QUEEN'S UNIVERSITY
Department of Public Health Sciences

EPID 821   **Essentials of Biostatistics**   **Fall 2022**

Course Instructor and Coordinator:

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SAS Instructors:

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Lecture Time and Location: Tuesdays, 8:30am - 10:00am and Thursdays, 8:30am - 10:00am, Carruthers Hall Room 102.

SAS Labs Time and Location: Thursdays, 10:45am - 12:45pm, Law Building 002

Tutorial Time and Location: TBD

Prerequisites: Appropriate quantitative skills at an undergraduate-level course in mathematics, statistics or data analysis.

Course Web Sites: A course web page at OnQ (https://onq.queensu.ca/) is available and used throughout the teaching. All course materials and announcements for this course will be posted there.

Learning Objectives: This course provides an overview of basic statistical concepts, principles, and techniques essential for public health and epidemiologic research. This course covers both descriptive and inferential statistics. Topics covered include measures of association, t-tests, regression, chi-square tests, analysis of variance, and some nonparametric methods. Emphasis is on understanding and interpreting fundamental statistical analyses from health research. By the end to the course, successful students will be able to

- define and apply fundamental statistical terminology;
- create and interpret descriptive summaries of health data;
- determine appropriate statistical methodology for health research projects;
- understand the basic principles that underlie research designs and statistical inference;
- interpret output from fundamental statistical analyses in health research projects;
- critically evaluate the use of basic statistical analyses in public health literature.

The SAS labs (for those who are interested in it or will take EPID 822) will provide an opportunity to learn SAS software for basic data analysis from experienced SAS instructors.

Reference Books: Rosner, B. *Fundamentals of Biostatistics*, Brooks/Cole, Cengage Learning, 8th edition, 2016. This book is available in the campus bookstore. A copy is reserved in Bracken Health Sciences Library for 3-hour loan.

Other reference books:

- Motulsky, H. (2014). Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking. Oxford University Press, USA.
- Daniel, W. (2009). Biostatistics: A Foundation for Analysis in the Health Sciences, Wiley, USA.
- Rossi RJ. (2010). Applied Biostatistics for the Health Sciences, Wiley, USA.

Evaluation: The final grade of this course will be based on the following evaluations:

	With SAS	Without SAS
Assignments (6)	45%	45%
Midterm Exam	15%	20%
Final Exam	30%	35%
SAS	10%	0%

Please note:

- The weights on the evaluations are different between those who choose to do SAS labs and those who choose not to do SAS labs. **If you are going to take EPID 822, you must take and pass the SAS evaluation.**
- The minimum passing grade in Graduate School is 70% for this course.
- Late assignments without valid reasons will only receive 75% of marks if handed in before solutions are posted.
- There will be no make-up exams and homework assignments. Students who miss any of these evaluations for a VALID REASON (proof required) will have the percentages of the missed evaluations to the remaining evaluations.

- Students who request accommodation should go through Queen's accessibility services and their Program Director (rather than course instructors):

Calculator: A non-programmable and non-graphical calculator can be useful in this course, particularly in exams.

Tentative Weekly Schedule for Lectures:

<u>Week 1:</u> Overview and Descriptive Statistics

The importance of implementing basic statistics in medicine will be illustrated with real examples that show the clinical and societal gains. This session will introduce different types of data and studies one may encounter in medical research, and ways of presenting data both numerically (quantitatively) and graphically. Some commonly used statistics for summarizing data and describing distributions will be presented. Variation involved in the data will be emphasized.

- Statistics in medical research
- Population and samples
- Tables and graphs for nominal, ordinal, and numerical data
- Measures of centrality and spread (dispersion)

Reading: Rosner (Chapter 1 and 2)

<u>Week 2:</u> Probability

The concept of probability and its relation to statistics in handling variability and uncertainty will be introduced.

- Multiplication law and addition law of probability
- Bayes rule and screening tests
- Prevalence and incidence
- Sensitivity and specificity

Reading: Rosner (Chapter 3)

<u>Week 3:</u> Important Distributions

This session will introduce some probability distributions commonly used for basic statistical inference.

- Bernoulli distribution
- Binomial distribution
- Poisson distribution
- Normal distribution

Reading: Rosner (Chapter 4 & 5)

<u>Week 4:</u> Sampling Distribution

This session will introduce the behaviour of the sample mean, which forms the basis for many statistical inference methods

- Student's t-distribution
- χ^2 distribution

- F distribution
- Estimation of the mean of a population
- Standard deviation and standard error
- Sample distribution and Central-Limit Theorem
- Confidence interval

Reading: Rosner (Chapter 6)

Week 5: Hypothesis testing

There are two principles behind the two basic approaches to statistical analysis – estimation and hypothesis testing. This session will introduce the basic concepts of hypothesis testing.

- Estimation for the binomial distribution
- Estimation for the Poisson distribution
- General concepts (type I and II errors, power, p-value, one-sided versus two-sided tests)
- One-sample test for the mean with known variance
- The power of a test
- Sample size determination
- Hypothesis testing versus confidence intervals

Reading: Rosner (Chapter 6 & 7)

Week 6: One-sample Inference

This session will focus on one sample test procedures and confidence intervals.

- One-sample t test
- One-sample test for a binomial proportion
- One-sample inference for an incidence rate (Poisson distribution)

Reading: Rosner (Chapter 7)

Week 7: Two-sample Inference for Continuous Data

This session will focus on two-sample test procedures for continuous data. Both parametric and non-parametric methods will be introduced.

- Two sample t test for independent sample
- Paired t test for dependent sample
- Testing for the equality of two variances (F test)
- The sign test
- Wilcoxon signed rank test
- Wilcoxon rank sum test

Reading: Rosner (Chapter 8 & 9)

Week 8: Hypothesis Testing for Categorical Data

This session will introduce two-sample test procedures for binomial data.

- Two-sample test for binomial proportions
- Chi-square (χ^2) test
- Fisher's exact test
- Two-sample test for binomial proportions for matched-pair data

Reading: Rosner (Chapter 10)

Week 9: Hypothesis Testing for Categorical Data (cont'd)

This session will continue with the last lecture to introduce additional hypothesis test procedures for the analysis of categorical data.

- Measure of effect for categorical data (e.g. risk ratio and odds ratio)
- R by C contingency tables
- Chi-square test for trend
- Comparing risks and combining several 2 by 2 tables (Mantel-Haenszel test)
- Chi-square goodness of fit test
- Kappa statistic

Reading: Rosner (Chapter 10 & 13)

Week 10: Correlation and Simple Linear Regression

This session will introduce two statistical methods, (i) the correlation coefficients, which measure how strong a relationship is between two variables, and (ii) the simple linear regression, which models the relationship between a dependent variable and an explanatory variable

- The correlation coefficients
- Statistical Inference for correlation coefficients
- Rank correlation
- Interpretation and presentation of correlation
- The simple linear regression and method of least squares
- Inference about parameters from regression lines
- Assessing the goodness of fit of regression lines

Reading: Rosner (Chapter 11)

Week 11: Multisample Inference

This session will introduce hypothesis test procedures for comparing more than two samples. Both parametric and non-parametric methods will be introduced.

- One-Way ANOVA
- Comparisons of specific groups in One-Way ANOVA
- Non-Parametric One-Way ANOVA (Kruskal-Wallis Test)
- Two-Way ANOVA

Reading: Rosner (Chapter 12)

Week 12: Additional Topics and Review

This session will provide an overview of more advanced statistical analysis methods for different types of data. This session will also provide a review of the concepts learned throughout this course. Possible additional topics to be introduced include

- Multiple regression
- Logistic regression
- Poisson regression
- Analysis of time to event data

Statement on Academic Integrity

Queen's students, faculty, administrators and staff all have responsibilities for upholding the fundamental values of academic integrity; honesty, trust, fairness, respect, responsibility and courage. See

www.academicintegrity.org

These values are central to the building, nurturing and sustaining of an aca-demic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University. See the Senate Report on Principles and Priorities

http://www.queensu.ca/secretariat/policies/senate/report-principles-and-priorities

Students are responsible for familiarizing themselves with the regulations concerning academic integrity and for ensuring that their assignments and their behaviour conform to the principles of aca-demic integrity. Information on academic integrity is available in the SGS Calendar

https://www.queensu.ca/sgs/graduate-calendar/academic-integrity-policy

and from the instructor of this course. Departures from academic integrity include plagiarism, use of unauthorized materials, facilitation, forgery, falsification and unauthorized use of intellectual property, and are antithetical to the development of an academic community at Queen's. Given the seriousness of these matters, actions which contravene the regulation on academic integrity carry sanctions that can range from a warning or the loss of grades on an assignment to the failure of a course to a requirement to withdraw from the university.

Statement on Copyright of Course Materials

Course materials created by the course instructor, including all slides, presentations, handouts, tests, exams, and other similar course materials, are the intellectual property of the instructor. It is a departure from academic integrity to distribute, publicly post, sell or otherwise disseminate an instructor's course materials or to provide an instructor's course materials to anyone else for distribution, posting, sale or other means of dissemination, without the instructor's express consent. A student who engages in such conduct may be subject to penalty for a departure from academic integrity and may also face adverse legal consequences for infringement of intellectual property rights.

Statement on Academic Accommodations for Students with Disabilities

Queen's University is committed to achieving full accessibility for people with disabilities. Part of this com-mitment includes arranging academic accommodations for students with disabilities to ensure they have an equitable opportunity to participate in all of their academic activities. The Senate Policy for Accommo-dations for Students with Disabilities was approved at Senate in November 2016. See

https://www.queensu.ca/secretariat/sites/webpublish.queensu.ca.uslcwww/
files/files/policies/senateandtrustees/ACADACCOMMPOLICY2016.pdf

If you are a student with a disability and think you may need academic accommodations, you are strongly encouraged to contact the Queen's Student Accessibility Services (QSAS) and register as early as possible. For more information, including important deadlines, please visit the QSAS website at:

Statement on Academic Consideration for Students with Extenuating Circumstances

Queen's University is committed to providing academic consideration to students experiencing extenuating circumstances that are beyond their control and are interfering with their ability to complete academic requirements related to a course for a short period of time. The Senate Policy on Academic Consideration for Students in Extenuating Circumstances is available at

http://www.queensu.ca/secretariat/sites/webpublish.queensu.ca.uslcwww/files/files/policies/senateandtrustees/Academic%20Considerations%20for%20Extenuating%20Circumstances%20Policy%20Final.pdf

Each Faculty has developed a protocol to provide a consistent and equitable approach in dealing with re-quests for academic consideration for students facing extenuating circumstances. SGS students can find the Academic consideration information at:

https://www.queensu.ca/sgs/accommodation-and-academic-consideration

If you need to request academic consideration for this course, you will be required to provide the name and email address of the instructor/coordinator. Please use the following: Instructor/Coordinator Name: Instructor/Coordinator email address:

Statement on Use and Retention of Video Recording (if using) Synchronous (live) classes will be delivered in this course through a video conferencing platform supported by the University [MS Teams, Zoom]. Steps have been taken by the University to configure these platforms in a secure manner. Classes will be recorded with video and audio (and in some cases transcription) and will be made available to students in the course for the duration of the term. The recordings may capture your name, image or voice through the video and audio recordings. By attending these live classes, you are consenting to the collection of this information for the purposes of administering the class and associ-ated coursework. If you are concerned about the collection of your name and other personal information in the class, please contact the course instructor to identify possible alternatives.

To learn more about how your personal information is collected, used and disclosed by Queen's University, please see the general Notice of Collection, Use and Disclosure of Personal Information. See

https://www.queensu.ca/accessandprivacy/privacy/notice-collection

Statements on Remote Proctoring (if using)

a) All students must be informed at the start of the course that the instructor will be using a remote proc-toring tool for tests/exams. In addition, it is recommended that instructors also address the use of the chosen remote proctoring tool at the outset of the course, whether the proctoring will be live or rec-orded, and the importance of academic integrity with students. The course syllabus must therefore contain the following statements for students:

The final exam and some tests/quizzes in this course will use remote proctoring provided by a third-party, cloud-based service that enables the completion of a proctored exam or test from an off-campus location, through onQ or Elentra. This online proctoring solution was chosen as part of the approach to maintaining academic integrity in online assessment. Precise details about how remote proctoring will be used in this course can be found in the "Getting Started with Remote Proctoring" content module in onQ or will be provided by the instructor.

When writing tests/exams using remote proctoring, you are connecting to the third-party service. Queen's has conducted a privacy and security review of the services in accordance with Ontario's privacy legislation, and has entered into binding agreements with Examity/Proctortrack.

You should also take measures yourself to protect your information by keeping your NetID password and challenge questions private, closing all applications prior to starting an exam/test, and ensuring your device is updated and safeguarded against malware.

For more information about remote proctoring, see the Student FAQs on the OUR Exams resource page for remote proctoring:

http://www.queensu.ca/registrar/students/examinations/exams-office-services/remote-proctoring

b) The course syllabus must contain the following statement for students who require academic accom-modations in their exams as authorized by QSAS:

To have your accommodations applied to a remote-proctored exam please follow the instructions for the course, as outlined on the QSAS website. Your exam accommodations, as authorized by your Letter of Accommodation, will be incorporated into your Examity/Proctortrack exam session. Please note that exam accommodations that are uploaded for a specific exam are only visible to students once they begin their exam in the Exam Portal.

c) Additional information related to academic integrity in the context of remotely-proctored exams should be included for courses where exams will be monitored by remote proctoring.

Departures from academic integrity include plagiarism, use of unauthorized materials or services, facilitation, forgery, falsification, unauthorized use of intellectual property, and collaboration, and are antithetical to the development of an academic community at Queen's. Given the seriousness of these matters, actions which contravene the regulation on academic integrity carry sanctions that can range from a warning or the loss of grades on an assignment to the failure of a course to a requirement to with-draw from the University. In the case of online exams, impersonating another student, copying from another student, making information available to another student about the exam questions or possible answers, communicating with another person during an exam or about an exam during the exam window, or accessing unauthorized materials, including smart devices, are actions in contravention of academic integrity.