

**Biostatistics 537: Longitudinal Data Analysis - Fall 2024**

Room B34 SPHPI      Tuesday & Thursday 10 - 11:45 am

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Office hours:      M W 3-5, F 1-3

Text:      Hedeker & Gibbons (2006) Longitudinal Data Analysis

Notes & handouts:      uic.blackboard.com

Computer programs:      PROC GLM, MIXED, GENMOD, GLIMMIX, NLMIXED, IML in SAS

Homework:      6 problem sets (60% of grade). Submit on BlackBoard. Computer output must be edited, only relevant portions submitted with original written discussion.

Exam:      Final Exam - take home (40% of grade - comprehensive). Submit on BlackBoard.

**Prerequisites** BSTT 523 and 536, or consent of the instructor. For consent, students must have thorough knowledge of multiple regression and ANOVA modeling, some knowledge of matrix algebra, logistic regression, and be **fluent** in SAS.

**Learning Objectives** Students will learn about statistical techniques for analyzing longitudinal, or repeated measures, data. The course will focus primarily on application of the statistical models using standard statistical software. Thus, students who complete the course will learn how to analyze longitudinal data and interpret the results from such analysis.

**Topics Addressed** The course will also cover the underlying statistical theory of models for longitudinal data analysis, including derivation and estimation of model parameters. Some of the models and topics for longitudinal data analysis that will be covered include the following:

- Univariate and multivariate analysis of variance for repeated measures
- Random or mixed-effects models (aka HLM or multilevel models)
- Covariance pattern models
- Generalized estimating equations (GEE) models
- Mixed-effects logistic regression models
- Missing data in longitudinal studies

## Student Responsibilities and Resources

**Academic Integrity Statement** Academic dishonesty is an offense against the University and I am obligated to report any incident to the Associate Dean for Academic Affairs. Academic dishonesty includes (but is not limited to): cheating or assisting someone else in academic dishonesty, plagiarism, unauthorized possession of class materials (e.g., tests, reserve materials), and unauthorized changing of one's grade. Students are encouraged to consult their instructor on rules for proper citation, or website sources such as

<http://www.library.illinois.edu/ugl/howdoi/citations.html>

Two excellent sources which define plagiarism and how to avoid it may be found at:

<http://www.indiana.edu/~wts/pamphlets/plagiarism.shtml>

<http://owl.english.purdue.edu/owl/resource/589/01/>

Students are also strongly encouraged to review UIC's Guidelines on Academic Integrity at

<http://www.uic.edu/depts/dos/studentconduct.html>

and the School of Public Health's Student Honor Code at

<http://publichealth.uic.edu/media/uicedu/sph/studenthandbooks/2014-2015/>

[SPH,Academic,Policies,and,Procedures,Handbook,2022-2023.pdf](#)

**Special Accommodation** If you require special accommodation because of a disability you must register with the UIC Disability Resource Center, and notify me of the required accommodation at the beginning of the semester. (See: [http://www.uic.edu/depts/oaa/disability\\_resources/index.html](http://www.uic.edu/depts/oaa/disability_resources/index.html).) If you have emergency medical information to share with me, or if you need special arrangements in case the building must be evacuated, please inform me immediately. Please see me privately after class, at my office, or email me.

**Mutual Tolerance and Respect** Mutual Respect and Tolerance Statement: Public health deals with controversial issues from multiple perspectives and consideration of these issues may cause disagreements among us or may evoke strong personal feelings, depending on our individual experience, histories, identities and worldviews. Therefore, in all of our interactions and communications, it is important that we strive to have mutual respect and tolerance for one another and for any course guests and members of the community with whom we come into contact. If you feel you have been offended by any content or interactions, you are encouraged to discuss this with the instructor or another faculty member.

## Approximate Schedule

Week	Date	Topic	HW Due
1	8/27 8/29	Introduction Univariate ANOVA - 1 group	
2	9/3 9/5	Univariate ANOVA - multi group Sphericity assumption. Intro to MANOVA	
3	9/10 9/12	MANOVA - 1 groups MANOVA - multi groups	HW1
4	9/17 9/19	Mixed-Effects Reg Models (MRM) Intro MRM multilevel representation	HW2
5	9/24 9/26	MRM Empirical Bayes Estimates MRM time-varying covariates	
6	10/1 10/3	MRM Orthogonal Polynomials MRM estimation and tests	HW3
7	10/8 10/10	Covariance pattern models MRM with autocorrelated errors	
8	10/15 10/17	MRM Var-Cov structure model selection MRM for dichotomous responses: Intro	HW4
9	10/22 10/24	Dichotomous MRM: Example Dichotomous MRM: Estimation	
10	10/29 10/31	GEE models for dichotomous responses Comparison of GEE and MRM	HW5
11	11/5 11/7	GMRM for ordinal responses Proportional Odds Assumption	
12	11/12 11/14	GMRM for nominal responses Nominal responses example	HW6
13	11/19 11/21	Missing data in longitudinal studies Pattern Mixture Models for missing data	
14	11/26 11/28	Pattern mixture and selection models Thanksgiving (no class)	
15	12/3 12/5	Sample size calculation R for Longitudinal Data	
16	12/9	<b>Final exam is due on Monday 12/9</b>	Final

*Some texts and collections:*

- Brown H. & Prescott R. (1999). *Applied Mixed Models in Medicine*. New York: Wiley.
- Collins L. & Sayer A.G. (Eds.) (2001). *New Methods for the Analysis of Change*. Washington, DC: APA Press.
- Davis C.S. (2002). *Statistical Methods for the Analysis of Repeated Measurements*. New York: Springer.
- Demidenko E. (2004). *Mixed Models: Theory and Applications*. New York: Wiley.
- Diggle P.J., Heagerty, P., Liang K.-Y., & Zeger, S.L. (2002). *Analysis of Longitudinal Data, 2nd edition*. New York: Oxford University Press.
- Fahrmeir L. & Tutz G. (1994). *Multivariate Statistical Modelling Based on Generalized Linear Models*. New York: Springer-Verlag.
- Fitzmaurice G.M., Laird, N.M. & Ware J. H. (2004). *Applied Longitudinal Analysis*. New York: Wiley.
- Frees E. W. (2004). *Longitudinal and Panel Data: Analysis and Applications in the Social Sciences*. New York: Cambridge University Press.
- Goldstein H. (2003). *Multilevel Statistical Models, 3rd edition*. London: Edward Arnold.
- Hand D. & Crowder M. (1996). *Practical Longitudinal Analysis*. New York: Chapman and Hall.
- Hardin J. W. & Hilbe J. M. (2002). *Generalized Estimating Equations*. New York: Chapman and Hall/CRC.
- Hsiao C. (2003). *Analysis of Panel Data, 2nd edition*. Cambridge: Cambridge University Press.
- Hox J. (2002). *Multilevel Analysis Techniques and Applications*. Erlbaum: Mahwah, New Jersey.
- Jones B. & Kenward M.G. (2003). *Design and Analysis of Cross-Over Trials*. New York: Chapman and Hall/CRC.
- Jones R.H. (1993). *Longitudinal Data with Serial Correlation: A State-Space Approach*. New York: Chapman and Hall.
- Longford N. (1993). *Random Coefficient Models*. New York: Oxford University Press.
- Lindsey J.K. (1999). *Models for Repeated Measurements, second edition*. New York: Oxford University Press.
- McCulloch C.E. & Searle S.R. (2001). *Generalized, Linear, and Mixed Models*. New York: Wiley.
- Molenberghs G. & Verbeke G. (2005). *Models for Discrete Longitudinal Data*. New York: Springer-Verlag.
- Moskowitz D.S. & Hershberger S.L. (Eds.) (2002). *Modeling Intraindividual Variability with Repeated Measures Data*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Pinheiro J.C. & Bates D.M. (2000). *Mixed-Effects Models in S and S-PLUS*. New York: Springer-Verlag.
- Raudenbush S. W. & Bryk A. S. (2002). *Hierarchical Linear Models, 2nd edition*. Thousand Oaks, CA: Sage.
- Singer J.D. & Willett J.B. (2003). *Applied Longitudinal Data Analysis*. New York: Oxford University Press.
- Skrondal A. & Rabe-Hesketh S. (2004). *Generalized Latent Variable Modeling*. New York: Chapman & Hall.
- Snijders T. & Bosker R. (1999). *Multilevel Analysis*. Thousand Oaks, CA: Sage.
- Twisk J.W.R. (2003). *Applied Longitudinal Data Analysis for Epidemiology*. New York: Cambridge University Press.
- Verbeke G. & Molenberghs G. (2000). *Linear Mixed Models for Longitudinal Data*. New York: Springer-Verlag.