University of Maryland School of Public Health

EPIB 655: Longitudinal Data Analysis

Semester:	Fall 2016
Section:	0101
Classroom and Time:	0227 SPH Building / Tuesday 1:00 PM – 3:45 PM
Course Webpage:	https://umd.instructure.com/courses/1200744
Instructor:	Xin He, Ph.D.
Office:	2234H SPH Building
Office Hours:	Tuesday 10:00 AM – 12:00 PM or by appointment
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Course Description:

This course covers statistical models for drawing scientific inferences from longitudinal data, longitudinal study design, and repeated measures. Modern methods for the analysis of repeated measures, correlated outcomes, and longitudinal data are included. It is intended for students with an interest in the analysis of longitudinal data and the emphasis will be on practical applications of statistical methods in the health sciences.

Course Prerequisites:

EPIB 650 *Biostatistics I* and EPIB 651 *Biostatistics II* or permission of instructor.

Course Learning Objectives:

Upon completing this course, the student will be able to:

1. Identify features of longitudinal data and understand the potential sources of correlation in longitudinal studies.
2. Prepare graphical or tabular displays of longitudinal data that effectively communicate the patterns of scientific interest.
3. Use linear models to make inferences about the relationship between response and explanatory variables while accounting for the correlation among repeated responses for an individual.
4. Use generalized linear mixed effects models or marginal models to analyze outcome data that are discrete or continuous.
5. Apply appropriate methods for handling missing data and dropout in longitudinal studies.
6. Use SAS to conduct an appropriate longitudinal data analysis.

Program Competencies Addressed in this Course:

The following competencies for the *Master of Public Health with concentration in Biostatistics* are addressed in this course:

1. Distinguish among the different measurement scales or types of variables and select appropriate descriptive statistical methods for summarizing public health data.
2. Select appropriate inferential statistical methods to answer research questions relevant to public health research.
3. Conduct descriptive and inferential statistical analyses that are appropriate to different basic study designs used in public health research.
4. Interpret results of statistical analyses found in public health studies.
5. Critically review and summarize statistical analyses presented in public health literature.

6. Perform appropriate sample size and power calculations to ensure that the study is sufficiently powered to achieve the scientific aims.
7. Use a basic software package to describe, explore, and summarize data as well as perform the basic conventional statistical procedures.
8. Identify limitations in public health studies.
9. Communicate results of statistical analyses to lay and professional audiences.

Required Texts and Other Readings:
   Required:
   - Fitzmaurice, G. M., Laird, N. M., and Ware, J. H. (2011). *Applied Longitudinal Analysis*, 2nd Edition. New York: Wiley. [ISBN: 978-0-470-38027-7]
   Recommended:
   - Diggle, P. J., Heagerty, P., Liang, K.-Y., and Zeger, S. L. (2002). *Analysis of Longitudinal Data*, 2nd Edition. New York: Oxford University Press. [ISBN: 978-0-19-852484-7]
   - Littell, R. C., Milliken, G. A., Stroup, W. W., Wolfinger, R. D., and Schabenberber, O. (2006). *SAS for Mixed Models*, 2nd Edition. SAS Institute, Cary, NC. [ISBN: 978-1590475003]
   - Verbeke, G. and Molenberghs, G. (2000). *Linear Mixed Models for Longitudinal Data*. New York: Springer. [ISBN: 978-1-4419-0299-3]

Course Requirements:

   Homework:
   There will be five homework assignments in this class, and each of them will be due at the beginning of the due date class. **Late homework will NOT be accepted without a reasonable and advance notice.**

   Exam:
   There will one in-class midterm exam which is closed book and closed note. You are allowed to bring a maximum of TWO pages of letter-size formula sheet. A calculator is required for the exam.

   As a general rule, make-up exams and advance exams will NOT be given. Exceptions to this rule are evaluated on a case-by-case basis. Students must submit the request before the exam takes place with valid supporting document. No post-exam request will be considered except the student is hospitalized during the exam period.

   Project:
   The project in this course accounts for a significant portion (40%) of the grade and should represent student's understanding of longitudinal data analysis. Each student will be responsible for finding a real data set from a longitudinal study, clearly stating the purpose of the analysis, carrying out the requisite analysis relative to that purpose, writing a report, and giving a 15-minute in-class presentation.

   Course Website:
   Course announcements, lecture notes, data sets, SAS programs, and homework assignments will be distributed on the course webpage (https://umd.instructure.com/courses/1200744). Please check it on a regular basis. Lecture notes will be posted before class. You may wish to print these notes prior to each lecture and use them as an outline for taking notes during the class.

Course Policies:

Email – The Official University Correspondence:
Verify your email address by going to *www.my.umd.edu.*

All enrolled students are provided access to the University's email system and an email account. *All official University email communication will be sent to this email address* (or an alternate address if provided by the student). Email has been adopted as the primary means for sending official communications to students, so email must be checked on a regular basis. Academic advisors, faculty, and campus administrative offices use email to communicate important and time-sensitive notices.

Students are responsible for keeping their email address up to date or for redirecting or forwarding email to another address. Failure to check email, errors in forwarding email, and returned email (from "full mailbox" or "unknown user" errors for example), will not excuse a student from missing University announcement, messages, deadlines, etc. Email addresses can be quickly and easily updated at *http://www.my.umd.edu* or in-person at the Student Service Counter on the first floor of the Mitchell Building.

For technical support for University email: *www.helpdesk.umd.edu* or call 301-405-1400.

Absence Policy:
In accordance with University policy if you are absent for a single (1) lecture due to illness or some form of personal or family emergency, this absence will be considered "excused" and the instructor will accept a note from you attesting to the date of the illness/incident, along with an acknowledgement that the information is true. Whenever feasible, you should try to contact the instructor in advance.

Multiple or prolonged absences, and absences that prevent attendance at a major scheduled grading event (like an exam or test) will require written documentation from an appropriate health care provider/organization.

A link to pull information on the new policy covering absences from class can be found at *http://www.president.umd.edu/policies/v100g.html*.

Course Evaluations:
The University, the School of Public Health, and the Department of Epidemiology and Statistics are committed to the use of student course evaluations for improving the student experience, course and curriculum delivery, and faculty instruction. Your evaluations help instructors improve their courses; help deans and department chairs decide on merit pay for faculty, renewal of contracts, and support tenure and promotion decisions; and help current and future students decide on classes. Your participation in the evaluation of courses through CourseEvalUM is a responsibility you hold as a student member of our academic community. Your feedback is confidential and important to the improvement of teaching and learning at the University as well as to the tenure and promotion process. CourseEvalUM will be open for you to complete your evaluations starting about two weeks prior to the last day of the term before exams begin. Please go directly to the website (*www.CourseEvalUM.umd.edu*) to complete your evaluations. By completing all of your evaluations each semester, you will have the privilege of accessing online evaluation reports for the thousands

of courses for which 70% or more students submitted their evaluations. You can access results at *www.CourseEvalUM.umd.edu*, the same link you use to submit your evaluations. Click View Past Results instead.

Grading Procedures:

Grade of this course will be determined as follows:
- Homework: 30%
- Midterm Exam: 30%
- Project: 40%

Course Outline / Course Calendar:

		Tentative Course Outline *				
Session Number	**Date**	**Topic**	**Assignments**
1	08/30/2016	Introduction to Longitudinal and Clustered Data	Chapters 1 & 2
2	09/06/2016	Univariate Repeated Measures Analysis of Variance; Overview of Linear Models for Longitudinal Data	Chapters 2 to 4 Homework 1 (Due date: 09/13/2016)
3	09/13/2016	Statistical Inference of Linear Models; Modeling the Mean: Analyzing Response Profiles	Chapters 4 & 5 Homework 2 (Due date: 10/04/2016)
4	09/20/2016	Modeling the Mean: Analyzing Response Profiles and Parametric Curves	Chapters 5 & 6
5	09/27/2016	Modeling the Mean: Parametric Curves; Modeling the Covariance	Chapters 6 & 7
6	10/04/2016	Linear Mixed Effects Models (I)	Chapters 8 & 9 Homework 3 (Due date: 10/18/2016)
7	10/11/2016	Linear Mixed Effects Models (II)	Chapters 8 & 9
8	10/18/2016	Review of Generalized Linear Models; Marginal Models and the Method of GEE (I)	Chapters 11, 12 & 13

9	10/25/2016	Marginal Models and the Method of GEE (II)	Chapters 13 & 14 Homework 4 (Due date: 11/01/2016)
10	11/01/2016	Generalized Linear Mixed Effects Models (I)	Chapter 14 Homework 5 (Due date: 11/08/2016)
11	11/08/2016	Generalized Linear Mixed Effects Models (II); Review for Midterm Exam	Chapter 15
12	11/15/2016	Midterm Exam	
13	11/22/2016	Contrasting Marginal and Mixed Effects Models; Missing Data and Dropout	Chapters 16 & 17
14	11/29/2016	Sample Size Calculations for Longitudinal Studies	Chapter 20
15	12/06/2016	Class Presentation	

* This is a tentative schedule, and the actual materials covered in each lecture might not be exactly the same.

Required Session Outline	
Session 1	**08/30/2016**
Topic: Introduction to Longitudinal and Clustered Data Learning Objectives for Session 1 [Relevant Program Competencies: #1, #3, #7, #8] - Identify features of longitudinal data and understand the potential sources of correlation in longitudinal studies. - Prepare graphical or tabular displays of longitudinal data that effectively communicate the patterns of scientific interest. - Use SAS to conduct an appropriate longitudinal data analysis. Reading: Chapters 1 & 2	
Session 2	**09/06/2016**
Topic: Univariate Repeated Measures Analysis of Variance; Overview of Linear Models for Longitudinal Data Learning Objectives for Session 2 [Relevant Program Competencies: #2, #3, #4, #5, #7, #8] - Identify features of longitudinal data and understand the potential sources of correlation in longitudinal studies. - Use linear models to make inferences about the relationship between response and explanatory variables while accounting for the correlation among repeated responses for an individual. - Use SAS to conduct an appropriate longitudinal data analysis.	

Reading: Chapters 2 to 4

Homework 1 (Due date: 09/13/2016)

Session 3	**09/13/2016**

Topic: Statistical Inference of Linear Models; Modeling the Mean: Analyzing Response Profiles

Learning Objectives for Session 3 [Relevant Program Competencies: #2, #3, #4, #7]
- Identify features of longitudinal data and understand the potential sources of correlation in longitudinal studies.
- Use linear models to make inferences about the relationship between response and explanatory variables while accounting for the correlation among repeated responses for an individual.
- Use SAS to conduct an appropriate longitudinal data analysis.

Reading: Chapters 4 & 5

Homework 2 (Due date: 10/04/2016)

Session 4	**09/20/2016**

Topic: Modeling the Mean: Analyzing Response Profiles and Parametric Curves

Learning Objectives for Session 4 [Relevant Program Competencies: #2, #3, #4, #7]
- Identify features of longitudinal data and understand the potential sources of correlation in longitudinal studies.
- Use linear models to make inferences about the relationship between response and explanatory variables while accounting for the correlation among repeated responses for an individual.
- Use SAS to conduct an appropriate longitudinal data analysis.

Reading: Chapters 5 & 6

Session 5	**09/27/2016**

Topic: Modeling the Mean: Parametric Curves; Modeling the Covariance

Learning Objectives for Session 5 [Relevant Program Competencies: #2, #3, #4, #7]
- Identify features of longitudinal data and understand the potential sources of correlation in longitudinal studies.
- Use linear models to make inferences about the relationship between response and explanatory variables while accounting for the correlation among repeated responses for an individual.
- Use SAS to conduct an appropriate longitudinal data analysis.

Reading: Chapters 6 & 7

Session 6	**10/04/2016**

Topic: Linear Mixed Effects Models (I)

Learning Objectives for Session 6 [Relevant Program Competencies: #2, #3, #4, #7]
- Identify features of longitudinal data and understand the potential sources of correlation in longitudinal studies.
- Use linear models to make inferences about the relationship between response and explanatory variables while accounting for the correlation among repeated responses for an individual.
- Use SAS to conduct an appropriate longitudinal data analysis.

Reading: Chapters 8 & 9

Homework 3 (Due date: 10/18/2016)	
Session 7	**10/11/2016**

Topic: Linear Mixed Effects Models (II)

Learning Objectives for Session 7 [Relevant Program Competencies: #2, #3, #4, #7]
- Identify features of longitudinal data and understand the potential sources of correlation in longitudinal studies.
- Use linear models to make inferences about the relationship between response and explanatory variables while accounting for the correlation among repeated responses for an individual.
- Use SAS to conduct an appropriate longitudinal data analysis.

Reading: Chapters 8 & 9

Session 8	**10/18/2016**

Topic: Review of Generalized Linear Models; Marginal Models and the Method of GEE (I)

Learning Objectives for Session 8 [Relevant Program Competencies: #2, #3, #4, #7]
- Use generalized linear mixed effects models or marginal models to analyze outcome data that are discrete or continuous.
- Use SAS to conduct an appropriate longitudinal data analysis.

Reading: Chapters 11, 12 & 13

Session 9	**10/25/2016**

Topic: Marginal Models and the Method of GEE (II)

Learning Objective for Session 9 [Relevant Program Competencies: #2, #3, #4, #7]
- Use generalized linear mixed effects models or marginal models to analyze outcome data that are discrete or continuous.
- Use SAS to conduct an appropriate longitudinal data analysis.

Reading: Chapters 13 & 14

Homework 4 (Due date: 11/01/2016)

Session 10	**11/01/2016**

Topic: Generalized Linear Mixed Effects Models (I)

Learning Objective for Session 10 [Relevant Program Competencies: #2, #3, #4, #7]
- Use generalized linear mixed effects models or marginal models to analyze outcome data that are discrete or continuous.
- Use SAS to conduct an appropriate longitudinal data analysis.

Reading: Chapters 14

Homework 5 (Due date: 11/08/2016)

Session 11	**11/08/2016**

Topic: Generalized Linear Mixed Effects Models (II); Review for Midterm Exam

Learning Objectives for Session 11 [Relevant Program Competencies: #2, #3, #4, #7]
- Use generalized linear mixed effects models or marginal models to analyze outcome data that are discrete or continuous.
- Use SAS to conduct an appropriate longitudinal data analysis.

Reading: Chapters 15

Session 12	**11/15/2016**

Midterm Exam

Session 13	11/22/2016

Topic: Contrasting Marginal and Mixed Effects Models; Missing Data and Dropout

Learning Objective for Session 13 [Relevant Program Competencies: #2, #3, #4, #5, #7, #8]
- Use generalized linear mixed effects models or marginal models to analyze outcome data that are discrete or continuous.
- Apply appropriate methods for handling missing data and dropout in longitudinal studies.
- Use SAS to conduct an appropriate longitudinal data analysis.

Reading: Chapters 16 & 17

Session 14	11/29/2016

Topic: Sample Size Calculations for Longitudinal Studies

Learning Objective for Session 14 [Relevant Program Competencies: #2, #3, #4, #5, #6, #7, #8]
- Use linear models to make inferences about the relationship between response and explanatory variables while accounting for the correlation among repeated responses for an individual.
- Use generalized linear mixed effects models or marginal models to analyze outcome data that are discrete or continuous.
- Use SAS to conduct an appropriate longitudinal data analysis.

Reading: Chapter 20

Session 15	12/06/2016

Topic: Class Presentation

Learning Objectives for Session 15 [Relevant Program Competencies: #1, #2, #3, #4, #5, #6, #7, #8, #9]
- Identify features of longitudinal data and understand the potential sources of correlation in longitudinal studies.
- Prepare graphical or tabular displays of longitudinal data that effectively communicate the patterns of scientific interest.
- Use linear models to make inferences about the relationship between response and explanatory variables while accounting for the correlation among repeated responses for an individual.
- Use generalized linear mixed effects models or marginal models to analyze outcome data that are discrete or continuous.
- Apply appropriate methods for handling missing data and dropout in longitudinal studies.
- Use SAS to conduct an appropriate longitudinal data analysis.

Assessment Activity	Learning Objectives Assessed with the Activity	Relevant Program Competencies
Homework 1	#1, #2, #3, #6	#2, #3, #4, #5, #7, #8
Homework 2	#1, #3, #6	#2, #3, #4, #7
Homework 3	#1, #3, #4, #6	#2, #3, #4, #7
Homework 4	#4, #6	#2, #3, #4, #7

Homework 5	#4, #6	#2, #3, #4, #7
Midterm Exam	#1, #2, #3, #4, #6	#1, #2, #3, #4, #7
Project	#1, #2, #3, #4, #5, #6	#1, #2, #3, #4, #5, #6, #7, #8, #9

Critical University Policies:

Religious Observances:
The University System of Maryland policy provides that students should not be penalized because of observances of their religious beliefs; students shall be given an opportunity, whenever feasible, to make up within a reasonable time any academic assignment that is missed due to individual participation in religious observances. **It is the student's responsibility to inform the instructor in advance of any intended absences for religious observance.**

Special Accommodations / Disability Support Services:
If you have a documented disability and wish to discuss academic accommodations for test taking or other needs, you will need documentation from Disability Support Service (301-314-7682). If you are ill or encountering personal difficulties, please let the instructor know as soon as possible. You can also contact Learning Assistance Services (301-314-7693) and/or the Counseling Center (301-314-7651) for assistance.

Academic Integrity:
The University's code of academic integrity is designed to ensure that the principle of academic honesty is upheld. Any of the following acts, when committed by a student, constitutes academic dishonesty:
- CHEATING: intentionally using or attempting to use unauthorized materials, information, or study aids in an academic exercise.
- FABRICATION: intentional and unauthorized falsification or invention of any information or citation in an academic exercise.
- FACILITATING ACADEMIC DISHONESTY: intentionally or knowingly helping or attempting to help another to violate any provision of this code.
- PLAGIARISM: intentionally or knowingly representing the words or ideas of another as one's own in any academic exercise.

For more information see: *http://www.shc.umd.edu/code.html*.

The Honor Pledge is a statement undergraduate and graduate students should be asked to write by hand and sign on examinations, papers, or other academic assignments. The Pledge reads:

I pledge on my honor that I have not given or received any unauthorized assistance on this assignment/examination.

The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at

Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit *http://www.shc.umd.edu*.

Inclement Weather / University Closings:
In the event that the University is closed for an emergency or extended period of time, the instructor will communicate to students regarding schedule adjustments, including rescheduling of examinations and assignments due to inclement weather and campus emergencies. Official closures and delays are announced on the campus website (*http://www.umd.edu*) and snow phone line (301-405-SNOW), as well as local radio and TV stations.