Approach to modeling turnover in sexual risk and implications for epidemics of sexually transmited infections

Jesse Knight, etc.

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1 Introduction

Core group theory has long underpinned the study of epidemics of sexually transmitted infections (STI). The theory posits that heterogeneity in acquistion and transmission risk are necessary and sufficient for an STI epidemic to emerge and persist. This heterogenetiy is often demarcated by identifing potential cores, comprised of subpopulations or geographies, where onward transmission risks are the highest such that the core's unmet STI prevention and treatment needs sustain local epidemics.

Mathematical models of STI transmission include heterogenetiy in risk by stratfying the modeled population by features such as the partner change rate and different levels of mixing between subgroups by partnership type. The implications of including heterogenetiy include higher basic repoductive ratios, R0, and often lower overall STI prevalence compared with assumptions of homogeneity if the latter still results in R0 greater than 1. R0 and overall STI prevalence are further influenced by mixing between subgroups. Thus, Models with more than two risk groups are increasingly relevant for exploring epidemic nuance and for aligning model outputs with programmatic decision support – i.e. prioritization specific interventions for specific risk groups.

Less often included in STI transmission models and less discussed is the influence of movement of individuals between risk groups, which we herein refer to as "turnover".For example, a period of higher risk could represent the average duration in formal sex work, which is often associated with larger number of sexual partners as paid clients and other STI-associated vulnerabilities. It could also represent periods of higher partner change outside the context of formal sex work. Stigum et al modeled movement between risk groups as a form of "migration" and

showed that [describe] and thus, had nearly as large an influence on overall STI prevalence as sexual mixing between subgroups. It has also been shown that rates of movement between risk groups can play an important role during estimation of intervention impact following model fitting to calibration targets

Yet, implementations of risk groups and turnover in recent models vary widely, from no modelled risk groupsto seven risk groups with highly context-specific turnover. A common challenge in structuring and parameterizing STI models are considerations on how best to incorporate turnover and duration of periods of risk using available data. Models require parameters on transition rates between risk groups, but must also contend with considerations such as stability in the relative size of risk groups over time.

First, estimating the rates of movement between groups directly from cross-sectional survey data is difficult, and typically requires strong assumptions. Second, ensuring the relative sizes of risk groups do not vary dramatically over time requires careful selection rates of turnover among groups, or other compensatory parameters.

Prior works have generally solved this problem *ad hoc*, without providing a generalized approach, while some simply rely on a "burn-in" period, which permits equilibriation of risk group sizes due to turnover dynamics before introduction of the infection.

We therefore draw on prior work to propose a unified framework for defining and parameterizing risk group dynamics. We present such a framework here, and draw direct links to modeling assumptions and relevant sources of data. Building on previous work bywe then leverage this framework to explore the influence of several risk group implementations on model outputs (incidence, prevalence) in a representative model.

1.1 A subsection

More text.