Project Details	
Project Code	MRCPHS26Br Fraser
Title	Modelling the epidemiological impact of HIV prophylaxis on a backdrop of social, cultural, and behavioural complexity
Research Theme	PHS
Project Type	Dry lab
Summary	This project would suit someone with a STEM background wanting to apply their talents to one of the most current challenges in global health. Since its introduction in 2012, pre-exposure prophylaxis (PrEP) has profoundly impacted efforts to eliminate HIV. This PhD programme will establish a deep understanding of HIV transmission in diverse populations where the use of PrEP is influenced heavily by social and behavioural factors. The candidate will develop mathematical models to explore the interaction between risk perception, PrEP adherence, and HIV transmission. They will consider real world settings, and provide policy recommendations on HIV control.
Description	Since Pre-exposure prophylaxis for HIV prevention (PrEP) was approved in 2012, it has become a critical component in The United Nations programme to end AIDS by 2030. To make this target a reality, investment is required to increase PrEP uptake in high-prevalence settings in the global south, while also maintaining a sufficient level of uptake in high-income countries where the risk of HIV is perceived to be low. Innovations in drug design continue to improve PrEP products, but the medication is only used by a fraction of the total population at risk. By increasing awareness, improving access, and reducing stigma, policy makers can address this problem. Mathematical models are widely used to predict the outcome of intervention policies. Vaccination campaigns, for example, routinely use models to decide between different delivery strategies and determine the coverage required to achieve population immunity. Unlike vaccination, however, the effectiveness of PrEP depends on the individual's adherence to the specified regimen. To successfully use modelling in this context, several challenges need to be addressed. For example, 1. The effectiveness of PrEP depends on how well the individual adheres to the prescribed regimen. Models should not assume that all PrEP users are protected, but instead assume a variable level of protection dependent on other factors. 2. The factors influencing adherence can be structural (e.g. access, cost, social, religious stigma) or can act at the individual level (e.g. risk perception, family stigma). Research in this area is ongoing; for example, the impact of recent innovations in long-acting PrEP will be observed over the coming years. 3. People who use PrEP may perceive a lower risk of infection and engage in risk compensation behaviours such as having a greater number of sexual partners, increasing sexual contact with HIV positive partners, and decreased condom use. 4. Who has sexual contact with whom is influenced by underlying structural factors. Low adherence across an entire structural subgroup could potentially have an amplifying effect on transmission within that group.

	The central theme of this project is the complex interplay between risk perception, risk taking, and the transmission of disease. Data analysis and mathematical modelling will be used to explore the interaction between structural factors, sexual contact, risk behaviours, and HIV infection. Our goal is to answer the following: How does the complex interplay between risk behaviour and PrEP usage affect the epidemiology of HIV? We outline three specific objectives: Objective 1: Build a comprehensive understanding of the factors influencing the effectiveness of PrEP to control HIV transmission The candidate will review a disparate evidence base spanning psychology, medicine, and mathematics to build a coherent narrative description of the complex interplay of variables relevant to the role of PrEP in reducing HIV incidence. Standard literature databases will be utilised, and the candidate will develop their ability to critically evaluate sources. Knowledge gaps will be identified, and the needs of stakeholders will be considered to formulate policy-relevant research questions. The candidate will make use of existing datasets available from both GW4 institutions, as well as being directed to other datasets which are available upon request. During this phase, the candidate will steer the project in their own direction. For example, they may choose to focus on low-prevalence or high-prevalence settings, key populations (e.g. men who have sex with men, female sex workers, people who inject drugs), or contribute to the mathematical theory of epidemics. Objective 2: Explore the dynamics of behaviour-driven models of infectious disease The infectious diseases modelling community increasingly recognizes the role that behavioural feedback mechanisms play in determining the trajectory of an epidemic. The project will contribute to this area of research using the PrEP-HIV system as a case study. Focusing primarily on simple theoretical systems, the candidate will use mathematics and computational methods to explore the relationships between variables such as adherence, risk compensation, effectiveness, and the effective reproduction number of the disease. Using their acquired knowledge of behaviour driven modelling, they provide critical analysis of the limitations of the state-of-the-art in HIV modelling. Objective 3: Model the impact of PrEP in real world settings The ultimate goal of the project is to apply modelling in real world settings where the complex interplay between structural factors, risk perception, and uptake/adherence to PrEP strongly influence the trajectory of HIV. After identifying settings where simpler models may not be adequate, the candidate will apply their acquired knowledge to the development of a sophisticated dynamic transmission model to be used for policy analysis. Depending on the previous objectives and the direction taken, the prospective student will either work with existing datasets the supervisory teams have access to or newly sourced ones. The model will be calibrated to the data and then used to explore different policy options. Results will be disseminated at academic conferences and with relevant decision makers.

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