Herpes at Coachella: Trouble in Paradise

Mapping alcohol's effect on the herpes outbreak at Coachella

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INTRODUCTION

Coachella is one of the most popular music festivals in the world with hundreds of thousands of attendees each year. In 2019, however, there was a very sharp spike in herpes cases in the surrounding area over the two weekends that the festival was occurring. The website HerpAlert, an online resource that helps diagnose and treat genital herpes, went from a normal 12 cases per day to 250 cases per day on these two weekends. "A whopping 1,105 cases have been reported in Indio, Palm Desert, and Coachella - and also L.A., Orange, and San Diego counties where most of the concertgoers live." How could this virus have spread so quickly?

Genital herpes, HSV-2 (Herpes Simplex Type 2), is a virus that produces blisters and sores around the genitals or rectum. It is transmitted through both vaginal and anal sex, and can also be transmitted through oral sex if the 'giver' has oral herpes, HSV-1. However, we will only be focusing on the spread of HSV-2 for multiple reasons, among them the difference in prevalence of HSV-1 (48.1% of adults) versus HSV-2 (12.1% of adults), the lack of research on HSV-1, and Newton & Kubel's equation's inability to account for HSV-1. A problem with herpes is that it can lie dormant for years, or even a lifetime, and the infected person can be completely unaware that they contain the virus. This makes herpes a much easier disease to spread, and all the more important to track its expansion.

At Coachella, and other events like it, there is a substantial increase in alcohol consumption among participants. "Although alcohol consumption does not by itself cause an STD, it can directly affect risk either by increasing the risk that one is exposed to an STD through risky sexual behavior or selection of high-risk partners." Studies have shown that a lifestyle with an increased amount of alcohol leads to an increase of likelihood of an STD. Furthermore, in an attempt to give more solutions to the attendees of Coachella, we looked at the effect that increased condom use would have on herpes spread. Using this research, in addition to the studies on herpes spread and prevalence and the information from Coachella, we attempted to estimate how many people at Coachella were really infected with genital herpes, and if the high number of cases that HerpAlert received is actually too few.

MODEL DEVELOPMENT & METHODS

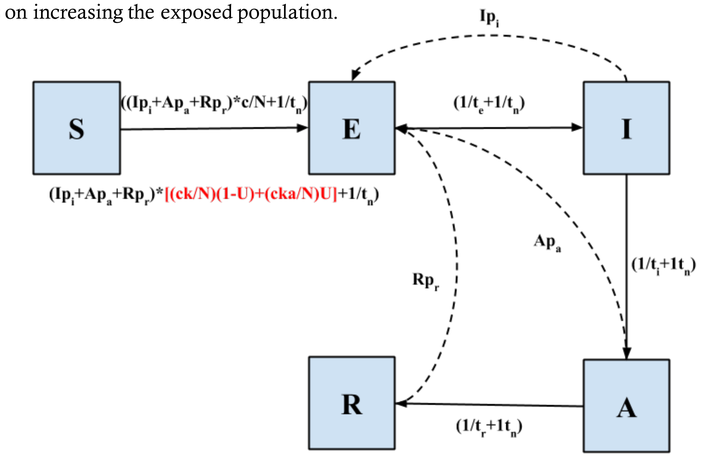
Coachella takes place on two consecutive three day weekends, and many concert-goers stay before and after, so we chose our models to map over the course of 10 days on average. Combining research from a study done of over a thousand music festival goers that showed around 20% of people have sex at Coachella and the fact that some people most likely have multiple partners and the density of the concert-goers, we say the average number of sexual partners over the span of the concert is 0.3. As far as the number of people who already have the disease, we adjusted the initial 12.1% of the overall population rate to 8%, since the average age range of music festival goers is in the low to mid-20s and this population has a lower chance of having herpes. We also used studies to find that 70.4% of festival goers drink alcohol at festivals and that those who drink are 2.23 times more likely to get an STD. These studies performed their analysis for a number of sexual partners as well as low condom use; this correlates with discussions of increased promiscuity and decreased safe sex in individuals consuming copious amounts of alcohol. In addition, we thought that, through more effort, Coachella can increase condom use by 100%. Furthermore, through research, we created a condom constant to account for both the success of condoms to prevent herpes (80%) and the condom use (varies, but starts at 1). This value will range from 0.2 (only 20% of sexual interactions with a condom result in herpes, assuming 100% usage) to 1 (normal condom use). Our constant begins at the value of 1 because our research on alcohol's effect in STDs sets a standard of low condom use among heavy drinkers. This value will vary to account for increased condom use.

We ran our model on MatLab for the following simulations:

- Fitting the herpes outbreak at Coachella with normal alcohol consumption and the original rate of condom use by festival-goers (U = 0.704, k = 1)
- Modeling herpes transmission at Coachella without the influence of alcohol, and with the original rate of condom usage amongst festival-goers (U = 0, k = 1).
- Modeling herpes transmission at Coachella with normal alcohol consumption and varying condom usage condom usage (U = 0.704, k ϵ [0.2,1])

BOX MODEL

Our box model has five compartments: "S (susceptible, no contact with the disease), E (exposed, infected but not yet infectious), I (primary infectious), A (asymptomatic but still infectious), and R (recurrent, symptomatic)." The red part of the equation accounts for the added effect that alcohol has on increasing the exposed population.



EQUATIONS

Although much of our equations are also based on the ones from Newton & Kuder, in order to add in alcohol's effect, we inserted our alcohol constant, *a*, into the portions of equations that would be affected by alcohol consumption, specifically partner-change rate c. Furthermore, we tested the effect of an increased usage of condoms by multiplying *c* by *k*, our condom constant.

S (susceptible, no contact with the disease):

$$\frac{dS}{dt} = N\left(\frac{t}{t_n}\right) - S\left(\left(Ip_i + Ap_a + Rp_r\right) * \left(\frac{c*k}{N}(1-U) + \frac{c*k*a}{N}U\right) + \frac{1}{t_n}\right)$$

= total population – susceptible population(with alcohol/condom constants)

E (exposed, infected but not yet infectious):

$$\frac{dE}{dt} = S * \left(Ip_i + Ap_a + Rp_r\right) * \left(\frac{c*k}{N}(1-U) + \frac{c*k*a}{N}U\right) - E * \left(\frac{1}{t_e} + \frac{1}{t_n}\right)$$

=susceptible population(with alcohol/condom constants) – exposed population

I (primary infectious):

$$\frac{dI}{dt} = E * \frac{1}{t_e} - I * \left(\frac{1}{t_i} + \frac{1}{t_n}\right)$$

= exposed population - infectious population

A (asymptomatic but still infectious):

$$\frac{dA}{dt} = I * \frac{1}{t_i} + R * \frac{1}{t_r} - A * \left(\frac{1}{t_a} + \frac{1}{t_n}\right)$$

= infectious population + recurrent population - asymptomatic population

R (recurrent, symptomatic):

$$\frac{dR}{dt} = A * \frac{1}{t_a} - R * \left(\frac{1}{t_r} + \frac{1}{t_n}\right)$$

= asymptomatic population - recurrent population

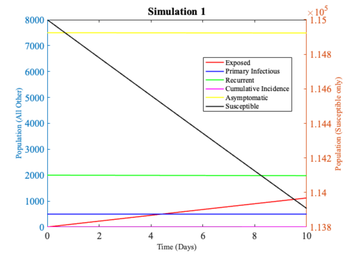
Z (cumulative incidence):

$$\frac{dZ}{dt} = E * \frac{1}{t_e}$$

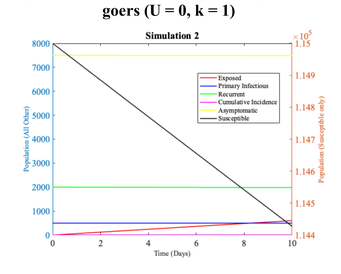
= exposed population

RESULTS

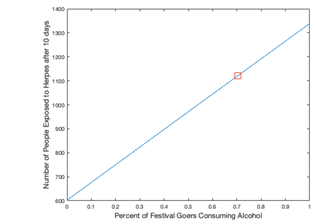
Fitting the herpes outbreak at Coachella with normal alcohol consumption and the original rate of condom use by festival-goers (U = 0.704, k = 1)



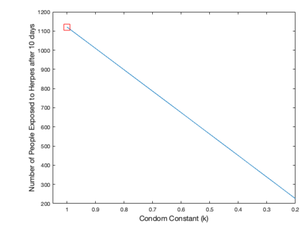
Modeling herpes transmission at Coachella without the influence of alcohol, and with the original rate of condom usage amongst festival-goers (U = 0, k = 1)



Plotting varying alcohol usage, from 0% to 100% consumption, with the original rate of condom usage amongst festival-goers (U ϵ [0,1], k = 1)



Plotting varying condom usage, from normal use to 100% use, with normal alcohol consumption amongst festival-goers (U = 0.704, k ϵ [0.2,1])



DISCUSSION & FURTHER RESEARCH

As we see in our results section, our research has found that HerpAlert's findings of around 1,105 herpes cases as a result of Coachella fits our model of 1,121 cases, with less than a 2% difference. This amount could, also, decrease further if alcohol is fully cut out of the picture, going down to 54% of our initial value (603 cases) of 1,121 new cases of herpes. Moreover, we found that if the Coachella organizers take extra steps to provide condoms and opportunities for safe sex, they can cut the festival-goers' exposure to herpes to below 250 new cases. Given our initial hypothesis, we have proven our theory that alcohol does have a major effect on the spread of STDs, which makes sense given published research.

Though our model is relatively accurate, there are assumptions that we made which could be reconsidered in further research. First, this research has been performed on genital herpes, HSV-2, but oral herpes, HSV-1, is much more common and much easier to spread. Second, future research could also account for the different sexes and also the different types of sexual transmission, such as same-sex transmission and transmission based on type of sex. We have grouped men and women together, but they do have slightly different rates of both herpes transmission and the effects of alcohol. Third, in the future, we could look at other music festival herpes-related figures (if available) to compare the increases based on different parameters, such as density, prevalence of alcohol, and sexual promiscuousness. Lastly, we could look at the effect that other drugs, such as marijuana, mushroom, and molly have on the spread of STDs, and how these drugs mix within the human body to produce different odds.

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