RUTGERS
School of Public Health

Course Title: Applied Longitudinal Data Analysis

Course Number: BIST 0650

Course Pre- and Co-requisite(s): BIST 0551 or BIST 0610

Course Location: 3A/3B SPH Piscataway

Course Date & Time: Tuesday, 3-5pm

Course Instructor: Jason Roy, Professor
Department of Biostatistics and Epidemiology
Rutgers School of Public Health
jason.roy@rutgers.edu

Office Hours: Fri 12pm and by appointment

Course Assistant: *None*

Course Website: *canvas.rutgers.edu*

Required Course Text: Fitzmaurice, G.M., Laird, N.M. and Ware, J.H. (2011). Applied Longitudinal Analysis, 2nd edition. Wiley Series in Probability and Statistics, Wiley-Interscience. ISBN: 978-0470380277

Additional/Supplemental Readings/Resources:

1) Hedeker, D. and Gibbons, R. (2006). Longitudinal Data Analysis. Wiley Series in Probability and Statistics, Wiley-Interscience. ISBN: 978-0471420279
2) Diggle, Heagerty, Liang, and Zeger (2012). Analysis of Longitudinal Data, 2nd Edition. Oxford University Press

Course Description: Longitudinal data consists of multiple measures over time on a sample of individuals. The analysis of longitudinal data requires much more sophisticated methodologies due to the correlation introduced by repeated measurements. This course covers modern statistical techniques for longitudinal data from an applied perspective. Emphasis will be on data analysis and interpretation. Topics include characteristics of the longitudinal design, graphical exploration of the mean and correlation structure, linear mixed effects models and multilevel modelling, maximum likelihood and restricted maximum likelihood estimation, modeling the variance-covariance structures, inference for random effects, logistic and Poisson mixed effects model for binary and count data, marginal models and generalized estimating equations (GEE), causal inference and time-dependent confounding (g-methods). Analysis of real and substantial data sets using statistical software R (primarily) and SAS (secondarily) will be integrated throughout.

Selected Concentration Competencies Addressed: Each Concentration identifies competencies for each degree offered. The competencies addressed in this course for the MPH and MS in BIST include*:*

MPH-BIST
1. Apply basic probability theory and standard statistical methods to problems relevant to biomedical, clinical, and public health research

2. Use statistical computer packages to organize, analyze, and report collect data
3. Communicate the results of statistical analyses both in writing and orally to investigators lay community members.

   MS-BIST:
1. Apply probability and statistical methods to design experimental and observational studies in biomedical, clinical, and public health research
2. Conduct appropriate statistical analysis of data to solve medical and public health problems
3. Communicate the results of statistical studies both in writing and orally to investigators and lay community members

Please visit the Concentration webpages on the School of Public Health's website at sph.rutgers.edu for additional competencies addressed by this course for other degrees and concentrations.

Course Objectives: By the completion of this course, students will be able to:

(a) Identify the special features of longitudinal designs, and describe how these features might related to the analysis.
(b) Graphically explore and present the longitudinal data.
(c) Use R or SAS to analyze continuous longitudinal data. Correctly specify fixed and random effects and covariance structure. Interpret the output.
(d) Use R or SAS to perform logistic and Poisson mixed effects modeling for repeated binary or count data.
(e) Use R or SAS to analyze the repeated binary or count data using generalized estimating equation techniques.
(f) Understand why specialized methods are needed for causal inference when there is time dependent confounding.
(g) Understand causal estimands, causal assumptions, and g-methods.
(h) Understand the impact of missing data on standard statistical inference and for a particular situation, be able to choose between the common approaches for handling missing values.
(i) Plan and design longitudinal studies, and use appropriate methods to analyze data from such designs and interpret the result.

MPH Competency	Course Objectives(s)	Lessons	Assessment(s)
1	a, f, g	1-14	Homework 1-5, Midterm
2	b, c, d, e, f	1-15	Homework 1-5, Final
3	g	2, 7, 13, 15	Final

MS Competency	Course Objectives(s)	Lessons	Assessment(s)
1	a, f, g	1-14	Homework 1-5, Midterm
2	b, c, d, e, f	1-15	Homework 1-5, Final
3	g	2, 7, 13, 15	Final

Course Requirements and Grading: *In this section, Instructor should include*

- Items evaluated for course grade:

a.	Midterm (in class, Oct 26)	25%
b.	Final (in class, Dec 14)	25%
c.	Homework (5 assignments; bi-weekly)	25%
d.	Project (critical review on the paper or data analysis)	15%
e.	Class participation/attendance	10%

  Homework: Homework will be assigned approximately once every two weeks; see the schedule below for tentative due dates. Homework will be collected at the beginning of the class on the date it is due. It should be neat, all work should be shown, and <u>no late homework accepted unless pre-arranged with the instructor</u>. For problems where R or SAS programs are assigned, both the program and its 'relevant' output included. Students are encouraged to consult one another on homework problems, but everyone should do their own programming and turn in their own homework.

  Project & Presentation: Students will have two options to complete this task. (1) Critically review a paper which must include longitudinal data analyses methods/results. The paper must be approved by the instructor by Thanksgiving break; or (2) Complete a data analysis. Datasets will be posted in Canvas before Thanksgiving. For either task, students are required to present their work in video recording (max 10 minutes) and provide a summary report. All video recordings should be posted in course website and a written report submitted to Canvas (due 3pm, Dec 7). All students will watch at least 6 of the videos and provide 'critical' reviews. Details will be provided in early November.

- *Please add the school-wide uniform grading scale:*

Grading Policy:	94 – 100	A
	90 – <94	A-
	87 – <90	B+
	84 – <87	B
	80 – <84	B-
	77 – <80	C+
	70 – <77	C
	<70	F

Course Schedule: This table provides a general plan for the course; some deviations may be necessary. Please visit the course web in the Canvas on a regular basis to check any update. 'Online 30' will be updated weekly via Canvas.

Week	Date	Course Topic	Online 30 [tentative]	Assignments/ Assessments

1	Sep 7	Review of generalized linear models; causation vs prediction. Introduction of longitudinal studies; definition, features and objectives of longitudinal data	Review video on calculus, probability, maximum likelihood (optional) Review video of causal inference from regression in cross-sectional studies	
2	Sep 14	Exploratory data analysis; data structure	Video on R converting wide data to long data	Homework 1 assigned
3	Sep 21	Linear mixed models (I)	Video on fitting random intercept model in R	
4	Sep 28	Linear mixed models (II)	Video on estimating random effects in R	Homework 1 due Homework 2 assigned
5	Oct 5	Marginal models (GEE; I)		Homework 2 due
6	Oct 12	Marginal models (GEE; II)	Video on fitting GEE linear models in R	Homework 3 assigned
7	Oct 19	GEE and review	Reviews	Homework 3 due
8	Oct 26	Midterm		In class exam
9	Nov 2	Generalized linear model (I): general introduction, marginal model and generalized estimation equation	Video on estimation	
10	Nov 9	Generalized estimating equations (GEE): logistic for binary data and log-linear for count data	Data analysis video	Homework 4 assigned
11	Nov 16	Generalized linear mixed effects models (GLMMs)		
12	Nov 23	Generalized Linear model (III): Modeling for binary and ordinal data		Homework 4 due Homework 5 assigned
13	Nov 30	Causal inference with time-dependent		Homework 5 due

		confounding: g-methods		
14	Dec 7	Missing data analysis in longitudinal data analysis:	Online 30: student presentations	Presentation/ written report due
15	Dec 14	Final		

Learning Management System: Canvas will be used extensively throughout the semester for course syllabus, assignments, announcements, communication and/or other course-related activities. It is the student's responsibility to familiarize themselves with Canvas and check it regularly. If you have difficulties accessing Canvas, please inform the instructor and Canvas Support (help@canvas.rutgers.edu). Canvas is accessible at canvas.rutgers.edu.

School of Public Health Honor Code: The School of Public Health Honor Code is found in the School Catalog (sph.rutgers.edu/academics/catalog.html). Each student bears a fundamental responsibility for maintaining academic integrity and intellectual honesty in his or her graduate work. For example, all students are expected to observe the generally accepted principles of scholarly work, to submit their own rather than another's work, to refrain from falsifying data, and to refrain from receiving and/or giving aid on examinations or other assigned work requiring independent effort. In submitting written material, the writer takes full responsibility for the work as a whole and implies that, except as properly noted by use of quotation marks, footnotes, etc., both the ideas and the works used are his or her own. In addition to maintaining personal academic integrity, each student is expected to contribute to the academic integrity of the School community by not facilitating inappropriate use of her/his own work by others and by reporting acts of academic dishonesty by others to an appropriate school authority. It should be clearly understood that plagiarism, cheating, or other forms of academic dishonesty will not be tolerated and can lead to sanctions up to and including separation from the Rutgers School of Public Health.

Students with Disabilities: Rutgers University welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student must apply for Services by first completing a Registration Form with the Rutgers Office of Disability Services (ODS) at ods.rutgers.edu. The student will also be required to participate in an ODS intake interview and provide documentation. If reasonable accommodations are granted, ODS will provide you with a Letter of Accommodations which should be shared with your instructors as early in your courses as possible.

Commitment to Safe Learning Environment: The Rutgers School of Public Health is committed to helping create a safe learning environment for all students and for the School as a whole. Free expression in an academic community is essential to the mission of providing the highest caliber of education possible. The School encourages civil discourse, reasoned thought, sustained discussion, and constructive engagement. Provocative ideas respectfully presented are an expected result. An enlightened academic community, however, connects freedom with responsibility. The School encourages all students to disclose any situations where you may feel unsafe, discriminated against, or harassed. Harassment or discrimination of any kind will be not tolerated and violations may lead to disciplinary actions.

Reporting Discrimination or Harassment: If you experience any form of gender or sex-based discrimination or harassment, including sexual assault, sexual harassment, relationship violence, or stalking, know that help and support are available. You may report such incidents to the RBHS Title IX Office or to the School of Public Health's Office of Student Affairs. Rutgers University has staff members trained to support survivors in navigating campus life, accessing health and counseling services, providing academic and housing accommodations, and more. If you experience any other form of

discrimination or harassment, including racial, ethnic, religious, political, or academic, please report any such incidents to the School's Office of Student Affairs. The School strongly encourages all students to report any incidents of discrimination or harassment to the School. Please be aware that all Rutgers employees (other than those designated as confidential resources such as advocates, counselors, clergy and healthcare providers as listed in Appendix A to Policy 10.3.12) are required to report information about such discrimination and harassment to the School and potentially the University. For example, if you tell a faculty or staff member about a situation of sexual harassment or sexual violence, or other related misconduct, the faculty or staff member must share that information with the RBHS Title IX Coordinator. If you wish to speak to a confidential employee who does not have this reporting responsibility, you can find a list of resources in Appendix A to University Policy 10.3.12. For more information about your options at Rutgers, please visit Rutgers Violence Prevention and Victim Assistance.

Graduate Student Computer Policy: Students are required to possess a personal laptop, no older than approximately two years, that must meet minimum requirements which may be found online at: sph.rutgers.edu/student-life/computer-support.html

Policy Concerning Use of Recording Devices and Other Electronic Communications Systems: When personally owned communication/recording devices are used by students to record lectures and/or classroom lessons, such use must be authorized by the faculty member or instructor who must give either oral or written permission prior to the start of the semester and identify restrictions, if any, on the use of mobile communications or recording devices.

Policy Concerning Use of Turnitin: Students agree that by taking this course all required papers may be subject to submission for textual similarity review to Turnitin.com (directly or via learning management system, i.e. Canvas) for the detection of plagiarism. All submitted papers will be included as source documents in the Turnitin.com reference database solely for the purpose of detecting plagiarism of such papers. Use of the Turnitin.com service is subject to the Usage Policy posted on the Turnitin.com site. Students who do not agree should contact the course instructor immediately.

Withdrawal/Refund Schedule: Students who stop attending their course(s) without submitting a completed Add/Drop Course form will receive a failing grade. Furthermore, students dropping to zero credits for the semester are considered withdrawn and must submit a completed Leave of Absence form from the School of Public Health's Office of Student Affairs. The School of Public Health refunds tuition only. Administrative and technology fees are non-refundable. You may find the Withdrawal/Refund Schedule on the School of Public Health website at: sph.rutgers.edu/academics/academic-calendar.html