How long will it take someone to get sick if they eat raw chicken every day?

A simple quantitative microbial risk assessment

Donald W Schaffner, PhD
don.schaffner@rutgers.edu

Introduction

This is a very simple and quick quantitative microbial risk assessment trying to answer the question about the Florida man that is eating raw chicken every day.

This work has not been peer reviewed and is deliberately simple because this is obviously a stupid thing to do, and this guy is going to get sick eventually. The purpose of this work is to explain how one might begin to try to answer this question with a little bit of science.

This guy has started making mixing up his videos eating other weird things, and the analysis does not include that. This analysis also assumes that the risk derives entirely from *Salmonella*, but that's also not true since he could get sick from *Campylobacter* from chicken as well.

Methods

While it is relatively easy to get historical data on the prevalence of *Salmonella* in chicken, it is much more difficult to get quantitative data on *Salmonella* concentration.

The concentration data I use is derived from Lambertini et al., 2019 https://doi.org/10.1016/j.mran.2019.06.002. I took the data from their Figure 2 panel B and digitized it using this online tool: https://apps.automeris.io/wpd/. They might have published their distribution somewhere in the manuscript, but I could not find it easily, so it was quicker just to use the tool. After taking the digitized data, I pasted it into Microsoft Excel and then just eyeballed the mean and standard deviation needed to fit a normal distribution. The best fit according to my eye was a mean of -3.6, and a standard deviation of 1.5, both in log CFU/g.

In this manuscript they've done a wonderful job of creating a distribution of serving sizes, but to simplify my work here I simply assumed a serving size of 100 g. This makes the math easy because once we have a number from the concentration distribution, we simply add two to convert a 1 g concentration to a 100 g concentration.

If the concentration per serving was less than one cell, the concentration was adjusted to be zero cells. If the concentration was more than one cell then this value was the input to the dose response function.

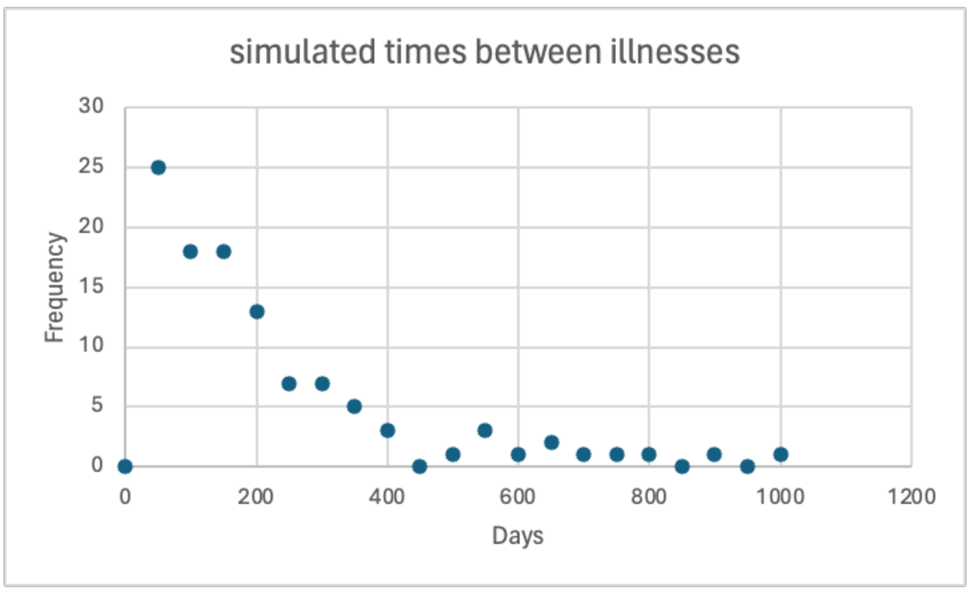
I needed a dose response value function to convert the concentration into probability of illness. The dose response function I used is a commonly accepted one from FAO/WHO: https://www.fao.org/documents/card/en?details=0b30f5fc-646c-5fed-9707-3fb83934ca6f/.

I then used a binomial distribution (n=1) to evaluate whether this probability occurs or not.

Since @risk no longer works on Apple silicon, I used a free program called XLRisk with fewer bells and whistles but with more than enough functionality to do this simple job. https://github.com/pyscripter/XLRisk/wiki.

I ran the simulation three times with iterations equal to 1000 once, and then 10,000 two times. I used the 21,000 points for all subsequent calculations.

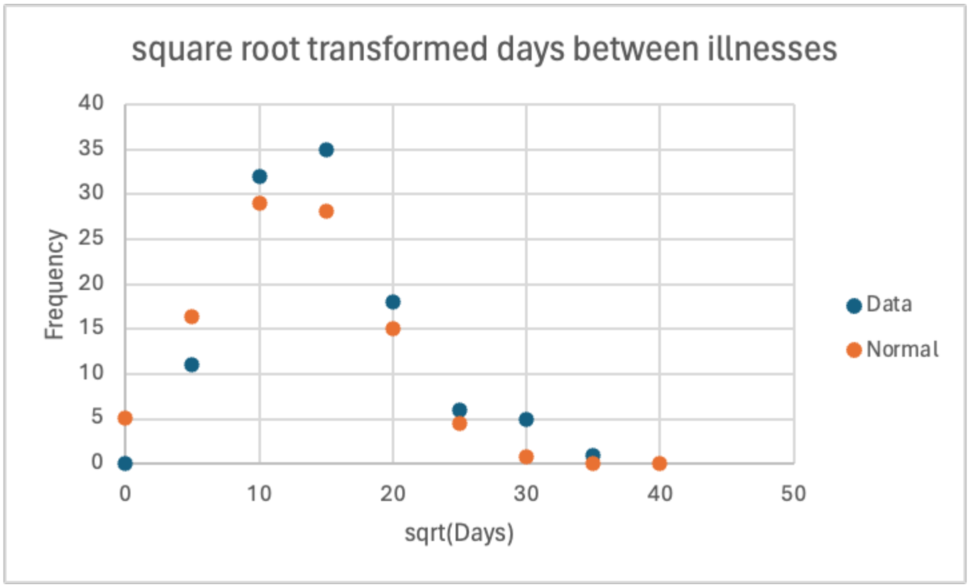
I'm sure there's a more elegant way to do the following steps but I did it by brute force because I didn't have time for elegance. I used Excel to calculate the time between predicted illnesses, and this gave me another distribution.



That distribution is skewed with the tail to the right so I looked for a transformation that would give me an approximately normal looking distribution.

The first distribution I tried was (of course) the logarithmic transformation, but this over corrected for the skewness.

I can never remember which other transformations could be used or their relationship to one another, so I looked up an old paper of mine where we lay all this out very nicely (DOI: 10.1128/aem.63.4.1237-1243.1997). As you will see from Figure 2 of that manuscript if the logarithmic transformation is too much, the distribution falling between that one and no transformation would be the square root, so that's what I tried.



Conclusions

When the number of days between illnesses is transformed by the square root transformation it's not exactly a normal distribution but it's pretty close. If we use the rules for normal distributions and consider plus or minus one standard deviation from the mean, we expect that about 68% of the time, the time to first illness (or the time between illnesses) will lie between about 33 days and 350 days, with the average time to illness being about 150 days.

As of the time of writing this article the guy is up to about 78 days. So what does this mean? Well it means that he's still less than the average expected time to illness. He might go almost a year and that would not be unexpected.

Some other things to think about

What the guy is measuring is the risk per serving, which is what every individual encounters when they eat a food.

It's also important to think about the population risk. The population risk is something that a regulatory agency might think about, or something that a food company might think about where the population in this case the number of people is eating a given product.

You could also think of this risk assessment as estimating the risk of consumption of 21,000 servings of food. If a company ships 21,000 servings of food with this level of contamination, all the assumptions in the analysis are true they could expect to make a little bit more than 100 people sick. That certainly enough to cause a detectable outbreak and would be a bad business decision.

Finally

Please feel free to reach out if you have feedback, but realize that I made this for me, not for you.