Herd Immunity: How does it Work

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In 1519, the Spanish conquistador Cortez disembarked in modern-day Mexico, and proceeded with a few guns, horses and men, to conquer the powerful Aztec Empire. The legend says that the most powerful weapon of Cortez was the invisible smallpox virus, which the previously immune Spaniards carried in their respiratory system. The virus was unknown in the entire new world, and all the indigenous populations were highly vulnerable to its deadly infection. Within one century, the virus had contributed largely to the extinction of the Aztec and other native nations and to the perpetuation of the Spanish rule over Central and South America.

Immunity is a natural physiological process. Faced with any aggression perceived as “non-self” the mammalian species activates two defense systems: an immediate, mostly cellular “non-specific” immunity, and a delayed, cellular and humoral specific immunity. The later is kept in memory in particularly programmed T-lymphocytes, so that any renewed aggression from the same agent, the “antigen”, elicits an effective reaction using specific immunoglobulins, the “antibodies”, able to immediately detect and destroy the aggressor. Any exposure to a pathogen will lead to the emergence of the specific immunity in “immune-competent” persons. Immuno-depressed persons either through congenital or acquired deficiencies, particular therapy, or age, may fail to mount or maintain the specific immunity. The duration of the natural immunity depends therefore on the host and also on the stability of an agent. With the emergence of vaccines, it has become possible to generate the immunity artificially in humans and animals, without waiting for exposure to a pathogen to actually occur.

When a large portion of a given community: village, city, state, country… are immunized against a given agent, its circulation in that community becomes extremely difficult. The collective immunity, aka “herd immunity” does not need to reach a 100%. Herd immunity protects those who are not immunized for one reason or the other, who are actually shielded as a consequence of the resistance of persons around them against the agent’s diffusion. The herd immunity threshold necessary to ensure that an agent will not be circulating any more depends on its infectivity, the presence of a vaccine and the sustainability of vaccination. Herd immunity cannot be transmitted from one generation to another. If the community exposure stops and vaccination is interrupted, the herd immunity can disappear within one or two generation. For example, smallpox was declared eradicated worldwide in 1980, and vaccination has been discontinued. All those born after 1980 are vulnerable to the virus, while the generation previously vaccinated is slowly decreasing. Today, if for some reason smallpox re-emerged; it will face a majority of the human species that has become immunologically “naïve” with a herd immunity quasi null. The herd immunity threshold (HIT) can be calculated from the basic reproduction number R0. R0 is the average number of new infections caused by each case in an entirely susceptible population that is well-mixed, meaning each individual can come into contact with every other susceptible individual in the population.

This HIT can be calculated by the formula
HIT= (1- R0)/ R0
Assume an R0 of 15 (as is the case in measles), the HIT necessary to stop the distribution of the agent would be at least 93%.

Several nations faced with the covid19 threat have decided to let the infection run loose in the country, so that the population gets well-mixed and the epidemic stops naturally when the HIT is reached. For example, in the UK, the average R0 is estimated to be above 1 may be 1.2, which puts the HIT at around 17%. It is believed that such a level of infection has not been reached yet, and it will have to be higher if R0 increases. Of course, if an effective vaccine is found, the HIT can be reached much faster.

In Lebanon, the original strategy was to break down social interaction in the country between February and April. The virus was trapped in small clusters (stage 3). It could easily be overrun by the collective immunity within those small populations. From June, and after the chaotic re-opening of the important and the failing communication strategy of MOPH, the virus was allowed to run loose across the nation. However, even with the apparent daily increase in cases (carriers + sick persons), the prevalence of covid19 immunity in Lebanon remains low: about 26,000 cases were exposed since February 21 over an estimated population of 5,000,000= 5.2 per 1000. If the R0 for Lebanon is estimated at 2, the required HRT would have to be 50%, which is practically impossible given the current estimation. In other terms, we cannot count on herd immunity to stop the spread in Lebanon.

In conclusion, the infection will continue to run unchecked for a while in Lebanon now that stage 3 has been over-run. The way out is:

- to keep new viral loads from entering the country by strictly isolating newcomers for two weeks,
- to improve the immunity capacity of the population: healthy nutrition, active life, smoking abstinence, eventually vaccination,
- to protect the most vulnerable segments of the population through heightened social distancing,
- to adopt national standards for covid19 treatment and isolation to avoid long hospitalization leading to congestion, and mercurial mismanagement leading to avoidable deaths.