

# Mediation (Missing Data)

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## References

**Pesigan et al.: Monte Carlo confidence intervals for the indirect effect with missing data** **Pesigan-Cheung-2023**

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Ivan Jacob Agaloos Pesigan and Shu Fai Cheung. “Monte Carlo confidence intervals for the indirect effect with missing data”. In: *Behavior Research Methods* (Aug. 2023). DOI: [10.3758/s13428-023-02114-4](https://doi.org/10.3758/s13428-023-02114-4).

Abstract: Missing data is a common occurrence in mediation analysis. As a result, the methods used to construct confidence intervals around the indirect effect should consider missing data. Previous research has demonstrated that, for the indirect effect in data with complete cases, the Monte Carlo method performs as well as nonparametric bootstrap confidence intervals (see MacKinnon et al., *Multivariate Behavioral Research*, 39(1), 99–128, 2004; Preacher & Selig, *Communication Methods and Measures*, 6(2), 77–98, 2012; Tofighi & MacKinnon, *Structural Equation Modeling: A Multidisciplinary Journal*, 23(2), 194–205, 2015). In this manuscript, we propose a simple, fast, and accurate two-step approach for generating confidence intervals for the indirect effect, in the presence of missing data, based on the Monte Carlo method. In the first step, an appropriate method, for example, full-information maximum likelihood or multiple imputation, is used to estimate the parameters and their corresponding sampling variance-covariance matrix in a mediation model. In the second step, the sampling distribution of the indirect effect is simulated using estimates from the first step. A confidence interval is constructed from the resulting sampling distribution. A simulation study with various conditions is presented. Implications of the results for applied research are discussed.

Wei Wu and Fan Jia. “A new procedure to test mediation with missing data through nonparametric bootstrapping and multiple imputation”. In: *Multivariate Behavioral Research* 48.5 (Sept. 2013), pp. 663–691. DOI: [10.1080/00273171.2013.816235](https://doi.org/10.1080/00273171.2013.816235).

Abstract: This article proposes a new procedure to test mediation with the presence of missing data by combining nonparametric bootstrapping with multiple imputation (MI). This procedure performs MI first and then bootstrapping for each imputed data set. The proposed procedure is more computationally efficient than the procedure that performs bootstrapping first and then MI for each bootstrap sample. The validity of the procedure is evaluated using a simulation study under different sample size, missing data mechanism, missing data proportion, and shape of distribution conditions. The result suggests that the proposed procedure performs comparably to the procedure that combines bootstrapping with full information maximum likelihood under most conditions. However, caution needs to be taken when using this procedure to handle missing not-at-random or nonnormal data.

Zhiyong Zhang and Lijuan Wang. “Methods for mediation analysis with missing data”. In: *Psychometrika* 78.1 (Dec. 2012), pp. 154–184. DOI: [10.1007/s11336-012-9301-5](https://doi.org/10.1007/s11336-012-9301-5).

Abstract: Despite wide applications of both mediation models and missing data techniques, formal discussion of mediation analysis with missing data is still rare. We introduce and compare four approaches to dealing with missing data in mediation analysis including listwise deletion, pairwise deletion, multiple imputation (MI), and a two-stage maximum likelihood (TS-ML) method. An R package *bmim* is developed to implement the four methods for mediation analysis with missing data in the structural equation modeling framework, and two real examples are used to illustrate the application of the four methods. The four methods are evaluated and compared under MCAR,

MAR, and MNAR missing data mechanisms through simulation studies. Both MI and TS-ML perform well for MCAR and MAR data regardless of the inclusion of auxiliary variables and for AV-MNAR data with auxiliary variables. Although listwise deletion and pairwise deletion have low power and large parameter estimation bias in many studied conditions, they may provide useful information for exploring missing mechanisms.

**Zhang et al.: Mediation analysis with missing data through multiple imputation and bootstrap** **Zhang-Wang-Tong-2015**

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Zhiyong Zhang, Lijuan Wang, and Xin Tong. “Mediation analysis with missing data through multiple imputation and bootstrap”. In: *Quantitative Psychology Research*. Springer International Publishing, 2015, pp. 341–355. DOI: [10.1007/978-3-319-19977-1\\_24](https://doi.org/10.1007/978-3-319-19977-1_24).