University of Maryland School of Public Health

EPIB 635 – Applied Multilevel Modeling of Health Data

Semester:	Summer II, 2018 (July 9–August 17)		
Section:			
Classroom and Time:	Tues/Thur 4:00pm-7:50pm, SPH0301		
Course webpage:	*[ELMS page or equivalent]*		
Instructor:	Sirin Yaemsiri, PhD, MSPH	Office Hours:	By appointment
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TA:	*[If applicable]*	Office Hours:	
Office:			
Phone:			
Email:			

Course Description: [*An extensive description of the course, beyond what is listed in the course catalog.*]

This course will provide an overview of multilevel models and their application to health data. Multilevel models are used when observations are nested, such as individuals nested in neighborhoods, children nested in families, repeated measures nested in individuals, or patients nested within doctors. These models account for the clustering of health outcomes and variation. In addition, multilevel models can help address important questions about the influence of factors at different levels and their interactions, as well as how health outcomes vary within and between groups.

Class time will be split between introducing concepts, group discussion of multilevel models in public health literature, and working through hands-on exercises. The hands-on portion will allow students to practice translating research questions into statistical models, applying and interpreting multilevel models using empirical data, and checking model fit and assumptions. Public use data will be used to illustrate concepts, including a national survey of children and families and a national survey of patients and medical providers. Some matrix notation may be used to explain concepts, but the course will not go into detail on the mathematical theory of multilevel models.

Course Pre- and Co-requisites: [*Please include required course prerequisites and corequisites, as well as recommended course prerequisites and corequisites. Be sure to specify. These should match those posted in the Undergraduate Catalog and Testudo's Schedule of Classes.*]

Students are *required* to have completed courses in the Foundations of Epidemiology (EPIB 610) and Biostatistics I (EPIB 650). Students are *recommended* to have completed Intermediate Epidemiology (EPIB611) and Biostatistics II (EPIB 651), which covers probability, random variables, statistical inference, analysis of variance, and multiple linear regression. In addition, students are *recommended* to have a foundation in using SAS statistical software through SAS Programming (EPIB 663) and Public Health Data Management (EPIB 697).

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

1. Recognize a multilevel research question and translate into statistical models.

2. Make inferences for individual or for population fixed effects (covariates) and random effects (variance components), while accounting for clustering.
3. Prepare graphical or tabular displays of nested data that effectively communicate the patterns of scientific interest.
4. Compare results from multilevel models with standard regression approaches.
5. Use SAS to conduct the appropriate multilevel analysis.
6. Evaluate multilevel model fit and assumptions. Describe the advantages and limitations of multilevel models.

Program Competencies Addressed in this Course:
The following competencies for the Epidemiology PhD program are addressed in this course:

1. Calculate advanced epidemiology measures
2. Critically evaluate measures of association
3. Critically appraise epidemiologic literature
4. Compare clustered data with traditional epidemiologic data from survey and randomized clinical trials

The following competencies for the Epidemiology MPH program are addressed in this course:

5. Draw appropriate inferences from epidemiologic data.

The following competencies for the Biostatistics MPH program are addressed in this course:

6. Select appropriate inferential statistical methods to answer research questions relevant to public health research.
7. Conduct descriptive and inferential statistical analyses that are appropriate to different basic study designs used in public health research.
8. Interpret results of statistical analyses found in public health studies.
9. Use a basic software package to describe, explore, and summarize data as well as perform the basic conventional statistical procedures.
10. Communicate results of statistical analyses to lay and professional audiences.

Required Texts and Other Readings: [*Includes titles, authors, dates of publication, and ISBN, if available]*

Required: *[Please include any required text here. You must include a complete listing of required readings in the weekly class schedule later in this syllabus.]*

- Gelman, Andrew, and Hill, Jennifer. 2006. Data Analysis Using Regression and Multilevel/Hierarchical Models. ISBN-13: 978-0521686891
- SAS Institute Inc. 2013. SAS/STAT® 13.1 User's Guide. Chapter 6: Introduction of Mixed Modeling Procedures. Cary, NC: SAS Institute Inc. Available at: https://support.sas.com/documentation/onlinedoc/stat/142/intromix.pdf

Recommended:

- Twisk, Jos W. R. 2006. Applied Multilevel Analysis: A Practical Guide. 2006. ISBN-13: 978-0521614986.

Required Technology and Other Materials: [*Lab materials, clickers, calculators, software, etc.*]

- SAS Software University Edition. Available at: https://www.sas.com/en_us/software/university-edition/download-software.html

Course Communication: *[how you will communicate with students regarding class cancellation, room change, or other timely announcements.]*

Official communications for the course will be sent through the course announcement tool in ELMS (CANVAS).

Course Requirements and Expectations: [*This should include a general description of the course content, information about instructional methods, course objectives/goals not listed above, expectations of students, rationale for course structure and a description of various assignments.*

Notes:

Be sure that course requirements (papers, exams, etc.) "match" your course objectives and mastery of identified program competencies above.

University policy prohibits mandating course attendance. As attendance is critical to learning and successful attainment of the course objectives and curriculum competencies, be sure to state the importance of attendance to a student performing well in your course. Specify the nature of in-class participation expected and the effects of the lack of participation – and thereby absences – on the student's grade.]

Class Materials

The syllabus, required journal articles, Powerpoint slides, and other course materials will be posted on the Canvas website: http://elms.umd.edu/.

Course Requirements and Expectations:

The class sessions will be lectures and discussions to review main concepts, techniques, and application of modeling analysis in depth, followed by exercises. Students are expected to complete the assigned readings **prior** to the class. Students are asked to actively participate in in-class discussions and exercises.

Major Graded Assignments*: [Please specify the assignment, due date and any specific instructions.]*

**Note that final examinations are scheduled by the campus in the first weeks of the semester and often do not occur during typical class days/times. That schedule is provided to students as soon as possible. Students are expected to attend the final exam as scheduled and should plan accordingly.

University Course Related Policies: [*Review the campus policies at the website listed below, in particular the section on "student rights regarding undergraduate courses." Instructors may add course-specific policies in the next section of the syllabus, but all such policies must conform with university policies.]*

All University of Maryland-approved course policies are provided at the following website:
http://www.ugst.umd.edu/courserelatedpolicies.html

Policy descriptions, resources, and links to official policy documents are provided for:

Academic Integrity: What is cheating? What is plagiarism? What is the Honor Pledge?

Code of Student Conduct: What behavior is prohibited?
Sexual Misconduct: What to do in case of sexual harassment or sexual assault.
Discrimination: Procedures to prohibit discrimination, complaints about discrimination, harassment, and retaliation.
Accessibility: Information about disability support services (DSS) and accommodations.
Attendance, Absences, or Missed Assignments: The student must notify the instructor in a timely manner (typically first week of class). Read this prior to Schedule Adjustment date.
Student Rights Regarding Undergraduate Courses: What should I find in the course syllabus? Am I allowed to see my exams after they are graded?
Official UMD Communication: Use of email, communication with faculty, communication about cancelled class meetings, and weather-related or other urgent notifications.
Mid-Term Grades: Provided for 100 and 200 level courses, and all student athletes.
Complaints About Course Final Grades: Questions about course grades should first be addressed to the course instructor.
Copyright and Intellectual Property: Who owns the work that I produce in class?
Final Exams: Final exams are scheduled by the University.
Course Evaluations: The School of Public Health is committed to the use of student course evaluations for improving the student experience, course and curriculum delivery, and faculty instruction.
Campus Resources: ELMS, counseling, learning workshops, tutoring, writing help, questions about graduation, adding or dropping classes, withdrawing from the semester, etc.

Course Procedures and Policies: [*You may add course-specific policies regarding late work, missed assignments, lab safety, classroom etiquette, etc., but all such policies must conform with university policies listed above. In the case of a discrepancy, university policy will override a course policy.]*

Inclement Weather / University Closings / Emergency Procedures:
In the event that the University has a delayed opening or 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.

Available Support Services: [*Information regarding any additional support services available to students that may be useful during the course. Examples include Learning Assistance Service programs and short courses, the Writing Center, library facilities/tools, computer facilities and helpdesk at OIT, etc. Some faculty have included a bibliography of sorts, including major peer-reviewed journals in the field that students may wish to reference, key websites with which students should be familiar, and notable books, articles or other cornerstone publications with historical significance and/or which contributed to a revolutionary or profound change in the thinking or practice of a particular field.*]

Grading Procedures: [*This should include a complete listing of all graded assignments, the point/percentage value of each in the overall grade calculation, and the grading scale/rubric for the course (e.g. the point range associated with each letter grade).*]

The final grade will be based on the final exam, quizzes, and homework assignments. The final exam will count toward 40% of the final grade. Quizzes and homework assignments will count toward 60% of the final grade; each will be equally weighted. There will be 10 quizzes and 10 homework assignments.

Quizzes may be completed open-book in assigned pairs. Quizzes will be timed. Homework assignments may be completed open-book. Students may work together, but each person's answers must be in their own words.

If a student has questions or concerns about grade(s) and believes I should review the grade, the student should submit a written request over email that describes concerns in detail. This request must be submitted within one week of the date that the assignment is returned to him/her.

Please show all of your work (i.e., code and output) on the exam, quizzes, and homework. If you provide the correct answer, but, do not show your work I will mark it as incorrect and give you no points. If you provide the incorrect answer, but, show in your calculations that you understood how to answer the question correctly, you will get partial credit. This partial credit will be entirely to the professor or grader discretion and indisputable.

Final letter grades will be assigned according to the following system:
A+ = 97+, A = 93-96.9999, A- = 90-92.9999
B+ = 87-89.9999, B = 83-86.9999, B- = 80-82.9999
C+ = 77-79.9999, C = 73-76.9999, C- = 70-72.9999
D+ = 67-69.9999, D = 63-66.9999, D- = 60-62.9999
F = below 60

Course Outline / Course Calendar: [*Schedule of topics to be covered by week or class meeting, dates for exams, quizzes and any other means of assessment listed above, due dates for assignments and readings, any required special events.*

Notes: If the course is a 100- or 200-level course, you are encouraged to have graded work available for your review by the submission dates for Early Warning Grades.]

Course Schedule Summary			
Session	**Date**	**Topic**	**Assignments**
# 1		Introduction to multilevel modeling and review of single level regression	HW1 assigned
# 2		Random effects ANOVA model	HW1 due HW2 assigned
# 3		Linear model with random intercept	HW2 due HW3 assigned
# 4		Linear model with random intercept and slope-Part 1	HW3 due HW4 assigned
# 5		Linear model with random intercept and slope-Part 2	HW4 due HW5 assigned
# 6		Multilevel analysis of three-level data	HW5 due HW6 assigned
# 7		Logistic regression with random intercept and slope	HW6 due HW7 assigned
# 8		Poisson regression with random intercept and slope	HW7 due HW8 assigned

# 9		Adding covariates to multilevel models	HW8 due HW9 assigned
# 10		Multilevel analysis in longitudinal studies-Part 1	HW9 due HW10 assigned
# 11		Multilevel analysis in longitudinal studies-Part 2	HW10 due
# 12		Multivariable multilevel analysis	
FE	TBA	Final Examination – schedule (day/time) to be announced.	

[*Faculty Instructions – Session Outline: For the date of each class meeting, specify: the subject matter/topics to be covered (e.g., lectures, field trips, guest lecturers, etc.) and the pre-class readings and other non-graded assignments due; Graded assignments due dates, preferably highlighted in bold or capitalized (e.g., homework, quizzes, papers, projects); exam dates, preferably highlighted*]

Note: Numbers in brackets after learning objectives show linkage between material covered in each session and the numbered program competencies shown on page 1 of this syllabus.

Session Outline	
Session 1	**Day/Date**
Introduction to multilevel modeling • Outline of the course, logistics, discussion of homework and exams • Multilevel data structures and research questions that multilevel models can help answer • High-level approach to fitting multilevel models • Review linear regression Learning Objectives for Session [Relevant Program Competencies: #1, #6, #7]	
Session 2	**Day/Date**
Random effects ANOVA model 1. Bayes theorem and shrinkage estimation 2. Connection with multilevel model with random intercept and no covariates 3. Example Learning Objectives for Session [Relevant Program Competencies: #1, #2, #3, #4, #5, #8, #9, #10]	
Session 3	**Day/Date**
Linear model with random intercept 1. Example of research questions 2. Combining variance components model and single-level regression model 3. Interpreting parameters, correlations, variances 4. Measures of clustering: intraclass correlation and variance partitioning coefficient 5. Likelihood ratio test 6. Effect of centering 7. Assumptions regarding correlation of level 1 and 2 residuals and covariance. 8. Example Learning Objectives for Session [Relevant Program Competencies: #1, #2, #3, #4, #5, #8, #9, #10]	
Session 4 and 5	**Day/Date**

Linear model with random intercept and slope

1. Examples of research questions
2. Model equation with random intercept and slope
3. Interpreting parameters, correlations, variances
4. Covariance between intercepts and slopes
5. Effect of scaling and centering
6. Interpreting cross-level interactions
7. Example

Learning Objectives for Session [Relevant Program Competencies: #1, #2, #3, #4, #5, #8, #9, #10]

Session 6	**Day/Date**

Multilevel analysis of three-level data

- When is a three-level variance component model needed?
- Three-level models for hierarchical data
- Interpreting three-level variance components and parameters
- Intraclass correlations
- Example

Learning Objectives for Session [Relevant Program Competencies: #1, #2, #3, #4, #5, #8, #9, #10]

Session 7	**Day/Date**

Logistic regression with random intercept and slope

- Review of logistic regression model
- Interpreting parameters of a multilevel logistic regression
- Visualizing multilevel logistic regression model and predictive probabilities
- Models: first order maximized quasi-likelihood estimation and penalized quasi-likelihood estimation procedure
- Example

Learning Objectives for Session [Relevant Program Competencies: #1, #2, #3, #4, #5, #8, #9, #10]

Session 8	**Day/Date**

Poisson regression with random intercept and slope

1. When is a Poisson regression with random intercept and slope needed?
2. Connection with random intercept model and marginal model for count data
3. Interpreting parameters of a multilevel logistic regression
4. Models: first order maximized quasi-likelihood estimation and penalized quasi-likelihood estimation procedure
5. Example

Learning Objectives for Session [Relevant Program Competencies: #1, #2, #3, #4, #5, #8, #9, #10]

Session 9	**Day/Date**

Adding covariates to multilevel modeling

1. Evaluating the necessity of adding covariates
2. Evaluating cross-level interactions

3. Prediction model versus association models
4. Example

Learning Objectives for Session [Relevant Program Competencies: #1, #2, #3, #4, #5, #8, #9, #10]

Session 10 and 11	**Day/Date**

Multilevel analysis in longitudinal studies

1. Types of longitudinal studies
2. Intraclass correlation coefficient and methods for addressing highly correlated observations
3. Modeling correlation structures
4. Three-level models for longitudinal data
5. Missing data in longitudinal studies
6. Example of growth curves

Learning Objectives for Session [Relevant Program Competencies: #1, #2, #3, #4, #5, #8, #9, #10]

Session 12	**Day/Date**

Multivariable multilevel analysis

1. Examples of research questions where multivariable multilevel analysis is needed
2. Connection to multivariate analysis of variance, multilevel analysis of three-level data, and multilevel analysis in longitudinal studies
3. Effect of centering
4. Example

Learning Objectives for Session [Relevant Program Competencies: #1, #2, #3, #4, #5, #8, #9, #10]

Optional table on course assignments, quizzes and exams, learning objectives and program competencies; the purpose is to explicitly link the competencies, objectives and assessment activities

Assessment activity (quiz, exam, paper, etc.)	*Specific learning objective assessed with the activity*	*Relevant program competency*

Additional Literature, Websites and Other Resources: *[Some faculty have included a bibliography of sorts, including major peer-reviewed journals in the field that students may wish to reference, key websites with which students should be familiar, and notable books, articles or other seminal publications with historical significance and/or which contributed to a revolutionary or profound change in the thinking or practice of a particular field.]*