Herd immunity in COVID-19: Needs de-emphasizing

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ABSTRACT

Despite the evolving science on Covid-19 pointing to the contrary, the concept of herd immunity continues to influence decision making in this pandemic. This paper attempts to evolve an understanding of the concept of herd immunity and its relevance in context of pandemics in general and Covid-19 in particular.

Keywords: Covid-19, de-emphasising, herd immunity

Context

The Delta variant of COVID-19 virus, now contributing to 87% of infection contrary to 13% of them in June 2021 across Israel, seems to be redefining the way we look at this pandemic. Israel, despite having more than 60% of its population completely vaccinated has seen a surge in cases, peaking on September 3, 2021.¹ If anything, this is enough to raise concerns about our concepts of reaching herd immunity in COVID-19.¹ This paper attempts to address our concepts.

Background

Has this pandemic changed the landscape of public health thinking across the world, apart from causing huge health and economic losses? Is public health subject to a viewpoint narrative? And is public health depending too much on this viewpoint narrative, despite a heterogeneity in response efforts which appear less diverse than what they should, given the geographical and economic divide this world faces in terms of implemented policies, duration of those policies, and the economic foundations (i.e., the different types of dominant economic activity)? Several factors seem to substantiate this belief. Among these are the theme of learning to live with the SARS-CoV-2 virus, and the argument that the pandemic will transition to the endemic stage and the disease will become a common seasonal illness akin to the flu. In addition, the argument that vaccines and immunity from prior infection will permanently reduce its prevalence and severity, allowing society to safely return to something very close to our pre-pandemic “normal,” also appears to substantiate this belief. A clearer understanding on this has implications for all but most important for health care professionals like family physicians and primary care physicians, the most.

As nations battle the pandemic, three common terms that circulate across the world are Covid appropriate behavior (CAB), vaccination, and herd immunity, the last two generally interlinked. While people have consistent albeit clearly differing opinions on CAB and vaccines, opinions on herd immunity have moved from a popular concept to a doubtful one. The doubt primarily seems to have been fuelled by the failure of the scientists to respond to the question: how much longer will this pandemic last?

Herd Immunity Concept

The concept of protection derived from herd immunity largely rested on our ability to achieve a threshold through high vaccination or past exposure to infection. However, the limit had

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been advanced from earlier thought of 60%–70% to around 90% now.\(^3\) But as the pandemic continues to unfold, the thinking on herd immunity has started to border on doubt because of factors including but not limited to vaccine hesitancy, the emergence of new variants, and the delayed arrival of vaccinations for children. This shift in thinking not only reflects the complexities and challenges of the pandemic, but also our inability to think beyond the three golden terms stated at the being.

Initially used a century ago, the term “herd immunity” gained widespread acceptance with increasing use of vaccines to target elimination and eradication of diseases. The threshold theorem by Smith in 1970\(^3\) and Dietz in 1975\(^4\) states that if immunity (i.e., successful vaccination) were delivered at random, and if members of a population mixed at random such that on average each individual contacted R0 individuals in a manner sufficient to transmit the infection,\(^3\) then incidence of the infection would decline if the proportion immune exceeded \((R0 - 1)/R0\), or \(1 - 1/R0\).\(^3\)

### The Concerns

However, the assumption of thresholds did not seem to have taken into account heterogenous mixing of the population besides the type of immunity offered by the vaccines as well their distribution influencing the public health importance of herd immunity. These factors have most recently been observed to play a role in the doubt creeping in our concepts regarding herd immunity in COVID-19. The imperfect immunity offered by the current crop of COVID-19 vaccines, heterogeneous populations exaggerated by the ever-increasing travel, vaccine hesitancy adding to an uneven distribution of vaccination, rise of new variants, and freeloaders, might be some of the factors explaining our concerns regarding herd immunity.

### Imperfect immunity through infection and vaccination

None of the vaccines in use across the world are claiming sterilizing or transmission-blocking immunity, nor do they claim long-term immunity. Similarly, data from Israel, India, and Brazil points to the fact that previous infection does not provide protection against reinfection. If infection or vaccination does not confer perfect immunity against infection, not only does that increase the threshold level of vaccination required to protect a population, but it also makes the attainment of threshold more complex than the simple description described above. At this point, therefore, if vaccination protects only a proportion among those vaccinated against infection transmission, it would be impossible to eliminate an infection even by vaccinating the whole population. With doubts about the sustainability of immunity due to vaccination or infection, regular booster vaccination or reinfection will be the norm. The number of boosters or reinfecions capable of providing herd immunity is therefore only a matter of speculation. As an example, it took multiple doses (up to 20) and a vertical program dedicated to polio to eliminate polio in India.\(^3\)

### Heterogeneous populations non-random mixing

The concept of Herd immunity assumes homogenous population mixing in a way easily definable by mathematical models.

But populations are heterogenous, they mix in a non-random manner, and do not travel equally across the world. Fundamental to the spread of infection is the rate of acquisition of infection by individuals through this non-random mixing with other groups. If the populations were to mix as per random models, the mixing behavior can be explained by a single parameter, but because populations are heterogeneous and mix in non-random manner, the explanation needs to capture all describing how each group interacts with every other group. The evaluation of the matrix so created, therefore, is speculative and based on estimates making assigning of the threshold for Herd immunity impractical. For example, individuals interact more commonly within groups than between groups, so the spread of infection within and between groups will influence the rate of infection depending upon the contact with the groups dominating transmission.

### Uneven distribution of vaccine

Threshold herd immunity needs a geographical structure to be effective. The world does not have a global vaccine, nor does it have the global spread of vaccine. The idea that the vaccine will help us see the end of this pandemic is largely dependent on perfectly coordinated global campaign, which given the current situation is very unlikely, with variations in the efficiency of vaccine roll-outs between countries and the vaccine nationalism depriving a large population. If Israel was able to vaccinate a large majority of beneficiaries, its neighbors Lebanon, Syria, Jordan, and Egypt have lagged behind.\(^5\) The story is no different in other parts of the world. Uneven distribution of vaccines even in a behaviorally homogeneous population creates issues with developing herd immunity as it results in clusters of unvaccinated individuals, who are always vulnerable to outbreaks and sustenance of infection. And because individuals mix in a non-random manner and with imperfect immunity, this unevenness of vaccine distribution is a potential source of the epidemic. The distribution of vaccine against COVID-19 is uneven also among different age groups within countries currently vaccinating, with children continuing to remain unvaccinated further reducing the chance of reaching the threshold for herd immunity.

### New variants change the herd-immunity equation

New variants of SARS-CoV-2, more transmissible and resistant to vaccines, are being recognized from time to time as we move into the second year of the pandemic. It is almost certain now that the longer it will take to stop the transmission of the virus, the higher are the chances of emergence and spread of new variants.

The story from Brazil probably is an eye opener on this. Science suggested that the slowdown of COVID-19 in the city of Manaus between May and October might have been due to the herd-immunity achieved in the population due to the infections occurring in that area.\(^6\) It was estimated that more than 60% of the population had been infected by June 2020; however, in
January 2021, Manaus saw a huge resurgence in cases, propelled by the emergence of a new variant, suggesting that previous infections did not confer broad protection to the virus. Similar reports from India point to the role of new variants leading the surge in populations reporting high seroprevalence for COVID-19. In addition, there are also worries regarding selective pressure, which would favor variants that are able to infect people who have been immunized.

The waiting game, vaccine hesitancy, and freeloaders

Much like interventions, the introduction of vaccination has also raised questions in terms of its side effects, efficacy, and inconvenience. These questions influence individual decisions about whether to be vaccinated or not. Introduction in the middle of the pandemic also makes individuals play a waiting game whereby they observe the balance between perceived benefits and costs. In an ideal scenario, a high coverage of vaccination will take care of the waiting game, hesitancy, and freeloaders through the indirect protection offered by the herd immunity. Therefore, if any of these is high and the vaccination of the rest is not to the maximum, the thresholds will not be achieved, something that we are seeing happen with vaccination against COVID-19, at least in some parts of the world.

Conclusions

The definition of herd immunity as a target threshold for vaccination is based on assumptions that greatly simplify the complexity of actual populations at least in the current pandemic. Vaccination managers running vaccination programs understand that achieving 100% coverage is impossible but necessary to achieve protective long-lasting immunity for all. Therefore, hoping to reach whatever is the “real” herd immunity threshold in the population concerned will be the aim. However, whether these thresholds provide protection to those not immunized is anybody’s guess. In terms of its implications, it is not just important to public health and policymakers but to primary care practitioners and family physicians as well, who are at the delivery of healthcare at a more direct interactive level.

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Conflicts of interest

There are no conflicts of interest.

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