MODULE SPECIFICATION

Academic Year (student cohort covered by specification)	2021-22
Module Code	2465
Module Title	Analysis of Hierarchical and Other Dependent Data
Module Organiser(s)	Prof Linda Sharples; Prof James Carpenter
Faculty	Epidemiology & Population Health
FHEQ Level	Level 7
Credit Value	**CATS:** 15 **ECTS:** 7.5
HECoS Code	101031 : 101034
Term of Delivery	Term 2
Mode of Delivery	For 2021-22 this module is currently planned as a mixture of online and face to face teaching. Teaching will comprise a combination of live and interactive activities (synchronous learning) as well as recorded or self-directed study (asynchronous learning). We currently plan to provide a weekly session for face-to-face teaching.
Mode of Study	Full-time
Language of Study	English
Pre-Requisites	Students must have a good understanding of the regression material taught in Term 1 of the MSc Medical Statistics and be familiar with issues in clinical trial design.
Accreditation by Professional Statutory and Regulatory Body	None
Module Cap (indicative number of students)	35 (numbers may be capped due to limitations in facilities or staffing)
Target Audience	This module is intended for people with both mathematical background (up to first year undergraduate level) and statistical background (undergraduate level in joint mathematics/statistics for example).
Module Description	The module will provide methods and practical experience for analysis of data that is non-independent, either because measurements are clustered or because they are repeated measurements over time. In this course, normally distributed data and two-level hierarchies will be assumed. Analysis of variance methods will be the main focus, although marginal

	methods will also be covered. The module will also give a brief introduction to other clustering methods and treatment of missing data.
Duration	5 weeks at 2.5 days per week
Timetabling slot	Slot D1
Last Revised (e.g. year changes approved)	September 2021

Programme(s) This module is linked to the following programme(s)	**Status**
MSc Medical Statistics	Recommended

Module Aim and Intended Learning Outcomes

Overall aim of the module
The overall module aim is to: • help students gain an understanding of how to analyse hierarchical, longitudinal and other dependent data that commonly arise in clinical trials and observational studies.

Module Intended Learning Outcomes
Upon successful completion of the module a student will be able to: 1. Recognise dependent data and understand why models for independent data are not appropriate for their analysis 2. Demonstrate an understanding of the theoretical basis of the most commonly adopted methods for the analysis of hierarchical, longitudinal and other dependent data 3. Make appropriate practical use of selected techniques for the analysis of dependent data with appropriate statistical software (STATA)

Indicative Syllabus

Session Content
The module is expected to cover the following topics: • The concept and consequences of dependence • Fixed and random effects in analysis of variance and variance components • Longitudinal data analysis including likelihood based hierarchical models for continuous outcome data • Marginal models for hierarchical and longitudinal data structures • Assessment, choice and impact of covariance structure • Introduction to generalised estimating equations • Handling missing data, including use of multiple imputation • Software for analysing dependent data

Teaching and Learning

Notional Learning Hours

Type of Learning Time	Number of Hours	Expressed as Percentage (%)
Contact time	48	32
Directed self-study	28	19
Self-directed learning	30	20
Assessment, review and revision	44	29
Total	**150**	**100**

Student contact time refers to the tutor-mediated time allocated to teaching, provision of guidance and feedback to students. This time includes activities that take place in face-to-face contexts such as lectures, seminars, demonstrations, tutorials, supervised laboratory workshops, practical classes, project supervision as well as where tutors are available for one-to-one discussions and interaction by email. Student contact time also includes tutor-mediated activities that take place in online environments, which may be synchronous (using real-time digital tools such as Zoom or Blackboard Collaborate Ultra) or asynchronous (using digital tools such as tutor-moderated discussion forums or blogs often delivered through the School's virtual learning environment, Moodle).

The division of notional learning hours listed above is indicative and is designed to inform students as to the relative split between interactive (online or on-campus) and self-directed study.

Teaching and Learning Strategy
For 2021-22 teaching will be mostly online, but will include some face-to-face teaching providing that it is safe.

Teaching and Learning Strategy
The teaching and learning strategy is structured around a combination of lectures followed by computer practical sessions. Students should make sure that they have viewed the recorded lecture before the related practical session. Practical sessions will start with a Q&A, followed by the opportunity to apply the concepts and methods covered by lecture content. The practical sessions provide students with "hands on" experience in analysing and interpreting data, using data sets drawn from research work of staff in the faculty or from other sources. Students are provided with detailed solutions to the tasks set in practical sessions, enabling them to check their understanding of the material. The assessment task, which comes towards the end of the module, is the point at which students demonstrate a consolidation of their learning across the whole module. Practicals will be in STATA, so that all students will need access to this package. Students may use other statistical packages, provided that they are confident that the models fitted are consistent with those used in the STATA code provided.

Assessment

Assessment Strategy
The assessment for this module has been designed to measure student learning against the module intended learning outcomes (ILOs) as listed above. Formative assessment methods may be used to measure students' progress. The grade for summative assessment(s) only will go towards the overall award GPA. The assessment for this module will be online.

Summative Assessment

Assessment Type	Assessment Length (i.e. Word Count, Length of presentation in minutes)	Weighting (%)	Intended Module Learning Outcomes Tested
Coursework	4-page report	100	1 – 3

Resitting assessment
Resits will accord with the LSHTM's Resits Policy Resit/deferred/new attempts - The task will be to carry out the analysis of a new dataset. The next assessment deadline will be during mid/late September of the current academic year.

Resources

Indicative reading list

References on which the course is based:
1. Rabe-Hesketh, S. and Skrondal, A. (2012) Multilevel and Longitudinal Modeling Using Stata, 3rd Edition. Stata Press.
2. Snijders, T. and Bosker, R. (1999) Multilevel Analysis SAGE Publications Ltd.
3. Verbeke, G. and Molenberghs, G. (2000) Linear Mixed Models for Longitudinal Data. Springer Verlag.
4. Fitzmaurice, G.M., Laird, N.M., and Ware, J.H. (2011) Applied Longitudinal Analysis. 2nd edition. John Wiley and Sons, New York.

Other important references:
1. Diggle, P.J.,Heagerty, P., Liang, K.-Y. and Zeger, S.L. (2002) Analysis of Longitudinal Data, Second Edition Oxford University Press.
2. Dwyer, J.H., Feinleib, M., Lippert, P. and Ho_meister, H. eds (1990) Statistical Methods for Longitudinal Studies of Health. Oxford University Press.
3. Fitzmaurice, G.M., Laird, N.M. and Ware J.H. (2004) Applied Longitudinal Analysis. Wiley.
4. Goldstein, H. (2011) Multilevel Statistical Models, Fourth Edition. Arnold, London.
5. Jones, B. and Kenward, M.G. (2003) The Design and Analysis of Cross-Over Trials. Second Edition. CRC/Chapman & Hall.
6. Longford, N.T. (1993) Random Coe_cient Models. Oxford University Press.
7. Molenberghs, G. and Kenward, M.G. (2007) Missing data in Clinical Studies. Wiley.

Other resources
STATA will be made available to all students. A set of reading notes with worked examples will be available on Moodle.

Teaching for Disabilities and Learning Differences

The module-specific site on Moodle gives students access to lecture notes and copies of the slides used during the lecture. Where appropriate, lectures are recorded and made available on Moodle. All materials posted on Moodle, including computer-based sessions, have been made accessible where possible.

LSHTM Moodle is accessible to the widest possible audience, regardless of specific needs or disabilities. More detail can be found in the Moodle Accessibility Statement which can also be found within the footer of the Moodle pages. All students have access to "SensusAccess" software which allows conversion of files into alternative formats.

Student Support Services can arrange learning or assessment adjustments for students where needed. Details and how to request support can be found on the LSHTM Disability Support pages.