EPID 7020: Advanced Topics in Epidemiologic Research **(last updated 01/29/2024)**

1. Background and Learning Objectives

The goal of EPID 7020 is to expose students to advanced epidemiologic research theories and methods that are limitedly or not otherwise covered in curriculum courses; it is the natural successor to EPID 7010 (*Introduction to Epidemiologic Research*, a prerequisite). EPID 7020 is intended for first-year epidemiology PhD students in the Graduate Group in Epidemiology and Biostatistics (GGEB). Non-GGEB graduate group students in any year of study are welcome, if fulfilling the prerequisite and/or at the discretion of the course director. EPID 7020 is built on a framework of the following modules: causal inference; advanced study design; and advanced modeling. See §4 below for detail on the sessions constituting each module. EPID 7020 has the following broad learning objectives: to provide one with an understanding of modern and cutting-edge quantitative methods, advanced topics, and best practices in epidemiologic, statistical, and biomedical research; and to improve one's ability to make informed decisions regarding the selection of analytic methods in individual and collaborative research projects. EPID 7020 emphasizes the following core competencies: knowledge within program area (epidemiologic and biostatistical methods); research skills (study planning, critically appraising published research); and quantitative and computational methodologies (data visualization, data analysis, statistical coding, model selection, and purposeful statistical inference). Through instructor-led lectures, reading of curated methods paper and tutorials, critical appraisal of applied papers, and in-class activities, EPID 7020 will provide instruction on rigorous and informed epidemiologic study design selection and statistical model selection, estimation, and interpretation.

2. Academic Integrity and Use of Generative Artificial Intelligence (AI)

Students must read and comply with the University of Pennsylvania's Code of Academic Integrity, available at https://catalog.upenn.edu/pennbook/code-of-academic-integrity/. The course director takes academic integrity very seriously. Violations will be reported to the University of Pennsylvania's Center for Community Standards and Accountability. If you have a question about what constitutes academic misconduct, please contact the course director and/or epidemiology PhD program leadership.

You may use artificial intelligence (AI) programs (e.g., ChatGPT) in a <u>very limited capacity</u>, i.e., to help generate ideas and brainstorm. Be aware though that the material generated by AI programs may be inaccurate, incomplete, or otherwise problematic. It may also stifle your own independent thinking and creativity. <u>You may not submit any work generated by an AI program as your own</u>. To be explicit, you may not use an AI program to write or check computer programming code or to generate answers to problem sets or quiz questions. Please review the *[Statement on Guidance for the University of Pennsylvania Community on Use of Generative Artificial Intelligence](#)*, especially the *Guidance for Students* subsection. Remember than any approved use of AI (detailed above) must also be in line with Penn's Code of Student Conduct and the Code of Academic Integrity.

3. Course Information

3.1 Leadership

3.1.1. Course Director

Charles Leonard, PharmD, MSCE, FISPE
Assistant Professor of Epidemiology, DBEI, PSOM
Senior Scholar, Center for Clinical Epidemiology and Biostatistics
Senior Fellow, Leonard Davis Institute of Health Economics
807 Blockley Hall
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3.1.2. Teaching Fellow

Dominique Medaglio, PharmD, MS
PhD Student in Epidemiology, DBEI, PSOM
dmedag@pennmedicine.upenn.edu

3.2. Lecturers (presented alphabetically)

Session lecturers are primary faculty within the Department of Biostatistics, Epidemiology, and Informatics (DBEI), unless otherwise noted.

Dr. Caniglia | ellen.caniglia@pennmedicine.upenn.edu
Dr. Chakraborti | yajnaseni.chakraborti@pennmedicine.upenn.edu | a DBEI postdoctoral researcher
Dr. Getz | getzk@chop.edu
Dr. Harhay | mharhay@pennmedicine.upenn.edu
Dr. Keele | luke.keele@pennmedicine.upenn.edu | Department of Surgery | GGEB affiliate
Dr. Leonard | celeonar@pennmedicine.upenn.edu
Dr. Mumford | sunni.mumford@ pennmedicine.upenn.edu
Dr. Schnellinger | United Network for Organ Sharing, a former epidemiology PhD trainee of the DBEI

3.3. Location

235 Blockley Hall

3.4. Credits

1.0 course unit

3.5. Prerequisite

EPID 7010 and/or at the discretion of the course director. Students are expected to have prior epidemiology and biostatistics experience or training and knowledge of and/or experience in working in biomedical research or a clinical domain.

3.6. Materials (textbooks and biomedical research papers)

Textbooks

Required | Hernán & Robins. Causal Inference: What If. 1st Edition. 2020. 01/02/2024 Update.
Note that a free preprint is available for download here. A hardback print version is scheduled for release in April 2024.

Optional | Lash, VanderWeele, Haneuse, & Rothman. Modern Epidemiology, 4th Edition. 2021.

Papers

Required | Biomedical research papers will typically be preloaded into Canvas by the Course Director. That said, it is ultimately the student's responsibility to find the assigned papers. Navigate to Penn Libraries' Holman Biotech Commons (https://www.library.upenn.edu/biotech-commons) for access to PubMed, Embase, and other relevant health science databases.

3.7. Format

Class is held on Thursdays from **10:15am – 1:15pm Eastern**. The first session is Thursday, 01/18/2024. Please refer to the University of Pennsylvania's academic calendar for other important information.

Lecture

Each session will begin with a faculty-led lecture. Accompanying slide decks will be posted to Canvas prior to the session.

Workshop

Many sessions will also include an activity designed to help students synthesize and/or apply lecture material and/or readings. Activity duration will vary (e.g., 15–90 minutes) yet always be contained within the three-hour class session. Some activities will be faculty-led, while others will be student-led. Regarding the latter: Students will be asked to volunteer to lead a 30- to 45-minute discussion of a methods topic that extends what is presented by the faculty lecturer. As an example, my lecture on self-controlled study designs will be followed by a student-led discussion on the case-time-control design. I understand that such an activity may be challenging, especially since the student will be digesting the method and developing their discussion presentation without yet having heard the faculty member's lecture on foundational concepts. I believe this activity is good practice though for what may occur in real-world career settings, where you will be asked to self-teach then implement a new epidemiologic method. For this reason, student-led methods extension presentations will not be graded.

3.8. Assignments and Evaluation

Problem sets

Approximately five (5) problem sets will be assigned throughout the semester. Unless otherwise instructed, each problem set is due before the next scheduled class. For example, if a problem set is assigned on 01/25/2024, it is

due before class on 02/01/2024. Each problem set will be graded. Late assignments may be penalized (e.g., decrement of 10% per day) at the discretion of the Course Director.

Checkpoint quizzes

Approximately six (6) checkpoint quizzes will be assigned throughout the semester. Note that quiz questions: may be drawn from in-class lecture and workshop material and/or the assigned readings (even if not explicitly covered in class); and may on occasion cover cumulative content. Unless otherwise instructed, each checkpoint quiz must be completed before the next scheduled class. For example, if a checkpoint quiz is released on 02/01/2024, it is due before class on 02/08/2024. Each quiz will be graded. Late quizzes may be assigned zero points at the discretion of the Course Director.

Important clarification

Note that prior iterations of the EPID 7010/7020 sequence required weekly reading journal entries and completion of a final project. The spring 2024 iteration of EPID 7020 does not have these requirements.

Evaluation/grading

Problem sets will count for 45% of one's grade. Checkpoint quizzes will count for 35% of one's grade. Class attendance and participation (quantity and quality) will count for 20% of one's grade.

4. Session Detail

Session	Date	Title	Lecturer(s)
1	01/18/24	Causal inference (Module 1 of 3) **Counterfactuals and directed acyclic graphs**	**Dr. Caniglia (lecture)** **Dr. Leonard (workshop)**
		Required readings	Hernán & Robins Chapter 1 and Chapter 6 (§6.1-6.3)
		Optional readings	Hernán & Robins Chapter 3 (§3.1-3.5)
		Workshop activity	Faculty-led | Estimating causal effects
		Problem set or checkpoint quiz	Neither
2	01/25/24	Causal inference (Module 1 of 3) **Target trials**	**Dr. Mumford (lecture)** **Drs. Leonard and Medaglio (workshop)**
		Required readings	Hernán & Robins Chapter 3 (§3.6) and Chapter 22; and PMID 26994063, 28748498, 28822996
		Optional readings	PMID 34942066, 34972229
		Workshop activity	Faculty-led | Emulating a randomized trial | PMID 28822996
		Problem set or checkpoint quiz	**Problem set #1**
3	02/01/24	Causal inference (Module 1 of 3) **Confounding**	**Dr. Caniglia (pre-recorded lecture)** **Dr. Leonard (live, for workshop)**
		Required readings	Hernán & Robins Chapter 7 and Chapter 12 (§12.1-12.5)
		Optional readings	Lash Chapter 12
		Workshop activity	Student-led methods extension (**Derartu Ahmed**) | Well-defined interventions | At a minimum, should cover PMID 26777446, 27641316
		Problem set or checkpoint quiz	**Checkpoint quiz #1**

4	02/08/24	Causal inference (Module 1 of 3) **Selection bias**	**Dr. Caniglia (pre-recorded lecture)** **Dr. Leonard (live, for workshop)**
		Required readings	Hernán & Robins Chapter 8 and Chapter 12 (§12.6)
		Optional readings	Lash Chapter 14
		Workshop activity	Student-led methods extension (**Jennifer Ko**)	Paradoxes in epidemiologic research	At a minimum, should cover PMID 25460531, 16931543
		Problem set or checkpoint quiz	**Problem set #2** (Adjustment for confounding and selection bias)
5	02/15/24	Causal inference (Module 1 of 3) **Measurement error and misclassification**	**Dr. Chakraborti**
		Required readings	Hernán & Robins Chapter 9 and PMID 15308962, 1591319, 25751609
		Optional readings	Lash Chapter 13
		Workshop activity	Faculty-led	General related methods
		Problem set or checkpoint quiz	**Checkpoint quiz #2**
6	02/22/24	Advanced Study Design (Module 2 of 3) **Longitudinal data collection and clustered study designs**	**Dr. Harhay**
		Required readings	PMID 7873953, 7703752, 9451271, 15911637, 29905618
		Optional readings	Lash Chapter 24
		Workshop activity	Faculty-led
		Problem set or checkpoint quiz	Neither
7	02/29/24	Advanced Study Design (Module 2 of 3) **Self-controlled study designs**	**Dr. Leonard**
		Required readings	PMID 24635348
		Optional readings	PMID 27618829, 24030723
		Workshop activity	Student-led methods extension (**Gaby Zuckerman**)	Case-time control design	At a minimum, should cover PMID 7619931, 9647910
		Problem set or checkpoint quiz	**Checkpoint quiz #3**
X	03/07/24	**NO CLASS: UNIVERSITY'S SPRING BREAK**	
8	03/14/24	Advanced Modeling (Module 3 of 3) **Basics of survival analysis and restricted mean survival time**	**Dr. Harhay**
		Required readings	PMID 29239842, 9836663, 15117797, 9703534, 28546261, 29307954
		Optional readings	Hernán & Robins Chapter 17
		Workshop activity	Faculty-led	Restricted mean survival time estimation
		Problem set or checkpoint quiz	Neither
9	03/21/24	Advanced Modeling (Module 3 of 3)	**Dr. Getz**

		Sensitivity analysis, secondary analysis, and quantitative bias analysis	(Please note: Course Director Leonard is unavailable to co-join on this date due to an unmovable work commitment)
		Required readings	PMID 25080530, 33778845, 29936049
		Optional readings	Lash Chapter 29
		Workshop activity	Student-led methods extension (**Jessica Wong**) | Validation studies
		Problem set or checkpoint quiz	**Problem set #3** (sensitivity analysis)
10	03/28/24	Advanced Modeling (Module 3 of 3) **Longitudinal and clustered modeling (technical)**	**Dr. Schnellinger (live, albeit virtual)**
		Required readings	PMID 18981315 and http://mfviz.com/hierarchical-models/
		Optional readings	None
		Workshop activity	Faculty-led | Longitudinal modeling
		Problem set or checkpoint quiz	**Checkpoint quiz #4**
11	04/04/24	Advanced Study Design (Module 2 of 3) **Quasi-experimental study designs**	**Dr. Keele** (Please note: Teaching Fellow Medaglio is unavailable to co-join on this date due to an unmovable commitment)
		Required readings	Hernán & Robins Chapter 16 and PMID 33978956, 28239929
		Optional readings	Lash Chapter 28 and PMID 27283160, 32879971
		Workshop activity	Student-led methods extension (**Quynh Long Khuong**) | Interrupted time series design | At a minimum, should cover PMID 27283160, 32879971
		Problem set or checkpoint quiz	**Problem set #4** (Instrumental variables)
12	04/11/24	Advanced Modeling (Module 3 of 3) **Mediation**	**Dr. Mumford** (Please note: Course Director Leonard is unavailable to co-join on this date due to an unmovable work commitment)
		Required readings	Hernán & Robins Chapter 23 and PMID 26653405, 27489089
		Optional readings	Lash Chapter 27
		Workshop activity	Faculty-led | Mediation analysis for health disparities research
		Problem set	**Problem set #5**
13	04/18/24	Advanced Modeling (Module 3 of 3) **Propensity scores**	**Dr. Leonard**
		Required reading	PMID 21818162
		Optional readings	Hernán & Robins Chapter 15 and PMID 16632131, 34504033, 19757444, 32460872, https://doi.org/10.1007/s41237-018-0058-8, and https://doi.org/10.1002/jac5.1591
		Workshop activity	Student-led methods extension (**Mattia Mah'moud**) | Disease risk scores | At a minimum, should cover Wyss et al 2016
		Problem set or checkpoint quiz	**Checkpoint quiz #5**

14	04/25/24	Advanced Modeling (Module 3 of 3) **High dimensional propensity scores**	**Dr. Leonard**
		Required readings	PMID 19487948, 29958191
		Optional readings	PMID 36349471
		Workshop activity	Student-led methods extension (**Saiido Noor**)	Combining Super Learner with hdPS to improve confounding adjustment	At a minimum, should cover PMID 37609668
		Problem set or checkpoint quiz	**Checkpoint quiz #6**

5. Acknowledgment