18. *Writing about Hierarchical Linear Models*

PROBLEM SET

Harrington and Elliott (2009) conducted a multilevel analysis of individual and neighborhood determinants of overweight and obesity. Selected results from their analysis are shown in table 18A.

TABLE 18A. Estimated coefficients and 95% confidence intervals for a multilevel random intercept model of body mass index,[a] Ontario, Canada, 1992

Variables	Coefficient	Lower 95% confidence limit	Upper 95% confidence limit
Individual level variables			
Age (years)	21.17*	20.35	22.00
Male	0.053*	0.037	0.069
High school not complete	0.94*	0.47	1.41
Married or with partner	NS		
Regular smoker	−0.82*	−1.50	−0.15
Sedentary	0.99*	0.42	1.55
Area-level variables			
Average dwelling value (ref. = high)			
Low	1.93*	1.01	2.78
Middle	1.28*	0.70	1.86
Model statistics			
Level 1 variance (standard error)		19.13* (1.17)	
Level 2 variance (standard error)		0.90* (0.29)	
Intraclass correlation		4.45%	

Adapted from Daniel W. Harrington and Susan J. Elliott, "Weighing the Importance of Neighbourhood: A Multilevel Exploration of the Determinants of Overweight and Obesity," *Social Science and Medicine* 68 (2009) 593–600, table 4, combined model.

[a] Body mass index in kilograms/meter^2

* $p < 0.05$; NS not statistically significant

1. Answer question based on table 18A.

   a. For the methods section, write a series of equations to convey their model specification, including
      i. Level-1
      ii. Level-2
   b. Explain what you learn based on the statistical significance for the level-1 and level-2 variances.
   c. Show how to calculate the intraclass correlation and write a sentence that interprets the number.

d. Write sentences that report and interpret the coefficients for
   i. "regular smoker"
   ii. "low average dwelling value"

2. Based on table 18.1 from Krivo et al. (2009) on p. 392 of *Writing about Multivariate Analysis, 2nd Edition*, write a sentence that identifies the level-1 and level-2 units of analysis, how they relate to one another, and their respective sample sizes.

Subedi et al. (2011) use a three-level HLM to study the effect of student, teacher, and school characteristics on mathematics gain scores over a one-year period among middle school students. Selected results from their analysis are shown in table 18B. Their analysis included 6,184 students and 253 teachers from all middle schools in the Orange County Public Schools. Mathematics scores were from the Norm Referenced Test-Normal Curve Equivalent portion of the FCAT (Florida Comprehensive Assessment Test); the range for this study was from 1 to 99. Mathematics gain scores were calculated by subtracting a student's 2004 score from his or her 2005 score. The mathematics gain scores in this sample ranged from −31.4 to 45.

TABLE 18B. Fixed effects estimates of mathematics gains scores by student, teacher, and school characteristics, Orange County Public Middle Schools, Florida, 2004–2005

Variable	Coefficient	*t*-statistic
Intercept	19.33**	27.69
Student characteristics		
Mathematics pretest score	0.026**	26.00
Low socioeconomic status[a]	−2.15**	−6.61
Teacher characteristics		
Holds mathematics teaching certification[b]	1.97**	3.21
Teaching experience (years)	0.042*	2.21
School characteristics		
School poverty[c]	−4.15**	−5.00
Cross-level interactions		
Student math pretest score _ teacher math certification	0.033**	3.30
Student math pretest score_school percent advanced math degree[d]	0.015**	3.01
Low student socioeconomic status_teacher math certification	0.91**	2.98
Low student socioeconomic status_school poverty	−0.12**	−2.93

Model also controls for main effects of school mean teacher experience and percentage of teachers in a school that have an advanced mathematics degree. * $p < 0.05$; ** $p < 0.01$.
[a] Low socioeconomic status as assessed by participation in the free and reduced lunch program.
[b] Holds mathematics content-area teaching certification for grades 5–9 or grades 6–12.
[c] Percentage of students in the school who participate in the free and reduced lunch program.
[d] Percentage of mathematics teachers in the school with a masters degree or higher in mathematics.
Adapted from Bidya Raj Subedi, Bonnie Swan, and Michael C. Hynes, "Are School Factors Important for Measuring Teacher Effectiveness? A multilevel Technique to Predict Student Gains through a Value-Added Approach," *Education Research International* 2011, Article ID 532737, doi:10.1155/2011/532737, table 1.

Use the information in table 18B from the study by Subedi et al. (2011) to answer questions 3 through 5.

3. For the methods section,

   a. Identify the level-1, level-2, and level-3 units of analysis.
   b. Write a paragraph for the methods section that justifies the use of an HLM.
   c. Write a rationale (hypothesis) for examining the cross-level interaction between low socioeconomic status (SES) and mathematics certification.

4. Create a chart to show the effect on mathematics gains scores of the cross-level interaction between SES and mathematics certification, following the guidelines in chapters 6, 16, and 18 and appendix D of *Writing about Multivariate Analysis, 2nd Edition*.

5. Write sentences for the results section that report and interpret

   a. the coefficient on math pretest scores
   b. the coefficient on teaching experience
   c. the shape of the pattern between student SES, teacher mathematics certification, and mathematics change scores, taking into account the cross-level interaction between SES and mathematics certification

Answer questions 6 and 7 based on table 18C, adapted from Subedi et al. (2011).

TABLE 18C. Variance components, variance explained, and statistical significance at teacher and school levels, Orange County Public Middle Schools, Florida, 2004–2005.

Random effect	Variance component	% of variance explained	*p*-value
Teacher-level effect			
Unconditional model	4.50	3.6	<0.0001
Conditional model	4.65	4.6	<0.0001
School-level effect			
Unconditional model	0.47	0.4	0.04
Conditional model	0.26	0.3	0.16

Adapted from: Bidya Raj Subedi, Bonnie Swan, and Michael C. Hynes, "Are School Factors Important for Measuring Teacher Effectiveness? A multilevel Technique to Predict Student Gains through a Value-Added Approach," *Education Research International* 2011, Article ID 532737, doi:10.1155/2011/532737, table 2.

6. Write sentences for the results section that

   a. report and interpret the following aspects of the teacher-level effect:
      i. variance components
      ii. percentage of variance explained
      iii. *p*-values for the unconditional and condition models

b. report and interpret the following aspects of the school-level effect:
   i. variance components
   ii. percentage of variance explained
   iii. *p*-values for the unconditional and condition models

7. Write sentences for the methods section that explain the purpose of comparing the random effects for different levels of analysis from unconditional and conditional models.

Pan et al. (2005) used growth trajectory HLM to study maternal correlates of growth in toddler vocabulary production among children from low-income American families. Selected results from their analysis are shown in table 18D.

TABLE 18D. Estimates of fixed and random effects from a series of individual growth models of toddler vocabulary between ages 14 and 26 months by maternal input, low-income families in Early Head Start

	Unconditional means model		Unconditional growth model		Growth model with number of types[a]	
Variable	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Fixed effects						
Intercept	2.48**	0.45	1.08*	0.43	1.87*	0.09
Age (centered)[b]			2.37***	0.32	1.74*	0.80
Age^2			0.03*	0.01	0.06†	0.04
Mother types[a]					−0.006	0.009
Mother types × age					0.014*	0.007
Mother types × age^2					−0.001**	0.000
Random effects						
Level 1: Time 1	17.81***	2.55	14.76***	2.57	14.31***	2.45
Level 1: Time 2	1,784.62***	274.29	566.82***	111.03	530.89***	106.22
Level 1: Time 3	6,095.77***	977.51	335.18†	206.27	319.02†	203.97
Level 2: Slope (linear)			0.79*	0.42	0.84*	0.42
Goodness of fit						
−2 Log likelihood	2,116.0		1,932.9		1,928.4	
AIC	2,130.0		1,952.9		1,954.4	

Adapted from Barbara Alexander Pan, Meredith L. Rowe, Judith D. Singer, and Catherine E. Snow.. "Maternal Correlates of Growth in Toddler Vocabulary Production in Low-Income Families," *Child Development* 76, no. 4 (2005): 763–82, table 2.

[a] "Types" are the number of different words produced by mother.

[b] Age centered at 14 months.

† $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; $N = 108$ mother/child dyads

Use the information in table 18B to answer questions 8 through 10.

8. Create a chart to show the overall age pattern of vocabulary development based on the cross-level interaction between mother's word types, child's age, and child's age-squared, following the guidelines

in chapters 6, 10, 16, and 18 and appendix D of *Writing about Multivariate Analysis, 2nd Edition*. Hint: Use the online spreadsheet templates for quadratic specifications and interactions to conduct the calculations and create the chart.

9. Identify the level-1 and level-2 units of analysis in the study by Pan et al (2005).

10. Write the following aspects of the results section:

    a. Interpret the results of the unconditional means model, including the
        i. Intercept
        ii. Random effects terms for level 1
    b. Interpret the results of the unconditional growth model, including
        i. The linear slope
        ii. How the unconditional growth specification adds to the overall fit of the model compared to the unconditional means model