

## Course guide

# 200654 - MME - Statistical Methods in Epidemiology

**Last modified:** 12/06/2023

**Unit in charge:** School of Mathematics and Statistics  
**Teaching unit:** 715 - EIO - Department of Statistics and Operations Research.  
**Degree:** MASTER'S DEGREE IN STATISTICS AND OPERATIONS RESEARCH (Syllabus 2013). (Optional subject).  
**Academic year:** 2023    **ECTS Credits:** 5.0    **Languages:** English

### LECTURER

---

**Coordinating lecturer:** KLAUS GERHARD LANGOHR  
**Others:** Segon quadrimestre:  
KLAUS GERHARD LANGOHR - A

### PRIOR SKILLS

---

The student has to be familiar with the concepts of statistical inference: the likelihood function, maximum likelihood estimation, hypothesis testing, and linear regression models. In particular, the student should be familiar with the contents of the first three chapters of the book "Principles of Statistical Inference" Cox (Cambridge University Press, 2006).

### REQUIREMENTS

---

Knowledge of the software package R.

### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

---

#### Specific:

3. CE-1. Ability to design and manage the collection of information and coding, handling, storing and processing it.
4. CE-2. Ability to master the proper terminology in a field that is necessary to apply statistical or operations research models and methods to solve real problems.
6. CE-5. Ability to formulate and solve real problems of decision-making in different application areas being able to choose the statistical method and the optimization algorithm more suitable in every occasion.  
Translate to english
7. CE-6. Ability to use appropriate software to perform the necessary calculations in solving a problem.
5. CE-3. Ability to formulate, analyze and validate models applicable to practical problems. Ability to select the method and / or statistical or operations research technique more appropriate to apply this model to the situation or problem.
8. CE-7. Ability to understand statistical and operations research papers of an advanced level. Know the research procedures for both the production of new knowledge and its transmission.
9. CE-8. Ability to discuss the validity, scope and relevance of these solutions and be able to present and defend their conclusions.

#### Transversal:

2. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

## TEACHING METHODOLOGY

### Lectures:

Sessions that last 90 minutes and during which the course material is presented with the help of a PC. The material, which is partially based on real data sets from epidemiological studies as well as on scientific papers, is previously available in the Intranet (ATENEA). Also, in different occasions the theory lectures will be used for exercises.

### Lab classes:

There will be 3 lab classes during which the use of functions from contributed packages of the R software will be explained and practiced with real world data sets from epidemiological studies on HIV/AIDS, postpartum depression, or sports injuries.

## LEARNING OBJECTIVES OF THE SUBJECT

The course aims to enable the student to design and analyze epidemiological studies. This includes, that s/he should be able to propose the adequate designs and analyses for an epidemiological study in such a way that these can be understood easily by other investigators.

In particular, after the completion of the course, the student should have acquired a profound knowledge on the following topics and should be able to apply the corresponding methods to real data:

1. Design of epidemiological studies: cohort studies, case-control studies, and population based studies.
2. Epidemiological measures of disease frequency, mortality, and exposure-disease association.
3. Sources of bias in epidemiological studies: information, selection, and confounding bias.
4. Bias control: stratification and matching.
5. Logistic, logbinomial and Poisson regression.

Specifically, the student should be able:

- To propose designs and analyses for epidemiological studies that provide the best information possible and that can be assimilated easily by the researchers that will have to interpret them.
- To assess the advantages and disadvantages of different types of epidemiological studies.
- To estimate, apply, and interpret measures of the disease frequency, mortality, and exposure-disease association.
- To have basic knowledge on causal inference in observational studies.
- To know different sources of bias in epidemiological studies and possible measures to avoid the bias.
- To fit logistic, log-binomial, and Poisson regression models to real data and interpret the results.

## STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	24.00
Hours small group	15,0	12.00
Self study	80,0	64.00

**Total learning time:** 125 h

## CONTENTS

### Introduction to Epidemiology

#### Description:

- a) Epidemiological studies vs. clinical trials.
- b) Design of epidemiological studies: cohort studies, case-control studies, and population-based studies.

#### Full-or-part-time: 3h

Theory classes: 2h 30m

Laboratory classes: 0h 30m

### Epidemiological measures: concepts and estimation

**Description:**

- a) Measures of disease frequency: prevalence, cumulative incidence, and incidence rate.
- b) Mortality rates and their comparison: direct and indirect standardization, comparative mortality figure, and standardized mortality ratio.
- c) Measures of exposition-disease association: relative risk, risk difference, odds ratio difference, and attributable risk.

**Full-or-part-time:** 13h 30m

Theory classes: 9h

Laboratory classes: 4h 30m

### Aspects of epidemiological studies

**Description:**

- a) Causal inference in epidemiological studies.
- b) Study of the cause-effect relation. Common causes and effects.
- c) Sources of bias in epidemiological studies: information bias, selection bias, and confounding.
- d) Strategies for error control and variance minimization: stratification and matching.
- e) Additive interaction versus multiplicative interaction.

**Full-or-part-time:** 13h 30m

Theory classes: 9h 30m

Laboratory classes: 4h

### Analysis of epidemiological studies

**Description:**

- a) Estimation of the relative risk, the odds ratio, and attributable fraction in cohort studies, case-control studies, and population based studies.
- b) Computation of comparative mortality figure and standardized mortality ratio.
- c) The Mantel-Haenszel estimator in the presence of a confounding variable.
- d) Analysis of matched data in case-control studies.
- e) Logistic regression: model expression, parameter estimation, and model interpretation.
- f) Log-binomial regression: model expression, parameter estimation, and model interpretation.
- g) Poisson regression: model expression, parameter estimation, and model interpretation.

**Full-or-part-time:** 15h

Theory classes: 9h

Laboratory classes: 6h

## GRADING SYSTEM

Assessment is based on the following:

- a) Final exam (50%),
- b) Problem sheets (30%),
- c) Summary and presentation of a scientific paper (20%).

## BIBLIOGRAPHY

---

### Basic:

- Jewell, Nicholas. Statistics for epidemiology. Chapman & Hall/CRC, 2004. ISBN 1584884339.
- Gordis, Leon. Epidemiología. 3ª ed. W.B. Saunders, 2005. ISBN 8481748390.
- Kahn, H. A.; Sempes, C.T. Statistical methods in epidemiology. Oxford University Press, 1989. ISBN 0195057511.
- McNeil, Don. Epidemiological research methods. Wiley, 1996. ISBN 0471961965.
- Rothman, Kenneth J. Epidemiology: an introduction. Oxford University Press, 2012. ISBN 9780199754557.

### Complementary:

- Porta, M. A Dictionary of epidemiology. Fifth edition. Oxford University Press, 2008. ISBN 9780195314502.
- Breslow, N.E.; Day, N.E. Statistical methods in cancer research. International Agency for Research on Cancer, 1980.
- Rothman, K. J.; Greenland, S. Modern epidemiology. 3rd ed. Lippincott Williams & Wilkins, 2008. ISBN 9780781755641.
- Woodward, Mark. Epidemiology study design and data analysis. Chapman & Hall/CRC Press, 1999. ISBN 1584880090.