ENVH 556 Syllabus
QUANTITATIVE EXPOSURE ANALYSIS
Winter Quarter, 2019
3 Credits

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Meetings:	Class: Tuesday, 8:30 - 10:20 Laboratory: Thursday, 8:30-9:20 (extended labs as needed)	HSB T 530 HSB T359 (bring laptop to lab sessions)

Class Website: https://canvas.uw.edu/courses/1099265

Office Hours: By arrangement

Course Goals: 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 analysis will be conducted using "real" exposure datasets and statistical analysis software. Specific topics will include:

1. Purposes and use of exposure data
2. Exposure distributions and their description
3. Sampling strategies
4. Modeling of exposure
5. Statistical and biological basis of exposure metrics
6. Measurement error
7. Special topics

Learning Objectives: 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 design 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 in predicting risk, including short-term peak exposures and the effects of biological dampening of variability.
7. Describe sources and effects of different types of measurement error.
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.

Disability Resources for Students (DRS) offers resources and coordinates reasonable accommodations for students with disabilities. Reasonable accommodations are established through an interactive process between you, your instructor(s) and DRS. If you have not yet established services through DRS, but have a temporary or permanent disability that requires accommodations (this can 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 or disability.uw.edu

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 University of Washington 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 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 website.

Course Requirements

1. Read and be prepared to discuss weekly readings in class. (It is possible that written reflections of these assignments will be required. Regardless, be prepared with comments.) Due Tuesdays in class. Bring your own laptop to Thursday laboratory sessions.
2. Complete weekly data analysis assignments, presented as summarized results and interpretation. (This means data analyses are in the form of a presentation (e.g., tables/figures) of results accompanied by a brief written description and interpretation.) Due Wednesdays at 5pm.
3. Analyze a dataset to answer a set of specific questions and provide a written report including rationale, methods, results and discussion. Due finals week.

Grading

1. Class preparation/participation: 25%
2. Homework Assignments: 50%
3. Final paper: 25%

Software: Students are encouraged to use R. Materials will be provided in R. Previous offerings of this class used Stata so those materials are available to students if necessary. Students may need to develop their own command code to complete assignments.

Texts: Readings will be drawn primarily from the primary research literature. These and additional supplementary papers are posted on the class website.

The **additional recommended texts** listed below :

- Ramachandran G. *Occupational Exposure Assessment for Air Contaminants*. Taylor and Francis Group, CRC Press. 2005.
- Rappaport SM, Kupper LL. *Quantitative Exposure Assessment*. S. Rappaport, El Cerrito, CA, 2008. Available at www.lulu.com (ID: 1341905).
- Nieuwenhuijsen MJ, ed. *Exposure assessment in occupational and environmental epidemiology*. Oxford University Press, 2003.

ENVH 556: Weekly Class Schedule

WEEK 1

8-Jan 2 Hours Introduction and Basic Concepts (NS)

Class structure, general introduction to term project
Introduction to datasets: DEMS, snapshot, Welding School Exposures
Exposure assessment for epidemiology, risk assessment, compliance
Descriptive statistics
Variability and uncertainty (including formulas for bias, precision and uncertainty)

Readings Due: Rappaport SM. The Rules of the Game. *AJIM* 6:291-303, 1984. (read in advance)

10-Jan 1 Hour Lab: Stata, Data, and Distributions (LS)

Read "Getting Started" and review Lab 1 Document in advance.
Introduction to R, and R Markdown. Familiarity with syntax, and reporting results. Exploring data, basic data analysis using the DEMS data, principles of reproducible research.

WEEK 2

15-Jan 2 Hours Exposure Assessment Strategies (NS)

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

Readings Due: DEMS II– Coble et al. Exposure Monitoring Surveys and Development of Exposure Groups. *AOH* 54:747, 2010.
Virgi MA, Woskie SR, Waters M, et al. Agreement between task-based estimates of the full-shift noise exposure and the full-shift noise dosimetry. *Ann Occup Hyg* 53:201-214. 2009.

Supplemental Reading: Fulk, F, Haynes E, Hilbert T, Brown D, et al. Comparison of stationary and personal air sampling with an air dispersion model for children's ambient exposure to manganese. 2016. J Exp Sci Environ Epid 26(5). doi:10.1093/annhyg/mel006

Lab Due: Data exploration

17-Jan 1 Hour Lab: Presentation and precision of distribution parameters

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

WEEK 3

22-Jan **2 Hours** **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

Readings Due: DEMS IV – Vermeulen et al 2012
Friesen MC, Davies HK, Teschke K, Marion S, Demers PA. Predicting historical dust and wood dust exposure in sawmills: Model development and validation. *JOEH*, 2005, 2:650-8

Optional reading: Burstyn and Teschke 1999. Studying the Determinants of Exposure: A Review of Methods. *AIHA Journal*, 1999, 60: 57-72
For Lab: also skim Mercer, 2011. Comparing universal kriging and land-use regression for predicting concentrations of gaseous oxides of nitrogen (NOx) for the Multi-Ethnic Study of Atherosclerosis and Air Pollution (MESA Air). *Atmospheric Environment* 45 (2011) 4412-4420.

Lab Due: Distributions

24-Jan **1 Hour** **Lab: Fitting and Interpreting Regression Models (LS)**

Regression model practice using the Snapshot data

WEEK 4

29-Jan **2 Hours** **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

Readings Due: Mercer, 2011. Comparing universal kriging and land-use regression for predicting concentrations of gaseous oxides of nitrogen (NOx) for the Multi-Ethnic Study of Atherosclerosis and Air Pollution (MESA Air). *Atmospheric Environment* 45 (2011) 4412-4420.

DEMS V – Stewart et al 2012

Lab Due: Regression models

31-Jan **1 Hours** **Lab: Prediction Modeling and Validation (LS)**

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

WEEK 5

5-Feb **2 Hours** **NO CLASS: SNOW DAY**

Lab Due: Regression for Prediction and Cross-validation

7-Feb **1 Hour** **Review and Term Project Lab Introduction**

WEEK 6

12-Feb **2 Hours** **Variance Components and Mixed Models (LS)**

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

Readings Due: Peretz, C, et al. Application of a mixed effects model for exposure assessment. *Ann Occup Hyg*, 2002.

Symanski E, Maberti S, Chan W. Meta-analytic approach for characterizing the within worker and between worker sources of variation in occupational exposure. 2006. Ann Occup Hyg 50:343-357. doi:10.1093/annhyg/mel006

Optional reading: Walker Ed, et al. The characterization of Polycyclic Aromatic Hydrocarbons in Northeastern US Trucking Terminals. AWEH 2017, 61:844-853, doi: 10.1093/annweh/wxx050

14-Feb **1 Hour** **Lab: Variance Components from Mixed Models (LS)**

Fit a mixed model, adjusting variable included in random and fixed terms and provide contrasting interpretations. Describe fixed and random effects in Welding School data.

WEEK 7

19-Feb **2 Hours** **Measurement Error in Epidemiology (LS)**

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

Readings Due: Szpiro AA, Paciorek C, Sheppard L. Does more accurate exposure prediction necessarily improve health effect estimates? *Epidemiology*, 2011, 22:680-685.

Heederik D, Attfield M. Characterization of dust exposure for the study of chronic occupational lung disease: A comparison of different exposure assessment strategies. *AJE*, 2000, 151: 982-90

Lab Due: Variance Components Analysis

21-Feb **1 Hours** **Lab: Measurement Error Exercise (LS)**

Measurement error exercise using simulation

WEEK 8

26 Feb **2 Hours** **Meta-analysis, DEMS Risk Assessment (NS/LS)**

Readings Due:

Lenters V, Vermeulen R, Dogger S, et al. A meta-analysis of asbestos and lung cancer: Is better quality exposure assessment associated with steeper slopes of the exposure response relationships? *Environ Health Perspect* 119:1547–1555 (2011). http://dx.doi.org/10.1289/ehp.1002879.

Vermeulen R, Silverman DT, Garshick E, et al. 2014. Exposure-response estimates for diesel engine exhaust and lung cancer mortality based on data from three occupational cohorts. Environ Health Perspect 122:172–177; http://dx.doi.org/10.1289/ehp.1306880

Supplemental readings:

Berman DW. Case BW. Overreliance on a single study: There is no real evidence that applying quality criteria to exposure in asbestos epidemiology affects the estimated risk. *Ann Occup Hyg*. 56: 869-878 (2012).

Silverman DT, et al. The diesel exhaust in miners study: A nested Case-control study of lung cancer and diesel Exhaust. Jnci 1041-14, 2012.

Attfield MD, et al. The diesel exhaust in miners study: A cohort mortality study with emphasis on lung cancer. JNCI 2012; 104-1-15.

DEMS III – Vermeulen et al 2010

Revisit DEMS II – Coble

Revisit DEMS V – Stewart et al 2012

More optional: Read: Borak 2011 Comment and Stewart's reply ,

28-Feb **1 Hours** **Lab: Meta-analysis Lab**

Explore and select models for prediction using personal REC data

Explore and describe CO historical data and covariates

Systematically evaluate quality of exposure assessments for Diesel and Lung CA Studies.

WEEK 9

5-Mar 2 Hours Air Pollutant Exposure Modeling (LS)

Land Use Regression (LUR) with extension to geostatistical smoothing. Kriging and variograms.

Readings Due: Reread: Mercer LD, Szpiro AA, Sheppard L, Lindström J, Adar SD, Allen RD, Avol EL, Oron AP, Larson T, Liu LJS, Kaufman JD. Predicting concentrations of oxides of nitrogen (NOx) in Los Angeles, CA using universal kriging for the Multi-Ethnic Study of Atherosclerosis and Air Pollution (MESA Air), *Atmospheric Environment*, 2011,45:4412-4420.

Hoek G, Beelen R, de Hoogh K, Vienneau D, Gulliver J, Fischer P, Briggs B. A review of land-use regression models to assess spatial variation of outdoor air pollution, *Atmospheric Environment*, 2008, 42: 7561-7578.

Supplemental Reading: Zuidema C, Sousan s, Stebounova LV, et al. Mapping occupational hazards with a multi-sensor network in a heavy-vehicle manufacturing facility. Annals Work Expos and Hlth, 2019. doi: 10.1093/annweh/wxy111.

7-Mar 1 Hour Lab: Geostatistics and Universal Kriging (LS)

Geostatistics: Kriging and Variograms using the Snapshot data

WEEK 10

12-Mar 2 Hours Biomonitoring and the Exposome (NS)

Comparison of biomonitoring and external exposure monitoring
Physiologic Dampening
Exposome concepts and realities

Readings Due: Walker DI, Uppal K, Zhang L,et al. High-resolution metabolomics of occupational exposure to trichloroethylene. 2016. Internat J Epidem, 45: 1517–1527. doi: 10.1093/ije/dyw218

P.Vineisa M, Chadeau-Hyama H, Gmuenderb J, et al. 2017. The exposome in practice: Design of the EXPOsOMICS project. Intern J Hyg Environ Health, 22: 142-151, , https://doi.org/10.1016/j.ijheh.2016.08.001

Supplemental Reading: Rappaport SM, Symanski, Yager and Kupper. The relationship between environmental monitoring and biological markers in exposure assessment. Environ Hlth Persp 103(Suppl3):49-54 (1995).

Lab Due: Geostatistics and Variograms

14-Mar 1 Hours Lab: Problem-solving for term project (NS)

Review and problem-solving for term project

EXAM WEEK

19 -Mar

Term project due