Master in Public Health

Course syllabus: Environmental Epidemiology

2025/2026

Department of Experimental and Health Sciences

UNIVERSITAT POMPEU FABRA –

UNIVERSITAT AUTÒNOMA DE BARCELONA

ISGlobal (Barcelona Institute for Global Health)

DESCRIPTION

Academic course: 2024-2025
Subject name: Environmental Epidemiology (Environmental Health)
Kind of subject: Compulsory research itinerary
Credits: 3 ECTS (75 hours)
Professors: Martine Vrijheid, Xavier Basagaña, and Elizabet Diago
Coordination: Martine Vrijheid and Xavier Basagaña
Language: English

PROFESSORS

Martine Vrijheid

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Xavier Basagaña

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PRESENTATION

Health effects of different environmental exposures such as air pollution, water quality, urban waste, radiation, food toxics, etc., are growing problems of concern to public health professionals who need to know how to affront them. This course presents some of the basic problems of environmental health from an epidemiological perspective with special attention to methodological aspects.

LEARNING OUTCOMES

a) To understand the main environmental risks to health.
b) To know how to apply epidemiological principles and methods to study environmental risks.
c) To understand the main strategies for the evaluation and control of environmental risks to health.

COMPETENCES TO ACHIEVE

GENERAL SKILLS

Instrumental skills

- Apply the theoretical foundations of epidemiology for the analysis and interpretation of environmental health problems.
- Develop criteria for critical reading of environmental epidemiology research articles.
- Develop a short research protocol to address an environmental health problem.

Interpersonal skills

- Work in group.
- Present in public.
- Critical thinking.

Systematic skills

- Critical reading of the epidemiological literature.
- Formalize socially relevant health problems using theories and methods.

SPECIFIC SKILLS

1. To know the main environmental risk factors in our environment
2. To know the uses and instruments of environmental epidemiology.
3. Understand the concepts of risk assessment, impact assessment and planetary health.
4. Interpret and synthesize the results of the literature in environmental epidemiology.
5. Working in group to solve real situations.
6. Public presentation.

METHODOLOGY

Lectures (8,5 hours of lectures; 21 hours of individual working)

- Environmental epidemiology: introduction and applications.
- Environmental exposure assessment and biomarkers.
- Air pollution: acute effects and chronic effects.
- Risk assessment and precautionary principle.
- Advanced designs and concepts in environmental epidemiology (DOHaD, Exposome).
- Natural and man-made disasters and preparedness.

Case studies (5,5 hours of working group in class; 12 hours of individual study)

- Biomarkers of environmental contaminants.
- Long term exposure effects to air pollution and mortality.
- The early life exposome and lung function.

Methodology

Working in small groups consisting of the critical reading of a research article and the use of a guide for discussion. The work is complemented by the discussion with the teacher and with the presentation and discussion with the other groups.

Research protocol in group (6 hours of small group work in class; 22 hours of group working)

Theme

The health effects of living near of a new municipal incinerator.

Methodology

- Preparation of a research protocol based on a pre-established guide.
- The protocol will be elaborated working in small groups.
- Each group will present and discuss the protocol in public.

EVALUATION

Contribution to the final grade:
Exam, short answer questions 30%
Participation in the case studies 30%
Research protocol 40%

The assessment will have an individual component (60%) and a group component (40%).

The individual component will be evaluated through and exam based on 4-6 short questions with narrative answers (30%) and the assessment of case studies (30%).

Assessment of case studies will be based on the attendance to case study sessions (15%) and a self-evaluation of participation (15%).

The evaluation of the research protocol (40%) will be based on the group public presentation (consensus score by two professors).

The teacher will take attendance list for each class. Students who do not attend at least 60% of the classes will fail the course.

TIME SCHEDULE

Date	Session	Professor
26 March of 2026		
15:00 - 16.30	*Session 1:* ***Environmental epidemiology: introduction and applications***	Martine Vrijheid
16:30 - 17:00	Pause	
17:00 - 19:30	***Introductory session of the research protocol***	Martine Vrijheid
9 April of 2026		
15:00 - 16:30	*Session 2:* ***Environmental exposure assessment and biomarkers***	Martine Vrijheid
16:30 - 17:00	Pause	
17:00 - 19:00	*Case study 1:* ***Biomarkers of environmental contaminants***	Martine Vrijheid
19:00 - 19:30	***Research protocol***	
16 April of 2026		
15:00 - 16:30	*Session 3:* ***Air pollution: acute effects and chronic effects***	Xavier Basagaña
16:30 - 17:00	Pause	
17:00 - 19:00	*Case study 2:* ***Long term exposure effects to air pollution and mortality***	Xavier Basagaña
19:00 - 19:30	***Research protocol***	
30 April of 2026		
15:00 - 16:30	*Session 4:* ***Risk assessment and precautionary principle***	Xavier Basagaña
16:30 - 17:00	Pause	
17:00 - 18:00	*Session 5:* ***Advanced designs and concepts in environmental epidemiology (DOHaD, Exposome)***	Martine Vrijheid
18:00 - 19:30	*Case study 3 – discussion:* ***The early life exposome and lung function***	
7 May of 2026		
15:00 - 16:30	*Session 6:* ***Natural and man-made disasters and preparedness***	Elizabet Diago
16:30 - 17:00	Pause	
17:00 - 19:30	***Research protocol presentation***	Xavier Basagaña/ Martine Vrijheid

Exam: 12 June (15:00-19:30)

OUTLINE SESSIONS AND READINGS

Session 1: **Environmental epidemiology: introduction and applications. Martine Vrijheid**		**Aula global**
Outline	1. Defining environmental epidemiology. 2. Environmental burden of disease. 3. Applications of environmental epidemiology. 4. Advanced conceptual models and methods. 5. New frontiers for environmental epidemiology in a changing world.	
Recommended reading	1. Dean Baker, Mark J Nieuwenhuijsen (editors). Environmental epidemiology: study methods and application. Oxford: Oxford University Press, 2008. ISBN 978-0-19-852792-3. Chapter 1: What is environmental epidemiology? https://academic.oup.com/eurpub/article/19/3/350/937155	YES
	2. Landrigan et al. Lancet Commission on Pollution and Health. Published online October 19, 2017 http://dx.doi.org/10.1016/S0140- 6736(17)32345-0.	YES
	3. Whitmee S, Haines A, et al. Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation- Lancet Commission on planetary health. Lancet 2015; 386 (10007):1973-2028. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(15)60901-1/fulltext	YES
	4. Tonne C, Basagaña X, Chaix B, Huynen M, Hystad P, Nawrot TS, Slama R, Vermeulen R, Weuve J, Nieuwenhuijsen M. New frontiers for environmental epidemiology in a changing world. Environ Int. 2017 Jul;104:155-162. doi: 10.1016/j.envint.2017.04.003. Epub 2017 Apr 26. https://pubmed.ncbi.nlm.nih.gov/28454882/	YES

Research protocol: **Developing a research protocol to study the health effects of living near of a new municipal incinerator.**

Aim of the exercise

The aim of this exercise is to allow participants to discuss the design of a study on environmental epidemiology: you must make a proposal for a study evaluating the potential adverse health effects associated with emissions from a municipal incinerator. You are free to define any specific objectives you believe are important and select any study design you feel is appropriate for these objectives. You are encouraged to incorporate the use of biological markers in your protocol. The proposed study should be realistic in terms of human resources, time span and budget. Put in writing the objectives of the proposed study but do not attempt to write a full proposal. You will be asked at the end of the exercise to present your proposal.

The general objective of the proposed study

The general objective of the proposed study is to examine whether emissions from a new modern municipal solid waste incinerator situated near a town, are dangerous for the health of the inhabitants of this town.

The setting

The Town (see map)

- The town has 300,000 inhabitants, evenly distributed throughout the town.
- Some houses are located outside the town in the shaded area indicated as farms. The families living there (total number about 500 subjects) are mainly involved in agriculture.
- The town has a regional hospital covering the whole population.
- There are 50 primary schools evenly distributed throughout the town.

The incinerator (see map)

This is a modern municipal solid waste incinerator and emissions are expected to be low. The main categories of emissions are:

(I) air pollutants such as, SO2, NO2, organic volatile compounds, fine particulates (PM10, PM2.5);
(II) heavy metals such as, cadmium (Cd), nickel (Ni), lead (Pb), mercury (Hg), arsenic (As), Beryllium (Be), hexavalent chromium (Cr+6); and,
(III) organochlorinated compounds such as, polychlorinated dibenzo dioxins (TCDD and other), polychlorinated furans (PCDFs) and polychlorinated biphenyls (PCBs).

The distance between the incinerator and the first houses of the town is approximately 500 meters. The circle drawn around the incinerator has a radius of 1 km.

Information on population characteristics, hospital admissions and mortality

Information on individuals (name, address, ages, sex, and occupation) can be abstracted from the municipal register. Information on admissions in the hospital and visits in outpatient departments can be retrieved. Information on mortality can be retrieved from the Regional Mortality Register. There is no cancer registry.

Biological measurements

Exposure, internal dose: Heavy metals

- Metals (Cd, Pb, Ni, Cr+6, As, Hg, Be) can be measured in blood or urine (depending on half-life). Some metals have also been measured in other media, e.g. Hg in hair. A quantity of about 2 ml of blood or 5 ml of urine is needed for the analysis of metals. It is not necessary to collect 24 hr urine. The cost for determining concentrations of a broad spectrum of metals in each sample is about 75 €.

Exposure, internal dose: Dioxins, furans, PCBs

- Dioxins, furans, and PCBs can be measured in blood or adipose tissue. A quantity of about 25 ml of blood or of 0.5 gr. of adipose tissue is necessary for the analysis of dioxins and furans. The cost of each analysis is about 250€. A quantity of about 2.5 ml of blood is necessary for the analysis of PCBs (if done separately from the dioxin analysis). The cost of each PCB analysis is about 40€.

Early effects

A quantity of about 5 ml of fresh blood is necessary for the determination of SCEs (sister chromatic exchanges), chromosomal aberrations, micronuclei etc.

Possible Structure of the Proposed Study Protocol

Objectives

State the specific objectives of the study.

Study design

- Describe the study design.
- Indicate whether you are proposing a prospective study, a cross sectional study, an ecological approach, a hybrid design, a health impact assessment study, etc.
- Indicate which is your study base, i.e. whether you are doing a study in the general population or, whether you are focusing on a specific sub-population, e.g. the farmers living close to the incinerator, school children, pregnant women.
- Define your control group.
- Indicate the sampling procedure for the populations included in the study.
- Discuss the advantages and limitations of the study design you propose and the reasons for your choice.

Outcomes

Describe the outcome(s) of the study and how are you planning to measure them. Possible outcomes could be:

- An exposure assessment study. Indicate whether you will measure environmental exposures, exposures in humans using biomarkers e.g., levels of agents in body fluids, DNA adducts.
- Occurrence of specific or general health outcomes/diseases, such as congenital anomalies, cancer, psychological problems, respiratory function, neuropsychological function in children, general health status.
- Measurement of early effects such as SCEs, chromosomal aberrations.
- Measurement of individual susceptibility.

Measurement of exposure

Indicate which exposures you are going to measure, and the potential confounding factors and effect modifiers.

Describe the instruments that you are going to use, e.g. questionnaires, biological measurements, functional tests, etc. If you are using a questionnaire don't attempt to construct one, but indicate the most important variables for which you would like to collect information. If you are doing environmental or biological measurements indicate what agents are you going to measure, the media (e.g. blood, urine, exhaled air, tumor biopsies, hair etc.), and the sampling policy (e.g. timing of the measurements).

Statistical power of the study

Indicate (roughly) which the power of the study is.

Analysis and results

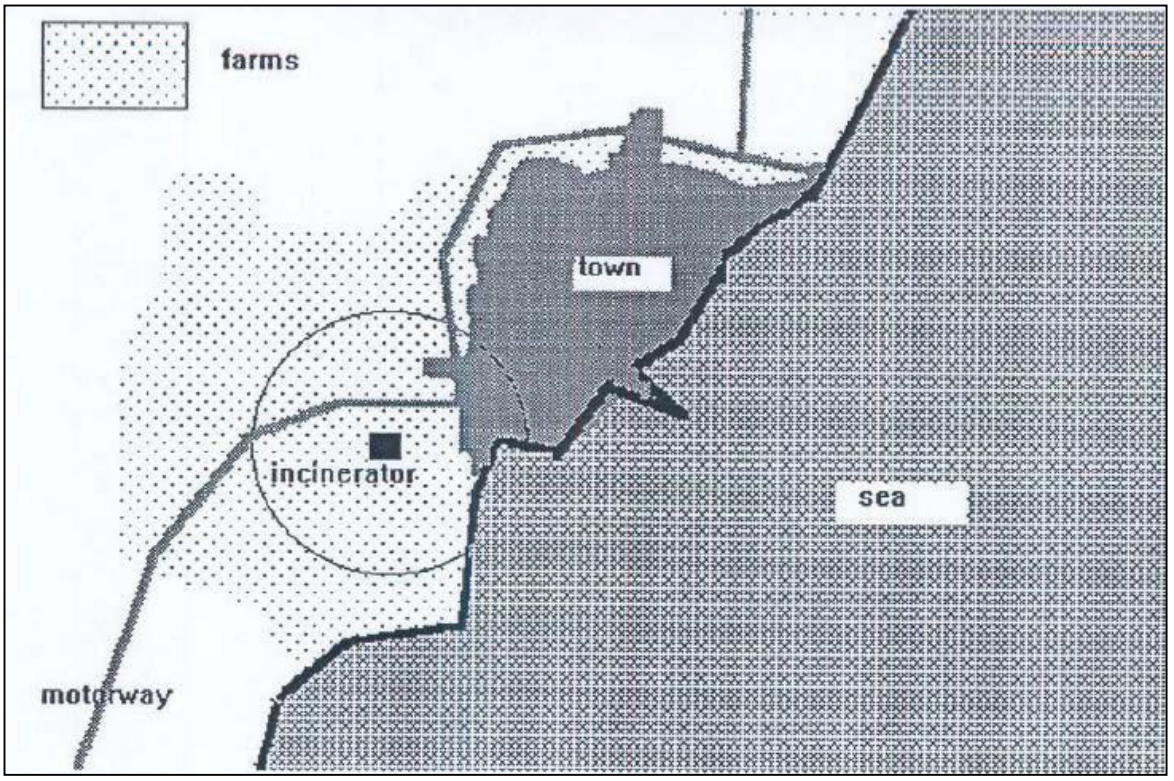
Briefly indicates the analysis you're planning to do, which statistical methods will be used and the main expected results.

Discussion and limitations

Briefly consider the study limitations and how do you plan to address their impact.

Relevance and applicability.

Explain the relevance of the study and how their results will be applied.


farms
town
incinerator
sea
motorway

Session 2: **Environmental exposure assessment and biomarkers** **Martine Vrijheid**		**Aula global**
Outline	1. Introduction to chemical exposures. 2. Definitions and concepts of exposure in environmental epidemiology. 3. Approaches to exposure assessment. 4. Biological markers to assess exposure. 5. Errors in exposure assessment. 6. Future perspectives.	
Recommended reading	1. Nieuwenhuijsen M.J. Introduction to exposure assessment. In: Nieuwenhuijsen M.J, editor. Exposure Assessment in Occupational and Environmental Epidemiology. London: Oxford University Press; 2003. 3-20. 2. Barr DB, Wang RY, Needham LL. Biologic monitoring of exposure to environmental chemicals throughout the life stages: requirements and issues for consideration for the National Children's Study. Environ Health Perspect 2005;113(8):1083-91. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1280353/	YES YES

Case study 1: **Biomarkers of environmental contaminants** **Martine Vrijheid**
Staessen JA, Nawrot T, Hond ED, Thijs L, Fagard R, Hoppenbrouwers K et al. Renal function, cytogenetic measurements, and sexual development in adolescents in relation to environmental pollutants: a feasibility study of biomarkers. Lancet 2001;357(9269):1660-9. (available on the Aula Global). Link

Introduction

1. What is the research question? And why do the authors do this study?
2. Could you identify the type of design?
3. Why did the study focus on adolescents?

Material and methods

1. Identify the biomarkers of exposure and those of health effects. What are the differences between an exposure marker and an early effect marker?

Results

1. Table 1: Interpret the results of Table 1 and evaluate if they are the ones you would have expected to find.
2. Tables 2 and 3: What are the differences in exposure and effect markers between study areas? Are these the differences between areas that you would have expected?
3. Table 4 and figures 1 and 2 show different dose-response analyzes. Can you identify them? List the conclusions.
4. What are the differences between the regional analysis (Tables 2 and 3) and the individual analysis (Table 4, fig 1, 2)? What is the contribution of each analysis?

Discussion

1. What is the most important conclusion according to the authors? Do you agree? If not, what is your conclusion?
2. The authors found some specific associations between pollutants and effects. What are the limitations of these results?

Session 3: **Air pollution: acute effects and chronic effects.** **Xavier Basagaña**		**Aula global**
Outline	1. Introduction to air pollution. a. What is it? b. How is it measured? 2. Types of study design for health effects of a. acute exposure. b. long-term exposure. 3. Summary of known health effects and burden.	
Recommended reading	1. Stafoggia M, Samoli E, Alessandrini E, Cadum E, Ostro B, Berti G et al. Short-term associations between fine and coarse particulate matter and hospitalizations in Southern Europe: results from the MED-PARTICLES project. Environ Health Perspect 2013;121(9):1026-33. link 2. Schraufnagel DE, Balmes JR, De Matteis S, Hoffman B, Kim WJ, Perez-Padilla R, Rice M, Sood A, Vanker A, Wuebbles DJ. Health benefits of air pollution reduction. Annals of the American Thoracic Society. 2019 Dec;16(12):1478-87. link 3. Beelen R, Raaschou-Nielsen O, Stafoggia M, Andersen ZJ, Weinmayr G, Hoffmann B et al. Effects of long-term exposure to air pollution on natural-cause mortality: an analysis of 22 European cohorts within the multicentre ESCAPE project. Lancet 2014;383(9919):785-95. link	YES YES YES

Case study 2: **Long term exposure to air pollution and mortality** **Xavier Basagaña**
Beelen R, Raaschou-Nielsen O, Stafoggia M, Andersen ZJ, Weinmayr G, Hoffmann B et al. Effects of long-term exposure to air pollution on natural-cause mortality: an analysis of 22 European cohorts within the multicentre ESCAPE project. Lancet 2014;383 (9919):785-95. (available on the Aula Global). Link

1. Technical summary of the study:

- What is the objective of the study?
- What is the design and the study population?
- How do they measure the outcome, type and timing?
- How do they measure exposure?
- What is the statistical analysis?

2. Interpretation of results.

- Table 4. Why do they fit 3 different models? Interpret the differences between the columns.
- What is the interpretation of Table 5 and why do they do this analysis?
- What is the interpretation of Figure 2?

3. Exposure assessment.

- What are some potential problems of the exposure assessment they did?
- How could it be improved?
- How should the results of the study be interpreted?

4. Causality.
- Think about potential limitations of the study and about potential reasons why the reported effects could not be true.
- After having read the paper and considered all of the above, do you (honestly) believe the study conclusions?

5. In the lecture we have seen that there is a lot of evidence of the health effects of air pollution. Why do we keep doing new studies? Are they needed?

Session 4: Risk assessment and precautionary principle Xavier Basagaña		Aula global
Outline	1. Risk assessment: definition and steps. 2. Health impact assessment. 3. Precautionary principle.	
Recommended reading	1. Brunekreef, B. (2008). Environmental epidemiology and risk assessment. Toxicology letters, 180(2), 118-122. Link 2. Pearce N. IARC monographs: 40 years of evaluating carcinogenic hazards to humans; Environ Health Perspect. 2015 Jun; 123(6):507-14. doi: 10.1289/ehp.1409149. Epub 2015 Feb 24. Link 3. Grandjean, P. (2004). Implications of the precautionary principle for primary prevention and research. Annu. Rev. Public Health, 25, 199-223. Link	YES YES YES

***Session 5:* Advanced designs and concepts in environmental epidemiology (DOHaD, Exposome)** **Martine Vrijheid**		**Aula global**
Outline	1. Early life, Developmental Origins of Health and Disease, and birth cohort studies. 2. The exposome concept and application in cohortstudies.	
Recommended reading	1. Barouki R, Gluckman PD, Grandjean P, Hanson M, Heindel JJ. Developmental origins of non-communicable disease: implications for research and public health. Environ Health. 2012 Jun 27;11:42. doi: 10.1186/1476-069X-11-42. Link 2. Guxens M1, Ballester F, Espada M, Fernández MF, Grimalt JO, Ibarluzea J, Olea N, Rebagliato M, Tardón A, Torrent M, Vioque J, Vrijheid M, Sunyer J; INMA Project. Cohort Profile: the INMA--INfancia y Medio Ambiente--(Environment and Childhood) Project. Int J Epidemiol. 2012 Aug;41(4):930-40. Epub 2011 Apr 5. Link 3. Vrijheid M. Thorax. 2014 Sep;69(9):876-8. doi: 10.1136/thoraxjnl-2013-204949. Epub 2014 Jun 6. The exposome: a new paradigm to study the impact of environment onhealth. Link	YES YES YES

Case study 3: **The early life exposome and lung function.** **Martine Vrijheid**
Agier L, Basagaña X, Maitre L, et al. Early-life exposome and lung function in children in Europe: an analysis of data from the longitudinal, population-based HELIX cohort. Lancet Planet Health. 2019 Feb;3(2):e81-e92. doi: 10.1016/S2542-5196(19)30010-5. Epub 2019 Feb 6. (available on the Aula Global). Link

In small groups and afterwards in the plenary, we will discuss the following aspects of this study:

1. Technical summary of the study:
   - What is the objective of the study?
   - What is the design and the study population?
   - How is the outcome measured?
   - How is exposure measured?
   - What is the statistical analysis?

2. Main results of the study:
   - Which results are shown in Figure 1 and Figure2?
   - How do you interpret Table 3 and4?
   - What is the difference between the results shown in the tables and the figures?

3. Strengths and limitations
   - What are some potential problems in the study of many exposures at the sametime?
   - And what are some advantages?
   - What are the main biases and confounding factors in this study?
   - Can this study conclude that some exposures have stronger effects on lung function than other exposures?

4. Concept
   - Do you believe the exposome is a useful concept in environmental health research?
   - How could future studies in this area beimproved?

Session 6: **Natural and man-made disasters and preparedness.** **Elizabet Diago**		**Aula global**
Outline	1. Accidents of Chernobyl and Fukushima - summary, exposed populations, and dose levels. 2. Population monitoring, results and uncertainties. 3. War and risk of radiation exposure from nuclear power plants. 4. Pandemic Preparedness 5. Recommendations for preparedness, response and long-term surveillance. 6. Implications for public health/environmental crises.	
Recommended reading	1. Hatch, M., Cardis, E. Somatic health effects of Chernobyl: 30 years on. Eur J Epidemiol. 2017; 32(12):1047-1054. https://doi.org/10.1007/s10654-017-0303-6. 2. Schneider, T et al 2020. Guest editorial: The SHAMISEN project - Applicability or lessons learnt and recommendations for disaster situations. Environ Int. 2021; 144, 106000. https://doi.org/10.1016/j.envint.2020.106000 3. Cléro E et al. Lessons learned from Chernobyl and Fukushima on thyroid cancer screening and recommendations in case of a future nuclear accident. Environ Int. 2021; 146:106230. https://doi.org/10.1016/j.envint.2020.106230 4. Liutsko, L et al, SHAMISEN Consortium, 2021. The SHAMISEN Recommendations on preparedness and health surveillance of populations affected by a radiation accident. Environ Int 146, 106278. https://pubmed.ncbi.nlm.nih.gov/33271440/ 5. Advice for the Public on Protection in Case of a Nuclear Detonation. https://www.icrp.org/page.asp?id=611 6. How Can We Be Better Prepared for the Next Public Health Crisis? Lessons Learned from the COVID-19 Pandemic. https://www.isglobal.org/en/-/how-can-we-be-better-prepared-for-the-next-public-health-crisis-lessons-learned-from-the-covid-19-pandemic	YES YES YES YES YES YES

BIBLIOGRAPHY AND INFORMATION RESOURCES

Bibliography

1. Barker D, Nieuwenhuijsen M. Environmental Epidemiology. 1st Edition. New York: Oxford University Press; 2008.

2. Chien-Jen Chen. Environmental health issues in public health. In: Oxford Textbook of Global Public Health (6 ed.) 2016. Edited by Roger Detels, Martin Gulliford, Quarraisha Abdool Karim, and Chorh Chuan Tan.

Information Resources

1. Nieuwenhuijsen MJ. Exposure Assessment in Occupational and Environmental Epidemiology. London: Oxford University Press;2003.

2. Wilkinson P. Environmental Epidemiology. London: Open University Press; 2006.

3. Hertz-Picciotto I. Environmental Epidemiology. In: Rothman K, Greenland S, Lash T. Modern Epidemiology. 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2008. 598-619.

4. Thomas C. Duncan. Statistical Methods in Environmental Epidemiology. New York: Oxford University Press; 2009.