2023

AUSTRALIAN AND NEW ZEALAND COLLEGE OF VETERINARY SCIENTISTS

FELLOWSHIP GUIDELINES

Veterinary Epidemiology

ELIGIBILITY

1. The candidate shall meet the eligibility prerequisites for Fellowship outlined in the *Fellowship Candidate Handbook.*

2. Membership of the College must be achieved prior to the Fellowship examination.

3. Membership must be in Veterinary Epidemiology.

OBJECTIVES

To demonstrate that the candidate has sufficient training, experience, knowledge and accomplishment in Epidemiology to be recognised as an authority in this field by his/her colleagues in the veterinary profession.

RESPONSIBILITY

It is the candidate's responsibility to ensure they have fulfilled all the requirements of the training program guidelines prior to submitting their credentials for eligibility for examination.

LEARNING OUTCOMES

A. The candidate will have a **detailed**[1] knowledge of:

1. **General concepts and principles of veterinary epidemiology**
   - 1.1. History (major events in the evolution of epidemiology), scope and terminology
   - 1.2. Scientific reasoning and logic, methods of inferring causality, and formation of a causal hypothesis.
   - 1.3. The use of component cause models to support identification of confounding and interaction.
   - 1.4. Hierarchy of evidence used to rank the relative strength of results obtained from different study designs.
   - 1.5. Determinants of disease occurrence, distribution, and transmission.
   - 1.6. Measures of disease occurrence.
   - 1.7. Measures of association and effect.

2. Design & implementation of epidemiologic studies

2.1. Study design and investigational approaches,

2.1.1 Descriptive studies, e.g., case reports, case series and surveys

2.1.2 Analytic studies, observational (cross-sectional, cohort, case-control, hybrid) and experimental studies (laboratory and controlled/ field trials).

2.2. Identifying and controlling sources of bias (selection and information bias) and confounding in observational studies.

2.2.1 Methods to identify bias and confounding.

2.2.2 Study design and sampling strategies to mitigate bias and confounding.

2.2.3 Analytic methods to control confounding.

2.3. Factors to be considered when calculating the required sample size for descriptive, analytic and freedom from disease studies.

2.4. Outbreak investigation procedures and methods.

3. Concepts in analytical epidemiology

3.1**. Fundamental** concepts of statistics and inference from data.

3.1.1. Principles of statistical theory

- Types of variables
  - Categorical or qualitative – nominal, ordinal
  - Numerical or quantitative – discrete or continuous

[1] **Knowledge Levels**
Detailed knowledge – candidates must be able to demonstrate an in-depth knowledge of the topic including differing points of view and published literature. The highest level of knowledge.
Sound knowledge – candidate must know all of the principles of the topic including some of the finer detail, and be able to identify areas where opinions may diverge. A middle level of knowledge.
Basic knowledge – candidate must know the main points of the topic and the major literature.

- Data distributions (e.g., normal, binomial, Poisson)
- Descriptive statistics (mean, median, mode, range, variance, standard deviation)
- Central-limit theorem
- Null and alternative hypotheses

3.1.2. Statistical error

- Systematic error vs random error / random effects
- Addressing systematic error
- type I and II errors, Power, standard error of the mean, confidence intervals, and P-values.

3.1.3. Parametric versus non-parametric methods.

3.1.4. Frequentist versus Bayesian approaches to analysis.

3.2. Approaches and assumptions for the statistical analysis of different study designs and data types.

3.2.1. hierarchical, nested, or clustered data

3.2.2. numerical or quantitative data

3.2.3. dichotomous data

3.2.4. ordinal or multinomial data

3.2.5. time-to-event data

3.2.6. repeated measures and autocorrelation

3.2.7. matched data

3.3. Appropriate methods to report and display different types of data.

3.4. Principles, rationale, and design of ecologic studies

3.4.1. Types of ecologic variables

3.4.2. Sources of ecologic bias

3.4.3. Inferential concepts applied in ecologic studies.

4. Concepts of infectious disease epidemiology

4.1. Principles of infectious disease epidemiology.

4.1.1. Microparasitic vs macroparasitic infections

4.1.2. Time course of infection vs. time course of disease

4.1.3. Modes of transmission

4.2. Transmission and maintenance of infection in a population

4.3. Fundamental principles of SIR models

4.4. The basic reproductive number, R_0, and the factors that contribute to R_0

4.5. Herd immunity

4.6 Critical percentage of the population that needs to be immune given R_0

4.7 Attack rates and secondary attack rates.

5. Evaluation and interpretation of diagnostic tests

5.1. Attributes of diagnostic tests

5.1.1. Precision, accuracy, repeatability vs. reproducibility vs. agreement

5.1.2. Sensitivity and specificity

5.1.3. Predictive values and likelihood ratios

5.2. Methods for measuring precision and agreement of diagnostic tests.

5.2.1. For tests with quantitative outcome

- Coefficient of variation
- Pearson correlation coefficient
- Concordance correlation coefficient
- Limits of agreement plot (Bland-Altman plot)

5.2.2. For tests with a qualitative outcome

- Kappa (multiple raters, weighted kappa)

5.3. Methods used to evaluate diagnostic test performance, with or without a gold standard.

- Gold standard reference test
- Reference test with known Se and Sp
- Latent class models

5.4. Selecting an appropriate cut-point for a diagnostic test.

- ROC curves
- Specificity-sensitivity plots

5.5. Interpretation of diagnostic test results and definition of cut-off points

5.6. Strategies for using diagnostic tests at the individual and the herd level.

5.6.1. Parallel and series interpretation

5.6.2. Herd Se and Sp.

6. Data collection, organisation, and management

6.1 Methods of data collection,

6.1.1. observation, questionnaires, and historical records.

6.2. Questionnaire design.

6.3. Uses and limitations of data collection methods.

6.4. Use of computers to collect and manage large data sets (large numbers of records and variables).

6.4.1. Database concepts and design

6.4.2. Validating the integrity of data,

6.4.3. Correcting errors

6.4.4. Handling missing data.

7. Surveillance, disease control, elimination, and eradication

7.1. The elements, aims, types, design and implementation of surveillance systems.

7.1.1 Monitoring vs surveillance

7.1.2 Active vs passive surveillance

7.1.3 Syndromic surveillance

7.1.4 Risk-based surveillance systems

7.4.5 Targeted surveillance systems.

7.2. Freedom from disease; concepts and implementation.

7.2.1 Principles for the design of disease control and eradication programs.

B. The candidate will have a **sound** knowledge of:

1. Statistical methods for epidemiological analysis

1.1. Analytical approaches suited to a specific problem presented to them.

1.2. Understand the virtues and limitations of each of the major analytical approaches in widespread use in epidemiology (without necessarily being experienced in applying more than a proportion of them).

1.3. Choice of the statistical method given the study design, (descriptive, observational, experimental) and data types (quantitative vs qualitative data, multilevel).

- Exploratory data analysis
- Parametric vs. non-parametric tests
- Simple vs advanced regression models
- Fixed vs. random effects models
- Least squares regression
- Bayes theorem and latent class analysis

1.4. Appropriate model building (e.g. causal web diagrams, information theoretical approaches, automated approaches) and statistical model implementation.

2. Principles of animal health economics

2.1. Understand the difference between, and application of, concepts in micro- and macro-economics in veterinary epidemiology and financial versus economic analysis.

2.2. Application of economic evaluation methods in animal health (for example, benefit-cost analysis, linear programming, and input/output analysis).

2.3. Data gathering for methods commonly applied in economic analyses.

2.4. Approaches for incorporation of intangibles and indirect costs and benefits in economic analysis.

3. Risk assessment and management

3.1. Risk analysis framework.

3.2. Principles of and approaches to risk assessment, including deterministic and stochastic approaches, qualitative and quantitative approaches, parameterisation of models, scenario modelling, and sensitivity analysis.

3.3. The principles of risk management, including biosecurity.

3.4. Animal trade/movement and how it relates to disease risk.

3.5. International disease reporting systems (WOAH).

3.6 Import risk analysis (IRA) including WTO, SPS and OIE guidelines for IRA.

4. Infectious disease epidemiology

4.1. Disease modelling concepts; types of models – deterministic and stochastic approaches; types of mathematical, computational and logical approaches to modelling. Parameterisation of models and sensitivity analysis.

4.2. Disease modelling implementation; steps in model building, including model validation and evaluation.

4.3. Use of models to represent disease occurrence and options for disease control.

5. Epidemiological design of animal health and productivity programs

5.1. Principles of animal health and productivity program design and implementation.

5.2. Discuss voluntary disease control and eradication campaigns.

5.3. Give examples of regional animal health programs and animal health information systems.

6. One Health and epidemiology

6.1. Principles underlying the "One Health" approach to health and disease.

6.2. Epidemiology of emerging One Health risks such as,

- 6.2.1. Emerging infectious diseases
- 6.2.2. Antimicrobial resistance emergence and dissemination
- 6.2.3. The impact of climate change on human, animal, and environmental health.
- 6.2.4. Ecosystem health, zoonotic disease risk

6.3. Production systems and animal health management strategies to reduce human health risks associated with zoonotic diseases.

6.4. The application of food safety and food safety risk assessment related to on-farm and abattoir interventions.

7. Epidemiology of important diseases relevant to Australia and New Zealand

7.1. Diseases of major importance from a national economic viewpoint, major notifiable diseases, major zoonotic diseases, and diseases with a large impact on animal welfare.

- 7.1.1 Causal factors, transmission, infection reservoirs, and control methods of endemic, exotic and zoonotic diseases, particularly those that are notifiable or under active control and/or eradication programs.

8. Evidence-based practice (EBP)

8.1. The application of EBP in veterinary medicine

- 8.1.1. Clinical activities that are central to EBP
- 8.1.2. The stages of the EBP process
- 8.1.3. Systematic reviews and meta-analysis in EBP
- 8.1.4. Patient, intervention, comparison, outcomes (PICO)

C. The candidate will have a **basic** knowledge of:

1. Other statistical methods used by epidemiologists

1.1. Systematic reviews and meta-analysis.

1.2. Social network analysis.

1.3. Spatial methods commonly used in epidemiologic data analysis.

1.3.1. clustering and disease clusters.

1.4. Principal component analysis,

1.5. Artificial intelligence applied to animal health (especially machine learning).

1.6. Analysis of genomic and molecular data to support epidemiological investigations in disease outbreaks and foodborne diseases.

1.6.1. Use of phylogenetic analysis to support epidemiological investigation, such as tracing the source of a disease outbreak.

2. Development and management of veterinary services

2.1. Tools used to evaluate the performance of national veterinary services.

2.2. Principles of project management and program management with respect to designing, implementing, and evaluating veterinary services.

2.3. Information management and decision support systems for veterinary services.

2.4. Policy development for animal health.

3. Special considerations for aquatic and wildlife epidemiologic investigations

3.1. General epidemiological principles for aquatic animals.

3.2. Practical differences between domestic, wildlife and aquatic populations that affect the design of epidemiological studies.

3.3. Problems in identifying individuals and sampling in aquatic and wildlife populations.

3.4. Disease emergence in aquatic and wildlife populations and the relationship between disease in these populations and disease in domestic animal and human populations.

4. Environmental epidemiology.

4.1. Principles of environmental epidemiology, including epidemiologic measures and basic epidemiologic study designs.

4.2. Challenges faced by environmental epidemiology and how to address these. For example, factors such as confounding, bias and exposure misclassification.

4.3. Strategies for establishing causal relations between environmental agents and disease.

D. The candidate will have **detailed**[2] expertise in:

1. **Creating and managing a computerised database** to hold a large volume of data typical of that generated from a substantial epidemiological study.

2. **Evaluating the integrity of a data set** by using commands or formulae to search for irregularities, illegal values, and inconsistencies.

3. **Creating hypotheses based on scientific reasoning.**

4. **Designing** epidemiologic studies.

5. **Preparing a data set for sophisticated statistical analysis** by manipulating the organisation and format of data to satisfy the requirements of whatever routine is being applied whilst also maintaining the integrity of the original data.
6. **Performing data analysis in a repeatable and auditable manner** such that the integrity of the original data is preserved. To satisfy this, it is essential that candidates acquire skills in one statistical software package of their choice, (such as R, SAS, STATA and SPSS, etc.).

7. **Extraction of descriptive information (e.g. summary statistics) from data sets** and presentation in appropriate graphical and tabular formats.

8. **Performing a range of statistical tests** – including univariable and multivariable analysis– and interpreting results given statistical assumptions.

9. **Critical appraisal of reported epidemiological studies** following the appropriate reporting guidelines (e.g., REFLECT statement, ARRIVE guidelines, STROBE statement, STARD, PRISMA statement and PRISMA-ScR).

E. The candidate will have **sound** expertise in:

1. Interpreting the results of economic studies in animal health.
2. Advising on studies for risk assessment and interpreting the results of such studies.
3. Determining the circumstances in which disease spread models should be used and providing advice on how to create, validate and use such models.
4. Designing animal health and productivity programs and studies addressing zoonotic and ecosystem health issues.
5. Identifying the critical issues of important diseases relevant to Australia and New Zealand.

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[2] **Skill levels**:
Detailed expertise – the candidate must be able to perform the technique with a high degree of skill, and have extensive experience in its application. The highest level of proficiency.
Sound expertise – the candidate must be able to perform the technique with a moderate degree of skill, and have moderate experience in its application. A middle level of proficiency.
Basic expertise – the candidate must be able to perform the technique competently in uncomplicated circumstances.

6. Scientific writing for the purposes of publication in peer-reviewed journals or for reporting the findings of an epidemiological study to a government or industry body.
7. Professional presentation of reports and manuscripts, including suitable formatting of documents, correct use of citations, and production of publication-ready plots and tables to communicate epidemiological findings.
8. Presenting the findings of epidemiological studies to epidemiologists, other scientists and interested parties.

F. The candidate will have **basic** expertise in:

1. Providing advice on when and how specific statistical methods should be used in epidemiology.
2. Elementary computer programming that can include the use of macro-languages for spreadsheets or scripting code for statistical packages.
3. Methods of collecting and analysing spatial information
4. Describing the critical steps in
    a. project implementation
    b. program management
    c. information management
    d. decision support systems
    e. assessment of veterinary services
5. Describe the process of animal health policy development.
6. Given assumptions, estimate R_0 and herd immunity.

EXAMINATIONS

Refer to the *Fellowship Candidate Handbook,* Section 5. The Fellowship examination has **four separate, autonomous components:**

1. **Written Paper 1** (*Component 1*) (four hours)
2. **Written Paper 2** (*Component 2*) (four hours)
3. **Practical Examination** (*Component 3*) (three hours)
4. **Oral Examination** (*Component 4*) (two hours)

The written examination will comprise of two separate four-hour written papers taken on two consecutive days. There will be an additional 20 minutes of perusal time for each paper, during which no typing is allowed. Each written paper will be worth a total of 240 marks. There is no choice of questions. Questions may be long essay type, a series of shorter answer sub-questions, or multiple-choice questions. A formula sheet will be provided. All steps in calculations are to be shown. Marks allocated to each question and to each subsection of questions will be clearly indicated on the written paper.

Written Paper 1:
This paper is designed to test the candidate's knowledge of the principles of veterinary epidemiology as described in the Learning Outcomes.

Written Paper 2:
This paper is designed to a) test the candidate's ability to apply the principles of veterinary epidemiology to particular cases, problems or tasks and b) test the candidate's familiarity with the current practices and current issues that arise from activities within the discipline of veterinary epidemiology in Australia and New Zealand.

The examinations will focus on how the candidate would approach particular types of problems and tasks, using a range of skills and knowledge of veterinary epidemiology.

Practical Examination:

Three hours will be allocated to complete the practical exam. The examination, however, will be structured so that the average candidate will take only 2 hours to complete it. No perusal time will be given for the practical exam. The practical examination will be worth a total of 120 marks. Marks allocated to each question and to each sub-section will be clearly indicated on the written paper.

The candidate will be given a set of problems, including design issues and epidemiological data, for analysis and interpretation. The candidate will be expected to describe, analyse, and report on one or more of the data sets provided. The candidate will be expected to provide the following in the written report:

* Descriptive analysis

* Bivariate analysis
* Exploration of potential confounding
* Implementation and interpretation of generalised linear models on simple datasets
* A proposal for further in-depth analysis

Oral Examination:

The oral examination is designed to test practical aspects of the Learning Objectives. Questions will be asked verbally in a face-to-face setting over a two-hour period. The oral examination will be worth a total of 120 marks.

TRAINING PROGRAMS

Refer to the *Fellowship Candidate Handbook*, Section 2.

Supervisors

- The primary supervisor should be a specialist/ fellow in epidemiology, preventive medicine, or veterinary public health.
- A secondary supervisor may be an academic with a PhD in veterinary public health, veterinary preventive medicine, and/or epidemiology, working in a university setting.

EXTERNSHIPS

Refer to the *Fellowship Candidate Handbook*, Section 2.4.1

Supervisors

- The primary supervisor should be a specialist/ fellow in epidemiology, preventive medicine, or veterinary public health.
- A secondary supervisor may be an academic with a PhD in veterinary public health, veterinary preventive medicine, and/or epidemiology, working in a university setting.

TRAINING IN RELATED DISCIPLINES

Refer to the *Fellowship Candidate Handbook*, 2.4.2.

This may include discipline that includes experiences in study design, data management, data analysis, reporting and recommendations.

ACTIVITY LOG SUMMARY

The Activity Log Summary (ALS) must be recorded throughout supervised training in the primary discipline. An example of an Activity Log Summary Entry is included in Appendix 1.

The objective of the Activity Log Summary is to demonstrate diversity in the types of activities in which candidates are involved. Candidates should strive to get experience across a wide range of epidemiological techniques and issues and avoid being too focused on just a few areas. Due to the nature of epidemiological work, it is expected that candidates will only report on 10-15 activities during their training period, however,

these activities should be classified by each of the following categories in the Activity Log Summary:

- Animal Species and Type (production animal, companion animal, wildlife)
- Study Type (for example, outbreak investigations, descriptive epidemiology, observational studies, herd health program, disease control, etc)
- Techniques used (for example, non-analytic or descriptive report, univariate & bivariate analyses, multivariate analyses – indicate specific analytical approaches, risk analysis, simulation modelling)
- Role (describe your role in this activity)
- Learning outcomes addressed (list number)

The Activity Log Summary will provide the Subject Standards Committee (SSC) with a realistic appraisal of the diversity of activities being undertaken by the candidate during the training period. Published papers and reports are one method of demonstrating satisfactory completion of the required activities. Other categories that might be included are consultancies and technical reports, courses attended, and other training completed, research grant proposals written or awarded, and conference presentations.

RECOMMENDED READING LIST[3]

List of Suggested Information Sources and Software

The candidate is expected to research the depth and breadth of knowledge in Epidemiology. The list is intended to guide the candidate to some core references and source material. The list is not comprehensive and is not intended as an indicator of the content of the examination. Books are regularly updated, and the most current edition should be sourced.

Texts Books and Proceedings

Core textbooks

1. Dohoo I, Martin W, Stryhn H (2014) *Veterinary Epidemiologic Research* 3rd ed.. VER Inc. Prince Edward Island, Canada. Now available online https://files.upei.ca/avc/VER_all.zip

2. Thrusfield, M. (2018). *Veterinary epidemiology* 4th ed. John Wiley & Sons..

Recommended textbook

1. Petrie A, Watson P, (2013). *Statistics for veterinary and animal science* (3rd ed). John Wiley & Sons, West Sussex, UK.
2. Sergeant, E, and Perkins N, (2015). *Epidemiology for field veterinarians: an introduction*. CABI, Boston, US.

Additional references

1. Proceedings of the International Society for Veterinary Epidemiology and Economics: (these conferences are held on a triennial basis with). Focus on the most recent 2 conferences.

2. Celentano DD and Szklo M (2019) *Gordis Epidemiology*, 6th ed. WB Saunders Co. Philadelphia, PA

3. Lash TL, VanderWeele TJ, Haneuse S, Rothman KJ. (2021) *Modern Epidemiology*, 4th ed. Lippincott Williams & Wilkins. Philadelphia, PA.

4. Parker, E. (2023). Diagnostic Strategies for Ruminant Populations. *Veterinary Clinics: Food Animal Practice*, *39*(1), 21-31.

[3] Textbook Definitions:
Core textbook – candidates are expected to own a copy of the textbook and have a detailed knowledge of the contents.
Recommended textbook – candidates should own or have ready access to a copy of the book and have a sound knowledge of the contents.
Additional references – candidates should have access to the book and have a basic knowledge of the contents.
Additional Reading Materials - These are conference proceedings, other non-refereed publications and other journals that would offer some information in the subject area including differing points of view, but are not required reading.

5. Magnet, A., & Izquierdo, F. (2023). *Epidemiology of Wildlife Infectious Diseases*. Veterinary sciences, 10(5), 332. https://doi.org/10.3390/vetsci10050332

6. Hosmer Jr, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied logistic regression* (Vol. 398). John Wiley & Sons.

7. Kleinbaum DG, Kupper LL, Muller KE. 2013. 5th edition. Applied Regression Analysis and other Multivariate methods. Duxbury Press. 928 pp

8. Pearce, Neil[a]; Vandenbroucke, Jan P.[a,b,c]; Lawlor, Deborah A.[a,d,e]. *Causal Inference in Environmental Epidemiology: Old and New Approaches*. Epidemiology 30(3):p 311-316, May 2019. | DOI: 10.1097/EDE.0000000000000987

Journals (From 3 years prior to 1st January of the examination year).

Core

1. Preventive Veterinary Medicine
2. National veterinary journals (such as the Australian Veterinary Journal, New Zealand Veterinary Journal)
3. Frontier in veterinary science- relevant discipline- veterinary epidemiology and economics articles

Recommended

1. American Journal of Epidemiology
2. International Journal of Epidemiology
3. Epidemiology
4. Australian Journal of Public Health
5. Emerging Infectious Diseases
6. Journal of Clinical Epidemiology
7. Zoonoses and Public Health

Additional

1. Statistics in Medicine
2. Transboundary and Emerging Diseases

Internet resources

Candidates should be aware of the vast amount of valuable information that is available on the internet, including:

- Discussion groups and list servers such as Promed and EpiVet-L
- Government and related websites that are directly relevant to veterinary epidemiology (for example, Animal Health Australia, the UK DEFRA, New Zealand Ministry of Agriculture and Forestry, US Centers for Disease Control and Prevention)
- R- discussion forums

- Chat GPT

Software useful for epidemiological research.
A wide range of software is available for data management, statistical and graphical analysis, report writing and presentation. These programs are very useful tools for veterinary epidemiologists, and candidates are expected to have skills in this area. While software experience is important, candidates should note that they are also expected to understand the key principles behind their use.

Candidates should have experience with the use of one or more major statistical software programs (such as R, SAS, SPSS, STATA, etc.).

FURTHER INFORMATION

For further information contact the College Office

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APPENDIX 1
ACTIVITY LOG SUMMARY – VETERINARY EPIDEMIOLOGY

DATE(S)	Intended Learning outcomes	*CATEGORY e.g. species, organ system, type of activity	ANIMAL/HERD DETAILS	PROBLEM DEFINITION	PROBLEM SOLVING AIDS	SOLUTION PROPOSED	OUTCOME	Role of candidate
Jan.-Mar. 2015	A2	Cattle	Various – NSW, Vic	Poor reproductive rates	Case-control study	Control based on risk factors identified, including nutrition	Publication, AVJ	Project design, implementation, data analysis and wrote the manuscript
May-July 2015	B2	Cattle, sheep	Australia	Import risk analysis	Risk assessment	Risk minimization procedures	Technical report, AHC	Conducted the risk assessment in R using publicly available sources of information. Wrote the report.
Feb.-May 2015	A7	Equine	Racing stables, Flemington	Outbreak investigation – respiratory disease	Cases series, Case-control study	Ongoing surveillance	Presentation AAEVP	Responded to the outbreak, implemented quarantine measures. Collected the history, and relevant samples. Made interim recommendations. Analysed the results. Updated

DATE(S)	Intended Learning outcomes	*CATEGORY e.g. species, organ system, type of activity	ANIMAL/HERD DETAILS	PROBLEM DEFINITION	PROBLEM SOLVING AIDS	SOLUTION PROPOSED	OUTCOME	Role of candidate
								recommendations and wrote a report.
Aug.-Dec. 2015	B4	Pigs	Australia	Exotic disease incursion and spread	Disease spread modelling	Expert opinion + disease spread model parameterization	Submission of research proposal – Australian Pork Limited	Found publicly available data, and elicited expert opinions via focus groups. Modelled disease spread with sensitivity analysis and parameterization in R.
Apr. 2015	B1	Short course	N/A	Analytical epidemiology	Logistic regression short course	N/A	Course completed	Developed knowledge and skills in multilevel modelling (mixed models)