EPID 821

Introductory Biostatistics

Instructor:

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Lecture Time: Wednesdays and Thursdays, 9:30–11:00am
Lecture Room: Chernoff Hall 117 on Wednesdays; Richardson Lab 104 on Thursdays

Tutorial Time: Thursdays, 1:00–2:30pm
Tutorial Room: Ellis Hall 324

Office Hour: Fridays 11:00–12:00pm, Carruthers Hall, 209
TA Office Hours: TBD

Course Description: This course introduces the basic statistical concepts, principles and techniques essential for community health and epidemiologic research. Topics include descriptive statistics, probability distribution, estimation, hypothesis testing, simple linear regression, correlation and measures of association, and some nonparametric methods.

Prerequisites: Appropriate quantitative skills; Undergraduate-level course in mathematics, statistics or data analysis

Course Web Site: OnQ is used throughout the teaching of the course (onq.queensu.ca). All course materials and announcements for this course will be posted there.

Learning Objectives: By the end to the course, succesful 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;
− interpret output from fundamental statistical analyses in health research projects;
− critically evaluate the use of statistical analyses in medical literature.

Course Notes: EPID 821: Introductory Biostatistics, Miu Lam and Michael McIsaac

(a copy of the book is reserved in Bracken Health Sciences Library for 3-hour loan).

Other reference books:


**Evaluation:**

Students will be evaluated in the following aspects:

- Assignments 30%
- Midterm exam (Wed, Oct 25, 9:30am–12:30pm; Kinesiology 101) 35%
- Final exam (Wed, Dec 13, 9:30am–12:30pm; Kinesiology 101) 35%

Please note:

- The minimum passing grade in Graduate School is 70% for this course.
- The midterm and final exams are closed-book. Students are allowed to have one sheet (letter size; two-sided) of formulas prepared by themselves and a non-programmable and non-graphical calculator in the exams.
- Late assignments without valid reasons will receive a maximum of 75% of the achieved mark if handed in before solutions are posted.

**Section Information:**

1. **Overview of Biostatistics:** (Sep 13)

The importance of implementing basic statistics in medicine will be illustrated with real examples that show the clinical and societal gains. An introductory session describes different types of data and studies one may encounter in medical research.

- Statistics in medical research
- Population and samples

**Reading:**

- Course Notes: Chapter 1
- Rosner: Chapters 1

2. **Descriptive Statistics and Probability:** (Sep 14)

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

- Tables and graphs for nominal, ordinal, and numerical data
- Measures of centrality and spread (dispersion)
- Variation in data
- Multiplication law and addition law of probability
- Bayes rule and screening tests
- Prevalence and incidence

**Reading:**

- Course Notes: Chapter 2
- Rosner: Chapters 2 & 3
3. Important Distributions: (Sep 20)
This session will also introduce some probability distributions commonly used for testing hypotheses and inference.
- Bernoulli distribution
- Binomial distribution
- Poisson distribution
- Normal distribution

Reading:
- Course Notes: Chapter 3
- Rosner: Chapters 4 & 5

4. Estimation: (Sep 21, 27)
There are two principles behind the two basic approaches to statistical analysis: estimation and hypothesis testing. This session will introduce the concepts of estimation.
- Population and sample (revisit)
- Estimation of the mean of a population
- Standard deviation and standard error
- Sample distribution and Central-Limit Theorem
- Confidence interval
- Student’s $t$-distribution
- Estimation for the binomial distribution
- Estimation for the Poisson distribution

Reading:
- Course Notes: Chapter 4
- Rosner: Chapter 6

5. Hypothesis testing: One-sample Inference: (Sep 28, Oct 4, 5)
These sessions will introduce the basic concepts of hypothesis testing. Hypotheses generated from epidemiologic studies will be discussed. One sample test procedures will be covered in these sessions.
- 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
- One-sample $t$ test
- The power of a test
- Sample size determination
- Hypothesis testing versus confidence intervals
- One-sample test for a binomial proportion
- One-sample inference for an incidence rate (Poisson distribution)

Reading:
- Course Notes: Chapter 5
- Rosner: Chapter 7
6. **Hypothesis testing: Two-sample Inference:**  
(Oct 11, 12, 18)

This session continues with the hypothesis testing procedures by comparing two groups of observations with respect to continuous data. Both parametric and non-parametric approaches will be introduced.

- Choosing an appropriate method of analysis
- The paired *t* test
- Wilcoxon signed rank test
- Confidence intervals (paired samples)
- Two-sample *t* test (equal variances)
- Confidence intervals (two independent samples)
- Testing for the equality of two variances (F test)
- Wilcoxon rank sum test
- Sample size and power

**Reading:**

- **Course Notes: Chapter 6**
- Rosner: Chapter 8 & 9

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7. **Analysis of Categorical Data:**  
(Oct 19, 26, Nov 1, 2, 8)

(Oct 25: Midterm covering sessions 1 to 6)

These sessions introduce confidence intervals and hypothesis testing for comparing proportions. The analysis of frequency (contingency) tables with Chi-square distribution will be presented. They are most relevant for epidemiologic data.

- Two-sample test for binomial proportions
- Chi-square test
- Relative risk and odds ratio
- Fishers exact test
- Two paired proportions (McNemar’s test)
- *r* × *c* contingency tables
- Chi-square test for trend
- Confounding and standardization
- Comparing risks and combining several 2 × 2 tables (Mantel-Haenszel test)
- Chi-square goodness of fit test
- Kappa statistic

**Reading:**

- **Course Notes: Chapter 7**
- Rosner: Chapters 10 & 13

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8. Regression and Correlation:  
(Nov 9, 15, 16, 22)
These sessions devote to two statistical techniques: (i) correlation, which is used to assess association between two variables and (ii) simple linear regression, which enables the value of one variable to be predicted from the other variable.

- General concepts
- Method of least squares
- Hypothesis testing
- Goodness of fit
- Interpretation of regression
- Correlation
- Statistical inference
- Use and misuse of correlation
- Rank correlation
- Interpretation and presentation of correlation

Reading:
- Course Notes: Chapter 8
- Rosner: Chapter 11

9. One-Way Analysis of Variance (ANOVA):  
(Nov 23, 29)
This session provides the statistical methods to simultaneously compare more than two samples (groups). It generalizes the two sample t-test methodology given in Session 6.

- Example and logic for one-way ANOVA
- Variation between groups and within groups
- ANOVA table and F test
- Multiple comparisons to deal with the problem of multiple testings.
- Non-parametric one-way ANOVA - Kruskal-Wallis test

Reading:
- Course Notes: Chapter 9
- Rosner: Chapter 12 (12.1 - 12.5)

10. Additional Topics and Review:  
(Nov 30)
This session provides a glimpse into more advanced statistical methodology. This session will involve a review of the concepts learned throughout this course and will help show how these concepts provide a foundation for future learning. Possible methodology to be introduced includes

- Multiple Regression
- Logistic Regression
- Time to Event Data
- Missing Data
- Propensity Scores
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