

# **SURVIVAL DATA ANALYSIS IN EPIDEMIOLOGY**

BIOST 537 / EPI 537 – SLN 11717 / 14595 – WINTER 2019

Department of Biostatistics  
School of Public Health, University of Washington

## **Course description**

In most human studies conducted in the biomedical sciences, the outcome of interest is not observed on all study participants for a variety of reasons, including patient drop-out or resource limitations. The broad goal of survival analysis is to address scientific queries about a time-to-event distribution while appropriately accounting for the data incompleteness that often characterizes biomedical data. This course covers the foundations of survival analysis, with a particular emphasis on topics relevant to epidemiology, public health and medicine. The focus of the course is on nonparametric and semiparametric techniques although common parametric approaches are also discussed. A substantial portion of the course is devoted to the multivariable analysis of survival outcome data, where multiplicative models are emphasized.

## **Learning objectives**

After successful completion of this course, the student will be able to:

1. Give basic definitions or descriptions of central concepts in survival analysis.
2. Estimate survival curves, hazard rates and measures of central tendency using the Kaplan-Meier and Nelson-Aalen approaches.
3. Estimate survival curves, hazard rates and measures of central tendency using simple parametric models.
4. Compare two or more survival curves using a log-rank or similar test.
5. Fit proportional hazards regression models to survival data and assess the scientific impact of the included explanatory variables together with their statistical stability and significance.
6. Use graphical and analytic methods to assess the adequacy of fitted models.
7. Use time-dependent covariates in the proportional hazards model and interpret the coefficients.
8. Be aware of the potential risks of using time-dependent covariates in a survival model.
9. Be aware of key pitfalls in the analysis of survival data, including immortal time bias, informative censoring, biased sampling, and problems posed by competing risks.
10. Contrast the interpretation of conditional parameters in regression models and the notion of marginalized (or adjusted) survival curves.
11. Distinguish between the considerations applicable to exploratory versus confirmatory survival analyses.
12. Describe the methods and results of a survival analysis to a non-statistical reader.

## **Course details**

**Lectures:** Tuesday + Thursday, 1:30–3:20 pm, Health Sciences Building, Room T-639 (4 credits)

**Discussion labs:** Tuesday 12:30–1:20 pm, Health Sciences Building, Room K-069

**Instructor:** Marco Carone (mcarone@uw.edu)  
Office: Health Sciences Building, Room F-644  
Office hours: to be determined

**Teaching assts.:** Jeremy Roth (jhroth@uw.edu)  
Office hours: to be determined

**Prerequisites:** All enrolled students are required to have already taken an intermediate-level course in regression modeling (e.g., BIOST 536) or otherwise obtained permission from the instructor.

**Suggested text:** Moore, D.F. *Applied survival analysis in R*. Springer. An electronic version is available for free at <https://link.springer.com/book/10.1007/978-3-319-31245-3> when this link is accessed from campus.

**Useful resources:** Breslow, N.E., Day, N.E. *Statistical methods in cancer research – Volume 2: The design and analysis of cohort studies*. IARC. A free electronic version is available online: <http://www.iarc.fr/en/publications/pdfs-online/stat/sp82/index.php>.

Kleinbaum, D.G., Klein, M. *Survival analysis: a self-learning text*. Springer.

Hosmer, D.W., Lemeshow, S., May, S. *Applied survival analysis: regression modeling of time-to-event data*. Wiley.

Collett, D. *Survival data in medical research*. CRC/Chapman & Hall.

Marubini, E., Valsecchi, M.G. *Analyzing survival data from clinical trials and observational data*. Springer.

Klein, J.P., Moeschberger, M.L. *Survival analysis: techniques for censored and truncated data*. Springer.

**Course website:** Lecture slides, homework assignments and solutions, and any additional material will be available to registered students on the course canvas website. A course discussion board administered by the TA will also be available there.

**Class recordings:** Whenever available, links to recordings of class lecture sessions (voice and computer screen) will be posted on the course website as soon as possible after each lecture. Certain recordings may not be available due to technical difficulties experienced in the classroom or other reasons. For this reason, there is no guarantee whatsoever regarding the availability of class recordings.

**Software:** Students will be expected to perform data analysis using statistical software. While R will be used in class and in TA lab sessions, students may use STATA if they desire.

R is available to all for free: <https://cran.fhcrc.org>.

Discounted personal copies of STATA 14 are available for UW Health Sciences faculty, students and staff: [www.washington.edu/itconnect/wares/uware/stata](http://www.washington.edu/itconnect/wares/uware/stata).

**Assessment:** Homework, written examinations and data analysis project. Homework will include between four and six assignments. Regular attendance of course lectures is strongly encouraged - please notify the instructor in case of a prolonged absence.

Final grade will be an aggregate of grades obtained on two in-person examinations (total weight of 50%: 30% and 20% for your highest and lowest examination scores, respectively), homework (25%) and a data analysis project (25%).

The first examination (i.e., midterm) will be scheduled approximately at the four or five-week mark. A confirmed date will be communicated at least two weeks in advance. The second examination will be scheduled either during the last week of classes or during the final examination period - this will be established early during the quarter.

**Homework policy:** Homework is an important part of the learning process. You are encouraged to do the best work you can as soon as possible after the relevant material has been covered in class. You may work with other students to solve homework problems or consult the TA or instructor. However, we expect your written homework to give a summary of your personal understanding of the answers, independent of others.

Homework not turned in or substantially incomplete will be given a zero grade. A late assignment will be penalized by 20 percentage points for each (partial) day elapsed

since the deadline. Once solutions are posted, late assignments will no longer be accepted. In case of extenuating circumstances, please contact the instructor directly.

- Topics covered:**
- I. Introduction
    - > Characteristics of survival data
    - > Key quantities in survival analysis
    - > Examples of survival data
  - II. Survival analysis based on one, two or multiple samples
    - > Estimation based on parametric models
    - > Nonparametric estimation of a cumulative hazard function
    - > Nonparametric estimation of a survival function
    - > Nonparametric estimation of measures of central tendency
    - > Nonparametric testing of equal survivorship between groups
    - > Motivation for regression modelling
  - III. Regression models in survival analysis: the proportional hazards model
    - > Formulation, properties and parameter interpretation
    - > Parametric proportional hazards model
    - > Semiparametric proportional hazards model
    - > Stratified proportional hazards model
    - > Model diagnostics
  - IV. Regression models in survival analysis: the accelerated failure time model
    - > Formulation, properties and parameter interpretation
    - > Parametric accelerated failure time model
    - > Model diagnostics
  - V. Regression models in survival analysis: additional considerations
    - > Delayed entry
    - > Time-varying covariates
    - > Immortal time bias
    - > Marginalization of survival regression models
    - > Exploratory versus confirmatory analyses
  - VI. Additional topics (time permitting only)
    - > Survival analysis in the presence of competing risks
    - > Incidence rate regression
    - > Sample size calculations

### **UW policy on course audits**

Attendance in courses as an auditor is by consent of the instructor involved and is conditioned by the extent to which space is available. Permission to audit is ordinarily granted for lecture classes only. An auditor may not participate in class discussion or laboratory work, and his or her registration may be canceled at the discretion of the instructor. No record of audited courses is kept. Regular tuition and fees are charged. To receive credit for an audited course, the student must register for the class in a subsequent quarter.

To audit this course, please register as an official auditor - the administrative contact for doing so will be provided upon request. Please sit in the back of the classroom and do not hand in homework write-ups.

### **Access and accommodations**

Your experience in this class is important to us. If you have already established accommodations with Disability Resources for Students (DRS), please communicate your approved accommodations to the instructor at your earliest convenience so your needs in this course can be discussed.

If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), you are welcome to contact DRS at 206-543-8924 or [uwdrs@uw.edu](mailto:uwdrs@uw.edu) or [disability.uw.edu](http://disability.uw.edu). DRS offers resources and coordinates reasonable accommodations for students with disabilities and/or temporary health conditions. Reasonable accommodations are established through an interactive process between you, your instructor(s) and DRS. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law.

### **Academic integrity**

Students at the University of Washington (UW) are expected to maintain the highest standards of academic conduct, professional honesty, and personal integrity.

The UW School of Public Health (SPH) is committed to upholding standards of academic integrity consistent with the academic and professional communities of which it is a part. Plagiarism, cheating, and other misconduct are serious violations of the UW Student Conduct Code (WAC 478-120). We expect you to know and follow the University's policies on cheating and plagiarism, and the SPH Academic Integrity Policy. Any suspected case of academic misconduct will be handled according to UW regulations. For more information, see the UW Community Standard and Student Conduct website.

### **Teaching assistant feedback**

If you have any concerns about the class or your TA, please see the TA about these concerns as soon as possible. If you are not comfortable talking with the TA or not satisfied with the response that you receive, you may contact the Department of Biostatistics Associate Director of Academic Affairs ([biostg@uw.edu](mailto:biostg@uw.edu)). If you are still not satisfied with the response that you receive, you may contact the Department of Biostatistics Chair ([bchair@uw.edu](mailto:bchair@uw.edu)). You may also contact the Graduate School at G-1 Communications Building, by phone at 206-543-5139 or by email at [raan@uw.edu](mailto:raan@uw.edu).

### **Classroom climate**

Diverse backgrounds, embodiments, and experiences are essential to the critical thinking endeavor at the heart of university education. Therefore, we expect you to follow the UW Student Conduct Code in your interactions with your colleagues and the instructor in this course by respecting the many social and cultural differences among us, which may include, but are not limited to: age, cultural background, disability, ethnicity, family status, gender identity and presentation, citizenship and immigration status, national origin, race, religious and political beliefs, sex, sexual orientation, socioeconomic status, and veteran status. Please immediately contact the instructor if you experience disrespect in this class, so that we may work to address it in an educational manner. [DCinfo@uw.edu](mailto:DCinfo@uw.edu) is a resource for students with classroom climate concerns.