Research School in Medical Science

MEFMV2F, 13.5 hp

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1. Introduction

Welcome to the Research School in Medical Science at the Faculty of Medicine, Lund University! We offer a course package to provide the basics in scientific theory, methods, statistics, and ethics, as well as skills for communicating science. Together, the aim of the research school is to help you achieve the learning outcomes of the PhD program and provide tools for all stages throughout your research project.

Approximately 160 PhD students (a third are full-time PhD students, two thirds part-time) per year are admitted to the Faculty of Medicine at Lund University. The group is heterogeneous, with 70-75% clinical and 20-25% pre-clinical students. Additionally, the PhD program hosts a significant number of international students with limited proficiency in Swedish and admission to the program is continuous throughout the year.

This research school is designed to secure timely participation, align students of different backgrounds, build professional networks across the Faculty, and improve the impact of the compulsory courses for each individual PhD student. The Research School in Medical Science offers all compulsory PhD courses during one semester together with a fixed class of students from various research topics across all disciplines at the Faculty. Students are offered admission to and are expected to attend the research school during the first year of their PhD program. The courses are taught in English using Canvas as the digital learning environment.

Two of the most important concepts when initiating the Research School were early access to compulsory courses as well as the idea of building networks across the various subjects of the Faculty. Therefore, students and supervisors are expected to prioritize the course and respect that active participation is compulsory throughout.

2. Learning objectives

The overall aim of the Research School in Medical Science is to provide a foundation based on the theory of science, methodology and ethics for scientific work in all steps of the research process.

Specific learning outcomes

Knowledge and understanding

1. Describe the PhD program's learning outcomes and define the function of the individual study plan (ISP).Identify roles and division of responsibilities between the PhD student, supervisor and others involved in the education process.
2. Identify and summarize key concepts and theories that are of importance for the student's own thesis.
3. Identify ethical considerations and problems in various research contexts and in the student's own research.
4. Compare perspectives on evidence and explain epistemological differences.
5. Identify differences in quantitative and qualitative study designs and discuss the level of evidence and generalizability.

Competence and skills

1. Apply ethical guidelines and legal rules in the student´s own research and in that of others.
2. Analyze and present the student's own research and others from an ethical perspective.
3. Analyse, discuss and present differences in study design, method and data handling in relation to research questions and research paradigms.
4. Independently select, justify, examine and evaluate a statistical method of relevance for the student's own research or a specific research question.
5. Problematize perceptions on gender, diversity, sustainability and equal rights in relation to the student's own research field.
6. Communicate, orally and in writing, the student's own research in a manner that is relevant in relation to the selected target group, situation and context.
7. Develop and argue for search strategies for the student's own research in relevant databases and explain the research publication process.

Judgment and approach

1. Justify the need for the student's continued personal competencies development in relation to their professional development as a researcher.
2. Critically reflect on the ethical challenges and standpoints through the various steps of the research process, as well as on the shortcomings and merits of ethical guidelines and legal rules in research.

3. Modules

The research school consists of the following course modules:

- Introduction to PhD studies (the module runs digitally and "on-demand" - you take it immediately after admission to PhD studies and it has to be completed before you start the other Research School courses)
- Introduction to Research Methodology, 3 hp/credits
- Scientific communication in theory and practice, 1.5 hp/credits
- Applied statistics I, 1.5 hp/credits
- Research ethics, 3 hp/credits
- Applied statistics II, 3 hp/credits, you choose one of the two level II-modules: Clinical and Epidemiological Research or Biomedicine and Laboratory Medicine
- Oral communication, 1.5 hp/credits

Module 1 (2100). Introduction to PhD studies

Contents and format

The module is fully digital and all documents and lectures can be viewed at any time-point in www.canvas.education.lu.se.

To complete the course, you will need to read and view the compulsory material and also pass a test with multiple choice questions (MCQ). You will also need to complete an individual reflection and together with your supervisor discuss the content of this reflection.

This digital introductory module will give you a glimpse of what modules to come and learning goals for the different modules, including Introduction to research methodology, Scientific communication, Statistics and choice of statistical software, Research ethics and Oral communication. Useful information to facilitate your academic writing will also be provided. In this module you will learn about your individual study plan (ISP) and be introduced to the Portfolio, which will be a reflection document you will work with throughout your PhD education.

Furthermore, you will get information from the post-graduate studies office, and the human resource department related to the working environment describing your and the employer's responsibility at the University and available support. You will get to know the role of the doctoral student ombudsman (DOMB), how to benefit from the Medical doctoral student council (MDR), and how Lund University Innovation can help you to utilize your research. The Career Centre will provide the perspective of what possibilities you have when you have obtained a PhD.

Aims

- To get an overview of the research studies at the Medical Faculty in Lund, including courses, learning goals, the individual study plan (ISP) and the portfolio.
- To provide information about the post-graduate studies office, the human resource department, the doctoral student ombudsman (DOMB), the Medical doctoral student council (MDR), and Lund University Innovation, and the Career Centre.

Learning objectives

- Describe the learning outcomes and content of the PhD program in its local context as well as the national aims and policies for doctoral studies.
- Define the function of the individual study plan (ISP) and how it can become a significant instrument in the learning process.
- Identify the value of self-reflection and how the Portfolio system can be of support in the learning process.
- Identify various roles and clarify the distribution of responsibilities between doctoral students, supervisors and others involved in the educational process.

Assignments

- Read and view the compulsory material.
- Pass a Multiple Choice Questions (MCQ) examination online.
- Complete an individual reflection and together with your supervisor discuss your reflection.

References

The Handbook for PhD Students
http://www.med.lu.se/english/intramed/teaching_research/phd_students_supervisors

Module 2 (2101). Introduction to Research Methodology (3hp/credits)

Contents and format

The module consists of lectures, group work, case-based demonstrations, practical exercises, quizzes, discussions and presentations. Attendance is compulsory for all components.
The course focuses on the different methods relevant in research at the Medical Faculty, Lund University. The course introduces the research process and scientific reasoning. It includes the following research methodology:

- Experimental designs and methodological pre-clinical studies
- Quantitative methods: clinical research & design, causal inference and epidemiology
- Health economics
- Qualitative methods
- Systematic review technique
- Mixed designs and methods

Aims

The course aims to enable the participants to develop an understanding of the research process, research design and methodology.

Learning objectives

- To gain the ability to put into perspective why and why not a certain design/research method for a specific purpose/a specific hypothesis should or should not be used.
- Identify differences in quantitative and qualitative study designs and discuss the level of evidence and generalizability.
- Analyse, discuss and present differences in study design, method and data handling in relation to research questions and research paradigms.

Assessment

The assessment is based on active participation in all the components of the course.

- Written individual report on own research process
- Multiple Choice Questions (MCQ)

References

Recommended reading is listed in Canvas and available from the start of the module.

Module 3 (2102). Scientific communication in theory and practice (1.5hp/credits)

Contents and format

The module consists of lectures, group work, demonstrations of and practical exercises in information management, group discussions. Attendance is compulsory for all components.

Aim

The module aims to enable the participants to develop an understanding of the different stages of the process of scientific communication.

Learning objectives

- Explain the process of research publication including examples from your own research area and different publication models.
- Develop a search strategy for your own research in relevant databases and reflect on this strategy.
- Formulate your own research in writing in a clear and accessible way for a target group in a popular science forum.
- Explain and analyse the composition and structure of research papers.
- Apply different tools for evaluation of research, identify strengths and weaknesses and discuss these.

Assessment

The assessment is based on active participation in all the components of the module and a number of assignments:

- Written assignment on the publication process.
- Written assignment on your own research for the general public.
- Written assignments on the composition and structure of research papers.
- Written assignment on search strategies for information related to their own projects.

References

Recommended reading is listed in Canvas and available from the start of the module.
Lexell J, Brogårdh C. Writing, reviewing and publishing scientific papers. Studentlitteratur, 2023.

<u>Module 4 (2103). Applied statistics I (1.5 hp/credits)</u>

Contents and format

The module includes the following three blocks:

1. Introduction to medical statistics
    - Study design
    - Generalizability
    - Basic statistical concepts
    - Descriptive statistics
2. Parameter estimation and hypothesis testing
    - Basic principles
    - P-value, confidence intervals, and statistical power
    - Common statistical tests for comparing two groups
3. Data management
    - Basic data handling
    - Documentation
    - Basic knowledge in a statistical package (R, SPSS, Stata or equivalent)
    - Reproducible analyses (script-based)

This module discusses questions that can be studied through quantitative methods. The module touches upon common study designs and basic statistical concepts, principles, and methods. The module introduces concepts like variable, distribution, parameter, random variability, and

variance. The concepts are illustrated by examples from medical science. The module also includes and discusses different measures of dispersion and proper graphical techniques to visualize and study the characteristics of the collected data. Furthermore, concepts like parameter estimation and uncertainty will be discussed and described through standard errors and confidence intervals. Additionally, hypothesis testing, p-values, and statistical power are introduced. The module will also cover basic tests for comparing two groups e.g., t-test, Mann-Whitney, Chi-square, and Fisher's exact test. The focus will be on interpretation and on which conclusions can be drawn from the results based on statistical significance, evidence, effect size, and generalizability.

The module includes lectures and group sessions and two afternoons with data management and analyses. Access to a laptop is required, with the statistical package installed that the participant plans to use for this and subsequent modules in Statistics. We recommend that participants choose STATA or R. Pros and cons with these two packages are discussed in the digital module Introduction to PhD studies. Other packages, such as SPSS or SAS, can also be chosen but it should be noted that these will not be supported to the same extent during the modules. Additional information will be provided before the module starts.

Aims
The module will provide the participant with basic knowledge of medical statistics, including basic concepts, descriptive statistics, parameter estimation, commonly used statistical tests and data management. The module will also prepare the participant for statistical modules and courses at a higher level at the Faculty.

Learning objectives
On completion of the module, the participant shall be able to conduct basic descriptive statistics, and suggest, perform and interpret commonly used methods for parameter estimation and hypothesis testing.

Assessment
The assessment is based on a take-home exam.

References
Kirkwood B and Sterne J. *Essential Medical Statistics*. Blackwell Science, 2nd edition, 2003. Chapter 2-8, 14, 15 and 17. Available as e-book at Lund University (www.lub.lu.se)

Complementary book can also be used (in Swedish only):
Björk J. *Praktisk statistik för medicin och hälsa*, 3rd edition, 2024

Module 5a (2104). Applied statistics II - Clinical and Epidemiological Research (3hp/credits)
Contents and format
The target group is PhD students at the Faculty of Medicine with a research project within clinical or epidemiological research.

The module includes the following four blocks:

1. Study designs, basic analyses of disease measures and measures of association
    - Experimental and observational studies, including cross-sectional, cohort and case-control studies
    - Descriptive, explanatory, and predictive research aims
    - Incidence and risk measures
    - Simple survival problems (time-to-event)
    - Absolute and relative measures of association
    - Sample size calculations

2. Fundamentals of correlation and regression analysis
    - Spearman's and Pearson's correlation coefficients
    - Simple linear regression
    - Simple logistic regression

3. Causal inference
    - Causal diagrams (DAGs) – confounding, mediation, and selection bias
    - Multiple linear and logistic regression
    - Simple and multiple Cox regression

4. Diagnostic studies and prediction modelling
    - Prediction accuracy: sensitivity, specificity, predictive values
    - ROC-analysis
    - Regression analysis for predictive research aims

This module considers how statistical models can be used to address different research aims, including description, causal inference, and prediction. We particularly focus on how regression methods can be used for these purposes. The module covers linear regression models for continuous outcomes, logistic regression for binary outcomes, and Cox regression for time-to-event outcomes. The conceptual framework for causal inference is based on causal diagrams (DAGs – Direct Acyclic Graphs). Such diagrams can be used to illustrate confounding, mediation, and selection bias, and how these can be dealt with in statistical analyses. The predictive research aims addressed in the module include both concurrent prediction (as in diagnostic tests) and prospective prediction (as with longitudinal data). Prediction accuracy is evaluated by sensitivity, specificity, positive and negative predictive values, and with ROC-analysis.

Aims

The module provides the participant with practical knowledge of how to design and analyze common types of empirical studies in clinical and epidemiological research. The module also prepares the participant to understand and critically examine other empirical research in medical science, outside of their own field of research.

Learning objectives
On completion of the module, the participant shall be able to propose, perform, interpret, and critically review basic statistical analyses suitable for description, causal inference, and prediction.

Assessment
The assessment is based on a take-home exam and a group assignment that is presented orally and discussed with the class. A Pass on the module requires a Pass on the take-home exam, as well as a completed group assignment, including active participation in the presentation of the group project and in the discussions about the group project, as well as in the discussions of other groups' projects.

References
Kirkwood B and Sterne J. Essential Medical Statistics. Blackwell Science, 2nd edition, 2003.
Chapter: 10-16, 18-22, 26-27, 29, 34-38.

Alternative:
Vittinghoff E, Glidden DV, Shiboski SC, McCulloch CE. Regression Methods in Biostatistics. Linear, Logistic, Survival, and Repeated Measures Models. 2nd edition, 2012.
Chapter: 1-6, 9-10, 13
Both are available as e-books at Lund University Libraries (www.lub.lu.se)

The module requires access to a laptop with an installed statistical package that the participant is familiar with from earlier modules (such as R or STATA).

Module 5b (2105). Applied statistics II – Biomedicine and Laboratory medicine (3hp/credits)
Contents and format
The target group is PhD students at the Faculty of Medicine with a research project within biomedicine or laboratory medicine.

The module includes four themes:

1) Non-parametric testing for the comparison of groups, for example Mann-Whitney test

2) Introduction to regression and analysis of variance
- Linear regression
- Logistic regression
- Analysis of variance (ANOVA)
- Relation between t-tests, linear regression and ANOVA
- Relation between t-tests, linear regression and ANOVA
- Multiple testing and its consequences

3) Issues in design of experiments
- Dependent and independent observations
- Randomization, blinding and confounding
- Statistical testing and confidence intervals
- Reporting of study design and statistical analyses in basic science papers

4) Reliability
- Correlation versus agreement
- Limits of agreement
- Cohen's kappa for categorical data

This advanced module in applied statistics, specializing in biomedicine and laboratory medicine, provides the participant with an introduction to the necessary tools for designing and analyzing experimental data in biomedicine and laboratory medicine. The module starts with non-parametric testing for group comparisons. The module also provides participants with an introduction to regression and analysis of variance, as well as issues in design of experiments. Finally, the module addresses different types of reliability analyses.

The module requires access to a laptop with an installed statistical package that you are familiar with from earlier modules (Stata or R). More information will be provided before the start of the module.

Aims
This module provides participants with practical knowledge of suitable ways to design experiments, manage and analyze empirical data in research projects within biomedicine and laboratory medicine. The module will also prepare participants for understanding and critically examining other empirical research in medical science, including outside their own field.

Learning objectives
On completion of the module, the participant shall be able to propose, perform, interpret, and critically review basic statistical analyses in relation to the four different themes of the module: non-parametric testing, introduction to regression and analysis of variance, issues in design of experiments and reliability.

Assessment
The assessment is based on a take-home exam. A Pass on the module requires a Pass on the take-home exam, as well as a completed individual and group assignments, including active participation in the discussions about own and other’s work.

References
Kirkwood B and Sterne J. Essential Medical Statistics. Blackwell Science, 2nd edition, 2003.
Other literature will be given during the course.

Module 6 (2107). Research Ethics (3hp/credits)

Contents and format

Codes, rules, and principles in different parts of research ethics, including an introduction to The Act on Ethical Review of Research Involving Humans. Ethical considerations on research on human subjects. Research integrity, including research misconduct, publication ethics, and researchers' relation to society.

Aims

The course aims to strengthen the participants' competence in research ethics and encourage a critical approach to their own research and that of others.

Learning objectives

After completion of the course, doctoral students should be able to identify ethical problems in different types of biomedical research, including the one conducted for his/her own doctoral studies, and to analyze such problems in an independent and informed way as well as apply laws, rules and recommendations about research that involves human subjects and personal data. Students should also be able to apply current provisions and guidelines regarding research misconduct and good research practice in an informed and independent way.

Assessment

Active participation in discussion exercises and group-work, and completion of an individual assignment on the ethical aspects of the research conducted as part of student's own research studies.

References

Will be handed out at the start of the module or with the welcome letter.

Module 7 (2108). Oral Communication (1.5 hp/credits).

Contents and format

The course covers different aspects of oral communication of scientific content. The focus is on various ways to audience-adapt, structure and visualize the content of an oral presentation, the use of voice and body language, and stress management strategies. The main emphasis is on research presentations to research colleagues, but adaptation to other target groups is also covered. The course content relates to rhetoric and theories of communication and adult learning. There is a considerable emphasis on the role of feedback in the learning process and how feedback from research colleagues contributes usefully and meaningfully to developing oral presentation skills.

The course is based on different types of practical exercises and builds on the participants' own material. The structure of the module is based on the participants' involvement and exchange of feedback in all activities. The structure is intended to boost the participants, so that they can take on and perform oral presentations with an increased awareness of their own resources and a feeling of security.

Aim
The aim of the module is that participants shall develop their ability to orally communicate and visualize research to different target groups in different contexts. Another aim is to inspire participants to explore different ways of orally presenting research in a safe learning climate.

Learning objectives
After completing the module, participants should be able to structure, visualize and orally communicate a scientific content taking into consideration the audience's needs, the situation and the context, to provide feedback that aims to support development of oral communication skills, and to analyze and discuss, based on the relevant literature, how an oral research presentation can be audience-adapted, structured, and performed.

Assessment
Active participation in the learning activities, two oral presentations and an analysis of presentation forms based on relevant literature.

References
Literature and resources will be made available with the welcome letter and/or through Canvas at the start of the module.