

Mel and Enid Zuckerman College of Public Health

University of Arizona

**SYLLABUS**

**Biostatistics 576B Biostatistics for Research**

# SPRING 2019

**Time**: Monday and Wednesday 10:30 am – 11:50 am

**Location**: A114 Drachman Hall

**Instructor**: Denise J. Roe, Dr.P.H.

Professor, Epidemiology & Biostatistics

1933 University of Arizona Cancer Center

Telephone: (520) 626-2281

[droe@email.arizona.edu](mailto:droe@email.arizona.edu)

**Office Hours**: A319 Drachman Hall

Monday and Wednesday 3:00 pm – 4:00 pm

By appointment (email to schedule an appointment):

Directions to 1933 University of Arizona Cancer Center:

Enter the Cancer Center using the doors closest to BUMC

(south-west corner of the building)

At the end of the hallway turn left

Take the stairwell on the right down to the first floor

Exit the stairwell and turn left

Take the first right

Follow the signs to the Biometry Shared Service

My office is the next to last door on the right

**Teaching Assistant:** Amber Koslucher [akoslucher@email.arizona.edu](mailto:akoslucher@email.arizona.edu)

**TA Office Hours**: Monday Noon – 1:00 pm (A319 Drachman Hall)

Tuesday 7:00 pm – 9:00 pm (Online)

**Catalog Description**: Descriptive statistics and statistical inference relevant to biomedical research, including data analysis, regression and correlation analysis, analysis of variance, survival analysis, statistical methods for epidemiology and statistical evaluation of clinical literature.

**Course Description:** An intermediate course in biostatistical methods and their application in epidemiology and public health. This course covers linear regression analysis, logistic regression analysis, time-to-event (survival) analysis, and study design.

**Course Prerequisites**

Biostatistics: Biostatistics 576A (Introduction to Biostatistics)

*Note: If you did not take Biostatistics 576A at UA please see me to make sure that you have the necessary prerequisites for the course*

Epidemiology: Epidemiology 573A (Basic Principles in Epidemiology)

Computing: Ability to use a statistical computing package (STATA, SAS, R)

**Course Learning Objectives**: At the end of the course, you should be able to:

* Apply statistical principles of sample size and power estimation to aid in the design of studies
* Use statistical modeling techniques, such as linear regression, logistic regression, log-binomial regression, time-to-event analysis, and Poisson regression, as appropriate, to meet the scientific objectives in research studies
* Analyze data by deciding the appropriate statistical techniques, ensuring that the assumptions are met, and effectively communicating analytic results
* Critically evaluate the use of statistics in published journal articles

**MPH and DrPH Foundational Public Health Knowledge:** At the end of the course, you should be able to:

Profession & Science of Public Health:

1. Explain the role of quantitative and qualitative methods and sciences in describing and assessing a population’s heath
2. Explain the critical importance of evidence in advancing public health knowledge

**MPH Foundational Competencies Covered:** At the end of the course, you should be able to:

Evidence-based Approaches to Public Health:

1. Apply epidemiological methods to the breadth of settings and situations in public health practice
2. Select quantitative and qualitative data collection methods appropriate for a given public health context
3. Analyze quantitative and qualitative data using biostatistics, informatics, computer-based programming and software, as appropriate
4. Interpret results of data analysis for public health research, policy or practice

Communication:

1. Communicate audience-appropriate public health content, both in writing and through oral presentation

**Biostatistics MPH Competencies Covered:** At the end of the course, you should be able to:

1. Ability to identify appropriate statistical tools to address specific scientific questions
2. Demonstrate excellent presentation skills and the ability to explain statistical concepts and findings to a general scientific audience

**Biostatistics MS Competencies Covered:** At the end of the course, you should be able to:

1. Recognize strengths and weaknesses of proposed statistical approaches, including alternative designs, data sources, and analytical methods
2. Suggest preferred methodological alternatives to commonly used statistical methods when assumptions are not met

**Biostatistics PhD Competencies Covered:** At the end of the course, you should be able to:

1. Apply descriptive and inferential methodologies according to the type of study design for answering a particular research question
2. Communicate understanding of the assumptions necessary for a given statistical procedure as well as the ability to determine if the assumptions are met for a given study design or data set

**Biostatistics Competencies Covered:** At the end of the course, you should be able to:

* Identify appropriate statistical tools to address specific scientific questions
* Select appropriate research designs to meet the needs of various studies, and be able to explain the limitations of implemented designs

**Course Notes**: A website has been created for this class using the Desire 2 Learn (D2L) interface. The course website contains the syllabus, class notes, Panopto recordings and homework assignments.

Class announcements also will be posted on this site, so it is a good idea to check the site before each class to stay current.

STATA and SAS will be used throughout the course. For each lecture two versions are provided – one using STATA and the other using SAS. The material will be the same in each format. I suggest printing the appropriate notes and bringing them with you to class.

To access the 576B website, login at: <http://d2l.arizona.edu>

* Click the ‘UA NetID’ Login.
* Enter your NetID and password, as you would to access your UA email account.
* Under ‘My Courses’, click on: ‘BIOS 576B SP19 001 102 202’
  + Announcements: This section contains any class announcements, such as the material to be covered in each class and suggestions/hints for the homework.
  + Content: Access the syllabus, Panopto recordings, class notes, homework assignments and supplemental information in this section.

For further information on how to use the D2L interface, go to: <http://www.help.d2l.arizona.edu>

Note that if you do not have a UA NetID, please see me so that I can give you access to the D2L site.

To access the Panopto recorded lecture you must use Firefox or Chrome as the browser when you log into D2L. Internet Explorer will not work.

To access a recorded lecture click on the “Lecture Recordings” module. Then “Click here” to go to our class recordings. Once the notes begin you can click on a slide at the bottom and it will take you to the appropriate verbal description.

**Recommended Texts**

**R***Fundamentals of Biostatistics Eighth Edition*, Bernard Rosner, Brooks/Cole, Cengage Learning, Boston, MA, 2016

The 8th Edition is available for purchase in the AHSC bookstore or from the publisher or other online sites. Alternatively you may rent a hard copy or purchase electronic access from the publisher. The link is:

<https://www.cengage.com/c/fundamentals-of-biostatistics-8e-rosner/9781305268920?filterBy=Student>

The link for the book companion site is:

<http://www.cengage.com/cgi-wadsworth/course_products_wp.pl?fid=M20b&product_isbn_issn=9781305268920&token=9AE29419C1268A54CA68E32085062519410D57EECD1582449D0D980B44D9EDFCAB5D7594F170D4043A192E004D101E5706E711DD63BDA74735DF87FD02D55051CA62B438359CBF68>

The book companion site includes:

* Data Set Descriptions (.doc)
* Data Sets (SAS and STATA)
* Study Guide (includes a summary of each chapter with additional problems and solutions)

**V** *Regression Methods in Biostatistics: Linear, Logistic, Survival, and Repeated Measures Models Second Edition*, Eric Vittinghoff, David V. Glidden, Stephen C. Shiboski, Charles E. McCulloch, Springer, New York, 2012

Available free online at <http://link.springer.com/book/10.1007/978-1-4614-1353-0>

(\* below implies that the material is more advanced than required for the course)

**A** *Practical Multivariate Analysis Fifth Edition*, Abdelmonem Afifi, Susanne May, Virginia A. Clark, CRC Press/Taylor & Francis Group, Boca Raton, FL, 2012

**H** *Applied Logistic Regression Third Edition*, David W. Hosmer, Jr., Stanley Lemeshow, Rodney X. Sturdivant, John Wiley & Sons, Inc., New York, 2013

Chapters can be downloaded from <http://onlinelibrary.wiley.com/book/10.1002/9781118548387>

**K** *Survival Analysis: A Self-Learning Text Third Edition*, David G. Kleinbaum and Mitchel Klein, Springer-Verlag, New York, 2012

Available free online at <http://link.springer.com/book/10.1007%2F978-1-4419-6646-9>

**Course Requirements**:

**Homework**

* 11 graded homework assignments
* Questions will be answered about the homework on the day shown on the syllabus (typically Monday)
* To be graded they must be turned in no later than Wednesday by midnight during the week discussed
* Two D2L assignment tabs (STATA and SAS) are available for each homework. Please turn in your homework to the appropriate assignment tab. If you are using R, please turn it into the STATA assignment tab.
* **Late homework assignments will not be accepted**
* Keep copies of all of your homework so that you can study for the exams while your submitted work is being graded by the TA.
* You can drop your **lowest** homework score. It is best to reserve this for times that you are unexpectedly out of town, cannot turn in the homework due to illness, or your computer crashes with your homework on it.

**Examinations**

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| --- | --- | --- | --- |
| Exam | Date Distributed | Date Due | Lectures and homework |
| Midterm 1 | Wednesday, February 13 | Monday, February 18 | LI - 1 through LI – 6  CA – 1 and CA - 2  Homework 1 – 4 |
| Midterm 2 | Wednesday, March 27 | Monday, April 1 | Cumulative with emphasis on  CA - 3 through CA – 4  LO – 1 through LO – 6  Homework 5 - 8 |
| Final | Wednesday, May 1 | Wednesday, May 8 | Cumulative with emphasis on  SU-1 through SU – 7  Homework 9 - 11 |

* All exams will be take-home. They will include a dataset with scientific questions to be addressed **and** interpretation of results from published papers.
* Exams must be turned in no later than midnight on the date due to the appropriate D2L assignment tab.
* For each exam, all students must sign the following statement (first page of the exam):

I have not discussed any aspects of this exam with other class members, former class members, other students, or faculty. I understand that if there is evidence that I have violated these restrictions, my grade on the exam will be reduced by 50%.

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|  |  |  |
| Signature | Printed Name | Date |

**Extra Credit**

* **No** extra credit is available for the course

**Grading/Student Evaluation**: Homework and examinations contribute to your final grade as follows:

Homework 10% (each assignment weighted the same, even if length differs)

Midterm 1 30%

Midterm 2 30%

Final 30%

Final grades are based on the following point system:

A = 90-100%

B = 80-89%

C = 70-79%

D = 60-69%

E = 59% or less

The instructor reserves the right to revise this scale, if necessary. Requests for incompletes (I) and withdrawal (W) must be made in accordance with University policies University policy regarding grades and grading systems is available at: <http://catalog.arizona.edu/policy-type/grade-policies>

**Class Attendance/Participation**: Class attendance **or** review of the recorded lecture is **strongly encouraged**, but not required. If a student does not attend class or review the appropriate lecture, they are responsible for meeting all course deadlines, and for working with other students, the TA and the instructor (during office hours) to catch up.

The UA’s policy concerning class attendance, participation, and administrative drops is available at: <http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop>

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable, <http://policy.arizona.edu/human-resources/religious-accommodation-policy>.

Absences pre-approved by the UA Dean of Students (or Dean Designee) will be honored,

<http://deanofstudents.arizona.edu/>

**Course Schedule**: Any changes to the following schedule will be announced in lecture or the D2L site. You are responsible for obtaining information on any changes.

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| --- | --- | --- | --- | --- |
| Notes | Date | Topic | Homework Due | Readings |
| **Linear Regression Analysis** | | | | |
| Overview  LI – 1 | Wed, 1/9 | Overview  Review of multiple linear regression |  | R 11.9  V 4.1 – 4.3.3 |
| LI – 2 | Mon, 1/14 | Regression diagnostics |  | V 4.7 |
| LI – 3 | Wed, 1/16 | Homework 1 questions  Analysis of covariance |  | A 9.3  V 4.6 |
| LI – 3 | Mon, 1/21 | No class – Martin Luther King Day |  |  |
| LI – 4 | Wed, 1/23 | Predictor selection methods | Homework 1 | A Ch 8 |
| LI – 5 | Mon, 1/28 | Homework 2 discussion  Modeling Strategies |  | V 10.1 – 10.6 |
| LI – 6 | Wed, 1/30 | Missing data and imputation | Homework 2 | A 9.2  V 11.1 – 11.5 |
| **Categorical Data Analysis** | | | | |
| CA – 1 | Mon, 2/4 | Homework 3 questions  Hypothesis testing and power for a 2 x 2 table |  | R 10.5 |
| CA – 2 | Wed, 2/6 | Power and sample size estimation in epidemiology studies | Homework 3 |  |
| CA – 3 | Mon, 2/11 | Homework 4 questions  Stratified Analysis |  | R 13.6 |
|  | Wed, 2/13 | Review  **Midterm 1 Distributed** | Homework 4 |  |
|  | Mon, 2/18 | **Midterm 1 Due**  No Class | **By Midnight** |  |
| CA – 4 | Wed, 2/20 | Stratified Analysis: Tests for trend |  | R 13.6 |
| **Logistic Regression** | | | | |
| LO – 1 | Mon, 2/25 | Homework 5 questions  Logistic regression |  | R 13.8  V 5.1 – 5.2.1 |
| LO – 2 | Wed, 2/27 | Review Midterm 1  Logistic regression: Interaction and confounding | Homework 5 | V 5.2.2 – 5.2.4  H 3.6 – 3.7 |
| Spring Recess | | | | |

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| Notes | Date | Topic | Homework Due | Readings |
| LO – 3 | Mon, 3/11 | Homework 6 discussion  Logistic regression: Goodness-of-fit |  | V 5.2.5 – 5.2.6, 5.4.3.2  H 5.1 – 5.2 |
| LO – 4 | Wed, 3/13 | Logistic regression: Diagnostics | Homework 6 | V 5.4  H 5.3 |
|  | Mon, 3/18 | Homework 7 questions  Logistic regression review |  |  |
| LO – 5 | Wed, 3/20 | Log-binomial regression | Homework 7 | V 5.5.3  H 5.3 |
| LO - 6 | Mon, 3/25 | Homework 8 questions  Multinomial logistic regression |  | V 5.5.6 |
|  | Wed, 3/27 | Review  **Midterm 2 Distributed** | Homework 8 |  |
|  | Mon, 4/1 | **Midterm 2 Due**  No class | **By Midnight** |  |
| **Survival Analysis** | | | | |
| SU – 1 | Wed, 4/3 | Survival Analysis |  | V 3.5.1 – 3.5.5  K Ch 1, 2.1 – 2.3 |
| SU – 2 | Mon, 4/8 | Homework 9 questions  Comparison of survival curves |  | V 3.5.6  K 2.4 – 2.6 |
| SU – 3 | Wed, 4/10 | Review Midterm 2  Cox proportional hazards model | Homework 9 | V 7.1 – 7.2  K Ch 3 |
| SU – 3 | Mon, 4/15 | Homework 10 discussion  Cox proportional hazards model |  |  |
| SU – 4 | Wed, 4/17 | Cox proportional hazards model: Diagnostics | Homework 10 | V 7.4  K Ch 4 |
| SU – 5  SU – 6 | Mon, 4/22 | Homework 11 questions  Poisson regression model  Logistic versus Cox versus Poisson |  | V 9.1 |
| SU – 7 | Wed, 4/24 | Power and sample size estimation for the log-rank test | Homework 11 |  |
|  | Mon, 4/29 | Review |  |  |
|  | Wed, 5/1 | No class  Fill out on-line course evaluation  **Final Exam Distributed** |  |  |
|  | Mon, 5/6 | **Final Examination Due** | **By Midnight** |  |

**Statistical Software**: You will need to use STATA or SAS or R to be able to complete the analyses required for the course. STATA and SAS will be emphasized during the lectures. You only need to use one of the software packages. You can move back and forth between them as you prefer.

A set of modules for learning STATA and SAS are on the D2L site. All students enrolled in the course have access to these modules.

A one-unit course “Introduction to Statistical Analysis using STATA” (Biostatistics 503) is available to those students who view all of the tutorials and complete an on-line exam for each module. You will need to register for the course to have access to the on-line exams and to receive credit for the course.

A one-unit course “Introduction to Statistical Analysis using SAS” (Biostatistics 504) is available to those students who view all of the tutorials and complete an on-line exam for each module. You will need to register for the course to have access to the on-line exams and to receive credit for the course.

**Computer Labs**: Stata and SAS are available for public use at two locations:

Drachman Hall Computing Lab: Drachman A319, open weekdays, from 8-5.

There are printers available free of charge if you want to print lecture notes, etc., but you must supply your own paper.

Arizona Health Sciences Library Computer Lab: AHSC 2150, open every day 6am-midnight.

These computers are behind the information/reference desk on the main floor. The first couple of banks of machines is not part of the lab, but is rather used for lit searching, etc. The lab is the ‘walled off’ section of computers behind the first couple of banks. You may print output here for a fee. Note that these are public facilities, and may or may not be crowded on a given day.

Students must register to use the AHSC Library Computer Lab at the Library Information Desk. A University of Arizona Catcard is required.

**Purchasing STATA or SAS**:

**STATA**: You can order online at the following link:

<http://stata.com/order/new/edu/gradplans/student-pricing>

STATA/IC 15 is available in the classroom and labs. It is appropriate for virtually all analyses except for very large datasets with an extremely large number of variables. STATA/IC 15 can be purchased at an academic rate of $89 for a one-year license and $198 for a perpetual license. After you purchase STATA you will be given directions on downloading and installing the package, with the necessary activation key.

PDF versions of the manuals can be accessed from the Help Tab within STATA. There is no reason for you to purchase the manuals.

SAS: SAS 9.4 can be ordered from the U of A BookStore. The cost is $99 per year. The link with the necessary information is: <http://uabookstore.arizona.edu/technology/stulicense.asp>

SAS also has a free “University Edition” of the SAS package.  The link with the necessary information is: <http://www.sas.com/en_us/software/university-edition.html>

Students who plan to use SAS in the workplace should learn SAS 9.4 as the “University Edition” is not available outside the University.

The current notes are based on the "full version" of SAS.  Please alert me if there are substantial differences between the notes and the “University Edition”.

**Tips for Succeeding in the Course:**

1. Attend class or review the lecture online
2. Ask questions about the notes and textbook
3. Do your homework early so that you can ask questions when it is reviewed in class
4. Turn your homework, Midterms and Final Exam in on time
5. Ask questions until you understand the material

**Required Statements:**

**Communications**: You are responsible for reading emails sent to your UA account from your instructor and the announcements that are placed on the course web site. Information about readings, news events, your grades, assignments and other course related topics will be communicated to you with these electronic methods. The official policy can be found at: <https://www.registrar.arizona.edu/personal-information/official-student-email-policy-use-email-official-correspondence-students>

**Disability Accommodations:**  **It is the University’s goal that learning experiences be as accessible as possible.  If you anticipate or experience physical or academic barriers based on disability or pregnancy, please let me know immediately, so that we can discuss options. You are also welcome to contact the Disability Resources (520-621-3268) to establish reasonable accommodations (as it is very important that you be registered with the DRC). For additional information on Disability Resources and reasonable accommodations, please visit** <http://drc.arizona.edu/students>

**Code of Academic Integrity:** All students are expected to do their own work. For homework, feel free to ask each other questions about concepts and procedures. However, when it comes time to complete the homework to turn in, do that on your own. Duplicate homework will be considered a breach of academic integrity. No communication between students is allowed during exams. Students are expected to adhere to the UA Code of Academic Integrity, available through the office of the UA Dean Students: <http://deanofstudents.arizona.edu/policies-and-codes/code-academic-integrity>

**Classroom Behavior**: Students are expected to be respectful of the instructor and other students at all times (including limited talking, no reading newspapers, etc). Cell phones should be in the mute or vibrate position. If you must take an emergency call during class please leave class quietly to speak with the caller (do not leave and return more than once as this disrupts the rest of the class). Please do not text during class. Students may use their laptops during class only for course related material.

Students are expected to be familiar with the UA Policy on Disruptive Student Behavior in an Instructional Settingfound at: <http://policy.arizona.edu/education-and-student-affairs/disruptive-behavior-instructional-setting>

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**Threatening Behavior Policy**: The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to one’s self, <http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students>

**Nondiscrimination and Anti-Harassment Policy:** The University of Arizona is committed to creating and maintaining an environment free of discrimination, <http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy>

**UA Smoking and Tobacco Policy:** The purpose of this Policy is to establish the University of Arizona’s (University) commitment to protect the health of University faculty, staff, students, and visitors on its campuses and in its vehicles,  
<http://policy.arizona.edu/ethics-and-conduct/smoking-and-tobacco-policy>

**Grievance Policy**:  Should a student feel he or she has been treated unfairly, there are a number of resources available. With few exceptions, students should first attempt to resolve difficulties informally by bringing those concerns directly to the person responsible for the action, or with the student's graduate advisor, Assistant Dean for Student and Alumni Affairs, department head, or the immediate supervisor of the person responsible for the action. If the problem cannot be resolved informally, the student may file a formal grievance using the Graduate College Grievance Policy found at: <http://grad.arizona.edu/academics/policies/academic-policies/grievance-policy>

**Grade Appeal Policy**: <http://catalog.arizona.edu/2015-16/policies/gradappeal.htm>

**Syllabus Changes:**  Information contained in the course syllabus, other than the grade and absence policies, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor.

**Plagiarism:**  What counts as plagiarism?

* Copying and pasting information from a web site or another source, and then revising it so that it sounds like your original idea.
* Doing an assignment with a friend and then handing in separate assignments that contain the same ideas, language, phrases, etc.
* Paraphrasing a passage without citing it, so that it looks like your own.
* Hiring another person to do your work for you, or purchasing a paper through any of the on- or off-line sources.