Bioengineering

Lecture 1: Biostatistics Primer

William Okech, PhD (Instructor)
2025

Outline

1. Class Logistics
2. Biological Data and Biostatisticians
3. Basic Biostatistical Concepts
4. Required Readings

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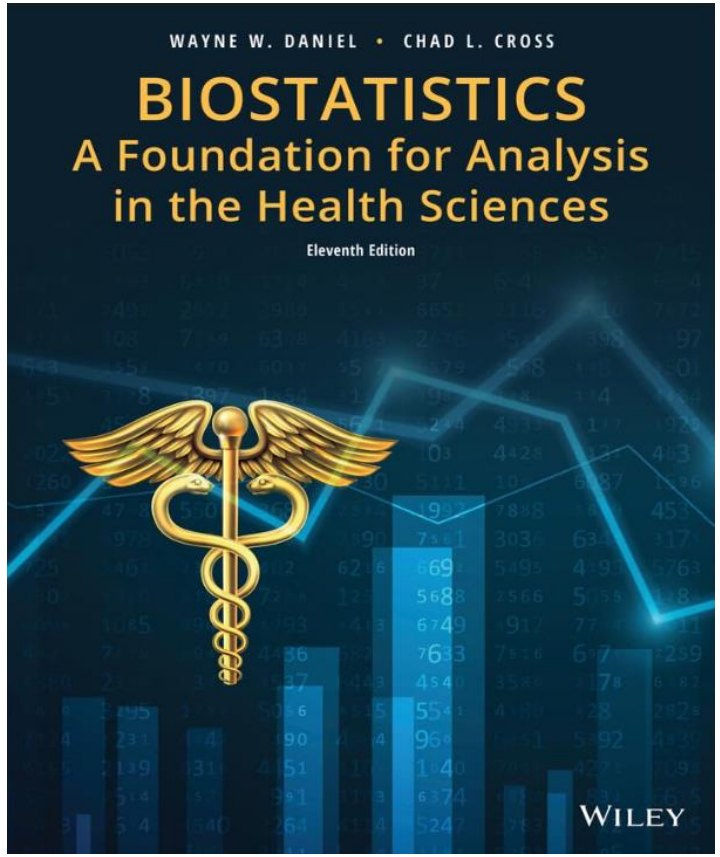
Class Policies

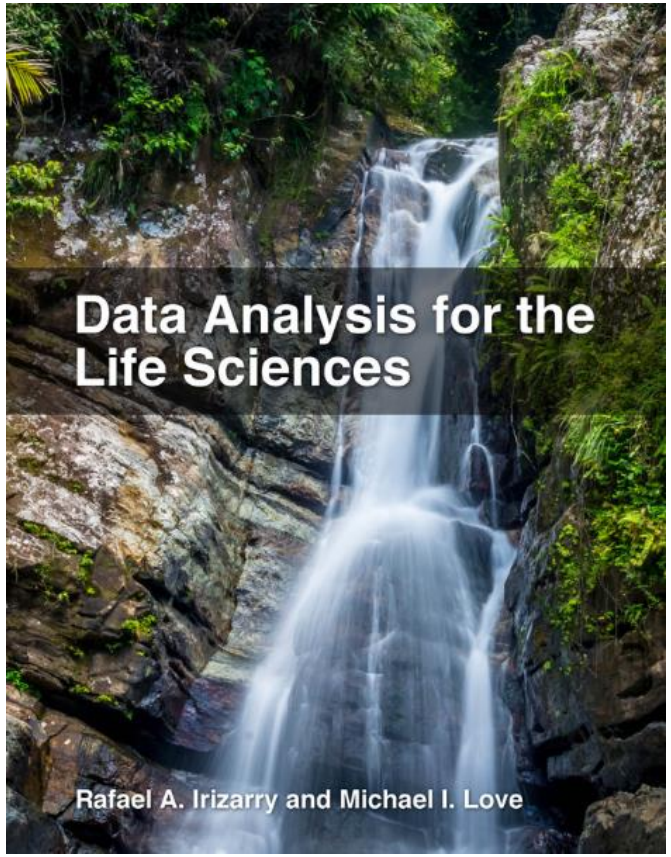
Expectations: To ensure a safe learning environment please treat each other with respect.

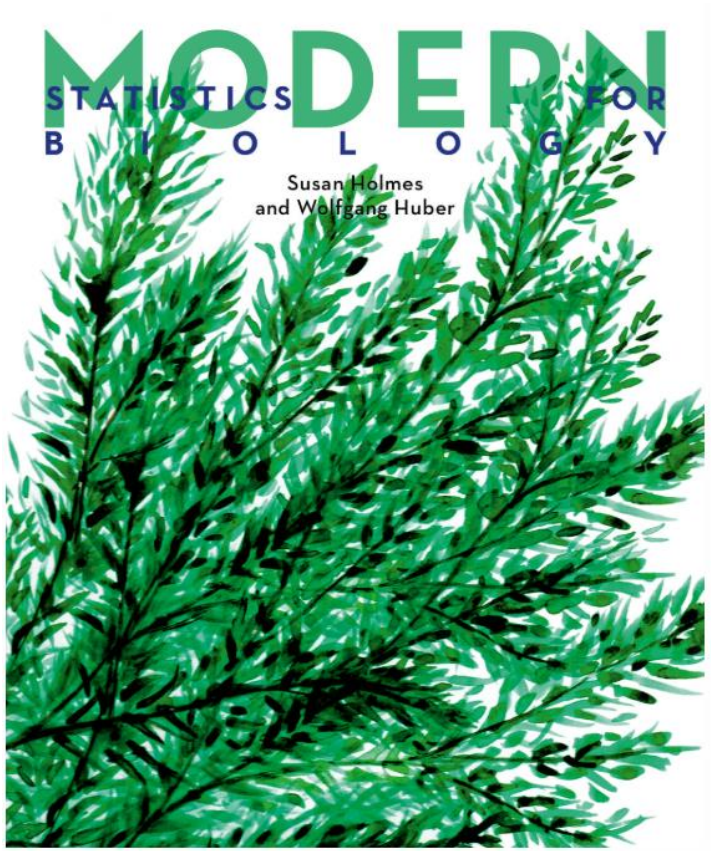
Attendance: Course is run using an in-person format and attendance is mandatory unless explicit permission is obtained from the instructor.

Assignments: Late homework and lab reports will not be accepted unless extensions have been requested in advance.

Reference Textbooks







Reference texts are available online and/or in the library.

Outline

1. Class Logistics ✓
2. Biological Data and Biostatisticians
3. Brief overview of Basic Biostatistical Concepts
4. Required Readings

Biological Data is Everywhere!

How is this data collected?

Biological Samples

Scientists and Clinicians

Data Analysts

BIOSTATISTICIANS

Note: Images obtained from https://bioart.niaid.nih.gov/

What is the role of a biostatistician?

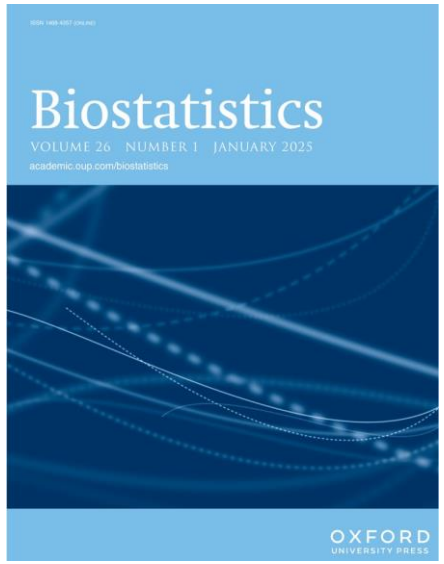
- A biostatistician “develops, implements, and applies statistical methods to analyze and interpret data in the fields of biology, medicine, and public health.”

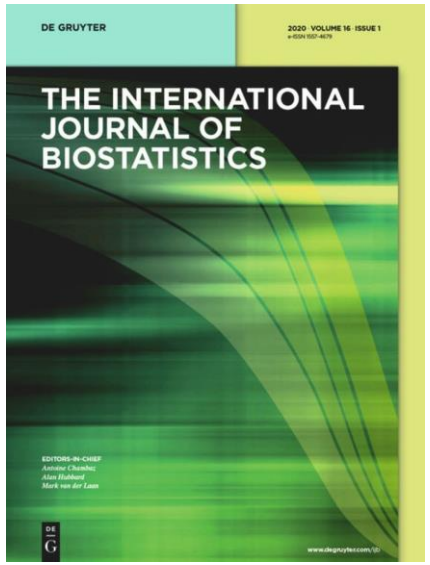
- **Employment**
  - Academic and Clinical Research Labs
  - Healthcare NGOs
  - Pharmaceutical and Medical Device Companies
  - Government Public Health Departments

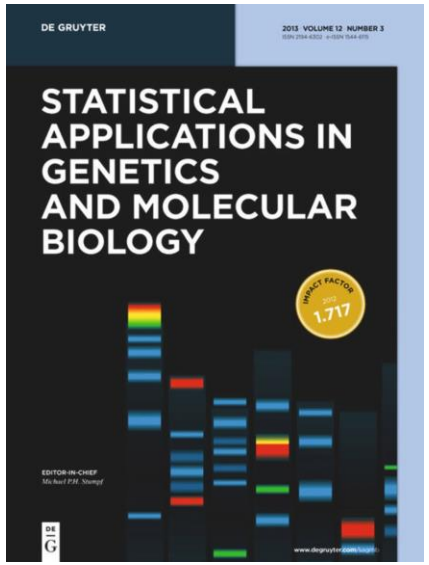
- **Specific Tasks**
  - Design studies and clinical trials to address specific scientific questions.
  - Develop stringent methodologies for collecting data.
  - Supervise collection and analysis of data sets.
  - Interpret results and assist with writing papers, reports and presentations

1. Zapf, A., Rauch, G. & Kieser, M. Why do you need a biostatistician?. BMC Med Res Methodol 20, 23 (2020).
2. What is a biostatistician? 2025 career guide. Coursera. https://www.coursera.org/articles/biostatistician

Where is the data published?







Cochrane

Trusted evidence.
Informed decisions.
Better health.

THE GLOBAL HEALTH OBSERVATORY

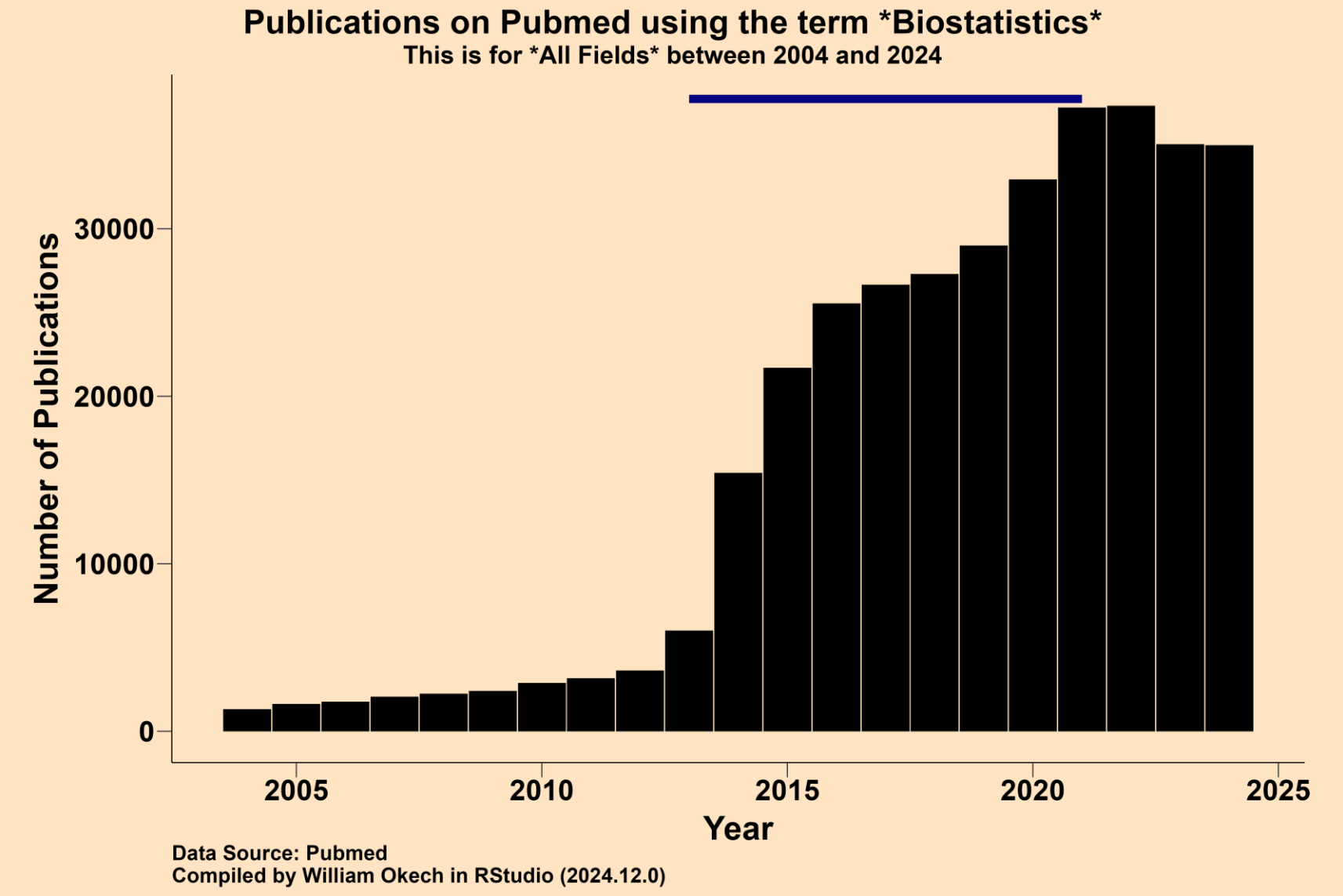
Explore a world of health data

CDC

Morbidity and Mortality Weekly Report (*MMWR*)

Note: Images obtained from respective journal/publication websites

Yearly Biostatistics Publications



Data Source: Pubmed (https://pubmed.ncbi.nlm.nih.gov/)

Outline

1. Class Logistics ✓
2. Biological Data and Biostatisticians ✓
3. Basic Biostatistical Concepts
4. Required Readings

Basic Biostatistical Concepts

Learning Objectives

- Identify biological sources of data
- Classify key data types
- Provide examples of various data types

Basic Biostatistical Concepts

A. Sources of Data

- Routinely Kept Records
  - Electronic Health Records
  - Crop Yield Records
- Surveys
  - National Health and Nutrition Examination Survey (NHANES)
  - Demographic and Health Survey (DHS)
  - Food Insecurity Experience Scale
- Experiments
  - Laboratory Experiments
  - Crop Field Trials
- Reports and Publications
  - Peer-reviewed Journals and Systematic Reviews
  - Government Reports and White Papers

Daniel, W. W., & Cross, C. L. (2018). Biostatistics: A Foundation for Analysis in the Health Sciences.

Basic Biostatistical Concepts

B. Types of Data

Broadly classified into two types:

1. Quantitative (Numerical) Data
   - Represents quantities or measurements that can be counted or measured numerically.
   - With this data we ask “how much?”

2. Qualitative (Categorical) Data
   - Describes non-numerical attributes such as qualities, characteristics, or categories.
   - With this data we ask “what type?”

Daniel, W. W., & Cross, C. L. (2018). Biostatistics: A Foundation for Analysis in the Health Sciences.

Basic Biostatistical Concepts

C. Quantitative (Numerical) Data

- Measured (continuous) or counted (discrete) variables.

Measured	**Counted**
• Age (years) • Weight (pounds or kilograms) • Height (centimeters or feet)	• Number of positive COVID cases in a city • Number of children enrolled in a school

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Basic Biostatistical Concepts

C. Qualitative (Categorical) Data

- Nominal (unordered categories) or ordinal (ordered categories) variables.

Nominal	**Ordinal**
• Race • Zip Code • Political Party • Disease State (Yes / No) • Blood Group (O, A, B, AB)	• Socioeconomic status (“low income”, “middle income”, “high income”) • Educational level (“high school diploma”, “bachelors”, “masters”, “doctorate”)

Daniel, W. W., & Cross, C. L. (2018). Biostatistics: A Foundation for Analysis in the Health Sciences.

Summary

1. Sources of Data

- Routinely Kept Records
- Surveys
- Experiments
- Reports and Publications

2. Types of Data

- Quantitative / Numerical – “How much?”
  - Examples – Age, Weight, and Number of children enrolled in school

- Qualitative / Categorical – “What type?”
  - Examples – Race, Political Party, and Education Level

Outline for today's class

1. Class Logistics ✓
2. Biological Data and Biostatisticians ✓
3. Basic Biostatistical Concepts ✓
4. Required Readings

Required Readings

1. Klaus B. (2015). Statistical relevance--relevant statistics, part I. *The EMBO journal*, *34*(22), 2727–2730. https://doi.org/10.15252/embj.201592958
2. Klaus B. (2016). Statistical relevance-relevant statistics, part II: presenting experimental data. *The EMBO journal*, *35*(16), 1726–1729. https://doi.org/10.15252/embj.201694659

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References

1. PubMed: https://pubmed.ncbi.nlm.nih.gov/
2. Bioart NIH: https://bioart.niaid.nih.gov/
3. Daniel, W. W., & Cross, C. L. (2018). Biostatistics: A Foundation for Analysis in the Health Sciences. John Wiley & Sons.
4. Zapf, A., Rauch, G. & Kieser, M. Why do you need a biostatistician?. BMC Med Res Methodol 20, 23 (2020).
5. What is a biostatistician? 2025 career guide. Coursera. https://www.coursera.org/articles/biostatistician