**Question:**

Our motivating question is how infective does a disease have to be for masks to no longer be effective? This is a design question because we are designing a model with the end goal of having masks not be effective in mind. We decided to choose this question because it would be useful to know when masks would no longer be effective against a disease and other preventive measures might be required. The background information that is necessary to understand this question and our modeling choices is the odds of getting infected when wearing different types of masks vs. no mask and how much of the population wears each type of mask or no mask.

Our literature search is as follows:

A screenshot of a computer

Description automatically generated

**Model:**

For our model we used an agent-based model with the transmission/recovery rates as our deterministic quantity and mask efficacy as our randomized quantity. To represent the probability that an individual would wear a certain type of mask we used a multinomial distribution as shown below:

*Insert Distribution here*

We then used simulate\_absir() to find run 100 realizations of our model and then graphed the mean and upper and lower quantiles of the max infected with or without masks.

*Insert max infected graph here*

The assumptions we made when creating our model were that all cloth masks were made from the same type of cloth and that every person who was wearing a mask was wearing one properly. These are acceptable for our modeling question because most cloth masks that are known to protect against viruses have very similar effectivity rates, therefore making it redundant to include all of them, and if we assumed some people were not wearing masks properly it would be difficult to know if our results were caused by just the masks or through a mix of masks and human error. We set the parameters of our model based on a mix of our literature research and values from previous worksheets. The mask efficacies and probabilities were determined from our literature research, and the recovery and infection rates were taken from a previous worksheet. The infection rate was swept to determine the answer to our modeling question. The verification facts we came up with are making sure the total number of people stays at 100 and making sure that everyone recovers at some point.

**Results:**

The metric we used to help answer our question was the max number of infected people. This is an appropriate metric because if the max infected for both the population wearing masks and the population not wearing masks is the same that means that masks are ineffective and will answer our modeling question. The results we generated using our model were that a disease must have an infectivity rate of ~0.0722 for masks to be completely ineffective.

*Insert Parameter Sweep here*

The most important trends in our parameter sweep are that both the masked and no masked graphs increase exponentially, with the difference in the mean max infected between them decreasing as they both increased.

**Interpretation:**

Our parameter sweep answers our question of at what infectivity rate are masks no longer ineffective, which is 0.0722. Some limitations of our model are that it cannot account for any other circumstances which would make someone more or less immune to a disease. It also does not consider the differences in effectivity between the different cloths that can be used to make a cloth mask. If we were to continue to develop our model, we would add more mask types to take into account the different materials used to make cloth masks, we might also take into account that some people do not wear masks the right way.

**Validation:**

According to a 2013 study analyzing what qualifies as an outbreak, in order for the spread of a disease to qualify as an outbreak, at least 57% of people must be infected. According to our results, 75% of people were infected when masks were considered ineffective, meaning that even with everyone wearing masks, a disease with an infection rate of 0.0722 would still cause an outbreak.