = \Phi\left(\hat{z}_0 + \frac{\hat{z}_0 + z_{\left(1-\frac{\alpha}{2}\right)}}{1 - \hat{d}\left(\hat{z}_0 + z_{\left(1-\frac{\alpha}{2}\right)}\right)}\right) \tag{36}$$

The values in the ordered distribution at the l_1^{th} and l_2^{th} percentiles are the lower and upper bounds of the BCA interval, $\left(\hat{t}(l_1)^*, \hat{t}(l_2)^*\right)$. The BC estimates are obtained in the same manner, with $\hat{d}$ constrained to zero.

For example, assume the bias ($\hat{z}_0$) was estimated as .15, and the acceleration ($\hat{d}$) was estimated as .05. Then, for an α of .05, l_1 and l_2 would be

$$l_1 = \Phi\left(.12 + \frac{.12 + (-1.96)}{1 - .05(.12 + (-1.96))}\right) = \Phi(-1.51) = .066 \quad (37)$$

and

$$l_2 = \Phi\left(.12 + \frac{.12 + 1.96}{1 - .05(.12 + 1.96)}\right) = \Phi(2.509) = .994 \quad (38)$$

If there were 1,000 bootstrap samples, the limits of the 95% confidence interval would be the 66^{th} and 995^{th} ordered values.

Research into the performance of the bootstrapped standard error and confidence limits of the indirect effects has shown that they perform better than standard errors and confidence intervals obtained from the MDM. Bollen and Stine (1990) compared the performance of MDM in estimating the standard error of the indirect effect to the estimate obtained through bootstrapping. Their results showed that for both direct and indirect effects, bootstrap estimates of the standard error were close to the MDM estimates for relatively large samples. However, for smaller samples, the bootstrap distributions of the indirect effects showed deviation from normality; the distributions

tended to be skewed. So, the assumption of a symmetric sampling distribution may be inappropriate in calculating confidence intervals for the indirect effects.

In the second part of their simulation study, MacKinnon, Lockwood and Williams (2004) compared the Type I error rates and power for confidence intervals obtained from the MDM to those obtained from various resampling methods. In their comparison, the MDM and product methods were shown to have poorer power and Type I error rates in estimating confidence intervals for the indirect effects than the bootstrap methods. For a sample of 50, the 95% confidence intervals obtained from the standard error estimate by the MDM showed a Type I error rate of 1%. For the same sample size, the error rate for the bootstrap percentile confidence intervals was 2.8% and 5.2% for the bias-corrected confidence intervals. Power for the same sample size was .339 for the confidence intervals obtained from the MDM standard error estimate, .418 for the bootstrap percentile intervals, and .479 for the bias-corrected intervals. For the largest sample size examined, the pattern of results remained the same; the confidence intervals from the MDM estimate showed low Type I error rates and power, the bias-corrected showed the best, and performance of the bootstrap percentile intervals was in between.

The results of the previous simulation studies and proposed methods to calculate the standard error and confidence intervals for testing the indirect effects in mediation models suggest that MDM is not the best method available to researchers. In addition, the assumption of a normal sampling distribution of the indirect effect seems to be unwarranted in most cases. However, there are other questions that should be

addressed. First, as previously stated, most research has focused on the simple mediation case. Since researchers are interested in more complex mediation models, the performance of the various methods should be examined in the multiple mediator case.

Second, MacKinnon et al. (2004) tested only mediation designs in which the direct effect, c', was constrained to zero in their simulated populations. Realistically, even in simple mediation models, c' often is different from zero. There is no indication about whether any of these methods accurately estimate the standard error of an indirect effect when only partial mediation exists.

Briefly mentioned earlier, MacKinnon (2000) extended the simple mediation approach to models that include more than one mediator simultaneously. In that demonstration, the *X*-*Y* relationship was mediated by four variables. The full model was estimated in a structural equation modeling program which supplied the asymptotic variances and covariances of the parameter estimates. From these estimates, the standard errors for the specific and total indirect effects were derived, as described in Equation 30.

This approach employs a particularly restrictive assumption, which impacts the calculation of the standard errors of the indirect effects. The expression for the standard error is based on the assumption that the residuals for the mediators are uncorrelated. It is conceivable that two variables, each related to an independent variable and dependent variable, show some sort of relationship to each other. In the multiple mediator model, the correlation between the mediators due to *X* would be accounted for by their

relationship to *X*. Any remaining correlation would be contained in the covariance between the error terms of M_1 and M_2. Figure 2 shows the models with the correlated errors included. In MacKinnon's (2000) example, these covariances were constrained to zero. It is arguable that treating the multiple mediator model as a simple extension of the simple mediation case could lead to more inaccuracy in the standard error estimation as proposed by MacKinnon.

A brief discussion of the derivation of the coefficient variances and covariances is warranted to illustrate how this assumption of uncorrelated errors can affect the standard error estimate. Bollen (1989) provided a more detailed description of the asymptotic variances and covariances. The inverse of the Fisher Information matrix, $\mathbf{I}\left(\hat{\boldsymbol{\Theta}}\right)^{-1}$, contains the variances of the estimates of model parameters on the diagonal while the off-diagonal terms are the covariances. In this example, $\hat{\boldsymbol{\Theta}}$ is the covariance matrix, $\hat{\boldsymbol{\Sigma}}$. An individual term in $\mathbf{I}\left(\hat{\boldsymbol{\Theta}}\right)$ is defined as

$$\mathbf{I}\left(\hat{\gamma}_i, \hat{\gamma}_j\right) = \frac{N}{2} tr\left[\hat{\boldsymbol{\Sigma}}^{-1} \frac{\partial \hat{\boldsymbol{\Sigma}}}{\partial \hat{\gamma}_i} \hat{\boldsymbol{\Sigma}}^{-1} \frac{\partial \hat{\boldsymbol{\Sigma}}}{\partial \hat{\gamma}_j}\right] \tag{39}$$

with $\hat{\gamma}_i$ being the estimate of parameter *i*. As shown in Equations 8, 9 and 10, $\hat{\boldsymbol{\Sigma}}$ can partitioned in LISREL notation as follows

$$\hat{\boldsymbol{\Sigma}} = \left(\mathbf{I} - \hat{\mathbf{B}}\right)^{-1} \hat{\boldsymbol{\Psi}} \left(\mathbf{I} - \hat{\mathbf{B}}'\right)^{-1} \tag{40}$$

For the model in Figure 2, the parameter estimates are

$$\hat{\mathbf{B}} = \begin{array}{c} \\ X \\ M_1 \\ M_2 \\ Y \end{array} \begin{array}{c} \begin{array}{cccc} X & M_1 & M_2 & Y \end{array} \\ \begin{bmatrix} 0 & 0 & 0 & 0 \\ \hat{a}_1 & 0 & 0 & 0 \\ \hat{a}_2 & 0 & 0 & 0 \\ \hat{c}' & \hat{b}_1 & \hat{b}_2 & 0 \end{bmatrix} \end{array} \text{ and } \hat{\mathbf{\Psi}} = \begin{array}{c} \\ X \\ M_1 \\ M_2 \\ Y \end{array} \begin{array}{c} \begin{array}{cccc} X & M_1 & M_2 & Y \end{array} \\ \begin{bmatrix} \hat{\psi}_{11} & 0 & 0 & 0 \\ 0 & \hat{\psi}_{22} & \hat{\psi}_{23} & 0 \\ 0 & \hat{\psi}_{32} & \hat{\psi}_{33} & 0 \\ 0 & 0 & 0 & \hat{\psi}_{44} \end{bmatrix} \end{array} \quad (41, 42)$$

Thus, in calculating the variance for many of the estimates of these parameters, the covariance between the residuals of the mediators ($\hat{\psi}_{32}$) is included. In MacKinnon's approach, the covariance of the mediator errors was constrained to zero. The model should be estimated with the error covariance included.

There are numerous issues for the researcher to consider when assessing the significance of indirect effects in multiple mediator models. First, the assumption of normality of the distribution of the product of the two coefficients involved in each specific indirect effect may not be correct. If the sample size is large enough, normality of the sampling distribution may be achieved. However, in psychological research sample sizes are usually relatively small and the distributions are likely to show substantial skew and kurtosis. Non-normality in the sample data can substantially affect the estimate of the standard error and confidence interval calculations, as demonstrated by MacKinnon et al. (2004) and Stone and Sobel (1990). Also, confidence intervals obtained by the MDM method are necessarily symmetric. If the sampling distribution is skewed, the resulting confidence interval is inaccurate.

In addition, the multiple mediation model presented by MacKinnon (2000) makes the strong assumption that the mediators are not correlated beyond the relationship accounted for by *X*; the error covariance is constrained to zero. In the

calculation of the variance-covariance matrix of the coefficients, the Fisher Information Matrix uses that correlation in the calculation of some elements. It may indeed be true that there exists little or no correlation between the errors; in which case, assuming it is zero does not impact the calculation of the standard error of the indirect effect(s). However, it is an unnecessary restriction and can lead to inaccurate standard errors and confidence intervals.

The use of bootstrap methods to estimate the standard error and confidence interval of the indirect effects avoids both of these problems. There is no assumption about the distribution of the indirect effects. Assuming the number of resamples is large enough, skew and kurtosis in the sample do not adversely affect the bootstrapped estimate of the indirect effect or its standard error. In addition, using bootstrap methods to obtain confidence intervals avoids the assumption that the sampling distribution is normal. Lastly, because the estimate of the standard error and confidence intervals does not involve the correlation of the mediator errors, the researcher does not have make any assumption about the relationship between them.

The major concerns in the use of bootstrap methods to estimate the standard errors and confidence intervals of the indirect effects are practical. First, if the raw data are not available to the researcher, bootstrapping cannot be done. Also, obtaining bootstrap samples can take a lot of time. However, modern computer processing speeds typically make this restriction irrelevant for many models. Finally, for complicated models, especially those involving latent variables, bootstrapping can encounter a number of problems. The bootstrapped data can result in a singular covariance matrix

and the model would not estimate. However, for the simple and multiple mediation models with measured variables only, the parameters estimates can be obtained using simple and multiple regression. In addition, if the simple or multiple mediator models are saturated models, the model will always fit the data perfectly. In this case, the singularity problem can be avoided.

In the next section, a simulation study examining the behavior of the MDM and bootstrapping methods in estimating the standard error and confidence intervals of the indirect effects in a multiple mediation model is described. Data were simulated, varying on a number of factors, including sample size and amount of mediation in the population, and Type I error rates and power were obtained for each method.

CHAPTER 2

SIMULATION STUDY DESIGN

Previous research examining the distribution of the indirect effect in simple mediation models has suggested that the assumption of normality of the sampling distribution is unwarranted for small samples. Conducting hypothesis tests and calculating confidence intervals using methods that employ this assumption has been shown to be problematic. Confidence intervals obtained from the MDM were shown to have lower power and higher Type I errors than they should, particularly in smaller samples. Using bootstrapped estimates increased power and resulted in more acceptable Type I error rates, generally. The previous studies were limited to the simple mediation case, however.

The purpose of this study was to examine the performance of various methods of estimation of the standard error and confidence limits for the indirect effects in a model with two mediators. Because of the predominance of published studies using measured variable models only in mediation analyses, this research design was limited to those models. Using known population values, simulated data were generated. First, population covariance matrices varying on three dimensions were constructed. The factors manipulated for each condition were the amount of mediation in the population

(three levels), distribution of the total indirect effect between the two specific indirect effects (three levels), and covariance between the errors of the two mediator variables (two levels; ψ_{32} in Figure 2). A total of 16 population covariance matrices were created (the No Mediation, Partial Indirect Effects condition was excluded). For each population condition, datasets corresponding to five different sample sizes were generated. This process was repeated 1,000 times. In all, 80,000 datasets were simulated. For each dataset, estimates of the two specific indirect effects and the total indirect effect were obtained. Two MDM estimates of the standard error for each indirect effect were calculated; these estimates were used to calculate the 99%, 95%, and 90% confidence limits. In addition, 1,000 resamples were generated for each of the 80,000 replication samples to obtain the bootstrap estimates of the standard errors and the resulting confidence limits. Finally, from bootstrap distributions, the bootstrap percentile, bias-corrected, and bias-corrected and accelerated bootstrap estimates of the 99%, 95%, and 90% confidence limits for the specific and total indirect effects were obtained. In addition, the skew and kurtosis of each of the distributions of the bootstrapped estimates were calculated.

Since researchers use the standard error estimates and confidence intervals in hypothesis testing, the overall performance in capturing the population value is important. So, in addition to descriptive information about the standard error estimates, the performance of the confidence intervals in capturing the known population value of the specific and total indirect effects was examined. Specifically, for each population condition, the proportion of intervals that did not capture the population value was

obtained, as were Type I error rates and power. Because confidence intervals can be used to test hypotheses, the performance of the standard error is implicit in these results.

2.1 Population Conditions

Population covariance matrices corresponding to each condition were generated. The amount of mediation, partitioning of the mediation effect, and the mediator error covariance were specified first, and the population covariance structure was specified as

$$\boldsymbol{\Sigma} = \left(\mathbf{I} - \mathbf{B}\right)^{-1} \boldsymbol{\Psi} \left(\mathbf{I} - \mathbf{B}'\right)^{-1} \tag{43}$$

In general form, the parameter matrices were

$$\mathbf{B} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ a_1 & 0 & 0 & 0 \\ a_2 & 0 & 0 & 0 \\ c' & b_1 & b_2 & 0 \end{bmatrix} \text{ and } \boldsymbol{\Psi} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & \psi_{23} & 0 \\ 0 & \psi_{32} & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{44, 45}$$

Table 1 presents the parameter values for the population conditions. The population values specifying the relationships among the variables are contained in matrix **B**. $\boldsymbol{\Psi}$ contains the population variances and covariances for the variables. The diagonal values for parameters in the $\boldsymbol{\Psi}$ matrices were fixed to 1, and only the covariance between the mediators changed between the no error covariance condition ($\psi_{32} = 0$) and the error covariance condition ($\psi_{32} = .2$). The resulting covariance matrices are shown in Appendix A and examples of the path diagrams for selected populations, one for each mediation condition, are presented in Figure 3.

Population	Amount of Mediation	Partitioning of Total Indirect Effect	ψ_{32}	a_1	b_1	a_2	b_2	c'
1	Total	Equal	0	.6	.4	.6	.4	0
2	Total	Equal	.2	.6	.4	.6	.4	0
3	Total	One	0	.6	.3	.6	0	0
4	Total	One	.2	.6	.3	.6	0	0
5	Total	Partial	0	.6	.4	.4	.2	0
6	Total	Partial	.2	.6	.4	.4	.2	0
7	Partial	Equal	0	.6	.4	.6	.4	.48
8	Partial	Equal	.2	.6	.4	.6	.4	.48
9	Partial	One	0	.6	.4	0	.4	.24
10	Partial	One	.2	.6	.4	0	.4	.24
11	Partial	Partial	0	.6	.4	.4	.2	.32
12	Partial	Partial	.2	.6	.4	.4	.2	.32
13	None	Equal	0	0	.6	0	.6	.30
14	None	Equal	.2	0	.6	0	.6	.30
15	None	One	0	0	.8	0	0	.30
16	None	One	.2	0	.8	0	0	.30

Table 1: Population conditions and parameters

2.1.1 Amount of Mediation

Previous research regarding mediation has assumed that the direct effect of X on Y is zero. However, it is likely that some direct influence remains after having accounted for any mediators. Therefore, in this study, the amount of mediation in the population was manipulated. The size of the indirect effect in the population undoubtedly influences the power of the test to detect a real effect. It can be reasonably argued that the various methods used to test for the size of the effect will differ in their power. Indeed, MacKinnon et al. (2004) found that MDM showed lower power than many of the methods tested. The BC method showed the highest power. Therefore,

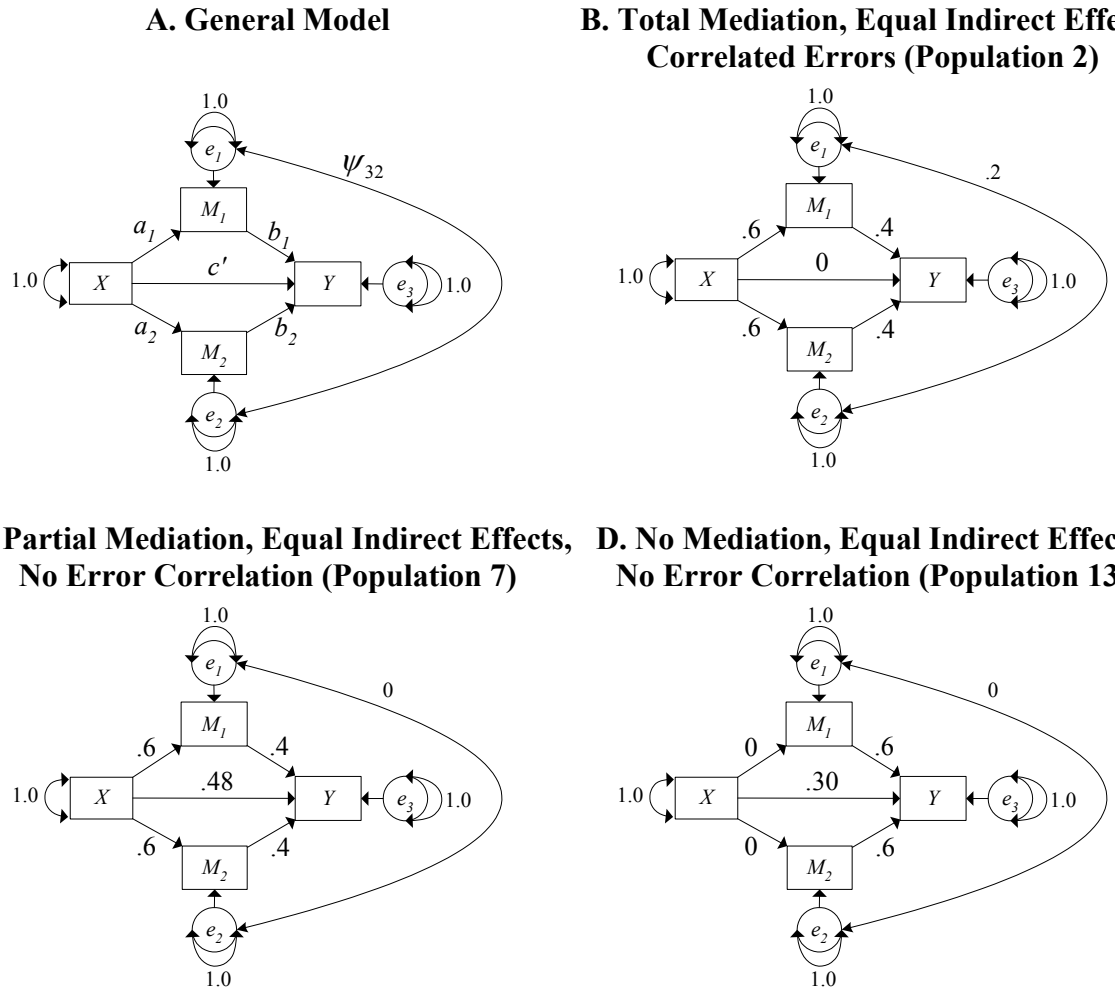


Figure 3: Path diagrams for selected population conditions.

three levels of size of total indirect effect were used. Population covariance matrices were generated showing total mediation (Total Mediation condition; Populations 1 – 6 in Table 1). For example, in Population 1 the total indirect effect was $(a_1b_1)+(a_2b_2)=(.6\times.4)+(.6\times.4)=.48$, the total effect, *c*, was .48 and the direct effect, c', was zero; the effect of *X* on *Y* was completely mediated by the two specific indirect effects. For the Partial Mediation condition (Populations 7 – 12 in Table 1), the direct effect remained sizeable. For example, in Population 7, the total effect was .96, the total indirect effect was .48, and the direct effect was .48. In this study, partial mediation was specified as the condition in which the total indirect effect was one-half the magnitude of the total effect in the population. Finally, a No Mediation condition was included (Populations 13 – 16 in Table 2.1). In this condition, both of the specific indirect effects were zero in the population, while the direct effect was sizable.

2.1.1 Partitioning of Total Indirect Effect

In models in which there are multiple mediators, it is possible that the indirect effect is attributable more to one mediator than the other. An interesting situation is one in which one mediator is responsible for the majority of the mediation effect. So, three conditions involving the distribution of the total indirect effect were included. The total indirect effect was distributed evenly in one condition, with both mediators accounting for one-half of the indirect effect (Equal Indirect Effects condition; Populations 1, 2, 7, 8, 13 and 14). For example, in Population 1, the total indirect effect was .48, and both indirect effects were .24. In the second condition, one mediator showed more

responsibility for the mediation effect, encompassing approximately 80% of the total indirect effect (Partial Indirect Effects condition). In Population 5, the total indirect effect was .32; the first specific indirect effect was .24, and the second specific indirect effect was .08. In the final condition, one mediator was responsible for the entire mediation effect (One Indirect Effect condition). For example, in Population 3, the first indirect effect was .18, and the second specific indirect effect was zero.

2.1.3 Correlated Errors

Only two conditions for the correlated errors portion of the study were examined. First, the correlation between the errors of the two mediators was fixed to zero in the population (No Error covariance condition). In the second condition, the correlation between the two mediator errors was fixed at .2 (Correlated Errors condition).

2.1.4 Sample Size

Random samples for each condition were generated. Because MDM is a large sample technique and research in the social sciences is often on small samples, five levels of sample size were included, with smaller sample sizes disproportionately represented. Data was generated for samples sizes of 30, 50, 100, 250 and 500.

For each $\boldsymbol{\Sigma}$, data were generated using a Cholesky decomposition of the matrix. For each sample size, random normal deviates for each variable were generated and postmultiplied by the Cholesky decomposition of $\boldsymbol{\Sigma}$. This resulted in a simulated set of

raw data that showed the approximate covariance structure in the population, within expected sampling error. For each population correlation matrix, 1,000 replication sample datasets were generated.

2.2 Obtaining Estimates of Standard Errors and Confidence Intervals

Three estimates of the standard error were obtained and confidence intervals for both specific indirect effects and the total indirect effect from six methods were calculated. Two MDM estimates of the standard error for each replication sample were calculated, one in which the error covariance was constrained to be zero and one in which it was estimated and included. The bootstrap estimate of the standard error was also obtained. Confidence intervals were then calculated from the standard error estimates obtained from the two MDM methods and the bootstrap. Finally, three bootstrap percentile-based methods were used to estimate the confidence intervals as well: the bootstrap percentile, the bias-corrected bootstrap percentile, and the bias-corrected and accelerated bootstrap percentile.

2.2.1 Multivariate Delta Method

For each of the replications, two MDM estimates of the standard error of the two specific indirect effects and the total indirect effect were calculated. First, the MDM estimate that assumed a zero correlation between the mediator errors was calculated. That is, the estimates for the parameter matrices $\hat{\mathbf{B}}$ and $\hat{\mathbf{\Psi}}$ were obtained. To obtain the standard error estimates for the MDM methods, the $\hat{\mathbf{\Psi}}$ matrix,

$$\hat{\boldsymbol{\Psi}} = \begin{bmatrix} \hat{\psi}_{11} & 0 & 0 & 0 \\ 0 & \hat{\psi}_{22} & \hat{\psi}_{32} & 0 \\ 0 & \hat{\psi}_{32} & \hat{\psi}_{33} & 0 \\ 0 & 0 & 0 & \hat{\psi}_{44} \end{bmatrix} \tag{46}$$

was specified. The diagonal elements in the matrix are the variance of X ($\hat{\psi}_{11}$), the mediator errors ($\hat{\psi}_{22}$ and $\hat{\psi}_{33}$), the covariance of the mediator errors ($\hat{\psi}_{32}$), and the error variance of *Y* ($\hat{\psi}_{44}$). For the condition in which there was no error included in the estimation of the standard error, $\hat{\psi}_{32}$ was constrained to zero. This estimate will be denoted MDM_{NE}. Second, the MDM estimate that included the estimated error covariance was calculated (MDM_E), allowing $\hat{\psi}_{32}$ to be freely estimated. (See Equation 30) The standard error expressions for the specific indirect effects are similar to that for the simple mediation case, with the variance and covariance values obtained from the model including *X*, M_1 and M_2 as predictors. This model was estimated in LISREL 8.50 using generalized least squares estimation. While LISREL does provide the option of obtaining the asymptotic covariance matrix of the coefficients, the Fisher Information Matrix approach was used to obtain the variances and covariances of $\hat{a}_1$, $\hat{b}_1$, $\hat{a}_2$ and $\hat{b}_2$. For the two specific and the total indirect effects, the intervals for 99%, 95% and 90% confidence levels were obtained using Equation 6.

2.2.2 Bootstrapping Methods

For each replication sample, 1,000 bootstrap resamples were obtained and the two specific indirect effects and the total indirect effect were calculated in each

resample. The standard deviation of the particular distribution of resample estimates was the estimated standard error for the indirect effect. This estimate was then used to calculate 99%, 95% and 90% confidence intervals using Equation 6. These intervals are denoted "BSE".

In addition, the BP estimates of the confidence limits were calculated. Based on MacKinnon et al.'s (2004) findings, obtaining BC estimates of the confidence interval for each indirect effect was warranted. In addition, BCA estimates were obtained. For the BP, the estimated values for the 1,000 resamples for both specific indirect effects and the total indirect effect were ordered in ascending fashion. The values corresponding to the 5^{th} and 95^{th} percentiles were the limits for the 90% confidence interval; likewise, the 2.5 and 97.5 percentile values correspond to the 95% confidence interval limits and the .5 and 99.5 percentile values correspond to the 99% confidence interval. Confidence limits for the BC and BCA methods were obtained as described previously.

While the sampling distribution of the indirect effects according to the MDM approach is assumed to be symmetric and normal, the BP, BC and BCA methods do not make this assumption. Indeed, previous research has shown this is not the case (Bollen & Stine, 1990; MacKinnon et al., 2004). So, to examine the extent of non-normality, the skew and kurtosis of the distribution of the specific and total indirect effects for each replication sample were calculated.

To summarize, various aspects of the population structure for each condition were varied systematically. Sixteen population covariance matrices varying on amount

of mediation, distribution of the total indirect effect and size of error covariance were calculated. Then, raw data for a range of sample sizes were generated. For each simulated sample dataset, the parameter estimates for the multiple mediator model were obtained. Estimates of the standard error of the specific and total indirect effects provided by six methods were calculated, and confidence intervals were obtained. The proportion of intervals that captured the population value, Type I errors and power for each population condition were calculated. The results are presented in the following section.

CHAPTER 3

RESULTS

For all sixteen population conditions, the proportion of confidence intervals that successfully captured the population value, Type I error rates, and power were calculated. First, a general overview of the results is presented, followed by a specific examination of each condition. For ease of presentation and comprehension, results are presented in figures. The tables containing the results for the 95% confidence intervals are presented in Appendix B. The results for the 90% and 99% confidence intervals are presented in Appendix C.

For all conditions, the performance of the confidence intervals was examined in order to assess the ability of the confidence intervals obtained from each of the methods to capture the true population value of the specific and total indirect effects. If the resulting confidence intervals are accurate, the percentage of confidence intervals obtained from each method of estimation that do capture the population value should match the confidence level. That is, for 1,000 replications of a particular condition, approximately 950 (95%) of the 95% confidence intervals from a given estimation method should contain the population value of the indirect effect, if the method is

accurate. This is considered the "success rate" of the method. The proportion of intervals that failed to capture the known population value is the "failure rate".

A confidence interval can fail in two ways. The interval can estimate the indirect effect as smaller than it actually is. In such a case, the upper bound of the confidence interval is lower than the population value. Alternatively, the lower bound of the interval could be higher than the population value. These intervals are considered "Too High." The sum of the "Too Low" and "Too High" rates is the failure rate. These values are reported in the tables in Appendices B and C.

The Type I error rate is a special case of the failure rate. In particular conditions, the indirect effect (specific or total) is zero in the population. A confidence interval for that effect that does not contain zero indicates that a significant indirect effect exists; a Type I error has occurred. Both the Type I error rate and the failure rate should be at the stated level of α. Here, they should be five percent.

Power of the method of estimation was examined as well. While a particular method may often capture the known population indirect effect in the confidence interval, the interval itself may be too wide to be useful. For population values that are not zero, the percentage of intervals that captured the population value and also excluded zero was examined.

Finally, descriptive statistics for the sampling distributions of the indirect effects produced by the bootstrapping procedure were calculated. The average skew and

average kurtosis of all 1,000 resamples for all conditions are reported in the tables in Appendices B and C, and are briefly discussed.[2]

3.1 General Overview of Results

The results of the simulation study ranged from the somewhat predictable to the interesting. The effect of sample size was what one would expect for nearly all conditions. In general for smaller samples, success and Type I error rates and power for all methods of estimation were worse for smaller sample sizes and much better for the larger samples. Increasing sample size, even moderately, tended to result in satisfactory power and success and Type I error rates, in most cases. These results are not especially surprising.

However, some results were less predictable. In many conditions in which an indirect effect (total or specific) was present in the population, a small sample size affected the success rates of the confidence intervals obtained from the MDM_E and MDM_{NE} methods more detrimentally than the intervals from the bootstrap percentile methods. Alternatively, for indirect effects that were zero in the population, the BC and BCA methods often showed higher Type I error rates for small sample sizes than the MDM, BSE or BP methods. There were no unexpected results for power with regard to sample size. Power was generally low for a sample of size 30, and increased to

[2] It is true that that the MDM_{NE}, MDM_E, and BSE methods are procedures that are used to estimate the standard error of a statistic, which can the be used to calculate confidence intervals. However, for ease of presentation in this paper, "MDM_{NE} intervals" should be understood to mean "confidence intervals calculated from the standard error obtained from the MDM_{NE} method. The same is true for "MDM_E intervals" and "BSE intervals".

satisfactory levels with an increase to a moderate sample size, and all methods showed similar increases in power with increasing sample size.

The effect of the correlated errors was rather small. Of the two standard errors obtained from the MDM, the MDM_E explicitly included the error correlation in the sample to be used in the calculation. Subsequently, it was expected that the confidence intervals calculated from the standard error with the error correlation included (MDM_E) would show more accurate success and Type I error rates and higher power overall than those obtained from the MDM_{NE} estimate. In the majority of conditions, the performance of the MDM_E and MDM_{NE} was similar, indicating little influence of including the error correlation in the standard error calculation. However, there were conditions in which slight differences emerged. In this simulation, MDM_{NE} actually showed slightly more power to detect an indirect effect in the sample than the MDM_E intervals. However, the higher power was also accompanied by a tendency to show a higher Type I error rate across error correlation conditions.

In addition, there was little difference in the pattern of results between the Total and Partial Mediation conditions. The effect of the size of the direct effect of *X* on *Y* seemed to have nearly no effect on the performance of the confidence intervals from the MDM and bootstrap methods of estimation, assuming that *some* amount of mediation did exist in the population; the pattern of success and Type I error rates and power was similar. Because there were no non-zero indirect effects in the No Mediation condition, Type I error rates were of particular interest, and power was not relevant. However, the pattern of Type I error rates was similar to those from the Total and Partial Mediation

conditions. The MDM methods and the bootstrap percentile methods did not show substantially different Type I error rates than they did for the Total and Partial Mediation conditions. Overall, intervals obtained from the bootstrap percentile methods sometimes showed substantially increased Type I error rates, and this was especially pronounced in the No Mediation condition.

The real difference in the performance of the various methods seemed to be due to the size of the indirect effects themselves rather than the amount of mediation or error correlation in the population. The interesting effects are observed in the results of the different partitions of the total indirect effect. In the One Indirect Effect and the Partial Indirect Effects conditions, the first indirect effect was relatively large. In the Equal Indirect Effects conditions, both specific indirect effects were sizable. It is not surprising, then, that the results for these indirect effects were similar. The BP, BC, and BCA confidence intervals showed success rates near the nominal level. The intervals calculated from the MDM methods showed low success rates for small samples, and increased to near the nominal level for larger samples. Power for these indirect effects across all methods was similar as well. For small sizes, power was low, but a moderate increase resulted in adequate power.

Success rates for the second, weaker indirect effect in the Partial Indirect Effects conditions (Populations 5, 6, 11, and 12) were rather different. Success rates for the intervals obtained from the MDM_{NE}, MDM_{E}, BC and BCA methods were low, and only reached the nominal level with the largest sample size. Interestingly, the BSE produced intervals that showed higher success rates than the nominal level at small

sample sizes, and the rates decreased steadily with larger samples. The results for the weaker second indirect effect were more predictable. Because the effect was small in the population, larger sample sizes were required to achieve adequate power, if adequate power was achieved at all. However, all methods showed similar levels of power and similar patterns.

It seems that the size of the indirect effect was an important factor in the performance of a particular method in estimating the standard error or obtaining the confidence interval. The sample size had a predictable effect on success and Type I error rates and power, and the inclusion of error correlation had a minimal effect on the MDM calculation. Finally, the amount of mediation was negligible in the differences in performance.

This general discussion focused mostly on the individual conditions (sample size; error correlation; amount of mediation; partitioning of indirect effect). However, there were interesting results in the specific combinations of conditions, which are examined in detail in the following section.

3.2 Success and Type I Error Rates

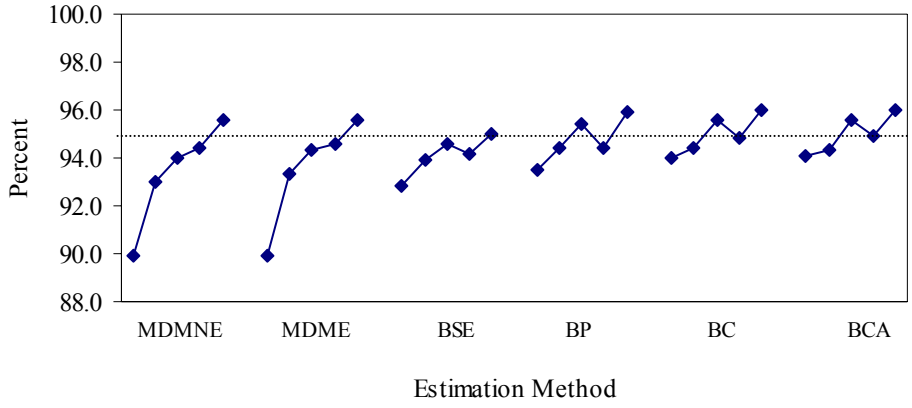
Three levels of amount of mediation present in the population were included in this study: Total, Partial, and None. The results for the Total Mediation condition and Partial Mediation condition were similar. Therefore, results will be presented for these two conditions together, and any differences between the mediation conditions will be noted. Results for the No Mediation condition are presented separately.

3.2.1 Equal Indirect Effects

In these conditions, the total indirect effect was distributed equally between the two specific indirect effects. For the both the total and partial mediation conditions, the specific indirect effects were .24 (a_1 = .6; b_1 = .4; a_2 = .6, b_2 = .4); in the partial mediation condition, the direct effect, c', remained sizable. Because both indirect effects were equal, the performance of all methods was similar for the two effects. Thus, the results for only the first indirect effect, a_1b_1, and the total indirect effect are discussed. Figures 4 and 5 present the results for the Total Mediation condition with no error covariance condition (Population 1). In this figure, the percentage of intervals that captured the population value is presented for each method of estimation. For each method there is one line with five points, representing the sample size condition in increasing order. So, for example, in Figure 4, the line for the MDM_{NE} results indicates that nearly 90% of the confidence intervals estimated captured the population value for the first indirect effect for a sample of 30. For a sample of 50, approximately 93% of intervals were successful. With an increase to a sample of 500 (the fifth point), over 95% of the intervals succeeded. The actual values are presented in the tables in Appendix B.

For the success rate figures, the dashed reference line indicates the 95% success level. If the 95% confidence interval were capturing the population value at the correct level and not consistently over or underestimating the value, the markers would be at that line. For the Type I error rate figures, the line indicates the 5% level.

A. First Indirect Effect



B. Total Indirect Effect

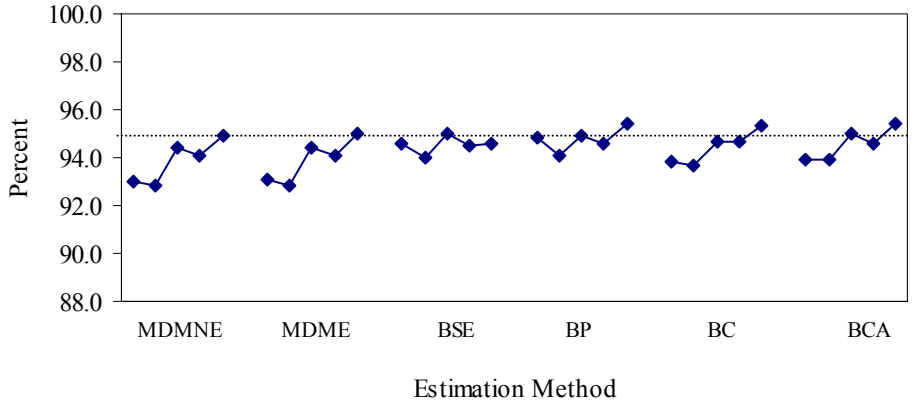
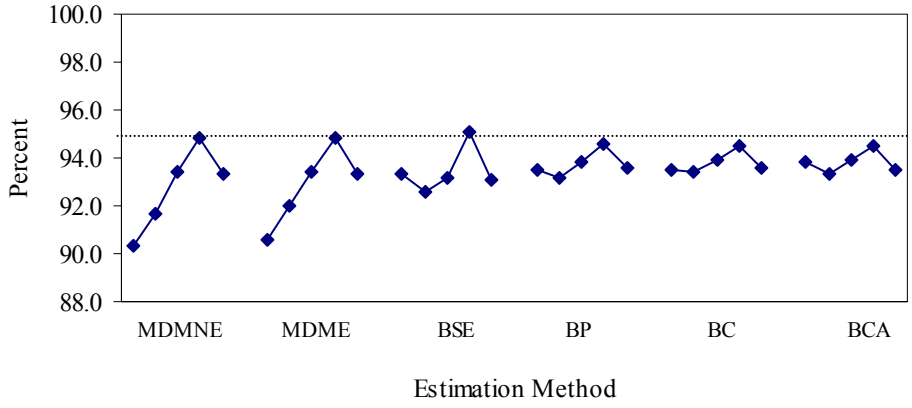


Figure 4: Success rate of 95% confidence interval, Population 1

A. First Indirect Effect



B. Total Indirect Effect

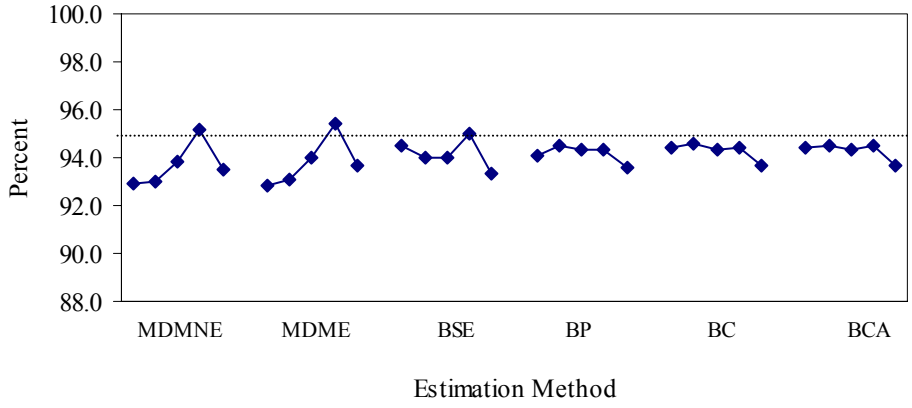


Figure 5: Success rate of 95% confidence interval, Population 7

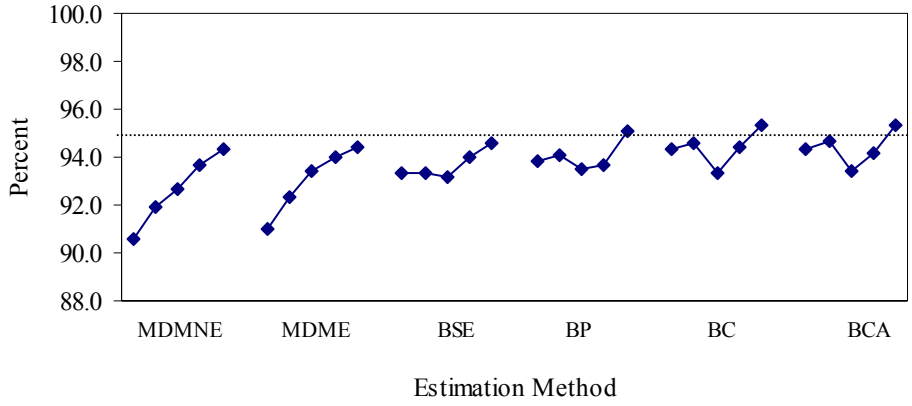
For the first indirect effect in Population 1, the MDM methods showed lower success rates than the bootstrap methods, especially for the small sample sizes, but all methods reached the nominal 95% success level with an increase in sample size (Figure 4). Even for the smallest sample size, the BP, BC and BCA intervals were all close to the nominal confidence level.

The performance for the total indirect effect confidence intervals was similar, though all values were closer to the appropriate level. The bootstrap methods, especially the BC and BCA, showed success rates closest to the nominal level for all sample sizes. The intervals obtained from the MDM_{NE} and MDM_{E} failed more often than the bootstrap intervals overall.

Figure 5 presents the results from Population 7, the corresponding population with only partial mediation. Again, the MDM methods produced intervals that showed much lower success rates with the small sample sizes for both the specific and total indirect effects. The bootstrap percentile intervals captured the population values near the 95% level for all sample sizes. However, the BC and BCA methods of estimating the confidence interval showed less fluctuation than either the BSE or the BP intervals.

The results for the conditions with correlated errors in the population are presented in Figures 6 (Population 2, Total Mediation; $a_1 = .6$; $b_1 = .4$; $a_2 = .6$, $b_2 = .4$, $\psi_{32} = .2$) and 7 (Population 7, Partial Mediation; $a_1 = .6$; $b_1 = .4$; $a_2 = .6$, $b_2 = .4$, $\psi_{32} = .2$). The results were similar to those for Populations 1 and 7. For the first indirect effect, it is apparent that for smaller sample sizes the MDM_{NE} and MDM_{E} standard error estimates resulted in confidence intervals that show a much higher failure rate than they

A. First Indirect Effect



B. Total Indirect Effect

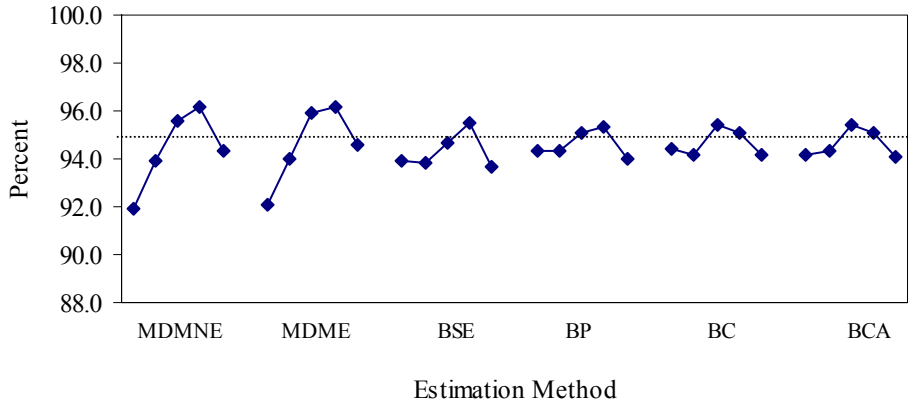
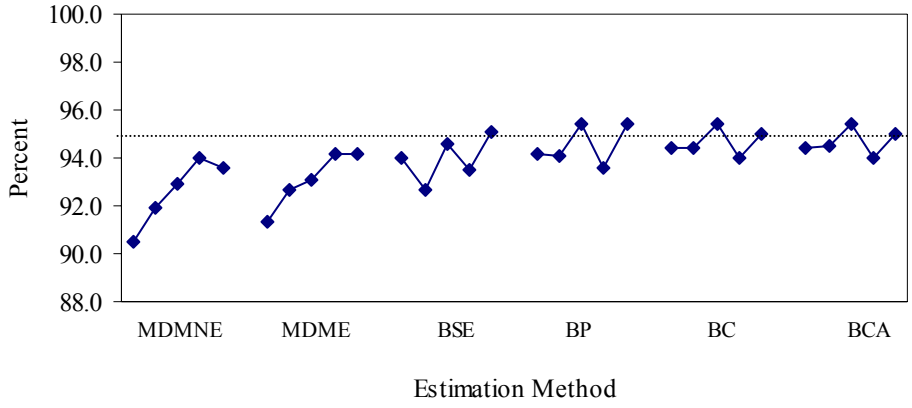


Figure 6: Success rate of 95% confidence interval, Population 2

A. First Indirect Effect



B. Total Indirect Effect

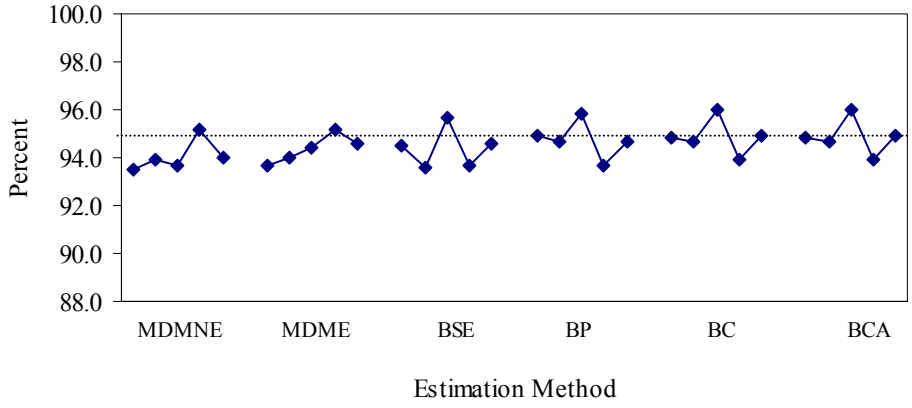


Figure 7: Success rate of 95% confidence interval, Population 8

should; for a sample size of 30, only about 90% of the MDM_{NE} and MDM_{E} intervals captured the known population value for both the Total and Partial Mediation conditions. However, even with an increase of sample size to 500, neither the MDM_{NE} nor the MDM_{E} intervals actually reached the 95% level.

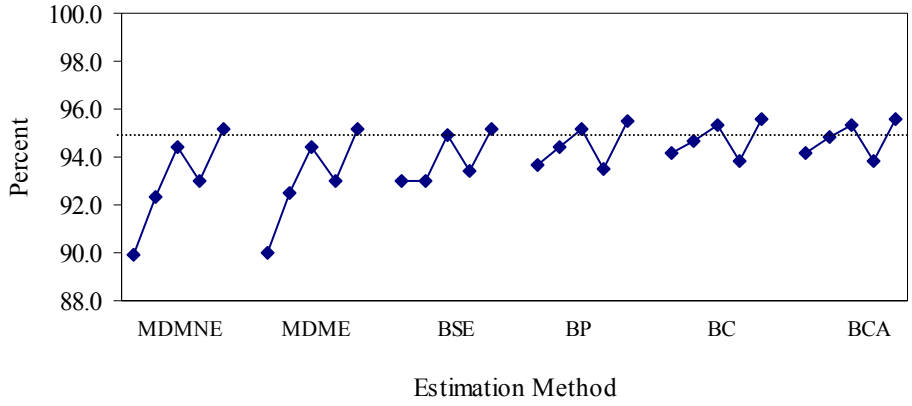
In contrast, the BP, BC, and BCA methods resulted in confidence intervals that captured the population value at least 93% of the time with a sample size of 30 and remained near that level for all sample sizes in both populations. The confidence intervals resulting from the BSE showed success rates in between the MDM methods and the bootstrap percentile methods.

For the total indirect effect, the performance for all methods in the smallest sample size condition was similar to that for the first indirect effect. The confidence intervals resulting from the MDM methods showed the lowest success rates; the BP, BC and BCA methods were close to the nominal level, and the BSE failure rate was in between but closer in pattern to the bootstrap percentile methods overall. With an increase in sample size, the BSE, BP, BC, and BCA methods fluctuated slightly around the nominal 95% level. Increasing the sample size resulted in a better success rate for the MDM_{NE} and MDM_{E} estimates, nearing the 95% level with higher sample sizes.

3.2.2 One Indirect Effect

The success rates for Populations 3 (Total Mediation) and 9 (Partial Mediation) are presented in Figures 8 and 9. In these conditions, only one of the indirect effects was responsible for mediating the relationship between *X* and *Y*; the second indirect

A. First Indirect Effect



B. Total Indirect Effect

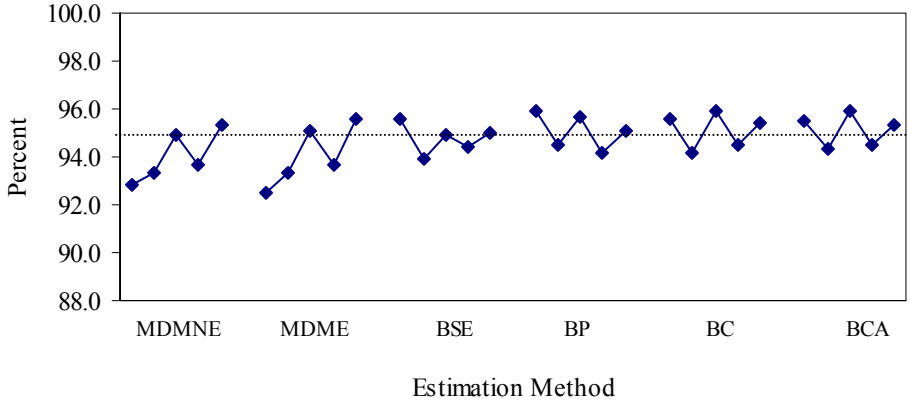
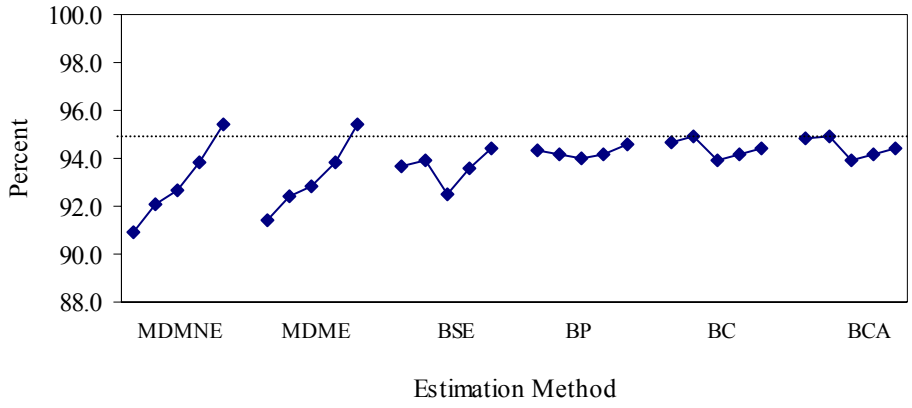


Figure 8: Success rate of 95% confidence, Population 3

A. First Indirect Effect



B. Total Indirect Effect

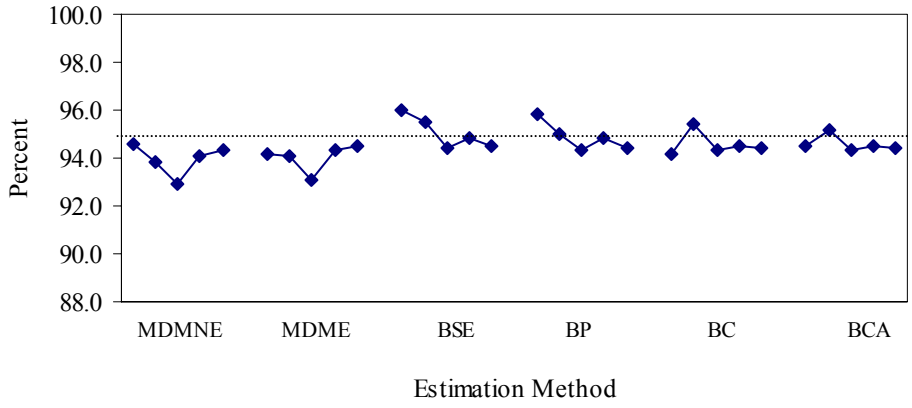


Figure 9: Success rate of 95% confidence interval, Population 9

effect (a_2b_2) was zero in the population (Population 3: $a_1 = .6$, $b_1 = .3$; $a_2 = .6$, $b_2 = 0$; Population 9: $a_1 = .6$, $b_1 = .4$; $a_2 = .6$, $b_2 = 0$). Again, for these populations, the confidence intervals resulting from the MDM_{NE} and MDM_E estimates showed a lower success rate than the nominal level with the smallest sample size while the bootstrap methods were closer to the 95% level. In Figure 8, the results for the first specific indirect effect show that the intervals from the MDM methods succeeded in only about 90% of cases, much lower than the 95% nominal level (Panel A). It was only with an increase to 500 that either of these methods of estimating the standard error resulted in intervals that captured the population value at the 95% level. The bootstrap methods showed much better success rates, with the BP, BC and BCA intervals successfully capturing the population value near the 95% level for all sample sizes. The BP and BSE intervals showed slightly more fluctuation but still tended to be more consistent than the MDM_{NE} and MDM_E intervals. The results for the total indirect effect (Panel B) show the same pattern. The results for the Partial Mediation condition, presented in Figure 9, were similar.

The second indirect effect in both populations was zero. Therefore the failure rate is the Type I error rate for this indirect effect. These errors are shown in Figures 10 and 11. In both populations, the MDM_{NE} and MDM_E methods resulted in confidence intervals with lower Type I error rates than expected for smaller samples. For a sample of 30, the figures show that both methods resulted in intervals that wrongly excluded zero in only about 1% of cases. In Population 3, increasing the sample size to 500 still did not result in an appropriate Type I error rate; both the MDM_{NE} and MDM_E methods

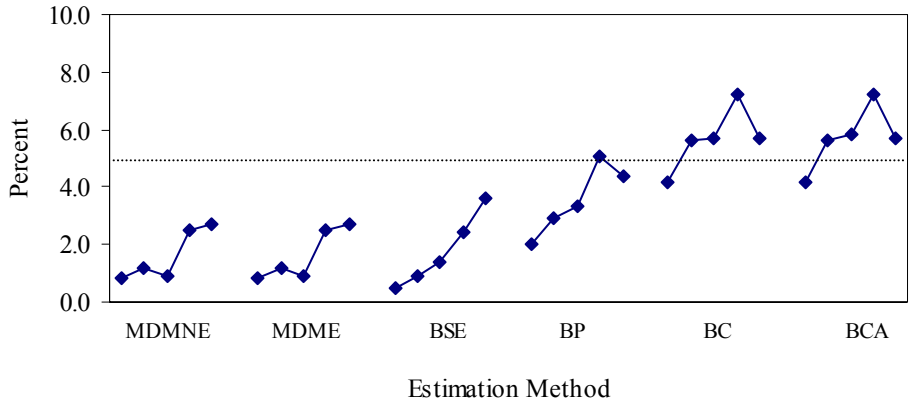


Figure 10: Type I error rate of 95% confidence interval, Second indirect effect, Population 3

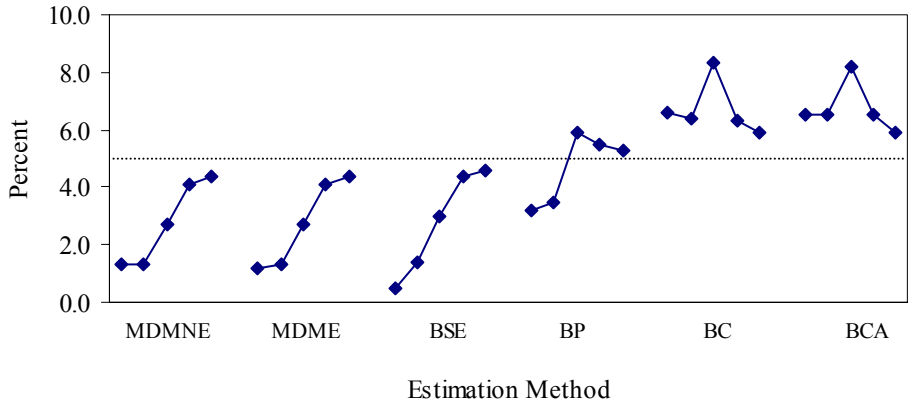
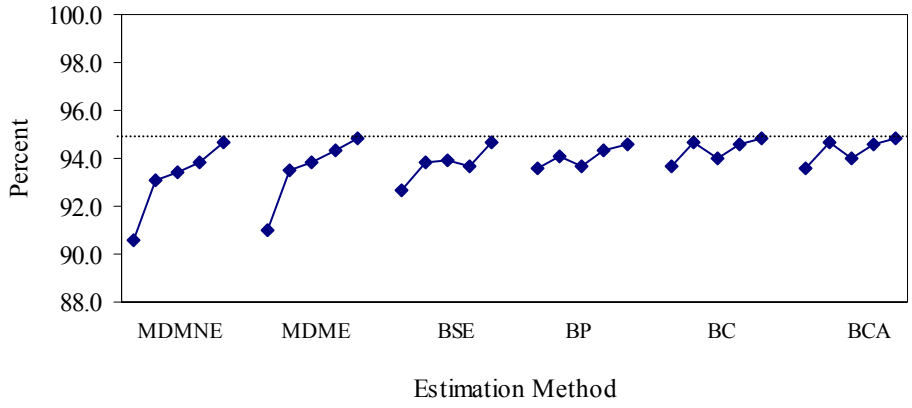


Figure 11: Type I error rate of 95% confidence interval, Second indirect effect, Population 9

showed error rates of about 3%. For Population 9, the error rates for sample of 250 and 500 were close to the nominal level. The Type I error rates for the BSE intervals were similar to the MDM methods. The bootstrap percentile methods showed error rates somewhat more consistent with the nominal level. The BP intervals for a sample of 30 showed an error rate of about 2%, but this proportion increased to near the 5% level with an increase in sample size (Figure 10). The BC and BCA intervals showed Type I error rates near 5% for nearly all sample sizes. However, there was an increase in errors to about 7% for sample of 250. In general, though, the bias-corrected confidence intervals showed better performance than any of the other intervals. The results for Population 9 were similar (Figure 11).

The results for Populations 4 and 10, the populations with one indirect effect responsible for the mediation effect and correlated mediator errors in the population, are similar to those of Populations 3 and 9. Again, the confidence intervals for $a_1 b_1$ calculated from the MDM_{NE} and MDM_E estimates of the standard error showed a lower success rate than the nominal level (Figures 12 and 13). For a sample size of 30, both methods captured the population value in less than 92% of cases in both populations. The proportion of successful intervals did approach 95% with a sample size of 500. The MDM_E intervals were slightly better than the MDM_{NE}, but the advantage was not appreciable. All the bootstrap percentile methods showed success rates only slightly lower than 95%, even with a sample size of 30, though the BC and BCA intervals showed the most consistent performance across all sample sizes.

A. First Indirect Effect



B. Total Indirect Effect

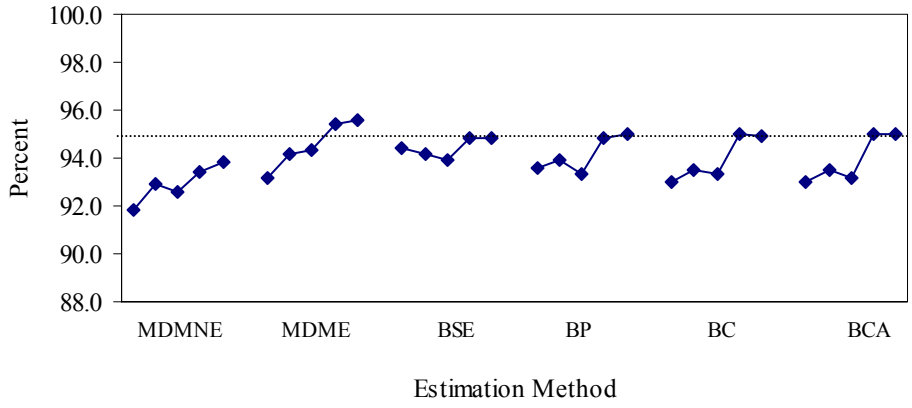
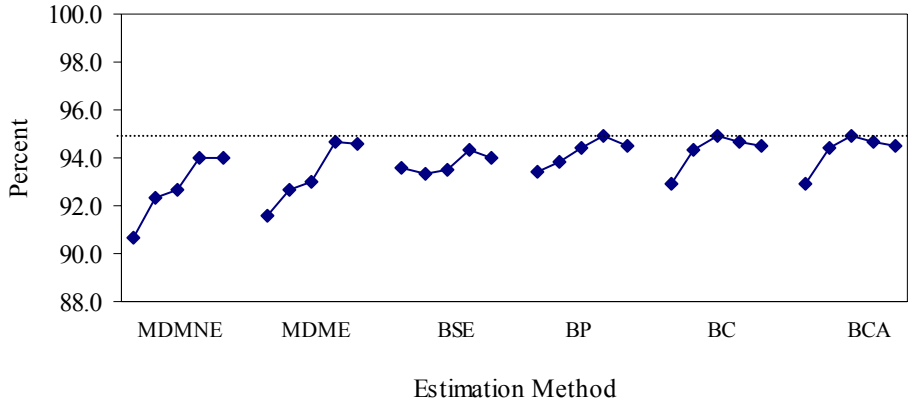


Figure 12: Success rate of 95% confidence, Population 4

A. First Indirect Effect



B. Total Indirect Effect

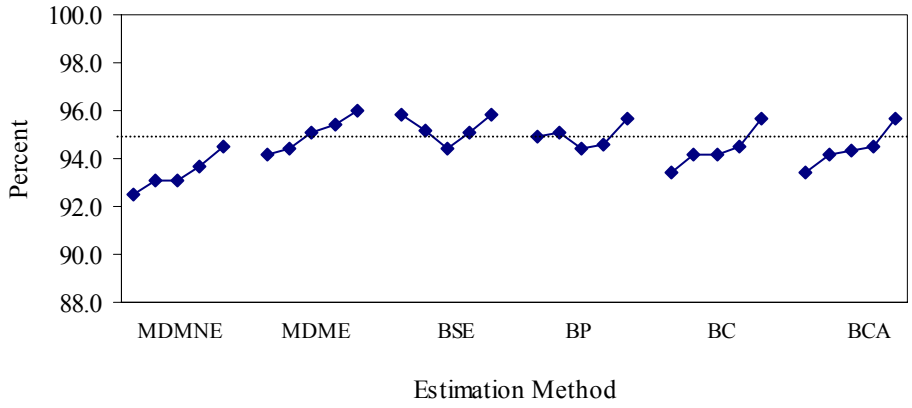


Figure 13: Success rate of 95% confidence interval, Population 10

For the total indirect effect, all methods except for the MDM_{NE} produced intervals that performed well in both populations. The MDM_E, BSE, BP, BC and BCA intervals all captured the population indirect effect value in at least 93% of cases with a sample size of 30, and reached the nominal level with an increase in sample size to 250. The intervals produced from the MDM_{NE}, however, showed a low success rate, capturing the population value only in about 92% of cases with a sample of 30 in both populations, and in less than 94% of cases with a sample of 500. In this case, it is clear that the MDM_{NE} method resulted in confidence intervals that were comparatively less accurate in capturing the known population values.

Figures 14 and 15 present the Type I error rates for Populations 4 and 10. Again, the Type I error rates for intervals from all methods were lower than the nominal level for the smaller sample sizes. The MDM_{NE}, MDM_E and BSE methods showed the lowest Type I error rates of all methods for all sample sizes, and the failure rates for all three never reached the nominal level of 5% for either of the populations. For a sample of 30, the error rates for all three methods were about 1%. With an increase in sample size to 500, the error rates were still below 5%. For a sample size of 30, the BP error rate was low as well, but higher than the MDM_{NE}, MDM_E and BSE intervals. With an increase in *n* to 50, the Type I error rate for the BP intervals was about 4% in Population 4, and it reached the nominal level with a sample of 500. For Population 10, the BP intervals approached the nominal level with a sample of 50. The performance of the BC and BCA methods in Populations 4 and 10 were somewhat different. In the Total mediation condition (Population 4), they showed slightly decreased error rates

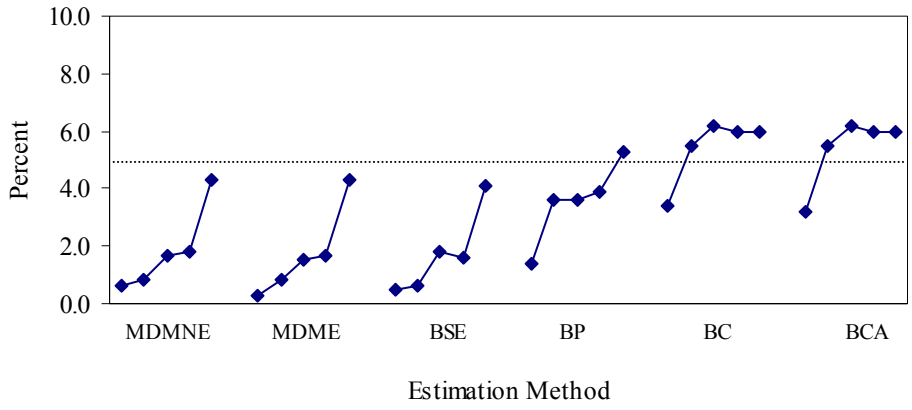


Figure 14: Type I error rate of 95% confidence interval, Second Indirect Effect, Population 4

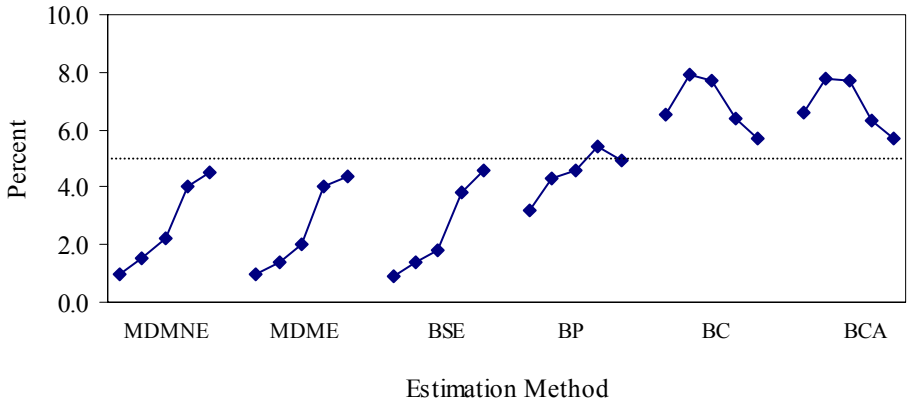


Figure 15: Type I error rate of 95%confidence interval, Second Indirect Effect, Population 10

with a small sample size. With an increase in sample size to 50, the error rates were about 6%, and they remained there for all other sample sizes. For Population 10, the Type I error rates were greater than 5% for all sample sizes.

3.2.2 Partial Indirect Effects

The results for Populations 5 and 11 are presented in Figures 16. In these populations, the first indirect effect was much stronger than the second ($a_1 = .6$, $b_1 = .4$; $a_2 = .4$, $b_2 = .2$). The results for Populations 5 and 11 were somewhat different, so they will be discussed separately. In Population 5 (Figure 16), a small sample size resulted in confidence intervals that failed to capture the population value more cases than the nominal level for all methods and all indirect effects. For the MDM_{NE} and MDM_{E} methods, less than 90% of the intervals were successful in capturing the first indirect effect (Figure 16, Panel A). The bootstrap methods showed better success rates, but none of them were at an acceptable level; the BSE and BP intervals were successful in about 93% of cases, and the BC and BCA intervals in about 92% of cases. The MDM_{NE} intervals reached the 95% level with a sample size of 250, as did the MDM_{E} and BSE intervals. The BP, BC and BCA confidence intervals reached the 95% level with a sample size of 100. However, with a sample size of 500, these three methods produced confidence intervals that captured the population value in about 96% of cases, indicating the intervals were slightly too large. The results for the total indirect effect (Panel C) were similar, though overall success rates were closer to the nominal level.

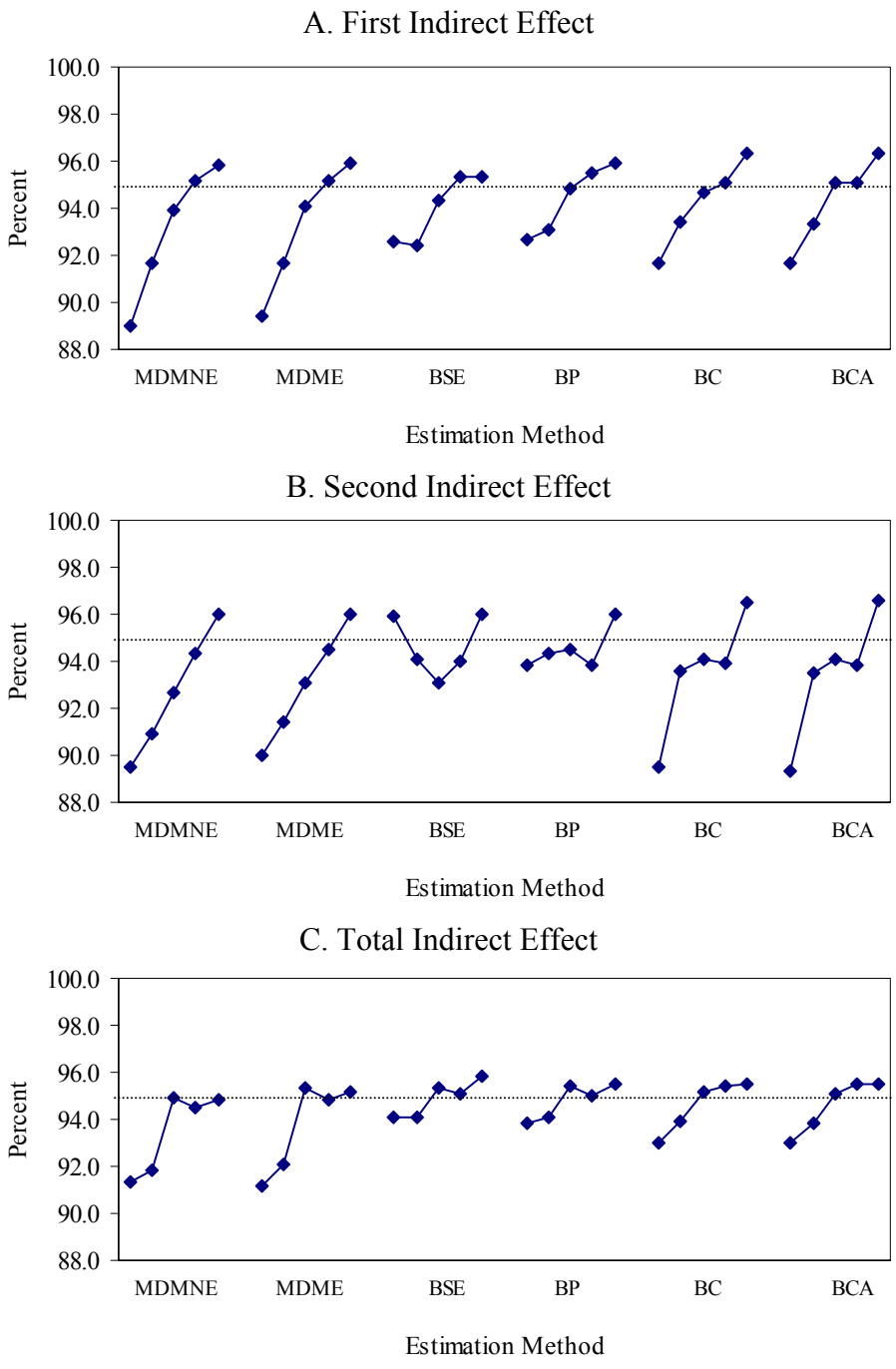


Figure 16: Success rate of 95% confidence interval, Population 5

For the weaker second indirect effect (Figure 16, Panel B), the MDM confidence intervals again showed a low success rate for a sample size of 30, capturing the population total indirect effect in less than 90% of cases. The success rates of both methods reached the 95% level with an increase in sample size to 250. The BSE and BP methods showed similar behavior overall. For an *n* of 30, the intervals from both methods showed slightly lower success rates for smaller sample sizes than expected. With an increase in sample size, success rates were about 5%. Interestingly, for this smaller indirect effect, the BC and BCA intervals captured the population value much less often than expected for the sample size of 30, in less than 90% of cases for each. Though, with a slightly larger sample size, the success rate was much closer to 95%, and remained relatively close to that level for the other sample sizes.

For Population 11 (Partial Mediation, Partial Indirect Effects), the intervals for the MDM_{NE} and MDM_{E} methods showed lower than expected success rates for the first indirect effect for the smaller sample sizes (Figure 17, Panel A). With an increase in sample size to 100, the success rates were more acceptable. The BSE success rates were slightly decreased for the small sample sizes, but reached 95% for the larger samples as well. The BP, BC, and BCA intervals all showed better success rates than the intervals calculated from the MDM and BSE methods for the small sample sizes, and remained near the nominal level for the larger sample sizes as well.

The results for the weaker second indirect effect are presented in Panel B. With one exception, all intervals showed a much lower rate of capture than expected. Only the success rate for the BSE intervals for a sample of 30 showed a higher than expected

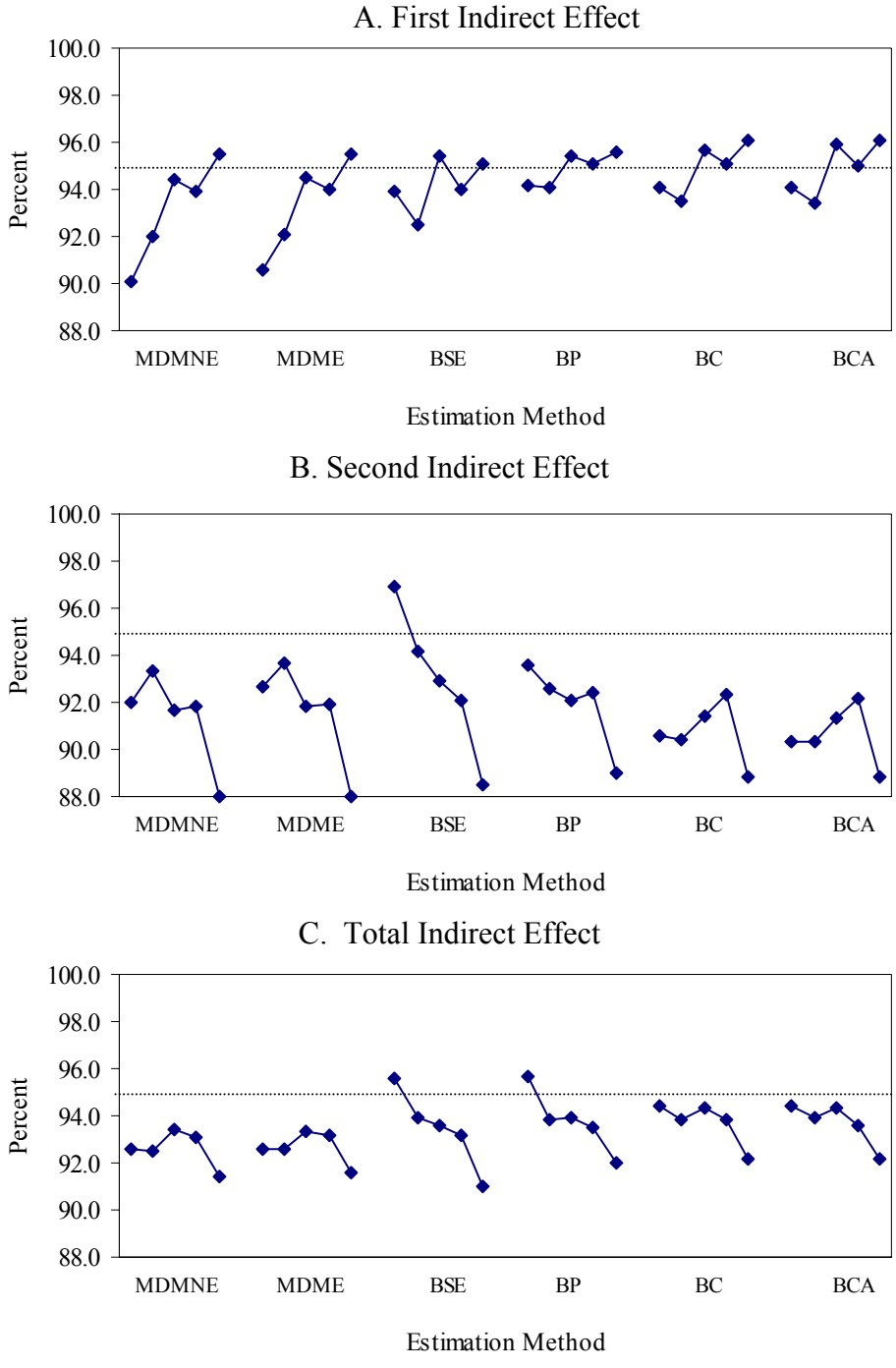


Figure 17: Success rate of 95% confidence interval, Population 11

success rate. Most other rates were less than about 92%. Interestingly, for the largest sample size, the success rate was the lowest for all methods. For the total indirect effect (Panel C), success rates were low for the MDM_{NE} and MDM_{E} intervals for all sample sizes, reaching only as high as 94%. The BSE and BP intervals showed relatively appropriate rates for all sample sizes except 500; for the sample of 500, success rates were decreased. Finally, the success rates for the BC and BCA intervals were slightly decreased for sample of up to 250, and even lower for a sample of 500.

Success rates for Populations 6 and 12 are presented in Figures 18 and 19. Again, the second indirect effect was much weaker than the first in the population. The mediator errors were also weakly correlated in the population. The results for the two populations will be discussed separately. For Population 6 (Total Mediation, Partial Indirect Effects) the confidence intervals resulting from the MDM_{NE} and MDM_{E} methods of estimation resulted in intervals that captured the population value for the first indirect effect in about 90% of cases (Figure 18, Panel A). Both MDM methods required a sample of 250 in order to reach 95%. The bootstrap methods all performed similarly, with slightly decreased success rates for small sample sizes, and increasing to the nominal level for a sample size of 250. All methods showed a similar pattern of failure rates for the total indirect effect (Panel C) as the first indirect effect.

As with Population 5, the results for the weaker second indirect effect in Population 6 (Panel B) showed that the success rates for the intervals obtained from the MDM estimates of the standard error, and the BC and BCA intervals were low for the sample of 30, lower than for the BSE and BP confidence intervals. The MDM_{NE} intervals

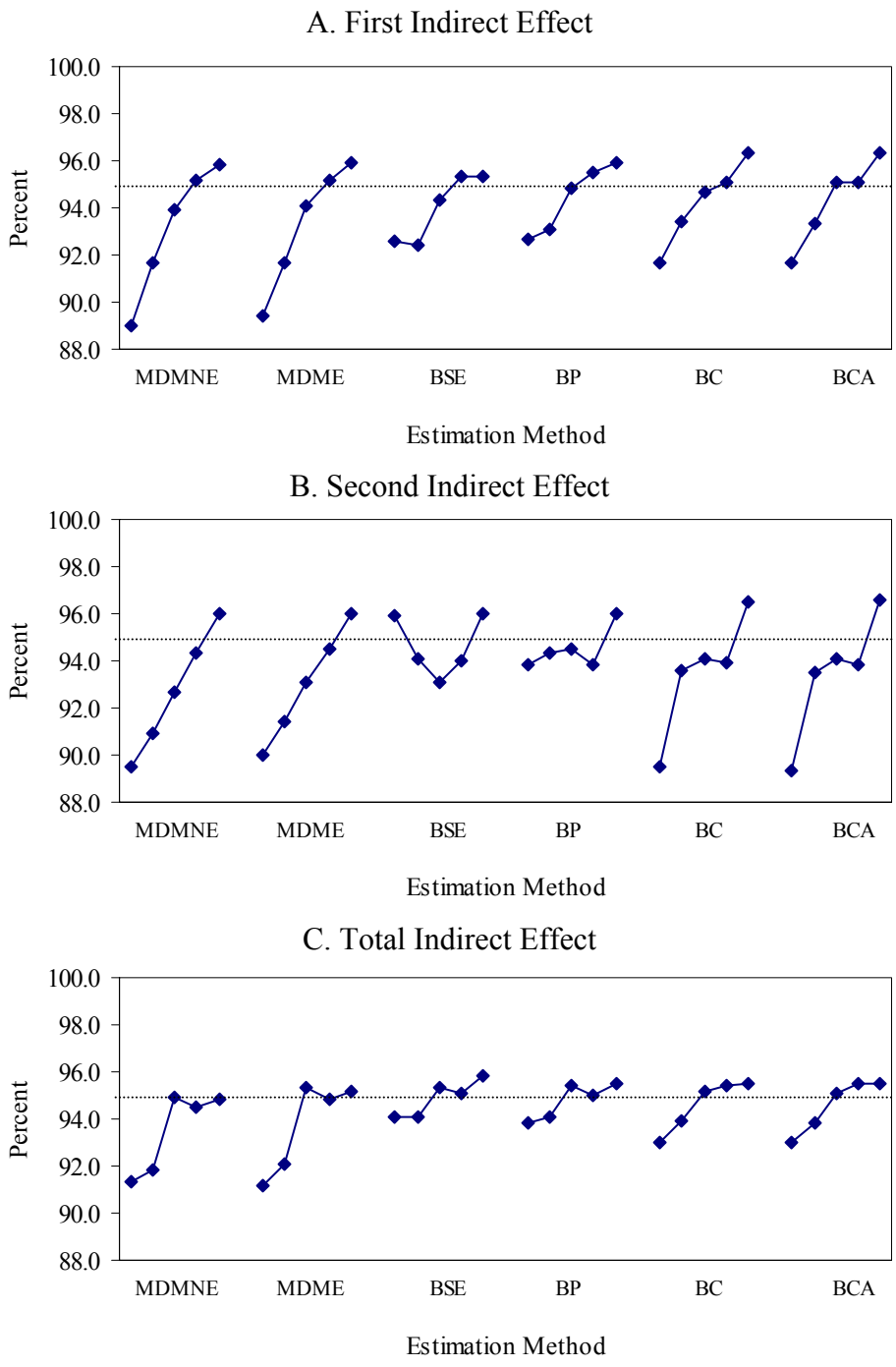


Figure 18: Success rate of 95% confidence interval, Population 6

captured the population value in only 90% of cases, and increased to an acceptable rate for a sample of 500. The rates were similar for the MDM_E intervals. The BC and BCA intervals both captured the population value in slightly more cases than the MDM methods, about 91% for a sample of 30, and required a sample of 250 to reach the 95% level. Both the BSE and BP confidence intervals showed success rates near the nominal level for all sample sizes.

The results for Population 12 are presented in Figure 19. For the first indirect effect (Panel A), intervals produced from the standard errors estimated with the MDM_{NE} and MDM_E methods showed low success rates for a 95% confidence interval. For a sample of 30, the MDM_{NE} intervals captured the population value in 90% of cases. With an increase in sample size to 250, about 95% of intervals captured the population value. With the largest sample size, the proportion of successful intervals dropped to about 93%. The MDM_E intervals showed a similar pattern, though to a lesser extent. The intervals produced with the bootstrapped standard error showed values more consistent with the nominal level, with 94% of intervals capturing the population value for an *n* of 30, 95% for a sample of 250, and some fluctuation in between. There was a similar decrease for the sample of 500. The BP intervals showed similar rates to the BSE method. Even though the proportion of successful intervals for the sample of 500 was decreased, at about 94%, it is still much closer to the nominal 95% level than for the other methods. The BC and BCA methods produced intervals that were the least affected by the change in sample size. The BC intervals captured the population value in about 94% of cases for a sample of 30; in 95% of cases for a sample

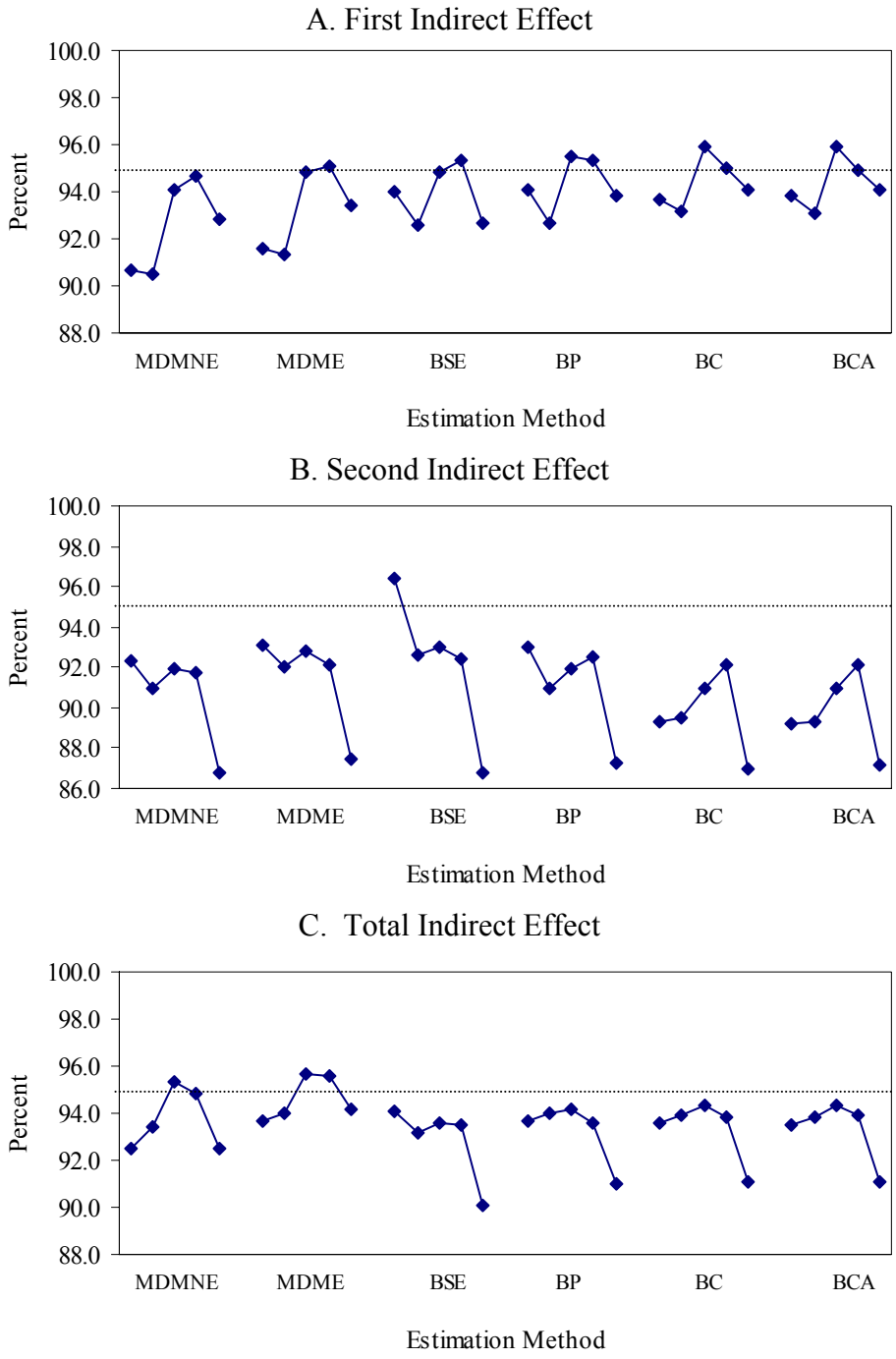


Figure 19: Success rate of 95% confidence interval, Population 12

of 250; and in slightly fewer cases for a sample of 500. For the BCA intervals, the success rates were similar.

None of the methods of estimation produced confidence intervals that were particularly impressive in capturing the population value of the second, weaker indirect effect. The results are shown in Figure 19, Panel B. For samples between 30 and 250, the proportion of cases captured by the MDM_{NE} and MDM_{E} confidence intervals was about 92%. These values decreased to below 88% for a sample of 500. Except for the sample of 30, the BSE intervals showed similar performance to the MDM intervals. For a sample of 30, the success rate was slightly above what would be expected; for all other samples, the success rate was below. The BP intervals showed rates similar to the MDM rates. The BC and BCA rates were universally poor. For a sample of 30, the BC and BCA success rates were below 90%. Approximately 92% of both BC and BCA intervals captured the population value for a sample of 250. For a sample of 500, the BC and BCA intervals captured the population value in less than 88% of cases.

The performance of all methods improved for the intervals for the total indirect effect (Panel C). The performance of the MDM_{NE} intervals improved from 92% for a sample of 30 to 95% for a sample of 100. Again, the proportion of successful intervals decreased with a sample of 500. For the MDM_{E} values, the proportion of intervals capturing the population value increased from 93% (*n* of 30) to 96% (*n* of 100). The proportion for a sample of 500 was 94%, much closer to 95% than the MDM_{NE} intervals. The intervals obtained from the BSE captured the population value in about 94% of cases for samples of 30 through 250. For a sample of 500, only 90% of

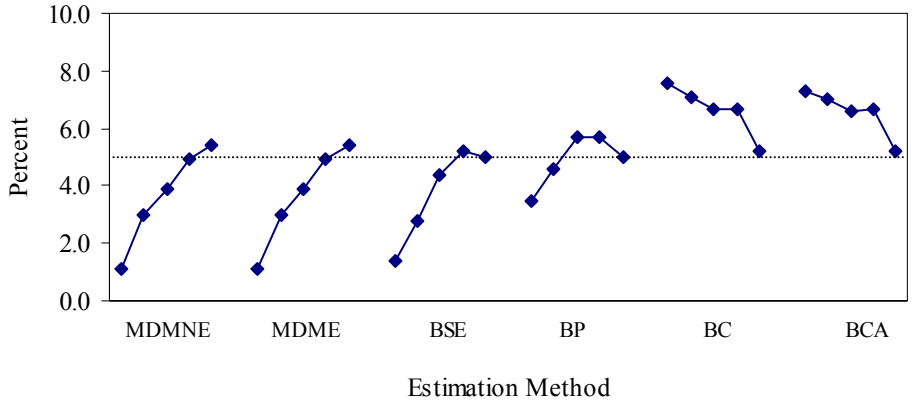
intervals were successful. The BP, BC and BCA intervals all performed similarly at all sample sizes. The intervals were successful in capturing the population value in about 94% of cases for the sample sizes of 30, 50, 100, and 250. For an *n* of 500, the rate dropped to 91%.

3.2.4 No Mediation Condition

For the last four population conditions, Populations 13 through 16, the effect of *X* on *Y* was not mediated by either of the indirect effects. Therefore, all the failure rates for these conditions are Type I error rates. Panel D of Figure 3 illustrates one of the No Mediation conditions.

Figure 20 contains the information for Population 13. The indirect effects were both zero in this condition, but the influences of the mediators on *Y* were equal. So, only the results for the first indirect effect are presented. The Type I error rates for the MDM_{NE} and MDM_{E} intervals are lower than the nominal level. For a sample of 30, the confidence intervals showed a Type I error rate of 1%. The error rates increased to an appropriate level with an increase in sample size to 250. The BSE confidence intervals showed the same pattern. The BP confidence intervals for a sample of 30 showed a Type I error rate of about 4%, but with an increase in sample size to 50, the error rate was about 5%, and remained near that level for the larger sample sizes. The BC and BCA intervals showed elevated Type I error rates, around 7% for all samples sizes except for 500. For a sample of 500, the Type I error rates were close to the expected 5%.

A. First Indirect Effect



B. Total Indirect Effect

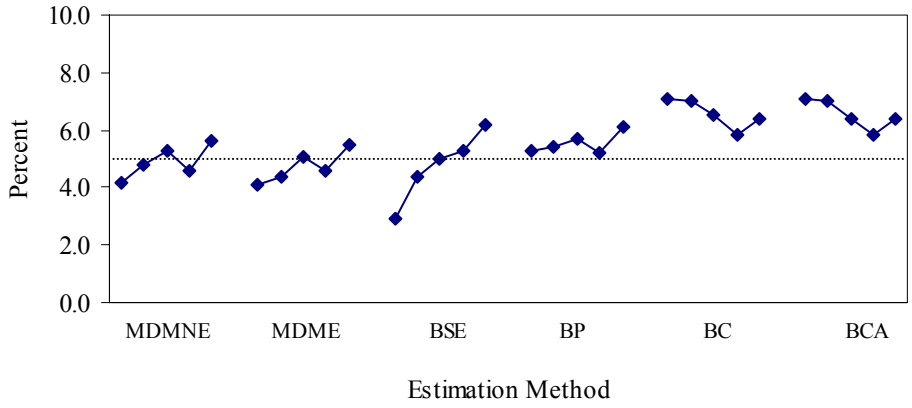
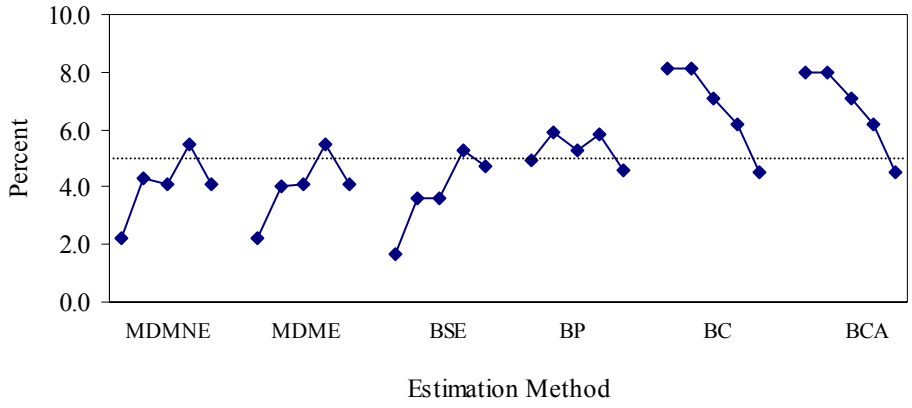


Figure 20: Type I error rate of 95% confidence interval, Population 13

The results for the total indirect effect, which was again zero in the population, are presented in Panel B of Figure 20. The Type I error rates for the MDM_{NE} and MDM_{E} intervals were acceptable for all sample sizes. The BSE intervals showed a lower than expected Type I error rate for the sample size of 30, at 3%. With an increase to 50, the Type I error rate increased to about 4% and remained near the nominal level for the intermediate sample sizes. For a sample of 500, the error rate increased to 6%. The Type I error rate for the BP confidence intervals was consistent with the nominal level across the sample sizes of 30, 50, 100 and 250. With an increase in sample size to 500, the error rate increased slightly to 6%. Finally, the BC and BCA Type I error rates were very similar to each other. For a sample of 30, the error rate for both the BC and BCA intervals was elevated, at about 7%. Increasing the sample size to 250, both methods produced intervals that failed to capture the population value in about 6% of cases. For the largest sample size, the error rate increases slightly to slightly above 6%.

Population 14 included the correlated error terms in the population. Figure 21 presents the results. Both the MDM methods produced intervals that failed to capture the population value for the first indirect effect in only 2% of cases for a sample of 30. With an increase to 100, the error rates were 4% and remained near the nominal 5% for samples of 250 and 500. The BSE confidence intervals showed a Type I error rate of less than 2% for a sample size of 30. Increasing the sample size to 100 resulted in an increase in error rate to about 3%. The samples of 250 and 500 showed appropriate Type I errors. The Type I error rates for the BP intervals were near the 5% level for all sample sizes. The BC and BCA intervals showed elevated Type I error rates for all

A. First Indirect Effect



B. Total Indirect Effect

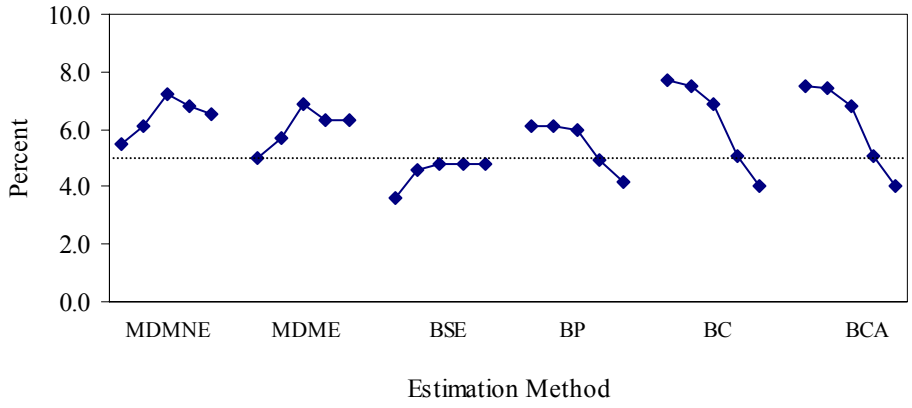


Figure 21: Type I error rate of 95% confidence interval, Population 14

sample sizes except for the largest. For samples of 30 and 50, the error rates were about 8% for both the BC and BCA methods. The error rates decreased slightly for a sample of 100, to about 7% for both methods, and to 6% for a sample of 250. The Type I errors were slightly below 5% for the sample size of 500.

The results for the total indirect effect are shown in Panel B of Figure 21. The Type I error rate for the MDM_{NE} intervals for a sample of 30 was slightly more than 5%, and increased with an increase in sample size, reaching 7% for a sample of 100. The error rates for the MDM_E intervals showed the same pattern, but were slightly more consistent with the nominal 5% level. The BSE intervals showed an error rate of about 3% for the smallest sample size. The error rates for the rest of the sample sizes were almost 5%. The confidence intervals produced by the BP method showed an error rate of 6% for samples of 30, 50 and 100, and decreased to slightly below 5% for a sample of 500. The BC and BCA methods showed a similar pattern of results. For an *n* of 30, the Type I error rates were over 7%. The error rates decreased to 5% for a sample size of 250, and to 4% for a sample of 500.

I n Population 15, again, there was no mediation in the population. However, while the influence of M_1 on Y was sizable in the population, the size of the effect of M_2 was zero. So, both elements comprising the second indirect effect, a_2b_2, were zero. The results are presented in Figure 22. For the confidence intervals obtained from the MDM_{NE} and MDM_E standard error estimates for the first indirect effect, the Type I error rates for all sample sizes were consistent with the 5% level. The Type I error rate for BSE confidence intervals for a sample size of 30 was about 3%, but increased to

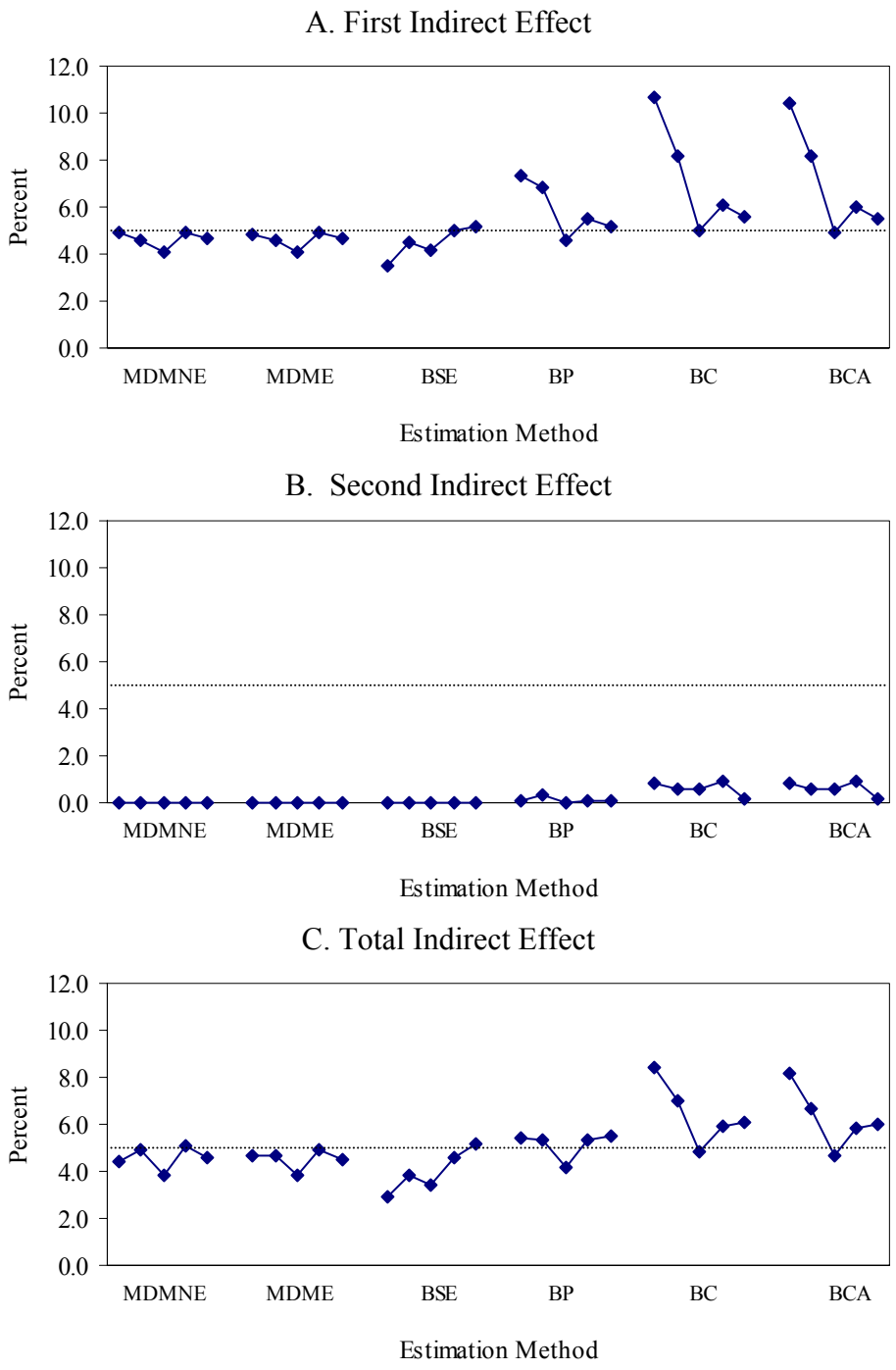


Figure 22: Type I error rate of 95% confidence interval, Population 15

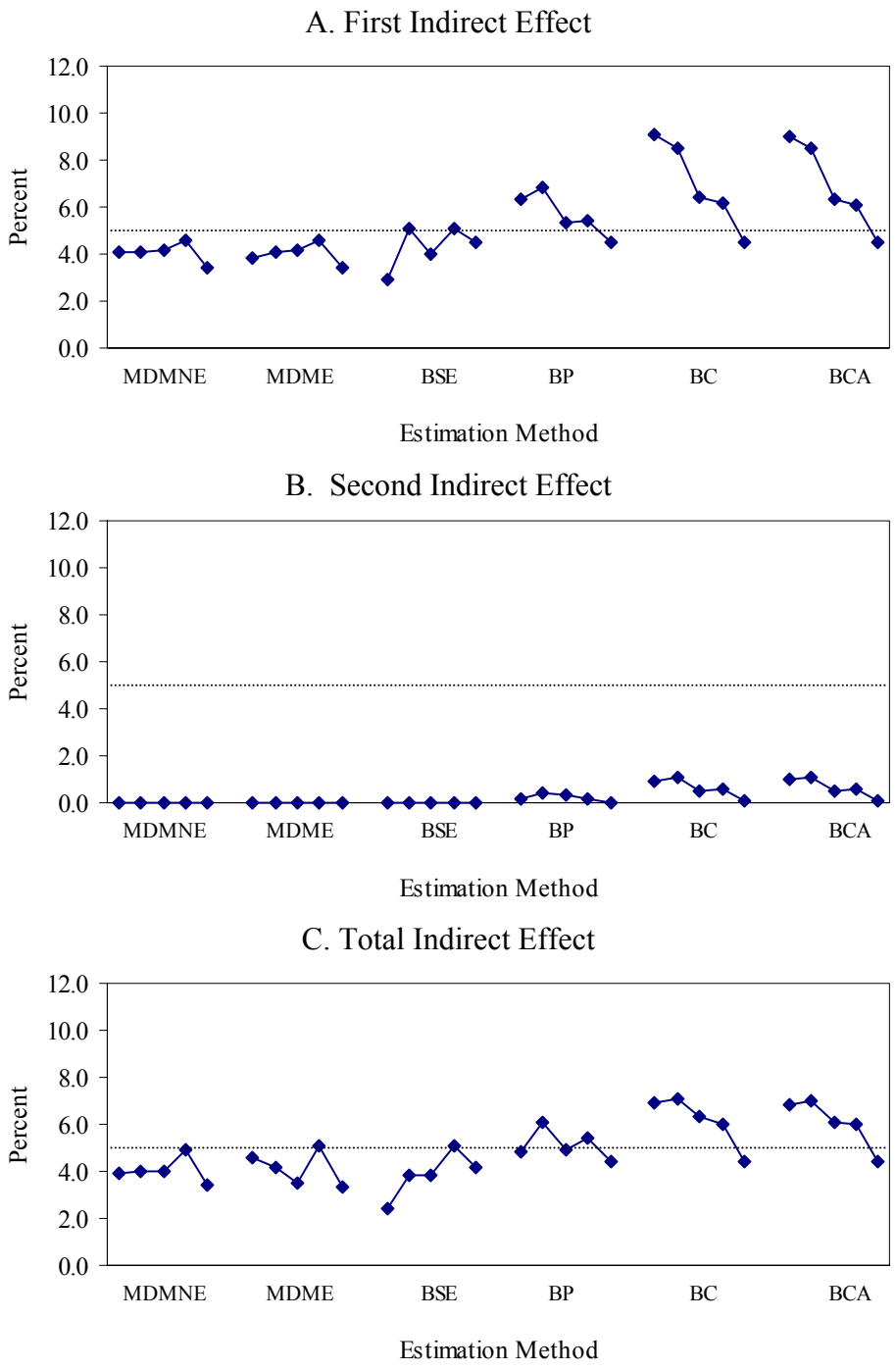


Figure 23: Type I error rate of 95% confidence interval, Population 16

about 5% for the other sample sizes. The three bootstrap percentile methods showed elevated error rates for small samples sizes, and the error rates decreased to appropriate levels with increased sample size. The BP Type I error rate for an *n* of 30 was about 7%. Increasing the sample size to 100 decreased the error rate to almost 5%, and it remained near 5% for samples of 250 and 500. The BC and BCA methods produced confidence intervals for a sample of 30 that showed very high Type I error rates, over 10% for both the BC and BCA intervals. As with the BP intervals, however, an increase to a sample size of 100 decreased the error rates to 5%.

The results for the second indirect effect, in which both elements are zero in the population, are presented in Panel B of Figure 22. The results show that all methods produced confidence intervals with very small Type I errors. Nearly every MDM_{NE}, MDM_{E} and BSE interval captured the population value of zero for all sample sizes. None of the error rates for the BP, BC and BCA intervals was greater than 1%.

Error rates for the total indirect effect are contained in Panel C. The results are similar to those for the first indirect effect. The Type I error rates for the MDM_{NE} and MDM_{E} intervals were generally acceptable, fluctuating between 4% and 5%. The intervals produced by the BSE method showed slightly decreased error rates. For a sample of 30, the error rate was 3%, and for a sample of 100, it was nearly 4%. With an increase to 250, the error rate increased to about 5%. The BP method showed acceptable error rates for all sample sizes. As for the first indirect effect, the BC and BCA methods showed a high error rate for smaller samples. For both types of intervals, error rates were over 8% for a sample of 30 and 7% for a sample of 50. Both methods

produced intervals that showed appropriate error rates with an increase in sample size to 100.

For Population 16, again, there was no mediation in the population and both elements of the second indirect effect were zero. The mediator errors were also correlated. The results are presented in Figure 23. For the first indirect effect (Panel A), the MDM_{NE} and MDM_{E} confidence intervals showed Type I error rates slightly below the nominal 5% level for all sample sizes. The same was true for the BSE confidence intervals. For the BP intervals, the error rate was elevated for smaller sample sizes, with a rate of 6% for a sample of 30 and almost 7% for a sample of 50. Increasing the sample size to 100 deceased the error rate to an appropriate level, where it remained for the larger samples. Once again, the Type I error rate for the BC and BCA intervals was high for most sample sizes. For a sample of 30, the BC intervals showed an error rate of 10%. Increasing sample size did lower the error rate, but it did not reach the nominal level until the sample size reached 500. The BCA intervals showed the same behavior. The BP method produced confidence intervals that showed performance intermediate to the BC and BCA methods and the BSE method. The error rate was slightly elevated for samples of 30 and 50, and decreased to nominal levels for the larger samples.

As with the results for the second indirect effect in Population 15, the Type I error rates for all intervals was very small (Panel B). Nearly all intervals obtained from the MDM_{NE}, MDM_{E} and BSE methods captured the population value for all sample

sizes. For the percentile methods, the error rates were similarly low, with only a few intervals for each sample size failing to capture the population value of zero.

The results for the total indirect effect are presented in Panel C. The MDM_{NE} intervals showed a slightly decreased Type I error rate for nearly all sample sizes. The intervals missed the population value in about 4% of cases overall. The MDM_{E} intervals showed error rates slightly more consistent with the nominal error rate. Most of the rates were near 5%, with the exceptions of the sample sizes of 100 and 500, which showed slightly lower rates. The confidence intervals obtained from the BSE failed to capture the population value slightly less often than expected, indicating a decreased Type I error rate for smaller samples. The error rate was appropriate for larger samples. The BP intervals, for the most part, showed Type I error rates consistent with the 5% level for all sample sizes. Again, the BC and BCA intervals showed elevated Type I error rates for the smaller sample sizes. It was only with a sample size of 500 that both the BC and BCA intervals showed an error rate of 5%.

3.3 Power

The six methods of estimation of the standard error and confidence interval for the indirect effects were also examined in reference to their ability to detect an effect that is present in the population. Sampling error and small effect sizes are problematic issues for power, so the most interesting conditions in terms of power are those that combine a relatively small indirect effect (the Partial Indirect Effects conditions) and smaller sample sizes.

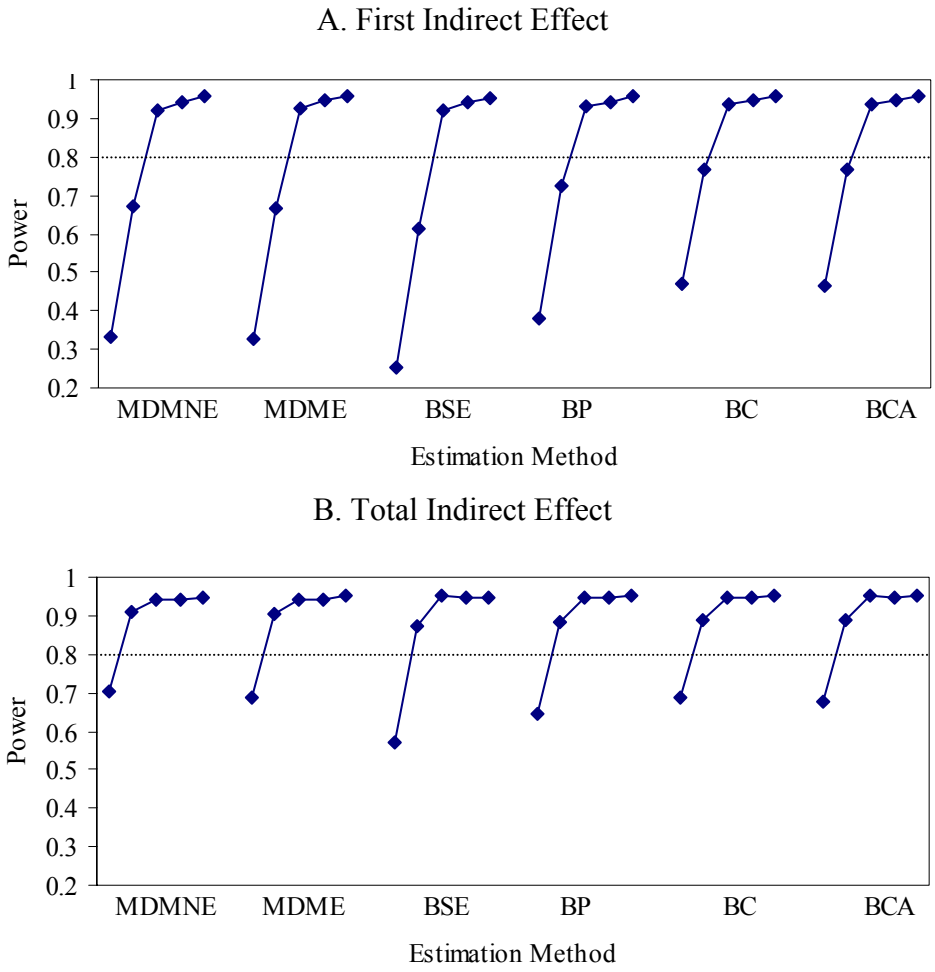
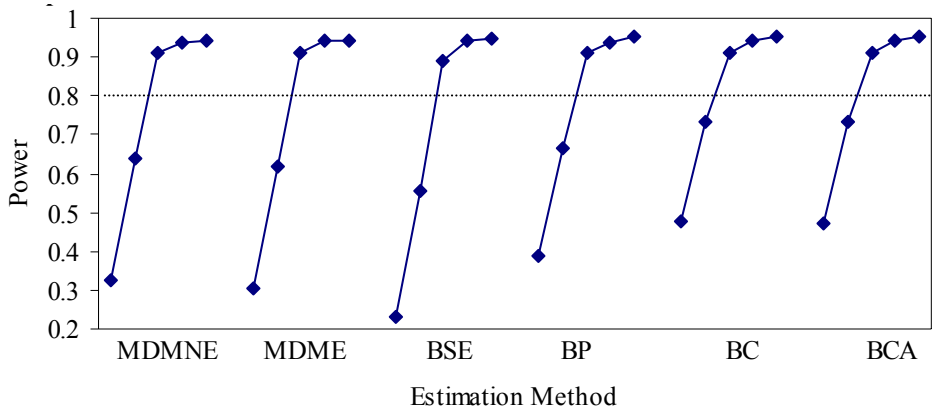


Figure 24: Power, 95% confidence interval, Population 1

A. First Indirect Effect



B. Total Indirect Effect

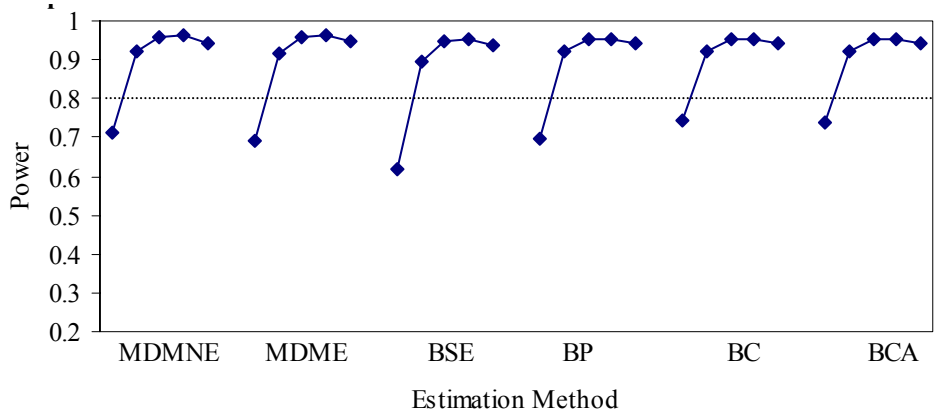


Figure 25: Power, 95% confidence interval, Population 2

For the figures in this section, power for the 95% confidence intervals obtained from each method of estimation are presented for each sample size. The dashed reference line indicates the conventional level of acceptable power, .80.

3.3.1 Total Mediation Condition

The power estimates for Populations 1 and 2 are presented in Figures 24 and 25. Because both specific indirect effects are equal in these populations, only the results for the first indirect effect are presented. Not surprisingly, power for the smaller samples was low for all methods. Figure 24 shows that for from Population 1, only about 30% of the intervals obtained from the MDM estimates of the standard error for the first specific indirect effect captured the population value and excluded zero for a sample of 30. Power rose to over .60 for a sample of 50. Only with an increase in sample size to 100 did power achieve an acceptable level, over .90. The BSE also required a sample of 100 to reach acceptable levels of power, with power slightly below that of the MDM_{NE} and MDM_{E} intervals. The percentile methods produced confidence intervals with power that was slightly higher than the normal-theory intervals, but they all still required a sample size of 100 to achieve .80 power. For the BP intervals, power was about .40 for a sample of 30; increasing the sample size to 50 did increase power to about .70. Power was above .90 for a sample of 100. The BC and BCA confidence intervals showed slightly higher power than the BP intervals for all sample sizes, and neared .80 power for a sample of 50.

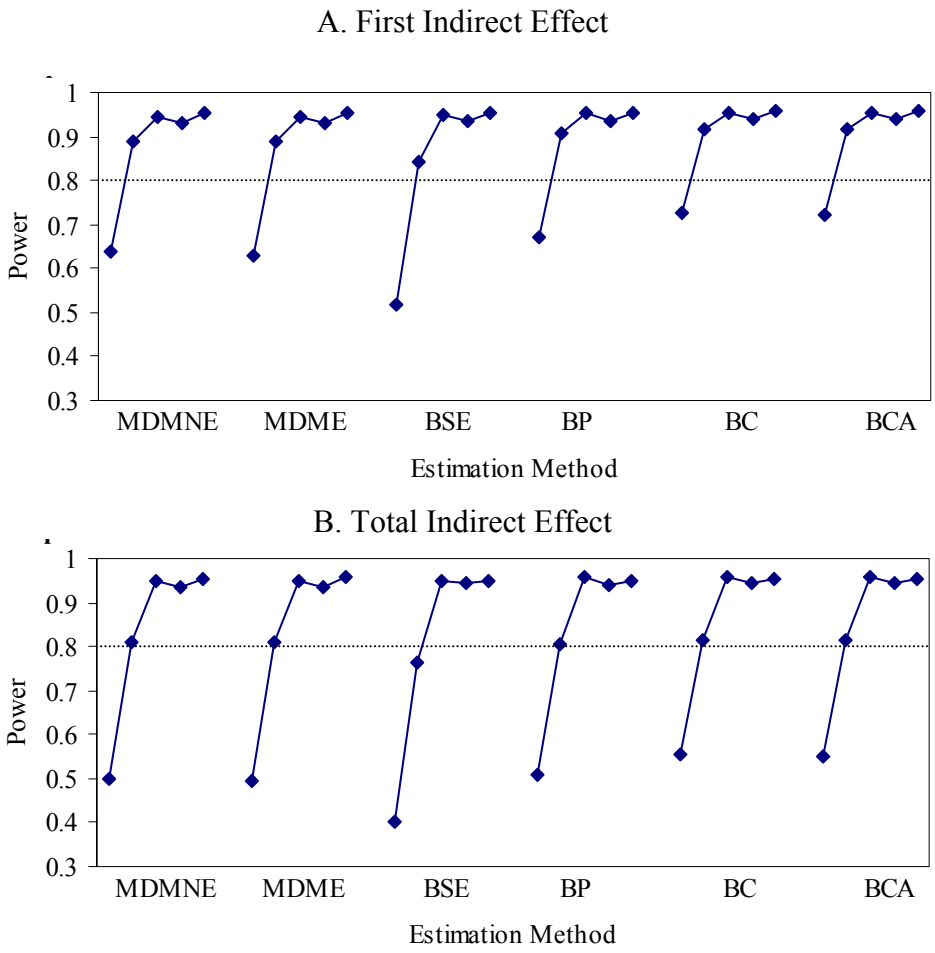
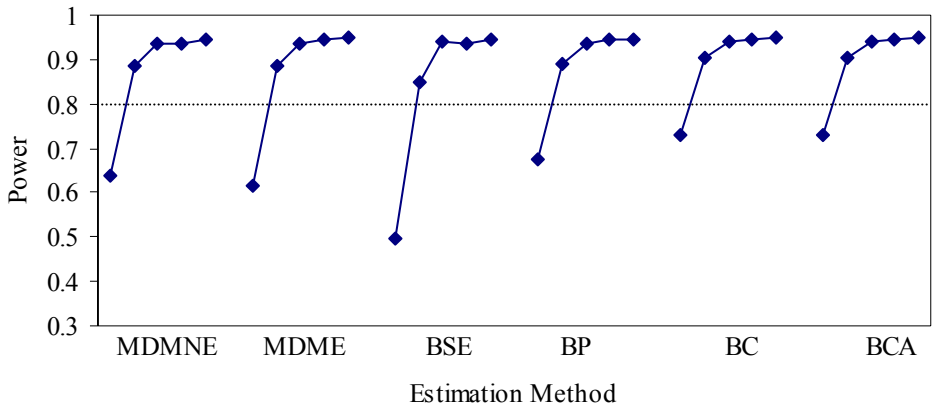


Figure 26: Power, 95% confidence interval, Population 3

A. First Indirect Effect



B. Total Indirect Effect

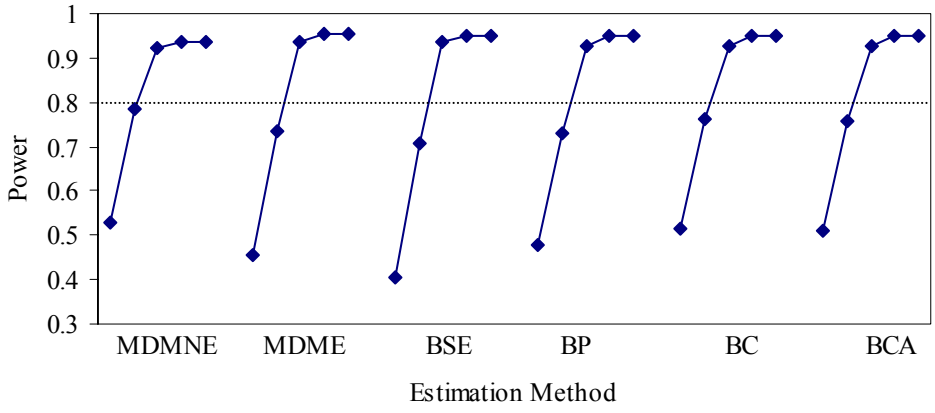


Figure 27: Power, 95% confidence interval, Population 4

The total indirect effect is much larger in magnitude than the specific indirect effects. So, it is not surprising that power is higher for all methods of estimation (Panel B). All methods required a sample of only 50 to reach at least .80 power in both populations. Even for a sample of 30, all methods were relatively good at capturing the population value and rejecting the null hypothesis. Only the power for BSE intervals was substantially below .70. The results for Population 2 are similar.

The results for Populations 3 and 4 are presented in Figures 26 and 27. Because the second specific indirect effect in these populations is zero, power is not an issue. So, only the results for the first specific indirect effect are presented.

For the first indirect effect, all methods produced confidence intervals that captured the population value and rejected the null hypothesis in at least 80% of cases with a sample of 50. For a sample of 30, MDM_{NE} and MDM_{E} confidence intervals showed power of about .60 for both populations. Power for the BSE intervals was somewhat lower, at .50. Power for the percentile methods was higher than for the MDM_{NE}, MDM_{E} and BSE methods. For the BP intervals, power was nearly .70 for the two populations. For the BC and BCA intervals, it was over .70.

Panel B in Figures 26 and 27 shows that power for the total indirect effect was slightly lower than for the first specific indirect effect. For the MDM_{NE} intervals, power for Population 3 was about .50 for a sample of 30. For Population 4, it was slightly higher. With an increased sample size of 50, power increased to .80 for Population 3 and slightly below .80 for Population 4. For the intervals calculated from the MDM_{E} estimate of the standard error, power was similar for the results for the MDM_{NE}

intervals, though slightly lower. The BSE intervals showed somewhat lower power. For a sample of 30, power was about .40 for both Populations 3 and 4. For a sample of 50, power was nearly .80 for Population 3 and about .70 for Population 4. Only with an increase in sample size to 100 did power for the BSE intervals exceed .80. For Population 3, the percentile methods showed power similar to the MDM methods. For a sample of 30, the BP intervals showed power of about .50. For the BC and BCA methods, power was slightly higher. Increasing sample size to 50 resulted in all three methods achieving power of at least .80. For Population 4, power was slightly lower. For a sample of 30, the BP, BC and BCA intervals showed power of about .50. Increasing the sample to 50 increased power to only slightly above .70. Power was above .90 with a sample of 100.

For Populations 5 and 6, the first specific indirect effect is much stronger in the population than the second specific indirect effect. Also, the first indirect effect is about equal in magnitude to the indirect effects in Populations 1 and 2. As a result, the results for all methods in detecting the first indirect effect are very similar to those for the specific indirect effect in Populations 1 and 2. In general, a sample of 100 was required for all methods in both populations to achieve acceptable power (Panel A in Figures 28 and 29). For a sample of 30, power for all intervals was low. With an increase to a sample of 50, power for the BC and BCA intervals was highest, nearing .80; all other methods produced intervals with power below .70. Also, power in Population 6 tended to be slightly lower than for Population 5.

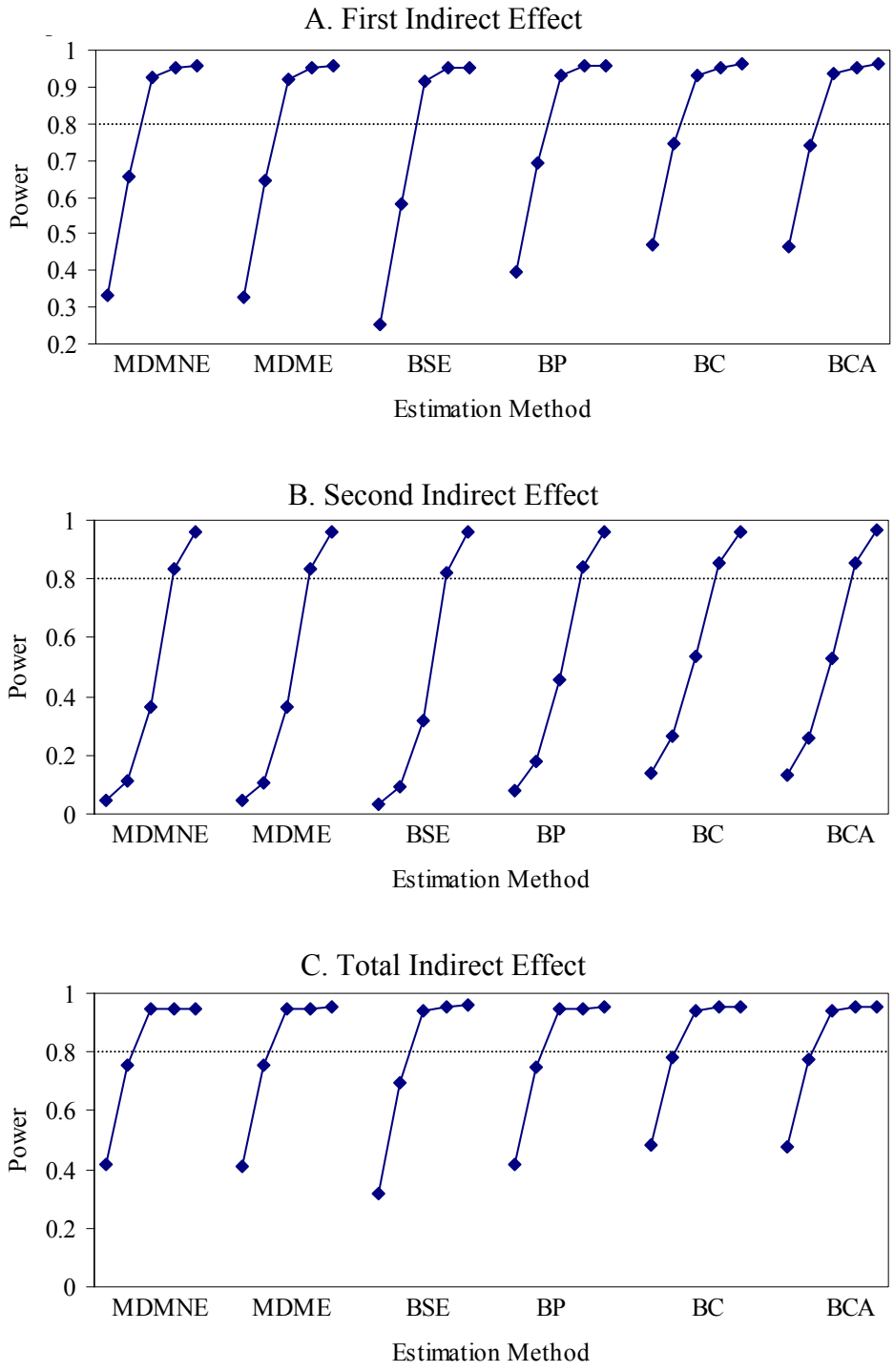


Figure 28: Power, 95% confidence interval, Population 5

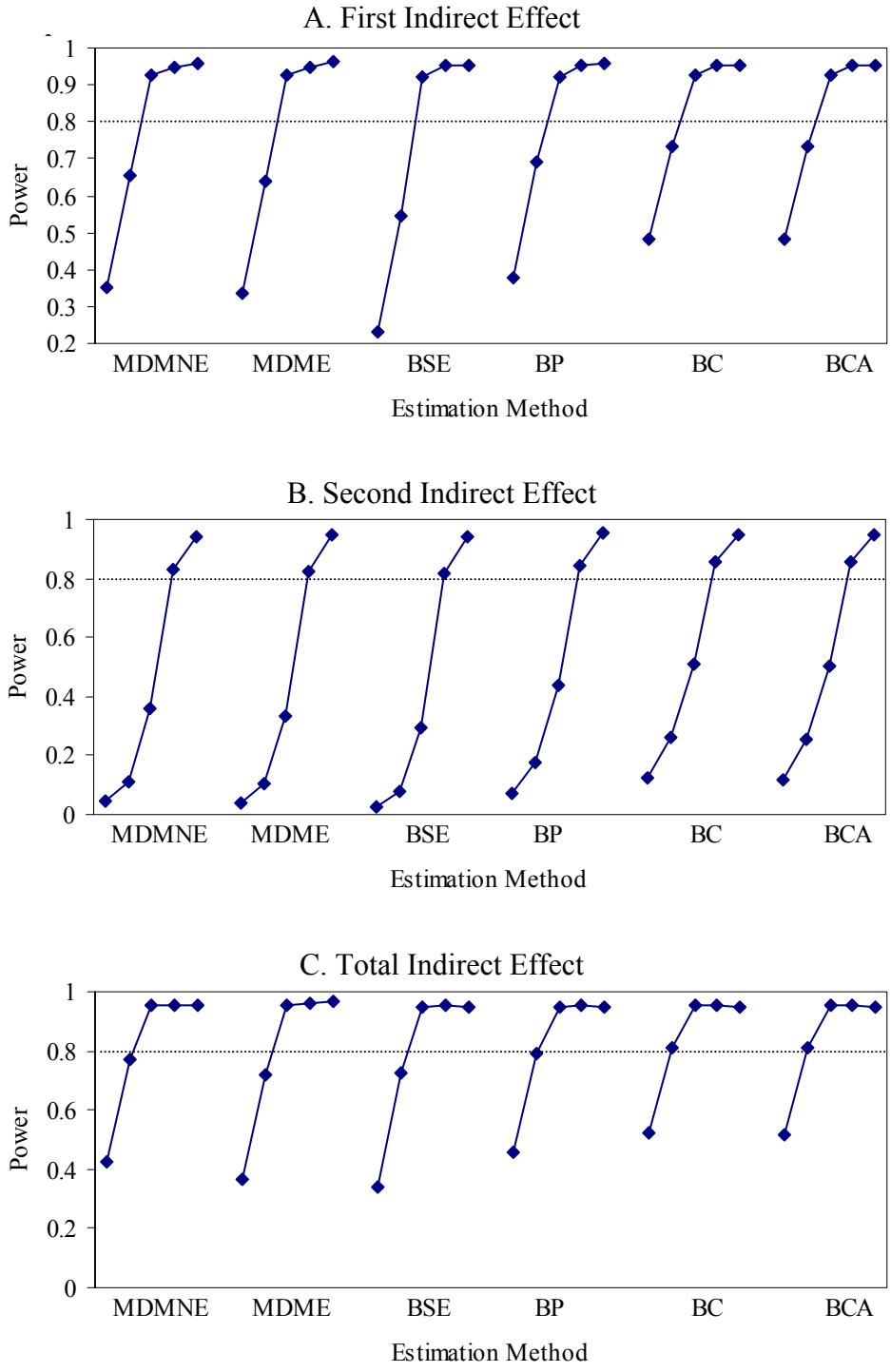


Figure 29: Power, 95% confidence interval, Population 6

The second specific indirect effect was much smaller than the first. Therefore, it is not surprising that power was lower (Panel B). Power for all methods was very low, especially for small and moderate sample sizes. For a sample of 30, power for the confidence intervals obtained from the MDM_{NE}, MDM_{E} and BSE methods of estimation was below .10 for both populations. A sample size of 50 increased power to just over .10, and for a sample of 100, power was still below .40 for both populations. Power for all three normal theory-based methods reached slightly more than .80 with a sample of 250. The BP, BC and BCA intervals showed slightly higher power than the MDM and BSE methods. However, they still needed a sample of 250 in both populations to achieve acceptable power.

For the total indirect effect (Panel C), power was much higher. The MDM_{NE} and MDM_{E} intervals required a sample of 100 to exceed power of .80. However, for a sample of 50, power was above .70 for both methods in Populations 5 and 6. The BSE intervals achieved a slightly lower level of power than the MDM intervals. The BP intervals showed more power than the normal-theory based confidence intervals, but still required a sample of 100 to reach power of .80 in Population 5; power was about .80 in Population 6. The BC and BCA intervals achieved the highest power of all the intervals. For a sample of 50, the BC intervals showed power of just slightly below .80 for Population 5 and over .80 for Population 6. The BCA intervals showed the same pattern.

3.3.2 Partial Mediation Condition

The results for Population 7 and 8 are presented in Figures 30 and 31. In these populations, the two specific indirect effects are equal in magnitude, so only the results for the first specific indirect effect are presented. In general the pattern of results is the same as for the first indirect effect for the Total Mediation condition (Figures 24 and 25). All methods required a sample of 100 for the confidence intervals to reach power of .80 for the specific indirect effect (Panel A). However, for a sample of 50, the BC and BCA intervals showed power above .70 for both Populations 7 and 8. In addition, the BC and BCA intervals showed the highest power overall, and the BSE intervals showed the lowest.

The results for the total indirect effect are presented in Panel C. Again, the results mirror those observed for the total indirect effect in Populations 1 and 2. Power for all methods and both populations reached or exceeded .80 with a sample of 50. Even with a sample of 30, most methods produced confidence intervals with power above .70. Only the intervals produced by the BSE method for both populations and the BP intervals for Population 7 were below .70. It is interesting that power for the MDM_{NE}, MDM_{E}, BC and BCA intervals for Population 7 are all very close, at about .70 for a sample of 30. For Population 8, power for the MDM_{NE} and MDM_{E} intervals did not change. However, power for the BC and BCA intervals increased to about .75.

The results for Populations 9 and 10 are presented in Figures 32 and 33. For the first specific indirect effect (Panel A), the results indicate that all methods required a

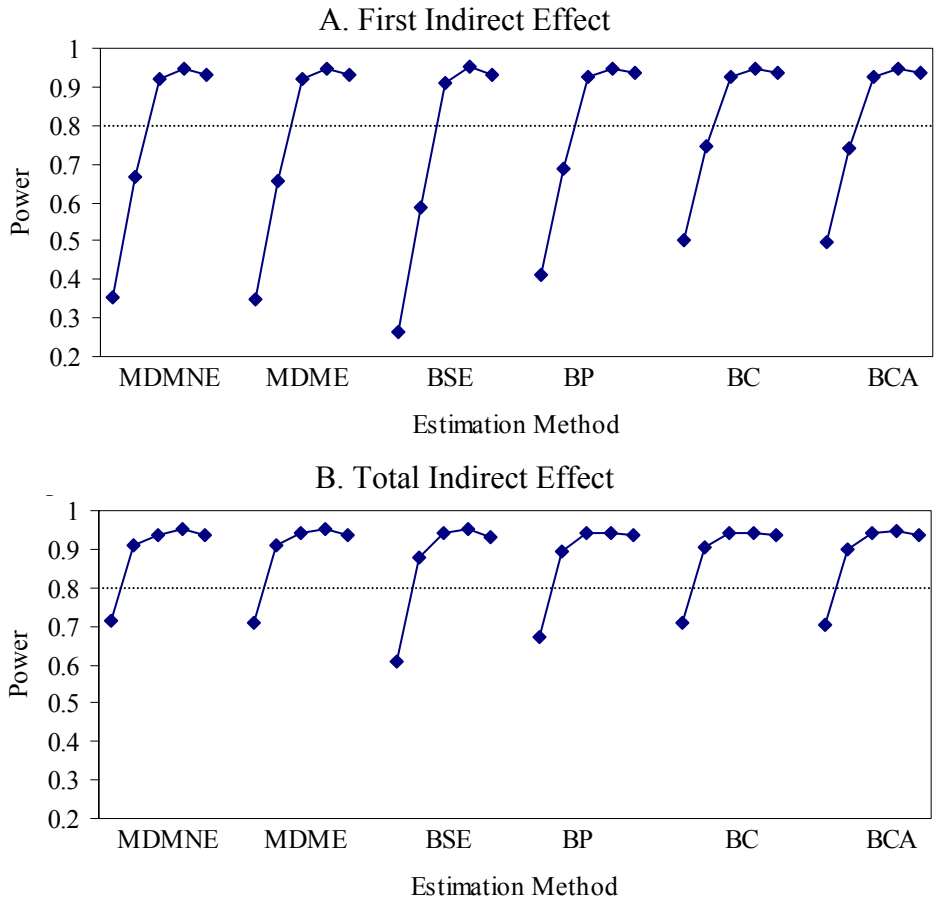


Figure 30: Power, 95% confidence interval, Population 7

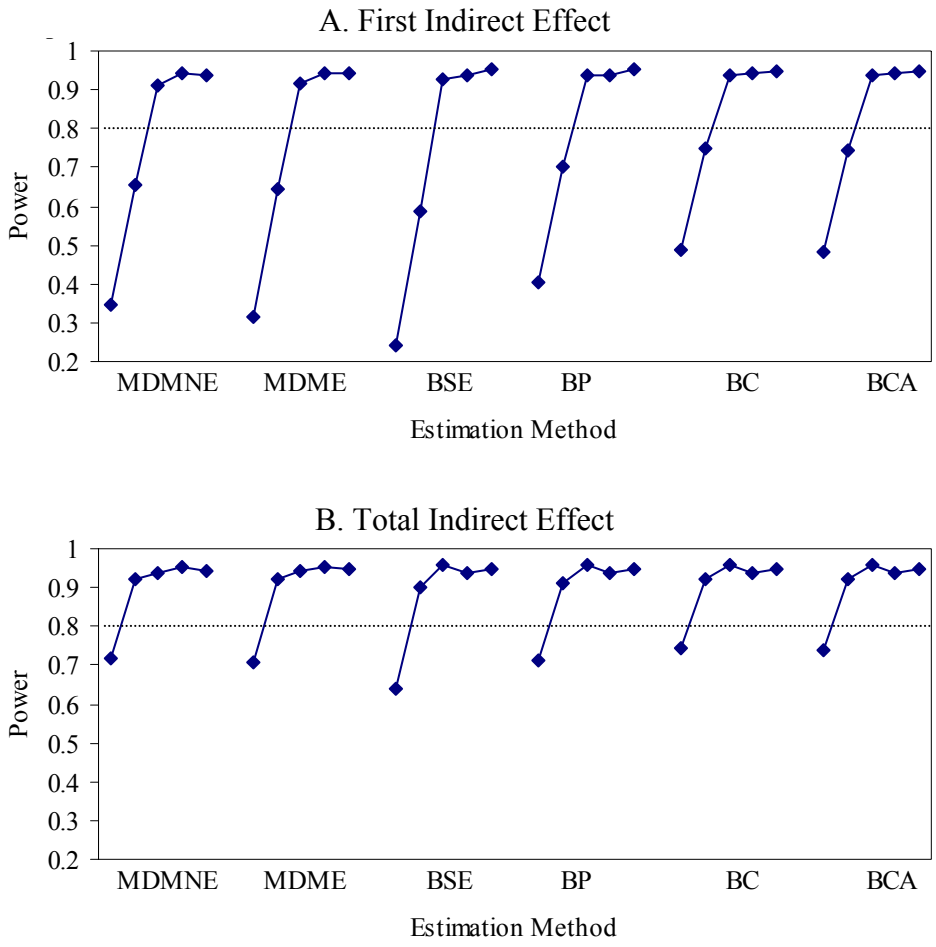


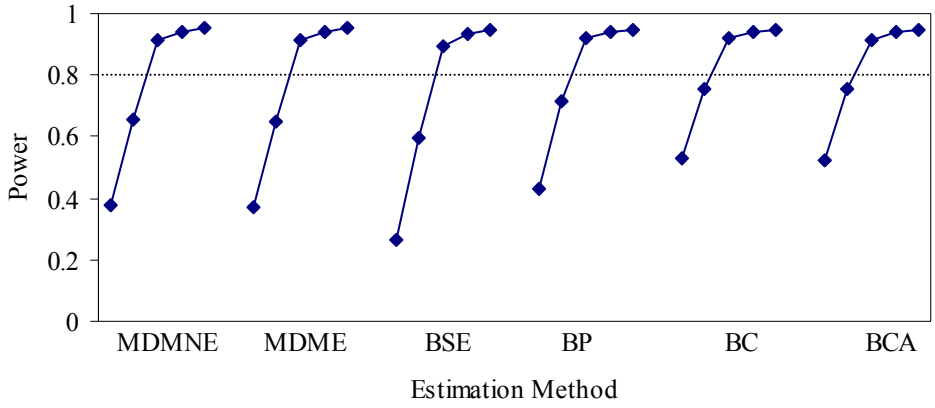
Figure 31: Power, 95% confidence interval, Population 8

sample of 100 to achieve power of .80 for both populations. For a sample of 50, the MDM_{NE} and MDM_{E} intervals reached power of nearly .70 for Populations 9 and 10. The BSE intervals showed slightly lower power, below .60 for the two populations. The percentile methods produced intervals that showed more power than the normal-theory intervals, with the BC and BCA intervals being the most powerful. For a sample of 50, the BP intervals achieved power of .70 for the two populations. Power for the BC and BCA intervals was even higher. The BC intervals captured the population value and excluded zero in nearly 80% of cases for both populations. For the BCA intervals, power reached similar levels.

The results for the total indirect effect are presented in Panel C of Figures 32 and 33. Again, power is slightly lower than for the first indirect effect. So, for Population 9, all methods required at least a sample of 100 to achieve power greater than .80. For population 10, only one of the methods (MDM_{NE}) achieved power of .80 for a sample of 100. All other methods achieved a slightly lower power for a sample of 100. For the sample sizes of 30 and 50, the BC and BCA intervals showed the highest power. Though, when "highest power" refers to levels such as .50 (BCA intervals, sample size of 50), that title is not as impressive as it may sound. Still, it is consistent with previous results.

Results for Populations 11 and 12 are presented Figures 34 and 35. The results for the first specific indirect effect (Panel A) indicate that all methods required a sample of 100 to meet or exceed power of .80. However, for a sample of 50, the BC and BCA intervals showed near-acceptable levels of power. For the same sample size, power for

A. First Indirect Effect



B. Total Indirect Effect

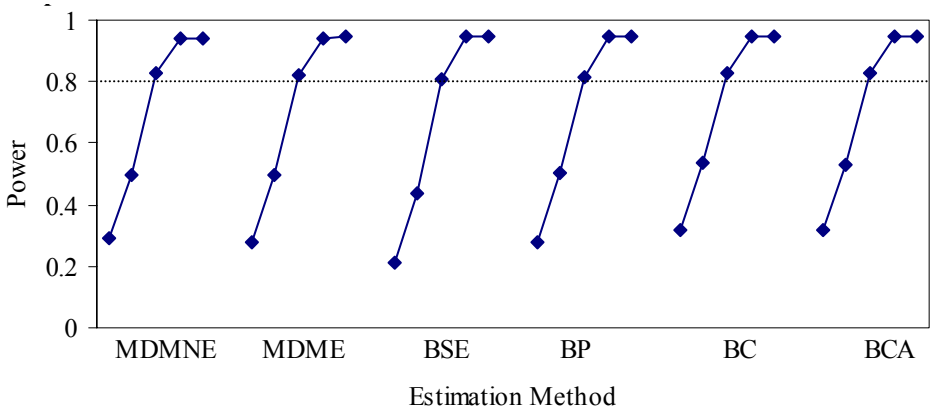
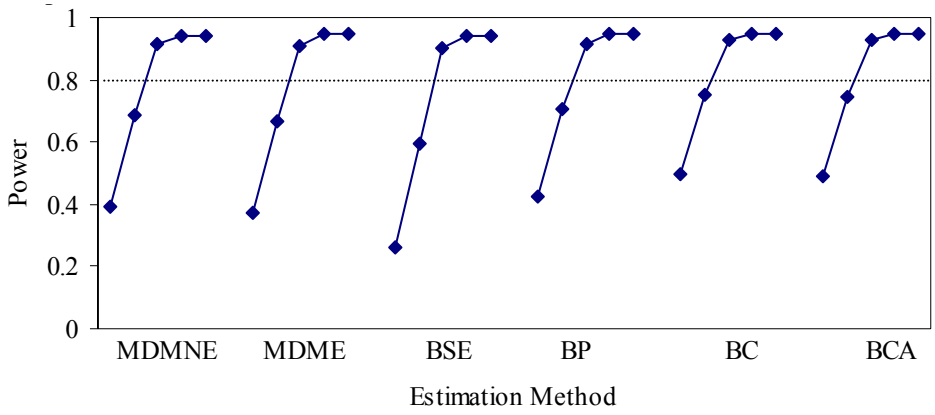


Figure 32: Power, 95% confidence interval, Population 9

A. First Indirect Effect



B. Total Indirect Effect

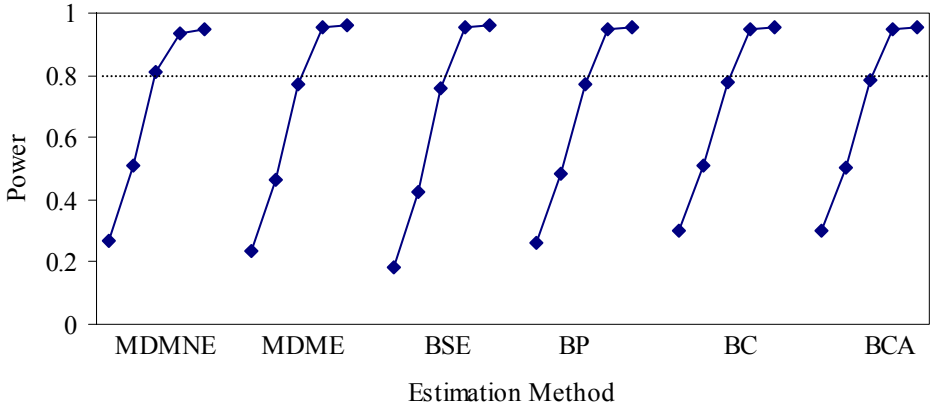


Figure 33: Power, 95% confidence interval, Population 10

the MDM_{NE} and MDM_{E} intervals was below .70. Again, the BSE intervals showed the lowest power, with power less than .60 for the two populations. The BP intervals showed higher power than the MDM or BSE intervals, though lower than the BC and BCA intervals.

The results for the second weak specific indirect effect (Panel B) show dismal levels of power for all methods at all sample sizes and both populations. Power was highest for the BC and BCA intervals with a sample size of 500, but even those intervals achieved power of only .60. None of the methods were able to detect the second indirect effect with an acceptable probability. Also, in general, power for Population 12 was slightly lower than for Population 11.

The results for the total indirect effect are presented in Panel C. Again, a sample of 100 was required for all methods to produce confidence intervals that met or exceeded .80. The intervals with the least power were those obtained with the BSE method. For a sample of 50, power was below .60 for both Populations 11 and 12, though the MDM_{NE} and MDM_{E} intervals showed similar levels of power. The BP intervals showed slightly more power, with nearly .60 for Population 11 and over .60 for Population 12. Consistent with other results, the intervals showing the most power were those obtained from the BC and BCA methods. For Population 11, both BC and BCA intervals achieved power of .60 for a sample of 50. For Population 12, power was well over .60.

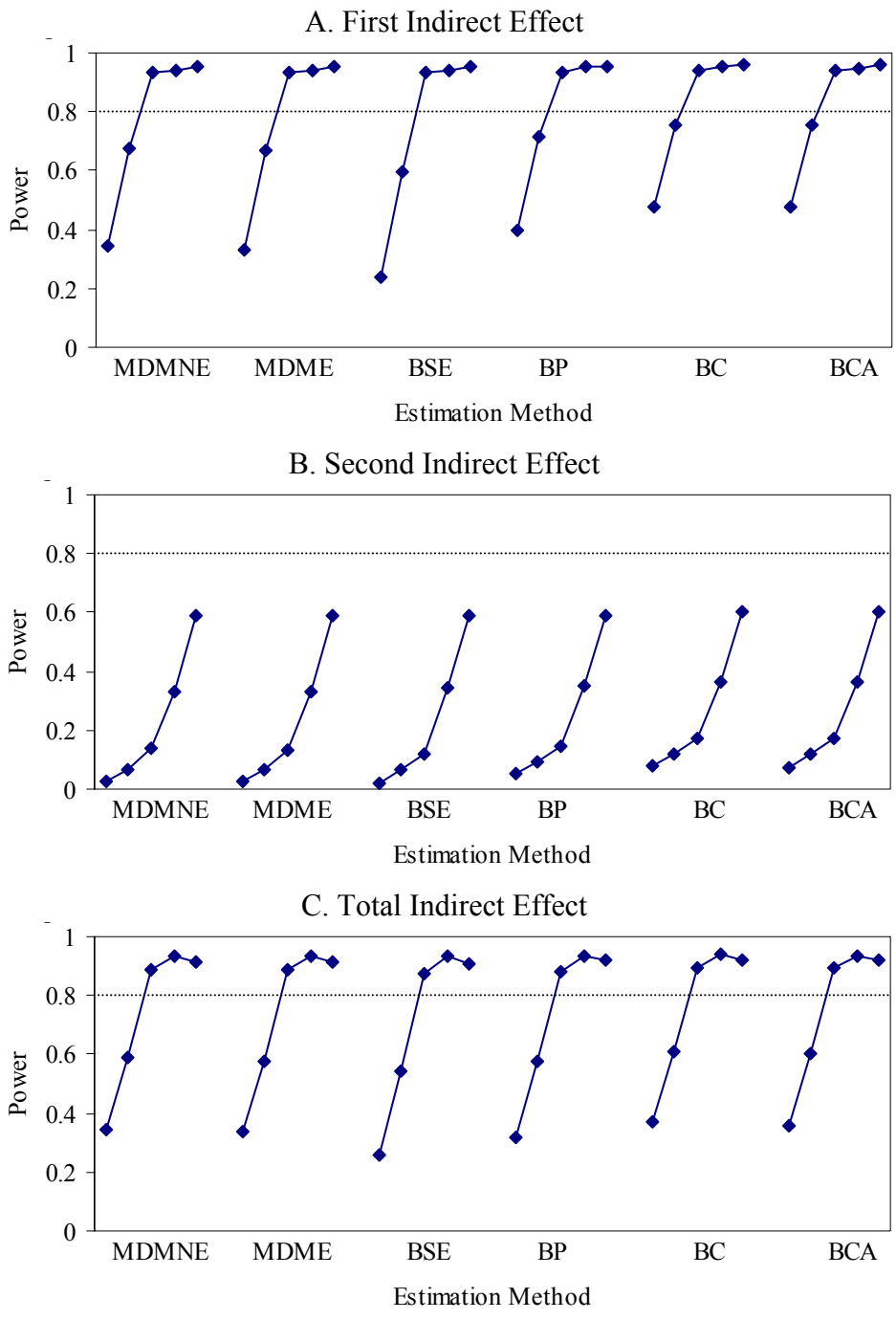


Figure 34: Power, 95% confidence interval, Population 11

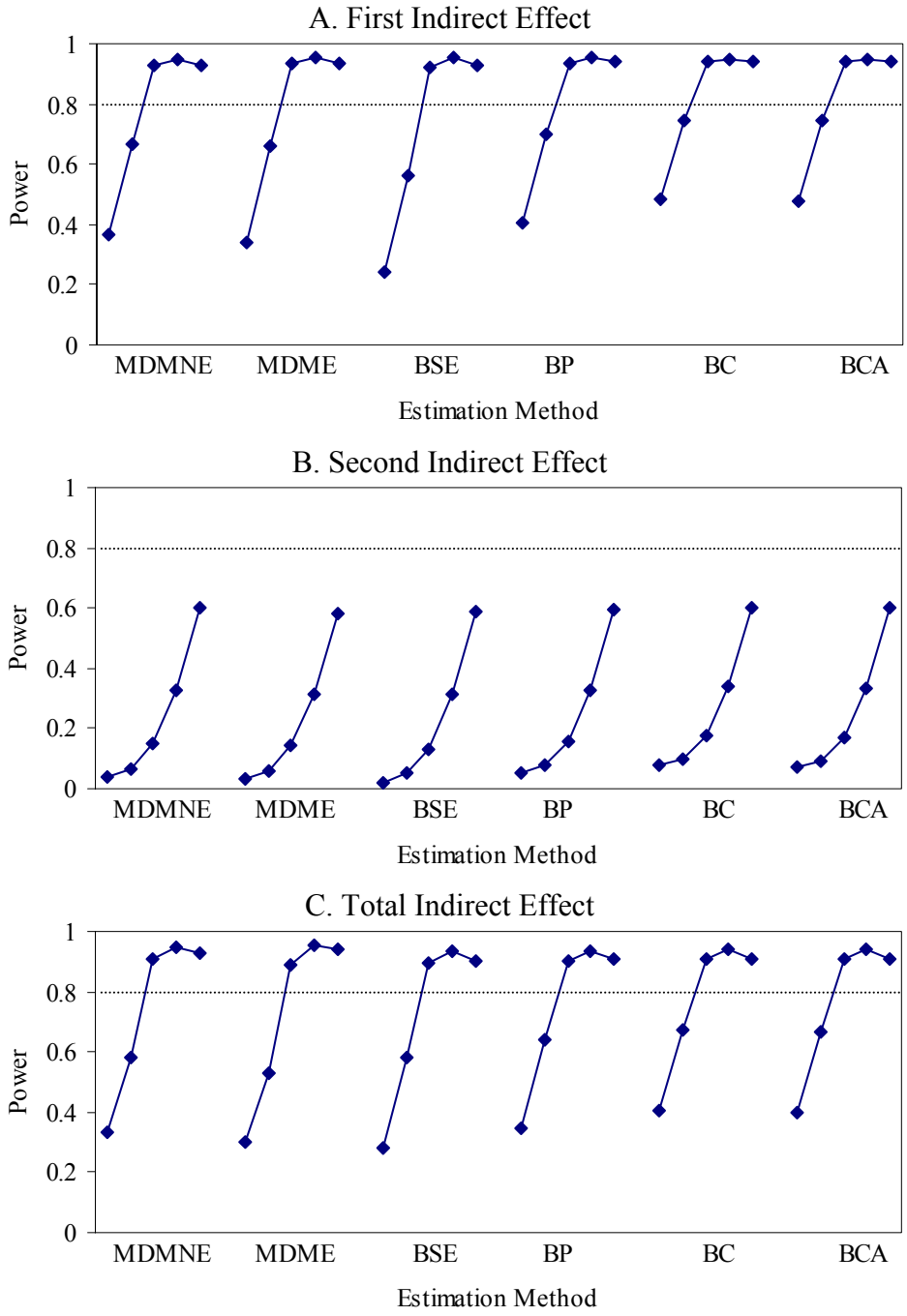


Figure 35: Power, 95% confidence interval, Population 12

3.4 Skew and Kurtosis of Confidence Intervals

The normal-theory based methods of calculating the confidence intervals require the assumption that the sampling distributions of the indirect effects are symmetric. However, specific indirect effects are calculated as the product of two coefficients, and the total indirect effect is the sum of two products. If the distributions of two coefficients comprising a specific indirect effect are normal, the distribution of the product is not.

The MDM methods of estimating the standard error of the indirect effects assume that the sampling distribution of the indirect effects shows zero skew and zero kurtosis. However, the bootstrap methods actually generate a sampling distribution from the resampled statistics. Therefore, the skew and kurtosis of the distributions generated from the resampling process can be assessed. The average skew and kurtosis for the 1,000 resamples for each specific and total indirect effect are reported in the failure and Type I error rate tables in Appendix B. For ease of presentation and discussion, particular examples are reproduced in this section.

n	Mean Skew	SD	Mean Kurtosis	SD
30	0.496	0.481	1.494	1.529
50	0.453	0.282	0.703	0.641
100	0.354	0.150	0.279	0.318
250	0.230	0.097	0.098	0.211
500	0.169	0.084	0.051	0.179

Table 2: Mean skew and kurtosis for first indirect effect, Population 1

If the assumptions about the sampling distribution of the indirect effect of the MDM and BSE methods are correct, the average skew and kurtosis should have been near zero and showed little variation. In many cases, however, this was not true. For the more sizable indirect effects, both specific and total, the skew for all sample sizes was above zero. For example, Table 2 contains the information for the first indirect effect for Population 1. For the smallest sample size, the average skew over all replications was .496 with a standard deviation of .481. Increasing the sample size did decrease skew, but even with a sample size of 500, the average skew was .169. Kurtosis was also positive for the smaller sample sizes. For the sample of 30, average kurtosis was 1.494. As sample size increased, mean kurtosis approached zero.

For specific indirect effects that were zero in the population, the distributions show a different pattern. In general, the average skew for these effects is zero; there was some variation, but the average skew remained zero. But, kurtosis was very high for smaller samples. For example, Table 3 shows statistics for the second indirect effect in Population 4. For skew, the average value was zero. For a sample of 30, the

n	Mean Skew	SD	Mean Kurtosis	SD
30	0.048	1.032	4.321	4.802
50	-0.041	0.764	2.603	2.077
100	-0.024	0.571	1.449	1.108
250	-0.002	0.295	0.580	0.425
500	-0.002	0.172	0.282	0.245

Table 3: Mean skew and kurtosis for second indirect effect, Population 4

standard deviation was 1.032, indicating that there were many samples for which the skew of the bootstrapped distribution was substantially different from zero. Indeed, Figure 36 shows the distribution of skew for the second indirect effect in Population 4. The distribution is approximately symmetric, so the distribution of an indirect effect that was zero in the population was as likely to show a negative skew in a sample as it was to show a positive skew. In addition, 20% of the samples showed distributions that showed skew less than –1.22 or greater than 1.33. So, the sampling distribution of an indirect effect that is zero in the population had a sizable likelihood of showing skew.

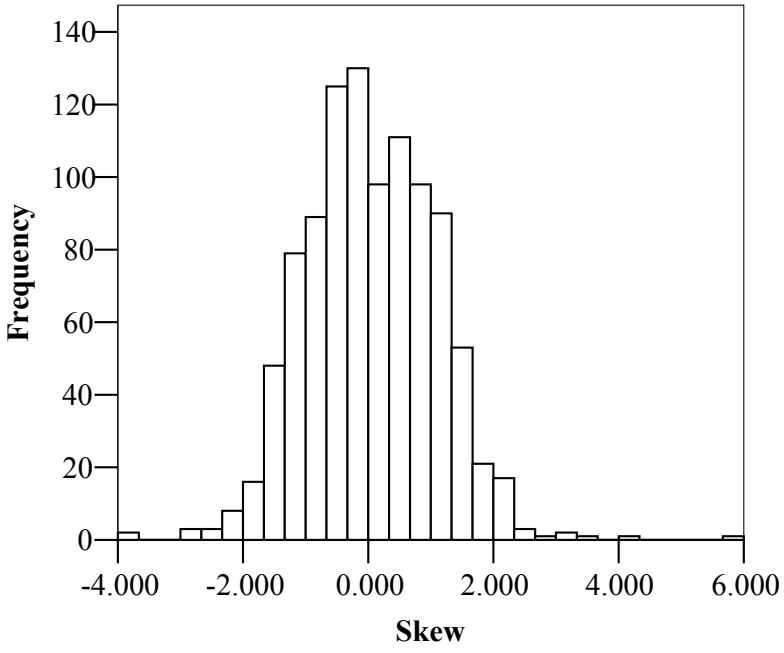


Figure 36: Skew of second indirect effect, Population 4

In addition, the kurtosis was very high, especially for the smaller sample sizes. For an *n* of 30, average kurtosis was 4.321, indicating that many of the sampling distributions generated by the bootstrap showed a higher proportion of values in the center of the distribution than would be expected if the distribution were normal (Figure 37). It could be argued that it is desirable for a sampling distribution for a null indirect effect shows a high proportion of values very near the mean, assuming the mean is near zero. If this is the case, though, then the assumption that the distribution is normal is wrong.

There is evidence that the sampling distributions of indirect effects, whether sizeable in the population or not, are not normal. So, test statistics and confidence

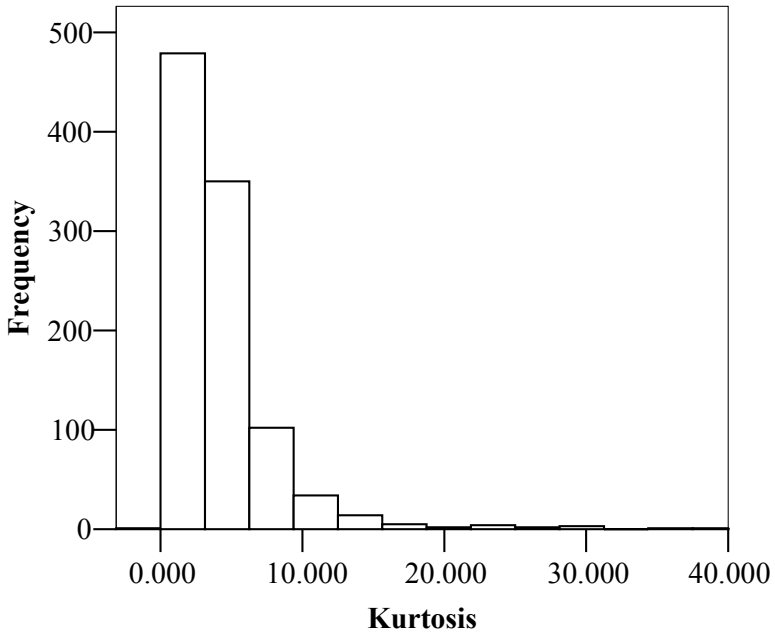


Figure 37: Kurtosis of second indirect effect, Population 4

intervals calculated based on normal theory methods, including the confidence intervals from the MDM estimates as well as the BSE method, can lead to faulty inferences. In addition, power can be adversely affected.

3.5 Summary of Results

The results suggest that the normal theory-based intervals are sometimes less accurate than bootstrap percentile methods in capturing the population values of specific and total indirect effects in a multiple mediator model. The BC and BCA methods, and, to a lesser extent, the BP method, resulted in confidence intervals that tended to show success and Type I error rates more consistent with the nominal level and higher power than the MDM_{NE}, MDM_{E}, and BSE methods. The difference in performance between the normal-theory methods and the percentile methods was most evident with the smaller sample sizes. In many cases, an increase in sample size to 100 or 250 resulted in success and Type I error rates that were consistent with the confidence level and acceptable power.

For indirect effects that were sizable in the population, the BC and BCA confidence intervals were more likely to successfully capture the population value at a rate more consistent with the confidence level than the normal theory-based intervals for small samples. Often, the success rate for the MDM_{NE} and MDM_{E} confidence intervals for small samples was low, sometimes to as much as 90% when the nominal level was 95%. When contrasted with the tendency of the bootstrap percentile confidence intervals to show success rates closer to the nominal level, it is clear that for

small samples, the percentile methods, the BC and BCA in particular, methods performed better.

The confidence intervals also showed differences in Type I error rates. For those effects that were zero in the population, the confidence intervals obtained from the MDM methods tended to show very low Type I error rates, especially for small sample sizes. Conversely, the BC and BCA confidence intervals often showed very high Type I error rates for those effects.

For the relatively large indirect effects, both specific and total, power for all methods of estimation behaved predictably; for small sample sizes, power was low, and increased with an increase in sample size. For the smaller indirect effects in the partial indirect effects conditions, the BC and BCA intervals often showed acceptable power with smaller sample sizes than the MDM_{NE}, MDM_{E}, BSE and BP intervals. It was not universally true that the BCA intervals showed adequate power even with a large sample size; in the partial mediation, partial indirect effects condition, none of the methods achieved acceptable power in the no error condition. However, there was no condition in which the MDM methods showed appreciably higher power than the BP, BC or BCA methods, and the intervals produced by the BC and BCA methods showed higher power more often than the BP intervals.

Finally, the distributions of the bootstrap estimates suggested that the sampling distributions of the indirect effects were often not normal. To obtain the confidence interval using the MDM_{NE}, MDM_{E} and BSE estimates of the standard error, the sampling distribution of the indirect effect is assumed to be normal. The bootstrap

distributions demonstrated that there is often extreme skew and kurtosis in the distributions. Thus, using any of the methods that assume a symmetric distribution leads to an increased chance of Type I errors and reduced power.

Overall, the BC and BCA confidence intervals performed better than the confidence intervals obtained from the other methods. The BC and BCA intervals captured the population value more often, required smaller samples to reach appropriate success and Type I error rates, and were more powerful than the MDM_{NE}, MDM_{E}, BSE and even the BP confidence intervals. These results suggest that, if possible, the BC or BCA confidence intervals should be used to assess the significance of the specific and total indirect effect in multiple mediator models.

CHAPTER 4

REAL DATA EXAMPLE

To demonstrate the performance of the different methods in estimating the standard error and confidence intervals of the specific and total indirect effects in a multiple mediator model, an example using real data is presented. The data are from the Aging, Status and Sense of Control study (ASSC; Mirowsky & Ross, 2001). The study collected data from older Americans to examine the relationship between age and sense of control over one's life. Respondents provided information about their physical and mental health, and health behaviors. They were also asked about their social activities, including family and work situations. Finally, respondents answered questions that focused on their sense of control.

For this example, data about sense of control, social support, opinions about work, and reported frequency of depressive symptoms were examined. The proposed multiple mediator model is presented in Figure 38. According to this model, the effect of one's sense of control on reported depressive symptoms is mediated by opinions about work and social support.

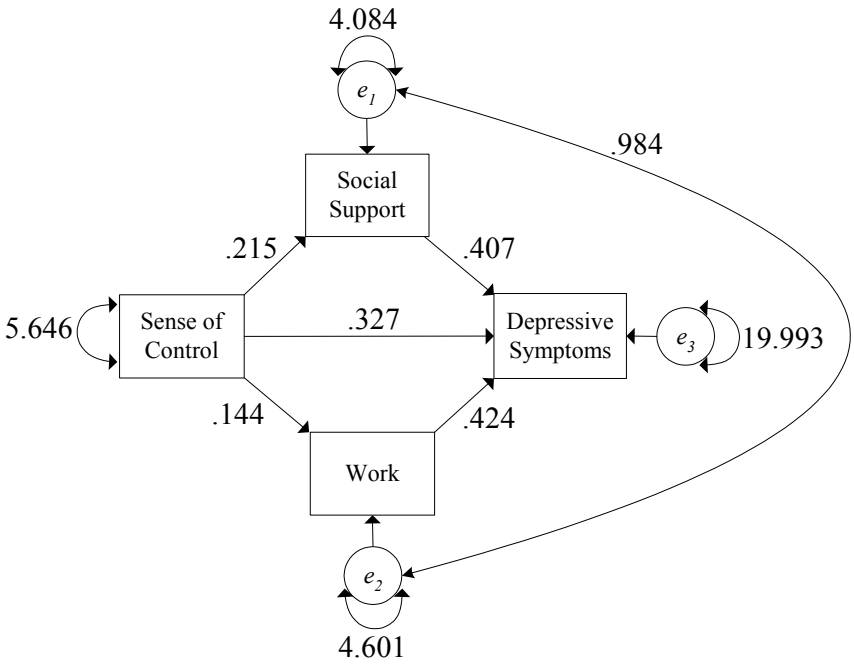


Figure 38: Coefficients for the ASSC data in the "population"

The variables involved were all measured with 4- or 5-point Likert items. The individual items are presented in Appendix D. Multiple items for each variable were summed to obtain a composite score. Items were chosen for inclusion in the composite variable if the correlations with other variables were moderate to large in magnitude. Individual respondents with any missing values or non-responses on any of the individual items were excluded from the final total sample. This resulted in a sample of 571 respondents who reported depressive symptoms and did not have any missing values. For this example, this large sample was considered the "population". Figure 38 shows the coefficients for the model in the population. It should be noted that the

depressive symptoms variable was reverse-coded so that higher values indicated fewer depressive symptoms.

The simulation study results presented previously indicated that for a sample as large as this one, the methods of estimation of the standard error of the indirect effects and their resulting confidence intervals are nearly equivalent in terms of failure rate, Type I errors and power. Also, many researchers do not have the resources to obtain large samples. So, a random sample of 100 cases was selected from these 571 respondents. Figure 39 shows the covariance matrix for the sample of 100 cases. The results obtained from this sample were compared to those from the population in order to examine the relative performance of the methods of estimation.

The data were analyzed using the model presented in Figure 38. The MDM_{NE} and MDM_{E} estimates for the parameters were obtained from LISREL 8.5. The Fisher Information Matrix method was used to calculate the standard error estimates for each specific indirect effect and the total indirect effect. The 95% confidence interval limits were then calculated.

Control	6.660			
Social Support	.2.988	5.980		
Work	.984	1.561	3.928	
Depression	4.754	3.960	2.012	31.497

Figure 39: Covariance matrix for sense of control, social support, work and depressive symptoms

Bootstrap estimates were also obtained. One thousand resamples from the original sample of 100 were generated. The bootstrapped standard error estimate was obtained for both specific indirect effects and the total indirect effect. Limits for the 95% confidence interval were calculated. Finally, the bootstrap percentile, bias-corrected, and bias-corrected and accelerated confidence limits were obtained. Results are presented in Table 4.

For the first specific indirect effect, the one-sample estimate of the effect was .149, and the standard error estimate for both the MDM_{NE} method and the MDM_{E} method were the same, .116. The resulting 95% confidence intervals both contained zero. The bootstrapped estimate of the specific indirect effect was the same as the MDM estimate, but the standard error estimate, .088, was smaller. Again, the confidence interval contained zero. The confidence interval provided by the BP method contained zero as well. However, for the two bias-corrected intervals, the limits excluded zero.

The second indirect effect was much weaker; the MDM methods estimated the effect at .037, and the bootstrapped estimate was .034. Not surprisingly, the confidence intervals calculated using the estimated standard errors contained zero. The bootstrap percentile methods all produced confidence intervals containing zero as well. Based on these results, there was no evidence that a second indirect effect was present in the population.

	Estimate	Standard Error	95% Confidence Interval
a_1b_1			
Population	0.088		
MDM_{NE}	0.149	0.116	(-0.079, 0.376)
MDM_E	0.149	0.116	(-0.079, 0.376)
BSE	0.149	0.088	(-0.023, 0.321)
BP			(-0.008, 0.338)
BC			(0.008, 0.356)
BCA			(0.007, 0.355)
a_2b_2			
Population	0.061		
MDM_{NE}	0.037	0.046	(-0.052, 0.127)
MDM_E	0.037	0.046	(-0.052, 0.127)
BSE	0.034	0.046	(-0.056, 0.125)
BP			(-0.036, 0.153)
BC			(-0.021, 0.197)
BCA			(-0.021, 0.195)
Total			
Population	0.149		
MDM_{NE}	0.186	0.127	(-0.064, 0.436)
MDM_E	0.186	0.127	(-0.064, 0.436)
BSE	0.183	0.089	(0.009, 0.358)
BP			(0.035, 0.382)
BC			(0.049, 0.394)
BCA			(0.048, 0.393)

Table 4: Standard error and 95% confidence interval estimates for real data example

For the total indirect effect, the MDM methods again produced confidence intervals that did not exclude zero. However, all of the bootstrap methods did. The standard error estimates provided by the MDM methods were relatively large, at .127, resulting in confidence intervals with limits that were wider than any of the bootstrap intervals.

In terms of hypothesis testing and interval estimation, the MDM methods failed in this case to detect the two specific indirect effects and the total indirect effect. It is not particularly surprising that the confidence intervals contained zero for the specific indirect effects; their values in the population were relatively small. However, the total indirect effect was somewhat larger in the population. Relative to the BSE estimate of the standard error, the MDM estimates were large, leading to wide confidence intervals.

If the researcher had turned to bootstrapping as an alternative, depending on the method of estimation used, she would have reached different conclusions. As with the MDM methods, the results from the BSE suggested that there was no specific indirect effect for either work or social support. The results for the BP confidence intervals suggested the same. Only the BC and BCA methods would have resulted in a conclusion that the sense of control—depression relationship was at least partially indirect, mediated by social support.

These results are consistent with the results presented in the simulation study. It is difficult to assess the failure or Type I error rates from one replication. However, only the BC and BCA methods resulted in confidence intervals for the first specific

indirect effect excluding zero; thus, no Type I errors were observed in the results for the MDM_{NE}, MDM_{E}, BSE, and BP methods.

This example also demonstrates that the sampling distribution of the indirect effects is not normal. Table 5 presents skew and kurtosis information for the bootstrapped distributions of a_1b_1, a_2b_2, and the total indirect effect. First, the skew for all indirect effects for the bootstrapped distributions was positive. Since the bootstrap distribution can be considered a representation of the sampling distribution, the assumption of a symmetric distribution is not tenable. Thus, confidence intervals obtained assuming symmetry are not accurate. Figure 40 shows the estimated confidence intervals for a_1b_1. In this figure, the estimated value for a_1b_1 by the MDM methods is shown as the large solid circle in the center of the two MDM confidence intervals. The estimated value according to the bootstrapped distribution is the large solid diamond. The vertical lines mark the population value (dashed line) and zero (solid line). The confidence limits for each method are also presented. The MDM_{NE}, MDM_{E}, and BSE confidence intervals are all symmetric around their respective means.

	Skew	Kurtosis
a_1b_1	0.989	1.688
a_2b_2	0.305	0.406
Total	0.350	0.431

Table 5: Skew and kurtosis for bootstrapped distributions of the indirect effects in real data example

However, the BP, BC and BCA confidence intervals are not symmetric; it is clear that the upper limit is farther away from the bootstrapped mean than the lower limit. In addition to the skew, all three distributions showed positive kurtosis, indicating a higher proportion of estimated values in the middle of the distribution than would be expected if the distributions were normal (see Table 5).

This example is consistent with the results from the simulation study. In the simulations, the failure and Type I error rates were generally acceptable for a sample size of 100. In this example, there was no evidence of a failure of any of the methods to capture a population value; all confidence intervals did actually capture the population values.

In the simulations, power for all methods for the stronger specific indirect effect and the total indirect effect was adequate for a sample of 100. For the weaker second

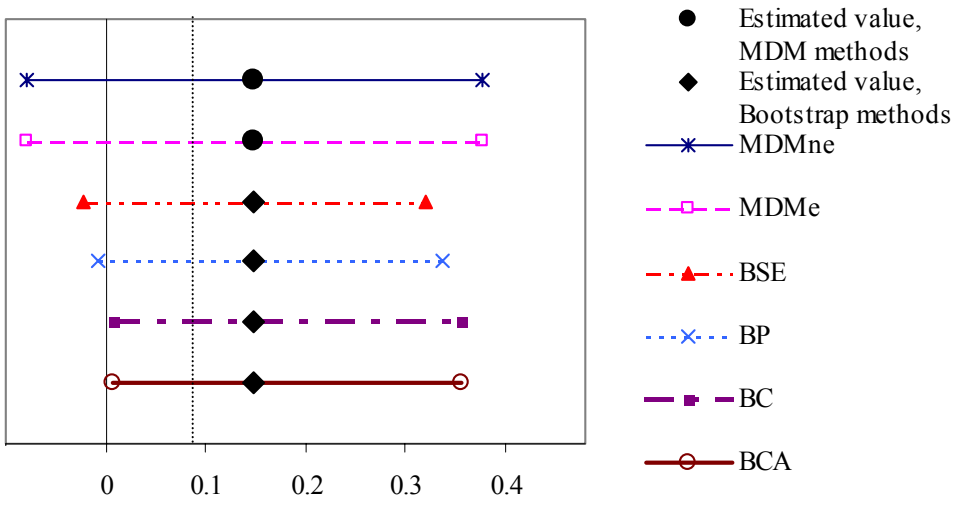


Figure 40: Estimated confidence intervals for a_1b_1

indirect effect, power was relatively low for all methods, but less so for the BC and BCA confidence intervals. In general, the BC and BCA confidence intervals were more likely than the other methods to detect an indirect effect that was present in the population. In this example, the BC and BCA intervals were the only ones that produced confidence intervals that did not contain zero for the larger specific indirect effect.

With the simulation results and the real data example, it appears that the best methods available to the researcher in constructing confidence intervals for the specific and total indirect effects in multiple mediator models are the bias-corrected and bias-corrected and accelerated bootstrap percentile methods. The BC and BCA intervals do not require the sampling distribution of the indirect effect to be symmetrical, unlike the MDM and BSE methods. In addition, power is slightly higher than for BP intervals.

The BC is a special case of the BCA; with the BC, the assumption is that the acceleration constant is zero. Since it is relatively easy to calculate the constant, it is not much more effort (or computing time) to obtain the BCA estimates. So, it seems the best choice for obtaining the confidence intervals for the indirect effects is the BCA.

CHAPTER 5

CONCLUSIONS

There were two primary issues of concern in this study. First, the study was designed to compare the performance of MDM methods of estimating the standard error and confidence intervals of the indirect effects in a multiple mediator model to those obtained through various bootstrapping methods. In addition, this study sought to examine the effect of allowing the standard error estimate for the specific and total indirect effects provided by MDM to use the estimate of the covariance between the mediators in a multiple mediator model. To address these issues, failure and Type I error rates and power were obtained for samples generated from 16 different populations.

5.1 Effect of error covariance in the population

This study was inspired in part by MacKinnon's (2000) use of the MDM in a multiple mediator situation. In that paper, MacKinnon demonstrated the use of the MDM to obtain the standard error for the indirect effects of a mediation model with four mediators. In his model, the possibility of a non-zero covariance between the errors of the mediators was excluded; that term was constrained to zero in the model.

However, this term is used in the calculation of the variances and covariances of various coefficients. So, constraining that element of the parameter estimate matrices to zero leads to inaccurate coefficient variances and covariances. If the coefficient variances and covariances are wrong, then the standard error will also be wrong, possibly affecting failure and Type I error rates and power.

These simulations included conditions in which the errors showed a small correlation in the population. The MDM_{NE} estimate of the standard error and confidence interval constrained the error covariance to zero when perhaps it should have been estimated. If this did substantially affect the calculation of the standard error, then failure and Type I error rates and power for the MDM_{NE} should have been poorer than for the MDM_{E} in those conditions in which the errors were correlated.

The results indicated that there was a slight tendency of the MDM_{E} standard error estimates to result in confidence intervals that show a rate of failure that was more consistent with the stated confidence level than the standard error calculated by MDM_{NE}. However, the difference was only slight. For example, Figure 16 (Panel A) shows the success rates for the confidence intervals for the first specific indirect effect in Population 5 (Total Mediation, Partial Indirect Effects). The intervals generated from the MDM_{NE} and MDM_{E} standard error estimates both showed low success rates for the smaller sample sizes, but the rates for the MDM_{NE} intervals are slightly worse. Figure 18 contains the success rates for Population 6, which had the same structure as Population 5 with a small covariance between the mediator errors in the population.

The success rates for the smaller samples sizes are again low, and the MDM_{NE} intervals showed a slightly lower rate of success than the MDM_E intervals.

The tendency for the MDM_{NE} to fail more is a bit more pronounced for the confidence intervals estimating the total indirect effects. For example, in Figure 9 (Panel B), the success rates for the MDM_{NE} and MDM_E intervals for Population 9 (Partial Mediation, One Indirect Effect) were approximately equal, with the MDM_{NE} intervals capturing the population value of the total indirect effect slightly less often than the MDM_E intervals. For Population 10, the equivalent population with a small error covariance, the failure rate for the MDM_E intervals remained about the same as for the intervals for Population 9 (Figure 12, Panel B). The failure rate for the MDM_{NE} intervals increased.

It is not surprising that the slight discrepancy in the error rates of the MDM_{NE} and MDM_E was larger for the total indirect effects than the specific indirect effects. Even if the error covariance term itself is not used in the calculation of the coefficient variances or covariances, constraining it to zero does affect the standard error as a whole. Every element of $\mathbf{I}(\hat{\boldsymbol{\Theta}})$ is calculated using the inverse of $\boldsymbol{\Psi}$. Even if all other elements in $\boldsymbol{\Psi}$ are equal, the inverse of a matrix with zero as the mediator correlation will not be the same as the inverse with a non-zero element.

The results from one of the simulated datasets in this study illustrate this situation well. One of the generated covariance matrices from the Total Mediation, Equal Indirect Effects condition with correlated errors was selected. The estimated coefficients for a sample of 50 were

$$\hat{\mathbf{B}} = \begin{bmatrix} & & \\ .598 & & \\ .694 & & \\ -.124 & .321 & .457 \end{bmatrix} \text{ and } \hat{\mathbf{\Psi}} = \begin{bmatrix} .681 & & & \\ & .922 & & \\ & .127 & .910 & \\ & & & .681 \end{bmatrix}$$

The standard error for the first specific indirect effect is calculated by

$$\hat{\sigma}_{a_1 b_1} = \sqrt{\hat{a}_1^{\,2}\hat{\sigma}_{b_1}^2 + \hat{b}_1^{\,2}\hat{\sigma}_{a_1}^2} \tag{47}$$

The variances and covariances of the coefficients are obtained from the inverse of $\mathbf{I}\left(\hat{\mathbf{\Theta}}\right)$. The actual values for this example are

$$I\left(\hat{a}_1, \hat{a}_1\right) = 50\left(0 \times 0 + .681 \times 1.106\right) = 37.659 \tag{48}$$

If the covariance of the errors is constrained to zero, leaving all other elements the same, the value is

$$I\left(\hat{a}_1, \hat{a}_1\right) = N\left(0 \times 0 + .681 \times 1.085\right) = 36.944 \tag{49}$$

There is a similar difference in the calculations for the variance of $\hat{b}_1$. So, for the first indirect effect, there are two terms that are impacted by constraining the error covariance to zero. The standard error for the total indirect effect, presented in Equation 26, contains multiple terms that are affected by the inverse of $\hat{\mathbf{\Psi}}$. So, it is not surprising that the confidence intervals obtained from the MDM_{NE} standard error failed to capture the population value more often than the intervals obtained from the MDM_E standard error. Also, it is worth noting that the error covariance in this example was slight. However, when the covariance is large, this discrepancy is also likely to be large, and the subsequent standard error will be inaccurate. In addition, even with a small difference in the calculation of $\mathbf{I}\left(\hat{\mathbf{\Theta}}\right)$, if there are multiple terms involved in the

standard error, as is the case with the total indirect effect, the total discrepancy could be large.

In terms of power, the MDM_{NE} confidence intervals tended to show slightly higher power than the MDM_E intervals, a result that may seem somewhat surprising. It seems logical that power for the MDM_E intervals would show higher power. However, the MDM_{NE} method showed elevated Type I error rates often substantially above the nominal confidence level. So, the actual error rate was higher, resulting in higher power. In restricting the error covariance to zero in calculating the standard error, there is a higher likelihood of incorrectly detecting an indirect effect.

The bootstrapped confidence intervals did not show any substantial difference in performance between the error covariance conditions. Success rates, Type I error rates and power were all similar for the pairs of populations with the same $\mathbf{B}$ and $\mathbf{\Gamma}$. This was true for the percentile-based methods (BP, BC and BCA) as well as the BSE.

5.2 MDM Versus Bootstrapping

This study was also concerned with examining the performance of various bootstrapping methods in estimating the standard error of the specific and total indirect effects (in the case of the BSE) and the confidence intervals for these effects from three bootstrap percentile methods. Because the MDM method of estimating a standard error is a large sample technique, its assumptions may not be appropriate for the samples that are common in psychological research. In addition, the use of the MDM standard errors in calculating confidence intervals requires assumptions about the shape of the sampling

distribution of the indirect effects. Bootstrap methods require fewer assumptions about the population and sampling distributions and could result in more valid statistical inferences.

In almost all situations, the bootstrap percentile methods showed better success rates and power than the confidence intervals produced by the MDM methods. While all methods showed poorer performance with the smaller sample sizes, the performance of the confidence intervals obtained from the BC and BCA methods was less adversely affected than the intervals obtained though the MDM_{NE}, MDM_{E}, BSE and, often, the BP methods. In addition, BC and BCA showed appropriate success rates and levels of power at smaller sample sizes the other methods.

The one notable exception to this result was the Type I error rate for the BC and BCA confidence intervals. For small samples, the Type I error rates for many of the indirect effects that were small or zero in the population were elevated. For example, Figure 11 presents the results for the second indirect effect in Population 9. In this population, the second indirect effect is zero. For a sample of 30, the Type I error rates for the MDM methods were very low. They were also low for the BSE and BP intervals. The error rates for the BC and BCA intervals, however, are high. These results are consistent with the results reported by MacKinnon, Lockwood and Williams (2004). In their study, for situations in which the true indirect effect in the population was zero, they found that almost all methods they examined except for the BC produced confidence intervals that showed lower than expected Type I error rates, suggesting intervals that were too wide. They also found that that the Type I error rates for the BC

intervals were higher than expected. In this study, the elevated Type I error rate was corrected with an increase in sample size, a finding that MacKinnon et al. reported as well.

An interesting feature of the bootstrapping results is the mild fluctuation of success rates with increasing sample sizes. For example, in Figure 4, Panel A, the proportion of successful BP intervals changes from below 95% for a sample of 50, to above for a sample of 100, and then back below for an *n* of 250. Ideally, the proportion would increase to the nominal 95% level with an increase in sample size. However, this is likely due to the bootstrap process. The number of resamples in this study was 1,000; and a larger number may have stabilized the estimates. So, these fluctuations likely reflect the uncertainty in the bootstrapping process rather than any systematic influence in the multiple mediator model. In addition, the fluctuations are not substantial in magnitude. Typically they were within one percent of the previous value, so the performance was not unduly affected.

Overall, results are consistent with MacKinnon, Lockwood and Williams (2004). The MDM methods of obtaining the standard error and confidence interval for the specific and total indirect effects showed the least consistency with the nominal confidence level and the lowest power. The BC and BCA intervals showed the most consistent success and Type I error rates and the highest power. The BSE and BP methods showed intermediate performance in terms of Type I error and power.

5.3 Amount of Mediation

In general, performance did not vary much due to the amount of mediation in the population. For the Equal Indirect Effects and One Indirect Effect conditions, the success rates, Type I error rates and power were similar over the Total and Partial Mediation conditions. For the Partial Indirect Effects conditions, however, there were some differences in the success rates. For example, consider the results presented in Figures 16 and 17. The results for the second indirect effect are different. For the Total Mediation, no error covariance condition, the success rates increased steadily from below 90% to just above 95% for the two MDM methods; in Figure 17, the rates varied around 93% for all sample sizes except 500, for which there was a large decrease in the success rate. This decrease for an *n* of 500 was reflected in all methods for the Partial Mediation condition. Figures 18 and 19 (results for the correlated errors condition) showed the same pattern.

This could be due to a combination of two factors: the sample size itself and the size of the indirect effect. The second indirect effect is relatively small in the population. For effects that are zero in the population, as discussed previously, Type I error rates can be inflated, indicating that the confidence intervals are not capturing the population value. Stone and Sobel (1990) reported similar results. In their study, they presented results for total indirect effects only. For those effects that were relatively small, the standard error estimates provided by the MDM showed more relative bias, especially for small samples, than those for the larger indirect effects. Perhaps a similar effect is occurring here. With a small effect, the methods may have difficulty

estimating the population value accurately. In addition, a large sample size will result in a smaller confidence interval than those obtained with smaller sample sizes. The combination of an inaccurate estimate and a small confidence interval could result in the lower rate of successful intervals.

5.4 Recommendations for the Researcher

The results of this study suggest that researchers using a multiple mediation approach in their research seriously consider using the BCA to estimate confidence intervals for the indirect effects. Overall, the BC and BCA methods showed better Type I error rates than the MDM, BSE and BP methods for the majority of situations tested. In addition, power reached acceptable levels for smaller sample sizes than for the other methods. While the BC and BCA method of generating confidence intervals for the indirect effects are equivalent in terms of failure rates and power, it is still worth the extra effort to obtain the BCA estimates. Calculating the acceleration constant is not very time-consuming, especially with the sample sizes typical in behavioral research. If the acceleration is actually zero, then the BC and BCA intervals would be equivalent. However, this may not always be the case. So, it seems too strong an assumption to restrict the acceleration constant to zero when it is relatively easy to calculate. MacKinnon et al. (2004) also found that the BC method achieved higher power and more consistent Type I error rates than the other methods tested and recommended this method in most situations if raw data are available for analysis. (MacKinnon et al. did not include BCA confidence intervals in their simulation.)

When the raw data are available for bootstrapping, there is one situation in which the optimal choice for computing the confidence interval is not the BCA. If the indirect effect is very small, a Type I error or a failure to capture the population effect is more likely to occur with the BC and BCA intervals than the other methods. So, if the researcher is especially concerned about incorrectly concluding that a small effect exists, then the BP method is likely the better choice.

Obviously, if the raw data are not available, only the MDM_{NE} and MDM_{E} methods are options. There is a slight advantage in power of the MDM_{NE} method. However, the MDM_{NE} confidence intervals also showed slightly higher failure and Type I error rates than the MDM_{E} intervals. Also, the advantage in power for the MDM_{NE} intervals in the few conditions in which it occurred was not appreciably large, whereas the increase in Type I error in some situations was. Finally, the assumption that there is absolutely no correlation between the mediators beyond that accounted for by X seems more extreme a measure than is necessary. Even if the assumption holds, the standard error estimate from MDM_{E} will be the same as that obtained from the MDM_{NE} method. Overall, if the MDM approach must be used to calculate the standard error of the indirect effects, it seems wiser to estimate the correlation between the mediator errors than not.

To this end, estimating the full model in structural equations model (SEM) rather than a series of multiple regressions is required. The coefficient estimates for a_1, a_2, b_1 and b_2 can be obtained from multiple regression analyses. However, to obtain correct variance and covariance estimates for the coefficients, the correct $\hat{\mathbf{\Psi}}$ is not

typically included in software output. The researchers must turn to SEM, use macros provided by other researchers (e.g., Preacher & Hayes, 2005), or write their own.

While this simulation study examined the performance of the various methods in estimating the standard error and confidence intervals for the indirect effects, the conclusions apply to direct effects in the model as well. As previously discussed, the estimate of covariance of the error terms is included in the calculation of the variances and covariances of the coefficients in the model. Its value will impact the standard errors of the individual coefficient estimates as well.

5.5 Other Considerations

This study has focused on how to assess the significance of specific and total indirect effects. Discussion of the use of mediation models in practice has been limited to a short examination of articles of major psychological journals to assess the relevance of this issue and not on how researchers use and interpret the results of mediation models. However, it is important to acknowledge that clear terminology and definitions are necessary. A number of articles in the psychiatry literature provide good arguments for the need for precision (Kraemer, et al., 1997; Kraemer, Stice, Kazdin, Offord & Kupfer, 2001; Kraemer, Wilson, Fairburn and Agras, 2002). Obviously, communication is impeded when definitions are ambiguous. Interpretation of results is also impacted. Researchers often use mediation models in an effort to assess "causal" relationships among variables. However, if mediation is present, it is not necessarily a causal relationship. As stated previously, mediation models are useful in correlational

research, and it is not wise to assume a causal relationship from correlational data. There is often not a guarantee that the independent variable, *X*, preceded the mediator. In addition, Kraemer, Wilson, Fairburn and Agras (2002) argue that there is a difference between a mediator that is a mechanism (causal) and one that is not. Simply identifying a mediator, even if it is preceded by *X*, is not sufficient to assume it is a causal factor.

Researchers have a variety of options when assessing the presence of indirect effects in mediation models. The most common approaches are the Baron and Kenny (1998) method and the Sobel test (1982). However, neither is sufficient when examining a model with more than one mediator. Alternatively, the multivariate delta method, from which the Sobel test is derived, can be used to calculate the standard error in order to test the significance of specific and total indirect effects in multiple mediator models. This is also not without its drawbacks. The indirect effects being tested are products of coefficients, and the distributional assumptions of the MDM are generally not appropriate. The results of this study suggest that, especially for small sample sizes, the failure and Type I errors rates for the MDM methods can be substantially higher than the nominal level. Generally, the bootstrap percentile methods, especially the BC and BCA, showed better failure and Type I error rates than the MDM methods. Power is also generally higher for the bootstrap percentile methods than for other available methods. So, if possible, researchers should seriously consider using the bias-corrected and accelerated bootstrap in their analyses of indirect effects in mediation models.

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APPENDIX A

POPULATION COVARIANCE MATRICES

Population	Σ	Population	Σ
1	$\begin{bmatrix} 1.000 & & & \\ .600 & 1.360 & & \\ .600 & .360 & 1.360 & \\ .480 & .688 & .688 & 1.550 \end{bmatrix}$	9	$\begin{bmatrix} 1.000 & & & \\ .600 & 1.360 & & \\ .000 & .000 & 1.000 & \\ .480 & .688 & .400 & 1.550 \end{bmatrix}$
2	$\begin{bmatrix} 1.000 & & & \\ .600 & 1.360 & & \\ .600 & .560 & 1.360 & \\ .480 & .768 & .768 & 1.614 \end{bmatrix}$	10	$\begin{bmatrix} 1.000 & . & & \\ .600 & 1.360 & & \\ 0.000 & .200 & 1.000 & \\ .480 & .768 & .480 & 1.614 \end{bmatrix}$
3	$\begin{bmatrix} 1.000 & & & \\ .600 & 1.360 & & \\ .000 & .000 & 1.000 & \\ .360 & .816 & .300 & 1.580 \end{bmatrix}$	11	$\begin{bmatrix} 1.000 & & & \\ .600 & 1.360 & & \\ .400 & .240 & 1.160 & \\ .640 & .784 & .456 & 1.610 \end{bmatrix}$
4	$\begin{bmatrix} 1.000 & & & \\ .600 & 1.360 & & \\ .000 & .200 & 1.000 & \\ .360 & .876 & .420 & 1.652 \end{bmatrix}$	12	$\begin{bmatrix} 1.000 & & & \\ .600 & 1.360 & & \\ .400 & .440 & 1.160 & \\ .640 & .824 & .536 & 1.642 \end{bmatrix}$
5	$\begin{bmatrix} 1.000 & & & \\ .600 & 1.360 & & \\ .400 & .240 & 1.160 & \\ .320 & .592 & .328 & 1.302 \end{bmatrix}$	13	$\begin{bmatrix} 1.000 & & & \\ .000 & 1.000 & & \\ .000 & .000 & 1.000 & \\ .300 & .600 & .600 & 1.810 \end{bmatrix}$
6	$\begin{bmatrix} 1.000 & & & \\ .600 & 1.360 & & \\ .400 & .440 & 1.160 & \\ .320 & .632 & .408 & 1.334 \end{bmatrix}$	14	$\begin{bmatrix} 1.000 & & & \\ .000 & 1.000 & & \\ .000 & .200 & 1.000 & \\ .300 & .720 & .720 & 1.954 \end{bmatrix}$
7	$\begin{bmatrix} 1.000 & & & \\ .600 & 1.360 & & \\ .600 & .360 & 1.360 & \\ .960 & .976 & .976 & 2.242 \end{bmatrix}$	15	$\begin{bmatrix} 1.000 & & & \\ .000 & 1.000 & & \\ .000 & .000 & 1.000 & \\ .300 & .800 & .000 & 1.730 \end{bmatrix}$
8	$\begin{bmatrix} 1.000 & & & \\ .600 & 1.360 & & \\ .600 & .560 & 1.360 & \\ .960 & 1.056 & 1.056 & 2.306 \end{bmatrix}$	16	$\begin{bmatrix} 1.000 & & & \\ .000 & 1.000 & & \\ .000 & .200 & 1.000 & \\ .300 & .800 & .160 & 1.730 \end{bmatrix}$

Table 6: Population covariance matrices

APPENDIX B

95% CONFIDENCE INTERVAL SUCCESS, FAILURE AND TYPE I ERROR RATES AND POWER

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	9.6 /	0.5 /	89.9				
	50	6.0 /	1.0 /	93.0				
	100	4.9 /	1.1 /	94.0				
	250	4.3 /	1.3 /	94.4				
	500	3.4 /	1.0 /	95.6				
MDM, error	30	9.6 /	0.5 /	89.9				
	50	5.8 /	0.9 /	93.3				
	100	4.8 /	0.9 /	94.3				
	250	4.2 /	1.2 /	94.6				
	500	3.4 /	1.0 /	95.6				
BSE	30	6.8 /	0.4 /	92.8				
	50	5.2 /	0.9 /	93.9				
	100	4.3 /	1.1 /	94.6				
	250	4.2 /	1.6 /	94.2				
	500	3.9 /	1.1 /	95.0				
BP	30	5.7 /	0.8 /	93.5	0.496	0.481	1.494	1.529
	50	4.1 /	1.5 /	94.4	0.453	0.282	0.703	0.641
	100	3.0 /	1.6 /	95.4	0.354	0.150	0.279	0.318
	250	3.5 /	2.1 /	94.4	0.230	0.097	0.098	0.211
	500	2.8 /	1.3 /	95.9	0.169	0.084	0.051	0.179
BC	30	4.8 /	1.2 /	94.0				
	50	3.1 /	2.5 /	94.4				
	100	2.6 /	1.8 /	95.6				
	250	2.9 /	2.3 /	94.8				
	500	2.7 /	1.3 /	96.0				
BCA	30	4.8 /	1.1 /	94.1				
	50	3.2 /	2.5 /	94.3				
	100	2.6 /	1.8 /	95.6				
	250	2.9 /	2.2 /	94.9				
	500	2.7 /	1.3 /	96.0				

Table 7: Success and failure rates of 95% confidence interval, First indirect effect, Population 1

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	5.8	/	1.2	/	93.0				
	50	5.6	/	1.6	/	92.8				
	100	4.0	/	1.6	/	94.4				
	250	4.3	/	1.6	/	94.1				
	500	3.4	/	1.7	/	94.9				
MDM, error	30	5.6	/	1.3	/	93.1				
	50	5.6	/	1.6	/	92.8				
	100	4.0	/	1.6	/	94.4				
	250	4.3	/	1.6	/	94.1				
	500	3.3	/	1.7	/	95.0				
BSE	30	4.0	/	1.4	/	94.6				
	50	5.1	/	0.9	/	94.0				
	100	3.4	/	1.6	/	95.0				
	250	3.8	/	1.7	/	94.5				
	500	3.7	/	1.7	/	94.6				
BP	30	3.6	/	1.6	/	94.8	0.341	0.370	0.966	0.874
	50	4.2	/	1.7	/	94.1	0.301	0.214	0.404	0.400
	100	3.0	/	2.1	/	94.9	0.246	0.127	0.159	0.236
	250	3.3	/	2.1	/	94.6	0.164	0.091	0.058	0.182
	500	2.7	/	1.9	/	95.4	0.116	0.082	0.022	0.165
BC	30	3.8	/	2.4	/	93.8				
	50	3.7	/	2.6	/	93.7				
	100	2.6	/	2.7	/	94.7				
	250	3.0	/	2.3	/	94.7				
	500	2.7	/	2.0	/	95.3				
BCA	30	3.8	/	2.3	/	93.9				
	50	3.8	/	2.3	/	93.9				
	100	2.6	/	2.4	/	95.0				
	250	3.1	/	2.3	/	94.6				
	500	2.7	/	1.9	/	95.4				

Table 8: Success and failure rates of 95% confidence interval, Total indirect effect, Population 1

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	8.3 /	1.1 /	90.6				
	50	7.2 /	0.9 /	91.9				
	100	5.1 /	2.2 /	92.7				
	250	3.6 /	2.7 /	93.7				
	500	3.3 /	2.4 /	94.3				
MDM, error	30	8.1 /	0.9 /	91.0				
	50	6.9 /	0.8 /	92.3				
	100	4.8 /	1.8 /	93.4				
	250	3.4 /	2.6 /	94.0				
	500	3.2 /	2.4 /	94.4				
BSE	30	5.7 /	1.0 /	93.3				
	50	5.7 /	1.0 /	93.3				
	100	4.7 /	2.1 /	93.2				
	250	3.5 /	2.5 /	94.0				
	500	3.3 /	2.1 /	94.6				
BP	30	4.7 /	1.5 /	93.8	0.501	0.505	1.639	1.828
	50	3.9 /	2.0 /	94.1	0.449	0.278	0.703	0.604
	100	3.8 /	2.7 /	93.5	0.340	0.161	0.291	0.322
	250	3.1 /	3.2 /	93.7	0.228	0.096	0.093	0.202
	500	2.3 /	2.6 /	95.1	0.169	0.082	0.053	0.176
BC	30	3.8 /	1.9 /	94.3				
	50	2.8 /	2.6 /	94.6				
	100	3.5 /	3.2 /	93.3				
	250	2.4 /	3.2 /	94.4				
	500	2.0 /	2.7 /	95.3				
BCA	30	3.9 /	1.8 /	94.3				
	50	2.8 /	2.5 /	94.7				
	100	3.5 /	3.1 /	93.4				
	250	2.6 /	3.2 /	94.2				
	500	2.0 /	2.7 /	95.3				

Table 9: Success and failure rates of 95% confidence interval, First indirect effect, Population 2

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	6.3 /	1.8 /	91.9				
	50	4.8 /	1.3 /	93.9				
	100	3.0 /	1.4 /	95.6				
	250	2.2 /	1.6 /	96.2				
	500	3.5 /	2.2 /	94.3				
MDM, error	30	6.2 /	1.7 /	92.1				
	50	4.7 /	1.3 /	94.0				
	100	2.8 /	1.3 /	95.9				
	250	2.1 /	1.7 /	96.2				
	500	3.2 /	2.2 /	94.6				
BSE	30	4.6 /	1.5 /	93.9				
	50	4.8 /	1.4 /	93.8				
	100	3.5 /	1.8 /	94.7				
	250	2.7 /	1.8 /	95.5				
	500	4.0 /	2.3 /	93.7				
BP	30	3.7 /	2.0 /	94.3	0.391	0.343	1.003	1.068
	50	3.9 /	1.8 /	94.3	0.335	0.208	0.429	0.450
	100	3.0 /	1.9 /	95.1	0.255	0.119	0.156	0.241
	250	2.3 /	2.4 /	95.3	0.173	0.087	0.052	0.193
	500	3.6 /	2.4 /	94.0	0.128	0.080	0.019	0.162
BC	30	3.1 /	2.5 /	94.4				
	50	3.3 /	2.5 /	94.2				
	100	2.2 /	2.4 /	95.4				
	250	2.0 /	2.9 /	95.1				
	500	3.0 /	2.8 /	94.2				
BCA	30	3.3 /	2.5 /	94.2				
	50	3.2 /	2.5 /	94.3				
	100	2.3 /	2.3 /	95.4				
	250	2.0 /	2.9 /	95.1				
	500	3.1 /	2.8 /	94.1				

Table 10: Success and failure rates of 95% confidence interval, Total Indirect Effect, Population 2

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	8.9 /	1.2 /	89.9				
	50	6.6 /	1.1 /	92.3				
	100	4.7 /	0.9 /	94.4				
	250	4.9 /	2.1 /	93.0				
	500	3.1 /	1.7 /	95.2				
MDM, error	30	8.9 /	1.1 /	90.0				
	50	6.5 /	1.0 /	92.5				
	100	4.7 /	0.9 /	94.4				
	250	4.9 /	2.1 /	93.0				
	500	3.1 /	1.7 /	95.2				
BSE	30	6.2 /	0.8 /	93.0				
	50	6.0 /	1.0 /	93.0				
	100	4.3 /	0.8 /	94.9				
	250	4.6 /	2.0 /	93.4				
	500	3.2 /	1.6 /	95.2				
BP	30	4.9 /	1.4 /	93.7	0.507	0.398	1.171	1.833
	50	3.9 /	1.7 /	94.4	0.434	0.227	0.511	0.498
	100	3.6 /	1.2 /	95.2	0.323	0.122	0.205	0.261
	250	3.8 /	2.7 /	93.5	0.216	0.091	0.072	0.195
	500	2.6 /	1.9 /	95.5	0.152	0.079	0.020	0.165
BC	30	3.8 /	2.0 /	94.2				
	50	2.8 /	2.5 /	94.7				
	100	3.0 /	1.7 /	95.3				
	250	3.3 /	2.9 /	93.8				
	500	2.3 /	2.1 /	95.6				
BCA	30	3.9 /	1.9 /	94.2				
	50	2.8 /	2.4 /	94.8				
	100	3.0 /	1.7 /	95.3				
	250	3.3 /	2.9 /	93.8				
	500	2.3 /	2.1 /	95.6				

Table 11: Success and failure rates of 95% confidence interval, First indirect effect, Population 3

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	0.3 /	0.5 /	99.2				
	50	0.7 /	0.5 /	98.8				
	100	0.6 /	0.3 /	99.1				
	250	1.0 /	1.5 /	97.5				
	500	1.6 /	1.1 /	97.3				
MDM, error	30	0.3 /	0.5 /	99.2				
	50	0.7 /	0.5 /	98.8				
	100	0.6 /	0.3 /	99.1				
	250	1.0 /	1.5 /	97.5				
	500	1.6 /	1.1 /	97.3				
BSE	30	0.4 /	0.1 /	99.5				
	50	0.5 /	0.4 /	99.1				
	100	0.9 /	0.5 /	98.6				
	250	1.1 /	1.3 /	97.6				
	500	2.1 /	1.5 /	96.4				
BP	30	1.2 /	0.8 /	98.0	-0.005	0.952	3.989	3.827
	50	1.1 /	1.8 /	97.1	0.012	0.789	2.636	2.019
	100	1.9 /	1.4 /	96.7	-0.015	0.547	1.421	1.161
	250	2.2 /	2.9 /	94.9	-0.004	0.293	0.565	0.389
	500	2.5 /	1.9 /	95.6	-0.004	0.172	0.277	0.258
BC	30	2.2 /	2.0 /	95.8				
	50	2.7 /	2.9 /	94.4				
	100	3.0 /	2.7 /	94.3				
	250	3.3 /	3.9 /	92.8				
	500	3.0 /	2.7 /	94.3				
BCA	30	2.2 /	2.0 /	95.8				
	50	2.7 /	2.9 /	94.4				
	100	3.1 /	2.7 /	94.2				
	250	3.3 /	3.9 /	92.8				
	500	3.0 /	2.7 /	94.3				

Table 12: Type I error rate of 95% confidence intervals, Second indirect effect, Population 3

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	5.7 /	1.5 /	92.8				
	50	5.7 /	1.0 /	93.3				
	100	4.4 /	0.7 /	94.9				
	250	4.5 /	1.8 /	93.7				
	500	2.7 /	2.0 /	95.3				
MDM, error	30	5.7 /	1.8 /	92.5				
	50	5.7 /	1.0 /	93.3				
	100	4.2 /	0.7 /	95.1				
	250	4.5 /	1.8 /	93.7				
	500	2.5 /	1.9 /	95.6				
BSE	30	3.9 /	0.5 /	95.6				
	50	5.2 /	0.9 /	93.9				
	100	4.1 /	1.0 /	94.9				
	250	4.0 /	1.6 /	94.4				
	500	2.8 /	2.2 /	95.0				
BP	30	3.0 /	1.1 /	95.9	0.356	0.381	1.051	1.342
	50	3.8 /	1.7 /	94.5	0.327	0.233	0.459	0.438
	100	3.1 /	1.2 /	95.7	0.258	0.126	0.185	0.251
	250	3.8 /	2.0 /	94.2	0.179	0.091	0.061	0.189
	500	2.4 /	2.5 /	95.1	0.126	0.080	0.021	0.168
BC	30	2.9 /	1.5 /	95.6				
	50	3.2 /	2.6 /	94.2				
	100	2.7 /	1.4 /	95.9				
	250	3.2 /	2.3 /	94.5				
	500	2.0 /	2.6 /	95.4				
BCA	30	3.0 /	1.5 /	95.5				
	50	3.2 /	2.5 /	94.3				
	100	2.7 /	1.4 /	95.9				
	250	3.2 /	2.3 /	94.5				
	500	2.1 /	2.6 /	95.3				

Table 13: Success and failure rates of 95% confidence interval, Total indirect effect, Population 3

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	7.8 /	1.6 /	90.6				
	50	5.4 /	1.5 /	93.1				
	100	4.7 /	1.9 /	93.4				
	250	4.5 /	1.7 /	93.8				
	500	3.3 /	2.0 /	94.7				
MDM, error	30	7.5 /	1.5 /	91.0				
	50	5.2 /	1.3 /	93.5				
	100	4.6 /	1.6 /	93.8				
	250	4.2 /	1.5 /	94.3				
	500	3.2 /	2.0 /	94.8				
BSE	30	6.3 /	1.0 /	92.7				
	50	5.0 /	1.2 /	93.8				
	100	4.9 /	1.2 /	93.9				
	250	4.8 /	1.5 /	93.7				
	500	3.2 /	2.1 /	94.7				
BP	30	4.7 /	1.7 /	93.6	0.523	0.388	1.133	1.081
	50	4.1 /	1.8 /	94.1	0.429	0.218	0.512	0.468
	100	4.1 /	2.2 /	93.7	0.332	0.125	0.221	0.282
	250	3.7 /	2.0 /	94.3	0.218	0.086	0.079	0.192
	500	2.8 /	2.6 /	94.6	0.157	0.082	0.032	0.169
BC	30	3.9 /	2.4 /	93.7				
	50	2.8 /	2.5 /	94.7				
	100	3.3 /	2.7 /	94.0				
	250	3.2 /	2.2 /	94.6				
	500	2.5 /	2.7 /	94.8				
BCA	30	4.0 /	2.4 /	93.6				
	50	2.8 /	2.5 /	94.7				
	100	3.4 /	2.6 /	94.0				
	250	3.2 /	2.2 /	94.6				
	500	2.5 /	2.7 /	94.8				

Table 14: Success and failure rates of 95% confidence interval, First indirect effect, Population 4

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	0.2	/	0.4	/	99.4				
	50	0.5	/	0.3	/	99.2				
	100	1.0	/	0.7	/	98.3				
	250	0.7	/	1.1	/	98.2				
	500	1.9	/	2.4	/	95.7				
MDM, error	30	0.1	/	0.2	/	99.7				
	50	0.5	/	0.3	/	99.2				
	100	0.8	/	0.7	/	98.5				
	250	0.7	/	1.0	/	98.3				
	500	1.9	/	2.4	/	95.7				
BSE	30	0.3	/	0.2	/	99.5				
	50	0.4	/	0.2	/	99.4				
	100	1.0	/	0.8	/	98.2				
	250	0.7	/	0.9	/	98.4				
	500	1.8	/	2.3	/	95.9				
BP	30	0.6	/	0.8	/	98.6	0.048	1.032	4.321	4.802
	50	2.1	/	1.5	/	96.4	-0.041	0.764	2.603	2.077
	100	2.6	/	1.0	/	96.4	-0.024	0.571	1.449	1.108
	250	1.5	/	2.4	/	96.1	-0.002	0.295	0.580	0.425
	500	2.6	/	2.7	/	94.7	-0.002	0.172	0.282	0.245
BC	30	1.6	/	1.8	/	96.6				
	50	3.4	/	2.1	/	94.5				
	100	3.5	/	2.7	/	93.8				
	250	2.6	/	3.4	/	94.0				
	500	3.0	/	3.0	/	94.0				
BCA	30	1.6	/	1.6	/	96.8				
	50	3.5	/	2.0	/	94.5				
	100	3.5	/	2.7	/	93.8				
	250	2.6	/	3.4	/	94.0				
	500	3.1	/	2.9	/	94.0				

Table 15: Type I error rate of 95% confidence intervals, Second indirect effect, Population 4

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	6.9 /	1.3 /	91.8				
	50	5.3 /	1.8 /	92.9				
	100	5.3 /	2.1 /	92.6				
	250	4.6 /	2.0 /	93.4				
	500	3.6 /	2.6 /	93.8				
MDM, error	30	5.8 /	1.0 /	93.2				
	50	4.6 /	1.2 /	94.2				
	100	4.1 /	1.6 /	94.3				
	250	3.4 /	1.2 /	95.4				
	500	2.9 /	1.5 /	95.6				
BSE	30	4.4 /	1.2 /	94.4				
	50	4.4 /	1.4 /	94.2				
	100	4.5 /	1.6 /	93.9				
	250	3.9 /	1.3 /	94.8				
	500	3.1 /	2.1 /	94.8				
BP	30	4.3 /	2.1 /	93.6	0.325	0.386	0.961	0.865
	50	3.9 /	2.2 /	93.9	0.284	0.225	0.438	0.398
	100	4.1 /	2.6 /	93.3	0.223	0.136	0.180	0.240
	250	3.4 /	1.8 /	94.8	0.156	0.086	0.061	0.174
	500	2.7 /	2.3 /	95.0	0.112	0.080	0.025	0.166
BC	30	4.1 /	2.9 /	93.0				
	50	3.8 /	2.7 /	93.5				
	100	3.7 /	3.0 /	93.3				
	250	2.9 /	2.1 /	95.0				
	500	2.6 /	2.5 /	94.9				
BCA	30	4.1 /	2.9 /	93.0				
	50	3.8 /	2.7 /	93.5				
	100	3.8 /	3.0 /	93.2				
	250	3.0 /	2.0 /	95.0				
	500	2.6 /	2.4 /	95.0				

Table 16: Success and failure rates of 95% confidence interval, Total indirect effect, Population 4

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	9.3 /	1.7 /	89.0				
	50	6.7 /	1.6 /	91.7				
	100	4.8 /	1.3 /	93.9				
	250	3.6 /	1.2 /	95.2				
	500	2.7 /	1.5 /	95.8				
MDM, error	30	9.1 /	1.5 /	89.4				
	50	6.7 /	1.6 /	91.7				
	100	4.6 /	1.3 /	94.1				
	250	3.6 /	1.2 /	95.2				
	500	2.6 /	1.5 /	95.9				
BSE	30	6.1 /	1.3 /	92.6				
	50	6.4 /	1.2 /	92.4				
	100	4.3 /	1.4 /	94.3				
	250	3.3 /	1.4 /	95.3				
	500	3.2 /	1.5 /	95.3				
BP	30	4.8 /	2.5 /	92.7	0.509	0.488	1.551	1.790
	50	5.3 /	1.6 /	93.1	0.436	0.284	0.692	0.608
	100	2.8 /	2.4 /	94.8	0.342	0.149	0.270	0.303
	250	2.9 /	1.6 /	95.5	0.231	0.096	0.111	0.219
	500	2.6 /	1.5 /	95.9	0.168	0.084	0.049	0.181
BC	30	5.1 /	3.2 /	91.7				
	50	4.5 /	2.1 /	93.4				
	100	2.2 /	3.1 /	94.7				
	250	2.7 /	2.2 /	95.1				
	500	2.2 /	1.5 /	96.3				
BCA	30	5.1 /	3.2 /	91.7				
	50	4.6 /	2.1 /	93.3				
	100	2.2 /	2.7 /	95.1				
	250	2.7 /	2.2 /	95.1				
	500	2.2 /	1.5 /	96.3				

Table 17: Success and failure rates of 95% confidence interval, First indirect effect, Population 5

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	9.6 /	0.9 /	89.5				
	50	8.6 /	0.5 /	90.9				
	100	6.6 /	0.7 /	92.7				
	250	4.0 /	1.7 /	94.3				
	500	2.7 /	1.3 /	96.0				
MDM, error	30	9.3 /	0.7 /	90.0				
	50	8.1 /	0.5 /	91.4				
	100	6.2 /	0.7 /	93.1				
	250	4.0 /	1.5 /	94.5				
	500	2.7 /	1.3 /	96.0				
BSE	30	3.2 /	0.9 /	95.9				
	50	5.3 /	0.6 /	94.1				
	100	6.0 /	0.9 /	93.1				
	250	4.4 /	1.6 /	94.0				
	500	2.7 /	1.3 /	96.0				
BP	30	5.0 /	1.2 /	93.8	0.419	0.790	3.040	3.616
	50	4.2 /	1.5 /	94.3	0.490	0.491	1.570	1.583
	100	4.2 /	1.3 /	94.5	0.441	0.270	0.690	0.527
	250	3.6 /	2.6 /	93.8	0.306	0.140	0.261	0.259
	500	2.5 /	1.5 /	96.0	0.231	0.100	0.114	0.214
BC	30	8.5 /	2.0 /	89.5				
	50	4.2 /	2.2 /	93.6				
	100	4.1 /	1.8 /	94.1				
	250	3.1 /	3.0 /	93.9				
	500	1.5 /	2.0 /	96.5				
BCA	30	8.7 /	2.0 /	89.3				
	50	4.4 /	2.1 /	93.5				
	100	4.1 /	1.8 /	94.1				
	250	3.2 /	3.0 /	93.8				
	500	1.5 /	1.9 /	96.6				

Table 18: Success and failure rates of 95% confidence interval, Second indirect effect, Population 5

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	6.5 /	2.2 /	91.3				
	50	6.1 /	2.1 /	91.8				
	100	3.6 /	1.5 /	94.9				
	250	4.1 /	1.4 /	94.5				
	500	3.3 /	1.9 /	94.8				
MDM, error	30	6.6 /	2.2 /	91.2				
	50	5.9 /	2.0 /	92.1				
	100	3.3 /	1.4 /	95.3				
	250	4.0 /	1.2 /	94.8				
	500	3.1 /	1.7 /	95.2				
BSE	30	4.2 /	1.7 /	94.1				
	50	4.4 /	1.5 /	94.1				
	100	3.0 /	1.7 /	95.3				
	250	3.8 /	1.1 /	95.1				
	500	2.7 /	1.5 /	95.8				
BP	30	3.8 /	2.4 /	93.8	0.359	0.423	1.188	1.356
	50	3.8 /	2.1 /	94.1	0.348	0.241	0.536	0.484
	100	2.4 /	2.2 /	95.4	0.269	0.135	0.208	0.259
	250	3.3 /	1.7 /	95.0	0.184	0.094	0.076	0.192
	500	2.5 /	2.0 /	95.5	0.138	0.080	0.037	0.173
BC	30	3.5 /	3.5 /	93.0				
	50	3.4 /	2.7 /	93.9				
	100	2.1 /	2.7 /	95.2				
	250	2.8 /	1.8 /	95.4				
	500	2.1 /	2.4 /	95.5				
BCA	30	3.6 /	3.4 /	93.0				
	50	3.5 /	2.7 /	93.8				
	100	2.2 /	2.7 /	95.1				
	250	2.8 /	1.7 /	95.5				
	500	2.1 /	2.4 /	95.5				

Table 19: Success and failure rates of 95% confidence interval, Total indirect effect, Population 5

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	8.4	/	1.5	/	90.1				
	50	6.7	/	1.6	/	91.7				
	100	5.4	/	0.9	/	93.7				
	250	3.5	/	1.6	/	94.9				
	500	2.4	/	1.9	/	95.7				
MDM, error	30	7.9	/	1.3	/	90.8				
	50	6.4	/	1.5	/	92.1				
	100	5.2	/	0.9	/	93.9				
	250	3.4	/	1.6	/	95.0				
	500	2.1	/	1.8	/	96.1				
BSE	30	6.1	/	1.7	/	92.2				
	50	5.8	/	1.4	/	92.8				
	100	5.0	/	1.1	/	93.9				
	250	3.3	/	1.2	/	95.5				
	500	2.6	/	1.9	/	95.5				
BP	30	5.0	/	2.4	/	92.6	0.478	0.491	1.478	1.329
	50	4.0	/	2.0	/	94.0	0.445	0.283	0.693	0.579
	100	4.4	/	1.8	/	93.8	0.354	0.149	0.285	0.303
	250	2.9	/	1.8	/	95.3	0.229	0.095	0.091	0.197
	500	2.0	/	2.2	/	95.8	0.166	0.080	0.042	0.173
BC	30	4.3	/	2.7	/	93.0				
	50	3.3	/	2.6	/	94.1				
	100	3.2	/	2.5	/	94.3				
	250	2.6	/	2.3	/	95.1				
	500	1.8	/	2.9	/	95.3				
BCA	30	4.3	/	2.7	/	93.0				
	50	3.3	/	2.6	/	94.1				
	100	3.3	/	2.5	/	94.2				
	250	2.6	/	2.2	/	95.2				
	500	1.9	/	2.9	/	95.2				

Table 20: Success and failure rates of 95% confidence interval, First indirect effect, Population 6

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	8.9	/	0.8	/	90.3				
	50	6.7	/	0.7	/	92.6				
	100	6.3	/	1.0	/	92.7				
	250	4.5	/	1.6	/	93.9				
	500	4.1	/	1.5	/	94.4				
MDM, error	30	8.4	/	0.8	/	90.8				
	50	6.3	/	0.7	/	93.0				
	100	5.7	/	0.8	/	93.5				
	250	4.2	/	1.4	/	94.4				
	500	3.8	/	1.5	/	94.7				
BSE	30	2.6	/	0.8	/	96.6				
	50	4.9	/	0.7	/	94.4				
	100	4.8	/	0.6	/	94.6				
	250	4.4	/	1.5	/	94.1				
	500	4.0	/	1.5	/	94.5				
BP	30	3.6	/	1.4	/	95.0	0.445	0.760	2.940	2.878
	50	4.5	/	1.5	/	94.0	0.472	0.478	1.454	1.238
	100	3.6	/	1.8	/	94.6	0.428	0.276	0.686	0.532
	250	3.4	/	1.7	/	94.9	0.312	0.144	0.264	0.284
	500	2.7	/	1.8	/	95.5	0.232	0.101	0.129	0.208
BC	30	6.5	/	1.9	/	91.6				
	50	4.9	/	2.0	/	93.1				
	100	3.4	/	2.1	/	94.5				
	250	2.5	/	2.1	/	95.4				
	500	2.5	/	2.2	/	95.3				
BCA	30	6.6	/	1.8	/	91.6				
	50	4.9	/	2.0	/	93.1				
	100	3.4	/	2.1	/	94.5				
	250	2.5	/	2.1	/	95.4				
	500	2.5	/	2.2	/	95.3				

Table 21: Success and failure rates of 95% confidence interval, Second indirect effect, Population 6

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	6.5	/	1.8	/	91.7				
	50	4.2	/	1.2	/	94.6				
	100	3.8	/	0.8	/	95.4				
	250	3.1	/	1.3	/	95.6				
	500	3.1	/	1.6	/	95.3				
MDM, error	30	6.0	/	1.4	/	92.6				
	50	4.0	/	1.2	/	94.8				
	100	3.1	/	0.8	/	96.1				
	250	2.6	/	1.1	/	96.3				
	500	2.1	/	1.2	/	96.7				
BSE	30	4.7	/	1.4	/	93.9				
	50	4.3	/	1.4	/	94.3				
	100	3.9	/	1.0	/	95.1				
	250	3.4	/	1.5	/	95.1				
	500	3.4	/	2.1	/	94.5				
BP	30	3.6	/	2.1	/	94.3	0.385	0.406	1.218	1.157
	50	3.1	/	2.1	/	94.8	0.360	0.229	0.529	0.446
	100	3.4	/	1.7	/	94.9	0.298	0.130	0.226	0.264
	250	2.7	/	1.9	/	95.4	0.205	0.090	0.066	0.195
	500	2.7	/	2.6	/	94.7	0.150	0.080	0.029	0.176
BC	30	3.2	/	3.0	/	93.8				
	50	2.7	/	2.7	/	94.6				
	100	2.7	/	1.9	/	95.4				
	250	2.4	/	2.2	/	95.4				
	500	2.3	/	2.8	/	94.9				
BCA	30	3.3	/	3.0	/	93.7				
	50	2.8	/	2.6	/	94.6				
	100	2.7	/	1.9	/	95.4				
	250	2.4	/	2.2	/	95.4				
	500	2.3	/	2.8	/	94.9				

Table 22: Success and failure rates of 95% confidence interval, Total indirect effect, Population 6

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	8.6 /	1.1 /	90.3				
	50	6.5 /	1.8 /	91.7				
	100	4.9 /	1.7 /	93.4				
	250	3.3 /	1.9 /	94.8				
	500	4.5 /	2.2 /	93.3				
MDM, error	30	8.4 /	1.0 /	90.6				
	50	6.3 /	1.7 /	92.0				
	100	4.9 /	1.7 /	93.4				
	250	3.3 /	1.9 /	94.8				
	500	4.5 /	2.2 /	93.3				
BSE	30	5.6 /	1.1 /	93.3				
	50	6.1 /	1.3 /	92.6				
	100	5.0 /	1.8 /	93.2				
	250	3.2 /	1.7 /	95.1				
	500	4.7 /	2.2 /	93.1				
BP	30	4.8 /	1.7 /	93.5	0.507	0.480	1.514	1.435
	50	4.7 /	2.1 /	93.2	0.455	0.283	0.726	0.668
	100	3.6 /	2.6 /	93.8	0.354	0.149	0.290	0.301
	250	2.7 /	2.7 /	94.6	0.234	0.094	0.097	0.201
	500	4.0 /	2.4 /	93.6	0.166	0.090	0.045	0.185
BC	30	3.9 /	2.6 /	93.5				
	50	4.0 /	2.6 /	93.4				
	100	2.6 /	3.5 /	93.9				
	250	2.2 /	3.3 /	94.5				
	500	3.7 /	2.7 /	93.6				
BCA	30	3.8 /	2.4 /	93.8				
	50	4.1 /	2.6 /	93.3				
	100	2.7 /	3.4 /	93.9				
	250	2.3 /	3.2 /	94.5				
	500	3.8 /	2.7 /	93.5				

Table 23: Success and failure rates of 95% confidence interval, First indirect effect, Population 7

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	5.6	/	1.5	/	92.9				
	50	5.3	/	1.7	/	93.0				
	100	4.3	/	1.9	/	93.8				
	250	2.9	/	1.9	/	95.2				
	500	4.0	/	2.5	/	93.5				
MDM, error	30	5.6	/	1.6	/	92.8				
	50	5.4	/	1.5	/	93.1				
	100	4.1	/	1.9	/	94.0				
	250	2.8	/	1.8	/	95.4				
	500	4.0	/	2.3	/	93.7				
BSE	30	4.2	/	1.3	/	94.5				
	50	4.7	/	1.3	/	94.0				
	100	3.8	/	2.2	/	94.0				
	250	2.9	/	2.1	/	95.0				
	500	4.3	/	2.4	/	93.3				
BP	30	3.8	/	2.1	/	94.1	0.356	0.370	0.987	0.938
	50	3.5	/	2.0	/	94.5	0.308	0.217	0.434	0.423
	100	3.0	/	2.7	/	94.3	0.248	0.125	0.170	0.229
	250	2.8	/	2.9	/	94.3	0.166	0.088	0.061	0.181
	500	4.0	/	2.4	/	93.6	0.120	0.084	0.025	0.168
BC	30	3.1	/	2.5	/	94.4				
	50	2.9	/	2.5	/	94.6				
	100	2.7	/	3.0	/	94.3				
	250	2.4	/	3.2	/	94.4				
	500	3.6	/	2.7	/	93.7				
BCA	30	3.1	/	2.5	/	94.4				
	50	3.1	/	2.4	/	94.5				
	100	2.7	/	3.0	/	94.3				
	250	2.4	/	3.1	/	94.5				
	500	3.6	/	2.7	/	93.7				

Table 22: Success and failure rates of 95% confidence interval, Total indirect effect, Population 7

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	8.8 /	0.7 /	90.5				
	50	7.0 /	1.1 /	91.9				
	100	5.2 /	1.9 /	92.9				
	250	4.7 /	1.3 /	94.0				
	500	4.8 /	1.6 /	93.6				
MDM, error	30	8.2 /	0.5 /	91.3				
	50	6.4 /	0.9 /	92.7				
	100	5.1 /	1.8 /	93.1				
	250	4.5 /	1.3 /	94.2				
	500	4.3 /	1.5 /	94.2				
BSE	30	5.3 /	0.7 /	94.0				
	50	6.6 /	0.7 /	92.7				
	100	4.1 /	1.3 /	94.6				
	250	4.8 /	1.7 /	93.5				
	500	3.4 /	1.5 /	95.1				
BP	30	4.1 /	1.7 /	94.2	0.471	0.488	1.445	1.483
	50	4.4 /	1.5 /	94.1	0.456	0.276	0.705	0.651
	100	2.8 /	1.8 /	95.4	0.347	0.146	0.280	0.286
	250	4.5 /	1.9 /	93.6	0.226	0.100	0.089	0.203
	500	2.9 /	1.7 /	95.4	0.164	0.082	0.044	0.171
BC	30	3.5 /	2.1 /	94.4				
	50	3.6 /	2.0 /	94.4				
	100	2.4 /	2.2 /	95.4				
	250	3.8 /	2.2 /	94.0				
	500	2.9 /	2.1 /	95.0				
BCA	30	3.5 /	2.1 /	94.4				
	50	3.6 /	1.9 /	94.5				
	100	2.4 /	2.2 /	95.4				
	250	3.8 /	2.2 /	94.0				
	500	2.9 /	2.1 /	95.0				

Table 25: Success and failure rates of 95% confidence interval, First indirect effect, Population 8

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	5.3	/	1.2	/	93.5				
	50	4.5	/	1.6	/	93.9				
	100	4.4	/	1.9	/	93.7				
	250	3.1	/	1.7	/	95.2				
	500	4.5	/	1.5	/	94.0				
MDM, error	30	5.1	/	1.2	/	93.7				
	50	4.6	/	1.4	/	94.0				
	100	4.1	/	1.5	/	94.4				
	250	3.1	/	1.7	/	95.2				
	500	4.0	/	1.4	/	94.6				
BSE	30	4.5	/	1.0	/	94.5				
	50	5.2	/	1.2	/	93.6				
	100	3.1	/	1.2	/	95.7				
	250	4.4	/	1.9	/	93.7				
	500	2.7	/	2.7	/	94.6				
BP	30	3.4	/	1.7	/	94.9	0.371	0.341	0.922	0.816
	50	3.8	/	1.5	/	94.7	0.331	0.213	0.433	0.448
	100	2.5	/	1.7	/	95.8	0.261	0.124	0.163	0.244
	250	3.9	/	2.4	/	93.7	0.176	0.089	0.052	0.181
	500	2.4	/	2.9	/	94.7	0.125	0.079	0.030	0.172
BC	30	3.0	/	2.2	/	94.8				
	50	3.3	/	2.0	/	94.7				
	100	2.1	/	1.9	/	96.0				
	250	3.4	/	2.7	/	93.9				
	500	2.3	/	2.8	/	94.9				
BCA	30	3.0	/	2.2	/	94.8				
	50	3.3	/	2.0	/	94.7				
	100	2.1	/	1.9	/	96.0				
	250	3.5	/	2.6	/	93.9				
	500	2.3	/	2.8	/	94.9				

Table 26: Success and failure rates of 95% confidence interval, Total indirect effect, Population 8

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	8.4 /	0.7 /	90.9				
	50	6.3 /	1.6 /	92.1				
	100	5.9 /	1.4 /	92.7				
	250	4.9 /	1.3 /	93.8				
	500	2.6 /	2.0 /	95.4				
MDM, error	30	8.1 /	0.5 /	91.4				
	50	6.0 /	1.6 /	92.4				
	100	5.8 /	1.4 /	92.8				
	250	4.9 /	1.3 /	93.8				
	500	2.6 /	2.0 /	95.4				
BSE	30	5.9 /	0.4 /	93.7				
	50	5.3 /	0.8 /	93.9				
	100	5.7 /	1.8 /	92.5				
	250	5.1 /	1.3 /	93.6				
	500	3.4 /	2.2 /	94.4				
BP	30	4.5 /	1.2 /	94.3	0.512	0.481	1.533	1.775
	50	3.8 /	2.0 /	94.2	0.445	0.276	0.682	0.649
	100	4.0 /	2.0 /	94.0	0.348	0.154	0.287	0.297
	250	4.0 /	1.8 /	94.2	0.240	0.099	0.110	0.222
	500	2.8 /	2.6 /	94.6	0.163	0.080	0.043	0.173
BC	30	3.5 /	1.8 /	94.7				
	50	2.8 /	2.3 /	94.9				
	100	3.5 /	2.6 /	93.9				
	250	3.7 /	2.1 /	94.2				
	500	2.4 /	3.2 /	94.4				
BCA	30	3.6 /	1.6 /	94.8				
	50	2.8 /	2.3 /	94.9				
	100	3.5 /	2.6 /	93.9				
	250	3.7 /	2.1 /	94.2				
	500	2.4 /	3.2 /	94.4				

Table 27: Success and failure rates of 95% confidence interval, First indirect effect, Population 9

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	0.7 /	0.6 /	98.7				
	50	0.4 /	0.9 /	98.7				
	100	1.4 /	1.3 /	97.3				
	250	2.6 /	1.5 /	95.9				
	500	1.3 /	3.1 /	95.6				
MDM, error	30	0.6 /	0.6 /	98.8				
	50	0.4 /	0.9 /	98.7				
	100	1.4 /	1.3 /	97.3				
	250	2.6 /	1.5 /	95.9				
	500	1.3 /	3.1 /	95.6				
BSE	30	0.2 /	0.3 /	99.5				
	50	0.8 /	0.6 /	98.6				
	100	1.3 /	1.7 /	97.0				
	250	2.8 /	1.6 /	95.6				
	500	1.4 /	3.2 /	95.4				
BP	30	1.5 /	1.7 /	96.8	0.040	0.915	3.425	3.870
	50	2.0 /	1.5 /	96.5	0.032	0.653	1.803	1.466
	100	2.7 /	3.2 /	94.1	-0.013	0.405	0.898	0.672
	250	3.3 /	2.2 /	94.5	0.000	0.204	0.325	0.304
	500	1.6 /	3.7 /	94.7	0.009	0.120	0.155	0.203
BC	30	3.1 /	3.5 /	93.4				
	50	3.0 /	3.4 /	93.6				
	100	4.2 /	4.1 /	91.7				
	250	3.6 /	2.7 /	93.7				
	500	2.0 /	3.9 /	94.1				
BCA	30	3.2 /	3.3 /	93.5				
	50	3.2 /	3.3 /	93.5				
	100	4.2 /	4.0 /	91.8				
	250	3.8 /	2.7 /	93.5				
	500	2.0 /	3.9 /	94.1				

Table 28: Type I error rate of 95% confidence interval, Second indirect effect, Population 9

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	4.6 /	0.8 /	94.6				
	50	4.3 /	1.9 /	93.8				
	100	4.5 /	2.6 /	92.9				
	250	4.4 /	1.5 /	94.1				
	500	2.9 /	2.8 /	94.3				
MDM, error	30	4.5 /	1.3 /	94.2				
	50	4.3 /	1.6 /	94.1				
	100	4.5 /	2.4 /	93.1				
	250	4.2 /	1.5 /	94.3				
	500	2.9 /	2.6 /	94.5				
BSE	30	3.0 /	1.0 /	96.0				
	50	3.1 /	1.4 /	95.5				
	100	3.7 /	1.9 /	94.4				
	250	4.1 /	1.1 /	94.8				
	500	2.6 /	2.9 /	94.5				
BP	30	2.6 /	1.6 /	95.8	0.309	0.415	1.158	1.062
	50	2.9 /	2.1 /	95.0	0.280	0.246	0.516	0.454
	100	3.0 /	2.7 /	94.3	0.225	0.149	0.219	0.243
	250	3.5 /	1.7 /	94.8	0.156	0.095	0.088	0.199
	500	2.4 /	3.2 /	94.4	0.112	0.081	0.041	0.167
BC	30	3.2 /	2.6 /	94.2				
	50	2.4 /	2.2 /	95.4				
	100	2.6 /	3.1 /	94.3				
	250	3.5 /	2.0 /	94.5				
	500	2.2 /	3.4 /	94.4				
BCA	30	3.1 /	2.4 /	94.5				
	50	2.6 /	2.2 /	95.2				
	100	2.6 /	3.1 /	94.3				
	250	3.5 /	2.0 /	94.5				
	500	2.2 /	3.4 /	94.4				

Table 29: Success and failure rates of 95% confidence interval, Total indirect effect, Population 9

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	8.0	/	1.3	/	90.7				
	50	6.5	/	1.2	/	92.3				
	100	5.9	/	1.4	/	92.7				
	250	4.5	/	1.5	/	94.0				
	500	3.9	/	2.1	/	94.0				
MDM, error	30	7.3	/	1.1	/	91.6				
	50	6.2	/	1.1	/	92.7				
	100	5.7	/	1.3	/	93.0				
	250	4.0	/	1.3	/	94.7				
	500	3.5	/	1.9	/	94.6				
BSE	30	5.5	/	0.9	/	93.6				
	50	5.6	/	1.1	/	93.3				
	100	5.4	/	1.1	/	93.5				
	250	4.5	/	1.2	/	94.3				
	500	4.2	/	1.8	/	94.0				
BP	30	5.1	/	1.5	/	93.4	0.465	0.471	1.441	1.323
	50	4.4	/	1.8	/	93.8	0.442	0.282	0.667	0.608
	100	4.0	/	1.6	/	94.4	0.340	0.162	0.311	0.359
	250	3.6	/	1.5	/	94.9	0.231	0.102	0.098	0.204
	500	3.3	/	2.2	/	94.5	0.167	0.084	0.043	0.174
BC	30	4.4	/	2.7	/	92.9				
	50	3.2	/	2.5	/	94.3				
	100	3.3	/	1.8	/	94.9				
	250	3.3	/	2.0	/	94.7				
	500	2.7	/	2.8	/	94.5				
BCA	30	4.4	/	2.7	/	92.9				
	50	3.2	/	2.4	/	94.4				
	100	3.3	/	1.8	/	94.9				
	250	3.3	/	2.0	/	94.7				
	500	2.7	/	2.8	/	94.5				

Table 30: Success and failure rates of 95% confidence interval, First indirect effect, Population 10

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	0.3	/	0.7	/	99.0				
	50	0.6	/	0.9	/	98.5				
	100	1.5	/	0.7	/	97.8				
	250	1.7	/	2.3	/	96.0				
	500	2.2	/	2.3	/	95.5				
MDM, error	30	0.3	/	0.7	/	99.0				
	50	0.6	/	0.8	/	98.6				
	100	1.4	/	0.6	/	98.0				
	250	1.7	/	2.3	/	96.0				
	500	2.1	/	2.3	/	95.6				
BSE	30	0.5	/	0.4	/	99.1				
	50	0.7	/	0.7	/	98.6				
	100	1.1	/	0.7	/	98.2				
	250	1.8	/	2.0	/	96.2				
	500	1.9	/	2.7	/	95.4				
BP	30	1.8	/	1.4	/	96.8	-0.018	0.946	3.531	4.031
	50	1.9	/	2.4	/	95.7	0.009	0.676	1.901	1.964
	100	2.6	/	2.0	/	95.4	0.002	0.431	0.934	0.894
	250	2.4	/	3.0	/	94.6	-0.002	0.204	0.340	0.277
	500	2.6	/	2.3	/	95.1	-0.002	0.128	0.173	0.222
BC	30	3.3	/	3.2	/	93.5				
	50	3.2	/	4.7	/	92.1				
	100	3.9	/	3.8	/	92.3				
	250	2.7	/	3.7	/	93.6				
	500	2.8	/	2.9	/	94.3				
BCA	30	3.5	/	3.1	/	93.4				
	50	3.4	/	4.4	/	92.2				
	100	3.9	/	3.8	/	92.3				
	250	2.7	/	3.6	/	93.7				
	500	2.8	/	2.9	/	94.3				

Table 31: Type I error rate of 95% confidence interval, Second indirect effect, Population 10

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	4.9	/	2.6	/	92.5				
	50	4.7	/	2.2	/	93.1				
	100	5.1	/	1.8	/	93.1				
	250	3.8	/	2.5	/	93.7				
	500	3.4	/	2.1	/	94.5				
MDM, error	30	4.4	/	1.4	/	94.2				
	50	4.0	/	1.6	/	94.4				
	100	3.9	/	1.0	/	95.1				
	250	2.9	/	1.7	/	95.4				
	500	2.4	/	1.6	/	96.0				
BSE	30	3.0	/	1.2	/	95.8				
	50	3.5	/	1.3	/	95.2				
	100	3.8	/	1.8	/	94.4				
	250	3.3	/	1.6	/	95.1				
	500	2.5	/	1.7	/	95.8				
BP	30	3.2	/	1.9	/	94.9	0.252	0.416	1.065	0.941
	50	3.1	/	1.8	/	95.1	0.242	0.254	0.485	0.428
	100	3.6	/	2.0	/	94.4	0.183	0.151	0.226	0.268
	250	3.1	/	2.3	/	94.6	0.131	0.097	0.065	0.177
	500	2.2	/	2.1	/	95.7	0.092	0.083	0.029	0.160
BC	30	3.8	/	2.8	/	93.4				
	50	3.6	/	2.2	/	94.2				
	100	3.6	/	2.2	/	94.2				
	250	3.1	/	2.4	/	94.5				
	500	1.9	/	2.4	/	95.7				
BCA	30	3.9	/	2.7	/	93.4				
	50	3.6	/	2.2	/	94.2				
	100	3.7	/	2.0	/	94.3				
	250	3.1	/	2.4	/	94.5				
	500	1.9	/	2.4	/	95.7				

Table 32: Success and failure rates of 95% confidence interval, Total indirect effect, Population 10

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	8.8	/	1.1	/	90.1				
	50	6.8	/	1.2	/	92.0				
	100	4.8	/	0.8	/	94.4				
	250	4.1	/	2.0	/	93.9				
	500	3.1	/	1.4	/	95.5				
MDM, error	30	8.3	/	1.1	/	90.6				
	50	6.7	/	1.2	/	92.1				
	100	4.7	/	0.8	/	94.5				
	250	4.0	/	2.0	/	94.0				
	500	3.1	/	1.4	/	95.5				
BSE	30	5.3	/	0.8	/	93.9				
	50	5.9	/	1.6	/	92.5				
	100	3.8	/	0.8	/	95.4				
	250	3.8	/	2.2	/	94.0				
	500	3.3	/	1.6	/	95.1				
BP	30	4.2	/	1.6	/	94.2	0.516	0.463	1.496	1.506
	50	4.0	/	1.9	/	94.1	0.432	0.274	0.672	0.573
	100	3.1	/	1.5	/	95.4	0.355	0.149	0.290	0.315
	250	2.5	/	2.4	/	95.1	0.234	0.095	0.109	0.210
	500	2.6	/	1.8	/	95.6	0.171	0.083	0.053	0.181
BC	30	3.5	/	2.4	/	94.1				
	50	3.4	/	3.1	/	93.5				
	100	2.3	/	2.0	/	95.7				
	250	2.0	/	2.9	/	95.1				
	500	2.0	/	1.9	/	96.1				
BCA	30	3.5	/	2.4	/	94.1				
	50	3.5	/	3.1	/	93.4				
	100	2.3	/	1.8	/	95.9				
	250	2.1	/	2.9	/	95.0				
	500	2.0	/	1.9	/	96.1				

Table 33: Success and failure rates of 95% confidence interval, First indirect effect, Population 11

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	7.1	/	0.9	/	92.0				
	50	6.0	/	0.7	/	93.3				
	100	7.8	/	0.5	/	91.7				
	250	7.8	/	0.4	/	91.8				
	500	11.7	/	0.3	/	88.0				
MDM, error	30	6.4	/	0.9	/	92.7				
	50	5.9	/	0.4	/	93.7				
	100	7.7	/	0.5	/	91.8				
	250	7.7	/	0.4	/	91.9				
	500	11.7	/	0.3	/	88.0				
BSE	30	2.4	/	0.7	/	96.9				
	50	5.3	/	0.5	/	94.2				
	100	6.6	/	0.5	/	92.9				
	250	7.6	/	0.3	/	92.1				
	500	11.2	/	0.3	/	88.5				
BP	30	5.5	/	0.9	/	93.6	0.194	0.690	2.142	2.192
	50	6.4	/	1.0	/	92.6	0.170	0.425	0.945	0.754
	100	7.0	/	0.9	/	92.1	0.145	0.233	0.405	0.336
	250	7.3	/	0.3	/	92.4	0.096	0.122	0.149	0.207
	500	10.7	/	0.3	/	89.0	0.074	0.093	0.075	0.177
BC	30	7.7	/	1.7	/	90.6				
	50	7.7	/	1.9	/	90.4				
	100	7.4	/	1.2	/	91.4				
	250	7.4	/	0.3	/	92.3				
	500	10.9	/	0.3	/	88.8				
BCA	30	8.0	/	1.7	/	90.3				
	50	7.8	/	1.9	/	90.3				
	100	7.5	/	1.2	/	91.3				
	250	7.5	/	0.3	/	92.2				
	500	10.9	/	0.3	/	88.8				

Table 34: Success and failure rates of 95% confidence interval, Second indirect effect, Population 11

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	6.3	/	1.1	/	92.6				
	50	6.6	/	0.9	/	92.5				
	100	5.9	/	0.7	/	93.4				
	250	6.2	/	0.7	/	93.1				
	500	8.3	/	0.3	/	91.4				
MDM, error	30	6.3	/	1.1	/	92.6				
	50	6.5	/	0.9	/	92.6				
	100	6.0	/	0.7	/	93.3				
	250	6.1	/	0.7	/	93.2				
	500	8.1	/	0.3	/	91.6				
BSE	30	3.7	/	0.7	/	95.6				
	50	5.3	/	0.8	/	93.9				
	100	5.8	/	0.6	/	93.6				
	250	6.1	/	0.7	/	93.2				
	500	8.6	/	0.4	/	91.0				
BP	30	3.3	/	1.0	/	95.7	0.283	0.405	1.103	1.081
	50	5.1	/	1.1	/	93.8	0.227	0.252	0.456	0.407
	100	5.3	/	0.8	/	93.9	0.188	0.142	0.185	0.235
	250	5.7	/	0.8	/	93.5	0.126	0.095	0.063	0.180
	500	7.6	/	0.4	/	92.0	0.094	0.084	0.034	0.166
BC	30	4.1	/	1.5	/	94.4				
	50	4.7	/	1.5	/	93.8				
	100	4.7	/	1.0	/	94.3				
	250	5.4	/	0.8	/	93.8				
	500	7.4	/	0.4	/	92.2				
BCA	30	4.1	/	1.5	/	94.4				
	50	4.7	/	1.4	/	93.9				
	100	4.7	/	1.0	/	94.3				
	250	5.6	/	0.8	/	93.6				
	500	7.4	/	0.4	/	92.2				

Table 35: Success and failure rates of 95% confidence interval, Total indirect effect, Population 11

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	8.4	/	0.9	/	90.7				
	50	7.7	/	1.8	/	90.5				
	100	4.7	/	1.2	/	94.1				
	250	4.1	/	1.2	/	94.7				
	500	4.7	/	2.5	/	92.8				
MDM, error	30	7.9	/	0.5	/	91.6				
	50	7.0	/	1.7	/	91.3				
	100	4.2	/	1.0	/	94.8				
	250	3.8	/	1.1	/	95.1				
	500	4.2	/	2.4	/	93.4				
BSE	30	5.5	/	0.5	/	94.0				
	50	6.2	/	1.2	/	92.6				
	100	4.3	/	0.9	/	94.8				
	250	3.7	/	1.0	/	95.3				
	500	4.5	/	2.8	/	92.7				
BP	30	4.8	/	1.1	/	94.1	0.498	0.504	1.592	1.822
	50	5.4	/	1.9	/	92.7	0.449	0.269	0.681	0.668
	100	3.3	/	1.2	/	95.5	0.352	0.151	0.296	0.310
	250	3.2	/	1.5	/	95.3	0.231	0.098	0.108	0.211
	500	3.4	/	2.8	/	93.8	0.166	0.081	0.057	0.176
BC	30	4.3	/	2.0	/	93.7				
	50	4.3	/	2.5	/	93.2				
	100	2.5	/	1.6	/	95.9				
	250	2.9	/	2.1	/	95.0				
	500	3.0	/	2.9	/	94.1				
BCA	30	4.2	/	2.0	/	93.8				
	50	4.4	/	2.5	/	93.1				
	100	2.5	/	1.6	/	95.9				
	250	3.0	/	2.1	/	94.9				
	500	3.0	/	2.9	/	94.1				

Table 36: Success and failure rates of 95% confidence interval, First indirect effect, Population 12

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	7.2 /	0.5 /	92.3				
	50	7.9 /	1.1 /	91.0				
	100	7.3 /	0.8 /	91.9				
	250	7.8 /	0.5 /	91.7				
	500	12.7 /	0.5 /	86.8				
MDM, error	30	6.5 /	0.4 /	93.1				
	50	7.0 /	1.0 /	92.0				
	100	6.6 /	0.6 /	92.8				
	250	7.4 /	0.5 /	92.1				
	500	12.0 /	0.5 /	87.5				
BSE	30	3.3 /	0.3 /	96.4				
	50	6.8 /	0.6 /	92.6				
	100	5.9 /	1.1 /	93.0				
	250	7.1 /	0.5 /	92.4				
	500	12.6 /	0.6 /	86.8				
BP	30	6.1 /	0.9 /	93.0	0.167	0.709	2.125	2.119
	50	7.3 /	1.7 /	91.0	0.162	0.443	1.031	0.887
	100	6.7 /	1.4 /	91.9	0.134	0.239	0.417	0.329
	250	6.8 /	0.7 /	92.5	0.097	0.124	0.154	0.211
	500	12.0 /	0.7 /	87.3	0.067	0.094	0.071	0.177
BC	30	9.3 /	1.4 /	89.3				
	50	8.2 /	2.3 /	89.5				
	100	7.3 /	1.7 /	91.0				
	250	6.9 /	1.0 /	92.1				
	500	12.2 /	0.8 /	87.0				
BCA	30	9.4 /	1.4 /	89.2				
	50	8.4 /	2.3 /	89.3				
	100	7.3 /	1.7 /	91.0				
	250	6.9 /	1.0 /	92.1				
	500	12.2 /	0.6 /	87.2				

Table 37: Success and failure rates of 95% confidence interval, Second indirect effect, Population 12

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	6.8	/	0.7	/	92.5				
	50	5.5	/	1.1	/	93.4				
	100	4.0	/	0.7	/	95.3				
	250	4.7	/	0.5	/	94.8				
	500	6.8	/	0.7	/	92.5				
MDM, error	30	5.8	/	0.5	/	93.7				
	50	5.0	/	1.0	/	94.0				
	100	3.7	/	0.6	/	95.7				
	250	4.0	/	0.4	/	95.6				
	500	5.2	/	0.6	/	94.2				
BSE	30	5.3	/	0.6	/	94.1				
	50	6.1	/	0.7	/	93.2				
	100	5.7	/	0.7	/	93.6				
	250	5.7	/	0.8	/	93.5				
	500	9.1	/	0.8	/	90.1				
BP	30	5.2	/	1.1	/	93.7	0.294	0.421	1.165	1.164
	50	4.9	/	1.1	/	94.0	0.287	0.244	0.512	0.436
	100	4.8	/	1.0	/	94.2	0.230	0.150	0.228	0.282
	250	5.2	/	1.2	/	93.6	0.157	0.094	0.074	0.189
	500	8.2	/	0.8	/	91.0	0.114	0.080	0.037	0.168
BC	30	5.0	/	1.4	/	93.6				
	50	4.3	/	1.8	/	93.9				
	100	4.2	/	1.5	/	94.3				
	250	4.9	/	1.3	/	93.8				
	500	8.1	/	0.8	/	91.1				
BCA	30	5.1	/	1.4	/	93.5				
	50	4.4	/	1.8	/	93.8				
	100	4.2	/	1.5	/	94.3				
	250	4.9	/	1.2	/	93.9				
	500	8.1	/	0.8	/	91.1				

Table 38: Success and failure rates of 95% confidence interval, Total indirect effect, Population 12

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	0.5 /	0.6 /	98.9				
	50	1.5 /	1.5 /	97.0				
	100	2.3 /	1.6 /	96.1				
	250	2.2 /	2.7 /	95.1				
	500	2.0 /	3.4 /	94.6				
MDM, error	30	0.5 /	0.6 /	98.9				
	50	1.5 /	1.5 /	97.0				
	100	2.3 /	1.6 /	96.1				
	250	2.2 /	2.7 /	95.1				
	500	2.0 /	3.4 /	94.6				
BSE	30	0.6 /	0.8 /	98.6				
	50	1.6 /	1.2 /	97.2				
	100	2.6 /	1.8 /	95.6				
	250	2.6 /	2.6 /	94.8				
	500	1.9 /	3.1 /	95.0				
BP	30	1.8 /	1.7 /	96.5	0.027	0.717	2.088	2.066
	50	2.6 /	2.0 /	95.4	-0.003	0.456	1.012	0.737
	100	3.1 /	2.6 /	94.3	0.001	0.259	0.461	0.377
	250	2.7 /	3.0 /	94.3	0.003	0.137	0.161	0.218
	500	2.0 /	3.0 /	95.0	-0.001	0.094	0.066	0.173
BC	30	3.9 /	3.7 /	92.4				
	50	3.5 /	3.6 /	92.9				
	100	3.6 /	3.1 /	93.3				
	250	3.2 /	3.5 /	93.3				
	500	2.1 /	3.1 /	94.8				
BCA	30	3.6 /	3.7 /	92.7				
	50	3.5 /	3.5 /	93.0				
	100	3.6 /	3.0 /	93.4				
	250	3.2 /	3.5 /	93.3				
	500	2.1 /	3.1 /	94.8				

Table 39: Type I error rate of 95% confidence interval, First indirect effect, Population 13

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	2.3 /	1.9 /	95.8				
	50	2.4 /	2.4 /	95.2				
	100	2.4 /	2.9 /	94.7				
	250	2.4 /	2.2 /	95.4				
	500	2.5 /	3.1 /	94.4				
MDM, error	30	2.5 /	1.6 /	95.9				
	50	2.3 /	2.1 /	95.6				
	100	2.3 /	2.8 /	94.9				
	250	2.4 /	2.2 /	95.4				
	500	2.4 /	3.1 /	94.5				
BSE	30	1.6 /	1.3 /	97.1				
	50	2.2 /	2.2 /	95.6				
	100	2.2 /	2.8 /	95.0				
	250	2.8 /	2.5 /	94.7				
	500	2.7 /	3.5 /	93.8				
BP	30	3.1 /	2.2 /	94.7	0.004	0.488	1.200	1.023
	50	2.8 /	2.6 /	94.6	0.001	0.317	0.596	0.497
	100	2.4 /	3.3 /	94.3	-0.004	0.184	0.251	0.255
	250	2.8 /	2.4 /	94.8	0.006	0.104	0.089	0.177
	500	2.5 /	3.6 /	93.9	0.001	0.088	0.032	0.164
BC	30	4.1 /	3.0 /	92.9				
	50	3.5 /	3.5 /	93.0				
	100	2.7 /	3.8 /	93.5				
	250	3.0 /	2.8 /	94.2				
	500	2.6 /	3.8 /	93.6				
BCA	30	4.1 /	3.0 /	92.9				
	50	3.5 /	3.5 /	93.0				
	100	2.7 /	3.7 /	93.6				
	250	3.0 /	2.8 /	94.2				
	500	2.6 /	3.8 /	93.6				

Table 40: Type I error rate of 95% confidence interval, Total indirect effect, Population 13

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	1.1	/	1.1	/	97.8				
	50	2.2	/	2.1	/	95.7				
	100	2.0	/	2.1	/	95.9				
	250	3.7	/	1.8	/	94.5				
	500	2.1	/	2.0	/	95.9				
MDM, error	30	1.1	/	1.1	/	97.8				
	50	1.9	/	2.1	/	96.0				
	100	2.0	/	2.1	/	95.9				
	250	3.7	/	1.8	/	94.5				
	500	2.1	/	2.0	/	95.9				
BSE	30	0.8	/	0.9	/	98.3				
	50	1.7	/	1.9	/	96.4				
	100	1.7	/	1.9	/	96.4				
	250	3.5	/	1.8	/	94.7				
	500	2.1	/	2.6	/	95.3				
BP	30	2.7	/	2.2	/	95.1	-0.033	0.708	2.021	1.853
	50	3.0	/	2.9	/	94.1	0.011	0.483	1.055	0.822
	100	2.8	/	2.5	/	94.7	-0.006	0.262	0.461	0.380
	250	3.9	/	1.9	/	94.2	-0.009	0.132	0.155	0.199
	500	2.0	/	2.6	/	95.4	0.001	0.098	0.076	0.177
BC	30	4.7	/	3.4	/	91.9				
	50	3.9	/	4.2	/	91.9				
	100	3.7	/	3.4	/	92.9				
	250	4.1	/	2.1	/	93.8				
	500	2.1	/	2.4	/	95.5				
BCA	30	4.6	/	3.4	/	92.0				
	50	3.9	/	4.1	/	92.0				
	100	3.7	/	3.4	/	92.9				
	250	4.1	/	2.1	/	93.8				
	500	2.1	/	2.4	/	95.5				

Table 41: Type I error rate of 95% confidence interval, First indirect effect, Population 14

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	3.0	/	2.5	/	94.5				
	50	2.6	/	3.5	/	93.9				
	100	3.1	/	4.1	/	92.8				
	250	3.8	/	3.0	/	93.2				
	500	2.9	/	3.6	/	93.5				
MDM, error	30	2.8	/	2.2	/	95.0				
	50	2.5	/	3.2	/	94.3				
	100	3.0	/	3.9	/	93.1				
	250	3.7	/	2.6	/	93.7				
	500	2.8	/	3.5	/	93.7				
BSE	30	1.8	/	1.8	/	96.4				
	50	2.1	/	2.5	/	95.4				
	100	2.3	/	2.5	/	95.2				
	250	3.1	/	1.7	/	95.2				
	500	2.1	/	2.7	/	95.2				
BP	30	3.2	/	2.9	/	93.9	0.001	0.455	1.085	0.911
	50	2.7	/	3.4	/	93.9	0.000	0.303	0.537	0.468
	100	2.7	/	3.3	/	94.0	0.000	0.176	0.224	0.237
	250	3.3	/	1.6	/	95.1	0.002	0.103	0.076	0.177
	500	1.9	/	2.3	/	95.8	0.004	0.083	0.031	0.166
BC	30	3.7	/	4.0	/	92.3				
	50	3.5	/	4.0	/	92.5				
	100	3.2	/	3.7	/	93.1				
	250	3.4	/	1.7	/	94.9				
	500	1.9	/	2.1	/	96.0				
BCA	30	3.6	/	3.9	/	92.5				
	50	3.5	/	3.9	/	92.6				
	100	3.2	/	3.6	/	93.2				
	250	3.4	/	1.7	/	94.9				
	500	1.9	/	2.1	/	96.0				

Table 42: Type I error rate of 95% confidence interval, Total indirect effect, Population 14

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	2.6	/	2.3	/	95.1				
	50	2.5	/	2.1	/	95.4				
	100	2.5	/	1.6	/	95.9				
	250	2.5	/	2.4	/	95.1				
	500	2.3	/	2.4	/	95.3				
MDM, error	30	2.5	/	2.3	/	95.2				
	50	2.5	/	2.1	/	95.4				
	100	2.5	/	1.6	/	95.9				
	250	2.5	/	2.4	/	95.1				
	500	2.3	/	2.4	/	95.3				
BSE	30	2.1	/	1.4	/	96.5				
	50	2.4	/	2.1	/	95.5				
	100	2.2	/	2.0	/	95.8				
	250	2.9	/	2.1	/	95.0				
	500	2.4	/	2.8	/	94.8				
BP	30	3.7	/	3.6	/	92.7	0.005	0.592	1.475	1.227
	50	3.5	/	3.3	/	93.2	0.000	0.356	0.679	0.559
	100	2.4	/	2.2	/	95.4	0.007	0.197	0.287	0.261
	250	3.2	/	2.3	/	94.5	0.002	0.106	0.091	0.181
	500	2.6	/	2.6	/	94.8	0.004	0.090	0.041	0.167
BC	30	5.5	/	5.2	/	89.3				
	50	3.9	/	4.3	/	91.8				
	100	2.8	/	2.2	/	95.0				
	250	3.2	/	2.9	/	93.9				
	500	2.7	/	2.9	/	94.4				
BCA	30	5.4	/	5.0	/	89.6				
	50	3.9	/	4.3	/	91.8				
	100	2.8	/	2.1	/	95.1				
	250	3.2	/	2.8	/	94.0				
	500	2.7	/	2.8	/	94.5				

Table 43: Type I error rate of 95% confidence interval, First indirect effect, Population 15

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	0.0	/	0.0	/	100.0				
	50	0.0	/	0.0	/	100.0				
	100	0.0	/	0.0	/	100.0				
	250	0.0	/	0.0	/	100.0				
	500	0.0	/	0.0	/	100.0				
MDM, error	30	0.0	/	0.0	/	100.0				
	50	0.0	/	0.0	/	100.0				
	100	0.0	/	0.0	/	100.0				
	250	0.0	/	0.0	/	100.0				
	500	0.0	/	0.0	/	100.0				
BSE	30	0.0	/	0.0	/	100.0				
	50	0.0	/	0.0	/	100.0				
	100	0.0	/	0.0	/	100.0				
	250	0.0	/	0.0	/	100.0				
	500	0.0	/	0.0	/	100.0				
BP	30	0.0	/	0.1	/	99.9	-0.021	1.165	6.015	5.543
	50	0.2	/	0.1	/	99.7	-0.015	0.927	4.487	3.155
	100	0.0	/	0.0	/	100.0	-0.012	0.857	4.182	2.860
	250	0.0	/	0.1	/	99.9	-0.022	0.792	3.950	2.045
	500	0.0	/	0.1	/	99.9	0.004	0.771	3.926	2.213
BC	30	0.5	/	0.3	/	99.2				
	50	0.4	/	0.2	/	99.4				
	100	0.2	/	0.4	/	99.4				
	250	0.6	/	0.3	/	99.1				
	500	0.1	/	0.1	/	99.8				
BCA	30	0.5	/	0.3	/	99.2				
	50	0.4	/	0.2	/	99.4				
	100	0.2	/	0.4	/	99.4				
	250	0.6	/	0.3	/	99.1				
	500	0.1	/	0.1	/	99.8				

Table 44: Type I error rate of 95% confidence interval, Second indirect effect, Population 15

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	2.7 /	1.7 /	95.6				
	50	2.5 /	2.4 /	95.1				
	100	2.2 /	1.6 /	96.2				
	250	2.6 /	2.5 /	94.9				
	500	2.2 /	2.4 /	95.4				
MDM, error	30	2.4 /	2.3 /	95.3				
	50	2.3 /	2.4 /	95.3				
	100	2.2 /	1.6 /	96.2				
	250	2.6 /	2.3 /	95.1				
	500	2.2 /	2.3 /	95.5				
BSE	30	1.5 /	1.4 /	97.1				
	50	2.0 /	1.8 /	96.2				
	100	2.0 /	1.4 /	96.6				
	250	2.6 /	2.0 /	95.4				
	500	2.6 /	2.6 /	94.8				
BP	30	2.6 /	2.8 /	94.6	-0.004	0.517	1.321	1.143
	50	2.7 /	2.6 /	94.7	-0.004	0.321	0.619	0.495
	100	2.5 /	1.7 /	95.8	0.009	0.189	0.279	0.252
	250	3.1 /	2.2 /	94.7	0.002	0.105	0.088	0.178
	500	2.7 /	2.8 /	94.5	0.003	0.090	0.040	0.168
BC	30	4.5 /	3.9 /	91.6				
	50	3.8 /	3.2 /	93.0				
	100	2.8 /	2.0 /	95.2				
	250	3.4 /	2.5 /	94.1				
	500	3.0 /	3.1 /	93.9				
BCA	30	4.4 /	3.8 /	91.8				
	50	3.7 /	3.0 /	93.3				
	100	2.7 /	2.0 /	95.3				
	250	3.3 /	2.5 /	94.2				
	500	2.9 /	3.1 /	94.0				

Table 45: Type I error rate of 95% confidence interval, Total indirect effect, Population 15

Method	N	Too Low /	Too High /	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	2.2 /	1.9 /	95.9				
	50	1.9 /	2.2 /	95.9				
	100	1.7 /	2.5 /	95.8				
	250	3.0 /	1.6 /	95.4				
	500	1.6 /	1.8 /	96.6				
MDM, error	30	1.9 /	1.9 /	96.2				
	50	1.9 /	2.2 /	95.9				
	100	1.7 /	2.5 /	95.8				
	250	3.0 /	1.6 /	95.4				
	500	1.6 /	1.8 /	96.6				
BSE	30	1.4 /	1.5 /	97.1				
	50	2.7 /	2.4 /	94.9				
	100	1.5 /	2.5 /	96.0				
	250	3.2 /	1.9 /	94.9				
	500	2.4 /	2.1 /	95.5				
BP	30	3.4 /	2.9 /	93.7	-0.002	0.556	1.426	1.337
	50	3.6 /	3.2 /	93.2	0.003	0.362	0.702	0.554
	100	2.3 /	3.0 /	94.7	0.000	0.204	0.290	0.273
	250	3.2 /	2.2 /	94.6	0.004	0.109	0.105	0.186
	500	2.4 /	2.1 /	95.5	0.000	0.090	0.054	0.170
BC	30	4.8 /	4.3 /	90.9				
	50	4.4 /	4.1 /	91.5				
	100	2.6 /	3.8 /	93.6				
	250	3.6 /	2.6 /	93.8				
	500	2.3 /	2.2 /	95.5				
BCA	30	4.8 /	4.2 /	91.0				
	50	4.4 /	4.1 /	91.5				
	100	2.6 /	3.7 /	93.7				
	250	3.6 /	2.5 /	93.9				
	500	2.3 /	2.2 /	95.5				

Table 46: Type I error rate of 95% confidence interval, First indirect effect, Population 16

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	0.0	/	0.0	/	100.0				
	50	0.0	/	0.0	/	100.0				
	100	0.0	/	0.0	/	100.0				
	250	0.0	/	0.0	/	100.0				
	500	0.0	/	0.0	/	100.0				
MDM, error	30	0.0	/	0.0	/	100.0				
	50	0.0	/	0.0	/	100.0				
	100	0.0	/	0.0	/	100.0				
	250	0.0	/	0.0	/	100.0				
	500	0.0	/	0.0	/	100.0				
BSE	30	0.0	/	0.0	/	100.0				
	50	0.0	/	0.0	/	100.0				
	100	0.0	/	0.0	/	100.0				
	250	0.0	/	0.0	/	100.0				
	500	0.0	/	0.0	/	100.0				
BP	30	0.2	/	0.0	/	99.8	-0.018	1.165	6.024	5.049
	50	0.1	/	0.3	/	99.6	-0.023	0.953	4.751	3.220
	100	0.2	/	0.1	/	99.7	-0.002	0.865	4.112	2.547
	250	0.2	/	0.0	/	99.8	0.021	0.805	3.895	2.090
	500	0.0	/	0.0	/	100.0	0.005	0.778	3.910	1.997
BC	30	0.5	/	0.4	/	99.1				
	50	0.3	/	0.8	/	98.9				
	100	0.4	/	0.1	/	99.5				
	250	0.4	/	0.2	/	99.4				
	500	0.0	/	0.1	/	99.9				
BCA	30	0.5	/	0.5	/	99.0				
	50	0.3	/	0.8	/	98.9				
	100	0.4	/	0.1	/	99.5				
	250	0.4	/	0.2	/	99.4				
	500	0.0	/	0.1	/	99.9				

Table 47: Type I error rate of 95% confidence interval, Second indirect effect, Population 16

Method	N	Too Low	/	Too High	/	OK	Skew	SD	Kurtosis	SD
MDM, no error	30	2.4	/	1.5	/	96.1				
	50	1.9	/	2.1	/	96.0				
	100	1.6	/	2.4	/	96.0				
	250	3.0	/	1.9	/	95.1				
	500	1.7	/	1.7	/	96.6				
MDM, error	30	3.2	/	1.4	/	95.4				
	50	2.5	/	1.7	/	95.8				
	100	1.8	/	1.7	/	96.5				
	250	3.5	/	1.6	/	94.9				
	500	1.7	/	1.6	/	96.7				
BSE	30	1.3	/	1.1	/	97.6				
	50	1.9	/	1.9	/	96.2				
	100	1.3	/	2.5	/	96.2				
	250	3.3	/	1.8	/	94.9				
	500	2.3	/	1.9	/	95.8				
BP	30	2.6	/	2.2	/	95.2	0.003	0.491	1.279	1.146
	50	3.0	/	3.1	/	93.9	0.007	0.319	0.630	0.491
	100	1.9	/	3.0	/	95.1	0.000	0.194	0.274	0.263
	250	3.2	/	2.2	/	94.6	0.003	0.108	0.101	0.185
	500	2.3	/	2.1	/	95.6	0.000	0.090	0.052	0.168
BC	30	3.7	/	3.2	/	93.1				
	50	3.6	/	3.5	/	92.9				
	100	2.7	/	3.6	/	93.7				
	250	3.4	/	2.6	/	94.0				
	500	2.4	/	2.0	/	95.6				
BCA	30	3.7	/	3.1	/	93.2				
	50	3.5	/	3.5	/	93.0				
	100	2.5	/	3.6	/	93.9				
	250	3.4	/	2.6	/	94.0				
	500	2.4	/	2.0	/	95.6				

Table 48: Type I error rate of 95% confidence interval, Total indirect effect, Population 16

Method	N	No Error	Error
MDM, no error	30	0.335	0.325
	50	0.670	0.641
	100	0.923	0.909
	250	0.944	0.937
	500	0.956	0.943
MDM, error	30	0.326	0.306
	50	0.665	0.616
	100	0.924	0.913
	250	0.946	0.940
	500	0.956	0.944
BSE	30	0.254	0.229
	50	0.611	0.553
	100	0.921	0.889
	250	0.942	0.940
	500	0.950	0.946
BP	30	0.381	0.389
	50	0.727	0.664
	100	0.931	0.909
	250	0.944	0.937
	500	0.959	0.951
BC	30	0.472	0.475
	50	0.768	0.732
	100	0.937	0.911
	250	0.948	0.944
	500	0.960	0.953
BCA	30	0.464	0.470
	50	0.767	0.731
	100	0.937	0.912
	250	0.949	0.942
	500	0.960	0.953

Table 49: Power, 95% confidence interval, First indirect effect, Populations 1 and 2

Method	N	No Error	Error
MDM, no error	30	0.702	0.710
	50	0.908	0.923
	100	0.944	0.956
	250	0.941	0.962
	500	0.949	0.943
MDM, error	30	0.687	0.691
	50	0.907	0.915
	100	0.944	0.959
	250	0.941	0.962
	500	0.950	0.946
BSE	30	0.573	0.620
	50	0.875	0.895
	100	0.950	0.947
	250	0.945	0.955
	500	0.946	0.937
BP	30	0.647	0.697
	50	0.886	0.919
	100	0.949	0.951
	250	0.946	0.953
	500	0.954	0.940
BC	30	0.685	0.742
	50	0.888	0.921
	100	0.947	0.954
	250	0.947	0.951
	500	0.953	0.942
BCA	30	0.679	0.739
	50	0.888	0.921
	100	0.950	0.954
	250	0.946	0.951
	500	0.954	0.941

Table 50: Power, 95% confidence interval, Total indirect effect, Populations 1 and 2

Method	N	No Error	Error
MDM, no error	30	0.638	0.640
	50	0.890	0.887
	100	0.944	0.934
	250	0.930	0.938
	500	0.952	0.947
MDM, error	30	0.627	0.614
	50	0.888	0.884
	100	0.944	0.938
	250	0.930	0.943
	500	0.952	0.948
BSE	30	0.516	0.499
	50	0.844	0.851
	100	0.949	0.939
	250	0.934	0.937
	500	0.952	0.947
BP	30	0.670	0.674
	50	0.905	0.889
	100	0.952	0.937
	250	0.935	0.943
	500	0.955	0.946
BC	30	0.727	0.731
	50	0.917	0.904
	100	0.953	0.940
	250	0.938	0.946
	500	0.956	0.948
BCA	30	0.724	0.730
	50	0.917	0.903
	100	0.953	0.940
	250	0.938	0.946
	500	0.956	0.948

Table 51: Power, 95% confidence interval, First indirect effect, Populations 3 and 4

Method	N	No Error	Error
MDM, no error	30	0.500	0.530
	50	0.812	0.784
	100	0.947	0.924
	250	0.937	0.934
	500	0.953	0.938
MDM, error	30	0.496	0.456
	50	0.810	0.736
	100	0.948	0.938
	250	0.937	0.954
	500	0.956	0.956
BSE	30	0.400	0.405
	50	0.763	0.707
	100	0.947	0.934
	250	0.944	0.948
	500	0.950	0.948
BP	30	0.508	0.477
	50	0.807	0.731
	100	0.956	0.926
	250	0.942	0.948
	500	0.951	0.950
BC	30	0.555	0.515
	50	0.816	0.761
	100	0.958	0.928
	250	0.945	0.950
	500	0.954	0.949
BCA	30	0.551	0.510
	50	0.815	0.756
	100	0.958	0.927
	250	0.945	0.950
	500	0.953	0.950

Table 52: Power, 95% confidence interval, Total indirect effect, Populations 3 and 4

Method	N	No Error	Error
MDM, no error	30	0.332	0.350
	50	0.654	0.655
	100	0.926	0.925
	250	0.952	0.949
	500	0.958	0.957
MDM, error	30	0.328	0.334
	50	0.644	0.637
	100	0.923	0.925
	250	0.952	0.950
	500	0.959	0.961
BSE	30	0.254	0.230
	50	0.581	0.545
	100	0.915	0.919
	250	0.953	0.955
	500	0.953	0.955
BP	30	0.394	0.377
	50	0.692	0.690
	100	0.930	0.919
	250	0.955	0.953
	500	0.959	0.958
BC	30	0.470	0.481
	50	0.745	0.734
	100	0.930	0.928
	250	0.951	0.951
	500	0.963	0.953
BCA	30	0.465	0.480
	50	0.743	0.732
	100	0.934	0.927
	250	0.951	0.952
	500	0.963	0.952

Table 53: Power, 95% confidence interval, First indirect effect, Populations 5 and 6

Method	N	No Error	Error
MDM, no error	30	0.044	0.044
	50	0.111	0.108
	100	0.367	0.357
	250	0.833	0.830
	500	0.958	0.944
MDM, error	30	0.045	0.040
	50	0.108	0.102
	100	0.361	0.332
	250	0.835	0.821
	500	0.958	0.946
BSE	30	0.032	0.029
	50	0.090	0.081
	100	0.319	0.295
	250	0.824	0.816
	500	0.957	0.943
BP	30	0.077	0.070
	50	0.182	0.174
	100	0.454	0.435
	250	0.840	0.840
	500	0.958	0.953
BC	30	0.136	0.121
	50	0.263	0.259
	100	0.535	0.509
	250	0.851	0.857
	500	0.963	0.950
BCA	30	0.135	0.118
	50	0.261	0.256
	100	0.532	0.506
	250	0.851	0.855
	500	0.964	0.950

Table 54: Power, 95% confidence interval, Second indirect effect, Populations 5 and 6

Method	N	No Error	Error
MDM, no error	30	0.417	0.422
	50	0.752	0.773
	100	0.945	0.953
	250	0.945	0.956
	500	0.948	0.953
MDM, error	30	0.412	0.369
	50	0.756	0.720
	100	0.949	0.957
	250	0.948	0.963
	500	0.952	0.967
BSE	30	0.319	0.343
	50	0.697	0.728
	100	0.943	0.948
	250	0.951	0.951
	500	0.958	0.945
BP	30	0.418	0.456
	50	0.749	0.790
	100	0.946	0.946
	250	0.950	0.954
	500	0.955	0.947
BC	30	0.481	0.521
	50	0.779	0.812
	100	0.943	0.952
	250	0.954	0.954
	500	0.955	0.949
BCA	30	0.479	0.515
	50	0.776	0.811
	100	0.942	0.952
	250	0.955	0.954
	500	0.955	0.949

Table 55: Power, 95% confidence interval, Total indirect effect, Populations 5 and 6

Method	N	No Error	Error
MDM, no error	30	0.356	0.345
	50	0.665	0.657
	100	0.923	0.913
	250	0.948	0.940
	500	0.933	0.936
MDM, error	30	0.347	0.317
	50	0.656	0.643
	100	0.922	0.914
	250	0.948	0.942
	500	0.933	0.942
BSE	30	0.264	0.241
	50	0.589	0.585
	100	0.911	0.927
	250	0.951	0.935
	500	0.931	0.951
BP	30	0.411	0.402
	50	0.689	0.704
	100	0.924	0.937
	250	0.946	0.936
	500	0.936	0.954
BC	30	0.501	0.488
	50	0.744	0.748
	100	0.925	0.939
	250	0.945	0.940
	500	0.936	0.950
BCA	30	0.498	0.483
	50	0.738	0.746
	100	0.924	0.939
	250	0.945	0.940
	500	0.935	0.950

Table 56: Power, 95% confidence interval, First indirect effect, Populations 7 and 8

Method	N	No Error	Error
MDM, no error	30	0.716	0.716
	50	0.909	0.922
	100	0.938	0.937
	250	0.952	0.952
	500	0.935	0.940
MDM, error	30	0.707	0.708
	50	0.910	0.920
	100	0.940	0.944
	250	0.954	0.952
	500	0.937	0.946
BSE	30	0.607	0.640
	50	0.880	0.901
	100	0.940	0.957
	250	0.950	0.937
	500	0.933	0.946
BP	30	0.672	0.714
	50	0.893	0.913
	100	0.943	0.958
	250	0.943	0.937
	500	0.936	0.947
BC	30	0.708	0.744
	50	0.903	0.922
	100	0.943	0.960
	250	0.944	0.939
	500	0.937	0.949
BCA	30	0.703	0.741
	50	0.901	0.920
	100	0.943	0.960
	250	0.945	0.939
	500	0.937	0.949

Table 57: Power, 95% confidence interval, Total indirect effect, Populations 7 and 8

Method	N	No Error	Error
MDM, no error	30	0.380	0.391
	50	0.656	0.689
	100	0.915	0.914
	250	0.938	0.940
	500	0.954	0.940
MDM, error	30	0.369	0.372
	50	0.651	0.666
	100	0.913	0.910
	250	0.938	0.947
	500	0.954	0.946
BSE	30	0.264	0.259
	50	0.596	0.592
	100	0.895	0.904
	250	0.936	0.943
	500	0.944	0.940
BP	30	0.433	0.425
	50	0.712	0.709
	100	0.918	0.917
	250	0.942	0.949
	500	0.946	0.945
BC	30	0.527	0.495
	50	0.758	0.749
	100	0.919	0.927
	250	0.942	0.947
	500	0.944	0.945
BCA	30	0.525	0.489
	50	0.754	0.746
	100	0.917	0.927
	250	0.942	0.947
	500	0.944	0.945

Table 58: Power, 95% confidence interval, First indirect effect, Populations 9 and 10

Method	N	No Error	Error
MDM, no error	30	0.289	0.271
	50	0.496	0.507
	100	0.825	0.809
	250	0.941	0.937
	500	0.943	0.945
MDM, error	30	0.275	0.233
	50	0.496	0.465
	100	0.818	0.774
	250	0.943	0.954
	500	0.945	0.960
BSE	30	0.209	0.183
	50	0.439	0.428
	100	0.807	0.759
	250	0.948	0.951
	500	0.945	0.958
BP	30	0.277	0.259
	50	0.501	0.482
	100	0.813	0.773
	250	0.948	0.946
	500	0.944	0.957
BC	30	0.321	0.299
	50	0.535	0.508
	100	0.826	0.781
	250	0.945	0.945
	500	0.944	0.957
BCA	30	0.319	0.298
	50	0.533	0.504
	100	0.825	0.782
	250	0.945	0.945
	500	0.944	0.957

Table 59: Power, 95% confidence interval, Total indirect effect, Populations 9 and 10

Method	N	No Error	Error
MDM, no error	30	0.345	0.363
	50	0.674	0.668
	100	0.935	0.928
	250	0.939	0.947
	500	0.955	0.928
MDM, error	30	0.333	0.338
	50	0.668	0.659
	100	0.936	0.932
	250	0.940	0.951
	500	0.955	0.934
BSE	30	0.236	0.245
	50	0.596	0.560
	100	0.934	0.921
	250	0.940	0.953
	500	0.951	0.927
BP	30	0.396	0.402
	50	0.718	0.699
	100	0.937	0.935
	250	0.951	0.953
	500	0.956	0.938
BC	30	0.478	0.482
	50	0.758	0.747
	100	0.941	0.942
	250	0.951	0.950
	500	0.961	0.941
BCA	30	0.474	0.477
	50	0.756	0.743
	100	0.943	0.942
	250	0.950	0.949
	500	0.961	0.941

Table 60: Power, 95% confidence interval, First indirect effect, Populations 11 and 12

Method	N	No Error	Error
MDM, no error	30	0.028	0.036
	50	0.067	0.068
	100	0.137	0.153
	250	0.330	0.327
	500	0.589	0.603
MDM, error	30	0.026	0.031
	50	0.068	0.058
	100	0.132	0.142
	250	0.329	0.316
	500	0.587	0.581
BSE	30	0.019	0.018
	50	0.063	0.051
	100	0.122	0.130
	250	0.342	0.311
	500	0.587	0.589
BP	30	0.050	0.050
	50	0.094	0.079
	100	0.148	0.155
	250	0.351	0.326
	500	0.592	0.592
BC	30	0.077	0.076
	50	0.121	0.096
	100	0.173	0.175
	250	0.363	0.337
	500	0.604	0.602
BCA	30	0.075	0.075
	50	0.119	0.093
	100	0.171	0.172
	250	0.362	0.333
	500	0.602	0.602

Table 61: Power, 95% confidence interval, Second indirect effect, Populations 11 and 12

Method	N	No Error	Error
MDM, no error	30	0.343	0.334
	50	0.587	0.582
	100	0.889	0.909
	250	0.931	0.948
	500	0.914	0.925
MDM, error	30	0.341	0.298
	50	0.579	0.572
	100	0.885	0.888
	250	0.932	0.956
	500	0.916	0.942
BSE	30	0.255	0.279
	50	0.540	0.584
	100	0.877	0.894
	250	0.932	0.935
	500	0.910	0.901
BP	30	0.320	0.347
	50	0.576	0.642
	100	0.884	0.905
	250	0.935	0.936
	500	0.920	0.910
BC	30	0.368	0.403
	50	0.607	0.670
	100	0.895	0.910
	250	0.938	0.938
	500	0.922	0.911
BCA	30	0.360	0.400
	50	0.604	0.666
	100	0.895	0.910
	250	0.936	0.939
	500	0.922	0.911

Table 62: Power, 95% confidence interval, Total indirect effect, Populations 11 and 12

APPENDIX C

99% AND 90% CONFIDENCE INTERVAL SUCCESS, FAILURE AND TYPE I ERROR RATES AND POWER

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	4.9 /	0.0 /	95.1	9.6 /	0.5 /	89.9
	50	2.7 /	0.0 /	97.3	6.0 /	1.0 /	93.0
	100	1.5 /	0.3 /	98.2	4.9 /	1.1 /	94.0
	250	0.8 /	0.1 /	99.1	4.3 /	1.3 /	94.4
	500	0.4 /	0.1 /	99.5	3.4 /	1.0 /	95.6
MDM, error	30	4.8 /	0.0 /	95.2	9.6 /	0.5 /	89.9
	50	2.6 /	0.0 /	97.4	5.8 /	0.9 /	93.3
	100	1.5 /	0.3 /	98.2	4.8 /	0.9 /	94.3
	250	0.8 /	0.1 /	99.1	4.2 /	1.2 /	94.6
	500	0.4 /	0.1 /	99.5	3.4 /	1.0 /	95.6
BSE	30	2.6 /	0.0 /	97.4	6.8 /	0.4 /	92.8
	50	2.0 /	0.0 /	98.0	5.2 /	0.9 /	93.9
	100	1.2 /	0.2 /	98.6	4.3 /	1.1 /	94.6
	250	1.3 /	0.3 /	98.4	4.2 /	1.6 /	94.2
	500	0.6 /	0.2 /	99.2	3.9 /	1.1 /	95.0
BP	30	1.7 /	0.0 /	98.3	5.7 /	0.8 /	93.5
	50	1.0 /	0.4 /	98.6	4.1 /	1.5 /	94.4
	100	0.6 /	0.4 /	99.0	3.0 /	1.6 /	95.4
	250	0.6 /	0.3 /	99.1	3.5 /	2.1 /	94.4
	500	0.4 /	0.2 /	99.4	2.8 /	1.3 /	95.9
BC	30	1.7 /	0.2 /	98.1	4.8 /	1.2 /	94.0
	50	0.6 /	0.4 /	99.0	3.1 /	2.5 /	94.4
	100	0.5 /	0.5 /	99.0	2.6 /	1.8 /	95.6
	250	0.5 /	0.5 /	99.0	2.9 /	2.3 /	94.8
	500	0.4 /	0.2 /	99.4	2.7 /	1.3 /	96.0
BCA	30	1.7 /	0.2 /	98.1	4.8 /	1.1 /	94.1
	50	0.6 /	0.4 /	99.0	3.2 /	2.5 /	94.3
	100	0.5 /	0.5 /	99.0	2.6 /	1.8 /	95.6
	250	0.5 /	0.5 /	99.0	2.9 /	2.2 /	94.9
	500	0.4 /	0.2 /	99.4	2.7 /	1.3 /	96.0

Table 63: Success and failure rates of 99% and 90% confidence intervals, First indirect effect, Population 1

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	2.5 /	0.1 /	97.4	9.8 /	3.3 /	86.9
	50	2.2 /	0.2 /	97.6	9.3 /	3.0 /	87.7
	100	0.9 /	0.2 /	98.9	7.4 /	3.2 /	89.4
	250	1.1 /	0.4 /	98.5	6.6 /	3.3 /	90.1
	500	0.5 /	0.4 /	99.1	7.1 /	4.1 /	88.8
MDM, error	30	2.4 /	0.1 /	97.5	9.4 /	3.0 /	87.6
	50	2.2 /	0.2 /	97.6	9.4 /	3.0 /	87.6
	100	0.9 /	0.2 /	98.9	7.2 /	3.1 /	89.7
	250	1.1 /	0.4 /	98.5	6.7 /	3.3 /	90.0
	500	0.5 /	0.3 /	99.2	6.9 /	3.9 /	89.2
BSE	30	1.2 /	0.1 /	98.7	7.3 /	2.7 /	90.0
	50	1.7 /	0.2 /	98.1	8.6 /	2.9 /	88.5
	100	1.0 /	0.2 /	98.8	6.4 /	3.8 /	89.8
	250	1.0 /	0.4 /	98.6	6.5 /	3.4 /	90.1
	500	0.8 /	0.2 /	99.0	6.6 /	4.0 /	89.4
BP	30	0.5 /	0.2 /	99.3	7.0 /	3.4 /	89.6
	50	1.1 /	0.3 /	98.6	8.0 /	3.6 /	88.4
	100	0.7 /	0.3 /	99.0	5.9 /	4.0 /	90.1
	250	0.8 /	0.4 /	98.8	5.9 /	3.9 /	90.2
	500	0.4 /	0.2 /	99.4	6.1 /	4.3 /	89.6
BC	30	1.1 /	0.7 /	98.2	5.7 /	4.3 /	90.0
	50	1.1 /	0.4 /	98.5	6.4 /	4.3 /	89.3
	100	0.7 /	0.3 /	99.0	5.5 /	4.7 /	89.8
	250	0.7 /	0.5 /	98.8	5.4 /	4.4 /	90.2
	500	0.4 /	0.3 /	99.3	6.0 /	4.4 /	89.6
BCA	30	1.0 /	0.6 /	98.4	5.6 /	4.2 /	90.2
	50	1.2 /	0.4 /	98.4	6.7 /	4.3 /	89.0
	100	0.7 /	0.3 /	99.0	5.6 /	4.7 /	89.7
	250	0.7 /	0.5 /	98.8	5.4 /	4.4 /	90.2
	500	0.4 /	0.3 /	99.3	6.0 /	4.3 /	89.7

Table 64: Success and failure rates of 99% and 90% confidence intervals,

Total indirect effect, Population 1

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	4.0 /	0.0 /	96.0	11.9 /	2.7 /	85.4
	50	3.1 /	0.0 /	96.9	10.2 /	2.6 /	87.2
	100	2.4 /	0.2 /	97.4	8.6 /	4.6 /	86.8
	250	0.9 /	0.4 /	98.7	5.3 /	4.3 /	90.4
	500	1.0 /	0.4 /	98.6	6.3 /	4.9 /	88.8
MDM, error	30	3.8 /	0.0 /	96.2	11.3 /	2.4 /	86.3
	50	3.1 /	0.0 /	96.9	9.9 /	2.5 /	87.6
	100	2.2 /	0.1 /	97.7	8.1 /	4.3 /	87.6
	250	0.9 /	0.4 /	98.7	5.3 /	4.3 /	90.4
	500	1.0 /	0.3 /	98.7	5.6 /	4.6 /	89.8
BSE	30	2.1 /	0.1 /	97.8	8.9 /	2.0 /	89.1
	50	1.6 /	0.1 /	98.3	9.2 /	2.8 /	88.0
	100	1.9 /	0.1 /	98.0	7.9 /	3.9 /	88.2
	250	1.1 /	0.3 /	98.6	5.5 /	4.7 /	89.8
	500	0.9 /	0.3 /	98.8	5.6 /	5.0 /	89.4
BP	30	1.2 /	0.2 /	98.6	8.5 /	2.8 /	88.7
	50	0.7 /	0.4 /	98.9	8.0 /	3.4 /	88.6
	100	0.9 /	0.5 /	98.6	6.9 /	4.8 /	88.3
	250	0.7 /	0.8 /	98.5	5.0 /	5.2 /	89.8
	500	0.7 /	0.5 /	98.8	5.1 /	5.3 /	89.6
BC	30	1.3 /	0.3 /	98.4	5.9 /	4.0 /	90.1
	50	0.6 /	0.6 /	98.8	5.8 /	4.0 /	90.2
	100	0.8 /	0.8 /	98.4	5.4 /	6.1 /	88.5
	250	0.5 /	0.9 /	98.6	4.2 /	5.3 /	90.5
	500	0.7 /	0.6 /	98.7	4.2 /	5.6 /	90.2
BCA	30	1.3 /	0.3 /	98.4	6.0 /	4.0 /	90.0
	50	0.6 /	0.6 /	98.8	5.9 /	3.9 /	90.2
	100	0.8 /	0.8 /	98.4	5.5 /	5.9 /	88.6
	250	0.5 /	0.9 /	98.6	4.2 /	5.3 /	90.5
	500	0.7 /	0.6 /	98.7	4.2 /	5.6 /	90.2

Table 65: Success and failure rates of 99% and 90% confidence intervals, First indirect effect, Population 2

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	2.7 /	0.1 /	97.2	9.2 /	3.2 /	87.6
	50	1.7 /	0.2 /	98.1	8.4 /	2.8 /	88.8
	100	1.2 /	0.2 /	98.6	5.8 /	3.3 /	90.9
	250	0.5 /	0.1 /	99.4	5.8 /	4.0 /	90.2
	500	0.7 /	0.5 /	98.8	7.3 /	3.9 /	88.8
MDM, error	30	2.6 /	0.2 /	97.2	8.6 /	3.1 /	88.3
	50	1.6 /	0.2 /	98.2	7.5 /	2.7 /	89.8
	100	1.1 /	0.2 /	98.7	5.6 /	3.0 /	91.4
	250	0.4 /	0.1 /	99.5	5.5 /	3.8 /	90.7
	500	0.6 /	0.5 /	98.9	6.8 /	3.8 /	89.4
BSE	30	1.8 /	0.1 /	98.1	7.6 /	2.8 /	89.6
	50	1.9 /	0.2 /	97.9	8.2 /	3.1 /	88.7
	100	1.1 /	0.3 /	98.6	5.7 /	3.4 /	90.9
	250	0.9 /	0.1 /	99.0	6.1 /	4.8 /	89.1
	500	0.8 /	0.9 /	98.3	7.4 /	4.3 /	88.3
BP	30	1.3 /	0.1 /	98.6	7.1 /	3.4 /	89.5
	50	1.1 /	0.2 /	98.7	7.4 /	4.3 /	88.3
	100	0.9 /	0.4 /	98.7	5.2 /	4.1 /	90.7
	250	0.9 /	0.3 /	98.8	5.2 /	5.1 /	89.7
	500	0.8 /	0.9 /	98.3	7.2 /	4.4 /	88.4
BC	30	1.3 /	0.3 /	98.4	5.9 /	4.9 /	89.2
	50	0.9 /	0.5 /	98.6	6.3 /	4.7 /	89.0
	100	0.7 /	0.7 /	98.6	4.5 /	4.8 /	90.7
	250	0.8 /	0.4 /	98.8	4.3 /	5.9 /	89.8
	500	0.6 /	1.3 /	98.1	6.2 /	4.6 /	89.2
BCA	30	1.3 /	0.3 /	98.4	6.0 /	4.7 /	89.3
	50	0.9 /	0.5 /	98.6	6.2 /	4.7 /	89.1
	100	0.7 /	0.5 /	98.8	4.5 /	4.8 /	90.7
	250	0.9 /	0.4 /	98.7	4.5 /	5.8 /	89.7
	500	0.7 /	1.3 /	98.0	6.2 /	4.6 /	89.2

Table 66: Success and failure rates of 99% and 90% confidence intervals, Total indirect effect, Population 2

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	4.1 /	0.4 /	95.5	8.9 /	1.2 /	89.9
	50	2.5 /	0.1 /	97.4	6.6 /	1.1 /	92.3
	100	1.6 /	0.0 /	98.4	4.7 /	0.9 /	94.4
	250	1.5 /	0.1 /	98.4	4.9 /	2.1 /	93.0
	500	0.6 /	0.2 /	99.2	3.1 /	1.7 /	95.2
MDM, error	30	3.8 /	0.4 /	95.8	8.9 /	1.1 /	90.0
	50	2.1 /	0.1 /	97.8	6.5 /	1.0 /	92.5
	100	1.6 /	0.0 /	98.4	4.7 /	0.9 /	94.4
	250	1.5 /	0.1 /	98.4	4.9 /	2.1 /	93.0
	500	0.6 /	0.2 /	99.2	3.1 /	1.7 /	95.2
BSE	30	2.8 /	0.2 /	97.0	6.2 /	0.8 /	93.0
	50	2.4 /	0.2 /	97.4	6.0 /	1.0 /	93.0
	100	1.2 /	0.0 /	98.8	4.3 /	0.8 /	94.9
	250	1.6 /	0.1 /	98.3	4.6 /	2.0 /	93.4
	500	0.7 /	0.3 /	99.0	3.2 /	1.6 /	95.2
BP	30	1.6 /	0.3 /	98.1	4.9 /	1.4 /	93.7
	50	1.2 /	0.2 /	98.6	3.9 /	1.7 /	94.4
	100	0.5 /	0.1 /	99.4	3.6 /	1.2 /	95.2
	250	1.1 /	0.2 /	98.7	3.8 /	2.7 /	93.5
	500	0.4 /	0.4 /	99.2	2.6 /	1.9 /	95.5
BC	30	0.8 /	0.3 /	98.9	3.8 /	2.0 /	94.2
	50	0.9 /	0.5 /	98.6	2.8 /	2.5 /	94.7
	100	0.5 /	0.2 /	99.3	3.0 /	1.7 /	95.3
	250	0.9 /	0.3 /	98.8	3.3 /	2.9 /	93.8
	500	0.4 /	0.5 /	99.1	2.3 /	2.1 /	95.6
BCA	30	0.9 /	0.3 /	98.8	3.9 /	1.9 /	94.2
	50	0.9 /	0.5 /	98.6	2.8 /	2.4 /	94.8
	100	0.5 /	0.2 /	99.3	3.0 /	1.7 /	95.3
	250	1.0 /	0.3 /	98.7	3.3 /	2.9 /	93.8
	500	0.4 /	0.4 /	99.2	2.3 /	2.1 /	95.6

Table 67: Success and failure rates of 99% and 90% confidence intervals,

First indirect effect, Population 3

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	0.0 /	0.0 /	100.0	1.3 /	1.2 /	97.5
	50	0.0 /	0.0 /	100.0	1.1 /	1.3 /	97.6
	100	0.0 /	0.0 /	100.0	2.5 /	1.9 /	95.6
	250	0.1 /	0.0 /	99.9	3.4 /	3.9 /	92.7
	500	0.0 /	0.5 /	99.5	4.3 /	3.5 /	92.2
MDM, error	30	0.0 /	0.0 /	100.0	1.3 /	1.2 /	97.5
	50	0.0 /	0.0 /	100.0	1.1 /	1.3 /	97.6
	100	0.0 /	0.0 /	100.0	2.4 /	1.9 /	95.7
	250	0.1 /	0.0 /	99.9	3.4 /	3.9 /	92.7
	500	0.0 /	0.5 /	99.5	4.2 /	3.5 /	92.3
BSE	30	0.0 /	0.0 /	100.0	1.1 /	0.5 /	98.4
	50	0.0 /	0.0 /	100.0	1.1 /	1.8 /	97.1
	100	0.1 /	0.0 /	99.9	1.9 /	1.5 /	96.6
	250	0.1 /	0.1 /	99.8	3.1 /	3.7 /	93.2
	500	0.1 /	0.4 /	99.5	4.3 /	4.1 /	91.6
BP	30	0.0 /	0.1 /	99.9	2.3 /	2.6 /	95.1
	50	0.4 /	0.2 /	99.4	2.8 /	3.2 /	94.0
	100	0.4 /	0.3 /	99.3	3.6 /	3.3 /	93.1
	250	0.2 /	0.5 /	99.3	4.9 /	5.1 /	90.0
	500	0.4 /	0.4 /	99.2	4.9 /	4.7 /	90.4
BC	30	0.1 /	0.5 /	99.4	4.8 /	5.4 /	89.8
	50	0.6 /	0.5 /	98.9	4.7 /	6.0 /	89.3
	100	0.6 /	0.4 /	99.0	4.9 /	5.2 /	89.9
	250	0.5 /	0.9 /	98.6	6.6 /	6.1 /	87.3
	500	0.9 /	0.6 /	98.5	5.2 /	5.1 /	89.7
BCA	30	0.1 /	0.5 /	99.4	4.8 /	5.4 /	89.8
	50	0.6 /	0.5 /	98.9	4.7 /	5.9 /	89.4
	100	0.7 /	0.4 /	98.9	4.9 /	5.2 /	89.9
	250	0.5 /	0.9 /	98.6	6.6 /	6.1 /	87.3
	500	1.0 /	0.6 /	98.4	5.3 /	5.1 /	89.6

Table 68: Type I error rate of 99% and 90% confidence intervals,

Second indirect effect, Population 3

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	2.4 /	0.4 /	97.2	9.5 /	3.1 /	87.4
	50	1.5 /	0.1 /	98.4	8.9 /	3.2 /	87.9
	100	1.5 /	0.0 /	98.5	6.5 /	2.5 /	91.0
	250	1.3 /	0.1 /	98.6	7.1 /	3.9 /	89.0
	500	0.5 /	0.4 /	99.1	5.3 /	4.4 /	90.3
MDM, error	30	2.2 /	0.3 /	97.5	9.4 /	2.9 /	87.7
	50	1.6 /	0.1 /	98.3	8.8 /	3.6 /	87.6
	100	1.5 /	0.0 /	98.5	6.5 /	2.5 /	91.0
	250	1.3 /	0.0 /	98.7	6.9 /	3.9 /	89.2
	500	0.5 /	0.4 /	99.1	5.3 /	4.3 /	90.4
BSE	30	1.3 /	0.2 /	98.5	7.0 /	1.7 /	91.3
	50	1.5 /	0.2 /	98.3	7.1 /	2.6 /	90.3
	100	1.0 /	0.0 /	99.0	6.2 /	2.3 /	91.5
	250	1.1 /	0.2 /	98.7	6.9 /	4.2 /	88.9
	500	0.7 /	0.5 /	98.8	5.4 /	3.6 /	91.0
BP	30	0.4 /	0.3 /	99.3	6.8 /	3.3 /	89.9
	50	0.7 /	0.3 /	99.0	6.7 /	3.1 /	90.2
	100	0.7 /	0.2 /	99.1	6.1 /	3.2 /	90.7
	250	0.9 /	0.3 /	98.8	6.5 /	4.7 /	88.8
	500	0.6 /	0.5 /	98.9	5.0 /	4.0 /	91.0
BC	30	0.4 /	0.4 /	99.2	6.0 /	4.1 /	89.9
	50	0.6 /	0.4 /	99.0	5.6 /	4.6 /	89.8
	100	0.7 /	0.2 /	99.1	4.9 /	3.7 /	91.4
	250	0.8 /	0.3 /	98.9	5.9 /	4.9 /	89.2
	500	0.6 /	0.5 /	98.9	4.7 /	4.5 /	90.8
BCA	30	0.4 /	0.4 /	99.2	6.1 /	4.0 /	89.9
	50	0.6 /	0.4 /	99.0	5.6 /	4.6 /	89.8
	100	0.8 /	0.2 /	99.0	4.9 /	3.7 /	91.4
	250	0.8 /	0.3 /	98.9	5.9 /	4.9 /	89.2
	500	0.6 /	0.5 /	98.9	4.7 /	4.5 /	90.8

Table 69: Success and failure rates of 99% and 90% confidence intervals,

Total indirect effect, Population 3

		99% CI			90% CI		
Method	N	Too Low	Too High	OK	Too Low	Too High	OK
MDM, no error	30	4.2	0.2	95.6	10.6	2.9	86.5
	50	2.2	0.3	97.5	8.1	3.9	88.0
	100	2.0	0.1	97.9	8.0	3.1	88.9
	250	0.9	0.1	99.0	7.1	3.4	89.5
	500	0.7	0.5	98.8	6.4	4.5	89.1
MDM, error	30	4.0	0.1	95.9	10.2	2.6	87.2
	50	2.1	0.3	97.6	7.7	3.3	89.0
	100	2.0	0.1	97.9	7.8	3.0	89.2
	250	0.9	0.1	99.0	6.7	3.4	89.9
	500	0.5	0.5	99.0	6.4	4.3	89.3
BSE	30	2.9	0.0	97.1	8.6	2.8	88.6
	50	2.0	0.2	97.8	7.5	3.3	89.2
	100	2.2	0.3	97.5	7.7	3.4	88.9
	250	1.2	0.1	98.7	6.5	3.3	90.2
	500	0.6	0.5	98.9	6.9	4.2	88.9
BP	30	1.9	0.2	97.9	7.6	3.4	89.0
	50	0.7	0.6	98.7	6.4	4.3	89.3
	100	1.3	0.7	98.0	7.0	4.0	89.0
	250	0.6	0.4	99.0	6.1	3.8	90.1
	500	0.5	0.5	99.0	6.5	4.5	89.0
BC	30	1.6	0.4	98.0	5.6	4.5	89.9
	50	0.5	0.7	98.8	4.8	5.5	89.7
	100	1.0	1.0	98.0	5.8	4.8	89.4
	250	0.3	0.5	99.2	5.6	4.3	90.1
	500	0.5	0.5	99.0	5.4	5.3	89.3
BCA	30	1.6	0.4	98.0	5.7	4.5	89.8
	50	0.5	0.7	98.8	5.0	5.4	89.6
	100	1.1	0.9	98.0	5.9	4.7	89.4
	250	0.3	0.5	99.2	5.7	4.2	90.1
	500	0.5	0.5	99.0	5.4	5.3	89.3

Table 70: Success and failure rates of 99% and 90% confidence intervals, First indirect effect, Population 4

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	0.0 /	0.0 /	100.0	1.4 /	0.8 /	97.8
	50	0.0 /	0.0 /	100.0	2.2 /	1.1 /	96.7
	100	0.0 /	0.1 /	99.9	2.2 /	1.2 /	96.6
	250	0.1 /	0.1 /	99.8	2.6 /	3.6 /	93.8
	500	0.4 /	0.1 /	99.5	4.3 /	4.1 /	91.6
MDM, error	30	0.0 /	0.0 /	100.0	1.4 /	0.8 /	97.8
	50	0.0 /	0.0 /	100.0	1.9 /	1.0 /	97.1
	100	0.0 /	0.1 /	99.9	2.1 /	1.1 /	96.8
	250	0.1 /	0.1 /	99.8	2.6 /	3.6 /	93.8
	500	0.4 /	0.1 /	99.5	4.3 /	4.1 /	91.6
BSE	30	0.0 /	0.1 /	99.9	0.6 /	0.6 /	98.8
	50	0.0 /	0.0 /	100.0	1.8 /	1.0 /	97.2
	100	0.0 /	0.1 /	99.9	2.3 /	1.3 /	96.4
	250	0.1 /	0.1 /	99.8	2.5 /	3.7 /	93.8
	500	0.3 /	0.0 /	99.7	4.3 /	3.9 /	91.8
BP	30	0.1 /	0.0 /	99.9	1.9 /	2.2 /	95.9
	50	0.5 /	0.0 /	99.5	3.7 /	2.2 /	94.1
	100	0.6 /	0.4 /	99.0	4.2 /	3.8 /	92.0
	250	0.4 /	0.5 /	99.1	3.9 /	4.9 /	91.2
	500	0.5 /	0.3 /	99.2	4.8 /	4.2 /	91.0
BC	30	0.4 /	0.1 /	99.5	5.2 /	4.8 /	90.0
	50	0.7 /	0.5 /	98.8	6.9 /	4.4 /	88.7
	100	1.1 /	0.7 /	98.2	7.6 /	6.1 /	86.3
	250	0.5 /	0.6 /	98.9	5.1 /	6.1 /	88.8
	500	0.7 /	0.3 /	99.0	5.2 /	4.6 /	90.2
BCA	30	0.4 /	0.1 /	99.5	5.3 /	4.7 /	90.0
	50	0.7 /	0.5 /	98.8	7.0 /	4.4 /	88.6
	100	1.1 /	0.6 /	98.3	7.6 /	6.1 /	86.3
	250	0.5 /	0.6 /	98.9	5.1 /	6.1 /	88.8
	500	0.7 /	0.3 /	99.0	5.2 /	4.5 /	90.3

Table 71: Type I error rate of 99% and 90% confidence intervals,

Second indirect effect, Population 4

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	3.2 /	0.4 /	96.4	9.9 /	4.3 /	85.8
	50	1.6 /	0.3 /	98.1	9.2 /	4.3 /	86.5
	100	2.3 /	0.5 /	97.2	7.6 /	3.6 /	88.8
	250	1.5 /	0.5 /	98.0	7.5 /	4.0 /	88.5
	500	1.4 /	0.5 /	98.1	6.3 /	5.5 /	88.2
MDM, error	30	2.6 /	0.1 /	97.3	8.6 /	2.8 /	88.6
	50	1.0 /	0.3 /	98.7	7.3 /	3.3 /	89.4
	100	1.6 /	0.3 /	98.1	6.7 /	3.0 /	90.3
	250	0.8 /	0.2 /	99.0	6.4 /	2.9 /	90.7
	500	0.8 /	0.4 /	98.8	4.6 /	4.3 /	91.1
BSE	30	1.6 /	0.0 /	98.4	6.1 /	3.4 /	90.5
	50	1.2 /	0.3 /	98.5	6.8 /	3.7 /	89.5
	100	1.8 /	0.3 /	97.9	6.9 /	3.7 /	89.4
	250	0.7 /	0.3 /	99.0	6.3 /	3.7 /	90.0
	500	1.0 /	0.3 /	98.7	5.2 /	4.8 /	90.0
BP	30	1.3 /	0.3 /	98.4	6.4 /	4.2 /	89.4
	50	0.7 /	0.5 /	98.8	6.5 /	4.9 /	88.6
	100	1.0 /	0.8 /	98.2	6.6 /	4.2 /	89.2
	250	0.5 /	0.4 /	99.1	6.0 /	3.6 /	90.4
	500	0.8 /	0.4 /	98.8	5.0 /	5.2 /	89.8
BC	30	1.5 /	0.6 /	97.9	6.0 /	5.2 /	88.8
	50	0.6 /	0.7 /	98.7	6.5 /	5.5 /	88.0
	100	0.8 /	0.8 /	98.4	6.1 /	4.6 /	89.3
	250	0.5 /	0.5 /	99.0	5.6 /	4.2 /	90.2
	500	0.9 /	0.4 /	98.7	4.5 /	5.6 /	89.9
BCA	30	1.5 /	0.6 /	97.9	6.0 /	5.1 /	88.9
	50	0.6 /	0.6 /	98.8	6.5 /	5.4 /	88.1
	100	0.9 /	0.8 /	98.3	6.2 /	4.6 /	89.2
	250	0.5 /	0.5 /	99.0	5.7 /	4.1 /	90.2
	500	0.9 /	0.4 /	98.7	4.5 /	5.5 /	90.0

Table 72: Success and failure rates of 99% and 90% confidence intervals,

Total indirect effect, Population 4

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	4.6 /	0.2 /	95.2	9.3 /	1.7 /	89.0
	50	3.8 /	0.3 /	95.9	6.7 /	1.6 /	91.7
	100	1.3 /	0.1 /	98.6	4.8 /	1.3 /	93.9
	250	1.1 /	0.2 /	98.7	3.6 /	1.2 /	95.2
	500	0.7 /	0.0 /	99.3	2.7 /	1.5 /	95.8
MDM, error	30	4.1 /	0.2 /	95.7	9.1 /	1.5 /	89.4
	50	3.7 /	0.3 /	96.0	6.7 /	1.6 /	91.7
	100	1.2 /	0.1 /	98.7	4.6 /	1.3 /	94.1
	250	1.1 /	0.2 /	98.7	3.6 /	1.2 /	95.2
	500	0.7 /	0.0 /	99.3	2.6 /	1.5 /	95.9
BSE	30	2.6 /	0.2 /	97.2	6.1 /	1.3 /	92.6
	50	3.2 /	0.2 /	96.6	6.4 /	1.2 /	92.4
	100	1.3 /	0.3 /	98.4	4.3 /	1.4 /	94.3
	250	1.2 /	0.4 /	98.4	3.3 /	1.4 /	95.3
	500	0.9 /	0.0 /	99.1	3.2 /	1.5 /	95.3
BP	30	1.6 /	0.4 /	98.0	4.8 /	2.5 /	92.7
	50	1.7 /	0.4 /	97.9	5.3 /	1.6 /	93.1
	100	0.4 /	0.5 /	99.1	2.8 /	2.4 /	94.8
	250	0.6 /	0.4 /	99.0	2.9 /	1.6 /	95.5
	500	0.8 /	0.2 /	99.0	2.6 /	1.5 /	95.9
BC	30	1.9 /	0.9 /	97.2	5.1 /	3.2 /	91.7
	50	1.5 /	0.6 /	97.9	4.5 /	2.1 /	93.4
	100	0.4 /	0.5 /	99.1	2.2 /	3.1 /	94.7
	250	0.6 /	0.4 /	99.0	2.7 /	2.2 /	95.1
	500	0.7 /	0.2 /	99.1	2.2 /	1.5 /	96.3
BCA	30	1.9 /	0.8 /	97.3	5.1 /	3.2 /	91.7
	50	1.5 /	0.5 /	98.0	4.6 /	2.1 /	93.3
	100	0.4 /	0.5 /	99.1	2.2 /	2.7 /	95.1
	250	0.6 /	0.4 /	99.0	2.7 /	2.2 /	95.1
	500	0.7 /	0.2 /	99.1	2.2 /	1.5 /	96.3

Table 73: Success and failure rates of 99% and 90% confidence intervals, First indirect effect, Population 5

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	3.8 /	0.1 /	96.1	14.3 /	2.1 /	83.6
	50	3.3 /	0.1 /	96.6	12.0 /	2.1 /	85.9
	100	2.6 /	0.0 /	97.4	9.9 /	1.9 /	88.2
	250	1.6 /	0.0 /	98.4	7.5 /	3.6 /	88.9
	500	0.4 /	0.0 /	99.6	5.5 /	2.6 /	91.9
MDM, error	30	3.7 /	0.1 /	96.2	13.7 /	2.1 /	84.2
	50	3.3 /	0.1 /	96.6	11.7 /	2.1 /	86.2
	100	2.6 /	0.0 /	97.4	9.8 /	1.9 /	88.3
	250	1.6 /	0.0 /	98.4	7.5 /	3.6 /	88.9
	500	0.4 /	0.0 /	99.6	5.5 /	2.6 /	91.9
BSE	30	0.5 /	0.1 /	99.4	8.0 /	1.6 /	90.4
	50	1.7 /	0.0 /	98.3	8.9 /	2.0 /	89.1
	100	2.0 /	0.1 /	97.9	9.2 /	2.0 /	88.8
	250	1.9 /	0.1 /	98.0	7.0 /	3.9 /	89.1
	500	0.5 /	0.0 /	99.5	5.4 /	3.0 /	91.6
BP	30	1.1 /	0.1 /	98.8	10.3 /	2.8 /	86.9
	50	0.9 /	0.1 /	99.0	8.5 /	3.1 /	88.4
	100	0.9 /	0.6 /	98.5	8.1 /	3.0 /	88.9
	250	1.3 /	0.3 /	98.4	6.1 /	4.2 /	89.7
	500	0.3 /	0.0 /	99.7	4.4 /	3.2 /	92.4
BC	30	2.8 /	0.4 /	96.8	11.6 /	5.0 /	83.4
	50	1.7 /	0.2 /	98.1	7.0 /	4.4 /	88.6
	100	1.1 /	0.6 /	98.3	6.0 /	3.7 /	90.3
	250	1.2 /	0.4 /	98.4	5.3 /	5.6 /	89.1
	500	0.3 /	0.2 /	99.5	3.9 /	3.9 /	92.2
BCA	30	2.9 /	0.4 /	96.7	11.9 /	4.8 /	83.3
	50	1.7 /	0.2 /	98.1	7.0 /	4.4 /	88.6
	100	1.1 /	0.6 /	98.3	6.2 /	3.7 /	90.1
	250	1.2 /	0.4 /	98.4	5.4 /	5.6 /	89.0
	500	0.3 /	0.2 /	99.5	3.9 /	3.9 /	92.2

Table 74: Success and failure rates of 99% and 90% confidence intervals,

Second indirect effect, Population 5

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	2.9 /	0.2 /	96.9	9.8 /	4.4 /	85.8
	50	2.5 /	0.3 /	97.2	8.9 /	3.7 /	87.4
	100	1.0 /	0.3 /	98.7	5.5 /	3.8 /	90.7
	250	1.3 /	0.2 /	98.5	6.8 /	3.3 /	89.9
	500	0.6 /	0.3 /	99.1	5.5 /	3.5 /	91.0
MDM, error	30	2.8 /	0.3 /	96.9	9.8 /	4.5 /	85.7
	50	2.4 /	0.3 /	97.3	8.5 /	3.7 /	87.8
	100	1.0 /	0.3 /	98.7	5.3 /	3.8 /	90.9
	250	1.4 /	0.2 /	98.4	6.7 /	3.3 /	90.0
	500	0.6 /	0.2 /	99.2	5.2 /	3.4 /	91.4
BSE	30	1.9 /	0.1 /	98.0	7.2 /	3.3 /	89.5
	50	2.1 /	0.1 /	97.8	6.9 /	3.4 /	89.7
	100	0.7 /	0.1 /	99.2	5.1 /	3.7 /	91.2
	250	1.2 /	0.1 /	98.7	6.6 /	3.0 /	90.4
	500	0.6 /	0.2 /	99.2	5.2 /	3.7 /	91.1
BP	30	0.8 /	0.6 /	98.6	7.5 /	5.4 /	87.1
	50	1.2 /	0.4 /	98.4	6.3 /	4.2 /	89.5
	100	0.4 /	0.5 /	99.1	4.8 /	4.2 /	91.0
	250	1.2 /	0.3 /	98.5	6.1 /	3.3 /	90.6
	500	0.7 /	0.3 /	99.0	5.2 /	4.1 /	90.7
BC	30	1.2 /	0.9 /	97.9	5.7 /	6.7 /	87.6
	50	1.2 /	0.4 /	98.4	5.8 /	4.9 /	89.3
	100	0.4 /	0.5 /	99.1	4.2 /	4.9 /	90.9
	250	1.2 /	0.5 /	98.3	5.8 /	4.2 /	90.0
	500	0.7 /	0.5 /	98.8	4.7 /	4.5 /	90.8
BCA	30	1.3 /	0.8 /	97.9	5.7 /	6.7 /	87.6
	50	1.1 /	0.4 /	98.5	5.8 /	4.7 /	89.5
	100	0.4 /	0.5 /	99.1	4.2 /	4.9 /	90.9
	250	1.2 /	0.5 /	98.3	5.8 /	4.1 /	90.1
	500	0.7 /	0.5 /	98.8	4.7 /	4.5 /	90.8

Table 75: Success and failure rates of 99% and 90% confidence intervals,

Total indirect effect, Population 5

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	4.2 /	0.4 /	95.4	11.2 /	3.6 /	85.2
	50	3.1 /	0.2 /	96.7	9.8 /	3.2 /	87.0
	100	2.1 /	0.0 /	97.9	7.8 /	3.5 /	88.7
	250	1.2 /	0.1 /	98.7	6.4 /	3.7 /	89.9
	500	0.6 /	0.1 /	99.3	4.7 /	4.1 /	91.2
MDM, error	30	3.9 /	0.2 /	95.9	10.6 /	3.3 /	86.1
	50	2.8 /	0.2 /	97.0	9.3 /	3.0 /	87.7
	100	1.8 /	0.0 /	98.2	7.4 /	3.1 /	89.5
	250	1.2 /	0.1 /	98.7	6.2 /	3.6 /	90.2
	500	0.5 /	0.0 /	99.5	4.6 /	4.0 /	91.4
BSE	30	2.8 /	0.2 /	97.0	8.9 /	3.2 /	87.9
	50	3.0 /	0.3 /	96.7	8.8 /	2.3 /	88.9
	100	2.2 /	0.1 /	97.7	7.4 /	3.4 /	89.2
	250	1.1 /	0.1 /	98.8	5.3 /	3.1 /	91.6
	500	0.6 /	0.1 /	99.3	5.2 /	3.9 /	90.9
BP	30	1.9 /	0.5 /	97.6	7.8 /	3.5 /	88.7
	50	1.6 /	0.5 /	97.9	7.9 /	3.3 /	88.8
	100	1.1 /	0.1 /	98.8	6.3 /	4.5 /	89.2
	250	0.8 /	0.2 /	99.0	4.9 /	3.9 /	91.2
	500	0.5 /	0.2 /	99.3	4.4 /	4.2 /	91.4
BC	30	2.2 /	1.1 /	96.7	5.9 /	5.0 /	89.1
	50	1.4 /	0.7 /	97.9	5.4 /	4.8 /	89.8
	100	1.0 /	0.2 /	98.8	5.4 /	5.5 /	89.1
	250	0.8 /	0.2 /	99.0	4.1 /	4.7 /	91.2
	500	0.5 /	0.3 /	99.2	3.6 /	5.3 /	91.1
BCA	30	2.1 /	1.1 /	96.8	6.0 /	4.9 /	89.1
	50	1.4 /	0.7 /	97.9	5.5 /	4.8 /	89.7
	100	1.0 /	0.2 /	98.8	5.5 /	5.5 /	89.0
	250	0.8 /	0.2 /	99.0	4.1 /	4.7 /	91.2
	500	0.5 /	0.3 /	99.2	3.7 /	5.3 /	91.0

Table 76: Success and failure rates of 99% and 90% confidence intervals, First indirect effect, Population 6

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	4.1 /	0.1 /	95.8	13.2 /	2.2 /	84.6
	50	3.2 /	0.0 /	96.8	10.7 /	1.9 /	87.4
	100	2.6 /	0.0 /	97.4	9.6 /	2.0 /	88.4
	250	1.4 /	0.2 /	98.4	7.7 /	2.9 /	89.4
	500	1.4 /	0.5 /	98.1	6.4 /	3.4 /	90.2
MDM, error	30	3.7 /	0.1 /	96.2	12.2 /	2.0 /	85.8
	50	2.6 /	0.0 /	97.4	10.4 /	1.8 /	87.8
	100	2.5 /	0.0 /	97.5	9.2 /	1.7 /	89.1
	250	1.2 /	0.2 /	98.6	7.1 /	2.7 /	90.2
	500	1.4 /	0.5 /	98.1	6.2 /	3.0 /	90.8
BSE	30	0.3 /	0.2 /	99.5	5.5 /	1.8 /	92.7
	50	1.4 /	0.0 /	98.6	8.4 /	1.9 /	89.7
	100	1.5 /	0.0 /	98.5	8.8 /	2.2 /	89.0
	250	1.2 /	0.2 /	98.6	6.9 /	3.2 /	89.9
	500	1.4 /	0.4 /	98.2	6.6 /	3.2 /	90.2
BP	30	0.5 /	0.2 /	99.3	8.1 /	2.6 /	89.3
	50	1.4 /	0.1 /	98.5	8.0 /	2.9 /	89.1
	100	0.7 /	0.1 /	99.2	8.0 /	2.9 /	89.1
	250	0.9 /	0.2 /	98.9	5.9 /	4.0 /	90.1
	500	0.8 /	0.5 /	98.7	5.6 /	4.0 /	90.4
BC	30	1.6 /	0.4 /	98.0	10.7 /	4.3 /	85.0
	50	2.3 /	0.4 /	97.3	7.6 /	4.6 /	87.8
	100	0.6 /	0.1 /	99.3	6.4 /	4.1 /	89.5
	250	1.0 /	0.4 /	98.6	5.0 /	4.6 /	90.4
	500	0.8 /	0.6 /	98.6	5.1 /	4.3 /	90.6
BCA	30	1.8 /	0.4 /	97.8	10.7 /	4.2 /	85.1
	50	2.3 /	0.3 /	97.4	7.6 /	4.6 /	87.8
	100	0.6 /	0.1 /	99.3	6.4 /	4.1 /	89.5
	250	1.0 /	0.4 /	98.6	5.0 /	4.6 /	90.4
	500	0.8 /	0.6 /	98.6	5.2 /	4.2 /	90.6

Table 77: Success and failure rates of 99% and 90% confidence intervals,

Second indirect effect, Population 6

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	2.5 /	0.3 /	97.2	9.3 /	3.1 /	87.6
	50	1.5 /	0.2 /	98.3	6.3 /	3.0 /	90.7
	100	1.4 /	0.1 /	98.5	6.4 /	2.8 /	90.8
	250	1.0 /	0.3 /	98.7	6.0 /	4.0 /	90.0
	500	0.3 /	0.4 /	99.3	5.1 /	4.4 /	90.5
MDM, error	30	2.4 /	0.2 /	97.4	8.7 /	2.5 /	88.8
	50	1.6 /	0.1 /	98.3	5.7 /	2.4 /	91.9
	100	1.3 /	0.1 /	98.6	5.7 /	2.0 /	92.3
	250	0.7 /	0.2 /	99.1	4.8 /	3.1 /	92.1
	500	0.2 /	0.3 /	99.5	4.3 /	3.4 /	92.3
BSE	30	1.3 /	0.1 /	98.6	7.9 /	3.2 /	88.9
	50	1.4 /	0.3 /	98.3	6.3 /	2.9 /	90.8
	100	1.6 /	0.2 /	98.2	7.0 /	2.4 /	90.6
	250	1.2 /	0.5 /	98.3	6.4 /	4.3 /	89.3
	500	0.6 /	0.3 /	99.1	5.5 /	4.9 /	89.6
BP	30	1.0 /	0.2 /	98.8	7.8 /	4.6 /	87.6
	50	0.8 /	0.6 /	98.6	5.9 /	3.4 /	90.7
	100	0.9 /	0.2 /	98.9	6.1 /	3.5 /	90.4
	250	0.8 /	0.5 /	98.7	5.7 /	4.6 /	89.7
	500	0.2 /	0.3 /	99.5	5.3 /	5.1 /	89.6
BC	30	1.1 /	0.9 /	98.0	5.7 /	5.4 /	88.9
	50	0.7 /	0.7 /	98.6	4.9 /	4.5 /	90.6
	100	0.9 /	0.3 /	98.8	5.1 /	4.5 /	90.4
	250	0.7 /	0.7 /	98.6	4.7 /	5.2 /	90.1
	500	0.2 /	0.5 /	99.3	4.7 /	5.1 /	90.2
BCA	30	1.1 /	0.9 /	98.0	5.8 /	5.3 /	88.9
	50	0.7 /	0.7 /	98.6	5.1 /	4.5 /	90.4
	100	0.9 /	0.3 /	98.8	5.2 /	4.5 /	90.3
	250	0.7 /	0.7 /	98.6	4.7 /	5.2 /	90.1
	500	0.2 /	0.5 /	99.3	4.7 /	5.1 /	90.2

Table 78: Success and failure rates of 99% and 90% confidence intervals,

Total indirect effect, Population 6

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	3.4 /	0.1 /	96.5	8.6 /	1.1 /	90.3
	50	3.2 /	0.2 /	96.6	6.5 /	1.8 /	91.7
	100	1.6 /	0.2 /	98.2	4.9 /	1.7 /	93.4
	250	0.9 /	0.0 /	99.1	3.3 /	1.9 /	94.8
	500	1.6 /	0.5 /	97.9	4.5 /	2.2 /	93.3
MDM, error	30	3.4 /	0.1 /	96.5	8.4 /	1.0 /	90.6
	50	3.1 /	0.2 /	96.7	6.3 /	1.7 /	92.0
	100	1.5 /	0.2 /	98.3	4.9 /	1.7 /	93.4
	250	0.9 /	0.0 /	99.1	3.3 /	1.9 /	94.8
	500	1.6 /	0.5 /	97.9	4.5 /	2.2 /	93.3
BSE	30	2.2 /	0.0 /	97.8	5.6 /	1.1 /	93.3
	50	2.8 /	0.2 /	97.0	6.1 /	1.3 /	92.6
	100	1.8 /	0.2 /	98.0	5.0 /	1.8 /	93.2
	250	0.9 /	0.2 /	98.9	3.2 /	1.7 /	95.1
	500	1.7 /	0.5 /	97.8	4.7 /	2.2 /	93.1
BP	30	1.4 /	0.4 /	98.2	4.8 /	1.7 /	93.5
	50	1.6 /	0.4 /	98.0	4.7 /	2.1 /	93.2
	100	0.8 /	0.8 /	98.4	3.6 /	2.6 /	93.8
	250	0.6 /	0.5 /	98.9	2.7 /	2.7 /	94.6
	500	1.6 /	0.8 /	97.6	4.0 /	2.4 /	93.6
BC	30	1.4 /	0.7 /	97.9	3.9 /	2.6 /	93.5
	50	1.0 /	0.5 /	98.5	4.0 /	2.6 /	93.4
	100	0.6 /	1.0 /	98.4	2.6 /	3.5 /	93.9
	250	0.5 /	0.5 /	99.0	2.2 /	3.3 /	94.5
	500	1.3 /	0.8 /	97.9	3.7 /	2.7 /	93.6
BCA	30	1.4 /	0.6 /	98.0	3.8 /	2.4 /	93.8
	50	1.1 /	0.5 /	98.4	4.1 /	2.6 /	93.3
	100	0.6 /	1.0 /	98.4	2.7 /	3.4 /	93.9
	250	0.5 /	0.5 /	99.0	2.3 /	3.2 /	94.5
	500	1.4 /	0.8 /	97.8	3.8 /	2.7 /	93.5

Table 79: Success and failure rates of 99% and 90% confidence intervals, First indirect effect, Population 7

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	2.4 /	0.5 /	97.1	8.2 /	3.7 /	88.1
	50	2.0 /	0.2 /	97.8	7.4 /	3.6 /	89.0
	100	1.5 /	0.4 /	98.1	7.1 /	4.0 /	88.9
	250	0.7 /	0.3 /	99.0	5.6 /	5.5 /	88.9
	500	1.0 /	0.3 /	98.7	6.7 /	3.8 /	89.5
MDM, error	30	2.2 /	0.5 /	97.3	7.7 /	3.5 /	88.8
	50	1.8 /	0.2 /	98.0	7.3 /	3.5 /	89.2
	100	1.2 /	0.3 /	98.5	7.0 /	4.0 /	89.0
	250	0.6 /	0.3 /	99.1	5.5 /	5.2 /	89.3
	500	0.9 /	0.4 /	98.7	6.5 /	3.6 /	89.9
BSE	30	1.4 /	0.1 /	98.5	6.3 /	2.8 /	90.9
	50	1.7 /	0.2 /	98.1	7.0 /	3.2 /	89.8
	100	1.3 /	0.6 /	98.1	6.8 /	4.6 /	88.6
	250	0.9 /	0.2 /	98.9	5.5 /	5.4 /	89.1
	500	1.0 /	0.4 /	98.6	6.5 /	3.7 /	89.8
BP	30	0.7 /	0.3 /	99.0	6.4 /	3.7 /	89.9
	50	1.0 /	0.3 /	98.7	5.8 /	3.9 /	90.3
	100	0.8 /	0.7 /	98.5	5.9 /	5.0 /	89.1
	250	0.5 /	0.3 /	99.2	5.2 /	5.7 /	89.1
	500	0.7 /	0.4 /	98.9	6.1 /	4.1 /	89.8
BC	30	0.8 /	0.6 /	98.6	5.5 /	4.8 /	89.7
	50	1.0 /	0.4 /	98.6	5.3 /	4.5 /	90.2
	100	0.8 /	1.0 /	98.2	5.1 /	5.5 /	89.4
	250	0.5 /	0.4 /	99.1	4.7 /	6.5 /	88.8
	500	0.7 /	0.5 /	98.8	6.1 /	4.5 /	89.4
BCA	30	0.8 /	0.6 /	98.6	5.5 /	4.6 /	89.9
	50	1.0 /	0.4 /	98.6	5.4 /	4.5 /	90.1
	100	0.8 /	1.0 /	98.2	5.1 /	5.4 /	89.5
	250	0.5 /	0.4 /	99.1	4.7 /	6.4 /	88.9
	500	0.7 /	0.5 /	98.8	6.1 /	4.5 /	89.4

Table 80: Success and failure rates of 99% and 90% confidence intervals, Total indirect effect, Population 7

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	4.3 /	0.1 /	95.6	11.8 /	2.2 /	86.0
	50	2.3 /	0.1 /	97.6	10.6 /	2.8 /	86.6
	100	2.1 /	0.2 /	97.7	7.5 /	4.2 /	88.3
	250	1.7 /	0.4 /	97.9	7.8 /	4.0 /	88.2
	500	1.4 /	0.2 /	98.4	7.6 /	3.7 /	88.7
MDM, error	30	4.1 /	0.1 /	95.8	11.3 /	1.9 /	86.8
	50	1.9 /	0.1 /	98.0	10.3 /	2.8 /	86.9
	100	2.0 /	0.2 /	97.8	7.2 /	4.0 /	88.8
	250	1.7 /	0.3 /	98.0	7.4 /	3.6 /	89.0
	500	1.2 /	0.2 /	98.6	7.4 /	3.6 /	89.0
BSE	30	1.8 /	0.1 /	98.1	7.3 /	2.5 /	90.2
	50	2.2 /	0.1 /	97.7	9.2 /	2.6 /	88.2
	100	1.6 /	0.2 /	98.2	7.0 /	3.0 /	90.0
	250	1.6 /	0.4 /	98.0	8.2 /	3.5 /	88.3
	500	0.4 /	0.2 /	99.4	6.0 /	3.1 /	90.9
BP	30	1.2 /	0.2 /	98.6	7.4 /	2.8 /	89.8
	50	1.3 /	0.2 /	98.5	7.8 /	3.1 /	89.1
	100	0.9 /	0.4 /	98.7	6.1 /	3.6 /	90.3
	250	1.1 /	0.4 /	98.5	7.0 /	4.1 /	88.9
	500	0.3 /	0.2 /	99.5	5.4 /	3.2 /	91.4
BC	30	1.5 /	0.3 /	98.2	5.8 /	3.5 /	90.7
	50	1.2 /	0.4 /	98.4	6.1 /	4.6 /	89.3
	100	0.6 /	0.9 /	98.5	4.7 /	4.4 /	90.9
	250	1.1 /	0.4 /	98.5	6.5 /	4.8 /	88.7
	500	0.3 /	0.4 /	99.3	4.9 /	3.8 /	91.3
BCA	30	1.5 /	0.3 /	98.2	6.0 /	3.5 /	90.5
	50	1.2 /	0.3 /	98.5	6.1 /	4.6 /	89.3
	100	0.6 /	0.9 /	98.5	4.7 /	4.4 /	90.9
	250	1.1 /	0.4 /	98.5	6.5 /	4.7 /	88.8
	500	0.3 /	0.4 /	99.3	4.9 /	3.8 /	91.3

Table 81: Success and failure rates of 99% and 90% confidence intervals, First indirect effect, Population 8

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	1.8 /	0.1 /	98.1	8.4 /	2.5 /	89.1
	50	1.1 /	0.1 /	98.8	8.4 /	3.6 /	88.0
	100	0.9 /	0.0 /	99.1	7.1 /	3.9 /	89.0
	250	0.9 /	0.3 /	98.8	5.4 /	3.8 /	90.8
	500	0.7 /	0.2 /	99.1	6.8 /	3.0 /	90.2
MDM, error	30	1.7 /	0.0 /	98.3	7.9 /	2.5 /	89.6
	50	1.1 /	0.1 /	98.8	8.2 /	3.5 /	88.3
	100	0.9 /	0.0 /	99.1	6.8 /	3.9 /	89.3
	250	0.8 /	0.2 /	99.0	4.9 /	3.6 /	91.5
	500	0.6 /	0.2 /	99.2	6.5 /	2.7 /	90.8
BSE	30	1.4 /	0.1 /	98.5	6.6 /	2.4 /	91.0
	50	2.1 /	0.1 /	97.8	8.4 /	2.3 /	89.3
	100	0.7 /	0.1 /	99.2	5.0 /	3.2 /	91.8
	250	1.7 /	0.6 /	97.7	7.4 /	3.7 /	88.9
	500	0.6 /	0.8 /	98.6	5.3 /	4.4 /	90.3
BP	30	0.6 /	0.3 /	99.1	6.3 /	2.8 /	90.9
	50	1.1 /	0.4 /	98.5	7.5 /	3.2 /	89.3
	100	0.5 /	0.1 /	99.4	4.4 /	3.8 /	91.8
	250	1.2 /	0.9 /	97.9	6.9 /	4.0 /	89.1
	500	0.3 /	1.2 /	98.5	5.2 /	4.9 /	89.9
BC	30	0.5 /	0.5 /	99.0	5.3 /	3.7 /	91.0
	50	1.0 /	0.6 /	98.4	5.9 /	4.1 /	90.0
	100	0.5 /	0.4 /	99.1	4.1 /	4.1 /	91.8
	250	0.8 /	1.0 /	98.2	6.1 /	4.2 /	89.7
	500	0.3 /	1.4 /	98.3	4.7 /	5.3 /	90.0
BCA	30	0.5 /	0.5 /	99.0	5.3 /	3.7 /	91.0
	50	1.0 /	0.6 /	98.4	6.0 /	4.0 /	90.0
	100	0.5 /	0.4 /	99.1	4.1 /	4.1 /	91.8
	250	0.9 /	1.0 /	98.1	6.1 /	4.2 /	89.7
	500	0.3 /	1.3 /	98.4	4.7 /	5.3 /	90.0

Table 82: Success and failure rates of 99% and 90% confidence intervals,

Total indirect effect, Population 8

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	4.4 /	0.1 /	95.5	8.4 /	0.7 /	90.9
	50	2.8 /	0.3 /	96.9	6.3 /	1.6 /	92.1
	100	2.0 /	0.2 /	97.8	5.9 /	1.4 /	92.7
	250	1.6 /	0.1 /	98.3	4.9 /	1.3 /	93.8
	500	0.8 /	0.4 /	98.8	2.6 /	2.0 /	95.4
MDM, error	30	4.2 /	0.1 /	95.7	8.1 /	0.5 /	91.4
	50	2.7 /	0.3 /	97.0	6.0 /	1.6 /	92.4
	100	2.0 /	0.2 /	97.8	5.8 /	1.4 /	92.8
	250	1.5 /	0.1 /	98.4	4.9 /	1.3 /	93.8
	500	0.8 /	0.4 /	98.8	2.6 /	2.0 /	95.4
BSE	30	2.2 /	0.0 /	97.8	5.9 /	0.4 /	93.7
	50	2.1 /	0.3 /	97.6	5.3 /	0.8 /	93.9
	100	2.0 /	0.2 /	97.8	5.7 /	1.8 /	92.5
	250	1.4 /	0.0 /	98.6	5.1 /	1.3 /	93.6
	500	1.0 /	0.4 /	98.6	3.4 /	2.2 /	94.4
BP	30	1.3 /	0.2 /	98.5	4.5 /	1.2 /	94.3
	50	1.1 /	0.3 /	98.6	3.8 /	2.0 /	94.2
	100	1.0 /	0.3 /	98.7	4.0 /	2.0 /	94.0
	250	0.7 /	0.2 /	99.1	4.0 /	1.8 /	94.2
	500	0.8 /	0.4 /	98.8	2.8 /	2.6 /	94.6
BC	30	1.4 /	0.2 /	98.4	3.5 /	1.8 /	94.7
	50	0.7 /	0.4 /	98.9	2.8 /	2.3 /	94.9
	100	0.6 /	0.7 /	98.7	3.5 /	2.6 /	93.9
	250	0.5 /	0.3 /	99.2	3.7 /	2.1 /	94.2
	500	0.7 /	0.6 /	98.7	2.4 /	3.2 /	94.4
BCA	30	1.4 /	0.2 /	98.4	3.6 /	1.6 /	94.8
	50	0.8 /	0.4 /	98.8	2.8 /	2.3 /	94.9
	100	0.6 /	0.7 /	98.7	3.5 /	2.6 /	93.9
	250	0.5 /	0.3 /	99.2	3.7 /	2.1 /	94.2
	500	0.8 /	0.6 /	98.6	2.4 /	3.2 /	94.4

Table 83: Success and failure rates of 99% and 90% confidence intervals, First indirect effect, Population 9

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	0.0 /	0.0 /	100.0	1.8 /	2.0 /	96.2
	50	0.0 /	0.1 /	99.9	1.7 /	1.8 /	96.5
	100	0.0 /	0.4 /	99.6	3.4 /	3.6 /	93.0
	250	0.0 /	0.1 /	99.9	5.2 /	3.8 /	91.0
	500	0.2 /	0.3 /	99.5	2.8 /	6.3 /	90.9
MDM, error	30	0.0 /	0.0 /	100.0	1.7 /	2.0 /	96.3
	50	0.0 /	0.1 /	99.9	1.7 /	1.8 /	96.5
	100	0.0 /	0.4 /	99.6	3.4 /	3.6 /	93.0
	250	0.0 /	0.1 /	99.9	5.2 /	3.8 /	91.0
	500	0.2 /	0.3 /	99.5	2.8 /	6.3 /	90.9
BSE	30	0.0 /	0.0 /	100.0	1.1 /	1.9 /	97.0
	50	0.0 /	0.0 /	100.0	1.7 /	1.8 /	96.5
	100	0.1 /	0.3 /	99.6	3.3 /	3.2 /	93.5
	250	0.0 /	0.2 /	99.8	4.9 /	3.9 /	91.2
	500	0.2 /	0.5 /	99.3	2.8 /	6.7 /	90.5
BP	30	0.3 /	0.4 /	99.3	3.3 /	3.7 /	93.0
	50	0.2 /	0.2 /	99.6	3.7 /	3.4 /	92.9
	100	0.5 /	0.9 /	98.6	5.7 /	4.7 /	89.6
	250	0.6 /	0.4 /	99.0	6.7 /	4.4 /	88.9
	500	0.3 /	0.9 /	98.8	3.2 /	6.7 /	90.1
BC	30	0.6 /	0.7 /	98.7	5.9 /	6.8 /	87.3
	50	0.8 /	0.8 /	98.4	6.1 /	6.3 /	87.6
	100	1.0 /	1.1 /	97.9	8.0 /	6.9 /	85.1
	250	1.1 /	0.4 /	98.5	7.4 /	4.8 /	87.8
	500	0.4 /	1.2 /	98.4	3.6 /	7.2 /	89.2
BCA	30	0.6 /	0.7 /	98.7	6.0 /	6.7 /	87.3
	50	0.8 /	0.7 /	98.5	6.2 /	6.3 /	87.5
	100	1.0 /	1.1 /	97.9	8.1 /	6.9 /	85.0
	250	1.1 /	0.4 /	98.5	7.4 /	4.7 /	87.9
	500	0.4 /	1.2 /	98.4	3.6 /	7.2 /	89.2

Table 84: Type I error rate of 99% and 90% confidence intervals,

Second indirect effect, Population 9

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	2.0 /	0.2 /	97.8	7.7 /	2.7 /	89.6
	50	1.1 /	0.4 /	98.5	6.8 /	3.2 /	90.0
	100	1.4 /	0.4 /	98.2	7.0 /	4.2 /	88.8
	250	1.5 /	0.1 /	98.4	7.7 /	3.7 /	88.6
	500	0.6 /	0.4 /	99.0	5.1 /	5.5 /	89.4
MDM, error	30	1.8 /	0.2 /	98.0	7.7 /	3.1 /	89.2
	50	1.3 /	0.4 /	98.3	6.9 /	3.1 /	90.0
	100	1.3 /	0.4 /	98.3	6.9 /	4.3 /	88.8
	250	1.4 /	0.1 /	98.5	7.3 /	3.7 /	89.0
	500	0.5 /	0.4 /	99.1	5.0 /	5.3 /	89.7
BSE	30	0.5 /	0.1 /	99.4	5.0 /	2.5 /	92.5
	50	0.7 /	0.3 /	99.0	6.4 /	2.6 /	91.0
	100	1.2 /	0.5 /	98.3	6.4 /	4.0 /	89.6
	250	1.4 /	0.0 /	98.6	7.5 /	3.4 /	89.1
	500	0.6 /	0.6 /	98.8	5.7 /	5.6 /	88.7
BP	30	0.6 /	0.2 /	99.2	5.2 /	3.5 /	91.3
	50	0.6 /	0.5 /	98.9	6.1 /	3.6 /	90.3
	100	0.9 /	0.7 /	98.4	5.6 /	4.8 /	89.6
	250	1.2 /	0.2 /	98.6	7.2 /	3.9 /	88.9
	500	0.5 /	0.6 /	98.9	5.2 /	5.8 /	89.0
BC	30	1.0 /	0.2 /	98.8	5.4 /	4.6 /	90.0
	50	0.6 /	0.7 /	98.7	5.4 /	4.5 /	90.1
	100	0.8 /	0.7 /	98.5	5.1 /	5.3 /	89.6
	250	1.3 /	0.2 /	98.5	6.1 /	4.2 /	89.7
	500	0.5 /	0.8 /	98.7	5.0 /	6.1 /	88.9
BCA	30	1.0 /	0.2 /	98.8	5.5 /	4.5 /	90.0
	50	0.6 /	0.7 /	98.7	5.4 /	4.4 /	90.2
	100	0.8 /	0.7 /	98.5	5.2 /	5.3 /	89.5
	250	1.3 /	0.2 /	98.5	6.3 /	4.2 /	89.5
	500	0.5 /	0.8 /	98.7	5.0 /	6.1 /	88.9

Table 85: Success and failure rates of 99% and 90% confidence intervals,

Total indirect effect, Population 9

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	4.3 /	0.2 /	95.5	11.5 /	3.6 /	84.9
	50	3.2 /	0.1 /	96.7	8.7 /	3.6 /	87.7
	100	2.3 /	0.3 /	97.4	8.8 /	2.6 /	88.6
	250	1.7 /	0.1 /	98.2	7.1 /	3.5 /	89.4
	500	0.9 /	0.4 /	98.7	7.2 /	4.0 /	88.8
MDM, error	30	3.3 /	0.1 /	96.6	10.9 /	3.3 /	85.8
	50	3.0 /	0.1 /	96.9	8.5 /	3.2 /	88.3
	100	1.9 /	0.1 /	98.0	8.4 /	2.4 /	89.2
	250	1.6 /	0.1 /	98.3	6.8 /	3.2 /	90.0
	500	0.9 /	0.3 /	98.8	7.1 /	3.8 /	89.1
BSE	30	2.4 /	0.1 /	97.5	9.1 /	2.5 /	88.4
	50	2.5 /	0.2 /	97.3	7.4 /	2.7 /	89.9
	100	2.0 /	0.3 /	97.7	8.8 /	2.3 /	88.9
	250	2.0 /	0.1 /	97.9	7.2 /	3.8 /	89.0
	500	1.1 /	0.3 /	98.6	7.1 /	4.1 /	88.8
BP	30	2.0 /	0.7 /	97.3	7.7 /	3.9 /	88.4
	50	1.0 /	0.3 /	98.7	6.5 /	3.8 /	89.7
	100	1.4 /	0.5 /	98.1	7.3 /	3.0 /	89.7
	250	1.4 /	0.2 /	98.4	6.7 /	4.0 /	89.3
	500	0.6 /	0.4 /	99.0	6.4 /	4.4 /	89.2
BC	30	2.4 /	0.8 /	96.8	6.5 /	5.2 /	88.3
	50	0.9 /	0.5 /	98.6	5.0 /	4.8 /	90.2
	100	1.1 /	0.5 /	98.4	6.4 /	3.9 /	89.7
	250	1.1 /	0.3 /	98.6	5.7 /	4.6 /	89.7
	500	0.5 /	0.8 /	98.7	5.5 /	4.8 /	89.7
BCA	30	2.2 /	0.8 /	97.0	6.6 /	5.0 /	88.4
	50	0.9 /	0.5 /	98.6	5.0 /	4.8 /	90.2
	100	1.1 /	0.5 /	98.4	6.4 /	3.9 /	89.7
	250	1.1 /	0.3 /	98.6	5.7 /	4.6 /	89.7
	500	0.5 /	0.8 /	98.7	5.5 /	4.8 /	89.7

Table 86: Success and failure rates of 99% and 90% confidence intervals, First indirect effect, Population 10

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	0.0 /	0.1 /	99.9	2.2 /	2.2 /	95.6
	50	0.1 /	0.0 /	99.9	2.5 /	2.9 /	94.6
	100	0.1 /	0.0 /	99.9	3.8 /	3.6 /	92.6
	250	0.3 /	0.8 /	98.9	3.1 /	5.1 /	91.8
	500	0.6 /	0.2 /	99.2	4.0 /	5.4 /	90.6
MDM, error	30	0.0 /	0.1 /	99.9	1.9 /	1.8 /	96.3
	50	0.1 /	0.0 /	99.9	2.3 /	2.6 /	95.1
	100	0.1 /	0.0 /	99.9	3.8 /	3.6 /	92.6
	250	0.3 /	0.8 /	98.9	3.1 /	5.1 /	91.8
	500	0.6 /	0.2 /	99.2	4.0 /	5.4 /	90.6
BSE	30	0.1 /	0.1 /	99.8	1.6 /	1.1 /	97.3
	50	0.2 /	0.0 /	99.8	1.9 /	1.7 /	96.4
	100	0.0 /	0.1 /	99.9	3.2 /	3.2 /	93.6
	250	0.2 /	0.5 /	99.3	3.5 /	5.4 /	91.1
	500	0.8 /	0.2 /	99.0	4.6 /	5.6 /	89.8
BP	30	0.4 /	0.4 /	99.2	3.4 /	3.3 /	93.3
	50	0.5 /	0.4 /	99.1	4.2 /	5.3 /	90.5
	100	0.8 /	0.3 /	98.9	5.0 /	5.8 /	89.2
	250	0.6 /	0.7 /	98.7	4.1 /	6.4 /	89.5
	500	0.8 /	0.3 /	98.9	4.7 /	5.7 /	89.6
BC	30	0.6 /	0.6 /	98.8	6.6 /	6.0 /	87.4
	50	0.7 /	0.9 /	98.4	7.0 /	6.9 /	86.1
	100	1.0 /	0.5 /	98.5	8.3 /	7.5 /	84.2
	250	0.7 /	0.8 /	98.5	4.9 /	7.3 /	87.8
	500	0.8 /	0.5 /	98.7	5.3 /	6.0 /	88.7
BCA	30	0.6 /	0.6 /	98.8	6.5 /	6.0 /	87.5
	50	0.8 /	0.9 /	98.3	7.1 /	6.8 /	86.1
	100	1.0 /	0.5 /	98.5	8.4 /	7.4 /	84.2
	250	0.7 /	0.8 /	98.5	4.9 /	7.3 /	87.8
	500	0.8 /	0.5 /	98.7	5.3 /	6.0 /	88.7

Table 87: Type I error rate of 99% and 90% confidence intervals,

Second indirect effect, Population 10

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	1.4 /	0.2 /	98.4	8.8 /	4.4 /	86.8
	50	2.0 /	0.1 /	97.9	7.4 /	4.5 /	88.1
	100	1.9 /	0.4 /	97.7	8.2 /	4.1 /	87.7
	250	1.4 /	0.4 /	98.2	6.4 /	3.8 /	89.8
	500	0.4 /	0.8 /	98.8	6.8 /	5.2 /	88.0
MDM, error	30	1.1 /	0.0 /	98.9	7.5 /	4.1 /	88.4
	50	1.5 /	0.1 /	98.4	6.7 /	3.2 /	90.1
	100	1.2 /	0.3 /	98.5	6.9 /	2.8 /	90.3
	250	1.0 /	0.3 /	98.7	5.3 /	3.5 /	91.2
	500	0.4 /	0.7 /	98.9	5.3 /	3.8 /	90.9
BSE	30	0.9 /	0.2 /	98.9	4.8 /	3.1 /	92.1
	50	1.2 /	0.1 /	98.7	6.0 /	2.7 /	91.3
	100	1.2 /	0.4 /	98.4	6.5 /	3.0 /	90.5
	250	1.0 /	0.4 /	98.6	5.3 /	3.3 /	91.4
	500	0.4 /	0.6 /	99.0	5.5 /	4.6 /	89.9
BP	30	1.0 /	0.5 /	98.5	6.4 /	4.3 /	89.3
	50	0.7 /	0.3 /	99.0	5.9 /	3.6 /	90.5
	100	0.9 /	0.5 /	98.6	6.3 /	3.8 /	89.9
	250	0.9 /	0.5 /	98.6	4.9 /	3.4 /	91.7
	500	0.3 /	0.5 /	99.2	5.3 /	5.1 /	89.6
BC	30	1.3 /	0.6 /	98.1	5.9 /	5.2 /	88.9
	50	0.7 /	0.5 /	98.8	5.6 /	4.2 /	90.2
	100	1.2 /	0.7 /	98.1	6.1 /	4.5 /	89.4
	250	0.8 /	0.5 /	98.7	4.3 /	4.1 /	91.6
	500	0.2 /	0.6 /	99.2	4.9 /	5.7 /	89.4
BCA	30	1.3 /	0.6 /	98.1	6.0 /	5.1 /	88.9
	50	0.7 /	0.5 /	98.8	5.6 /	4.2 /	90.2
	100	1.2 /	0.7 /	98.1	6.2 /	4.5 /	89.3
	250	0.8 /	0.5 /	98.7	4.4 /	4.1 /	91.5
	500	0.2 /	0.6 /	99.2	5.0 /	5.6 /	89.4

Table 88: Success and failure rates of 99% and 90% confidence intervals,

Total indirect effect, Population 10

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	3.3 /	0.2 /	96.5	8.8 /	1.1 /	90.1
	50	3.2 /	0.2 /	96.6	6.8 /	1.2 /	92.0
	100	1.8 /	0.1 /	98.1	4.8 /	0.8 /	94.4
	250	0.7 /	0.2 /	99.1	4.1 /	2.0 /	93.9
	500	0.7 /	0.1 /	99.2	3.1 /	1.4 /	95.5
MDM, error	30	3.2 /	0.2 /	96.6	8.3 /	1.1 /	90.6
	50	3.0 /	0.1 /	96.9	6.7 /	1.2 /	92.1
	100	1.7 /	0.1 /	98.2	4.7 /	0.8 /	94.5
	250	0.7 /	0.2 /	99.1	4.0 /	2.0 /	94.0
	500	0.7 /	0.1 /	99.2	3.1 /	1.4 /	95.5
BSE	30	2.1 /	0.1 /	97.8	5.3 /	0.8 /	93.9
	50	2.1 /	0.1 /	97.8	5.9 /	1.6 /	92.5
	100	1.5 /	0.1 /	98.4	3.8 /	0.8 /	95.4
	250	1.0 /	0.3 /	98.7	3.8 /	2.2 /	94.0
	500	0.5 /	0.2 /	99.3	3.3 /	1.6 /	95.1
BP	30	1.3 /	0.3 /	98.4	4.2 /	1.6 /	94.2
	50	1.5 /	0.1 /	98.4	4.0 /	1.9 /	94.1
	100	0.7 /	0.1 /	99.2	3.1 /	1.5 /	95.4
	250	0.4 /	0.8 /	98.8	2.5 /	2.4 /	95.1
	500	0.3 /	0.2 /	99.5	2.6 /	1.8 /	95.6
BC	30	1.0 /	0.6 /	98.4	3.5 /	2.4 /	94.1
	50	1.2 /	0.2 /	98.6	3.4 /	3.1 /	93.5
	100	0.5 /	0.2 /	99.3	2.3 /	2.0 /	95.7
	250	0.3 /	0.8 /	98.9	2.0 /	2.9 /	95.1
	500	0.2 /	0.2 /	99.6	2.0 /	1.9 /	96.1
BCA	30	1.0 /	0.6 /	98.4	3.5 /	2.4 /	94.1
	50	1.2 /	0.2 /	98.6	3.5 /	3.1 /	93.4
	100	0.6 /	0.2 /	99.2	2.3 /	1.8 /	95.9
	250	0.3 /	0.8 /	98.9	2.1 /	2.9 /	95.0
	500	0.2 /	0.2 /	99.6	2.0 /	1.9 /	96.1

Table 89: Success and failure rates of 99% and 90% confidence intervals,

First indirect effect, Population 11

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	1.0 /	0.1 /	98.9	11.8 /	2.0 /	86.2
	50	1.7 /	0.0 /	98.3	10.9 /	2.4 /	86.7
	100	2.0 /	0.1 /	97.9	12.4 /	1.6 /	86.0
	250	1.8 /	0.0 /	98.2	13.8 /	1.2 /	85.0
	500	4.1 /	0.1 /	95.8	19.4 /	0.6 /	80.0
MDM, error	30	0.9 /	0.1 /	99.0	11.4 /	2.0 /	86.6
	50	1.6 /	0.0 /	98.4	10.6 /	2.3 /	87.1
	100	2.0 /	0.1 /	97.9	12.2 /	1.6 /	86.2
	250	1.8 /	0.0 /	98.2	13.8 /	1.2 /	85.0
	500	4.1 /	0.1 /	95.8	19.4 /	0.5 /	80.1
BSE	30	0.2 /	0.0 /	99.8	6.1 /	1.4 /	92.5
	50	1.3 /	0.0 /	98.7	9.6 /	1.8 /	88.6
	100	2.0 /	0.0 /	98.0	12.1 /	1.4 /	86.5
	250	1.6 /	0.1 /	98.3	14.0 /	1.2 /	84.8
	500	4.7 /	0.1 /	95.2	19.5 /	0.7 /	79.8
BP	30	1.3 /	0.1 /	98.6	9.4 /	2.3 /	88.3
	50	1.9 /	0.2 /	97.9	10.9 /	3.0 /	86.1
	100	2.1 /	0.1 /	97.8	12.9 /	1.6 /	85.5
	250	1.7 /	0.1 /	98.2	13.9 /	1.3 /	84.8
	500	4.0 /	0.1 /	95.9	19.0 /	0.8 /	80.2
BC	30	2.8 /	0.2 /	97.0	13.3 /	3.1 /	83.6
	50	2.9 /	0.5 /	96.6	11.9 /	3.6 /	84.5
	100	2.5 /	0.1 /	97.4	12.9 /	2.2 /	84.9
	250	2.0 /	0.1 /	97.9	13.4 /	1.3 /	85.3
	500	3.8 /	0.1 /	96.1	18.4 /	0.9 /	80.7
BCA	30	2.9 /	0.2 /	96.9	13.3 /	2.9 /	83.8
	50	2.9 /	0.4 /	96.7	12.0 /	3.6 /	84.4
	100	2.5 /	0.1 /	97.4	12.9 /	2.2 /	84.9
	250	2.0 /	0.1 /	97.9	13.4 /	1.3 /	85.3
	500	3.8 /	0.1 /	96.1	18.5 /	0.9 /	80.6

Table 90: Success and failure rates of 99% and 90% confidence intervals,

Second indirect effect, Population 11

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	2.3 /	0.3 /	97.4	10.5 /	2.9 /	86.6
	50	2.0 /	0.1 /	97.9	9.1 /	2.5 /	88.4
	100	2.1 /	0.1 /	97.8	9.3 /	1.8 /	88.9
	250	1.7 /	0.1 /	98.2	9.5 /	2.2 /	88.3
	500	3.2 /	0.0 /	96.8	13.4 /	1.2 /	85.4
MDM, error	30	2.4 /	0.3 /	97.3	9.9 /	2.9 /	87.2
	50	2.0 /	0.1 /	97.9	8.8 /	2.5 /	88.7
	100	2.1 /	0.1 /	97.8	9.4 /	1.8 /	88.8
	250	1.9 /	0.1 /	98.0	9.3 /	2.0 /	88.7
	500	3.0 /	0.0 /	97.0	13.3 /	1.1 /	85.6
BSE	30	1.4 /	0.1 /	98.5	7.2 /	1.7 /	91.1
	50	1.9 /	0.1 /	98.0	9.2 /	2.0 /	88.8
	100	2.2 /	0.1 /	97.7	8.6 /	1.9 /	89.5
	250	2.1 /	0.1 /	97.8	9.3 /	2.2 /	88.5
	500	3.2 /	0.0 /	96.8	13.2 /	1.5 /	85.3
BP	30	1.0 /	0.1 /	98.9	7.8 /	2.7 /	89.5
	50	1.3 /	0.2 /	98.5	9.3 /	2.5 /	88.2
	100	1.8 /	0.1 /	98.1	8.3 /	2.2 /	89.5
	250	1.9 /	0.1 /	98.0	9.0 /	2.3 /	88.7
	500	2.6 /	0.0 /	97.4	12.1 /	1.7 /	86.2
BC	30	1.1 /	0.3 /	98.6	6.7 /	3.6 /	89.7
	50	1.4 /	0.2 /	98.4	8.1 /	3.3 /	88.6
	100	1.6 /	0.1 /	98.3	7.8 /	2.5 /	89.7
	250	1.8 /	0.1 /	98.1	8.9 /	2.6 /	88.5
	500	2.4 /	0.0 /	97.6	11.6 /	1.7 /	86.7
BCA	30	1.1 /	0.1 /	98.8	6.8 /	3.6 /	89.6
	50	1.4 /	0.2 /	98.4	8.2 /	3.3 /	88.5
	100	1.7 /	0.1 /	98.2	7.8 /	2.5 /	89.7
	250	1.9 /	0.1 /	98.0	8.9 /	2.6 /	88.5
	500	2.5 /	0.0 /	97.5	11.8 /	1.7 /	86.5

Table 91: Success and failure rates of 99% and 90% confidence intervals,

Total indirect effect, Population 11

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	3.9 /	0.0 /	96.1	12.3 /	3.1 /	84.6
	50	4.2 /	0.2 /	95.6	10.7 /	3.7 /	85.6
	100	1.9 /	0.0 /	98.1	7.7 /	2.8 /	89.5
	250	1.4 /	0.2 /	98.4	6.7 /	3.5 /	89.8
	500	1.1 /	0.3 /	98.6	7.6 /	5.0 /	87.4
MDM, error	30	3.5 /	0.0 /	96.5	12.0 /	2.9 /	85.1
	50	4.1 /	0.2 /	95.7	10.3 /	3.4 /	86.3
	100	1.6 /	0.0 /	98.4	7.4 /	2.4 /	90.2
	250	1.2 /	0.2 /	98.6	6.5 /	3.3 /	90.2
	500	0.8 /	0.3 /	98.9	7.4 /	4.6 /	88.0
BSE	30	2.2 /	0.1 /	97.7	9.7 /	1.7 /	88.6
	50	3.6 /	0.2 /	96.2	9.1 /	2.9 /	88.0
	100	1.3 /	0.1 /	98.6	7.0 /	2.5 /	90.5
	250	1.3 /	0.2 /	98.5	6.2 /	3.4 /	90.4
	500	1.0 /	0.2 /	98.8	7.5 /	4.6 /	87.9
BP	30	0.8 /	0.3 /	98.9	8.8 /	3.1 /	88.1
	50	2.2 /	0.4 /	97.4	8.1 /	4.3 /	87.6
	100	0.6 /	0.1 /	99.3	6.0 /	3.2 /	90.8
	250	0.6 /	0.2 /	99.2	5.4 /	4.0 /	90.6
	500	0.6 /	0.7 /	98.7	6.8 /	4.9 /	88.3
BC	30	1.5 /	0.5 /	98.0	6.5 /	4.2 /	89.3
	50	1.6 /	0.5 /	97.9	6.7 /	5.2 /	88.1
	100	0.6 /	0.3 /	99.1	4.8 /	4.0 /	91.2
	250	0.5 /	0.2 /	99.3	4.7 /	4.5 /	90.8
	500	0.6 /	0.7 /	98.7	6.2 /	5.6 /	88.2
BCA	30	1.4 /	0.3 /	98.3	6.6 /	4.2 /	89.2
	50	1.7 /	0.5 /	97.8	6.9 /	5.2 /	87.9
	100	0.6 /	0.2 /	99.2	4.8 /	4.0 /	91.2
	250	0.5 /	0.2 /	99.3	4.7 /	4.5 /	90.8
	500	0.6 /	0.7 /	98.7	6.2 /	5.5 /	88.3

Table 92: Success and failure rates of 99% and 90% confidence intervals, First indirect effect, Population 12

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	1.2 /	0.0 /	98.8	11.3 /	1.9 /	86.8
	50	2.8 /	0.0 /	97.2	13.5 /	2.4 /	84.1
	100	1.9 /	0.1 /	98.0	11.5 /	2.2 /	86.3
	250	2.1 /	0.1 /	97.8	13.0 /	1.5 /	85.5
	500	4.0 /	0.1 /	95.9	19.5 /	1.0 /	79.5
MDM, error	30	0.9 /	0.0 /	99.1	10.4 /	1.7 /	87.9
	50	2.4 /	0.0 /	97.6	12.7 /	2.2 /	85.1
	100	1.8 /	0.1 /	98.1	11.4 /	1.9 /	86.7
	250	1.9 /	0.1 /	98.0	12.6 /	1.4 /	86.0
	500	3.4 /	0.1 /	96.5	18.5 /	0.9 /	80.6
BSE	30	1.2 /	0.0 /	98.8	6.9 /	1.2 /	91.9
	50	1.7 /	0.0 /	98.3	10.7 /	2.2 /	87.1
	100	1.6 /	0.2 /	98.2	11.0 /	2.0 /	87.0
	250	2.0 /	0.0 /	98.0	12.5 /	1.7 /	85.8
	500	3.6 /	0.1 /	96.3	18.6 /	0.9 /	80.5
BP	30	1.7 /	0.1 /	98.2	10.6 /	1.9 /	87.5
	50	2.1 /	0.1 /	97.8	12.0 /	2.9 /	85.1
	100	1.8 /	0.3 /	97.9	11.4 /	2.3 /	86.3
	250	2.4 /	0.1 /	97.5	12.4 /	1.7 /	85.9
	500	3.9 /	0.0 /	96.1	17.9 /	0.9 /	81.2
BC	30	4.1 /	0.3 /	95.6	13.3 /	2.8 /	83.9
	50	3.2 /	0.1 /	96.7	12.6 /	3.4 /	84.0
	100	1.9 /	0.4 /	97.7	11.7 /	2.5 /	85.8
	250	2.5 /	0.3 /	97.2	11.8 /	1.9 /	86.3
	500	3.8 /	0.1 /	96.1	18.2 /	0.9 /	80.9
BCA	30	4.2 /	0.4 /	95.4	13.4 /	2.9 /	83.7
	50	3.2 /	0.1 /	96.7	12.7 /	3.4 /	83.9
	100	2.0 /	0.3 /	97.7	11.7 /	2.5 /	85.8
	250	2.5 /	0.2 /	97.3	11.8 /	1.9 /	86.3
	500	3.9 /	0.1 /	96.0	18.2 /	0.9 /	80.9

Table 93: Success and failure rates of 99% and 90% confidence intervals,

Second indirect effect, Population 12

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	2.6 /	0.0 /	97.4	9.9 /	1.4 /	88.7
	50	1.9 /	0.1 /	98.0	8.8 /	2.6 /	88.6
	100	1.8 /	0.1 /	98.1	8.3 /	1.6 /	90.1
	250	1.6 /	0.1 /	98.3	8.5 /	1.6 /	89.9
	500	1.6 /	0.1 /	98.3	12.5 /	1.0 /	86.5
MDM, error	30	2.0 /	0.0 /	98.0	9.2 /	1.4 /	89.4
	50	1.8 /	0.1 /	98.1	7.9 /	2.2 /	89.9
	100	1.1 /	0.1 /	98.8	7.1 /	1.3 /	91.6
	250	1.6 /	0.1 /	98.3	7.7 /	1.4 /	90.9
	500	1.2 /	0.1 /	98.7	11.3 /	1.0 /	87.7
BSE	30	1.5 /	0.1 /	98.4	8.2 /	1.7 /	90.1
	50	2.2 /	0.3 /	97.5	9.1 /	2.4 /	88.5
	100	2.1 /	0.1 /	97.8	8.6 /	2.0 /	89.4
	250	2.0 /	0.2 /	97.8	11.1 /	1.6 /	87.3
	500	2.6 /	0.1 /	97.3	14.9 /	1.4 /	83.7
BP	30	1.8 /	0.1 /	98.1	8.7 /	2.6 /	88.7
	50	1.5 /	0.2 /	98.3	8.6 /	2.9 /	88.5
	100	1.8 /	0.3 /	97.9	7.9 /	2.6 /	89.5
	250	1.7 /	0.2 /	98.1	10.1 /	1.7 /	88.2
	500	2.7 /	0.1 /	97.2	14.3 /	1.5 /	84.2
BC	30	2.2 /	0.4 /	97.4	8.1 /	3.2 /	88.7
	50	1.4 /	0.3 /	98.3	7.5 /	3.9 /	88.6
	100	1.7 /	0.4 /	97.9	7.4 /	2.8 /	89.8
	250	1.6 /	0.2 /	98.2	9.5 /	2.0 /	88.5
	500	2.5 /	0.1 /	97.4	13.2 /	1.8 /	85.0
BCA	30	2.4 /	0.4 /	97.2	8.0 /	3.2 /	88.8
	50	1.4 /	0.3 /	98.3	7.6 /	3.9 /	88.5
	100	1.7 /	0.4 /	97.9	7.4 /	2.8 /	89.8
	250	1.6 /	0.2 /	98.2	9.7 /	2.0 /	88.3
	500	2.6 /	0.1 /	97.3	13.4 /	1.8 /	84.8

Table 94: Success and failure rates of 99% and 90% confidence intervals,

Total indirect effect, Population 12

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	0.0 /	0.1 /	99.9	0.5 /	0.6 /	98.9
	50	0.0 /	0.1 /	99.9	1.5 /	1.5 /	97.0
	100	0.3 /	0.3 /	99.4	2.3 /	1.6 /	96.1
	250	0.0 /	0.5 /	99.5	2.2 /	2.7 /	95.1
	500	0.8 /	0.5 /	98.7	2.0 /	3.4 /	94.6
MDM, error	30	0.0 /	0.1 /	99.9	0.5 /	0.6 /	98.9
	50	0.0 /	0.1 /	99.9	1.5 /	1.5 /	97.0
	100	0.3 /	0.3 /	99.4	2.3 /	1.6 /	96.1
	250	0.0 /	0.5 /	99.5	2.2 /	2.7 /	95.1
	500	0.8 /	0.5 /	98.7	2.0 /	3.4 /	94.6
BSE	30	0.0 /	0.2 /	99.8	0.6 /	0.8 /	98.6
	50	0.0 /	0.2 /	99.8	1.6 /	1.2 /	97.2
	100	0.5 /	0.3 /	99.2	2.6 /	1.8 /	95.6
	250	0.0 /	0.7 /	99.3	2.6 /	2.6 /	94.8
	500	0.7 /	0.5 /	98.8	1.9 /	3.1 /	95.0
BP	30	0.1 /	0.4 /	99.5	1.8 /	1.7 /	96.5
	50	0.6 /	0.6 /	98.8	2.6 /	2.0 /	95.4
	100	0.8 /	0.6 /	98.6	3.1 /	2.6 /	94.3
	250	0.1 /	0.7 /	99.2	2.7 /	3.0 /	94.3
	500	0.8 /	0.8 /	98.4	2.0 /	3.0 /	95.0
BC	30	0.5 /	0.9 /	98.6	3.9 /	3.7 /	92.4
	50	1.1 /	0.8 /	98.1	3.5 /	3.6 /	92.9
	100	1.5 /	0.8 /	97.7	3.6 /	3.1 /	93.3
	250	0.4 /	0.9 /	98.7	3.2 /	3.5 /	93.3
	500	0.9 /	0.8 /	98.3	2.1 /	3.1 /	94.8
BCA	30	0.5 /	0.8 /	98.7	3.6 /	3.7 /	92.7
	50	1.1 /	0.8 /	98.1	3.5 /	3.5 /	93.0
	100	1.2 /	0.7 /	98.1	3.6 /	3.0 /	93.4
	250	0.4 /	0.8 /	98.8	3.2 /	3.5 /	93.3
	500	0.9 /	0.8 /	98.3	2.1 /	3.1 /	94.8

Table 95: Type I error rate of 99% and 90% confidence intervals,

First indirect effect, Population 13

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	0.4/	0.1/	99.5	4.4 /	4.0 /	91.6
	50	0.3/	0.4/	99.3	4.4 /	4.4 /	91.2
	100	0.5/	0.5/	99.0	4.6 /	5.1 /	90.3
	250	0.2/	0.3/	99.5	4.5 /	4.4 /	91.1
	500	0.5/	0.9/	98.6	5.3 /	6.3 /	88.4
MDM, error	30	0.4/	0.2/	99.4	4.4 /	3.9 /	91.7
	50	0.3/	0.2/	99.5	4.3 /	4.8 /	90.9
	100	0.4/	0.5/	99.1	4.4 /	5.1 /	90.5
	250	0.2/	0.3/	99.5	4.4 /	4.3 /	91.3
	500	0.5/	0.9/	98.6	5.2 /	6.3 /	88.5
BSE	30	0.1/	0.1/	99.8	3.8 /	3.0 /	93.2
	50	0.4/	0.2/	99.4	4.5 /	4.3 /	91.2
	100	0.8/	0.6/	98.6	4.2 /	4.8 /	91.0
	250	0.2/	0.5/	99.3	4.7 /	5.1 /	90.2
	500	0.4/	1.1/	98.5	5.1 /	6.4 /	88.5
BP	30	0.6/	0.3/	99.1	5.6 /	4.5 /	89.9
	50	1.1/	0.4/	98.5	5.5 /	5.0 /	89.5
	100	1.1/	0.8/	98.1	4.9 /	5.3 /	89.8
	250	0.2/	0.5/	99.3	4.7 /	5.0 /	90.3
	500	0.5/	1.0/	98.5	5.3 /	6.3 /	88.4
BC	30	0.9/	0.4/	98.7	6.9 /	6.2 /	86.9
	50	1.3/	0.8/	97.9	6.8 /	6.5 /	86.7
	100	1.1/	0.9/	98.0	5.6 /	6.1 /	88.3
	250	0.2/	0.6/	99.2	5.1 /	4.9 /	90.0
	500	0.5/	1.3/	98.2	5.3 /	6.3 /	88.4
BCA	30	0.8/	0.4/	98.8	6.9 /	6.1 /	87.0
	50	1.3/	0.7/	98.0	6.5 /	6.2 /	87.3
	100	1.1/	0.9/	98.0	5.6 /	6.0 /	88.4
	250	0.2/	0.6/	99.2	5.0 /	4.9 /	90.1
	500	0.5/	1.2/	98.3	5.3 /	6.3 /	88.4

Table 96: Type I error rate of 99% and 90% confidence intervals,

Total indirect effect, Population 13

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	0.1 /	0.2 /	99.7	3.5 /	4.0 /	92.5
	50	0.0 /	0.2 /	99.8	3.2 /	4.5 /	92.3
	100	0.4 /	0.0 /	99.6	5.3 /	4.8 /	89.9
	250	0.8 /	0.2 /	99.0	5.4 /	3.8 /	90.8
	500	0.3 /	0.1 /	99.6	4.2 /	4.6 /	91.2
MDM, error	30	0.1 /	0.2 /	99.7	3.4 /	3.7 /	92.9
	50	0.0 /	0.1 /	99.9	3.2 /	4.4 /	92.4
	100	0.4 /	0.0 /	99.6	5.3 /	4.7 /	90.0
	250	0.8 /	0.2 /	99.0	5.4 /	3.8 /	90.8
	500	0.3 /	0.1 /	99.6	4.2 /	4.6 /	91.2
BSE	30	0.0 /	0.2 /	99.8	3.1 /	2.4 /	94.5
	50	0.3 /	0.1 /	99.6	3.1 /	3.5 /	93.4
	100	0.5 /	0.3 /	99.2	4.9 /	4.4 /	90.7
	250	1.1 /	0.2 /	98.7	5.6 /	3.9 /	90.5
	500	0.5 /	0.3 /	99.2	4.2 /	5.2 /	90.6
BP	30	0.4 /	0.3 /	99.3	5.5 /	4.8 /	89.7
	50	1.1 /	0.9 /	98.0	4.9 /	5.5 /	89.6
	100	1.0 /	0.6 /	98.4	6.2 /	4.8 /	89.0
	250	1.4 /	0.3 /	98.3	6.2 /	4.6 /	89.2
	500	0.6 /	0.5 /	98.9	4.6 /	5.1 /	90.3
BC	30	0.8 /	0.7 /	98.5	7.8 /	7.6 /	84.6
	50	1.4 /	1.8 /	96.8	6.7 /	7.7 /	85.6
	100	1.1 /	0.7 /	98.2	7.1 /	5.8 /	87.1
	250	1.4 /	0.4 /	98.2	6.7 /	4.8 /	88.5
	500	0.6 /	0.5 /	98.9	4.4 /	5.3 /	90.3
BCA	30	0.7 /	0.6 /	98.7	7.6 /	7.4 /	85.0
	50	1.4 /	1.6 /	97.0	6.7 /	7.6 /	85.7
	100	1.1 /	0.7 /	98.2	7.1 /	5.8 /	87.1
	250	1.4 /	0.4 /	98.2	6.7 /	4.7 /	88.6
	500	0.6 /	0.5 /	98.9	4.4 /	5.2 /	90.4

Table 97: Type I error rate of 99% and 90% confidence intervals,

First indirect effect, Population 14

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	0.4 /	0.4 /	99.2	6.2 /	6.1 /	87.7
	50	0.7 /	0.4 /	98.9	5.9 /	7.0 /	87.1
	100	1.0 /	0.7 /	98.3	6.1 /	7.0 /	86.9
	250	1.3 /	0.4 /	98.3	6.7 /	5.5 /	87.8
	500	0.8 /	1.2 /	98.0	6.2 /	6.5 /	87.3
MDM, error	30	0.2 /	0.3 /	99.5	6.0 /	5.7 /	88.3
	50	0.7 /	0.3 /	99.0	5.9 /	6.4 /	87.7
	100	0.8 /	0.7 /	98.5	5.7 /	6.5 /	87.8
	250	1.3 /	0.4 /	98.3	6.1 /	5.3 /	88.6
	500	0.8 /	1.2 /	98.0	5.8 /	6.4 /	87.8
BSE	30	0.1 /	0.0 /	99.9	5.0 /	4.5 /	90.5
	50	0.4 /	0.2 /	99.4	3.9 /	4.8 /	91.3
	100	0.3 /	0.5 /	99.2	4.8 /	5.4 /	89.8
	250	0.7 /	0.2 /	99.1	5.2 /	4.0 /	90.8
	500	0.5 /	0.9 /	98.6	4.2 /	4.7 /	91.1
BP	30	0.4 /	0.5 /	99.1	6.0 /	5.3 /	88.7
	50	0.6 /	0.7 /	98.7	4.7 /	5.8 /	89.5
	100	0.6 /	0.4 /	99.0	5.5 /	6.0 /	88.5
	250	0.9 /	0.2 /	98.9	5.4 /	4.3 /	90.3
	500	0.5 /	1.1 /	98.4	4.3 /	5.1 /	90.6
BC	30	0.6 /	1.0 /	98.4	8.0 /	6.8 /	85.2
	50	0.8 /	0.8 /	98.4	5.2 /	6.3 /	88.5
	100	0.9 /	0.4 /	98.7	5.9 /	6.7 /	87.4
	250	0.9 /	0.2 /	98.9	5.3 /	4.4 /	90.3
	500	0.6 /	1.1 /	98.3	4.5 /	4.9 /	90.6
BCA	30	0.6 /	0.9 /	98.5	7.9 /	6.8 /	85.3
	50	0.8 /	0.8 /	98.4	5.2 /	6.3 /	88.5
	100	0.9 /	0.4 /	98.7	5.9 /	6.7 /	87.4
	250	0.9 /	0.2 /	98.9	5.3 /	4.4 /	90.3
	500	0.6 /	1.1 /	98.3	4.5 /	4.9 /	90.6

Table 98: Type I error rate of 99% and 90% confidence intervals,

Total indirect effect, Population 14

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	0.1 /	0.3 /	99.6	2.6 /	2.3 /	95.1
	50	0.3 /	0.3 /	99.4	2.5 /	2.1 /	95.4
	100	0.6 /	0.6 /	98.8	2.5 /	1.6 /	95.9
	250	0.7 /	0.2 /	99.1	2.5 /	2.4 /	95.1
	500	0.3 /	0.5 /	99.2	2.3 /	2.4 /	95.3
MDM, error	30	0.1 /	0.2 /	99.7	2.5 /	2.3 /	95.2
	50	0.3 /	0.3 /	99.4	2.5 /	2.1 /	95.4
	100	0.6 /	0.6 /	98.8	2.5 /	1.6 /	95.9
	250	0.7 /	0.2 /	99.1	2.5 /	2.4 /	95.1
	500	0.3 /	0.5 /	99.2	2.3 /	2.4 /	95.3
BSE	30	0.6 /	0.2 /	99.2	2.1 /	1.4 /	96.5
	50	0.5 /	0.7 /	98.8	2.4 /	2.1 /	95.5
	100	0.6 /	0.6 /	98.8	2.2 /	2.0 /	95.8
	250	0.6 /	0.2 /	99.2	2.9 /	2.1 /	95.0
	500	0.3 /	0.6 /	99.1	2.4 /	2.8 /	94.8
BP	30	1.3 /	0.6 /	98.1	3.7 /	3.6 /	92.7
	50	1.5 /	1.0 /	97.5	3.5 /	3.3 /	93.2
	100	1.0 /	0.7 /	98.3	2.4 /	2.2 /	95.4
	250	1.0 /	0.3 /	98.7	3.2 /	2.3 /	94.5
	500	0.6 /	0.5 /	98.9	2.6 /	2.6 /	94.8
BC	30	1.8 /	1.2 /	97.0	5.5 /	5.2 /	89.3
	50	1.7 /	1.6 /	96.7	3.9 /	4.3 /	91.8
	100	1.2 /	0.8 /	98.0	2.8 /	2.2 /	95.0
	250	1.0 /	0.4 /	98.6	3.2 /	2.9 /	93.9
	500	0.6 /	0.5 /	98.9	2.7 /	2.9 /	94.4
BCA	30	1.8 /	1.1 /	97.1	5.4 /	5.0 /	89.6
	50	1.7 /	1.5 /	96.8	3.9 /	4.3 /	91.8
	100	1.2 /	0.8 /	98.0	2.8 /	2.1 /	95.1
	250	1.0 /	0.4 /	98.6	3.2 /	2.8 /	94.0
	500	0.6 /	0.5 /	98.9	2.7 /	2.8 /	94.5

Table 99: Type I error rate of 99% and 90% confidence intervals,

First indirect effect, Population 15

		99% CI			90% CI		
Method	N	Too Low	Too High	OK	Too Low	Too High	OK
MDM, no error	30	0.0	0.0	100.0	0.2	0.1	99.7
	50	0.0	0.0	100.0	0.2	0.2	99.6
	100	0.0	0.0	100.0	0.0	0.0	100.0
	250	0.0	0.0	100.0	0.0	0.1	99.9
	500	0.0	0.0	100.0	0.0	0.1	99.9
MDM, error	30	0.0	0.0	100.0	0.2	0.1	99.7
	50	0.0	0.0	100.0	0.2	0.1	99.7
	100	0.0	0.0	100.0	0.0	0.0	100.0
	250	0.0	0.0	100.0	0.0	0.1	99.9
	500	0.0	0.0	100.0	0.0	0.1	99.9
BSE	30	0.0	0.0	100.0	0.0	0.0	100.0
	50	0.0	0.0	100.0	0.1	0.1	99.8
	100	0.0	0.0	100.0	0.0	0.0	100.0
	250	0.0	0.0	100.0	0.0	0.1	99.9
	500	0.0	0.0	100.0	0.0	0.1	99.9
BP	30	0.0	0.0	100.0	0.6	0.4	99.0
	50	0.0	0.0	100.0	0.5	0.4	99.1
	100	0.0	0.0	100.0	0.2	0.2	99.6
	250	0.0	0.0	100.0	0.6	0.4	99.0
	500	0.0	0.0	100.0	0.1	0.1	99.8
BC	30	0.0	0.0	100.0	1.5	1.2	97.3
	50	0.0	0.0	100.0	1.7	1.4	96.9
	100	0.0	0.0	100.0	1.0	1.1	97.9
	250	0.0	0.0	100.0	1.4	0.6	98.0
	500	0.0	0.0	100.0	0.2	0.3	99.5
BCA	30	0.0	0.0	100.0	1.5	1.3	97.2
	50	0.0	0.0	100.0	1.7	1.4	96.9
	100	0.0	0.0	100.0	1.0	1.1	97.9
	250	0.0	0.0	100.0	1.4	0.6	98.0
	500	0.0	0.0	100.0	0.2	0.3	99.5

Table 100: Type I error rate of 99% and 90% confidence intervals,

Second indirect effect, Population 15

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	0.3 /	0.2 /	99.5	5.6 /	4.2 /	90.2
	50	0.1 /	0.3 /	99.6	4.2 /	4.6 /	91.2
	100	0.4 /	0.6 /	99.0	4.3 /	3.9 /	91.8
	250	0.7 /	0.2 /	99.1	5.3 /	5.8 /	88.9
	500	0.2 /	0.5 /	99.3	5.5 /	4.9 /	89.6
MDM, error	30	0.4 /	0.3 /	99.3	4.9 /	4.3 /	90.8
	50	0.4 /	0.2 /	99.4	4.2 /	4.6 /	91.2
	100	0.3 /	0.6 /	99.1	4.0 /	3.8 /	92.2
	250	0.7 /	0.2 /	99.1	5.4 /	5.7 /	88.9
	500	0.2 /	0.5 /	99.3	5.4 /	4.6 /	90.0
BSE	30	0.3 /	0.2 /	99.5	3.7 /	3.2 /	93.1
	50	0.3 /	0.5 /	99.2	4.1 /	4.3 /	91.6
	100	0.4 /	0.6 /	99.0	3.9 /	3.3 /	92.8
	250	0.5 /	0.2 /	99.3	5.9 /	5.6 /	88.5
	500	0.3 /	0.6 /	99.1	5.8 /	4.8 /	89.4
BP	30	0.6 /	0.5 /	98.9	5.3 /	4.8 /	89.9
	50	1.0 /	0.7 /	98.3	5.9 /	5.0 /	89.1
	100	0.7 /	0.6 /	98.7	4.3 /	3.7 /	92.0
	250	0.9 /	0.3 /	98.8	5.9 /	5.5 /	88.6
	500	0.6 /	0.5 /	98.9	6.0 /	4.8 /	89.2
BC	30	1.2 /	0.8 /	98.0	7.2 /	7.1 /	85.7
	50	1.4 /	1.2 /	97.4	6.5 /	6.1 /	87.4
	100	0.9 /	0.7 /	98.4	4.7 /	4.8 /	90.5
	250	0.9 /	0.4 /	98.7	5.9 /	5.8 /	88.3
	500	0.6 /	0.5 /	98.9	6.4 /	4.7 /	88.9
BCA	30	1.2 /	0.7 /	98.1	7.0 /	7.1 /	85.9
	50	1.4 /	1.0 /	97.6	6.4 /	5.9 /	87.7
	100	0.8 /	0.7 /	98.5	4.7 /	4.7 /	90.6
	250	0.9 /	0.4 /	98.7	5.9 /	5.7 /	88.4
	500	0.5 /	0.5 /	99.0	6.4 /	4.7 /	88.9

Table 101: Type I error rate of 99% and 90% confidence intervals,

Total indirect effect, Population 15

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	0.3 /	0.0 /	99.7	5.1 /	4.5 /	90.4
	50	0.2 /	0.2 /	99.6	4.7 /	4.7 /	90.6
	100	0.2 /	0.7 /	99.1	3.9 /	5.4 /	90.7
	250	0.7 /	0.1 /	99.2	5.0 /	4.2 /	90.8
	500	0.4 /	0.1 /	99.5	4.5 /	4.0 /	91.5
MDM, error	30	0.3 /	0.0 /	99.7	5.0 /	4.3 /	90.7
	50	0.2 /	0.2 /	99.6	4.7 /	4.7 /	90.6
	100	0.2 /	0.7 /	99.1	3.9 /	5.4 /	90.7
	250	0.7 /	0.1 /	99.2	5.0 /	4.2 /	90.8
	500	0.4 /	0.1 /	99.5	4.5 /	4.0 /	91.5
BSE	30	0.0 /	0.1 /	99.9	4.1 /	3.5 /	92.4
	50	0.2 /	0.2 /	99.6	4.4 /	4.7 /	90.9
	100	0.2 /	0.5 /	99.3	4.2 /	5.7 /	90.1
	250	0.9 /	0.4 /	98.7	5.0 /	4.3 /	90.7
	500	0.5 /	0.1 /	99.4	4.6 /	4.1 /	91.3
BP	30	0.6 /	0.7 /	98.7	6.4 /	5.3 /	88.3
	50	0.8 /	1.1 /	98.1	5.6 /	6.2 /	88.2
	100	0.5 /	0.8 /	98.7	4.7 /	6.1 /	89.2
	250	1.0 /	0.3 /	98.7	5.2 /	4.1 /	90.7
	500	0.7 /	0.1 /	99.2	4.8 /	4.1 /	91.1
BC	30	0.8 /	1.6 /	97.6	7.9 /	7.3 /	84.8
	50	1.2 /	1.5 /	97.3	6.8 /	7.4 /	85.8
	100	0.6 /	0.8 /	98.6	5.1 /	6.3 /	88.6
	250	1.2 /	0.5 /	98.3	5.5 /	4.3 /	90.2
	500	0.8 /	0.1 /	99.1	4.9 /	4.1 /	91.0
BCA	30	0.8 /	1.5 /	97.7	7.9 /	7.0 /	85.1
	50	1.2 /	1.4 /	97.4	6.8 /	7.4 /	85.8
	100	0.6 /	0.8 /	98.6	5.0 /	6.3 /	88.7
	250	1.2 /	0.5 /	98.3	5.5 /	4.3 /	90.2
	500	0.8 /	0.1 /	99.1	4.9 /	4.1 /	91.0

Table 102: Type I error rate of 99% and 90% confidence intervals,

First indirect effect, Population 16

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	0.0 /	0.0 /	100.0	0.0 /	0.0 /	100.0
	50	0.0 /	0.0 /	100.0	0.0 /	0.2 /	99.8
	100	0.0 /	0.0 /	100.0	0.2 /	0.0 /	99.8
	250	0.0 /	0.0 /	100.0	0.1 /	0.1 /	99.8
	500	0.0 /	0.0 /	100.0	0.0 /	0.0 /	100.0
MDM, error	30	0.0 /	0.0 /	100.0	0.0 /	0.0 /	100.0
	50	0.0 /	0.0 /	100.0	0.0 /	0.2 /	99.8
	100	0.0 /	0.0 /	100.0	0.2 /	0.0 /	99.8
	250	0.0 /	0.0 /	100.0	0.1 /	0.1 /	99.8
	500	0.0 /	0.0 /	100.0	0.0 /	0.0 /	100.0
BSE	30	0.0 /	0.0 /	100.0	0.0 /	0.0 /	100.0
	50	0.0 /	0.0 /	100.0	0.0 /	0.3 /	99.7
	100	0.0 /	0.0 /	100.0	0.1 /	0.1 /	99.8
	250	0.0 /	0.0 /	100.0	0.0 /	0.0 /	100.0
	500	0.0 /	0.0 /	100.0	0.0 /	0.0 /	100.0
BP	30	0.0 /	0.0 /	100.0	0.4 /	0.6 /	99.0
	50	0.0 /	0.0 /	100.0	0.2 /	0.8 /	99.0
	100	0.0 /	0.0 /	100.0	0.4 /	0.1 /	99.5
	250	0.0 /	0.0 /	100.0	0.3 /	0.2 /	99.5
	500	0.0 /	0.0 /	100.0	0.0 /	0.1 /	99.9
BC	30	0.0 /	0.0 /	100.0	1.5 /	1.0 /	97.5
	50	0.0 /	0.0 /	100.0	0.6 /	1.2 /	98.2
	100	0.1 /	0.1 /	99.8	1.0 /	1.1 /	97.9
	250	0.0 /	0.0 /	100.0	1.5 /	0.4 /	98.1
	500	0.0 /	0.0 /	100.0	0.2 /	0.2 /	99.6
BCA	30	0.0 /	0.0 /	100.0	1.5 /	1.0 /	97.5
	50	0.0 /	0.0 /	100.0	0.7 /	1.2 /	98.1
	100	0.1 /	0.1 /	99.8	1.0 /	1.1 /	97.9
	250	0.0 /	0.0 /	100.0	1.5 /	0.4 /	98.1
	500	0.0 /	0.0 /	100.0	0.2 /	0.2 /	99.6

Table 103: Type I error rate of 99% and 90% confidence intervals,

Second indirect effect, Population 16

		99% CI			90% CI		
Method	N	Too Low /	Too High /	OK	Too Low /	Too High /	OK
MDM, no error	30	0.3 /	0.0 /	99.7	4.3 /	4.0 /	91.7
	50	0.2 /	0.4 /	99.4	4.3 /	4.5 /	91.2
	100	0.2 /	0.6 /	99.2	3.6 /	5.3 /	91.1
	250	0.7 /	0.0 /	99.3	4.9 /	4.3 /	90.8
	500	0.4 /	0.1 /	99.5	4.3 /	4.1 /	91.6
MDM, error	30	0.4 /	0.0 /	99.6	5.3 /	2.8 /	91.9
	50	0.4 /	0.1 /	99.5	5.1 /	3.8 /	91.1
	100	0.2 /	0.4 /	99.4	4.0 /	4.6 /	91.4
	250	1.0 /	0.0 /	99.0	5.2 /	3.7 /	91.1
	500	0.6 /	0.1 /	99.3	4.7 /	3.8 /	91.5
BSE	30	0.0 /	0.2 /	99.8	3.7 /	2.9 /	93.4
	50	0.2 /	0.2 /	99.6	4.3 /	4.3 /	91.4
	100	0.2 /	0.5 /	99.3	3.9 /	5.3 /	90.8
	250	0.7 /	0.3 /	99.0	5.0 /	4.5 /	90.5
	500	0.4 /	0.1 /	99.5	4.5 /	4.3 /	91.2
BP	30	0.2 /	0.6 /	99.2	5.4 /	3.8 /	90.8
	50	0.4 /	0.5 /	99.1	5.5 /	5.1 /	89.4
	100	0.5 /	0.6 /	98.9	4.5 /	6.0 /	89.5
	250	0.8 /	0.3 /	98.9	5.2 /	4.2 /	90.6
	500	0.6 /	0.1 /	99.3	4.7 /	4.4 /	90.9
BC	30	0.5 /	1.0 /	98.5	6.7 /	5.5 /	87.8
	50	0.9 /	0.8 /	98.3	6.3 /	6.5 /	87.2
	100	0.7 /	0.8 /	98.5	5.0 /	6.0 /	89.0
	250	1.1 /	0.4 /	98.5	5.3 /	4.5 /	90.2
	500	0.8 /	0.1 /	99.1	4.7 /	4.2 /	91.1
BCA	30	0.5 /	1.0 /	98.5	6.6 /	5.5 /	87.9
	50	0.9 /	0.7 /	98.4	6.3 /	6.5 /	87.2
	100	0.7 /	0.8 /	98.5	5.0 /	6.0 /	89.0
	250	1.0 /	0.3 /	98.7	5.3 /	4.5 /	90.2
	500	0.8 /	0.1 /	99.1	4.7 /	4.2 /	91.1

Table 104: Type I error rate of 99% and 90% confidence intervals,

Total indirect effect, Population 16

		99% CI		90% CI	
Method	N	No Error	Error	No Error	Error
MDM, no error	30	0.100	0.093	0.489	0.488
	50	0.323	0.294	0.777	0.761
	100	0.849	0.830	0.895	0.864
	250	0.991	0.986	0.890	0.904
	500	0.995	0.986	0.908	0.888
MDM, error	30	0.095	0.081	0.478	0.471
	50	0.315	0.270	0.772	0.747
	100	0.848	0.809	0.895	0.871
	250	0.991	0.986	0.891	0.904
	500	0.995	0.987	0.909	0.898
BSE	30	0.068	0.066	0.386	0.389
	50	0.283	0.229	0.730	0.699
	100	0.817	0.778	0.899	0.875
	250	0.984	0.986	0.893	0.898
	500	0.992	0.988	0.905	0.894
BP	30	0.158	0.154	0.514	0.510
	50	0.460	0.405	0.790	0.767
	100	0.882	0.843	0.898	0.876
	250	0.991	0.984	0.893	0.898
	500	0.994	0.988	0.906	0.896
BC	30	0.220	0.217	0.582	0.580
	50	0.543	0.479	0.810	0.808
	100	0.897	0.863	0.908	0.880
	250	0.990	0.985	0.898	0.905
	500	0.994	0.987	0.906	0.902
BCA	30	0.212	0.209	0.580	0.577
	50	0.535	0.474	0.810	0.809
	100	0.895	0.860	0.907	0.881
	250	0.990	0.985	0.898	0.905
	500	0.994	0.987	0.906	0.902

Table 105: Power, 99% and 90% confidence intervals,

First indirect effect, Populations 1 and 2

		99% CI		90% CI	
Method	N	No Error	Error	No Error	Error
MDM, no error	30	0.406	0.405	0.774	0.796
	50	0.809	0.806	0.872	0.884
	100	0.988	0.986	0.894	0.909
	250	0.985	0.994	0.901	0.902
	500	0.991	0.988	0.888	0.888
MDM, error	30	0.392	0.383	0.774	0.786
	50	0.799	0.788	0.872	0.894
	100	0.988	0.987	0.897	0.914
	250	0.985	0.995	0.900	0.907
	500	0.992	0.989	0.892	0.894
BSE	30	0.307	0.322	0.697	0.738
	50	0.726	0.745	0.869	0.882
	100	0.982	0.984	0.898	0.909
	250	0.986	0.990	0.901	0.891
	500	0.990	0.983	0.894	0.883
BP	30	0.376	0.437	0.741	0.787
	50	0.784	0.821	0.871	0.880
	100	0.984	0.986	0.901	0.907
	250	0.988	0.988	0.902	0.897
	500	0.994	0.983	0.896	0.884
BC	30	0.433	0.494	0.763	0.797
	50	0.814	0.850	0.880	0.887
	100	0.985	0.985	0.898	0.907
	250	0.988	0.988	0.902	0.898
	500	0.993	0.981	0.896	0.892
BCA	30	0.426	0.482	0.763	0.796
	50	0.810	0.844	0.876	0.888
	100	0.985	0.987	0.897	0.907
	250	0.988	0.987	0.902	0.897
	500	0.993	0.980	0.897	0.892

Table 106: Power, 99% and 90% confidence intervals,

Total indirect effect, Populations 1 and 2

		99% CI		90% CI	
Method	N	No Error	Error	No Error	Error
MDM, no error	30	0.270	0.271	0.750	0.753
	50	0.682	0.692	0.868	0.867
	100	0.982	0.977	0.902	0.889
	250	0.984	0.990	0.884	0.895
	500	0.992	0.988	0.903	0.891
MDM, error	30	0.265	0.244	0.750	0.747
	50	0.677	0.673	0.871	0.876
	100	0.982	0.977	0.904	0.892
	250	0.984	0.990	0.886	0.899
	500	0.992	0.990	0.903	0.893
BSE	30	0.186	0.196	0.669	0.656
	50	0.614	0.586	0.853	0.863
	100	0.977	0.967	0.907	0.889
	250	0.983	0.987	0.885	0.902
	500	0.990	0.989	0.901	0.889
BP	30	0.366	0.361	0.754	0.752
	50	0.783	0.769	0.860	0.870
	100	0.990	0.977	0.911	0.890
	250	0.987	0.990	0.884	0.901
	500	0.992	0.990	0.900	0.890
BC	30	0.457	0.458	0.801	0.782
	50	0.830	0.807	0.886	0.882
	100	0.991	0.977	0.916	0.894
	250	0.988	0.992	0.891	0.901
	500	0.991	0.990	0.900	0.893
BCA	30	0.447	0.452	0.800	0.779
	50	0.823	0.805	0.884	0.880
	100	0.990	0.977	0.917	0.894
	250	0.987	0.992	0.889	0.901
	500	0.992	0.990	0.900	0.893

Table 107: Power, 99% and 90% confidence intervals,

First indirect effect, Populations 3 and 4

		99% CI		90% CI	
Method	N	No Error	Error	No Error	Error
MDM, no error	30	0.220	0.260	0.649	0.636
	50	0.567	0.565	0.843	0.809
	100	0.958	0.938	0.910	0.888
	250	0.986	0.980	0.890	0.885
	500	0.991	0.981	0.903	0.882
MDM, error	30	0.219	0.201	0.637	0.582
	50	0.573	0.456	0.832	0.811
	100	0.953	0.900	0.910	0.903
	250	0.987	0.990	0.892	0.907
	500	0.991	0.988	0.904	0.911
BSE	30	0.139	0.166	0.559	0.527
	50	0.484	0.434	0.829	0.777
	100	0.942	0.906	0.914	0.894
	250	0.987	0.990	0.889	0.900
	500	0.988	0.987	0.910	0.900
BP	30	0.227	0.227	0.617	0.573
	50	0.583	0.505	0.838	0.789
	100	0.962	0.913	0.906	0.892
	250	0.988	0.991	0.888	0.904
	500	0.989	0.988	0.910	0.898
BC	30	0.294	0.282	0.664	0.604
	50	0.634	0.554	0.847	0.794
	100	0.968	0.923	0.913	0.893
	250	0.989	0.990	0.892	0.902
	500	0.989	0.987	0.908	0.899
BCA	30	0.284	0.274	0.662	0.604
	50	0.629	0.552	0.847	0.794
	100	0.965	0.921	0.913	0.892
	250	0.989	0.990	0.892	0.902
	500	0.989	0.987	0.908	0.900

Table 108: Power, 99% and 90% confidence intervals,

Total indirect effect, Populations 3 and 4

		99% CI		90% CI	
Method	N	No Error	Error	No Error	Error
MDM, no error	30	0.105	0.100	0.478	0.502
	50	0.331	0.317	0.767	0.771
	100	0.855	0.865	0.883	0.884
	250	0.987	0.987	0.905	0.899
	500	0.993	0.993	0.911	0.912
MDM, error	30	0.101	0.091	0.467	0.482
	50	0.323	0.290	0.765	0.759
	100	0.852	0.845	0.883	0.892
	250	0.987	0.987	0.905	0.902
	500	0.993	0.995	0.912	0.914
BSE	30	0.080	0.067	0.369	0.383
	50	0.282	0.265	0.719	0.715
	100	0.832	0.812	0.889	0.888
	250	0.984	0.988	0.900	0.916
	500	0.991	0.993	0.912	0.909
BP	30	0.167	0.156	0.494	0.522
	50	0.450	0.423	0.769	0.760
	100	0.877	0.885	0.889	0.888
	250	0.990	0.990	0.909	0.912
	500	0.990	0.993	0.913	0.914
BC	30	0.231	0.224	0.579	0.587
	50	0.522	0.512	0.801	0.779
	100	0.898	0.911	0.901	0.887
	250	0.990	0.990	0.907	0.912
	500	0.991	0.992	0.915	0.911
BCA	30	0.227	0.219	0.575	0.586
	50	0.515	0.503	0.800	0.779
	100	0.896	0.906	0.901	0.886
	250	0.990	0.990	0.907	0.912
	500	0.991	0.992	0.914	0.910

Table 109: Power, 99% and 90% confidence intervals,

First indirect effect, Populations 5 and 6

		99% CI		90% CI	
Method	N	No Error	Error	No Error	Error
MDM, no error	30	0.006	0.006	0.095	0.090
	50	0.019	0.011	0.217	0.233
	100	0.081	0.086	0.510	0.527
	250	0.593	0.607	0.856	0.860
	500	0.965	0.953	0.919	0.902
MDM, error	30	0.005	0.004	0.091	0.089
	50	0.018	0.009	0.210	0.221
	100	0.079	0.078	0.504	0.509
	250	0.592	0.585	0.856	0.858
	500	0.965	0.947	0.919	0.908
BSE	30	0.006	0.004	0.065	0.069
	50	0.021	0.017	0.177	0.173
	100	0.082	0.082	0.471	0.473
	250	0.578	0.561	0.852	0.850
	500	0.963	0.950	0.916	0.902
BP	30	0.020	0.014	0.130	0.124
	50	0.058	0.046	0.285	0.295
	100	0.209	0.195	0.570	0.559
	250	0.675	0.670	0.860	0.854
	500	0.972	0.955	0.924	0.904
BC	30	0.037	0.033	0.184	0.194
	50	0.093	0.080	0.359	0.369
	100	0.286	0.262	0.617	0.602
	250	0.712	0.703	0.859	0.861
	500	0.973	0.959	0.922	0.906
BCA	30	0.035	0.032	0.181	0.192
	50	0.086	0.078	0.358	0.368
	100	0.283	0.258	0.614	0.600
	250	0.709	0.701	0.858	0.858
	500	0.973	0.959	0.922	0.906

Table 110: Power, 99% and 90% confidence intervals,

Second indirect effect, Populations 5 and 6

		99% CI		90% CI	
Method	N	No Error	Error	No Error	Error
MDM, no error	30	0.177	0.173	0.564	0.573
	50	0.471	0.463	0.817	0.848
	100	0.936	0.932	0.907	0.908
	250	0.985	0.987	0.899	0.900
	500	0.991	0.993	0.910	0.905
MDM, error	30	0.180	0.150	0.556	0.533
	50	0.459	0.404	0.816	0.838
	100	0.935	0.910	0.909	0.923
	250	0.984	0.991	0.900	0.921
	500	0.992	0.995	0.914	0.923
BSE	30	0.120	0.123	0.469	0.504
	50	0.398	0.414	0.783	0.819
	100	0.906	0.929	0.909	0.906
	250	0.987	0.983	0.904	0.893
	500	0.992	0.991	0.911	0.896
BP	30	0.179	0.195	0.534	0.584
	50	0.519	0.542	0.814	0.839
	100	0.919	0.950	0.907	0.903
	250	0.985	0.987	0.906	0.897
	500	0.990	0.995	0.907	0.896
BC	30	0.230	0.257	0.565	0.639
	50	0.575	0.607	0.824	0.855
	100	0.932	0.963	0.906	0.904
	250	0.983	0.986	0.900	0.901
	500	0.988	0.993	0.908	0.902
BCA	30	0.223	0.249	0.563	0.639
	50	0.569	0.602	0.823	0.854
	100	0.932	0.962	0.906	0.903
	250	0.983	0.986	0.901	0.901
	500	0.988	0.993	0.908	0.902

Table 111: Power, 99% and 90% confidence intervals,

Total indirect effect, Populations 5 and 6

		99% CI		90% CI	
Method	N	No Error	Error	No Error	Error
MDM, no error	30	0.102	0.098	0.493	0.522
	50	0.321	0.299	0.761	0.761
	100	0.843	0.852	0.877	0.882
	250	0.991	0.979	0.905	0.882
	500	0.979	0.984	0.883	0.887
MDM, error	30	0.094	0.085	0.486	0.510
	50	0.310	0.267	0.756	0.750
	100	0.842	0.841	0.879	0.887
	250	0.991	0.980	0.905	0.890
	500	0.979	0.986	0.883	0.890
BSE	30	0.083	0.059	0.399	0.416
	50	0.272	0.255	0.709	0.716
	100	0.810	0.786	0.879	0.897
	250	0.989	0.980	0.904	0.883
	500	0.978	0.994	0.881	0.909
BP	30	0.166	0.160	0.547	0.539
	50	0.468	0.455	0.761	0.773
	100	0.877	0.869	0.885	0.899
	250	0.989	0.985	0.901	0.889
	500	0.976	0.995	0.881	0.914
BC	30	0.227	0.225	0.610	0.607
	50	0.545	0.530	0.797	0.795
	100	0.898	0.889	0.891	0.905
	250	0.990	0.985	0.898	0.887
	500	0.979	0.993	0.885	0.913
BCA	30	0.222	0.217	0.610	0.605
	50	0.534	0.521	0.795	0.794
	100	0.896	0.887	0.890	0.905
	250	0.990	0.985	0.898	0.888
	500	0.978	0.993	0.885	0.913

Table 112: Power, 99% and 90% confidence intervals,

First indirect effect, Populations 7 and 8

		99% CI		90% CI	
Method	N	No Error	Error	No Error	Error
MDM, no error	30	0.006	0.006	0.095	0.090
	50	0.019	0.011	0.217	0.233
	100	0.081	0.086	0.510	0.527
	250	0.593	0.607	0.856	0.860
	500	0.965	0.953	0.919	0.902
MDM, error	30	0.005	0.004	0.091	0.089
	50	0.018	0.009	0.210	0.221
	100	0.079	0.078	0.504	0.509
	250	0.592	0.585	0.856	0.858
	500	0.965	0.947	0.919	0.908
BSE	30	0.006	0.004	0.065	0.069
	50	0.021	0.017	0.177	0.173
	100	0.082	0.082	0.471	0.473
	250	0.578	0.561	0.852	0.850
	500	0.963	0.950	0.916	0.902
BP	30	0.020	0.014	0.130	0.124
	50	0.058	0.046	0.285	0.295
	100	0.209	0.195	0.570	0.559
	250	0.675	0.670	0.860	0.854
	500	0.972	0.955	0.924	0.904
BC	30	0.037	0.033	0.184	0.194
	50	0.093	0.080	0.359	0.369
	100	0.286	0.262	0.617	0.602
	250	0.712	0.703	0.859	0.861
	500	0.973	0.959	0.922	0.906
BCA	30	0.035	0.032	0.181	0.192
	50	0.086	0.078	0.358	0.368
	100	0.283	0.258	0.614	0.600
	250	0.709	0.701	0.858	0.858
	500	0.973	0.959	0.922	0.906

Table 113: Power, 99% and 90% confidence intervals,

Total indirect effect, Populations 7 and 8

		99% CI		90% CI	
Method	N	No Error	Error	No Error	Error
MDM, no error	30	0.116	0.108	0.541	0.521
	50	0.335	0.347	0.770	0.777
	100	0.847	0.837	0.872	0.884
	250	0.983	0.982	0.882	0.894
	500	0.988	0.987	0.886	0.888
MDM, error	30	0.112	0.096	0.533	0.507
	50	0.332	0.321	0.766	0.775
	100	0.843	0.823	0.871	0.890
	250	0.984	0.983	0.883	0.900
	500	0.988	0.988	0.886	0.891
BSE	30	0.063	0.072	0.439	0.424
	50	0.266	0.272	0.717	0.732
	100	0.805	0.775	0.880	0.882
	250	0.986	0.978	0.880	0.890
	500	0.986	0.986	0.884	0.888
BP	30	0.174	0.154	0.575	0.539
	50	0.428	0.458	0.782	0.772
	100	0.877	0.845	0.879	0.890
	250	0.991	0.984	0.880	0.893
	500	0.988	0.990	0.888	0.892
BC	30	0.246	0.231	0.631	0.617
	50	0.510	0.535	0.813	0.791
	100	0.890	0.872	0.886	0.891
	250	0.992	0.986	0.880	0.897
	500	0.987	0.987	0.892	0.897
BCA	30	0.242	0.219	0.630	0.615
	50	0.502	0.528	0.813	0.791
	100	0.889	0.870	0.884	0.891
	250	0.992	0.986	0.880	0.897
	500	0.986	0.987	0.893	0.897

Table 114: Power, 99% and 90% confidence intervals,

First indirect effect, Populations 9 and 10

		99% CI		90% CI	
Method	N	No Error	Error	No Error	Error
MDM, no error	30	0.087	0.089	0.417	0.406
	50	0.223	0.263	0.620	0.613
	100	0.631	0.601	0.864	0.836
	250	0.980	0.975	0.886	0.898
	500	0.990	0.988	0.894	0.880
MDM, error	30	0.089	0.069	0.417	0.361
	50	0.229	0.203	0.623	0.588
	100	0.631	0.505	0.855	0.833
	250	0.981	0.971	0.890	0.912
	500	0.991	0.989	0.897	0.909
BSE	30	0.049	0.057	0.335	0.302
	50	0.180	0.184	0.573	0.567
	100	0.598	0.507	0.850	0.822
	250	0.979	0.968	0.891	0.914
	500	0.988	0.990	0.887	0.899
BP	30	0.088	0.086	0.401	0.349
	50	0.247	0.242	0.618	0.596
	100	0.646	0.548	0.851	0.821
	250	0.975	0.972	0.889	0.917
	500	0.989	0.992	0.890	0.896
BC	30	0.128	0.128	0.445	0.397
	50	0.284	0.288	0.648	0.613
	100	0.667	0.576	0.858	0.820
	250	0.976	0.970	0.897	0.916
	500	0.987	0.992	0.889	0.894
BCA	30	0.126	0.123	0.444	0.393
	50	0.281	0.279	0.648	0.612
	100	0.663	0.569	0.857	0.817
	250	0.975	0.970	0.895	0.915
	500	0.987	0.992	0.889	0.894

Table 115: Power, 99% and 90% confidence intervals,

Total indirect effect, Populations 9 and 10

		99% CI		90% CI	
Method	N	No Error	Error	No Error	Error
MDM, no error	30	0.090	0.104	0.504	0.505
	50	0.333	0.326	0.770	0.768
	100	0.871	0.843	0.896	0.891
	250	0.991	0.984	0.887	0.898
	500	0.992	0.986	0.905	0.874
MDM, error	30	0.082	0.085	0.491	0.490
	50	0.329	0.298	0.768	0.760
	100	0.869	0.822	0.896	0.898
	250	0.991	0.986	0.888	0.902
	500	0.992	0.989	0.905	0.880
BSE	30	0.068	0.055	0.397	0.407
	50	0.283	0.257	0.727	0.716
	100	0.817	0.777	0.900	0.899
	250	0.987	0.985	0.882	0.904
	500	0.993	0.988	0.898	0.879
BP	30	0.159	0.148	0.521	0.519
	50	0.443	0.445	0.782	0.768
	100	0.896	0.864	0.901	0.902
	250	0.988	0.992	0.890	0.906
	500	0.995	0.987	0.902	0.883
BC	30	0.221	0.208	0.594	0.594
	50	0.526	0.518	0.803	0.793
	100	0.923	0.888	0.917	0.905
	250	0.989	0.993	0.893	0.908
	500	0.996	0.987	0.908	0.882
BCA	30	0.215	0.202	0.593	0.590
	50	0.519	0.508	0.805	0.790
	100	0.922	0.886	0.918	0.905
	250	0.989	0.993	0.893	0.908
	500	0.996	0.987	0.908	0.883

Table 116: Power, 99% and 90% confidence intervals,

First indirect effect, Populations 11 and 12

		99% CI		90% CI	
Method	N	No Error	Error	No Error	Error
MDM, no error	30	0.006	0.004	0.076	0.079
	50	0.008	0.017	0.121	0.114
	100	0.036	0.040	0.221	0.248
	250	0.143	0.145	0.448	0.452
	500	0.360	0.347	0.705	0.705
MDM, error	30	0.005	0.002	0.072	0.072
	50	0.007	0.015	0.116	0.102
	100	0.034	0.037	0.217	0.238
	250	0.142	0.133	0.448	0.431
	500	0.358	0.331	0.706	0.700
BSE	30	0.005	0.003	0.045	0.035
	50	0.008	0.012	0.108	0.082
	100	0.034	0.035	0.206	0.220
	250	0.139	0.126	0.451	0.426
	500	0.362	0.337	0.698	0.695
BP	30	0.014	0.010	0.090	0.082
	50	0.026	0.026	0.134	0.119
	100	0.051	0.059	0.240	0.245
	250	0.147	0.150	0.452	0.446
	500	0.349	0.342	0.701	0.699
BC	30	0.025	0.015	0.126	0.124
	50	0.038	0.043	0.174	0.147
	100	0.070	0.067	0.263	0.271
	250	0.169	0.162	0.462	0.458
	500	0.357	0.356	0.700	0.701
BCA	30	0.025	0.014	0.126	0.122
	50	0.039	0.041	0.173	0.145
	100	0.069	0.066	0.261	0.269
	250	0.167	0.162	0.462	0.456
	500	0.356	0.352	0.700	0.701

Table 117: Power, 99% and 90% confidence intervals,

Second Indirect effect, Populations 11 and 12

		99% CI		90% CI	
Method	N	No Error	Error	No Error	Error
MDM, no error	30	0.114	0.100	0.474	0.475
	50	0.328	0.261	0.701	0.707
	100	0.753	0.758	0.883	0.892
	250	0.982	0.983	0.883	0.899
	500	0.968	0.983	0.854	0.865
MDM, error	30	0.120	0.080	0.462	0.435
	50	0.319	0.223	0.699	0.673
	100	0.748	0.711	0.880	0.900
	250	0.980	0.982	0.887	0.909
	500	0.970	0.987	0.856	0.877
BSE	30	0.077	0.082	0.392	0.423
	50	0.267	0.275	0.663	0.702
	100	0.711	0.778	0.877	0.886
	250	0.977	0.977	0.885	0.873
	500	0.968	0.973	0.853	0.837
BP	30	0.116	0.138	0.447	0.487
	50	0.335	0.361	0.679	0.734
	100	0.736	0.800	0.881	0.887
	250	0.979	0.980	0.887	0.882
	500	0.974	0.972	0.862	0.842
BC	30	0.162	0.182	0.488	0.519
	50	0.370	0.425	0.691	0.748
	100	0.758	0.818	0.884	0.891
	250	0.981	0.982	0.885	0.885
	500	0.976	0.974	0.867	0.850
BCA	30	0.155	0.178	0.482	0.517
	50	0.366	0.414	0.690	0.745
	100	0.752	0.814	0.884	0.891
	250	0.980	0.982	0.885	0.883
	500	0.975	0.973	0.865	0.848

Table 118: Power, 99% and 90% confidence intervals,

Total indirect effect, Populations 11 and 12

APPENDIX D

INDIVIDUAL ITEMS FROM THE AGING, STATUS AND SENSE OF CONTROL STUDY

For the composite variables used in the real data example, data from the Aging, Status and Sense of Control study (2001) were used. The following items were combined to produce composite variables:

Sense of control

1. There's no sense planning a lot. If something good is going to happen, it will.
2. The really good things that happen to me are mostly luck.
3. Most of my problems are due to bad breaks.
4. I am often a victim of things I can't control.
5. A lot of my problems are caused by others who are selfish, greedy, or mean.

Social Support

1. I have someone I can turn to for support and understanding when things get rough.
2. I have someone I can really talk to.
3. I have someone who would help me out with things.
4. I have someone who would take care of me if I were sick.

Work

1. My work gives me a chance to do things I enjoy.
2. My work gives me a chance to develop and to learn new things.
3. In my work I have to figure out how to solve problems.
4. My work gives me a chance to interact with people I like.

Depressive Symptoms

1. On how many of the past 7 days have you felt sad?
2. On how many of the past 7 days have you felt lonely?
3. On how many of the past 7 days have you felt you couldn’t shake the blues?