Type of MLM

(Tabachnick & Fidell, 2013)

Repeated Measures

One of the more common uses of MLM is to analyze a repeated-measures design, which violates some of the requirements of repeated-measures ANOVA. Longitudinal designs (called growth curve data) are handled in MLM by setting measurement occasions as the lowest level of analysis with cases (e.g., students) the grouping variable. However, the repeated measures need not be limited to the first level of analysis (e.g., there could be repeated measurement of teachers and/or schools, as well). A big advantage of MLM over repeated-measures ANOVA is that there is no requirement for complete data over occasions (although it is assumed that data are missing at random), nor is there need for equal numbers of cases or equal intervals of measurements for each case. Another important advantage of MLM for repeated-measures data is the opportunity to test individual differences in growth curves (or other patterns of responses over the repeated measure). Are the regression coefficients the same for all cases? Because each case has its own regression equation when random slopes and intercepts are specified, it is possible to evaluate whether individuals do indeed differ in their mean response and/or in their pattern of responses over the repeated measure.

Higher-Order MLM

The model described in Section 4 has two levels: skiers and runs. This is the most common type of model and, obviously, the easiest to analyze. Most MLM software is capable of analyzing three-level models; and some programs accommodate even more levels. An alternative strategy if the soft- ware is limited is to run a series of two-level models, using the slopes and intercepts from one level (as seen in Table 2) as DVs for the next higher level. A three-level example with repeated measures is demonstrated in Section 7.

Latent Variables

Latent variables are used in several ways in MLM—observed variables combined into factors, analysis of variables that are measured without error, analyses with data missing on one or more predictors, and models in which the latent factors are based on time.

The HLM manual (Raudenbush, et al., 2004) shows examples of two applications. In the first, the latent variable regression option is chosen to analyze a latent variable measured without error, gender, which is entered on both levels of a two-level repeated-measures model (occasion and participant), with age as a level-1, occasion-level predictor. The DV is attitude toward deviant behaviors. Coefficients are available to test the linear growth rate in the DV (trend over occasions); the effect of gender on the growth rate; the effect of the initial value of the DV on the linear growth rate; and the total, direct, and indirect associations between gender and growth rate.

Nonnormal Outcome Variables

As a variant of the general linear model, MLM assumes multivariate normality. Some MLM programs also provide specialized techniques for dealing with nonnormal data (see Table 33). Models with nonnormal outcomes (DVs) are often referred to as multilevel generalized linear models.

MLwiN allows analysis of binomial and Poisson as well as normal error distributions for MLM. A binary response variable is analyzed using the binomial error distribution, as is a response variable that is expressed as a proportion. The Poisson distribution is used to model frequency count data. The MLwiN manual (Rasbash et al., 2000, Chapters 8 and 9) describes many choices of link functions and estimation techniques and demonstrates examples of these models. A special MLwiN manual (Yang, Rasbash, Goldstein, & Barbosa, 1999) discusses categorical responses with ordered and unordered categories.

Multiple Response Models

The true multivariate analog of MLM is the analysis of multiple DVs as well as multiple predictors. These models are specified by providing an additional lowest level of analysis, defining the multivariate structure in a manner similar to that of repeated measures. That is, a case has as many rows as there are DVs, and some coding scheme is used to identify which DV is being recorded in that row. Snijders and Bosker (1994) discuss some of the advantages of multivariate multilevel models over MANOVA. First, missing data (assuming they are missing at random) pose no problem. This is a less restrictive assumption than required by MANOVA with imputed values for missing data, which is that data be missing completely at random (Hox, 2002). Second, tests are available to determine whether the effect of a predictor is greater on one DV than another. Third, if DVs are highly correlated, tests for specific effects on single DVs are more powerful because standard errors are smaller. Fourth, covariances among DVs can be partitioned into individual and group level, so that it is possible to compare size of correlations at the group versus the individual level.

Reference:

Tabachnick, B. G., & Fidell, L. S. (2013). *Using Multivariate Statistics*. Pearson Education. https://books.google.com/books?id=ucj1ygAACAAJ