BIOS 6643

# Longitudinal Data Analysis

**Fall Semester 2021**

**Lecture info** M, W 10:30-11:50 AM, Room Ed2S L28-2306 (in person)

**Instructor**  Elizabeth Juarez-Colunga

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*Office hours* TBD

**TA**  Randy (Xin) Jin

**Approach to teaching the course**

You will be provided the set of course notes and lecture slides for the course. The textbooks mentioned below may be useful, but are considered optional and are not required. All notes and slides will be made available on Canvas; course notes are already posted, and slides will generally be posted at least a couple of days prior to lecture. **Please plan to review these slides before the lecture, and be prepared to ask and answer questions**. I like to make the lecture time as interactive as possible. I want to promote active learning, as opposed to passive learning. To help facilitate this, 5% of your grade is based on participation. **Note for 2021**: the class will be held in an in-person fashion. If there are any conflicts you might have for a particular day or in general, just let me know and we can work something out. I do plan to record the lectures, so if you have any conflicts, you will be able to view the lecture when you are able.

**A brief outline of the main topics for the course (see the calendar for more details)**

|  |  |
| --- | --- |
| 1. Introduction to longitudinal and clustered data 2. Review of GLMs and introductory LMMs 3. Linear mixed models advanced material 4. Generalized linear models 5. Generalized linear mixed models 6. Interpreting parameters in longitudinal models | 1. Missing data in longitudinal studies 2. MCMC 3. Special topics |

**Texts**

*BIOS 6643 course notes; these will be made available on Canvas.*

Some other references (asterisks on key texts):

1. *\*Longitudinal Data Analysis*, Hedeker and Gibbons, Wiley, 2006.
   1. Hedeker’s course web site: <http://www.uic.edu/classes/bstt/bstt513>.
   2. Hedeker’s program and data set web site: <http://www.uic.edu/~hedeker/long.html>.
2. *\*Linear Mixed Models for Longitudinal Data*; Verbeke and Molenberghs; Springer; 2000.
3. *Analysis of Longitudinal Data*; Diggle, Liang and Zeger; Oxford; 1996.
4. *Statistical Methods for the Analysis of Repeated Measurements*; Davis; Springer; 2002.
5. *Modeling Longitudinal Data*; Weiss; Springer; 2005.
6. *Applied Longitudinal Analysis, 2nd ed.*; Fitzmaurice, Laird and Ware; Wiley; 2011.
7. *Longitudinal data analysis*, Fitzmaurice, Davidian, Verbeke and Molenberghs, editors; 2009.
8. *Regression Methods in Biostatistics: Linear, Logistic, Survival, and Repeated Measures Models*, Vittinghoff, Glidden, Shiboski, McCulloch, 2012.
9. Linear / Matrix algebra: see GLM notes for references.

**Prerequisites:** BIOS 6611, 6612 or consent of instructors. (BIOS6631, 6632 Statistical Theory I and II recommended.)

**Computer programming**

The course uses SAS and R software. Although SAS is used a bit more, I am trying to integrate R more into the class. For more details, see the website <https://www.ucdenver.edu/offices/office-of-information-technology/software/sas>.

**Course objectives**

The main objective of the course is to learn about and be able to use longitudinal or clustered data models in appropriate situations. Primary objectives related to this main objective are listed below.

* To understand the theoretical foundations of general linear models and how they apply to models for longitudinal or clustered data.
* To have a basic understanding of classical methods of longitudinal (or clustered) data analysis.
* To understand and be able to use linear mixed models for modeling of longitudinal or clustered data.
* To become familiar with models for correlated non-normal outcomes.
* To recognize the differences between parametric and nonparametric models for longitudinal or clustered data.
* To get an initial understanding of advanced topics related to longitudinal data and methods.

**Course competencies**

*Competencies mapped to this course for assessment:* This course partially or fully addresses the followingMPH core knowledge and competencies, and is used for assessing achievement:

|  |  |
| --- | --- |
| MS-BIOS 4 | Carry out valid and efficient modeling, estimation, model checking and inference using standard statistical methods and software. |

This competency will be completed and assessed using class homework, quizzes, and the course project.

*Competencies mapped to this course for instruction:* This course fulfills a requirement for one or more programs and partially or fully addresses the following MPH core knowledge and competencies, but the primary assessment for these is in other coursework.

|  |  |
| --- | --- |
| MS-BIOS 7 | Communicate, orally and in writing, simple and complex statistical ideas, methods and results in non-technical terms appropriate for collaborator needs (e.g. preparation of analysis section of grant proposals and methods and results sections of manuscripts). |

This competency will be completed and assessed with the course project. (Final assessments are made with a class presentation and paper.)

**Integration of this Course with other Biostatistics courses:**

This course was previously taught in a sequence of courses (BIOS7711, which lead into BIOS7712 and 13). Although it has been taken out of that sequence, longitudinal and clustered data methods may be examined in BIOS7712, 7713 or other higher level courses. In this past, GLM theory was first reviewed, building on what students learned in BIOS6611 and 12. Starting in the last academic year, the BIOS6611 and 12 sequences were taught at a faster pace, so that more material originally in BIOS6643 went to those courses. We will do some review of GLMs and LMMs but will get into more advanced material more quickly.

**Academic Conduct Policy**

All students are expected to abide the Honor Code of the Colorado School of Public Health.  Unless otherwise instructed, all of your work in this course should represent completely independent work.  Students are expected to familiarize themselves with the Student Honor Code that can be found at <http://www.ucdenver.edu/academics/colleges/PublicHealth/resourcesfor/currentstudents/academics/Documents/PoliciesHandbooks/CSPH_Honor_Code.pdf> or in the Policies and Handbooks section under Student Resources of the ColoradoSPH website.  Any student found to have committed acts of misconduct (including, but not limited to cheating, plagiarism, misconduct of research, breach of confidentiality, or illegal or unlawful acts) will be subject to the procedures outlined in the CSPH Honor Code.

I encourage you to work together to a limited degree on homework. ‘To a limited degree’ means that you are actively participating in completing the homework, but the sharing of some ideas is o.k., especially at the brainstorming phase. Examinations will take place either in the classroom or remotely for a limited amount of time (e.g., 2 hours). There are no ‘take home’ exams. For all exams I expect that you do not consult with other people at all and that you only access and use materials that I have approved beforehand.

**Academic Integrity Course:** The ColoradoSPH requires students to complete an academic honesty online course. If you have not yet completed the online course, you must do so as soon as possible.

**Student evaluation**

The course will follow a **reading**, lecture and discussion format - students will be expected to participate in and lead discussion, and ask and answer questions. In addition, students will be required to work and submit several homework assignments that will include both theory exercises and application problems on the computer. All assignments should be organized neatly and typed. Homework assignments must be completed and turned in ***on time*** as required. Failure to accomplish this will result in a grade of Incomplete. You are encouraged to work together on these assignments, *but the work you submit must be your own*.

There will be three in-class quizzes (75 minutes). ***These are on the honor system (see next page) and are to reflect only your own work without the aid of others.*** No re-dos will be permitted on the exams.

During the last few weeks of class you will be required to make a 10-minute oral presentation of a data analysis project that will develop during the semester.

**Grading**

* Homework – 30%
* Quizzes – 3 at 15% each (75 minutes, in class)
* Data analysis project – 20%
* In class participation – 5%

**A final grade** will be assigned on a fixed (not “curved” scale):

Average Letter grade

94-100 A

90-93.99 A-

* + 1. B+

83-86.99 B

* + 1. B-

77-79.99 C+

73-76.99 C

70-72.99 C-

67-69.99 D+

* + 1. D
    2. D-

< 60 F

## Assignments/Homework

* There will be 6 or 7 assignments assigned.
* Detailed work is expected for full credit.
* I encourage discussion of assignment exercises with classmates if it helps, but do your own work.
* Please turn in work that is concise but complete. Put abbreviated SAS code and output at the end of the homework unless otherwise mentioned. (Abbreviated means trying to keep it down to a few pages rather than turning in 20 to 30 pages of output.)
* All assignments will be posted on the course web site.

**Quizzes**

* These will either be closed book or with 1 sheet of notes allowed.
* The quizzes will primarily focus on checking understanding of methods and concepts discussed in class and practiced with homework.

**Data analysis project**

* You will first find a real data set (e.g., from your work or hobby), analyze it using methods learned in this course, prepare and turn in a short report, and finally, give a brief presentation of your project.
* You will need to find your data by about the 2nd or 3rd week of class that involves clustered or longitudinal data. There will be questions I provide, to help guide you with the analysis.
* Presentations will be about 10 minutes per person, and I expect questions from students (re: participation grade). Aim to ask at least 2 questions during all of the presentations.

**ACKNOWLEDGMENTS**

Thank you to Dr. Matt Strand for sharing his comprehensive lecture notes and assignments.

**Inclusive Learning Environments**

In this class, we will work together to develop a learning community that is inclusive and respectful. Our diversity may be reflected by differences in race, age, sexual orientation, gender identity and expression, religion/spirituality, ability, socioeconomic background, and myriad other social identities and life experiences. In a diverse community, the goal of inclusiveness encourages and appreciates expressions of different ideas, opinions, and beliefs so that conversations and interactions are opportunities for intellectual and personal enrichment.

A dedication to inclusiveness requires respecting what others say, their right to say it, and the thoughtful consideration of others' communication. Both speaking up and listening are valuable tools for furthering thoughtful and enlightening dialogue. Respecting one another's individual differences is critical in transforming a collection of diverse individuals into an inclusive and collaborative learning community. We will hold ourselves and one another accountable, which includes bringing attention to times when microaggressions or macroaggressions happen in a classroom. Our core commitment shapes our core expectations for behavior inside and outside of the classroom. We encourage students to review the ColoradoSPH Equity, Diversity, and Inclusion Common Language and Commitment Statement <https://www1.ucdenver.edu/docs/librariesprovider151/default-document-library/edi-commitment-and-terms-5-11-21.pdf?sfvrsn=804479ba_0>

**Title IX: Non-Discrimination and Sexual Misconduct, Intimate Partner Violence, and Stalking**

**Non-Discrimination**

The ColoradoSPH and [University of Colorado Non-Discrimination Policy](https://www1.ucdenver.edu/docs/librariesprovider102/default-document-library/3054---nondiscrimination-policy.pdf?sfvrsn=651609b9_2) prohibits discrimination on the basis of race, color, national origin, sex, age, disability, pregnancy, creed, religion, sexual orientation, veteran status, gender identity, gender expression, political philosophy or political affiliation in admission and access to, and treatment and employment in, its educational programs and activities.

**Sexual Misconduct, Intimate Partner Violence, and Stalking**

The ColoradoSPH and University of Colorado [Sexual Misconduct, Intimate Partner Violence, and Stalking Policy](https://www.cu.edu/ope/aps/5014) prohibits conduct including sexual assault, dating violence, domestic violence, Title IX stalking, stalking, sexual exploitation, Title IX harassment, hostile environment, Title IX quid pro quo sexual harassment, and quid pro quo sexual harassment.

**ColoradoSPH Partner Campus Title IX Offices and Contact Information:**

Incidents of discrimination, sexual misconduct, intimate partner violence, and stalking should be reported to the **Title IX office of the university where the incident occurred**. Incidents involving microaggressions or incidents that may not otherwise rise to the level of a policy violation, may also be reported to the appropriate university Title IX office listed below. Please refer to the CU Anschutz campus Office of Equity website for a self-learning guide about [microaggressions](https://www1.ucdenver.edu/offices/equity/education-training/self-guided-learning/diversity-equity-and-inclusion-101#Microaggressions).

If you have any questions on clarity related to the reporting of incidents, please contact the **ColoradoSPH Title IX Liaison**, Dr. Danielle (Dani) Brittain, PhD. You can reach Dr. Brittain at [Danielle.Brittain@cuanschutz.edu](mailto:Danielle.Brittain@cuanschutz.edu).

**CU Anschutz Campus:** On the CU Anschutz campus, please contact the [Office of Equity](https://www1.ucdenver.edu/offices/equity). The Office of Equity staff, including the University’s Title IX Coordinator, may be reached at (303) 315-2567 or [equity@ucdenver.edu](mailto:equity@ucdenver.edu).

**Accommodations for Disabilities**

The University of Colorado Anschutz Medical Campus is committed to providing equitable access to our programs for students with disabilities (e.g., psychological, attentional, learning, chronic health, sensory, and physical).

To engage in a confidential conversation about the process for requesting reasonable accommodations in the classroom and clinical settings please contact The Office of Disability, Access, and Inclusion at: [disabilityaccess@cuanschutz.edu](mailto:disabilityaccess@cuanschutz.edu) or begin the process via the [website](https://www.cuanschutz.edu/offices/office-of-disability-access-and-inclusion)  Accommodations are not provided retroactively, therefore, students are encouraged to begin this process early.