MS 771 - Topics in Research Methodology   (2021-F)

Overview:

This course does not actually deal with any specific aspect of Health Science, but rather addresses the basic principles underlying the "science" of **research**, as it relates to Health Science. The overall aim of the course is to introduce you to the idea that being a "researcher" should include the ownership of a set of skills and understanding that will make you valuable in any research laboratory. The topics covered in the course cover a wide range, including: the philosophy of science, generating hypotheses and specific questions, experimental design, evaluation and validation of measurement techniques, how to "look" at your data, statistical considerations (with an overview of statistical theory followed by discussion of the basic concepts of different analyses), displaying your data, interpreting your data, communicating your data to others and finally a discussion of the ethics of health research. The course will include 12 teaching sessions, each lasting approximately 90 min. Each student will also attend 3 tutorials over the course of the year, where you will give a series of presentations where you develop your own research project. The project that you present and discuss will usually be your thesis project, but that is not a requirement, you may choose to develop a different project.

Evaluation:

Tutorials (1/3 of final mark): Tutorials are designed to allow each student to design a research project proceeding from the origins of the hypothesis through to how the data will be evaluated and presented. Ideally this will be your thesis project (often meaning that it has been designed to some extent already, but don't worry about that). Students will meet in groups of 4-6 , three times over the course of the term. In the first two tutorials, each student in the group will give a presentation on the same topic, as it relates to their own research project. The content of each presentation should keep pace with and reflect discussions from the lectures. This will be aided by fairly clear questions that students should address in each session. At the final tutorial, each student will pick a research paper to present. The focus should be on an aspect of research methodology/design/analysis that the student found interesting in the course and is relevant in that paper. One third of the final mark will come from tutorial presentations. This mark will be largely based on whether the guiding questions were answered in the presentation. Credit will also be given for taking part in the discussions around other students' presentations. These are not intended to be intimidating sessions, but are aimed at providing you with a collegial environment in which to develop your ideas.

Weekly Assignments (1/3 of final mark): On six of the weeks without tutorials, you will be asked to hand in answers to questions that will be assigned the week before. Early in the course, the first three of these questions will address the topics to be covered in that week's lecture, and will often be quite vague in nature – not requiring a specific answer. This is designed as a means to ensure that you are reading and thinking about the topics being covered. Consistent with this approach, there will not be assigned readings for these questions and you will be required to find your own resources. There is a textbook entitled *Research Methodology in the Medical and Biomedical Sciences*, by Laake, Benestad and Olsen. It is quite useful for some of the earlier questions, but you are encouraged to seek your own

resources too. There is a one page limit to your answers. While you may be tempted to write more, the one-page limit is strict (single space). What we are looking for in these answers is a demonstration of "scholarliness", meaning that you are encouraged to refer to the ideas of earlier authors, but that you demonstrate that you have ownership of these ideas, through critical interpretation or use of illustrations (examples). You should include references and these may be on a separate page. These assignments will be marked and returned to you every week. Later in the course, the last thee of these assignments will deal with application of approaches that we have covered in previous sessions. For example, you may be asked to calculate the sample size for an experimental design, or provide what you think is the best approach to analyse a set of data you have been presented with. For these three assignments, you are encouraged to work with classmates so that there is sharing of ideas.

Story Board Assignment (1/3 of final mark): At the end of the course (due before the last lecture session) students will hand in an assignment with a focus on their own research project (usually this is the student's thesis project). The project involves addressing all aspects of research design and analysis and should incorporate ideas that were raised during tutorials. Clear guidelines will be provided.

Lectures: Thursdays: 9:30 -11:30, with a short break after an hour.
                   See table below for a detailed schedule

Each week will involve a presentation covering the following topics (the order may be adjusted and there may be some changes in the topics to be presented)

1/ Introduction and logistics
        Who everybody is & class picture
        Describe how the lectures and tutorials will work
        Describe how students will be evaluated
        Discuss tutorial times.

2/ Philosophy of Science
        Empiricism and the Scientific Method – Sir Francis Bacon
        "Critical Rationalism' – Sir Karl Popper
        "Proof" of causation – Koch and Bradford-Hill
        Hypotheses, Specific Hypotheses and Specific Questions
        Generating a Hypothesis

3/ Experimental Design & Measurement Techniques
        Deciding whether there are research tools that make your hypothesis testable
        Will the results of your experiment address your specific question?
        Is your design an observational or experimental one?
        Will a positive or negative finding from your experiment be informative; will you believe either?
        How do you know the techniques that you plan to use are valid, reliable and sensitive?
        Making sure that you are measuring what you think you are measuring

4/ Conceptual basis of mean comparisons I

       What is the difference between a distribution of measurements and of means.

       What different information do you get from SD and SEM?

       How can you compensate for a large measurement variation

       The difference between statistical and biological/clinical significance

       Comparing values from multiple conditions – Family Wise Error

       Power – looking for important differences, not just any difference

5/ Conceptual basis of mean comparisons II

       Do you always need to perform statistics? (BOT approach)

       Why would you use an ANOVA instead of t-tests?

       Can and should you use a repeated measures design?

       Can measuring covariates help with your analysis?

       Revisit calculating sample size

6/ ANOVAs and post hoc analyses

       Understand the different levels of ANOVAs

       Look briefly at post hoc tests and how to choose the right one

7/ Conceptual basis of regression analysis

       Correlation and Regression – are they the same thing?

       Should I look at the r value, the r^2 value or the p value?

       How many samples or subjects should I put into a correlation study?

       The importance of outliers - when are they liars and when are they important?

       When to use Multiple regression and Logistic regression

8/ Diagnostic tests and biomarkers

       If item A is present can this predict whether item is B is also present?

       Calculating the sensitivity and specificity of predictive tests

       Understand the importance of event prevalence in the utility of predictive tests

       Using the Received Operator Curve to compare predictive tests

9/ Relative Risks and Odds Ratios (Categorical Outcomes) & An introduction to Omics

       Does exposure to event A influence the likelihood of event B happening

       Look at the many ways that these tests can be presented (and sometimes abused)

       Understand the importance of disease/event prevalence in interpreting results

       Briefly look at the multiple "Omic" approaches to uncover disease mechanisms and targets

       Talk about humanomics and how this can get lost in the process

10/ Looking at and Presenting Your Data (two very different things)

       The way that your first look at your data should not be the way you plan to present it

Are you able to look at your data in its rawest form?

Are you convinced that your "data" is valid? If not, it's not data!

Make sure that you've "looked" at your data before you do any statistics!!

Making sure that the figures and tables show what you want them to show

Make sure that you are showing data that answers the questions you asked when you started

The method you use to illustrate the data should reflect the method you used to analyse it

11/ Ethics in Research, Research Oversight

Discuss the ethical issues in cell, animal and human research

How to complete an ethics submission

Look at the requirement being imposed by major medical journals

Study registration – why is this important

Data sharing agreements

12/ Systematic Reviews and Meta-Analyses & Preparing a Committee Report

Why are systematic reviews and meta-analyses considered the highest form of evidence

Overview of the system behind a systematic review

Things to think about when preparing for your committee meetings

Schedule (subject to change). We may add more topics if there is interest:

Date	Lecture/Discussion	Student Responsibility
Sep 16	1. Introduction and logistics	Attend the class (this is true for all the rest too!)
Sep 23	2. The philosophy of science Proof Hypotheses	Hand in **One pager #1**
Sep 30	3. Testable Hypotheses Translating a hypothesis into a research question	Hand in **One pager #2**
Oct 7	4. <u>Conceptual</u> Basis of Mean Comparisons I <u>-how a t-test works</u>	Hand in **One pager #3**

Oct 14	5. Conceptual basis of Mean
	Comparisons II
	-sample size requirements
	-multiple comparisons
		First Tutorial
		    What is your hypothesis?
		    Where did it come from?
		    Why is it worth studying?

Oct 21	6. Conceptual basis of regression analyses	Hand in **Analysis project #1**
Oct 28	7. Categorical outcomes Introduction to OMICS research	Hand in **Analysis project #2**
Nov 4	8. ANOVAs and post-hoc comparisons	Hand in **Analysis project #3**

Nov 11	9. Diagnostic Tests and Biomarkers	Second Tutorial
		    What is your research design?
		    How did you calculate your sample size?
		    How will you analyse your data?

Nov 18	10. Looking at and presenting your data	Nothing Due – work on final assignment

Nov 25	11. Ethics in research.
	    Research Oversight
		Third Tutorial
		    Present an interesting paper

Dec 2	12. Systematic Reviews/Meta Analyses Preparing a committee report.	Hand in final assignment – **Story Board**