

# ENVH 556 Quantitative Exposure Analysis

Fall 2024

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## CONTACT INFORMATION

**Instructor1:** **Lianne Sheppard, PhD** (*she/her/hers*)  
Rohm & Haas Endowed Professor in Public Health Sciences, Interim Chair EOHS  
Departments of Environmental & Occupational Health Sciences & Biostatistics

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**Office hours:** Mondays 3:30-4:30 p.m. or by appointment, HRC 232

**Instructor2:** **Magali Blanco, PhD** (*she/her/hers*)  
Postdoctoral Fellow  
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**Office hours:** Tuesdays 3:30-4:30 p.m. or by appointment

## Course times and locations

**Meeting times:** Tuesdays 1:30-3:20; Thursdays 1:30-2:20, SOCC 322

## Course links

**GitHub:** [https://github.com/magali17/ENVH556\\_2024](https://github.com/magali17/ENVH556_2024)

**Canvas:** <https://canvas.uw.edu/courses/1754087>

**Zoom:** <https://washington.zoom.us/j/91428165225?pwd=I3jOGqgXegb2nR32cLot701qpmjxAJ.1>  
(Requires UW netID authentication to join)

## PREREQUISITES

This course assumes

- You have a working knowledge of biostatistics at the level covered in BIOST 511 **and** 512 (or 517 and 518). Students should have completed BIOST 512/518 or a comparable course that covers multiple linear regression. While much more challenging, students are allowed take BIOST 512 or 518 concurrently with ENVH 556. Please inform your instructors if you have not completed BIOST 512 or 518 or an equivalent course.
- You understand basic concepts in public and environmental health, as well as epidemiology.
- You have basic R skills. We will provide some review of R in early labs and provide an introduction to R Markdown.

## COURSE DESCRIPTION

This course will introduce students to quantitative aspects of occupational/environmental exposure data analysis with the goal of better understanding the nature of exposures and their interpretation for human health. Issues in the analysis and interpretation of exposure data will be explored through reading and discussions of the primary literature on exposure assessment methods. Practice exposure data analyses will be conducted using real exposure datasets and statistical analysis software.

Specific topics will include:

- Purposes and use of exposure data
- Exposure distributions and their description
- Sampling strategies
- Modeling of exposure
- Exposure measurement error
- Special topics

## COURSE LEARNING OBJECTIVES

The overall objective of this course is to give students a deep and broad understanding of quantitative exposure assessment for environmental and occupational health. A secondary goal is to train students to analyze exposure data and develop the confidence and skills needed to conduct an analysis of exposure data and write it up with the goal of publication in mind. By the conclusion of this class, students should be able to:

1. Describe the primary purposes of exposure assessment
2. Calculate and describe the meaning of measures of central tendency and distributional properties of normal and lognormal data
3. Describe and understand the importance of design of major exposure assessment strategies, citing the logistical and statistical strengths and weaknesses of each
4. Develop, validate, interpret, and use multivariable linear models from existing exposure datasets to describe and predict exposures
5. Effectively use random, fixed and mixed models for exposure determinants
6. Identify importance of time-related factors in exposure distributions
7. Describe sources and effects of different types of exposure measurement error in epidemiology
8. Discern general lessons from and implications of primary research papers on exposure assessment methods, and use these lessons to design effective assessment strategies for future studies
9. Use reproducible research tools to conduct exposure analyses
10. Create a complete exposure analysis and write-up that covers its purpose, methods, results, and interpretation.

## GRADING

Grades will be determined by homework assignments (60%), final project (25%), and class engagement (15%).

**Homework:** Complete 8 weekly labs. These are data analysis assignments, presented as lab reports that include summarized results and interpretation. Due Wednesdays the week following the Thursday lab.

**Class preparation and engagement:** Read and be prepared to discuss weekly readings in class. Written reflections of these discussions will be required. Complete the readings prior to Tuesday's class and turn in the written reflections before Thursday's class.

**Final project:** Analyze a dataset to answer a set of specific questions and provide a written report including rationale, methods, results and discussion. Final project due finals week; there may be some interim deadlines to support progress.

### Grading Criteria

**Labs and the final project** are graded using a point scale. There is a rubric associated with each assignment on Canvas. Interim project assignments are turned in to support student progress and solicit instructor feedback.

Class engagement will be largely graded on a satisfactory/unsatisfactory basis. We will give scores of 0, 8,9, and 10 used on a 10-point scale for completed reflections. (See the rubric on Canvas.) Students are encouraged to show their engagement in other ways as well, e.g., participation in class discussions, asking questions, posting on the discussion boards, sharing code.

### Late assignment policy

10% per day will be deducted from the assignment final score, to 50% of the final score.

## REQUIRED, RECOMMENDED AND SUPPLEMENTARY READINGS

Readings will be drawn primarily from the primary research literature. Typically, you will be asked to read papers from the primary literature each week. We will also recommend additional supplementary papers. These and the additional supplementary papers are posted on Canvas. We also provide a list of recommended supplemental texts and textbooks on Canvas.

## LAND ACKNOWLEDGEMENT

*The University of Washington acknowledges the Coast Salish people of this land, the land which touches the shared waters of all tribes and bands within the Duwamish, Suquamish, Tulalip and Muckleshoot nations.*

# Course Session Schedule (subject to change)

## WEEK 0

### **Thursday 26-Sept Introduction (LS)**

- Introductions
- Class structure, class norms, syllabus review
- Introduction to datasets: Mobile Monitoring, DEMS, Snapshot, Welding School Exposures
- General introduction to term project

## WEEK 1

### **Tuesday 1-Oct Basic Concepts (LS)**

- Purposes of exposure assessment and quantitative exposure modeling
- Exposure measurements, data, data exploration
- Variability and uncertainty
- Principles of reproducible research, computing best practices
- Outline and plans for term project

### **Thursday 3-Oct Lab: R, R Markdown, RStudio, GitHub, Data, and Distributions (MB)**

- Introduction to R, and R Markdown
- Familiarity with syntax, and reporting results
- Exploring data, basic data analysis using the mobile monitoring stationary data
- Lab report formatting and structure of term project

## WEEK 2

### **Tuesday 8-Oct Exposure Assessment Strategies (LS, Chris Zuidema)**

- Lognormal distribution and its parameters
- Exceedance probabilities
- Survey design
- Stationary and personal Sampling
- Sample size
- Exposure metrics
- Individual, task and group assessment
- Concept of HEGs/SEGs/JEMs
- Variance components concepts

**Wednesday 9-Oct**

**Lab 1 due**

**Thursday 10-Oct**

**Lab: Presentation and precision of distribution parameters (MB)**

- Exceedance fractions, impact of sample size and compliance exercise using the DEMS data
- Includes assessing distributions, calculation of lognormal (LN) parameters, exceedance
- Data presentation principles

**WEEK 3**

**Tuesday 15-Oct**

**Regression Models and Regression for Association (LS)**

- Linear regression introduction
- Estimation vs. prediction goals
- Dummy variables, co-factors, confounding, interaction
- Mean and variance models concepts
- Model selection for association models
- Update on term project

**Wednesday 16-Oct**

**Lab 2 due**

**Thursday 17-Oct**

**Lab: Fitting and Interpreting Regression Models (MB)**

- Regression model practice using the Snapshot data

**WEEK 4**

**Tuesday 22-Oct**

**Prediction Modeling and Validation (LS)**

- Regression for prediction
- Model selection for prediction
- Validating regression models: In-sample vs. out-of-sample validation, cross validation
- Bias-variance tradeoff

**Wednesday 23-Oct**

**Lab 3 due; preliminary term project plan due**

**Thursday 24-Oct**

**Lab: Prediction and Cross-Validation (LS)**

- Bias-variance tradeoff and cross-validation exercise using the Snapshot data

## WEEK 5

**Tuesday 29-Oct**

**Variance Components and Mixed Models (LS)**

- Variance components estimation
- Integration of variance components and regression: Mixed models

**Wednesday 30-Oct**

**Lab 4 due**

**Thursday 31-Oct**

**Lab: Variance Components from Mixed Models (MB)**

- Fit mixed models with the adjusting variable included in random and fixed terms; provide contrasting interpretations
- Describe fixed and random effects in the Welding School data

## WEEK 6

**Tuesday 5-Nov**

**Geostatistics and Air Pollutant Exposure Modeling (LS)**

- Spatial and spatio-temporal prediction models
- Variograms
- Mobile monitoring example
- NO<sub>2</sub> national model example with random vs. spatially clustered cross-validation

**Wednesday 8-Nov**

**Lab 5 due; updated term project plan due**

**Thursday 7-Nov**

**Lab: Geostatistics and Universal Kriging (MB)**

- Geostatistics: Kriging and variograms using the Snapshot data
- Plotting predictions on maps

## WEEK 7

**Tuesday 12-Nov**

**Term Project discussion (MB)**

- Discuss papers and results related to the mobile monitoring campaign
- Discuss term project assignment and approach, feedback on plans
- Group project work

**Wednesday 13-Nov**

**Lab 6 due**

**Thursday 14-Nov**

**data (MB)**

**Work on Term Project with a focus on the mobile monitoring**

- Details TBD. May include developing code, working on structure, exploring and selecting models for prediction or other goal, drawing maps

## WEEK 8

### **Tuesday 19-Nov Exposure Measurement Error in Epidemiology (LS)**

- Misclassification
- Regression measurement error
- Classical and Berkson error models
- Consequences and exceptions

### **Thursday 21-Nov Lab: Exposure Measurement Error Exercise (MB or LS)**

- Exposure measurement error exercise using simulation

## WEEK 9

### **Tuesday 26-Nov TBD**

- TBD

### **Wednesday 27-Nov Lab 7 due**

### **Thursday 28-Nov No class: Thanksgiving**

## WEEK 10

### **Tuesday 3-Dec Topic TBD**

- TBD

### **Thursday 5-Dec Lab: Problem-solving for term project (MB, LS)**

- Review and problem-solving for the term project

## FINALS WEEK

### **TUESDAY 10-Dec**

- Term project due

# Course Resources

## Class Sessions and Learning Remotely

The basic structure of this course is 1 hour 50 minutes of lecture and discussion on Tuesdays and 50 minutes for a lab exercise on Thursdays. While this course will allow remote participation, we recommend that you participate in person as much as possible. If you need to participate remotely, please join synchronously. The instructors will also hold regular office hours to support your learning.

- Tuesday's class will be a combination of lecture and discussion. Turn in the post-class reflection after class and no later than Thursday before class.
- Thursday's class will be a lab structured as an introductory lecture of approximately 25 minutes followed by in-class practice. Turn in your lab write-up the following Wednesday.
- The lectures will be recorded, and materials will be posted online. The discussions and in-class practice may not be recorded.

## Student responsibilities and specific ENVH 556 expectations

- You are welcome and encouraged to discuss your lab assignments with your peers, but you should not copy each other's work. You must turn in your own individual lab write-ups and analyses
- If you wish to share code chunks with your peers, please post these in an accessible location such as on the class discussion board so that all students in the class may benefit.
- The term project can be a group project. Groups should make plans for their team project early in the quarter.

## Software and Computing

This course assumes a basic working knowledge of R which would have been gained through various Biostatistics courses at UW (e.g. BIOST 511 and 512, BIOST 509). We will teach R Markdown and use RStudio. While you are welcome to do your work locally on your laptop, we will not be able to provide support for local installations. For more information, see the GettingStarted document (html and qmd on GitHub).

All labs and other R Markdown files for this course will be maintained on a GitHub template repository (link above). The most up-to-date versions of all R Markdown files will be in this GitHub repository and students should download files from the repository. While we encourage students to sign up for and learn [GitHub](#), this is not required. (For guidance on using GitHub with RStudio, see <https://resources.github.com/whitepapers/github-and-rstudio/>).



## Use of Generative Artificial Intelligence in ENVH 556

Artificial Intelligence (AI) content generators, such as ChatGPT, present opportunities that can contribute to your learning and academic work. However, using these technologies may also violate academic standards of the UW. Under the Student Conduct Code, cheating includes the unauthorized use of assistance, including AI technology, in completing assignments or exams.

You are permitted to use AI tools to assist you in coding and debugging your code. While we prefer that you not use AI for the following, you are also permitted to use AI tools to assist you in gathering information, writing drafts, and revising your writing. Whenever you use an AI tool, you are expected to include a disclosure statement at the end of your assignment describing which AI tool you used and how you used it. For example, "AI tools were used to debug R code used in this lab. I reviewed all AI-produced code for accuracy and relevance."

## Additional resources to support your learning

These include class discussion boards on Canvas, office hours, and emailing the instructors. Your instructors are committed to supporting the best learning experience possible. Please let your instructors know if you need additional resources to support your success in this course and we will do our best to help you with additional support or accommodation.

## Course Communication

- **Course updates** will be posted on Canvas. We will send Canvas announcements for all time-sensitive updates. Please make sure your Announcements setting on Canvas is "Notify Immediately".
- **Discussion board:** This is an excellent mechanism for students to get their technical questions answered and for all students to be able to support each other in this process. It is very likely that other students will have the same question as you and sharing your questions this way will benefit everyone in the course. We also encourage you to post responses to peer questions.
- **Office hours: There** is currently one office hour per instructor scheduled per week. We will add more or change the time as needed. Please make use of this time to get additional assistance and feedback.
- **Email the instructors:** You are encouraged to contact one or both of us with your questions. We will strive to respond as soon as possible and within 48 hours on weekdays.

## Communication and Writing Skills

Communication through writing and speaking is an important transferable skill for all career pathways. Establishing a strong foundation in communication skills will help you be successful throughout your future course work and career. Therefore, this course includes assignments with the goal of helping you identify areas of strength and improvement in your communication. If you feel that you could benefit from additional opportunities to improve your writing skills in particular, a list of resources at the UW and others accessible online can be found on the SPH website [here](#).

# Course Norms and Important Policies

## Pronouns

We share our pronouns because we strive to cultivate an inclusive environment where people of all genders feel safe and respected. We cannot assume we know someone's gender just by looking at them. So, we invite everyone to share their pronouns.

## Illness Protocol

If you feel ill or exhibit respiratory or other symptoms, you should not come to class. Seek medical attention if necessary and notify your instructor(s) as soon as possible by email. Follow the [COVID-19 Public Health Flowchart](#) if you have COVID-19 symptoms, exposure or test positive, and adhere to the [UW Face Covering Policy](#).

Additional recommendations include getting your [annual flu shot](#) and getting boosted with the updated COVID vaccines (available [at clinics and pharmacies, as well as through UW Medicine](#) and local health agencies).

Please check your email and CANVAS announcements daily BEFORE coming to class. If we need to conduct class remotely because the instructor or a guest speaker is unable to attend in person, we will send all registered students an email and/or post a CANVAS announcement with a Zoom link for remote instruction or a plan for making up the class.

## Access and Accommodations

Your experience in this class is important to us. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law. If you have already established accommodations with Disability Resources for Students (DRS), please activate your accommodations via myDRS so we can discuss how they will be implemented in this course.

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), contact DRS directly to set up an Access Plan. DRS facilitates the interactive process that establishes reasonable accommodations. Contact DRS at [disability.uw.edu](https://disability.uw.edu).

## Religious Accommodations

Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW's policy, including more information about how to request an accommodation, is available at [Religious Accommodations Policy \(https://registrar.washington.edu/staffandfaculty/religious-accommodations-policy/\)](https://registrar.washington.edu/staffandfaculty/religious-accommodations-policy/). Accommodations must be requested within the first two weeks of this course using the [Religious Accommodations Request form \(https://registrar.washington.edu/students/religious-accommodations-request/\)](https://registrar.washington.edu/students/religious-accommodations-request/).

## 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, unauthorized use of artificial intelligence (AI) tools, and other misconduct are serious violations of the University of Washington [Student Conduct Code \(WAC 478-121\)](#). We expect you to know and follow the university's policies on cheating and plagiarism, and the [SPH Academic Integrity Policy](#). Any suspected cases of academic misconduct will be handled according to University of Washington regulations. For more information, see the University of Washington [Community Standards and Student Conduct](#).

## Inclusion & Diversity

Diverse backgrounds, embodiments and experiences are essential to the critical thinking endeavor at the heart of university education. In SPH, we are expected:

1. To respect individual differences, which may include, but are not limited to, age, cultural background, disability, ethnicity, family status, gender, immigration status, national origin, race, religion, sex, sexual orientation, socioeconomic status and veteran status.
2. To engage respectfully in the discussion of diverse worldviews and ideologies embedded in course readings, presentations and artifacts, including those course materials that are at odds with personal beliefs and values.
3. To encourage students with concerns about classroom climate to talk to their instructor, adviser, a member of the departmental or SPH EDI Committee, the Assistant Dean for EDI, or the program's director.

## Classroom Climate

Your success in learning is important to your instructors. In addition to providing materials and assignments to support your success, we will do our best to provide a welcoming and supportive classroom environment. Our learning space is our collective mutual responsibility; as such, we all have a responsibility to engage in dialogue in a way that supports learning for all of us. To support a healthy learning environment for everyone we will discuss and revise these ground rules together during the first week of class. The ground rules are:

### Norms for everyone to follow:

- Be respectful and supportive of our diverse knowledge, experiences and backgrounds
- Affirm and encourage, and respect multiple pathways to learning
- If comfortable, share your questions and your strategies with the whole class

### Additional norms for the instructors:

- Teach and help inclusively; adapt to students' different learning styles
- Be flexible and understanding of students' diverse and challenging situations
- Be responsive: check in regularly to confirm students are following the materials; answer questions in the chat; post common questions and their answers on Canvas

In addition to these norms, if you have any comments or suggestions regarding the classroom climate please get in touch with your instructors using the mechanisms described in the *Course Communication* section above. It is our highest priority to address your comments as satisfactorily as possible. However, if you are not satisfied with our response, you may reach out to others at the Department, School, and/or University level. If you wish to follow up with others, we encourage you to first contact Trina Sterry, Manager of Student and Academic Services (tsterry@uw.edu; 206 616-4177) in the Department of Environmental and Occupational Health Sciences. See also the following section on bias concerns.

## **Bias Concerns**

The Office of the Dean has a [student concern policy](#), a faculty concern policy and standard HR procedures for staff concerns. Our 2018 climate survey states that most people in SPH do not report bias incidents because they do not know where to go. Students are encouraged to report any incidents of bias to someone they feel comfortable with, including instructors, advisers or department staff. They can email [dcinfo@uw.edu](mailto:dcinfo@uw.edu) for immediate follow up. Bias concerns can be anonymously and confidentially reported via the online form found here: <https://sph.washington.edu/about/diversity/bias-concerns>. Data is collected by the Assistant Dean for EDI and the Director of Program Operations for Student and Academic Services and tracked for resolution and areas are identified for further training.

## **Sexual Harassment**

Sexual harassment is a form of harassment based on the recipient's sex that is characterized by:

1. Unwelcome sexual advances, requests for sexual favors, or other verbal or physical conduct of a sexual nature by a person who has authority over the recipient when:
  - Submission to such conduct is an implicit or explicit condition of the individual's employment, academic status, or ability to use University facilities and services, or
  - Submission to or rejection of the conduct affects tangible aspects of the individual's employment, academic status, or use of university facilities.
2. Unwelcome and unsolicited language or conduct that creates an intimidating, hostile, or offensive working or learning environment, or has the purpose or effect of unreasonably interfering with an individual's academic or work performance.

If you believe that you are being harassed, or have observed harassment, you can report it to SPH using the [bias concerns link](#). The University also has designated offices to help you: [SafeCampus](#); [Office of the Ombud](#); [Title IX Investigation Office](#); and [University Complaint Investigation and Resolution Office](#).

## **Safety**

Call SafeCampus at 206-685-7233 anytime – no matter where you work or study – to anonymously discuss safety and well-being concerns for yourself or others. SafeCampus's team of caring professionals will provide individualized support, while discussing short- and long-term solutions and connecting you with additional resources when requested.