PROJECT LIST

Title of PhD project	**Infection clustering: Detecting socioeconomic and ethnic gradients in infection burden using OpenSAFELY**
Supervisory team	**LSHTM: Daniel Grint (primary)** **https://www.lshtm.ac.uk/aboutus/people/grint.daniel** **Imperial:** An Imperial supervisor will be identified based on the focus of the project. **UKHSA: Andrew Hayward** https://profiles.ucl.ac.uk/3398 https://scholar.google.com/citations?user=MPoKBygAAAAJ&hl=en
Brief description of project / theme	It is well established that infectious diseases exhibit socioeconomic gradients, and differences by ethnicity (ref 1). The reasons for these differences are not fully elucidated (ref 2, 3, 4) and evidence is needed to clarify how this burden is distributed across a range of infections, and indeed, if some groups are disproportionately affected by multiple different infectious diseases. This research project will analyse large-scale electronic health records include GP, hospitalisation and testing data to quantify health inequalities across a range of infections and to delve into the interactions and intersections

between them. We will analyse infection burden by socioeconomic status and ethnicity, and by severity of infection, and determine if there have been changes through time. We will consider the underlying health status of individuals, such as pre-existing health conditions, and consider different health-seeking behavioural modes.

There is scope for part of the project to focus on specific interests of the candidate in this area, for example development of dynamic transmission models, health service utilisation and pathways, prescriptions and antibiotic use, or health economics.

The principal supervisors will be Dr Daniel Grint (LSHTM) and Professor Andrew Hayward (UKHSA), aided by Professor Rosalind Eggo (who will be part of the advisory team). Dr Grint is a statistician with expertise (amongst other things) in the design and conduct of observational studies using electronic health records. Professor Andrew Hayward is a specialist in health inequalities and electronic health records research and Lead of Health Equity and Inclusion Health at UKHSA. The student will also benefit from supervision from a supervisor at Imperial, who will be identified based on the focus of the project.

1. UKHSA 2023
https://www.gov.uk/government/publications/covid-19-and-flu-inequalities-in-emergency-hospital-admission-rates/inequalities-in-emergency-hospital-admission-rates-for-influenza-and-covid-19-england-september-2022-to-february-2023

2. Wing et al 2022
https://academic.oup.com/ije/article/51/6/1745/6665821

3. Watkinson et al 2023
https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1004289

	4. Forbes et al 2021 https://www.bmj.com/content/372/bmj.n628
The role of the different institutions in this collaborative project	The successful applicant will be part of the Faculty of Epidemiology and Population Health at LSHTM as well as the Health Equity and Inclusion Unit at UKHSA. The applicant will join the vibrant Centre for Mathematical Modelling of Infectious Diseases at LSHTM which has a focused early-career researcher seminar and team-learning series. The student will also join the Electronic Health Records group at LSHTM and have the opportunity to take training courses offered by either Centre. The student will also benefit from interacting with other national experts e.g. through the HPRU in Vaccines and Immunisation. The student and supervisors will meet remotely every week to begin, meeting fortnightly after 6 months, and the student and supervisors will meet in person at least 3 times per year. It is anticipated that the student will attend the LSHTM campus at least 8 days per month, and therefore see the lead supervisor much more frequently. This project will deepen collaborative links between the partner organisations through regular interaction and feedback with colleagues at the institutions. They will present their findings at internal seminars at each institution to share results and methods.
Particular *prior* educational requirements and skills for a student undertaking this project	• MSc (or equivalent training) in a quantitative subject, ideally with some experience of electronic health records • Experience or enthusiasm for learning to code in R and/or other languages

Skills we expect a student to develop/acquire whilst pursuing this project	This project will train the student in epidemiology, analysis of electronic health records, and use of the OpenSAFELY research platform. Depending on student interests and focus, training can include mathematical modelling of infectious disease and Bayesian parameter inference. They will build skills in scientific writing, as well as critical reading of the literature. The student will also improve their skills in research coding and management and learn to give clear scientific presentations communicating their work.

Title of PhD project	**Incorporating stratification by ethnicity in mathematical models of respiratory virus transmission in England**
Supervisory team	**LSHTM: Rosalind Eggo (primary)** Webpage: https://www.lshtm.ac.uk/aboutus/people/eggo.rosalind ORCID: https://orcid.org/0000-0002-0362-6717 Google Scholar: https://scholar.google.co.uk/citations?user=xaNfZ9wAAAAJ&hl=en **Imperial: Neil Ferguson** Web page: https://profiles.imperial.ac.uk/neil.ferguson ORCID: https://orcid.org/0000-0002-1154-8093 Google Scholar: https://scholar.google.co.uk/citations?user=edH2q8AAAAAJ&hl=en **UKHSA:** A UKHSA supervisor will be identified based on the focus of the project.

Brief description of project / theme	Respiratory viruses, such as RSV, influenza and Covid-19, exhibit disparities in impact by ethnicity in England [ref 1]. The reasons for these differences are not fully elucidated and evidence is needed to understand drivers of disparities and to design strategies that could mitigate them [ref 2]. Social contact data are frequently used to parameterise transmission models of respiratory viruses, but until recently, social contact data stratified by ethnicity or socioeconomic status have not been available. This project will analyse new data from the UK Social Contact Survey survey, in which participants have reported their own and their contact's ethnicity. This will allow the student to estimate mixing matrices stratified by age and ethnicity and characterise resulting assortativity. The student will use these data to develop a transmission model stratified by age, ethnicity and (if feasible) socioeconomic status (similar to models stratified by deprivation [ref 3]) for one of the named viruses and fit this model to available data using Bayesian methods. The model can be used to design and evaluate mitigation strategies if those are indicated, such as via vaccination (ref 4), and determine if those affect health inequalities. Examples could include: a) modelling and analysis of seasonal influenza vaccination in older adults and children, b) pandemic modelling and preparedness, c) analysis of Covid vaccination (retrospective or prospective), d) evaluation of health inequalities of the RSV vaccination programme. There is scope for part of the project to focus on specific interests of the candidate in this area, for example analysis of health datasets, methodological development (e.g. agent-based models), or health economics. The principal supervisors will be Professor Rosalind Eggo (LSHTM) and Professor Neil Ferguson (Imperial). Professor Eggo is a leading researcher in modelling of directly-transmitted pathogens, with a major research focus on health inequalities of infections. Professor Ferguson is an

	expert in infectious disease modelling, parameter inference and policy-relevant research. The student will also benefit from supervision from a leading researcher at UKHSA, who we will identify based on the focus of the project. 1. Mathur et al 2020 https://www.thelancet.com/article/S0140-67362100634-6/fulltext 2. Wing et al 2022 https://academic.oup.com/ije/article/51/6/1745/6665821 3. Goodfellow et al 2024 https://link.springer.com/article/10.1186/s12916-024-03387-y 4. Baguelin et al 2013 https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1001527
The role of the different institutions in this collaborative project	The successful applicant will be part of the Faculty of Epidemiology and Population Health at LSHTM as well as a unit at UKHSA. The applicant will join the vibrant Centre for Mathematical Modelling of Infectious Diseases at LSHTM which has a focused early-career researcher seminar and team-learning series. The student will also benefit from interacting with other national experts e.g. through the HPRU in Vaccines and Immunisation. The student and supervisors will meet remotely every week to begin, meeting fortnightly after 6 months, and the student and supervisors will meet in person at least 3 times per year. It is anticipated that the student will attend the LSHTM campus at least 8 days per month, and therefore see the lead supervisor much more frequently. This project will deepen collaborative links between the partner organisations through regular interaction and feedback with colleagues at the institutions. They will

	present their findings at internal seminars at each institution to share results and methods.
Particular *prior* educational requirements and skills for a student undertaking this project	• MSc (or equivalent training) in a quantitative subject, ideally with some experience of mathematical modelling • Experience or enthusiasm for learning to code in R and/or other languages
Skills we expect a student to develop/acquire whilst pursuing this project	This project will train the student in epidemiology, transmission modelling, and Bayesian inference. Depending on student interests and focus, training can include health economic analysis, technical coding skills, or data analytic methods. They will build skills in scientific writing, as well as critical reading of the literature. The student will also improve their skills in research coding and management and learn to give clear scientific presentations communicating their work.

Title of PhD project	**Improving Estimation and Analysis of Epidemiological Delays for Infectious Disease Outbreaks**

Supervisory team	**LSHTM:** Sebastian Funk sebastian.funk@lshtm.ac.uk https://www.lshtm.ac.uk/aboutus/people/funk.sebastian **Imperial:** Anne Cori a.cori@imperial.ac.uk https://profiles.imperial.ac.uk/a.cori **UKHSA:** Christopher Overton christopher.overton@ukhsa.gov.uk Christopher E. Overton - Google Scholar
Brief description of project / theme	Epidemiological delays, such as incubation periods, generation times, and reporting delays, are key to understanding infectious disease dynamics and informing outbreak responses. Despite advances, existing methods often struggle with biases, including incomplete data, and are limited in their ability to account for time-varying changes or to scale effectively for large datasets. This project aims to address these challenges through methodological improvements and case studies on recent outbreaks of diseases such as COVID-19, mpox, and others. It will do so by identifying biases that could arise from common approaches and implications for model-based predictions, as well as by assessing the impact of changes over time and epidemiological factors that could explain them. This project will involve refining existing statistical approaches to delay estimation and developing tools that enhance accessibility and scalability, building on efforts like the **epidist** R package, in order to improve critical decision-making during the initial stages of disease emergence. 1. Charniga, K., Park, S. W., Akhmetzhanov, A. R., Cori, A., Dushoff, J., Funk, S., Gostic, K. M., Linton, N. M., Lison, A., Overton, C. E., Pulliam, J. R. C., Ward, T., Cauchemez, S., & Abbott, S. (2024). Best practices for estimating and reporting epidemiological delay distributions of infectious diseases using public health surveillance and healthcare data. *arXiv [Stat.ME]*. https://arxiv.org/abs/2405.08841

	2. Park, S. W., Akhmetzhanov, A. R., Charniga, K., Cori, A., Davies, N. G., Dushoff, J., Funk, S., Gostic, K., Grenfell, B., Linton, N. M., Lipsitch, M., Lison, A., Overton, C. E., Ward, T., & Abbott, S. (2024). Estimating epidemiological delay distributions for infectious diseases. *bioRxiv*. https://doi.org/10.1101/2024.01.12.24301247
The role of the different institutions in this collaborative project	The student will be supervised by a team of supervisors representing all participating institutions and part of a team of researchers that spans the institutions. The Imperial College and LSHTM supervisors will bring the substantial methodological expertise and breadth of their institution as well as experience in bringing these to bear on public health problems. UKHSA will bring the UK-specific public health focus and ensure the project is firmly grounded in the application to data and problems as they are present in the UK.
Particular *prior* educational requirements and skills for a student undertaking this project	A postgraduate degree, ideally in a quantitative subject (e.g. Biostatistics, Bioinformatics, Mathematics, Statistics, Computer Science or Physics) or a related discipline (e.g. Epidemiology or Biology) with a strong quantitative element either awarded or imminent or equivalent training. Also some coding experience, ideally in R.
Skills we expect a student to develop/acquire whilst pursuing this project	Insights into the application of quantitative techniques in public health contexts, specifically advanced analytics applied in epidemiological contexts; inference with mathematical models applied to infectious disease data set.

Title of PhD project	**Improving Infectious Disease Forecasts and Forecast Evaluation**
Supervisory team	**LSHTM:** Sebastian Funk sebastian.funk@lshtm.ac.uk https://www.lshtm.ac.uk/aboutus/people/funk.sebastian **Imperial:** Anne Cori a.cori@imperial.ac.uk https://profiles.imperial.ac.uk/a.cori **UKHSA:** Edwin van Leeuwen <Edwin.VanLeeuwen@ukhsa.gov.uk> https://researchportal.ukhsa.gov.uk/en/persons/edwin-vanleeuwen
Brief description of project / theme	Infectious disease forecasting plays a critical role in outbreak response, guiding public health interventions and resource allocation. However, many existing forecasting models rely on oversimplified assumptions, such as constant reproduction numbers (Rt), which limit their utility for long-term predictions. Furthermore, while ensemble methods have proven effective in other fields, their systematic application to epidemiological forecasting, including learning from past performance, remains underexplored. Evaluation approaches often lack focus on the specific aspects of predictive performance that are most relevant to decision-making. This project seeks to improve infectious disease forecasting by addressing three interconnected areas. First, it will develop models that move beyond stationary assumptions, enabling forecasts to better account for dynamic changes in disease transmission. Second, it will

	systematically investigate ensemble methods, including advanced weighting schemes such as those implemented in tools like the **qraensemble** and **stackr** R packages, to combine predictions from multiple models more effectively. Third, it will design evaluation frameworks tailored to decision-making, focusing on practical metrics such as outbreak peak timing, magnitude, and critical thresholds. The research will be applied to case studies including COVID-19, mpox, influenza and other infectious diseases, ensuring the methods are rigorously tested and broadly applicable, and aim to improve the utility of infectious disease forecasts in future epidemics. 1. Sherratt K et al. (2023) Predictive performance of multi-model ensemble forecasts of COVID-19 across European nations. eLife https://doi.org/10.7554/eLife.81916 2. Bosse NI, Abbott S, Cori A, van Leeuwen E, Bracher J, Funk S (2023) Scoring epidemiological forecasts on transformed scales. PLoS Comput Biol 19(8): e1011393. https://doi.org/10.1371/journal.pcbi.1011393
The role of the different institutions in this collaborative project	The student will be supervised by a team of supervisors representing all participating institutions and part of a team of researchers that spans the institutions. The Imperial College and LSHTM supervisors will bring the substantial methodological expertise and breadth of their institution as well as experience in bringing these to bear on public health problems. UKHSA will bring the UK-specific public health focus and ensure the project is firmly grounded in the application to data and problems as they are present in the UK.
Particular *prior* educational requirements and skills for a student undertaking this project	A postgraduate degree, ideally in a quantitative subject (e.g. Biostatistics, Bioinformatics, Mathematics, Statistics, Computer Science or Physics) or a related discipline (e.g. Epidemiology or Biology) with a strong quantitative element either awarded or imminent or equivalent training. Also some coding experience, ideally in R.
Skills we expect a student to	Insights into the application of quantitative techniques in public health contexts, specifically advanced analytics

develop/acquire whilst pursuing this project	applied in epidemiological contexts; as well as broader understanding of forecasting and forecast evaluation.

Title of PhD project	**The Informational Value of Infectious Disease Surveillance Datasets in Understanding Transmission Dynamics and Intervention Effectiveness**
Supervisory team	**LSHTM:** • **Marc Baguelin** (Primary Supervisor) Email: marc.baguelin@lshtm.ac.uk Profile: https://www.lshtm.ac.uk/aboutus/people/baguelin.marc • **Kathleen O'Reilly** (Secondary Supervisor) Email: Kathleen.OReilly@lshtm.ac.uk Profile: https://www.lshtm.ac.uk/aboutus/people/oreilly.kathleen **Imperial:** • **Lilith Whittles** Email: l.whittles@imperial.ac.uk Profile: https://profiles.imperial.ac.uk/l.whittles • **Neil Ferguson** Email: neil.ferguson@imperial.ac.uk Profile: https://profiles.imperial.ac.uk/neil.ferguson **UKHSA:** • **Matt Wade**

	Email: matthew.wade@ukhsa.gov.uk
Brief description of project / theme	Estimates of key epidemic metrics, such as the basic reproduction number (R0), infection fatality rate, or the community effectiveness of vaccines, depend heavily on the availability and quality of surveillance data. However, these estimates often come with wide intervals, reflecting significant uncertainty. This uncertainty impacts the understanding of both the effectiveness and cost-effectiveness of interventions, presenting challenges for public health decision-making. During the early stages of an outbreak, estimating the underlying size of an epidemic is especially challenging due to limited data. Often, the number of reported cases is the only available data, providing little insight into the true extent of disease spread. This project aims to quantify how additional types of data - such as randomised population sampling or wastewater surveillance - can improve estimates of epidemic metrics and reduce uncertainty. Building on Bayesian evidence synthesis methods developed and widely used at the three institutions, this PhD will extend these methods to a Value of Information (VoI) framework. This framework will assess the expected value of additional datasets in reducing uncertainty surrounding the effectiveness of interventions and the estimated disease burden. Specifically, the project will explore: • The value of randomised population sampling for improving estimates of case ascertainment and epidemic size. • The value of wastewater surveillance for narrowing the time window of epidemic onset. The research will focus on hypothetical scenarios involving pathogens with varying profiles: highly symptomatic (e.g., mpox-like), less detectable but severe (e.g., polio-like), and

intermediate (e.g., COVID-like). Outputs from this research will provide actionable insights for prioritising infectious disease datasets during future surveillance planning, including for emerging threats like 'Disease X.'

Additionally to scenarios, this work will involve case studies such as influenza, SARS-CoV-2, and norovirus, utilising datasets including SGSS, NHS 111, hospital admission data, electronic health records, and wastewater data. It will also explore how surveillance strategies can reduce parameter uncertainty in the most commonly used models such as SEIR transmission epidemic models and branching processes.

1. **Baguelin M, Flasche S, Camacho A, Demiris N, Miller E, Edmunds WJ.** Assessing Optimal Target Populations for Influenza Vaccination Programmes: An Evidence Synthesis and Modelling Study. *PLoS Medicine*. 2013 Oct;10:e1001527. Available here
2. **Jackson C, Presanis A, Conti S, De Angelis D.** Value of Information: Sensitivity Analysis and Research Design in Bayesian Evidence Synthesis. *Journal of the American Statistical Association*. 2019 Apr;528:1436–49. Available here
3. **Diamond MB, Keshaviah A, Bento AI, Conroy-Ben O, Driver EM, Ensor KB, et al.** Wastewater surveillance of pathogens can inform public health responses. *Nature Medicine*. 2022 Oct;28(10):1992–5. Available here
4. **Endo A, Murayama H, Abbott S, Ratnayake R, Pearson CAB, Edmunds WJ, et al.** Heavy-tailed sexual contact networks and monkeypox epidemiology in the global outbreak, 2022. *Science*. 2022;94(October):90–4. Available here
5. **Jackson C, Johnson R, de Nazelle A, Goel R, de Sá TH, Tainio M, et al.** A guide to value of information methods for prioritising research in health impact modelling. *Epidemiological Methods*. 2021 Nov;10(1):20210012. Available here

The role of the different institutions in this collaborative project	This project will leverage the extensive expertise of the three institutions in evidence synthesis, particularly from their work during the COVID-19 pandemic and vaccine impact analyses over the years. Each institution will play a crucial role: • UKHSA: UKHSA will provide access to key surveillance datasets, including SGSS, NHS 111, hospital admissions, and wastewater data. These datasets will form the basis of the case study scenarios for the project. Additionally, UKHSA's work in pandemic preparedness and scenario development, as part of their responsibilities related to the Joint Committee on Vaccination and Immunisation (JCVI), will align closely with the project's aims. • LSHTM: LSHTM will contribute significant expertise in mathematical modelling and Bayesian evidence synthesis, particularly from their leadership in modelling during COVID-19 and other infectious disease outbreaks. The primary supervision of the PhD project will be hosted at LSHTM, ensuring robust methodological support and academic development. • Imperial College London: Imperial will provide expertise in advanced epidemiological modelling, including branching processes and Value of Information methodologies. Imperial's long-standing experience in infectious disease research and modelling interventions will complement the project's analytical objectives. To ensure effective collaboration and alignment, regular meetings will be held between the three institutions and the PhD candidate. These meetings will foster knowledge sharing, methodological discussions, and timely feedback on the project's progress. In addition, the project outcomes will be presented and discussed with policymakers, including those at UKHSA and potentially JCVI if relevant, to maximise the real-world impact of the research findings.

Particular *prior* educational requirements and skills for a student undertaking this project	To successfully undertake this project, the student should possess the following prior knowledge and skills: • Quantitative background: A degree (master's preferred) in epidemiology, statistics, mathematics, physics, computer science, or a related field. • Mathematical and statistical modelling: Familiarity with modelling frameworks used in infectious disease dynamics, such as compartmental or branching process models. • Programming experience: Proficiency in at least one statistical programming language, such as R or Python. • Bayesian inference methods: Basic understanding of Bayesian principles and their application in parameter estimation. • Data management skills: Experience working with datasets related to public health, epidemiology, or similar fields. • Communication skills: Ability to write reports and present findings to diverse audiences, including those outside of academic settings.
Skills we expect a student to develop/acquire whilst pursuing this project	This PhD project is designed to equip the student with a diverse set of technical and transferable skills, including: • Advanced Bayesian modelling: Expertise in Bayesian evidence synthesis and Value of Information (VoI) frameworks for decision-making in public health contexts. • Branching process modelling: Developing and parameterising branching process models for outbreak scenarios. • Data simulation and analysis: Simulating infectious disease outbreaks and evaluating the impact of different datasets (e.g., random population sampling, wastewater surveillance) on reducing uncertainty.

	• Epidemiological research: Practical experience with infectious disease surveillance datasets, including SGSS, NHS 111, hospital admission data, and wastewater data. • Statistical software proficiency: Advanced skills in using R for Bayesian inference, EVSI calculations, and data visualisation. • Best-practice coding: Hands-on experience with version control systems (e.g., Git/GitHub) to ensure reproducibility and collaboration in scientific programming. • Critical thinking and decision analysis: Applying quantitative methods to evaluate the cost-effectiveness of public health interventions and prioritise data collection strategies. • Communication and dissemination: Opportunities to present findings at academic conferences and write high-impact publications, alongside tailored outputs for public health practitioners.

Title of PhD project	**Understanding and predicting behavioural drivers of epidemic dynamics**

Supervisory team	**LSHTM: Adam Kucharski (lead)** https://www.lshtm.ac.uk/aboutus/people/kucharski.adam **Imperial:** Marisa Miraldo https://profiles.imperial.ac.uk/m.miraldo **UKHSA:** Prof Peter White: https://profiles.imperial.ac.uk/p.white **UKHSA**: Katy Turner katy.m.turner@ukhsa.gov.uk www.linkedin.com/in/katymeturner/
Brief description of project / theme	Human behaviour plays a crucial role in the dynamics of influenza and coronavirus pandemics. However, measuring and predicting behaviour relevant for disease transmission remains challenging, particularly in real-time. This project will use epidemiological, policy and behavioural data from the COVID-19 pandemic in different European countries to better understand population behavioural change drivers, behavioural dynamics, and understand how those responses can differ by socio-economic status, gender, age, and ethnicity. The project will bring together multiple datasets (e.g. the Oxford COVID-19 Government Response Tracker, Google Mobility, Facebook, OpenTable,

	CoMix, YouGov surveys) to quantify drivers of epidemiologically-relevant behaviour change (both spontaneous and in response to policy changes) across different socio-economic groups using a combination of statistical analysis, mathematical modelling, and machine learning. As well as traditional transmission dynamic modelling approaches integrated with economic modelling, the project will evaluate methods that combine mechanistic understanding with estimation of unknown relationships in datasets, such as 'universal differential equation' approaches, which can combine known epidemiological processes with neural networks to learn as-yet little-understood behavioural dynamics. As well as retrospective analysis of COVID, it will consider implications for future emerging disease threats. This work will be conducted in close collaboration with teams across LSHTM, Imperial and UKHSA, and has the potential to inform interventions that promote protective behaviours in the context of outbreaks, as well as enabling more accurate epidemiological predictions. **References:** Kucharski AJ et al. The Contribution of Social Behaviour to the Transmission of Influenza A in a Human Population. PLOS Path, 2014 Gibbs et al. Detecting behavioural changes in human movement to inform the spatial scale of interventions against COVID-19. PLOS Comp Biol, 2021

	Gimma et al. Changes in social contacts in England during the COVID-19 pandemic between March 2020 and March 2021 as measured by the CoMix survey: A repeated cross-sectional study. PLOS Med, 2022
The role of the different institutions in this collaborative project	The project will build on strengths of teams across LSHTM, Imperial and UKHSA. In particular, it will draw on experience of behavioural surveys and analysis (e.g. CoMix at LSHTM), behavioural economics (Imperial), modelling tools for pandemic preparedness (e.g. Epiverse at LSHTM, odin/monty at Imperial), and epidemic surveillance and response at UKHSA.
Particular *prior* educational requirements and skills for a student undertaking this project	The project will require a good basic knowledge of epidemiology and statistics, as well as some experience of programming (e.g. with R or Python) and of using mathematical and/or statistical models including from microeconomics or behavioural science. Students should have a Master's level degree or equivalent in a relevant quantitative subject.
Skills we expect a student to develop/acquire whilst pursuing this project	Modelling of infectious diseases, Bayesian inference, neural networks, behavioural dynamics, pandemic preparedness and response, science communication, scientific computing.

Imperial-registered projects

Title of PhD project	**The impact of deprivation-induced environmental, viral, behavioural, phyco-social exposures on human health.**
Supervisory team	**Imperial:** Dr Elizaveta Semenova https://profiles.imperial.ac.uk/e.semenova https://www.elizaveta-semenova.com/ https://profiles.imperial.ac.uk/e.semenova/about https://scholar.google.com/citations?user=jqGIgFEAAAAJ&hl=en Prof Marc Chadeau-Hyam https://profiles.imperial.ac.uk/m.chadeau https://orcid.org/0000-0001-8341-5436 https://scholar.google.com/citations?user=bkSYXgsAAAAJ&hl=en&oi=ao **UKHSA:** Prof Andrew Hayward

	https://profiles.ucl.ac.uk/3398 https://scholar.google.com/citations?user=MPoKBygAAAAJ&hl=en **LSHTM:** An LSHTM supervisor will be identified based on the focus of the project.
Brief description of project / theme	This PhD project will investigate the impact of deprivation-induced environmental, viral, behavioural, phyco-social exposures on human health with focus on chronic conditions, including cancers and cardio-respiratory, and cognitive outcomes. Taking an exposome approach, we will investigate social gradients in (co-occurring and correlated) exposures including , air pollution, noise, living environment (including green and blue space proximity, urban density, food environments, and area-level deprivation), behaviours along with history of viral infection to characterise (complex and multi-facetted) exposure profiles associated with social adversity, and will explore the geographical distribution of these profiles. This research will examine how these profiles affect health outcomes, including incident chronic conditions and multimorbidity. The definition of deprivation will not only rely on established metrics but will also leverage the data to come up with a reproducible and interpretable definition of 'socio-environmental deprivation' affecting health. The data will also offer the possibility to investigate the biological signatures of exposure profiles, through multiple omics data available in the REACT study and their joint and marginal effects on health.

	The REACT study includes data on more than 2mio individuals with detailed socio-demographic information and exposure to SARS CoV-2. Multiomics data have been generated in over 10K participants including genome sequencing, proteomics and metabolomics. Data on environmental exposures will be obtained through linkage to existing surfaces generated by partners, and already accessible. REACT data will be made available, subject to submission of access request. The project will use modern computational methodologies, including deep learning-based clustering to identify patterns of comorbidities and spatiotemporal models to assess the impacts of exposures. Mediation analysis will further disentangle causal pathways, revealing how environmental and social determinants collectively shape health disparities. By linking data from the REACT study with existing exposure surfaces, this research aims to advance our understanding of the biological and geographical dimensions of health inequities along the social gradient, providing evidence for targeted public health interventions.
The role of the different institutions in this collaborative project	The successful applicant will be part of the Department of Epidemiology and Biostatistics (EBS) at Imperial College London as well as the Health Equity and Inclusion Unit at UKHSA. EBS provides a vibrant environment with an opportunity to interact with other researchers focusing on exposome.
Particular *prior* educational requirements and skills	• MSc (or equivalent training) in a quantitative subject, such as statistics, data analysis, mathematics, computer science or a closely

for a student undertaking this project	relate discipline. Ideally with some experience of computational statistics. • Good coding skills in R and/or Python
Skills we expect a student to develop/acquire whilst pursuing this project	This project will train the student in computational epidemiology, exposome research, statistical inference, and, potentially, deep learning. They will also build skills in scientific writing, as well as critical reading of the literature. The student will also improve their skills in research coding and management and learn to give clear scientific presentations communicating their work.

Title of PhD project	**Optimising vaccination to combat outbreaks and AMR in sexually-transmitted infections**
Supervisory team	**UKHSA: Prof Peter White (primary)** https://profiles.imperial.ac.uk/p.white **Imperial: Prof Helen Ward** https://profiles.imperial.ac.uk/h.ward **LSHTM: Dr Nicholas Davies**

	https://www.lshtm.ac.uk/aboutus/people/davies.nicholas Wider supporting team: • REACT team members: Dr Christina Atchison (Consultant in Public Health Medicine), Dr Matt Whitaker (Research Associate in Computational Epidemiology), Prof Marc Chadeau, Dr Elizaveta Semenova (Lecturer) • STI modelling: Dr Lilith Whittles (Lecturer) • UKHSA Immunisation: Prof Shamez Ladhani
Brief description of project / theme	Sexually-transmitted infections present a growing threat to global public health, with increasing incidence, increasing antimicrobial resistance leading to multidrug-resistant infection, and the emergence of mpox - with men who have sex with men (MSM) disproportionately affected in the UK. Fortunately, vaccines are available for gonorrhoea and mpox, and are in development for other STIs. For gonorrhoea the Bexsero (4CMenB) meningitis B vaccine offers partial protection, and gonorrhoea-specific vaccines are in development, with results from trials expected during the project. Key questions are how to target vaccination to maximise health gains and address inequalities within a limited health budget, which requires identifying groups most at risk, and understanding their views on vaccination ("vaccine sentiment") to inform promotion campaigns and provision of services. We published in *Lancet Infectious Diseases* (2022) the first transmission-dynamic model of gonorrhoea vaccination used for cost-effectiveness analysis,

	which underpinned the decision by the UK's Joint Committee on Vaccination and Immunisation (JCVI) to advise the UK to become the first country to implement a national vaccination programme, targeting high-risk persons – primarily MSM. In further modelling work in *Journal of Infectious Diseases* (2024) we showed the importance of understanding variation in vaccine sentiment (i.e. the rates of uptake of vaccination in different population subgroups). We now have an exciting opportunity to collect the most representative data set on sexual behaviour and vaccine sentiment (for multiple vaccines) in MSM, and use it to parameterise a transmission-dynamic model of STIs more robustly than has been previously possible. The student will be involved in analysis of both parts of the project: 1. The novel data set will come from targeted surveys of participants in the REACT cohort, which comprises 2.5 million people across England who were recruited through population-based sampling and who consented to contact for further study. Previously, population-based studies of MSM have been small (so providing limited information), and large studies of MSM have been convenience samples (with unquantifiable biases). 2. Transmission-dynamic modelling will synthesise data from the behavioural survey with surveillance data on rates of testing and diagnoses, estimates from literature on natural history of infection, and estimates of vaccine effectiveness from observational studies and trials using Bayesian methods. This model will represent in detail heterogeneity in sexual behaviour and mixing patterns in the population,

	linked to vaccine uptake and healthcare utilisation. It will then be used to optimise vaccination strategies. The intended priority of the work will be gonorrhoea, as this is a complex problem with rising incidence, drug resistance being a growing concern, and novel vaccines in development. However, mpox might become a priority if there are changes in its transmission patterns or emergence of new variants of concern. There will be scope to tailor to work to the student's particular interests as the project evolves. For example, there can be further data collection, including qualitative (via focus groups) or quantitative (further surveys), use of machine learning in data analysis, or development of methods for dynamic representation of behaviour in transmission-dynamic models (linking with other work of the HPRU). 1. Nikitin D, Whittles LK, Imai-Eaton JW, White PJ. Cost-effectiveness of 4CMenB vaccination against gonorrhea: importance of dosing schedule, vaccine sentiment, targeting strategy, and duration of protection. *Journal of Infectious Diseases* 2024: jiae123. doi.org/10.1093/infdis/jiae123. 2. Whittles LK, Didelot X, White PJ. Public health impact and cost-effectiveness of gonorrhoea vaccination: an integrated transmission-dynamic health-economic modelling analysis. *Lancet Infectious Diseases* 2022; 22: 1030–41. doi.org/10.1016/S1473-3099(21)00744-1. 3. Whittles LK, White PJ, Didelot X. Assessment of the Potential of Vaccination to Combat Antibiotic Resistance in Gonorrhea: A Modeling Analysis to Determine Preferred Product Characteristics. *Clinical Infectious Diseases* 2020; 71(8): 1912–1919. doi.org/10.1093/cid/ciz1241. 4. Whittles LK, White PJ, Didelot X. A dynamic power-law sexual network model of

	gonorrhoea outbreaks. *PLOS Computational Biology* 2019; 15(3): e1006748. 5. Whittles LK, White PJ, Didelot X. Estimating the fitness cost and benefit of cefixime resistance in *Neisseria gonorrhoeae* to inform prescription policy: a modelling study. *PLOS Medicine* 2017; 14(10): e1002416.
The role of the different institutions in this collaborative project	UKHSA's Immunisation Division provides advice to the Department of Health & Social Care and JCVI on vaccination policy, and to the health service in implementation. UKHSA's Blood Safety, Hepatitis, STIs and HIV (BSHSH) Division collects STI surveillance data and provides advice on STI control. The student will gain experience of how this advice is generated and communicated as part of the policy-making process. Imperial College developed the *gonovax* model in R (https://rdrr.io/github/mrc-ide/gonovax/), which will be the basis of the modelling component of this project. As this model has evolved it has been used for the papers in *Clinical Infectious Diseases* 2020, *Lancet Infectious Diseases* 2022, and *Journal of Infectious Diseases* 2024, and is used in other papers in preparation. • The work in *Lancet Infectious Diseases* 2022 provided the essential cost-effectiveness evidence which underpinned JCVI's decision to advise a national targeted vaccination programme. • The work in *Journal of Infectious Diseases* 2024 on the importance of understanding variation in vaccine sentiment is what inspired this project. Imperial College is also modelling other STIs including mpox. Imperial hosts the Vaccine Impact Modelling Consortium, which has many international members. The REACT study is run by Imperial College and provided vital population-based information on

	COVID. It was also been used for other studies (https://www.imperial.ac.uk/medicine/research-and-impact/groups/react-study/) Imperial's Patient Experience Research Centre promotes participatory approaches to improving healthcare and biomedical research. LSHTM hosts the NIHR Health Protection Research Unit in Immunisation, a partnership based at LSHTM and with additional researchers at UKHSA, UCL, and the University of Cambridge. The HPRU in Immunisation performs modelling and cost-effectiveness analysis of changes to the UK's immunisation policy for JCVI. In addition to modelling, the HPRU in Immunisation also has strong programmes in social science and electronic health records research pertaining to vaccines, which will help the student gain experience in critical considerations of vaccine acceptance and real-world data to ensure that their work is grounded and robust.
Particular *prior* educational requirements and skills for a student undertaking this project	• Masters degree (or equivalent) in a relevant quantitative subject, ideally with experience in transmission-dynamic modelling. • Experience of analysis of survey data would be beneficial but not essential. • Strong skills in coding, ideally in R, but skills developed in other languages are acceptable if willing to use R for this project.
Skills we expect a student to develop/acquire whilst pursuing this project	This project will train the student in epidemiology, modern survey data analysis methods, advanced coding techniques, model design and implementation, infectious disease transmission-dynamic modelling, and Bayesian parameter inference. It will provide an introduction to health-

	economic analysis integrated with transmission-dynamic modelling. There will be opportunities to engage with affected communities through Patient and Public Involvement and Engagement (PPIE) activity, and potentially through running focus groups to use qualitative research to help understand quantitative patterns detected in the survey, or to design follow-up surveys to collect additional data. The student will build skills in critical appraisal of literature, and communications skills including, visualisation of data and results, oral presentation skills, and scientific writing as well as. The study will provide experience in project management, collaboration across disciplines and institutions, and translation of research to inform policy and practice.

Title of PhD project	**Improving Estimation of Reproduction Numbers in Dynamic Outbreak Contexts**
Supervisory team	**Imperial:** Anne Cori a.cori@imperial.ac.uk https://profiles.imperial.ac.uk/a.cori **LSHTM:** Sebastian Funk sebastian.funk@lshtm.ac.uk

	https://www.lshtm.ac.uk/aboutus/people/funk.sebastian **UKHSA:** Edwin van Leeuwen <Edwin.VanLeeuwen@ukhsa.gov.uk> https://researchportal.ukhsa.gov.uk/en/persons/edwin-vanleeuwen
Brief description of project / theme	The reproduction number (R) and generation time are fundamental parameters in infectious disease epidemiology, guiding understanding of disease spread and informing outbreak response strategies. However, their estimation is complex due to the interdependence between R and generation times, and the challenges introduced by temporal changes in these parameters. These temporal changes can have multiple causes including changes in pathogen biology (e.g. new variants), changes in population-level behaviours (possibly prompted by interventions or public health messaging) and changes in the immune landscape in the population. Existing methods often fail to fully capture these dynamics, limiting their reliability for real-time decision-making during outbreaks. This project aims to address these challenges by developing robust statistical methods for the joint estimation of R and generation times, with a focus on their dynamic interplay. This will include using household-level data from COVID-19 and other diseases in order to determine their utility for real-time decision making when analysed jointly with population-level data. It will also explore how temporal changes in one parameter affect the estimation of the other and what the implications are

	for outbreak modelling. The research will build on existing software tools for real-time estimation of reproduction numbers such as the **EpiEstim** and **EpiNow2** R packages and ultimately aim to improve situational awareness in infectious disease outbreaks. 1. Gostic KM, McGough L, Baskerville EB, Abbott S, Joshi K, Tedijanto C, et al. (2020) Practical considerations for measuring the effective reproductive number, Rt. PLoS Comput Biol 16(12): e1008409. https://doi.org/10.1371/journal.pcbi.1008409 2. Nash RK, Nouvellet P, Cori A (2022) Real-time estimation of the epidemic reproduction number: Scoping review of the applications and challenges. PLOS Digit Health 1(6): e0000052. https://doi.org/10.1371/journal.pdig.0000052
The role of the different institutions in this collaborative project	The student will be supervised by a team of supervisors representing all participating institutions and part of a team of researchers that spans the institutions. The Imperial College and LSHTM supervisors will bring the substantial methodological expertise and breadth of their institution as well as experience in bringing these to bear on public health problems. UKHSA will bring the UK-specific public health focus and ensure the project is firmly grounded in the application to data and problems as they are present in the UK.
Particular *prior* educational requirements and skills for a student undertaking this project	A postgraduate degree, ideally in a quantitative subject (e.g. Biostatistics, Bioinformatics, Mathematics, Statistics, Computer Science or Physics) or a related discipline (e.g. Epidemiology or Biology) with a strong quantitative element either awarded or imminent or equivalent training. Also some coding experience, ideally in R.
Skills we expect a student to	Insights into the application of quantitative techniques in public health contexts, specifically

develop/acquire whilst pursuing this project	advanced analytics applied in epidemiological contexts; inference with mathematical models applied to infectious disease data sets.

Title of PhD project	**The health, economic and educational impacts of respiratory pandemics in the UK**
Supervisory team	**Imperial:** Katharina Hauck (lead supervisor), k.hauck@imperial.ac.uk, https://profiles.imperial.ac.uk/k.hauck **LSHTM:** John Edmunds, john.edmunds@lshtm.ac.uk, https://www.lshtm.ac.uk/aboutus/people/edmunds.john **UKHSA:** Michael Borowitz, Michael.Borowitz@ukhsa.gov.uk
Brief description of project / theme	The world needs to get prepared to prevent a catastrophic pandemic from ever happening again, and effectively respond to emerging threats. Imperial has launched the 'The Jameel Institute – Kenneth C Griffin Initiative for the Economics of Pandemic Preparedness' (EPPI), an ambitious international program of research on the health, economic and educational impacts of epidemic threats. Aims are to project the societal losses associated with hypothetical

	future pandemics under alternative scenarios, develop modelling tools that can provide real-time evidence on the health and economic impacts of mitigation measures during outbreaks, and evaluate the broader returns to investments into pandemic preparedness. EPPI is novel and innovative in its integrated approach to epidemiological, economic, and social research by drawing upon advanced methods of data science and analytics including modelling of infectious transmission dynamics, micro- and macro-economic analyses, econometrics, behavioural science, and health economics. EPPI has developed an integrated economic-epidemiological model DAEDALUS for the COVID-19 pandemic in the UK, and *DAEDALUS Explore*, an online dashboard that projects the health, economic and educational losses associated with 7 hypothetical future respiratory pandemics for 67 countries in the world. The PhD project will be based within EPPI. The specific aims of the PhD will be to build a UK version of DAEDALUS that can be used for real-time modelling to support policy makers in emergency response to an outbreak. The model will be powered to project health, economic and education impacts of alternative mitigation strategies into the future, relying on automated data streams from other projects within the HPRU. A particular focus will be to build in fiscal impacts considering alternative fiscal relief interventions, including government transfers such as furlough payments, and subsidies to businesses. A second objective of the PhD project is to use the model to estimate the societal value and return-on-investment to UK specific pandemic prevention and preparedness investments including investments into

	vaccine R&D and manufacturing capacity, surveillance and test-and-trace capacity. The PhD project will generate urgently needed modelling tools to assess the complex and varied impacts of severe epidemics on population health, economic welfare, and the social fabric of the UK society. **References** 'The Jameel Institute – Kenneth C Griffin Initiative for the Economics of Pandemic Preparedness': DAEDALUS Explore (2024). A pandemic simulation tool. https://daedalus.jameel-institute.org/scenarios/new 'The Jameel Institute – Kenneth C Griffin Initiative for the Economics of Pandemic Preparedness': DAEDALUS (2024). Software. https://github.com/jameel-institute/daedalus Haw, David J., Giovanni Forchini, Patrick Doohan, Paula Christen, Matteo Pianella, Robert Johnson, Sumali Bajaj, et al. 2022. Optimizing Social and Economic Activity While Containing SARS-CoV-2 Transmission Using DAEDALUS. *Nature Computational Science* 2 (4): 223–33.
The role of the different institutions in this collaborative project	Katharina Hauck will integrate the student in a team of established researchers and software engineers that work in closely related fields. John Edmunds will contribute his unique experience in real-time modelling and epidemiological-economic analysis to the supervisory team. Michael Borowitz will make sure that the direction of the PhD remains aligned with UKHSA priorities on pandemic preparedness.

Particular *prior* educational requirements and skills for a student undertaking this project	We are looking for a student with very strong quantitative skills, with a background in mathematical epidemiology, quantitative economics, or related subjects. The student should already have a Masters level qualification in these subjects.
Skills we expect a student to develop/acquire whilst pursuing this project	The student will most likely come from either an epidemiological/modelling background, or economic background, and will need to acquire skills from the respective other discipline.

Title of PhD project	**Design of genomic surveillance systems**
Supervisory team	**Imperial:** Erik Volz (lead) e.volz@imperial.ac.uk https://profiles.imperial.ac.uk/e.volz **LSHTM:** Stephane Hue

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Brief description of project / theme	Efficiency of pathogen genomic surveillance systems (GSS) depends on intelligent design based on best practices and principles of sample survey methodology. Large-scale genomic surveillance of SARS-CoV-2 has provided a vivid demonstration of the promise of GSS and revealed new challenges for the analysis of epidemiological big data. Optimal design of GSS must account for different types of analyses and the expected outputs that are provided to stakeholders. The implementation of new GSS's will be suboptimal or yield uninterpretable data if plans for data collection are divorced from analytical pipelines. This PhD project concerns the development of bespoke sample designs for GSS, including sample size calculations and power analysis leveraging clinical, genomic and public health surveillance data. We will conduct research into optimal design of GSS with a view towards developing guidelines for design of GSS to meet a wide variety of public health needs across a wide variety of pathogens. This project will involve the design of a GSS which begins with the anticipated outputs of the surveillance system and involves the optimisation of data collection under resource and logistical constraints. This project

	will require the Ph.D. candidate to gain skills in pathogen genomic analysis, phylogenetics, population genetics, epidemiological modelling, and sample-survey methodology. Objective 1. We will carry out research into GSS design best-practices, including methods for sample size calculation and the utility of different genomic data streams, including clinical data, community sampling, random household surveys, and environmental sampling including wastewater surveillance. This will involve the optimisation of sampling effort across data streams and the investigation of surge-sampling strategies. Objective 2. Design choices are more difficult for surveillance based on contact tracing or convenience sampling. It is common for convenience sampling from clinical sources to be used by necessity in GSS, and we will provide methods and statistical modelling to de-bias such samples using patient-level covariates. We will develop methods tailored for clustered data, contact tracing studies, and household surveys, providing optimal genomic sequencing choices within contact pairs or other highly correlated samples. Objective 3. We will develop easy-to-use software libraries and dashboard for sample design choices. This will facilitate uptake of these procedures to a wider community and translation to real-world applications.
The role of the different institutions in this collaborative project	**Imperial:** - Tutorial elements related to infectious disease modelling - Advice on infectious disease models tailored to various sample design tasks - Primary supervision on development of methods, models and software for sample design

	LSHTM: - Tutorial elements related to pathogen evolution and genetics - Advice on genetic clustering methods and applications to infectious disease surveillance **UKHSA:** - Contribution of data and expertise related to current and planned genomic surveillance systems - Provide experience to student of working within a public health agency
Particular *prior* educational requirements and skills for a student undertaking this project	It is expected that the student will have a Master-level degree or equivalent experience in a computational field (bioinformatics, computational biology, computer science) and/or a quantitative (mathematics, statistics) field.
Skills we expect a student to develop/acquire whilst pursuing this project	- Principles of sample survey methodology and statistics - Infectious disease modelling - Phylogenetic analysis