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# Epidemic Data Analysis and Modelling

## Summative Assessment: Coursework Project (100% of Unit Marks)

## Key deadlines for your diary:

Assessment Submission: 12 noon on Wednesday 28 April 2025.

## 1. Assessment Instructions

This summative assessment contributes 100% towards the final mark for the Epidemic Data Analysis and Modelling unit. The assessment involves applying the data analysis and modelling skills that you have developed during the unit to investigate an epidemic outbreak and strategies to reduce the epidemic. You should use R (or R markdown) to answer the questions. You will need to submit both the model coded in R and a short report (up to 1200 words) summarising your approach and findings. You may discuss the work with other students, but the assessment and report must be entirely your own work. Any evidence of plagiarism will be penalized in your final mark.

We anticipate you will spend up to 10 hours on this assessment, including two timetabled hours on 20 March 2025.

The assignment is split into two related parts but should be written all in one report.

**Background**

Measles is a highly infectious disease caused by the measles virus, *Morbillivirus hominis*. Measles is transmitted by respiratory droplets between close contacts. Symptoms include a generalised rash, fever and cold-like symptoms.

The incubation period (from exposure to the first symptoms) is typically 11–12 days. A rash follows the initial symptoms 2–4 days later and usually lasts 5–6 days. Measles is infectious 4 days before and 4 days after rash onset. The *Basic Reproduction Number* for measles is estimated to be between 12 and 18.

Measles vaccines are highly protective against infection. In the UK, children receive their first measles vaccination at 12-13 months, and then a pre-school booster vaccine is given at 3 years and 4 months. It is estimated that 84.5% of children received two doses of the Measles, Mumps, Rubella (MMR) combined vaccine in England in 2022/2023.

**Part 1. Epidemic data analysis**

The accompanying dataset contains the number of laboratory-confirmed measles cases by month of symptom onset in 2023 and 2024 in England from the UK Health Security Agency

1. Explain what biases might exist in national surveillance data such as these.
2. Explore and discuss the dataset, including plotting the case numbers over time.
3. Explain why there are cases of measles, despite the universal vaccine programme in England.
4. Give the definition of the basic reproduction number and explain why it is relevant for infectious disease outbreaks.
5. Identify when exponential growth occurs in the data and estimate the exponential growth rate.
6. Approximate the reproduction number for measles during the exponential growth phase.
7. Give at least two reasons why the number you estimated is different from the number reported above.
8. What are the drawbacks and limitations of your approach?
9. Based on these results, estimate the percentage of the exposed population that were protected from infection through vaccination.

**Part 2. Modelling**

Using the information above, develop a model to describe measles transmission in England in 2023/2024.

1. Draw a schematic model flow diagram representing the key elements of the epidemic. Make sure you justify your choices and assumptions.
2. Write out the model equations, derive an expression for the basic reproduction number andcalculate using the parameters.
3. Programme the model in R and parameterise it accordingly.
4. Plot the infection states and the total population size over the time period.
5. Using the model that you have coded, explore the impact of increasing vaccination coverage. If you had started a catch-up vaccine programme in December 2023, how many cases would have been prevented?
6. Summarise your findings.

**Expected features of the report**

Suppose you are writing a report on this outbreak and you have to describe how you have undertaken different analyses to provide information to the local public health team. The report should be a concise narrative combining a description of the outbreak, the methods undertaken with explanation of what you have done, and results with interpretation in the context of relaying your findings to a scientific expert (but not necessarily an epidemic modeller). The total word count should be limited to 1200 words, excluding equations, figures, tables, and references. Specifically, the report should include the sections outlined in the marking section below.

## 2. Intended learning outcomes

This assessment covers the following intended learning outcomes (ILOs):

1. Discuss the use and relevance of quantities such as the reproduction ‘R’ number, the epidemic growth rate, and the final epidemic size for characterising epidemics.
2. Identify sources of data suitable for infectious disease model development.
3. Devise an appropriate plan for analysing observational/surveillance epidemic data, including data cleaning, manipulation, visualisation and analysis.
4. Use the R programming language to estimate theory-informed epidemic statistics from time series case data, and present results using graphics and summary measures.
5. Apply epidemic theory to develop mathematical descriptions of infectious disease transmission.

## 3. Good academic practice

This coursework will be used to derive your unit mark. You may:

* + Draw upon a range of accepted resources including, your own notes, lecture slides/ recordings, course material, textbooks, journal articles, online resources. ALL work should be written in your own words.
  + Ask for help from your personal tutors or academic lecturers to help you understand how to complete the work.
  + Post any questions on the discussion board on Blackboard.
  + Have a broad discussion with your tutors, fellow students, friends and family on the assessment topic and your ideas/approach, which may help you to further your knowledge and understanding.
  + Use your network of family and friends to gain support and encouragement during the assessment period.

Please remember this is a formal assessment and you should behave in a manner consistent with our values. This means you cannot:

* + Allow others to directly contribute to your written answer by revising or adding to the academic content. This is collusion and is against University Regulations.
  + Share your assessment with others or ask others to share their work with you.
  + Copy and paste any material (text, images, coding, calculations) from other sources, including teaching material, shared revision notes, and AI-generated material directly into your answer without appropriate acknowledgement. This is plagiarism (see section 6).
  + Pay another person or company to complete the assessment for you. This is contract cheating and is against University Regulations.

Note that this means that in this specific case the reproducible research practices you employ should not include approaches such as pair programming or code review by a second person.

## 4. Assessment submission

* Each assessment component should be submitted via Blackboard by **12 noon on Wednesday 28 April** **2025** in the corresponding submission point.
* Your report should be in a Word document. Please use a clear font at 12-point size. It should be named EDAM\_report\_[your student number] (e.g. EDAM\_report\_01234.docx).
* Your R model can be a single R script or a pipeline consisting of multiple R scripts. It should be named EDAM\_code\_[your student number] (e.g. EDAM\_code\_01234.zip).

**Failure to submit on time will incur penalties unless you have an approved extension.** Please see the Programme Handbook on Blackboard for details on the extension and extenuating circumstances procedure, and for the penalties for late submission of coursework. If you encounter problems with your submission, or if you are likely to have a problem submitting on time, please email the course administrator as soon as possible [brms-msdscourseadmin@bristol.ac.uk](mailto:brms-msdscourseadmin@bristol.ac.uk).

## 5. Marking

You will be assessed according to the following categories, each with a portion of the marks allocated to it. Within each category, marks will be assigned based on the marking scale in the programme handbook.

* Report (60 marks)
  1. Description of the outbreak and objectives, including figures and estimates of the exponential growth rate and reproduction numbers (20 marks)
  2. Appropriate model structure shown in a model flow diagram and model equations (10 marks)
  3. Parameters and their meanings (5 marks)
  4. Results from compartmental modelling, including figures and tables (15 marks)
  5. Interpretation and conclusions (5 marks)
  6. Limitations (5 marks)
* Code (40 marks)

Your code should be working (20 marks), well-organized (10 marks), and readable (10 marks) for all analyses and outputs included in the report. Working code implies not only that the code should run without error and perform specified tasks correctly, but it should also be accompanied by clear instructions for how to rerun the entire pipeline. Organization includes clear separation of code into different sections for data loading, data pre-processing, analysis, and output generation. Readability includes proper indenting, reasonable variable, function and file names, and informative comments in code. A reasonable coding style is described here: <http://adv-r.had.co.nz/Style.html>, but you may use other coding styles provided they are used with reasonable consistency.

## 6. Referencing, Copyright and intellectual property

You need to include references in your report including sources for any data in the R model.

It is important that the coursework you submit is your own work. All written assessments will be checked by Turnitin for issues related to plagiarism, collusion, and cheating. Please see the Programme Handbook for important information on academic integrity. You are also able to re-listen to the course Welcome Week academic integrity talk at any time or view the guidance on the University’s website [www.bristol.ac.uk/students/support/academic-advice/academic-integrity/](http://www.bristol.ac.uk/students/support/academic-advice/academic-integrity/)

Copyright and intellectual property rights are also important issues to be aware of when using the work of others in your coursework. This is not just about ensuring that you correctly reference everything, but you also need to be sure that you have *permission* to re-use this work. Examples of this might be displaying a figure you have taken from someone else’s work. If you have any concerns about copyright issues, please speak to the unit leads in advance of submitting your assessment.

You may include photographs or scans of your own hand-drawn, labelled diagrams or calculations, if appropriate. We would advise you to generate your own diagrams but if you include diagrams or pictures that you have not produced yourself, or are modified versions of existing images, you should ensure you reference them appropriately.

## 7. Wordcount

Your report should be no more than 1200 words. This includes:

* + **All** text including in-text titles and headings
* Figure and table legends
* All in-text citations

The word limit does not include:

* + Equations
  + Text in figures
  + Text in tables
  + List of references

Submissions should include no more than 6 figures and 2 tables. Any additional figures and tables will not be marked. All figures should be presented in the report. There are no restrictions on the R file sizes.

You must provide the word count of the report section of the submitted work on the cover sheet accompanying your submission.

Exceeding the word limit will incur the following penalties. You will be informed of any penalties applied to your assessment:

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| --- | --- |
| Coursework that exceeds the stated word limit by: | Penalty (absolute): |
| Up to 5% | 5% of total mark available is deducted\* |
| Between 6-10% | 10% of total mark available is deducted\* |
| Between 11% and 20% | 20% of total mark available is deducted\* |
| Between 21% and 50% | 50% of total mark available is deducted\* |
| By over 50% | A mark of 0 is awarded |

\*Note: the minimum mark is 0, negative marks will not be given.

Please see the Programme Handbook for further information on word count limits and penalties.