Biostatistics 140.656
Lab 2

Topics:

- Centering within multilevel models with two levels
- Visualization of total, between, within, and contextual effects
- Interpretation of contextual effects

Learning Objectives:

Students who successfully complete this lab will be able to:

- Construct graphical displays of 2-level multilevel data where the focus is on a level-1 outcome and a level-1 covariate.
- Simulate 2-level multilevel data with specific between, within and contextual effects
- Fit linear mixed models and interpret contextual effects within these models.

Scientific Background:

Suppose you are an obstetrician interested in women's satisfaction with their labor and childbirth experiences. You have access to patient information from three local hospitals: Greater Baltimore Medical Center (GBMC, Hospital 1), Mercy Medical Center (Hospital 2) and Johns Hopkins Hospital (Hospital 3).

You were able to obtain a random sample of 30 nulliparous women (women having their first child) from each hospital and for each woman you have measures of:

- casemix: score for how complicated the birth is likely to be; higher scores mean the birth is expected to be more complicated based on pre-existing conditions, prenatal care, and socioeconomic status
- patient satisfaction score (Y): scores for patient satisfaction with labor and childbirth experiences; higher scores indicate greater satisfaction with the birth experience

Your goals are as follows:

1. Quantify the relationship between patient satisfaction and casemix within a hospital
2. Determine how the hospital mean patient satisfaction changes with hospital mean casemix
3. Determine if the context of the hospital matters; i.e. do women of the same casemix benefit from attending GBMC (whose casemix is lower on average) verses Mercy or Hopkins.

These goals can be addressed by the following mixed model where Y_{ij} is the patient satisfaction score and X_{ij} is the casemix for woman j from hospital i.

$$Y_{ij} = \beta_0 + b_{0i} + \beta_1\left(X_{ij} - \bar{X}_{i.}\right) + \beta_2\bar{X}_{i.} + \varepsilon_{ij}, b_{0i} \sim N(0, \tau^2), \varepsilon_{ij} \sim N(0, \sigma^2)$$

Lab Exercise:

1. Simulated world 1: No contextual effect ($\beta_1 = \beta_2$).

   Run the lab2 do-file or R script.

   Consider the graphical display of the data produced by the do-file or R script and answer the following questions:

   a. Which hospital has lowest average casemix?

   b. Which hospital has highest average patient satisfaction?

   c. What patterns in the data support the claim that the between cluster and within cluster association between patient satisfaction and casemix are the same?

   d. Relative to grand mean centering the casemix variable, what is the advantage of hospital mean centering the casemix variable?

   Consider the results of the linear mixed model and answer the following questions:

   e. Interpret the estimated value of β_1

   f. Interpret the estimated value of β_2

   g. Estimate and interpret the contextual effect

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2. Positive contextual effect.

   In your group, discuss what it would mean within the context of this problem to have a positive contextual effect.

   Modify the lab2 do-file or R script to simulate a positive contextual effect, i.e. provide new values of β_1 and β_2. Simulate a single study with the positive contextual effect. Review the graphical displays and model fits for this single simulated study.

   Provide the estimate of and interpretation of the positive contextual effect from your single simulated study.

3. Negative contextual effect.

   In your group, discuss what it would mean within the context of this problem to have a negative contextual effect.

   Modify the lab2 do-file or R script to simulate a negative contextual effect, i.e. provide new values of β_1 and β_2. Simulate a single study with the negative contextual effect. Review the graphical displays for this single simulated study.

   Change the mixed model specification to directly estimate the contextual effect within your single simulated study. Specify the model below:

   Provide the estimate of and interpretation of the negative contextual effect from your single simulated study.

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