PM511c: Correlated Data Analysis
Units: 4
Fall 2023
Location: SSB 116
Lecture: 9-10:55am
Lab: 11-12:55pm

Instructor: Sandy Eckel, PhD
Associate Professor, Division of Biostatistics
Director, PhD Program in Biostatistics
Office: SSB-202B
Office Hours: By appointment. Email me to schedule.
Contact Info: eckel@usc.edu (expect replies ≤1 business day)

Teaching Assistants:
TBA, email TBA

IT Help: George Martinez
Hours of Service: Weekdays, 8am-4pm
Contact Info: georgem@usc.edu
Blackboard help: Call 213-740-5555 and choose option 2 to receive assistance 24 hours a day, 365 days a year.

Course Description
This course introduces regression methods for correlated data, including longitudinal and multilevel data. Correlated data violate the usual independence assumption in regression models. In typical multilevel data, the predictor and the outcome variables occur at multiple levels of aggregation (e.g., at the person, family, town, and/or regional levels). Multilevel models account for the correlation induced by the clusters at each level and can be used to quantify associations of the outcome with factors at each level. Longitudinal data arises from studies with repeated measurements on participants. Depending on research goals, the within-person correlation can be addressed in generalized estimating equation (GEE) models or mixed models. Growth curve models focus on modeling trends over time. The audience for this course includes second year and beyond Biostatistics graduate students as well as graduate students from other Divisions, Departments, or Schools interested in analyzing correlated data for their research.

Learning Objectives
Upon successfully completing this course, students will be able to:

- Interpret parameters of multilevel/longitudinal models
- Translate substantive questions into the form of a multilevel/longitudinal model
- Use the R statistical software package to: prepare graphical and tabular displays of multilevel/longitudinal data that effectively communicate the patterns of scientific interest, and to fit multilevel/longitudinal models
- Critique multilevel/longitudinal data analyses published in the biomedical literature
- Write methods and results sections summarizing multilevel/longitudinal data analyses, as if for a manuscript

Prerequisite(s): PM511b; open to other students by consent of instructor
Recommended Preparation: Coursework in concepts and applications of Generalized Linear Models.
Course Notes
This course is taught in a traditional on-ground format with live in-person lecture, followed by live in-person lab. Should you be unable to attend the live in-person course session (e.g., due to COVID), please notify the instructional team (email Dr. Eckel and the TA). Please do not attend class if you are feeling unwell. We aim to make the course accessible by zoom as a backup (not primary) mode of attendance. Recordings from a prior version of this class are also available.

This 4 unit course is taught during the 15 week Fall semester, according to the following USC rules:
- Minimum required weekly contact time (e.g., lectures/labs/discussion sections): 3 hour 20 min
- Weekly out-of-class time (e.g., homework, readings): 8 hours

Technological Proficiency and Hardware/Software Required
You need to have access to a computer to access course materials, complete the lab exercises, HW, midterm, and final project for this course. The statistical software R will be used extensively in this course.

Required Readings and Supplementary Materials
There is no required textbook.

Recommended textbooks:


Other relevant books available as free pdf downloads from the USC library:
Mixed Effects Models and Extensions in Ecology with R. Zuur, Alain; Ieno, Elena N; Walker, Neil; Saveliev, Anatoly A; Smith, Graham M. New York, NY : Springer New York : Imprint: Springer; 2009 https://uosc.primo.exlibrisgroup.com/permalink/01USC_INST/mbk0s6/alma991043230758903731 (Great readable text, with practical applications and some theory. Applications are in ecology – not biomedical.)


Modeling Binary Correlated Responses using SAS, SPSS and R. Wilson, Jeffrey R; Lorenz, Kent A. Cham : Springer International Publishing : Imprint: Springer; 2015 https://uosc.primo.exlibrisgroup.com/permalink/01USC_INST/mbk0s6/alma991042485319503731 (SAS focus, chapter on missing data in longitudinal studies, chapter on Bayesian approach)
Description and Assessment of Assignments

**Homework**: There will be 5 homework assignments. Homework must be submitted in electronic form on blackboard by 9am on the due date. The lowest HW score will be dropped.

**Midterm exam**: The midterm will be held from Thursday 9-11am on Week 7. The format will likely be an “open book/notes” in-class multiple choice/short answer and you will need to bring your laptop. There will be no lab on the day of the midterm.

**Final project**: The final consists of a group project (data analysis, report writeup) and a small individual in-class component which will take place during the scheduled final exam period.

**Grading Breakdown**

<table>
<thead>
<tr>
<th>Assessment Tool</th>
<th>% of Grade</th>
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<tbody>
<tr>
<td>Homework</td>
<td>50%</td>
</tr>
<tr>
<td>Midterm Exam</td>
<td>20%</td>
</tr>
<tr>
<td>Final project</td>
<td>30%</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100%</strong></td>
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**Assignment Submission Policy**

Assignments are to be submitted electronically through blackboard. No late assignments or final projects will be accepted. For the homework, students may discuss strategies with one another, but must turn in individual write ups. For the midterm, all work must be your own (no discussions with anyone else). The final project is group work, so you must work together within your group but you may not discuss with other groups.
Grading Timeline
We aim to have assignments graded within 1 week.

Additional Policies
Note on academic integrity.
Any violations of the academic integrity policies will result in zero credit for all students involved, submission of the incident to the Academic Integrity Coordinator for the Keck School of Medicine for adjudication and, likely, an F in the course for all students involved.

Policy regarding intellectual content related to the course. Recordings, slides or any other material that you are given access to via Blackboard, email or shared drives are strictly for your learning and should not be shared with anyone who is not enrolled in the course. The University’s SCampus policy regarding class notes (https://policy.usc.edu/scampus-part-c/) applies to these materials and prohibits misuse, inappropriate dissemination, attempted sale or appropriation of intellectual property. Violation of these policies will be met with appropriate disciplinary actions.
## Course Schedule: A Weekly Breakdown

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture Topic</th>
<th>Lab Topic</th>
<th>Deliverables</th>
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</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>8/24/23 Introduction to correlated data</td>
<td>Introduction to R/RStudio</td>
<td>HW1 out</td>
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<tr>
<td></td>
<td>Review of Generalized Linear Models</td>
<td>Linear &amp; Logistic Regression in R</td>
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<tr>
<td>Week 2</td>
<td>8/31/23 Two-level linear models (Part I):</td>
<td>Linear random intercept models in R</td>
<td>HW1 due</td>
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<td></td>
<td>Random intercept/variance components models</td>
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<td>HW2 out</td>
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<tr>
<td>Week 3</td>
<td>9/07/23 Two-level linear models (Part II):</td>
<td>Two-level linear mixed models in R</td>
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<td></td>
<td>Random intercept models with covariates</td>
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<td></td>
<td>Random coefficient models</td>
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<tr>
<td>Week 4</td>
<td>9/14/23 Centering and contextual effects</td>
<td>Centering and contextual effects &amp;</td>
<td>HW2 due</td>
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<tr>
<td></td>
<td>Three-level linear models</td>
<td>Three-level linear models in R</td>
<td>HW3 out</td>
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<tr>
<td>Week 5</td>
<td>9/21/23 Exploratory Data Analysis (EDA) for trends</td>
<td>EDA for longitudinal data mean trends</td>
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<td></td>
<td>in longitudinal data</td>
<td>in R</td>
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<tr>
<td>Week 6</td>
<td>9/28/23 Linear mixed effects models for longitudinal data</td>
<td>Growth curve modeling and LMM model checking in R</td>
<td>HW3 due</td>
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<tr>
<td>Week 7</td>
<td>10/05/23 MIDTERM exam</td>
<td>No lab</td>
<td>MIDTERM</td>
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<td></td>
<td>(no module activities this week)</td>
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<td>10/12/23</td>
<td>Fall Recess. No class</td>
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<tr>
<td>Week 8</td>
<td>10/19/23 EDA for correlation in longitudinal data</td>
<td>EDA for longitudinal data correlation</td>
<td>HW4 out</td>
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<td></td>
<td>Generalized estimating equations (GEE)</td>
<td>and GEE in R</td>
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<td>Week 9</td>
<td>10/26/23 Binary outcomes</td>
<td>GEE for binary outcomes in R</td>
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<tr>
<td>Week 10</td>
<td>11/02/23 Ordinal outcomes</td>
<td>Two and three-level logistic regression models in R</td>
<td>HW4 due</td>
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<td></td>
<td></td>
<td></td>
<td>HW5 out</td>
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<tr>
<td>Week 11</td>
<td>11/09/23 Count outcomes</td>
<td>Correlated count outcomes in R</td>
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<td>Weekly COVID mortality counts</td>
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<td>Week 12</td>
<td>11/16/23 Distributed lag models (Dr. Jason Niu)</td>
<td>TBD</td>
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<td>Additional pearls of wisdom</td>
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<tr>
<td>11/23/23</td>
<td>Thanksgiving Holiday. No class</td>
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<tr>
<td>Week 13</td>
<td>11/30/23 Review</td>
<td>Final project group work</td>
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<tr>
<td>FINAL</td>
<td>12/07/23 (Thurs)</td>
<td>Final project - in class component</td>
<td>FINAL PROJECT DUE</td>
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<tr>
<td></td>
<td>11am-1pm</td>
<td>Refer to the USC final exam schedule:</td>
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<td>classes.usc.edu</td>
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**Statement on Academic Conduct and Support Systems**

**Academic Integrity:**
The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, comprises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university’s mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or “recycle” work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see [the student handbook](#) or the [Office of Academic Integrity’s website](#), and university policies on [Research and Scholarship Misconduct](#).

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

**Students and Disability Accommodations:**

USC welcomes students with disabilities into all of the University’s educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at [osas.usc.edu](mailto:osas.usc.edu). You may contact OSAS at (213) 740-0776 or via email at [osasfrontdesk@usc.edu](mailto:osasfrontdesk@usc.edu).

**Support Systems:**

*Counseling and Mental Health* - (213) 740-9355 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

**988 Suicide and Crisis Lifeline** - 988 for both calls and text messages – 24/7 on call
The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

**Relationship and Sexual Violence Prevention Services (RSVP)** - (213) 740-9355(WELL) – 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

**Office for Equity, Equal Opportunity, and Title IX (EEO-TIX)** - (213) 740-5086
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

**Reporting Incidents of Bias or Harassment** - (213) 740-5086 or (213) 821-8298
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

**The Office of Student Accessibility Services (OSAS)** - (213) 740-0776
OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

**USC Campus Support and Intervention** - (213) 740-0411
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

**Diversity, Equity and Inclusion** - (213) 740-2101
Information on events, programs and training, the Provost’s Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

**USC Emergency** - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

**USC Department of Public Safety** - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call
Non-emergency assistance or information.

**Office of the Ombuds** - (213) 821-9556 (UPC) / (323-442-0382 (HSC)
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

*Occupational Therapy Faculty Practice* - (323) 442-2850 or otfp@med.usc.edu

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.