SPPH681A: CAUSAL INFERENCE IN PUBLIC HEALTH SCIENCES

ACKNOWLEDGMENT

In-person classes take place on UBC Point Grey Campus, which is located on the traditional territory of the Musqueam people.

COURSE INFORMATION

Course Title	Course Code Number	Credit Value
Causal Inference in Public Health Sciences	SPPH 681A	3

TIME AND PLACE

1. Term 1, Weekly 3-hour class on Mondays, 2 to 5 pm, Room SPPH102
2. Term 1, Weekly 1-hour tutorial on Thursdays, 9 to 10 am, Room SPPH102

PREREQUISITES

This 600-level course builds on the knowledge and skills acquired in SPPH500, SPPH503, and SPPH548. Working knowledge of statistical software is recommended.

INSTRUCTORS

Prof. Boris Sobolev, office hours: Wednesdays, 9 to 11am, Room 705 at VGH Research Pavilion, or by appointment boris.sobolev@ubc.ca

COURSE DESCRIPTION

Causal inference from observational data is common in health research. The goal of this 3-credit course is to develop knowledge and skills in causal inference. The course offers in-depth coverage of methods of causal analysis developed over the past three decades. We will explore probabilistic causality, causal diagrams, counterfactuals, mediation analysis, and evaluating treatment effects.

COURSE STRUCTURE

The course combines lectures, discussions, and tutorials with in-class and homework assignments based on provided materials. We will use the "flipped classroom" approach. Students are expected to be prepared for each class by reviewing pre-recorded videos, readings, and other materials at home. Class time will involve revisiting topics, group discussions, collaborative work, and evaluation. You will receive a road map for each class in advance. It will detail the learning objectives and provide links to materials to review.

SCHEDULE OF TOPIC

This course consists of 12 modules. For each module, I provide readings, videos and tutorials that complement each other. The readings introduce topics, the videos discuss key ideas, and the tutorials help you apply them in practice. The tutorials will use your knowledge of R from previous courses. Additional tutorials will teach creating and analyzing causal diagrams. Please consult the tentative weekly schedule for details.

RATIONALE FOR TAKING THIS COURSE

This course will be useful for those who analyze data from patient registries, routine medical records, hospital discharges, or research cohorts. After taking it, you will be able to create causal diagrams for your thesis projects, refine your research questions, find variables to adjust, detail your analysis plan, and attempt to estimate causal effects using data from your projects. Whether studying epidemiology, public health, occupational health, or environmental health, you will benefit from the lectures, videos, tutorials, and readings in 681A! We will start by outlining the framework for causal reasoning. You will get a full exposition of causal reasoning. Then you will learn about the conditions for classifying associations as causal. The course will then invite you to master causal reasoning by practical application to real data.

LEARNING OUTCOMES

On completion of the course, students will be able to

(1) explain the framework of causal inference;
(2) develop directed acyclic graphs and identify a minimal sufficient adjustment set;
(3) estimate total, direct and indirect treatment effects from observational data; and
(4) express causal queries through counterfactuals quantities.

ASSESSMENT OF LEARNING

Evaluation will be conducted using a combination of marks for 12 in-class assessments (maximum 24% of the total mark), six homework assignments (36%), and final homework assignment (40%).

In-class assignments

Each class involves assessment of the learning progress in class. The assessment tools will include a combination of multiple-choice tests and short writing exercises covering the content from lectures, in-class discussions and required readings. The assessments provide an opportunity for students to evaluate their own progress through the course and help strengthen their understanding of core concepts and methods. Each test is worth 2 points (**maximum 24 points for 12 tests**).

Homework assignments

Bi-weekly homework assignments will involve various aspects of data analysis and preparing short reports. The quality of each report will be judged by clarity of presentation, suitability of methods, and interpretation of results. Each assignment is worth 6 points (**maximum 36 points for 6 assignments**).

Final report

A final homework assignment will involve data analysis and paper preparation. The paper should contain the following sections: Introduction, Methods, Results, Discussion, and References. Results should be presented in an organized fashion, such as in table or graphical formats. Computer outputs should be edited to eliminate irrelevant or redundant material. The quality of the report will be judged by the suitability of methods, correct computing, interpretation of results, and clarity of presentation (**maximum 40 points**).

AI tools

You may use generative AI tools in this course. However, if you employ them to generate ideas, partial answers, draft or final text for any assignment, you must declare their use. Please also add a couple sentences detailing the extent of their use. You must save any generated text in case requested.

PREPARATION

The student is expected to be prepared for topics discussed in class. Sufficient time should be allocated for reading of required and assigned texts, watching video lectures.

LEARNING MATERIALS

Video lectures:

Course videos are available here http://tiny.cc/CWBsobor

Class road maps:

To help you navigate the course material, I have prepared road maps for each class. There you will find the learning objective for each class, suggested literature, brief summaries and chapters of each video: http://tiny.cc/CWBRM

Lecture slides and handouts of lab tutorials

Selected articles and book chapters:

1. Pearce N, Vandenbroucke JP. Educational note: types of causes. Int. J Epidemiol. 2020;49(2):676-685. DOI: 10.1093/ije/dyz229
2. Clarke GM, Conti S, Wolters AT, Steventon A. Evaluating the impact of healthcare interventions using routine data. BMJ. 2019;365:l2239 doi:10.1136/bmj.l2239
3. Berkson J. Limitations of the applications of fourfold table analysis to hospital data. Int. J Epidemiol 2014: 1-5
4. Maldonado G, Greenland S. Estimating causal effects. Int J Epidemiol 2002;31(2):422-429.
5. Hernán MA. A definition of causal effect for epidemiological research. J Epidemiology & Community Health. 2004;58:265-271
6. Digitale JC, Martin JN, Glymour MM. Tutorial on directed acyclic graphs. J of Clin Epidemiology, 2022;142:264-267
7. Westreich D, Greenland S. The table 2 fallacy: presenting and interpreting confounder and modifier coefficients. Am J Epidemiol. 2013;177(4):292–298
8. Williamson EJ, Aitken Z, Lawrie J, Dharmage SC, Burgess JA, Forbes AB. Causal diagrams. Respirology 2014;19:303-311. https://doi.org/10.1111/resp.12238
9. Elwert F. Graphical Causal Models. In: Morgan SL (ed.), Handbook of Causal Analysis for Social Research: Springer Netherlands; 2013. p. 245-273.
10. Vittinghoff E, Glidden DV, McCulloch CE, Shiboski SC. Chapter 9: Strengthening Causal Inference. Regression Methods in Biostatistics. 2nd ed.: Springer; 2012. p. 331-394.
11. Vittinghoff E, Glidden DV, McCulloch CE, Shiboski SC. Chapter 10: Predictor Selection. Regression Methods in Biostatistics. 2nd ed.: Springer; 2012. p. 395-429.
12. Stuart E. Matching Methods for Causal Inference: A Review and a Look Forward. Statistical Science, 2010; 25(1), 1-21
13. Miettinen O. Stratification by a multivariate confounder score. Am J Epidemiol. 1976;106:609-620
14. Pearl J. Probabilities of causation: three counterfactual interpretations and their identification. Synthese. 1999;121:93-149
15. Tian J, Pearl J. Probabilities of causation: Bounds and identification. Annals of Mathematics and Artificial Intelligence, 2000; 28:287–313
16. Petersen ML, Sinisi SE, van der Laan MJ. Estimation of direct causal effects. Epidemiology 2006;17(3):276-284
17. Richiardi L, Bellocco R, Zugna D, Mediation analysis in epidemiology: methods, interpretation and bias. Int J Epidemiol 2013; 42(5):1511–1519 https://doi.org/10.1093/ije/dyt127

18. Suzuki E, Yamamoto E, Tsuda T. On the relations between excess fraction, attributable fraction, and etiologic fraction. Am J Epidemiol 2012;175(6):567-575.

Further readings:

1. Susser M. Glossary: Causality in Public Health Science. Journal of Epidemiology and Community Health 2001;55(6):376-378.
2. Cattaneo. Journal of Econometrics 2010, 155:147
3. Almond D. The Quarterly Journal of Economics 2005:1031-83
4. Austin PC. Absolute risk reductions, relative risks, relative risk reductions, and numbers needed to treat can be obtained from a logistic regression model. J Clin Epidemiol 2010;63(1):2-6.
5. Holland PW. Statistics and Causal Inference. Journal of the American Statistical Association 1986;81(396):945-960.
6. Textor J, Hardt J, Knüppel S. DAGitty: A Graphical Tool for Analyzing Causal Diagrams. Epidemiology 2011;22(5):745-745.
7. Textor J, Liskiewicz M. Adjustment Criteria in Causal Diagrams: An Algorithmic Perspective. 2012.

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SPPH is committed to providing a positive education experience free from discrimination. If you have had an experience in this course where you feel unsafe, have been mistreated or have witnessed mistreatment, please let us know. If you want to raise this beyond the course instructor, the School recommends the following. You may contact your academic supervisor, the education manager for your program or the Associate Director-Education. You may also report your concerns to the Faculty of Medicine Office of Respectful Environments, Equity, Diversity & Inclusion (REDI) at https://mistreatmenthelp.med.ubc.ca/. Both SPPH and the REDI Office have procedures in place for recording and acting on reports of mistreatment in the educational environment.