

University of Manitoba
Department of Statistics

**STAT 3910 – Intermediate Topics in Statistics with Laboratory:
Biostatistical Research Methods**

Winter Term 2025

Course Details

Course Number & Title: STAT 3910, Intermediate Topics in Statistics with Laboratory:
Biostatistical Research Methods

Section & CRN: STAT 3910 B01 and T01,
CRN 64248 and 64247

Lecture Schedule: Biological Sciences Room 301
Thursday 10:00 AM to 11:15 PM

Lab Schedule: EITC E2 Room 399
Tuesday 2:30 PM to 3:45 PM

Prerequisites: STAT 3100 - Introduction to Statistical Inference
STAT 3450 - Linear Models

Instructor Contact Information

Instructor: Sumeet Kalia

Office Location: 256 Parker Building

Email: Sumeet.Kalia@umanitoba.ca

Office Hours: Help Centre in 107 Allen
Thursday 11:30 PM to 1:00 PM.
by appointment (for individual meetings)
I'm also generally available after class or by appointment.
Changes/additions to be announced on UMLearn.

Teaching Assistant (TA) Contact Information

Teaching Assistant: Alamgir Chowdhury

Email: chowdh62@myumanitoba.ca

Office Hours: by appointment (for individual meetings)

Course Description

This topics course is an introduction to modern causal inference theory and methods applicable to epidemiological research. The presentation of this course is aimed for students interested in the application of statistics in the context of health research. As a motivation, we quote Miettinen and Karp (2012, “Epidemiological Research: An Introduction”) who points out causality is inherently unobservable:

“Research on etiogenesis of morbidity - or of illness per se - is, by the very nature of this genre of causation in medicine, generally bound to be non-experimental; but a much greater added challenge is that causation is not a phenomenon, subject to observation; it is a ‘conception a priori,’ a noumenon (Kant), needing to be inferred from phenomenal patterns.”

Causal inference needs to be defined and understood using a conceptual framework with necessary identifiability assumptions. Under such framework, a causal estimand can be specified to measure the causal effect by linking the counterfactual quantity with observed data. Subsequently, inferential statistics can then be used to produce evidence, and make conclusive statements. Such statements may focus on etiognosis (relating to causes of disease) or intervention-prognosis (relating to effects of treatments). A challenge in causal inference using non-experimental (i.e., observational) data is measured confounding: a non-causal explanation for an observed association between hypothesized “cause” and “effect”.

Novel statistical methods to control for measured (and unmeasured) confounding have a major role in causal inference. This course will introduce students to the potential outcome (counterfactual) model for causation, and also conceptual frameworks such as causal diagrams. The statistical methods covered in the point treatment setting will include propensity score estimation, direct standardization/g-computation, marginal structural models estimated using inverse probability of treatment weighting, doubly robust estimation, instrumental variables and principal stratification. An extension to causal inference in longitudinal settings with time-dependent treatment-confounder feedback, mediation analysis will also be covered. R statistical environment will be used for instruction.

Course Delivery

Lecture Delivery: This class will be delivered through in-person teaching: all the lectures and labs for this course will be delivered synchronously, in a traditional classroom setting. Currently, there are no plans to have any remote lectures.

COVID-19 Policy: Although that may change during the term, the current policy regarding COVID-19 stipulates that proof of vaccination and masks are no longer required to come to campus. This being said, please wear a mask or stay at home if you are feeling unwell. I will be posting scanned notes from class after each lecture in order to help students keep up with the pace of the course even after missing a lecture. I’m happy to hold individual meetings and office hours virtually via Zoom to accommodate students that are self-isolating.

Textbook and Other Materials

Textbook: The following text can be used as a reference on the topics discussed in this course:

1. Hernán MA, Robins JM (2020). Causal Inference: What If. Boca Raton: Chapman & Hall/CRC.
2. Ding, P. (2023). A First Course in Causal Inference. arXiv preprint arXiv:2305.18793.

Both texts are freely available online. In addition, selected recent articles and tutorial papers in the field will be introduced and discussed, as listed in the weekly readings.

Other Materials: Lecture notes, reading material, assignments, practice problems will be added to the [UM Learn portal](#) regularly.

Assessments and Grading Scheme

Final Mark: The final mark for the course will be allocated with the following rule:

Three Assignments	75%
Oral Presentation and Report	25%

Assignments: Three assignments will count towards 75% of the course grade. Assignments will contain hands-on exercise, and evaluation material derived from the content discussed during the lecture. Students are expected to submit the electronic copy of the assignments on the due dates (listed below).

Presentation: Students will find (or select) a published paper in the clinical, epidemiological, or health services research literature that presents a causal analysis. Students will get an approval on the selected paper by the instructor. A student will give a 20 minutes presentation critically appraising the selected publication followed by Question and Answer period. A minimum 6 slides and maximum 18 slides are allowed. The presentation will be evaluated using the following rubric:

- Identify study objective (2 mark).
- Describe the method section including design, variables, statistical analysis, and any sensitivity or secondary analysis (6 marks).
- Describe study results and conclusion (3 marks).
- Comment on the study design and analysis, strengths and limitations, as well as suggestions for future research (3 marks).
- Discussion on Question and Answer Period (1 mark).

Report: Students will provide a written summary appraising the selected publication along with presentation slides. The written report must be less than three pages (double spaced), and contain the following sections:

- Identify study objective (2 mark).
- Describe the method section including design, variables, statistical analysis, and any sensitivity or secondary analysis (3 marks).
- Describe study results (1 mark).
- Comment on the study design and analysis, strengths and limitations, as well as suggestions for future research (3 marks).
- State the conclusion of the study (1 mark).

Late Submission: A penalty of 10% will apply to the grades per day if the assignment is submitted after the due date. Assignments will not be accepted three days after the due date. No attendance at the presentation will result in a grade of zero unless a prior arrangement for alternative date is agreed upon with the instructor.

Letter Grade: The following cutoffs will be used to assign letter grades:

Letter Grade	Mark out of 100	Letter Grade	Mark out of 100
A+	90-100	C+	65-70
A	80-90	C	60-65
B+	75-80	D	50-60
B	70-75	F	below 50

Grading timeline: Under normal circumstances, results should be available within two to three weeks of submission.

Important Dates

The following dates are important as to how the course will progress throughout the term.

Date	Information
Jan 9	First Lecture
Jan 14	First Lab
Jan 20	End of the Registration Revision Period
Jan 30	Assignment 1 Due*
Feb 27	Assignment 2 Due*
Mar 20	Assignment 3 Due*
Mar 19	Last day to voluntary withdraw (VW) the course
Mar 27	Presentations start
Apr 8	Presentations end
Apr 9	Report Due

*Assignments will be released at least two weeks prior to the due date.

Outline of Lecture Topics

Timeline	Topics
Week 1 (Jan 9)	Introduction to Biostatistics and Epidemiology
Week 2 (Jan 16)	Randomized Experiments and Observational Studies
Week 3 (Jan 23)	Effect Modification and Interaction
Week 4 (Jan 30)	Causal Inference Framework
Week 5 (Feb 6)	Causal inference in Point Treatment Setting
Week 6 (Feb 13)	Causal Inference in High Dimensional Setting
Week 7 (Feb 20)	Winter term break (no classes or lab)
Week 8 (Feb 27)	Instrumental Variable Estimation
Week 9 (Mar 6)	Causal Mediation Analysis
Week 10 (Mar 13)	Sensitivity Analysis
Week 11 (Mar 20)	Target Trial Emulation
Week 12 (Mar 27)	Presentations
Week 13 (Apr 3)	Presentations

Outline of Tutorial Topics

Timeline	Topics
Week 1 (Jan 7)	No Lab
Week 2 (Jan 14)	Introduction to R
Week 3 (Jan 21)	Study design and rates in R
Week 4 (Jan 28)	Effect modification and interaction in R
Week 5 (Feb 4)	Directed acyclic graphs in R
Week 6 (Feb 11)	Causal inference methods with point treatment in R
Week 7 (Feb 18)	Winter term break (no classes or lab)
Week 8 (Feb 25)	Causal inference methods with time-dependent treatment in R
Week 9 (Mar 4)	Instrumental Variable Analysis in R
Week 12 (Mar 11)	NHANES data analysis in R
Week 10 (Mar 18)	Causal Mediation analysis in R
Week 11 (Mar 25)	Causal Sensitivity analysis in R
Week 13 (Apr 1)	Presentations
Week 14 (Apr 8)	Presentations (if needed)

The dates and covered materials are tentative (and subject to change at instructors' discretion).

Respectful Behaviour and Use of Technology in the Classroom

It is expected that you conduct yourself professionally and do not distract your fellow students while in the classroom. It is also a general University of Manitoba policy that all technology resources are to be used in a responsible, efficient, ethical and legal manner. Students should restrict their use of technology to those approved by the instructor *for educational purposes only*. Electronic messaging, email, social networking, gaming, etc. should be avoided during class time. Cell phones should be turned off. If a student is on call for emergencies, their cell phone should be in vibrate mode and the student should leave the classroom before using it.

Class Communications

The University requires all students to activate an official U of M email account. You should be using this for all communications between you and me (and, in fact anything related to the university, including all your instructors). All these email communications should comply with the University's policy on electronic communication with students, which can be found at

umanitoba.ca/governance/governing-documents/governing-documents-university-community

When emailing me, please make sure to follow proper email etiquette: emails should start with an opening salutation, be written in complete English sentences and be signed with your name and student number. I will generally reply to emails within 24-48 hours, depending on the urgency of the situation and my availability, except during weekends. Note that I will not divulge grades over email.

Copyrights

Copyrighted Materials: We will use copyrighted content in this course. I have ensured that the content I use is appropriately acknowledged and is copied in accordance with copyright laws and University guidelines. Copyright works, including those created by me, are made available for private study and research and must not be distributed in any format without permission.

In particular, note that you do not have permission to upload any course content used for this course to any note sharing websites. Videos and other recordings available through UMLearn are meant for your own personal use only.

Lectures: No audio or video recording of lectures or presentations is allowed in any format, openly or surreptitiously, in whole or in part without my permission.

More details are available online at www.umanitoba.ca/copyright/.

Academic Integrity

The value of a degree from the University of Manitoba is dependent on students and faculty strictly upholding values of honesty and academic integrity in all their work. Academic dishonesty devalues the hard work and effort of students who are working honestly to achieve their degrees. For these reasons, it is important that you understand the basics of academic integrity, what constitutes academic dishonesty and what are its very serious consequences. Useful resources can be found at

umanitoba.ca/student-supports/academic-supports/academic-integrity

and

umanitoba.ca/science/student-experience/academic-integrity

I generally expect students to hold themselves to the highest standards of academic integrity. Impersonation, plagiarism, and using unauthorized materials are all very serious offences. When in doubt, it is generally a good idea to contact your instructor to discuss what is and what is not allowed. Asking is a sign of integrity, not a signal that you are planning to cheat. All your instructors expect you to follow the rules: ignorance is not an acceptable excuse for academic misconduct.

Generative artificial intelligence tools (genAI)

The use of generative artificial intelligence tools (genAI) or apps for assignments and final report in this course, including tools like ChatGPT and other AI writing or coding assistants, is prohibited. Use of genAI in this course may be considered use of an unauthorized aid, which is a form of cheating. The knowing use of genAI tools, including ChatGPT and other AI writing and coding assistants, for any form of academic assessment may be considered as academic misconduct in this course. Students may not copy or paraphrase from any genAI applications, including ChatGPT and other AI writing and coding assistants, for the purpose of completing assignments and final report in this course. This course policy is designed to promote your learning and intellectual development and to help you reach course learning outcomes.

ROASS Schedule A

Schedule “A” of the *Responsibilities of Academic Staff with regards to Students* (ROASS) policies of the Faculty of Science at the University of Manitoba lists resources and policies for students. It is important that you familiarize yourself with these resources and policies. This document is available in UMLearn in the *Syllabus and Course Notes* folder for the course.