Herd Immunity of Covid 19: The Challenges and Measures

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Abstract:
Herd immunity (also called herd effect, community immunity, population immunity, or mass immunity) is a form of indirect protection from infectious disease that can occur with some diseases when a sufficient proportion of the population has become immune to infection due to previous infection or vaccination. Herd immunity reduces the chance of infection for people who lack immunity. Immune individuals are unlikely to contribute to disease transmission, break chains of infection, or stop or slow the spread of disease. The greater the proportion of immune individuals in the community, the smaller the probability that non-immune individuals will come into contact with an infectious individual. Herd immunity to covid 19 is still challenging. As the wave of covid 19 vaccination in many countries begins to be successful, the concept of herd immunity is being underestimated under close scrutiny. Through this article, we review the history, challenges and measures with herd immunity of Covid 19 to hopefully overcome the pandemic in the future.
***Keywords**: herd immunity, history, vaccination, challenges, measures.*

1. Overview:

A brief overview of the history, challenges and measures with herd immunity of Covid 19 is highlighted in this article. Herd immunity (also called herd effect, community immunity, population immunity, or mass immunity) is a form of indirect protection from infectious disease. When a sufficient proportion of the population has become immune to an infection, whether, before infection or vaccination, herd immunity can occur. It reduces the possibility of infection for people who lack immunity. Immune individuals are unlikely to contribute to disease transmission, break chains of infection, or stop or slow the spread of disease. The greater the proportion of immune individuals in the community, the smaller the probability that non-immune individuals will come into contact with an infectious individual. [1][2][3]

History: Daniel Elmer Salmon, the American veterinary scientist and then the US Department of Agriculture's Director of Livestock has first used the term "herd immunity" to describe the healthy vitality and resistance to disease of well-fed herds in 1894. In 1916, veterinary scientists in the same Bureau of Animal Industry used the term to refer to immunity that arose after recovery in cattle infected with brucellosis, also known as " infectious abortion". By 1923, it had been used by British bacteriologists to describe experimental epidemics of rats. The experiments were carried out as part of an effort to model epidemics in humans. By the late 1920s, the concept was widely used - especially among British scientists - to describe the formation of a population's immunity to diseases such as diphtheria, scarlet fever, and diphtheria, flu.[4] Herd immunity was recognized as a naturally occurring phenomenon in the 1930s when AW Hedrich published a study on the epidemiology of measles in Baltimore. He found that after many children became immune to measles, the number of new infections temporarily decreased, including among those who were susceptible. [5] Despite these insights, efforts to control and eliminate measles were unsuccessful until mass vaccination with the measles vaccine began in the 1960s. Mass vaccination, discussion of epidemic elimination and cost-benefit analyzes of vaccination subsequently prompted wider use of the term herd immunity. [2] In the 1970s, the theorem used to calculate the threshold of immunity herds was developed. [2] Herd immunity created through vaccination contributed to the final eradication of smallpox in 1977 and has contributed to the reduction of other diseases.[6] Measles cases in the United States before and after the start of the measles series of vaccines. Herd immunity applies only to contagious diseases, which means it is passed from one individual to another. [7] For example, tetanus is infectious but not contagious, so herd immunity does not apply. [8]

2. Challenges:

2.1 Evolutionary pressure and serotype substitution: Herd immunity itself acts as an evolutionary pressure on pathogens. It affects the evolution of viruses that produce new strains, called mutants, that can evade herd immunity and infect previously immune individuals. [9] The evolution of new strains is called serotype substitution, or serotype change. When the prevalence of a particular serotype decreases due to high levels of immunity, allow other serotypes to replace it. [10] As this evolution poses a challenge to herd immunity, broadly neutralizing antibodies and "universal" vaccines that can protect beyond a specific serotype are being developed. [9]

2.2 Freeriding: The problem of people easily riding the community can affect the community's immunity. Individuals who lack immunity, including those who choose not to be vaccinated, are immune from the herd created by those who are already immune. [11] As the number of free carriers in the population increases, outbreaks of preventable diseases become more common and more severe due to the loss of herd immunity. [12] Individuals may choose to freely infect or be hesitant not to vaccinate for a variety of reasons, including a belief that vaccines are ineffective, [13] or that the risks associated with vaccines are greater than those associated with infection, [14] mistrust of vaccines or public health officials, [14] group thinking, social norms or peer pressure, [13] and religious beliefs. Some individuals are more likely to choose not to receive the vaccine if vaccination rates are high enough to convince a person that they may not need vaccination since a sufficiently large proportion of others are already immune. [2]

2.3 Passive immunity: Maternal antibodies, mainly immunoglobulin G antibodies, are transferred across the placenta and in colostrum to the fetus and neonate. It is passive immunity, which can happen naturally. Passive immunity can also be artificially achieved when a susceptible person is injected with antibodies from the serum or plasma of an already immune person. [15] The protection generated from passive immunity is immediate but wanes over weeks to months, so any contribution to herd immunity is temporary. [6] For particularly serious illnesses in the fetus and newborn, such as influenza and tetanus, pregnant women can be vaccinated to pass on antibodies to the baby. [16] To prevent these infections or to reduce their severity, groups at high risk are either more likely to get an infection or more likely to develop complications from an infection, can receive antibody preparations. [15]

3. Measures:

3.1 Theoretical background: An individual's immunity can be achieved through natural infection or man-made means, like vaccination. Individuals who are immune to a disease act as a barrier to the spread of the disease, slowing or stopping the transmission of the disease to others. When a significant proportion of a population becomes immune, called the herd immunity threshold (HIT) or herd immunity level (HIL). At this time, the disease may no longer persist for a long time in a population, is no longer an endemic disease. [7] The theoretical basis for herd immunity generally assumes that vaccines confer solid immunity, populations mix randomly, pathogens have not evolved to avoid immune responses, and no mediators are available. The transmission of the disease is not human. [2]

The critical value, or threshold, in a given population, is the point at which the disease reaches a circulating steady state. This threshold can be calculated from the effective reproduction number Re, obtained by taking the product of the base reproduction number R0, the average number of new infections caused by each case in a completely susceptible population, cohort, or well-mixed, meaning that each individual is equally likely to come into contact with any other susceptible individual in the population, and s, the proportion of the population susceptible to infection, and set this product to 1. The more infectious the virus, the more we need to

immunize humans to achieve herd immunity. Measles, one of the most contagious diseases with an R0 above 12, needs about 90% of people with resistance to the unprotected to be without herds. That's why new outbreaks can start when even a small number of people refuse to get the measles vaccine. Similarly, if coronavirus spreads more easily than experts think, more people will get sick before herd immunity is achieved. [17]
How many people does a population need to have herd immunity? The exact threshold for herd immunity (HIT) varies depending on the underlying reproductive number of the disease. An example of a disease with a high threshold is measles, with a HIT exceeding 90%. If R0 > 1, then the epidemic is existing and the community is threatened. But when R < 1 then the disease disappears. So, to have herd immunity, we have to somehow get R < 1. And R = sR0 where s is the proportion of the population that is susceptible, so we need sR0 < 1. From that: s < 1/R0. In other words, we need to bring the proportion of the population susceptible to s below 1/R0. The number of people who gain immunity is 1 – s. From there we have: s < 1/R0 means: 1 - s > 1 - 1/R0. Assuming, R0 = 3 and a vaccine effective against 75% disease, the population that needs to be vaccinated will be at least [(1 - 1/3)/0.75] = 0.88, or 88% of the population should be vaccinated herd immunity will achieve. The duration of protection of the vaccine decreases over time, requiring additional injections. The fact that vaccines cannot be 100% effective and the number of infected people who have recovered from the disease still contribute to herd immunity. [17] About 80,000 people have recovered from the coronavirus and are now likely resistant, although the extent of immunity is unknown. "I would be surprised but not entirely surprised if people don't become immune," said Myron Levine, an infectious disease expert at the University of Maryland. Some viruses, like the flu, always find a way to keep changing, which is why immunity against such seasonal germs isn't perfected. [18]
3.2 Cost-benefit analysis: Herd immunity is considered to be a positive extrinsic factor of high levels of immunity. It creates an additional benefit of disease reduction that would not occur without community immunity being created within the population. Herd immunity is often taken into account when conducting cost-benefit analyzes of vaccination programs. As a result, the inclusion of herd immunity in cost-benefit analyzes leads to both a more favorable cost-effectiveness or cost-benefit ratio, and an increase in the number of cases prevented by vaccination. [19] Study designs performed to estimate the benefit of herd immunity include incidence before and after vaccination program initiation; the incidence in households with vaccinated members. From there, it can be observed that morbidity may be reduced to levels beyond what would be predicted with direct protection alone, suggesting that herd immunity contributed to the minimize. [20] When serotype substitution is taken into account, it reduces the predictive benefit of vaccination. [19]

Conclusion:
Herd immunity is real with the stated challenges. As the wave of covid 19 vaccination in many countries begins to be successful, the concept of herd immunity is being underestimated under close scrutiny. Far from the obvious target we might aim for in vaccination programs, herd immunity has become a generic term that can have a wide range of meanings - and it is not clear whether it is possible to use the strategy to destroy the virus. Because there's still a lot we don't know about both this virus and vaccine. Hopefully, the challenges will be overcome with the stated measures so that herd immunity of Covid 19 becomes a reality in the future.

Declaration of Interests: The authors state no conflicts of interest.

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