Benefits of Using Multilevel Models on Longitudinal Nested Data
A brief illustration using Pressley Ridge data

Ana Regina Andrade, Ph.D.

Pressley Ridge
Serving Children and Families Since 1832

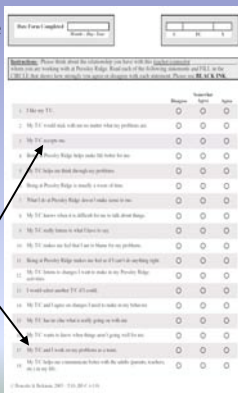Vanderbilt University

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Objective

The objective of this presentation is to compare two statistical methodologies.

The main message is this: when dealing with longitudinal nested data multilevel models are more appropriate statistical tools than simple traditional methods.

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Data at hand: Pressley Ridge Alliance Data

- This analysis uses alliance data collected in a partial hospitalization setting: Day School during the school year 2002-03.
- Each youth rated his/her relationship with the Teacher Counselor about once a month.
- Type of measure: Therapeutic Alliance Questionnaire is 30-item, 3-point scale.
- Youth Alliance rating is the mean of non-missing 20 items.
- Youth are assigned to classrooms; each class has 10-15 youth ➔ nested data.

Day School: Alliance Data Structure

Josh has 4 youth alliance repeated measures

Josh ID 1001

Amy ID 1002

Amy has 5 youth alliance repeated measures

Alliance Day School Data: Longitudinal -Nested

Data at hand:
- Each youth had a different number of repeated alliance measures: longitudinal data.

- Children are not randomly distributed –they are clustered in classrooms based on their main diagnoses, age, academic level, etc.

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What do we want to know?

1. Did the relationship get better/worse over time? Was there any change? We want to determine each child's growth trajectory – its shape and growth rate.

2. Was change the same or was it different across individuals?

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Let's use Traditional Methods
Ordinary Least Square Methods (OLS)

Traditional methods like OLS are simple to use.

OLS fits a linear equation where the goal is to estimate averages chosen to minimize the distances between real data (dots) and estimated line:

$$TA = \theta_0 + \theta_1 Time + M$$

Results of traditional approach:
Youth Alliance= 2.4 - .003*Month
p-values   0.001   0.59

$\theta_0 \rightarrow$ **Intercept = 2.4**

Youth Alliance — Traditional Least Square Methods

Dots show actual alliance ratings

Time in Months

$\theta_1 \rightarrow$ **Slope = on average no change**

But we want to measure each child's trajectory – see how different they are

This animated graph on the right shows the alliance ratings of 6 youths to illustrate how unique and different each child sees the alliance with his/her teacher counselor.

Youth 1001: started w/high alliance but then it decreased a little

Youth 1004 reported an unfavorable alliance at the beginning of the school year but it improved significantly over time.

Youth 1003 started with a very high alliance and it did not change much over time.

Youth Alliance — Reported Data

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Traditional Methods
Advantages & Disadvantages

Easy to use

Unrealistic assumptions of OLS when using longitudinal nested data

– Individuals are not drawn from simple random samples
– Independence is violated: children are clustered in classrooms based in their MH diagnoses, age, and academic level
– Measures of alliance per youth are correlated across occasions ➔ making the error variance differ over each occasion within each child.

Do not sweep the problems/limitations of OLS under the rug/rock!

OLS problems

Traditional Least Squares Methods ➔ good for exploratory purposes when dealing with repeated measures and nested data but the results are misleading ➔ you can reach the wrong conclusions.

Let's use Multilevel Models (MLM)

Why? Multilevel models are ideal for studying change, they deal with longitudinal and nested data.

Multilevel

MLM answers what we want to know:
1. Estimate a trajectory for each youth – *level 1*
2. Estimate whether the trajectory shapes & slopes are the same across youths – *level 2*

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Comparing MLM vs. Traditional Methods

Estimated Coefficients	Multilevel Method	Interpretation from MLM	Traditional Least Sq
Intercept	2.34***	On average, children started above Neutral	2.34***
Slope/rate of change	-0.004	On average, there is no change	-0.003
Variance Component			
Level 1 - Within-individual youth	0.20***	Children have different trajectories	0.32***
Level 2 - Differences across individuals			
When School starts –	0.16***	Alliance at beginning of school differ among youth.	n/a
Slope/Rate of change -	0.0001**	Some children's alliance improve - others don't change.	n/a
Covariance between Intercept & Slope	-0.008*	Some started low-improved, others went down.	n/a

*** = p=0.001; ** = p=0.05, * = p=0.1

**Information not given by OLS**

OLS ignores individual differences

Estimating Individual Trajectories using Multilevel Models

➢ Children are individuals.

➢ MLM lets us estimate each child's individual trajectory
  ● Shapes of growth curves are different
  ● Rate of change differs across individuals.

Youth Alliance — Multilevel Methods

Time in Months

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MLM Results Showing Group of Children Improving their Alliance, Getting Worse, No Change Over Time

➢ **67 percent of children reported a flat alliance with no change over time.**
➢ **17 percent reported an increasing alliance, the relationship got better (blue line).**
➢ **Remaining 16 percent said their relationship with her/his teacher counselor deteriorated over time (red line).**

Day School Youth Alliance

Red = Decreasing TA Black = Flat TA Blue = Increasing TA
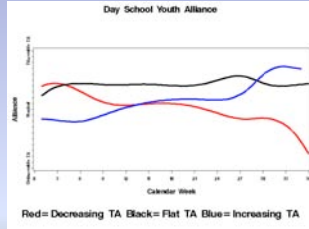
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Conclusions

➢ MLM ideal to capture each child's uniqueness and measure individual trajectories – growth curves.

➢ MLM ideal to capture differences across youths.

➢ Traditional approaches cannot handle longitudinal nested data – the results are misleading.

➢ Multilevel Models provide additional information not available in traditional methods.

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