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Research on sexually transmitted infections - taking HIV as an example

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Abstract. In today's society, there are still a big number of sexually transmitted infection carriers. A range of sexually transmitted illnesses, such as gonorrhea, syphilis, and others, are continually harming people's life as a result of all kinds of bad living practices and styles. This research employs case study and comparative methodologies to investigate the origins of these STDs in the context of HIV, how they develop, the many routes of infection, and the diverse repercussions on society and people. Following the sorting of the gathered data, multiple models employed in the relevant literature were compared and selected to choose the best model for further study. Furthermore, many preventive actions and solutions are recommended based on the model's conclusions, including how to protect neonates from congenital STDs. Our findings indicate that frequent screening is critical for eradicating local epidemics and that condom marketing initiatives are only effective when accompanied with screening. The results of our research were then extended using Monte Carlo simulations to better understand the function of partner networks and partner notifications as markers of STI control.

Keywords: HIV, sexually transmitted infection carriers, STD, lockdowns.

1. Introduction

The mathematical model is built on a huge amount of actual data and current mathematical knowledge, and it can accurately reflect data changes. As a result, developing mathematical models of infectious diseases is critical. It can analyze the present situation based on existing infection data, synthesize the experience and lessons learned, and implement a series of successful future infectious disease control strategies to reduce the number of infections. Furthermore, mathematical models of infectious diseases can be used to forecast future epidemics in order to better control them. Sexually transmitted infections are one of the most dangerous and unique areas of infectious disease. Sexually transmitted illnesses have existed since the dawn of time and have spread widely for ages. Yet, ever since Scottish doctor Alexander Fleming discovered penicillin in 1928, prevalent sexually transmitted illnesses have been greatly underestimated [1]. Such miracle treatments divert attention away from the fact that STIs can cause major health concerns. For than a century, humans have abused and overused antibiotics, resulting in the emergence of antibiotic resistance in sexually transmitted illnesses (particularly gonorrhea). This indirectly leads to "revenge" sexually transmitted illnesses later on. Even during the COVID-19 epidemic, studies have shown that hazardous sexual behavior did not reduce amid government-mandated lockdowns and social isolation, lessening the likelihood of sexually transmitted transmission [2]. Reduced visits could result in a quiet worldwide pandemic because STIs are generally asymptomatic or mild in the early stages. While condoms are extremely effective at

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preventing the spread of sexually transmitted illnesses, their use varies, and unsafe sexual practices are far too widespread [3]. As a result, the current condition of STI necessitates a deeper knowledge of the dynamics behind current risky behavior trends and their impact on STI transmission, which may be critical in developing and implementing more effective control strategies. As a result, modeling is required to understand the dynamic impact of STIs and to aid in the development of more effective preventive and detection measures.

This research employs case analysis and comparative approaches to investigate where these STDs come from, how they progress, the varied transmission channels, and the varying impacts on different populations from an HIV perspective. After the data was organized, many models from the chosen literature were compared and contrasted to determine which would be most suited for further investigation. Furthermore, the model's findings inform a range of recommendations, such as steps to reduce the risk of congenital STDs in neonates. The primary contributions of this study go beyond just the mathematical definition of the behavioral SIS model. Firstly, we explicitly construct the model's epidemic threshold, that is, two unique negotiation procedures about the application of protection, when there is no network of romantic ties present and when specific homogeneity assumptions are made about the model parameters. Our findings, derived from a mean-field analysis of a population-restricted sample size of 37, provide important insight into the function of routine screening and marketing activities in preventing sexual transmission and their efficacy in reducing its prevalence. To be more specific, we learned that regular screening is crucial to preventing the spread of STIs, and that marketing campaigns are only helpful when used in tandem with regular screening.

2. Comparison of different models

The transmission of infectious diseases in real-world populations can be effectively represented and studied using mathematical epidemic models available on the internet. Insights gathered from examining these models can be utilized to guide control efforts that ultimately lead to the disease's eradication. The dynamic nature of human interactions has led to widespread use of temporal networks. The vast majority of the literature on epidemic modeling [4] focuses on airborne illnesses like influenza viruses, SARS, and more recently, tremendous efforts have been made to successfully mimic COVID-19 [5]. The influence of human behavior on model parameters is widely assumed, and models of behavioral reactions that are bound by consciousness-driven response mechanisms are common. Although it is reasonable to believe that general epidemic models that disregard or simplify human behavior can accurately capture STI transmission, this assumption should be made with caution due to the fact that STI transmission is directly tied to an individual's sexual conduct. To better understand the transmission of sexually transmitted infections (STIs), several groups have attempted to develop cyber epidemic models. However, the utility of these research is severely constrained since they do not explicitly consider or simulate human behavioral preferences for conservation use and its fluctuations. Furthermore, the effect of control activities on STI mitigation is often oversimplified in the literature, with examples including merely re-reducing infection rates. To further complicate matters, human beings are frequently the link in the transmission of sexually transmitted infections. It's a new problem to account for people's varying assumptions in the model.

2.1. Kathinka Frieswijk team's SIS model

Sexual transmission is the focus of Kathinka Frieswijk's model. This model explicitly integrates a propensity for sexual conduct and replicates its evolution, providing a means by which to study the dynamics of sexual transmission [6]. To begin, a sexual transmission simulation was added to the widely used random susceptibility transmission model (SIS). Additional gaps are then introduced to depict (I) the preferences of infected individuals, (ii) the existence of asymptomatic, unaware, but infectious individuals, and (iii) the administration of treatment. The trade-off between the cost of using protection and the perceived risk is what ultimately determines an individual's behavior preference, and this preference can shift based on encounters with other people who have different behavioral preferences and may be able to persuade one to adopt their own. There is a two-stage probability

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process that leads to sexual intercourse. One individual initiates sexual contact with another at a predetermined period, while the other randomly engages with their friends, resulting in dynamic patterns of social interaction over time. In particular, the proposed mechanism considers the prevalence of partnerships in the population and the fact that people have an inclination to cheat. Second, the random nature of the bargaining process, which results in unexpected encounter, provides an explanation for the degree to which individuals give in to the usage of protection measures. Their models will incorporate these considerations. Three additional preventative measures were also implemented to mitigate the disease's spread: Several strategies have been shown to reduce the spread of sexually transmitted infections: I marketing campaigns to increase the use of condoms, which have been shown through systematic studies to have a positive impact on the likelihood of using protective measures [7]; (ii) routine screening in STI clinics, which has been identified as the most effective way to control the spread of STIs [8]. However, there are several obstacles to overcome when trying to track down a casual contact; patients typically inform their partners, but not their casual acquaintances [9], therefore this model makes the assumption that patients inform their concealed partners. The behavioural SIS model was developed by Kathinka Frieswijk's group.

2.2. A simple model derived from Poisson clock and Markov process

A basic model based on the Poisson clock and the Markov process is shown below. For example, four times, each node will always offer an encounter to another node at random, and there will be hesitancy in the face of rejection and consent.

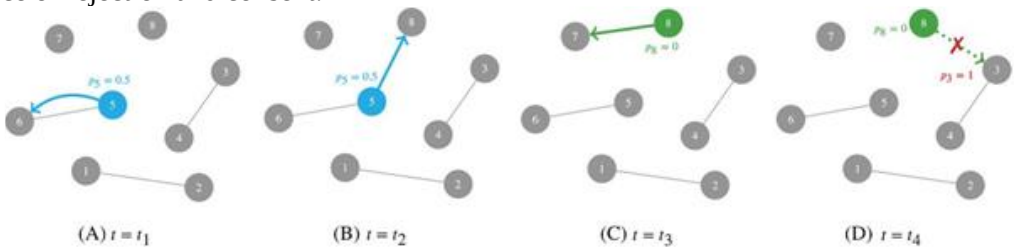

Figure 1. Examples of four time instances of sexual advocacy networks 2021 [2].

2.3. The extended classical SIS model

The extended classical SIS model is depicted in figure 2. To account for infected persons who have been tested and are undergoing treatment, as well as behavioral preferences for using protection during sexual interaction.

$$X_j(t) = \begin{cases} S_r & \text{if } j \text{ is } \textit{susceptible} \text{ and prefers to not use protective measures } (\textit{risky}), \\ S_p & \text{if } j \text{ is } \textit{susceptible} \text{ and prefers to use } \textit{protective} \text{ measures}, \\ I_r & \text{if } j \text{ is } \textit{infected}, \text{ unaware, and prefers to not use protective measures } (\textit{risky}), \\ I_p & \text{if } j \text{ is } \textit{infected}, \text{ unaware, and prefers to use } \textit{protective} \text{ measures}, \\ I_t & \text{if } j \text{ is } \textit{infected}, \text{ aware, and is receiving } \textit{treatment}, \end{cases}$$

Figure 2. Polymerization and Disassembly of Nanoparticle Groups and Capture of t -PA Molecules [2].

As model selection advances, people's classification and screening become more extensive and comprehensive, and conclusions may be formed through more effective comparison.

3. Impacts of sexually transmitted infections

Sexually transmitted illnesses are both a physical and a social problem. As a result, it does significant harm to society and people. Sexual intercourse, even skin-to-skin contact, can result in the transmission of sexually transmitted illnesses. STDs can cause long-term health concerns, particularly in mothers and newborns. Pelvic inflammatory illness, infertility, tubal or ectopic pregnancies, cervical cancer, and perinatal or congenital infections in infants born to infected moms are some of the

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health issues caused by STDS. Not only do viral infections of sexual illnesses affect health, but they can also cause cancer in human reproductive organs, lymph nodes, and even skin and critical organ ailments. On an emotional level, it can also lead to family breakup. It can also impair infected people's mental health, causing stress, worry, low self-esteem, self-abandonment, and even suicide.

The interaction between diverse groups of people is the most powerful element determining sexually transmitted illnesses. A susceptible pair is protected against infection if the relationship is monogamous. And a pair of infected persons will keep the infection from spreading as long as they live. Furthermore, an infected individual who has been healed may be re-infected by an infected partner. And gay people are more prone to contract the virus than straight people. Even if men become infected, the physical health consequences are not as severe. Women are not only more likely to get infected, but they are also at greater risk to their health, which can be fatal. According to research, women are most at risk of recurring infections between two and five months after treatment [10]. Long-term, stable relationships with different persons, on the other hand, might lead to the spread of sexually transmitted illnesses. The diagram below depicts the transmission process from women (which can be repeated).

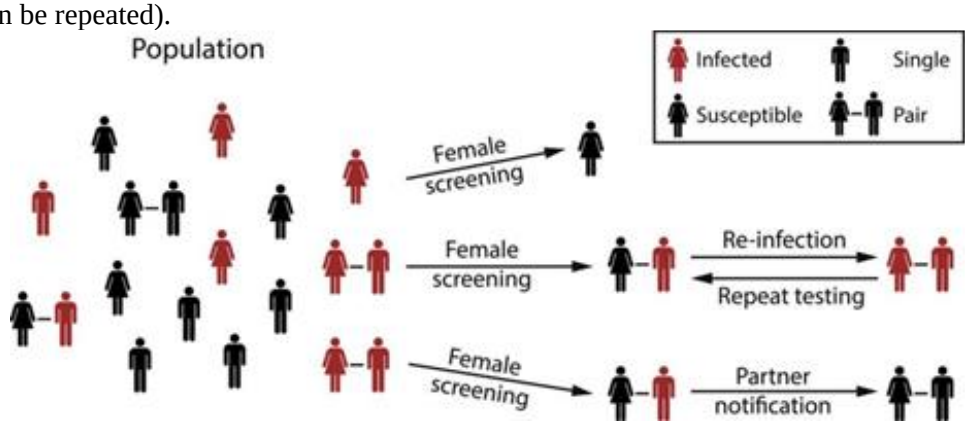

Figure 3. Polymerization and Disassembly of Nanoparticle Groups and Capture of t -PA Molecules [2].

4. Discussion and suggestion

The main topic of this study is to rely on the model's conclusions and how to solve the problem. The first issue that is mentioned in relation to sexually transmitted infections is the question of sex education for young people. Francesca Trani and her colleagues selected 644 students aged 14 to 20 from Catanzaro University and public high schools in Italy using questionnaires [10]. The findings revealed that the majority of respondents were uninformed of the various methods that STIs could be transmitted. And discovered that a far higher percentage of teens (33.8 percent) than predicted were already having sex. The average age of first sexual encounter is only 16 years old. The good news is that most teenagers choose to use condoms. However, methods for improving youth education and reducing hazardous sex must be created and implemented. Parents and schools can approach the issue of preventing teenagers from developing sexually transmitted illnesses from two angles. Parents must provide a good example and teach their children, especially girls, about sex from an early age. Schools must hold sex education lectures on a regular basis, highlight negative situations, raise young people's gender awareness, and implement safety measures.

HIV is the deadliest and prevalent sexually transmitted disease in people's lives. HIV is a distinct sexually transmitted illness that is exacerbated by other bacterial and viral STIs that cause vaginal ulcers and mucous membrane inflammation [10]. Stis are also a sign of high-risk sex. STIs increase the infectivity of HIV-infected people by raising the concentration of virus in the reproductive tract and increasing the possibility of infection in HIV-infected people. Furthermore, several STIs can raise the concentration of HIV in the blood, accelerating the disease's course. Although antibiotics can

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provide successful treatment, the more pressing issue is preventing the transmission of HIV. Despite having ineffective mechanisms of transmission, the disease is widespread in society. Many farmers are coerced into selling their blood for a lucrative profit in some isolated areas in China, yet practically all of them get infected with AIDS due to substandard grounds and syringes. Wenlou Village in China's Henan Province is a well-known AIDS settlement. As a result, the government should widely disseminate information about comparable sexually transmitted diseases. To keep more men and women from straying. Kevin F Kamis proposes that regular appointments and tests be scheduled at sexually transmitted illness clinics in order to prevent HIV [10]. This is a very safe and well-accepted pattern of behavior for enrolling HIV-risk individuals in PrEP therapy. PrEP evaluations should surprise more than just adults, teenagers, and pregnant women. More events might be held at STDS clinics to encourage more individuals to get tested. According to Kevin F Kamis and his colleagues' research, while more funding is required to enable testing and follow-up treatment, a significant number of persons are admitted and have numerous tests within a year.

Sexually transmitted infections (STIs) have long been a major source of worry. Men and women must both learn to love themselves. Don't participate in risky sex on the spur of the moment. Teenagers, in particular, should not be exposed to or engage in this type of behavior when they are immature. It is best to perform some checks after entering and leaving any public water sites. Young people with hectic schedules should make it a point to visit a sexually transmitted illness clinic on a regular basis. Although models can be used to forecast and research infectious diseases, the most important variable in sexually transmitted diseases is people's preferences, which is also the most controlled and predictable factor. People can behave in various ways. If you are unfortunate enough to contract this sickness, you must seek medical assistance immediately. You will die if you do not treat it. You must take care whether your partner has been affected or presently has a sexually transmitted disease (preferably leave him or her).

5. Conclusion

In conclusion, mathematical modeling tools such as SIS and paired models reveal that people's rates of infection and transmission are affected by geography, gender, identity, age, and a variety of other characteristics. While the distribution of condoms and other means of transmission can help to limit the spread of the virus, it is more vital to mentally educate young people about the dangers of promiscuity and unsafe sex. Because of a lack of mathematical knowledge, understanding more sophisticated models is difficult, making further research unfeasible. In addition to academic aspects, further information can be gathered through personal study and research interviews with members of the neighboring communities.

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