August 4, 2021

The Elusive Herd Immunity

From the onset of the COVID-19 pandemic, the societal goal seemed to be achieving herd immunity, either by vaccination, or by natural processes. The simple idea of herd immunity is that once enough people have contracted the virus, it would run out of people to infect. The degree of infection "necessary" is related to the infectiousness of the disease, the number of people infected, and the resistance of those who have not yet been infected.

The natural processes seemed to provide a severe remedy. After all, 675,000 Americans (out of a population of about 104 million), and between 20 and 100 million people throughout the world (out of a population of about two billion) died of the Spanish flu in 1918-1919. This is a health economics blog, and your blogger has calculated the severe costs of the morbidities (illnesses) and the mortalities (deaths) due to COVID-19. Vaccination, if available, would reduce the morbidities, mortalities, and resulting costs. Operation Warp Speed delivered vaccinations at close to warp speed. By early 2021, less than a year after the virus hit, vaccines were available to address the problem.

So, it is early August 2021 and why aren't we immune? Why can't we go where we want, unmasked, and unafraid? In a March 2020 blog, YB and colleagues discussed the Susceptible-Infective-Removed (SIR) model originally developed by Kermack and McKendrick and reinterpreted mathematically by Hethcote.(Hethcote 2000, Kermack and McKendrick 1927). That model relates the disease incidence to its (1) *infectiousness*, (2) *the size of the population*, and (3) the *percentage of the population that is susceptible*. R_0, or reproductive rate is the number of susceptible people that one infected person can infect. The higher the reproductive rate, the more quickly an infection can spread.(Van den Driessche and Watmough 2002)

We noted that public health disease control activities must target the three incidence factors above. We also noted that epidemic-related public health (i.e., government) interventions such as health information and guidance, quarantine policies, or vaccines can produce profound economic good. Sufficient vaccine coverage is needed to protect the population to attain "herd immunity", which once achieved, will cause the rate of new cases to fall. The equation for vaccine coverage indicated by reproductive rate is $1 - 1/R_0$.(Scherer and McLean 2002). The 1918 influenza had an R_0 value of about 2, implying that about 50 percent of the population would have required inoculation.

A couple of things happened on the way to the end of the COVID-19 pandemic.

1. Rather than finding a single R_0, we seem to have found a multitude of them, with the current Delta variant only the most recent. It seems that the "operative R_0" must be interpreted as the maximum of the current R_0 values. Certainly our "operative R_0" is larger than 2 (particularly on college campuses where people work and live in very close proximity). Fifty percent vaccination rates (as of August 2021) have brought us nowhere near herd immunity.

2. Large numbers of people have simply refused to get vaccinated. While there are a multitude of reasons, members of YB's generation, who grew up with polio, MMR (measles, mumps, rubella), tetanus, or chicken pox, find it "mind-blowing" that otherwise mentally competent people would refuse (let alone actively campaign against) vaccines that can limit infection and/or save hundreds of thousands of lives.

With little appetite for hard lockdowns (particularly in the United States), it looks like herd immunity will take longer to achieve. People in the United States want their parties, their football (and football parties), their in-person weddings (and funerals), and in-person school for themselves and their children. Large numbers of red-state residents (largest numbers in Texas and Florida) and younger people (ages 18 to 39) remain unvaccinated. Many blue-state governors (such as Michigan) find new hard lockdowns and mask mandates to be politically unpalatable in facing 2022 elections.

We have the vaccines, and we know about effective mitigation procedures. Why haven't we achieved herd immunity? For the answer, look in a mirror.

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