Department of Epidemiology and Public Health
Miller School of Medicine
University of Miami

BST 630 (3 Credit Hours)
Longitudinal and Multilevel Data
Wednesday-Friday 9:00 – 10:15PM
Course Location: CRB 995

Course Instructor

Name: Daniel J. Feaster, Ph.D.
Office Phone: (305) 243-7881
E-mail: dfeaster@miami.edu
Office Location: CRB 1059
Office Hours: by appointment

Course Prerequisites
EPI 501 and EPI 502, familiarity with the linear statistical model and ability to use a statistical analysis package such as SAS/STATA/SPSS/MPLUS

Course Description
This course will offer students an introduction to linear and generalized linear models for the analysis of multilevel and longitudinal medical and public health data. The course will also provide students with the opportunity to develop the skills necessary to perform analysis of these types of data using statistical software packages.

Course Objectives
Upon completion of this course, the student will be able to

- Fit statistical models to longitudinal data: predicting the relationship between a specific outcome over time and a set of covariates
- Assess the fit of longitudinal models and design statistical test of significance of effects
- Understand the different model selection strategies for longitudinal data
- Use statistical software (e.g., SAS, Mplus) to analyze linear and generalized linear models for longitudinal data
- Understand the concept of statistical power and its application to statistical models involving longitudinal data
- Understand ethical issues involved with analysis and interpretation of longitudinal models

Overview of course structure and policies
The class will meet twice per week for one hour and 20 minutes. The class sessions will consist of lectures, class discussions, assignments, and examinations. Students are responsible for reading and completing all assignments prior to class. Students will be graded on class participation, their presentations of their homework (see Homework Assignments, below) exams, and a final paper.

Required Readings
1) Fitzmaurice, GM, Laird NM, & Ware JH. Applied Longitudinal Analysis, 2nd Ed. Wiley, 2011. ISBN 978-0-470-38027-7
2) Articles will be assigned for reading throughout the course of the semester and will be available on Blackboard.

3) Optional Readings from Hedeker, D. & Gibbons, R. D. Longitudinal Data Analysis. Wiley-Interscience, 2006.

Software

SAS 9.3 for Windows and Mplus V7 will be used during the semester to illustrate how to analyze data using a statistical software package.

Exams

Exams and homework presentations will assess how well students are meeting the course objectives. Exams will focus on both theory and applications of statistical models. To complete the exams students will need to have a (non-graphing) calculator. There will be 1 midterm and a final. Students will be allowed 75 minutes to complete the mid-term. All exams will count toward the students' final grades. Make-up exams will not be provided unless there is **documented evidence of an emergency** (e.g., hospitalization due to severe illness). Missed exams without documented evidence of an emergency will be scored as a zero.

Homework Assignments

Students will be given an example dataset by the instructor that the student will use throughout the semester for assignments and presentations. This data is for use in homework only, and the copy of the data is to be destroyed at the end of the class. For each of the methods introduced in class, every student is responsible for specifying a model with pre-specified hypotheses, estimating that model (and testing the hypotheses) and writing a brief summary of results using the dataset provided. There will be 4 times when these projects will be collected throughout the semester (see timeline below). At the 4 times that homework are due, 3-5 students will be chosen at random to present their analyses and results (from the homework) in front of the class. Depending on enrollment, students should expect to present at least twice during the semester and if possible up to 4 times. Presentations should be at most 10 minutes.

Attendance

Class attendance is required and necessary to complete the (randomly chosen) student presentations. Students are expected to actively participate in class.

Student Conduct

Students are responsible for knowing and complying with all University of Miami Policies and Regulations which are listed in the Student Handbook.

Grading

A	92.6-100%	C	72.6-76.5%
A-	89.6-92.5%	C-	69.6-72.5%
B+	86.6-89.5%	D+	66.6-69.5%
B	82.6-86.5%	D	62.6-66.5%
B-	79.6-82.5%	D-	59.6-62.5%
C+	76.6-79.5%	F	59.5-0%

Final Grades will be determined based on the following percentages:

Midterm: 30%
Final Exam: 40%
Homework and Presentation of Homework in Class: 30%

Tentative Course Schedule

Course Session	*Date*	**LINEAR MODEL EXTENSIONS for LONGITUDINAL DATA** *Topics and Assigned Reading*
1	16-Jan	**Course Introduction and Repeated Measures Example** Including ethical aspects of ensuring analysis method fits the data **FLW** Chapters 1 & 2
2	18-Jan	**Matrix Algebra Review** **Review Linear Model and adapt for Longitudinal Data** **FLW** Chapter 3
3	23-Jan	**Repeated Measures ANOVA**
4	25-Jan	**Mixed Models Estimation and Inference** **FLW** Chapter 4
5	30-Jan	**Modeling the Mean: Response Profiles** **FLW** Chapter 5
6	1-Feb	**Modeling Response Trajectories** **FLW** Chapter 6
7	6-Feb	**Modeling the Mean and Choosing a Structure for Covariance Matrices: Compound Symmetry, Autoregressive errors, and other Structures** **FLW** Chapter 7 Grady, J. J. & Helms, R. W. (1995). Model selection techniques for the covariance matrix for incomplete longitudinal data. *Statistics in Medicine, 14*, 1397-1416. Jennrich R.I. & Schlucter, M. D. (1986). Unbalanced repeated measures models with structured covariance matrices. *Biometrics, 42, 805-820* Schluchter, M. D. (1988). Analysis of Incomplete Multivariate Data using Linear Models With Structured Covariance Matrices. Statistics in Medicine, 7, 317-324.

Course Session	*Date*	**MIXED MODEL APPROACHES TO LONGITUDINAL ANALYSIS** *Topics and Assigned Reading*
8	8-Feb	**Student Presentations of Progress on Handed In Homework 1**
9	13-Feb	**CONTRASTS**
10	15-Feb	**HOMEWORK 1 DUE** **Mixed Model Approach to Growth Curve Estimation: Random Coefficients, Random Intercepts and Random Time Paths using the Hierarchical Modeling Approach** **FLW**: Chapter 8 Laird, N. M. & Ware, J. H. (1982). Random Effects Models For Longitudinal

Feaster, Daniel 2/15/13 10:44 AM
Formatted Table

		Data. *Biometrics*, 38, 963-974. Singer, JD. (1998). Using SAS Proc Mixed to fit multilevel models, hierarchical models and individual growth models. *Journal of Educational and Behavioral Statistics*, 24, 323-355. Francis, D. J., Fletcher, J. M., Stuebing, K. K., Davidson, K. C., & Thompson, N. M. (1991). Analysis of Change: Modeling Individual Growth. *Journal of Consulting and Clinical Psychology,* 59, 27-37 **Orthogonal Coding** Beisanz, JC, Deeb-Sossa, N, Papadakis, AA, Bollen KA & Curran PJ. (2004). The role of coding time in estimating and interpreting growth curve models. *Psychological Methods, 9*, 30-52.
11	20-Feb	**Empirical Bayes Estimates (BLUPs and EBLUPS)** Hui, S. L. & Berger, J. O. (1983). Empirical Bayes Estimation of Rates In Longitudinal Studies. *Journal of the American Statistical Association*, 78, 753-760. Jiang, J. (2007). Linear and Generalized Linear Mixed Models and their Applications. NY: Springer. pp. 74-80. **Residual Analysis and Diagnostics FLW:** Chapter 10
12	22-Feb	**FIXED EFFECTS versus RANDOM EFFECTS-ECONOMETRIC View** FLW: Chapter 9
13	27-Feb	**Contextual Effects with A Family Data Example of Contextual Effects** Hofmann, D. A. (1997). An overview of the logic and rationale of hierarchical linear models. *Journal of Management*, 23, 723-744. Hofmann, D. A. & Gavin, M. B. (1998). Centering decisions in hierarchical linear models: Implications for research in organizations. *Journal of Management*, 24, 623-641.F Feaster, D. J., Brincks, A.M., Robbins. M. S., & Szapocznik, J. Multilevel models to identify family contextual effects on individual family members' stress processes. *Family Process*, 50, 167-183 2011.
14	1-Mar	Class Participation Day
15	6-Mar	**Growth Curve Modeling: Latent Growth Factor Approach Using Structural Equations Modeling; REVIEW and Summary of RANDOM EFFECT MODELS for Longitudinal Data** Including an assessment of ethical issues around choice of model and reporting of the results Muthen B.O. & Khoo S. (1998). Longitudinal studies of achievement growth using latent variable modeling. *Learning and Individual Differences, 10*, 73-101.
16	8-Mar	Midterm
		Spring Break March 9-17

Course Session	*Date*	**Generalized Linear Mixed Models For Categorical and Count Data and Missing Data Issues** *Topics and Assigned Reading*
17	20-Mar	Review of Generalized Linear Models **FLW**: Chapter 11
18	22-Mar	**Marginal Models and Generalized Estimating Equations (GEE)** **FLW**: Chapters 12 & 13
19	27-Mar	**Generalized Estimating Equations (GEE) for Binary and Count Data** Liang, K. Y. & Zeger, S. L. (1986). Longitudinal data analysis using generalized linear models. *Biometrika*, 73, 13-22 Fitzmaurice, G. M., Laird, N. M., & Lipsitz, S. R. (1994). Analyzing Incomplete Longitudinal Binary Responses: A Likelihood-Based Approach. *Biometrics*, 50, 601-612.
20	29-Mar	**Intro to Generalized Linear Modeling of Multilevel Data** **Logit, Probit and Ordinal Models with Random Effects** Hedeker & Gibbons : Chapter 9 Hedeker, D. & Gibbons R. D. (1994). A random-effects ordinal regression model for multilevel analysis. Biometrics, 50, 933-944. Gibbons, R. D., & Hedeker, H., (1997), Random effects probit and logistic regression models for three-level data. Biometrics, 53, 1527-1537.
21	3-Apr	**Poisson & Negative Binomial Models with Random Effects** Hedeker & Gibbons: Chapter 12 Afifi, A. A., Kotlermena, J. B., Ettner, S. L., & Cowan M. (2007). Methods for improving regression analysis of skewed countinuous or counted responses. Annual Review of Public Health, 28, 95-111. Cook, J. D. (2009). Notes on the Negative Binomial Distribution. Downloaded from //www.johndcook.com/negativebinomial.pdf. O'Hara, R. B. & Kotze, D. J. (2010). Do not log-transform count data. Methods in Ecology and Evolution, 1, 118-122.
22	5-Apr	**Excess Zeros** Delucchi KL, B. A. (7-7-2005). Methods for analysis of skewed data distributions in psychiatric clinical studies: working with many zero values. *Am J Psychiatry*. 161[7], 1159-1168. HOMEWORK 3 and Presentations 2nd half of class
23	10-Apr	**Truncated (Tobit) and Censored Models with Random Effects** Baser, O. Gardiner, J. C., Bradley, C. J., Yuce, H., & Given, C. (2006). Longitudinal Analysis of censored medical cost data. Health Economics, 15, 513-525.
24	12-Apr	**Zero-Inflation, Hurdle and Two-Part Models with Random Effects** Olsen M. K. & Schafer, J. L. (2001). A Two-Part Random-Effects Model for Semi-continuous Longitudinal Data. *Journal of the American Statistical Association*, 96, 730-745
25	17-Apr	**Missing Data Issues:** Including ethical issues in the reporting of how missing data was assessed and handled in analysis FLW: Chapters 17 & 18 Hedeker, D. & Gibbons, R. D. (1997). Application of random-effects pattern-

		mixture models for missing data in longitudinal studies. Psychological Methods, 2, 64-78. Little, R. J. A. (1993). Pattern-Mixture Models for Multivariate Incomplete Data. Journal of the American Statistical Association, 88, 125-134. Little, R. J. A. (1995). Modeling the Drop-Out Mechanism in Repeated-Measures Studies. Journal of the American Statistical Association, 90, 1112-1121 Little, R. J. A. & Wang, Y. (1996). Pattern-Mixture Models for Multivariate Incomplete Data with Covariates. Biometrics, 52, 98-111. Schafer, J. L. & Graham, J. W. (2002). Missing Data: Our View of the State of the Art. Psychological Methods, 7, 147-177.
26	19-Apr	**Statistical Power Analysis for Linear Longitudinal Models** Including ethical issues in the preparation and implementation of study design Hedeker, Gibbons & Waternaux (1999). Sample size estimation for longitudinal designs with attrition: Comparing time-related contrasts between two groups. *Journal of Educational and Behavioral Statistics,* 24, 70-93
27	24-Apr	**Catch-up/Make-up**
28	26-Apr	Final Homework and Presentations for 1st half of class **Review**