

Further Reading on Multilevel Regression

Less Technical Texts

Hox, J.J., Moerbeek, M., & van de Schoot, R. (2010). *Multilevel analysis. Techniques and applications, third edition*. New York: Routledge.

Snijders, T.A.B., & Bosker, R.J. (2012). *Multilevel analysis: An introduction to basic and advanced multilevel modeling (2nd Edition)*. London: Sage.

Kreft, Ita & de Leeuw, Jan (1998). *Introducing Multilevel Modeling*, London: Sage.

Bickel, R. (2007). *Multilevel Analysis for Applied Research: It's Just Regression*. Guilford Press.

More Technical Texts

Raudenbush, S. W. Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods. 2nd edition*. Newbury Park, CA: Sage.

Longford, N. (1993). *Random coefficient models*. London: Sage.

Goldstein, H.I. (2010). *Multilevel statistical models*. (4th Edition). New York: Wiley.

Centering in HLM

Kreft, I.G.G., de Leeuw, J., & Aiken, L. (1995). The effect of different forms of centering in hierarchical linear models. *Multivariate Behavioral Research*, 30, 1-22.

Enders, C.K., Tofighi, D. (2007). Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. *Psychological Methods*, 12, 121-138.

Paccagnella, O. (2006). Centering or not centering in multilevel models? The role of group mean and assessment of group effects. *Evaluation Review*, 30, 66-85.

Algina, J., & Swaminathan, H. (2011). Centering in two-level nested designs. In J. de Leeuw & E. Meijer (Eds.), *Handbook of advanced multilevel analysis* (pp. 285-312). Springer, New York.

Random Effects ANOVA and HLM

Raudenbush, S.W. (1993). Hierarchical linear models and experimental design. In Lynne K. Edwards (Ed.), *Applied analysis of variance in behavioral science* (pp. 459-496). New York: Marcel Dekker.

Cross-level interactions

Curran, P.J., Bauer, D.J. & Willoughby, M.T. (2006). Testing and probing interactions in hierarchical linear growth models. In C.S. Bergeman & S.M. Boker (Eds.), *The Notre Dame Series on Quantitative Methodology, Volume 1: Methodological Issues in Aging Research* (pp. 99-129). Mahwah, NJ: Lawrence Erlbaum Associates.

Psychometric Applications

Kreft, I.G.G. (1997). The interactive effect of alcohol prevention programs in high school classes: An illustration of item homogeneity scaling and multilevel analysis techniques. In K.J. Bryant, M. Windle, and S.G. West (eds.), *Science of prevention: Methodological advances from alcohol and substance abuse research*. Washington, D.C.: American Psychological Association.

Steele, F., & Goldstein, H. (2006) Multilevel models in psychometrics. In Rao, C. R. & Sinharay, S., (eds.) *Handbook of Statistics* (pp. 401-420). Elsevier North-Holland, Amsterdam; London.

French, B. F., Finch, W. H., & Vazquez, J. A. V. (2016). Differential Item Functioning on mathematics items using multilevel SIBTEST. *Psychological Test and Assessment Modeling*, 58(3), 471.

Fox, J.P. (2005). Multilevel IRT using dichotomous and polytomous response data. *British Journal of Mathematical and Statistical Psychology* 58, 145–172.

Binary Outcome Models and Hierarchical Generalized Linear Models

Hox, J.J., Moerbeek, M., & van de Schoot, R. (2010). *Multilevel analysis. Techniques and applications, third edition*. New York: Routledge. (Ch. 6,7)

Hedeker, D. (2005). Generalized linear mixed models. In B. Everitt & D. Howell (Eds.), *Encyclopedia of Statistics in Behavioral Science*. Wiley, New York

Hedeker, D. (2008). Multilevel models for ordinal and nominal variables. In J. de Leeuw & E. Meijer (Eds.), *Handbook of Multilevel Analysis* (pp. 237-274). Springer, New York.

Snijders, T.A.B., & Bosker, R.J. (2012). *Multilevel analysis: An introduction to basic and advanced multilevel modeling, second edition*. London: Sage.

Raudenbush, S.W., & Bryk, A.S. (2002). *Hierarchical Linear Models: Applications and data analysis methods* (2nd Edition). Thousand Oaks, CA: Sage.

Longford, N. (1993). *Random coefficient models*. London: Sage.

Pinheiro, J., & Bates, D. (1995). Approximations to the log-likelihood function in the nonlinear mixed-effects model. *Journal of Computational and Graphical Statistics*, 4, 12-35.

Rodriguez, G., & Goldman, N. (1995). An assessment of estimation procedures for multilevel models with binary responses. *Journal of the Royal Statistical Society, Series A*, 158, 73-89.

Willet, J.B., Singer, J.D., & Martin, N.A. (1998). The design and analysis of longitudinal studies of development and psychopathology in context: Statistical models and methodological recommendations. *Development and Psychopathology*, 10, 395-426.

Fielding, A. (2003). Ordered category responses and random effects in multilevel and other complex structures. In S.P. Reise & N. Duan (Eds.), *Multilevel modeling: Methodological advances, issues, and applications* (pp. 181-208). Mahwah, NJ: Erlbaum.

Power

Dziak, J.J., Nahum-Shani, I., & Collins, L.M. (2012). Multilevel factorial experiments for developing behavioral interventions: Power, sample size, and resource considerations. *Psychological Methods*, 17, 153-175.

Mathieu, J., Aguinis, H., Culpepper, S. A., & Chen, G. (2012). Improving the accuracy of inferences about cross-level interaction tests in random coefficient modeling. *Journal of Applied Psychology*, 97, 951-966

Moinuddin, R., Matheson, F., & Glazier, R. (2007). A simulation study of sample size for multilevel logistic regression models. *BMC Medical Research Methodology*, 7, 34

Moerbeek, M., & Teerenstra, S. (2011). Optimal design in multilevel experiments. In J.J. Hox & J.K. Roberts (Eds.), *Handbook of Advanced Multilevel Analysis* (pp. 257-281). New York: Routledge.

Muthen, B.O., & Curran, P.J. (1997). General longitudinal modeling of individual differences in experimental designs: A latent variable framework for analysis and power estimation. *Psychological Methods*, 2, 371-402.

Raudenbush, S.W. (1997). Statistical analysis and optimal design for cluster randomized trials. *Psychological Methods*, 2, 173-185.

Raudenbush, S.W., & Liu, X. (2000). Statistical power and optimal design for multisite randomized trials. *Psychological Methods*, 5, 199-213.

Raudenbush, S.W. (2008). Many Small Groups. In Handbook of Multilevel Analysis. Jan de Leeuw and Erik Meijer (Eds.) *Handbook of Multilevel Analysis* (pp 207-236). New York: Springer.

Scherbaum, C.A. & Ferreter, J.M. (2009). Estimating statistical power and required sample sizes for organizational research using multilevel modeling. *Organizational Research Methods*, 12, 347-367.

Snijders, T.A.B., & Bosker, R.J. (1993). Standard errors and sample sizes for two-level research. *Journal of Educational Statistics*, 18, 237-259.

The Hox et al. (2018) and the Snijders and Bosker (2012) texts have the best coverage of power issues.

The PinT, <http://stat.gamma.rug.nl/multilevel.htm>, and the OpDes, http://sitemaker.umich.edu/group-based/optimal_design_software, programs are free online.

Mediation

Krull, J.L., & MacKinnon, D.P. (1999). Multilevel mediation modeling in group-based intervention studies. *Evaluation Review*, 23, 418-444.

Krull, J. L., & MacKinnon, D. P. (2001). Multilevel modeling of individual and group level mediated effects. *Multivariate Behavioral Research*, 36, 249-277.

Kenny, D.A., Korchmaros, J.D., & Bolger, N. (2003). Lower level mediation in multilevel models. *Psychological Methods*, 8, 115-128.

MacKinnon, D. P. (2008). *Introduction to Statistical Mediation Analysis*. New York: Erlbaum.(Ch. 10)

Zhang, Z., Zyphur, M. J., & Preacher, K. J. (2009). Testing multilevel mediation using hierarchical linear models problems and solutions. *Organizational Research Methods*, 12(4), 695-719.

Preacher, K. J., & Selig, J. P. (2010, July). *Monte Carlo method for assessing multilevel Mediation: An interactive tool for creating confidence intervals for indirect effects in 1-1-1 multilevel models* [Computer software]. Available from <http://quantpsy.org/>.

Preacher, K. J., Zhang, Z., & Zyphur, M. J. (2016). Multilevel structural equation models for assessing moderation within and across levels of analysis. *Psychological methods*, 21, 189.

Tofighi, D. and MacKinnon, D. P. (2011). RMediation: An R package for mediation analysis confidence intervals. *Behavior Research Methods*, 43, 692-700

Tofighi, D., & MacKinnon, D. P. (2016). Monte Carlo Confidence Intervals for Complex Functions of Indirect Effects. *Structural Equation Modeling: A Multidisciplinary Journal*, 23, 194-205.

Three-Level Models

McNeish, D., & Wentzel, K. R. (2017). Accommodating Small Sample Sizes in Three-Level Models When the Third Level is Incidental. *Multivariate behavioral research*, 52, 200-215.

Tasca, G. A., Illing, V., Joyce, A. S., & Ogrodniczuk, J. S. (2009). Three-level multilevel growth models for nested change data: A guide for group treatment researchers. *Psychotherapy Research*, 19, 453-461.

Heo, M., & Leon, A. C. (2008). Statistical power and sample size requirements for three level hierarchical cluster randomized trials. *Biometrics*, 64, 1256-1262.

Multivariate Hierarchical Linear Models

Raudenbush, S.W., & Bryk, A.S. (2002). *Hierarchical Linear Models: Applications and data analysis methods* (2nd Edition). Thousand Oaks, CA: Sage.

Thum, Y.M. (1997). Hierarchical linear models for multivariate outcomes. *Journal of Educational and Behavioral Statistics*, 22, 77-108.

Hox, J.J., Moerbeek, M., & van de Schoot, R. (2010). *Multilevel analysis. Techniques and applications, third edition*. New York: Routledge. (Ch. 10)

Cross-classified Random Effects

Beretvas, S. N. (2011). Cross-classified and multiple-membership models. In J.J. Hox & J.K. Roberts (Eds.), *Handbook of Advanced Multilevel Analysis* (pp. 313-334). New York: Routledge.

Hill, P.W., & Goldstein, H. (1998). Multilevel modeling of educational data with cross-classification and missing identification of units. *Journal of Educational and Behavioral Statistics*, 23, 117-128.

Hox, J.J., Moerbeek, M., & van de Schoot, R. (2010). *Multilevel analysis. Techniques and applications, third edition*. New York: Routledge. (Ch. 9)

Raudenbush, S.W., & Bryk, A.S. (2002). *Hierarchical Linear Models: Applications and data analysis methods* (2nd Edition). Thousand Oaks, CA: Sage.

Assumptions and Diagnostics

Snijders, T. A. and Berkhof, J. (2008). Diagnostic checks for multilevel models. In De Leeuw, J. & Meijer, E., (eds.), *Handbook of Multilevel Analysis* (pp. 141-175). New York: Springer.

Ecob, R., & Der, G. (2003). An interactive method for the detection of outliers in longitudinal growth data using multilevel models. In S.P. Reise & N.

Duan (Eds.), *Multilevel modeling: Methodological advances, issues, and applications* (pp. 229-254). Mahwah, NJ: Erlbaum. Langford, I.H., & Lewis, T. (1998). Outliers in multilevel data. *Journal of the Royal Statistical Society, Series A*, 161, 121-160.

Raudenbush, S.W., Bryk, A.S., Cheong, Y.F., & Congdon, R.T., Jr (2000). *HLM 5: Hierarchical linear and nonlinear modeling*. (Statistical software manual). Lincolnwood, IL: Scientific Software International.

Seltzer, M., Novak, J., Choi, K., & Lim, N. (2002). Sensitivity analysis form hierarchical models employing t level-1 assumptions. *Journal of Educational & Behavioral Statistics*, 27, 181-222.

Shi, L., & Chen, G. (2008). Case deletion diagnostics in multilevel models. *Journal of Multivariate Analysis*, 99, 1860-1877.

Growth Curve Models

Bryk, A.S., & Raudenbush, S.W. (1987). Application of hierarchical linear models to assessing change. *Psychological Bulletin*, 101, 147-158.

Cudeck, R., & Klebe, K.J. (2002). Multiphase mixed-effects models for repeated measures data. *Psychological Methods*, 7, 41-63.

Miyazaki, Y., & Raudenbush, S.W. (2000). A test for linkage of multiple cohorts from an accelerated longitudinal design. *Psychological Methods*, 5, 44-63.

Raudenbush, S.W., & Chan, W.-S. (1993). Application of hierarchical linear models to the study appendix of adolescent deviance in an overlapping in an overlapping cohort design. *Journal of Clinical and Consulting Psychology*, 61, 941-951.

Willet, J.B., Singer, J.D., & Martin, N.A. (1998). The design and analysis of longitudinal studies of development and psychopathology in context: Statistical models and methodological recommendations. *Development and Psychopathology*, 10, 395-426.

Singer, J.D., & Willett, J.B. (2003). *Applied Longitudinal Data Analysis: Modeling Change and Event Occurrence*. New York: Oxford Press.

Latent Growth Curve Models (using Structural Equation Modeling)

Bollen, K.A., & Curran, P.J. (2006). *Latent Curve Models: A Structural Equation Approach*. New York: Wiley.

Duncan, T.E., Duncan, S.C., & Stycker, L.A. (2006). *An introduction to latent variable growth curve modeling: Concepts, issues, and applications* (2nd Edition). Mahwah, NJ: Erlbaum.

Willet, J. B., & Sayer, A. G. (1994). Using covariance structure analysis to detect correlates and predictors of individual change over time. *Psychological Bulletin*, 116, 363-381.

Singer, J.D., & Willett, J.B. (2003). *Applied Longitudinal Data Analysis: Modeling Change and Event Occurrence*. New York: Oxford Press.

Newsom, J.T. (2015). *Longitudinal Structural Equation Modeling: A Comprehensive Introduction*. New York: Routledge. (Ch. 7, 8)

Multilevel Structural Equation Models

Hox, J.J., Moerbeek, M., & van de Schoot, R. (2010). *Multilevel analysis. Techniques and applications, third edition*. New York: Routledge. (Ch. 14,15)

du Toit, S. H. C., & du Toit, M. (2008). Multilevel structural equation modeling. In J. de Leeuw, & E. Meier (Eds.), *Handbook of multilevel analysis* (pp. 435-78). New York: Springer.

Muthen, B., & Asparouhov, T. (2011). Beyond multilevel regression modeling: Multilevel analysis in a general latent variable framework. In J.J. Hox & J.K. Roberts (Eds.), *Handbook of Advanced Multilevel Analysis* (pp. 15-40). New York: Routledge.

J.J. Hox & C.J.M. Maas (2001). The Accuracy of Multilevel Structural Equation Modeling With Pseudobalanced Groups and Small Samples. *Structural Equation Modeling*, 8, 2, 157-174.

Heck, R. H., & Thomas, S. L. (2015). *An Introduction to Multilevel Modeling Techniques: MLM and SEM Approaches Using Mplus*. New York: Routledge.

Multilevel Meta-Analysis

Hox, J.J., & de Leeuw, E.D. (2003). Multilevel models for meta-analysis. In S.P. Reise & N. Duan (Eds.), *Multilevel modeling: Methodological advances, issues, and applications* (pp. 90-111). Mahwah, NJ: Erlbaum.

Hox, J.J., Moerbeek, M., & van de Schoot, R. (2010). *Multilevel analysis. Techniques and applications, third edition*. New York: Routledge. (Ch. 11)

Critiques

Draper, D. (1995). Inference and hierarchical modeling in the social sciences. *Journal of Educational and Behavioral Statistics*, 20, 115-147. Special issue with replies by Raudenbush, Rogosa and Saner, Longford, de Leeuw and Kreft, Mason.

McNeish, D., Stapleton, L. M., & Silverman, R. D. (2017). On the unnecessary ubiquity of hierarchical linear modeling. *Psychological methods*, 22(1), 114.

Gelman, A. (2006). Multilevel (hierarchical) modeling: What it can and cannot do. *Technometrics*, 48(3), 432-435.