



# University of Maryland School of Public Health

## EPIB 612 Epidemiologic Study Design

**Semester:** Fall, 2016  
**Section:** 0101  
**Classroom and Time:** SPH 0307, 4:00 pm -6:45 pm on Mondays  
**Course webpage:** <https://myelms.umd.edu/courses/1200740>  
**Instructor:** Hongjie Liu, Ph.D., M.S.  
**Office:** SPH 2234A  
**Office Hours:** Mondays 2:45 pm – 3:45pm or by appointment  
**Phone:** 301 405 3102  
**Email:** [Hliu1210@umd.edu](mailto:Hliu1210@umd.edu)

### Course Description:

The course focuses on the application of epidemiologic study designs and analytic methods used for analysis of data collected from cohort, case-control, and cross-sectional studies and clinical trials. Its overall objective is to allow students to develop a solid understanding of the theoretical basis and practical tools of epidemiologic study designs. Features of epidemiologic designs and analytic reasoning are emphasized throughout the class. The course provides analytic approaches for selection of an appropriate study design to address a specific research question, identification of bias, control of confounding, and assessment of interaction effects. It extends the concepts and methods of epidemiology from EPIB610 and 611.

### Course Pre- and Co-requisites:

Required: EPIB 610 Foundations of Epidemiology; EPIB 611 Intermediate Epidemiology; and EPIB 650 Biostatistics I,

Recommended: None

### Course Learning Objectives:

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

1. In-depth understand the theoretic issues in each type of epidemiologic study designs and its strengths and weaknesses.
2. Define a research question, select an appropriate epidemiologic study design to address the question, execution of the study, map out and implement an analytic plan, and interpret findings.
3. Identify and control major sources of bias (i.e., information, selection, and confounding bias) in each type of epidemiologic study designs and approaches to evaluate their likely direction, magnitude, and nature of their threats to causal inference.
4. Demonstrate the ability to independently plan epidemiologic studies and data analysis with emphases on effect estimation, controlling for confounding, and assessment of interaction.
5. Demonstrate understanding of epidemiologic methods through critical review of published epidemiologic research.

### Program Competencies Addressed in this Course:

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

1. Design, analyze, and evaluate an epidemiologic study.
2. Design interventions to reduce prevalence of major public health problems.

3. Describe and apply statistical approaches to address threats to validity in epidemiologic studies.
4. Critique different study designs.
5. Critically appraise epidemiologic literature.

### **Required Texts and Other Readings:**

#### Required:

No required books, but class notes and readings from various epidemiology journals will be distributed in class.

#### Recommended:

- Woodward M. Epidemiology: Study Design and Data Analysis, 3<sup>rd</sup> edition, Champan & Hall/CRC, 2013 ISBN-10: 1439839700
- Moyses Szklo M and Nieto J. Epidemiology: Beyond the basic, 3<sup>rd</sup> edition, Jones & Bartlett Learning, 2012 ISBN-10: 1439839700
- Rothman KJ and Greenland S. Modern Epidemiology, 3<sup>rd</sup> edition, Lippincott Williams & Wilkins, Philadelphia, PA, 2008 ISBN-10: 1439839700

### **Required Technology and Other Materials:**

Students will use a calculator or SAS to do their homework and exams.

### **Course Communication:**

Students will be notified by emails of class cancellation, room change, or other timely announcements.

### **Course Requirements and expectations:**

The class sessions will be lectures and discussions to review main concepts of epidemiology in depth, followed by exercises. Lectures will not necessarily cover all materials included in the reading assignments. Students are expected to complete the assigned readings **prior** to the class. Students are asked to actively participate in in-class discussions and exercises.

The instructor welcomes meetings with students outside of class to discuss questions, as well as to gain more insight about the material presented in class. Students may e-mail or ask the instructor for an appointment. Please be reminded, however, that the **class will be taught during class time only**. Material will not be presented again on a one-on-one basis at other times. Therefore, attendance at every class is expected and crucial for success in the course. Excessive lateness or absence from class is disruptive to the class and your learning. **Students who miss class are responsible for obtaining notes and hand-outs from other students**. The instructor will not meet with student to retrieve copies of hand-outs from past lectures except in pre-arranged circumstances.

### **Major Graded Assignments:**

#### **Hands-on exercise (40 points)**

Six hands-on exercises will be assigned. You are encouraged to form study groups and discuss homework with your peers. Homework assignments will be posted on CANVAS one week before the due date.

Homework 1 and 2: 5 credit points for each

Homework 3-5: 10 points for each.

**Midterm exam (15 points)**

Formats of the mid-term exam include multiple choices, true or false, calculations, and short answers. It is an open-book exam. You are required to work independently on the mid-term in class.

**Final Exam (30 points)**

A final exam will be given between in the final exam week. Formats of the final exam include multiple choices, true or false, short answers, and calculations. It is an open-book exam.

**Project (15 points)**

Students will be required to develop a research protocol in which one type of epidemiologic study designs is selected to investigate a research question. You are required to submit a short-form protocol. The proposal should be no more than 3 pages in Word. Use 11-point Arial as the minimum font size for the text of the protocol. Single-spaced text is acceptable, and space between paragraphs is recommended. The margins of your text should be at least 0.5 inch all around. You are required to work independently on the project. The deadline for the submission of it is December 12, 2016 (before the last day of class).

**Contents and Grade of final project**

1. Defining a research question with concise explanations	1 points
2. Clearly stating an testable hypothesis	1 points
3. Selecting an appropriate study design and briefly stating the reasons for the selection	4 Points
4. Describing and explaining the major variables of interest, i.e., select one for each of the outcome, exposure, and modifiers.	1 points
5. Listing potential information bias, selection bias, and confounding that may take place in your selected study design. Briefly stating your rationales	5 points
6. Stating approaches that you will use to prevent or eliminate the potential bias listed in 5.	2 points

7. Statistic approaches used to test the hypothesis	1 points
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**Readings**

After completion of each topic, students are required to critically read one publication that is relevant to the topic. Although reading is not graded, learning the main knowledge and approach used in the published work will help students to deeply understand class materials.

**University Course Related 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:**

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.

### 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>

### Late work and Missed Exams / Assignments:

All work is due when assigned. **Only hard copies of assignments, reports and papers are accepted except where indicated. E-mail and FAX copies will not be accepted except where indicated.** Any work not completed and handed in at the beginning of class on the due date will receive a reduction of one letter grade. Work not handed in by 5pm the following day will receive an additional letter grade reduction. Work will not be accepted beyond this point except in extreme circumstance approved by your instructor.

### Course Evaluations

The University, the School of Public Health, and the Department of Epidemiology and Biostatistics 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. You will be notified when the system ([www.CourseEvalUM.umd.edu](http://www.CourseEvalUM.umd.edu)) is open.

### **Available 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.

### **Grading Procedures:**

Your final grade will be determined by scores of the final exam (30%), midterm exam (15%); homework (40%), and research project (15%).

### **Grading:**

Below is a ‘general guideline’ for grading.

97-100	A+
94-96	A

90-93	A-
87-89	B+
84-86	B
80-83	B-
77-79	C+
74-76	C
70-73	C-
60-69	D
< 60	F

**Course Outline / Course Calendar:**

<b>Course Schedule Summary</b>			
<b>Session</b>	<b>Date (Tentative)</b>	<b>Topic</b>	<b>Assignments (Tentative)</b>
# 1	08/29	Lecture 1: Introduction to this course and overview of epidemiologic research	
# 2	09/12	Lecture 2: Study design: Cohort studies Lecture 3: Study design: Cross-sectional studies	
# 3	09/19	Lecture 4: Study design: Case-control studies	Homework 1 (Due on 09/26)
# 4	09/26	Lecture 4: Study design: Case-control studies	
# 5	10/03	Lecture 5: Study design: Experimental studies	Homework 2 (due on 10/10)
# 6	10/10	Lecture 6: Measures of disease occurrence	Homework 3 (due on 10/17)
# 7	10/17	Lecture 7: Measures of association and impact	Homework 4 (due on 10/24)
# 8	10/24	Lecture 8: Bias in epidemiologic studies: Selection bias Lecture 9: Bias in epidemiologic studies: Information bias	
# 9	10/31	Midterm exam and Lecture 9	
# 10	11/7	Lecture 10: Bias in epidemiologic studies: Confounding	
# 11	11/14	Lecture 10: Bias in epidemiologic studies: Confounding	Homework 5 (Due on 11/21)
# 12	11/21	Lecture 10: Bias in epidemiologic studies: Confounding	
# 13	11/28	Lecture 11: Interaction effect	Homework 6 (due on 12/05)
# 14	12/5	Lecture 12: Use logistic regression to assess interaction effects and control for confounding	Homework 7 (due on 12/12 )
# 15	12/12	Review session	

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.

<b>Required Session Outline</b>	
<b>Session 1</b>	<b>Day/Date</b>
Topic	

**Lecture 1: Introduction to this course and overview of epidemiologic research**

1. Introduction to this course
2. Type of populations
3. Aims of epidemiologic research and practice
4. Hypothesis and study design
5. Quantitative procedures in epidemiologic methods
6. Counterfactual theory in epidemiology

Learning Objectives for Session (#1 in “Program Competencies Addressed in this Course” on page 1)

- Overview the course
- Understand types of study populations.
- Improve ability to develop a research hypothesis
- Understand the counterfactual theory to

Required and recommended readings:

- (1) Höfler M. Causal inference based on counterfactuals. BMC Med Res Methodol. 2005;5:28

**Session 2****Day/Date**

Topic

**Lecture 2: Study design: Cohort studies**

1. Basic observational study designs
2. Elements of cohort studies
3. Dynamic population
4. Strength and limitation

**Lecture 3: Study design: Cross-sectional studies**

5. Elements of cross-sectional studies
6. Examples of National surveys
7. Survey weights
8. Strength and limitation

Learning Objectives for Session (#1 and #4)

- Able to design and conduct cohort and cross-sectional studies
- Understand in what conditions that a cohort or cross-sectional study needs to be used.

Required and recommended readings

- (2) Bech BH, Nohr EA, Vaeth M, Henriksen TB, Olsen J. Coffee and fetal death: a cohort study with prospective data. Am J Epidemiol. 2005;162(10):983-90.
- (3) Liu H, Liu H, Cai Y, Rhods A, Hong F. Money boys, HIV risks, and the associations between norms and safer sex: A respondent-driven sampling study in Shenzhen, China 2009;13:652-662

**Session 3****Day/Date**

Topic

**Lecture 4: Study design: Case-control studies**

1. Basic case-control studies
2. Critical assumption in case-control studies
3. Selection of cases
4. Principles of control selection
  - Base population principle
  - Deconfounding principle

Comparable accuracy principle.

Required and recommended readings

- (4) Yu TS, Liu H, Hui K. A case-control study of eye injuries in the workplace in Hong Kong. *Ophthalmology*. 2004;111(1):70-4.

**Session 4**

**Day/Date**

Topic

**Lecture 4: Study design: Case-control studies**

5. Population-based case-control studies
6. Case-crossover studies
7. Strength and limitation

Learning Objectives for Session (#1 and #4)

- Understand the principle of case-control studies
- Ability to design and conduct case-control studies

Hands-on exercise one

**Session 5**

**Day/Date**

Topic

**Lecture 5: Study design: Experimental studies**

1. Two basic study designs
  - (1) Randomized controlled trials
  - (2) Crossover trials
2. General procedures for clinical trials
  - (1) Selection of study subjects
  - (2) Sample size determination
  - (3) Recruitment of subjects
  - (4) Randomization allocation
  - (5) Follow up and data collection
  - (6) Blinding
  - (7) Compliance or adherence
3. Strategies for RCT data analysis
  - (1) Intention-to-treatment (ITT) analysis
  - (2) Treatment-received analysis (TR)

Learning Objectives for Session (#2 and #3)

- Understand the application of experimental studies
- Design a valid RCT
- Able to analyze data collected in RCTs

Required and recommended readings

- (5) Makrides M, Gibson RA, McPhee AJ, Collins CT, Davis PG, Doyle LW, Simmer K, Colditz PB, Morris S, Smithers LG, Willson K, Ryan P. Neurodevelopmental outcomes of preterm infants fed high-dose docosahexaenoic acid: a randomized controlled trial. *JAMA*. 2009;301(2):175-82.

**Hands-on exercise two**



Session 6	Day/Date
<p>Topic</p> <p><b>Lecture 6: Measures of disease occurrence</b></p> <ol style="list-style-type: none"> <li>1. Outcomes of epidemiologic research</li> <li>2. Review of epidemiological measures</li> <li>3. Review of frequency measures</li> <li>4. Incidence based on individuals at risk               <ol style="list-style-type: none"> <li>(1) General Cumulative incidence (Risk)</li> <li>(2) Life-table method of cumulative incidence (risk) estimation</li> <li>(3) Kaplan-Meier (KM) method of CI estimation</li> <li>(4) Assumptions</li> </ol> </li> <li>5. Incidence based on person-time units at risk</li> <li>6. Comparison between measures of incidence</li> <li>7. Measures of prevalence</li> <li>8. Relationship between prevalence and incidence</li> </ol> <p>Learning Objectives for Session (#3, #4, #5)</p> <ul style="list-style-type: none"> <li>- Able to select most appropriate measures</li> <li>- Able to estimate risk, rate, and prevalence in different study designs</li> </ul> <p>Required and recommended readings</p> <p>(6) Vu TT, Nguyen CK, Nguyen TL, Le BM, NguyenTrung Le D, Bui TN, Nakamori M, Kunii D, Sakai T, Yamamoto S. Determining the prevalence of osteoporosis and related factors using quantitative ultrasound in Vietnamese adult women. <i>Am J Epidemiol.</i> 2005;161(9):824-30.</p> <p><b>Hands-on exercise three</b></p>	
Session 7	Day/Date
<p>Topic</p> <p><b>Lecture 7: Measures of association and impact</b></p> <p><b>Cohort studies:</b></p> <p>Risk ratio (RR), odds ratio of disease (DOR), and Incidence ratio (IDR)</p> <p><b>Cross-sectional, case-control, and ecologic studies:</b></p> <ol style="list-style-type: none"> <li>(1) Prevalence ratio (PR) and prevalence odds ratio (POR)</li> <li>(2) Disease OR and Exposure OR</li> <li>(3) OR as an estimate of RR in case-control studies</li> <li>(4) Calculation of OR when there are more than 2 exposure categories</li> <li>(6) RR in ecologic studies</li> </ol> <p>Learning Objectives for Session (#3, #4, and #5)</p> <ul style="list-style-type: none"> <li>- Understand the measure of association and impact</li> <li>- Enable to use best measure in different study designs.</li> </ul> <p>Required and recommended readings</p> <p>(7) Yang J, Carmichael SL, Canfield M, Song J, Shaw GM; National Birth Defects Prevention Study. Socioeconomic status in relation to selected birth defects in a large multicentered US case-control study. <i>Am J Epidemiol.</i> 2008;167(2):145-54.</p>	

<b>Hands-on exercise four</b>	
<b>Session 8</b>	<b>Day/Date</b>
Topic	
<b>Lecture 8: Bias in epidemiologic studies: Selection bias</b>	
<ol style="list-style-type: none"> <li>1. Selection bias</li> <li>2. Type of selection bias</li> <li>3. Self-selection bias</li> <li>4. Selective loss to follow-up</li> <li>5. Selective survival bias</li> <li>6. Berkson's bias</li> <li>7. Detection bias</li> <li>8. Temporal ambiguity bias</li> <li>9. Dealing with selection bias</li> </ol>	
<b>Lecture 9: Bias in epidemiologic studies: Information bias</b>	
<ol style="list-style-type: none"> <li>1. Reliability and validity</li> <li>2. Valid studies</li> <li>3. Exposure identification bias <ul style="list-style-type: none"> <li>Recall bias</li> <li>Interviewer bias</li> <li>Approach to prevent recall and interview bias</li> </ul> </li> <li>4. Outcome identification bias <ul style="list-style-type: none"> <li>Observer bias:</li> <li>Respondent bias</li> <li>Approach to prevent observer and respondent bias</li> </ul> </li> <li>5. Consequence of information bias <ul style="list-style-type: none"> <li>Differential misclassification bias</li> <li>Non-differential misclassification bias</li> </ul> </li> </ol>	
Learning Objectives for Session (#4, #5)	
<ul style="list-style-type: none"> <li>- Identify different bias in epidemiologic studies</li> <li>- Control for bias at different stages in a study</li> </ul>	
Required and recommended readings	
<p>(8) Mezei G, Spinelli JJ, Wong P, Borugian M, McBride ML. Assessment of selection bias in the Canadian case-control study of residential magnetic field exposure and childhood leukemia. <i>Am J Epidemiol.</i> 2008;167(12):1504-10.</p> <p>(9) Maclure M, Schneeweiss S. Causation of bias: the episcopo. <i>Epidemiology.</i> 2001;12(1):114-22.</p> <p>(10) Colman S, Joyce T, Kaestner R. Misclassification bias and the estimated effect of parental involvement laws on adolescents' reproductive outcomes. <i>Am J Public Health.</i> 2008;98(10):1881-5.</p>	
Assignments – explanation and due date	
<b>Session 9</b>	<b>Day/Date</b>
Mid-term exam	
<b>Session 10</b>	<b>Day/Date</b>
Topic	

### **Lecture 10: Bias in epidemiologic studies: Confounding**

1. Review of Concept of counterfactual conditions
2. Property of confounders
3. Directed Acyclic Graphics (DAGs) in causal inference
  - Concept and terminology
  - Assumption in using DAGs
  - Graphical representation of confounding
  - Minimal sufficient adjustment models
4. Adjusting for confounding: Stratification Methods
5. How to identify a confounder?
  - The prior knowledge strategy (knowledge-driven approach)
  - The “change-in-estimate” (CIE) strategy (data-driven approach)
6. Caveats in use conventional roles for confounding
7. Methods to controlling for confounding
  - At the stage of design and execution
  - At the stage of data analysis

#### Learning Objectives for Session (#1 and #3)

- Understanding confounding issues in epidemiologic studies
- Identify confounders at the stage of study design, execution, data collection and data analysis
- Able to control for confounding

#### Required and recommended readings

- (11) Krueger PM, Friedman EM. Sleep duration in the United States: a cross-sectional population-based study. *Am J Epidemiol.* 2009;169(9):1052-63.

### **Hands-on exercise five**

#### **Session 11**

**Day/Date**

#### Topic

### **Lecture 11: Interaction effect**

1. Homogeneity/heterogeneity of effects
2. Comparison between joint expected and joint observed effects
3. Assessment of interaction effect in cohort and case-control studies
4. Interaction and confounding
5. Reporting of interaction effect

#### Learning Objectives for Session (#1 and #3)

- Understand interaction effect
- Differentiate confounding and interaction
- Estimate interaction effect
- Interpret findings

#### Required and recommended readings

- (12) Olshan AF, Li R, Pankow JS, Bray M, Tyroler HA, Chambless LE, Boerwinkle E, Pittman GS, Bell DA. Risk of atherosclerosis: interaction of smoking and glutathione S-transferase genes. *Epidemiology.* 2003;14(3):321-7.

Assignments – explanation and due date

Session 12	Day/Date
Topic	
<b>Lecture 12: Use logistic regression to assess interaction effects and control for confounding</b>	
<ol style="list-style-type: none"> <li>1. Review RR, OR and logistic regression model</li> <li>2. Reasons for using logistic regression control for confounding</li> <li>3. Multiple logistic regression model</li> <li>4. Assumptions in logistic regression model</li> <li>5. Modeling strategy guidelines               <ol style="list-style-type: none"> <li>(1) Variable selection</li> <li>(2) Interaction assessment</li> <li>(3) Confounding assessment</li> </ol> </li> <li>6. A common mistake: use of bivariable analysis to screen candidates in multiple logistic regression</li> <li>7. Use “Tests of regression”, “ R2 ” and “test of fit” with caution</li> <li>8. Ordinal logistic regression: the Proportional odds model</li> <li>9. Conditional logistic regression</li> </ol>	
Learning Objectives for Session (#3)	
<ul style="list-style-type: none"> <li>- Apply epidemiologic principles in data analysis</li> <li>- Understand logistic regression</li> <li>- Ability to use it to control for confounding</li> <li>- Ability to use it to estimate interaction effects</li> </ul>	
Required and recommended readings	
(13)Weng, HY, Hsueh YH, Messam LLM, Hertz-Picciotto I. Methods of covariate selection: Directed acyclic graphic and the change-in-estimate procedure. American Journal of Epidemiology. 2009;169:1182-1190	
(14)Sun G, Shook TL, Kay GL. Inappropriate use of bivariable analysis to screen risk factors for use in multivariable analysis. Journal of Clinical Epidemiology. 1996;49:907-916	
(15) Bagley SC, White H, Golomb BA. Logistic regression in the medical literature: Standards for use and reporting, with particular attention to one medical domain.	
<b>Hands-on exercise seven</b>	

**Critical university policies:**