Effect Size Measures and Sample Size Determination in Multilevel Mediation Analysis within the Structural Equation Modeling Framework

This study aims to investigate the sample size requirement for the multilevel mediation model. In quantitative research, sample size determination is an inevitable part in study design. An adequate sample size ensures the power of the test to detect the nonzero effect, if there is any, and reduces the bias in parameter estimation. Hence, sample size plays a critical role in that it affects the reliability, trustworthiness, and replicability of the conclusion drawn in the study. The statistical mediation model is commonly used for studying human processes in social sciences and behavioral research. Research on mediation with multilevel data further allows researchers to examine the human processes at different levels (e.g., school- and student-levels). Despite growing scientific interest in the use of multilevel mediation analysis for addressing theoretically meaningful questions, the importance of sample size is underemphasized. One reason is that sample size determination in a complex model involves multiple considerations such as effect size, model specification of the analysis, and advanced programming skills. It has been found that many studies could not satisfy the sample size requirements for mediation analysis with multilevel data (McNeish, 2017). Also, although previous researchers have already shown that the sample size requirement varies depending on multiple factors such as intraclass correlation and unbalanced cluster design, applied researchers sometimes tend to overgeneralize a single "rule of thumb" for sample size in multilevel modeling to different model conditions, such as those in mediation analysis.

This study will address the sample size issues in the multilevel mediation context. The study is divided into three parts. Part I will investigate the effect size measures for multilevel mediation effect, benchmarking other existing measures for multilevel modeling. Effect size is one factor that affects the adequacy of sample size. The results of Part I will enhance researchers' understanding of the effect size and help to anticipate the effect size of the study prior to data collection. In Part II, simulation studies will be conducted to systematically evaluate the performance of the multilevel mediation model at varying sample sizes within the multilevel structural equation modeling framework and formulate some rules governing sample size determination in the multilevel mediation context. In Part III, a R-based program for sample size and effect size computation for multilevel mediation analysis will be developed based on the results of Parts I and II. This study will help researchers to determine an optimal sample size for multilevel mediation analysis in face of resource limitation and will contribute to improving the study design for mediation with multilevel data and enhancing the methodological rigor of research studies.