SARS-CoV-2 virus group immunity: how does that work?

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Monday evening, March 16, Prime Minister Rutte explained in his speech to the Dutch people that the government's goal is to control the corona virus as much as possible: *"We can slow down the spread of the virus. And build group immunity at the same time. Those who have had the virus are usually immune afterwards. The larger the group that is immune, the less likely the elderly and the weak are affected. '*

This is the same strategy that has been suggested in England (see the speech of Boris Johnson and his chief scientific advisor on March 12th on bbc.com), although we are more cautious in the Netherlands for now — schools, pubs and restaurants and many shops are closed, and visiting nursing homes is restricted.

In the parliamentary debate on March 18, Rutte said that Dutch policy *does not have* the primary goal of achieving group immunity, but to spread the wave of infections as much as possible over time i.e. to 'flatten the curve'.

I think there is a lot of confusion about group immunity. In this paper use a simple simulation model to illustrate how immunity in younger age groups can help to prevent a major shortage of beds in the intensive care units of the hospitals.

For the population under the age of 50, infection with the corona virus is relatively mild: 2% must be hospitalized, 0.12% go to the ICU. This is different for people over 50: 17% hospital admissions, 6% to the ICU. If the population younger than 50 years is first to be exposed to the corona virus, that age group becomes largely immune, so that people over 50 are protected.

An intervention consisting of the following measures has been simulated in the model:

1. reducing the transmission probability per contact through better hand hygiene, keeping distance etc.
2. reducing the number of contacts per unit of time
3. reducing contacts between the age groups

Measures 1) and 2) reduce the R0 (the number of secondary infections caused by one infectious case in a fully susceptible population).

After 300 days, the measures for the age group < 50 are largely withdrawn (but hand hygiene and keeping a distance are still advisable).

The effect of measures 1 and 2 in detail:

	age group	basic	intervention	after 300 days
R0	<50	2.84	1.39	2.00
R0	50+	1.75	0.74	0.86

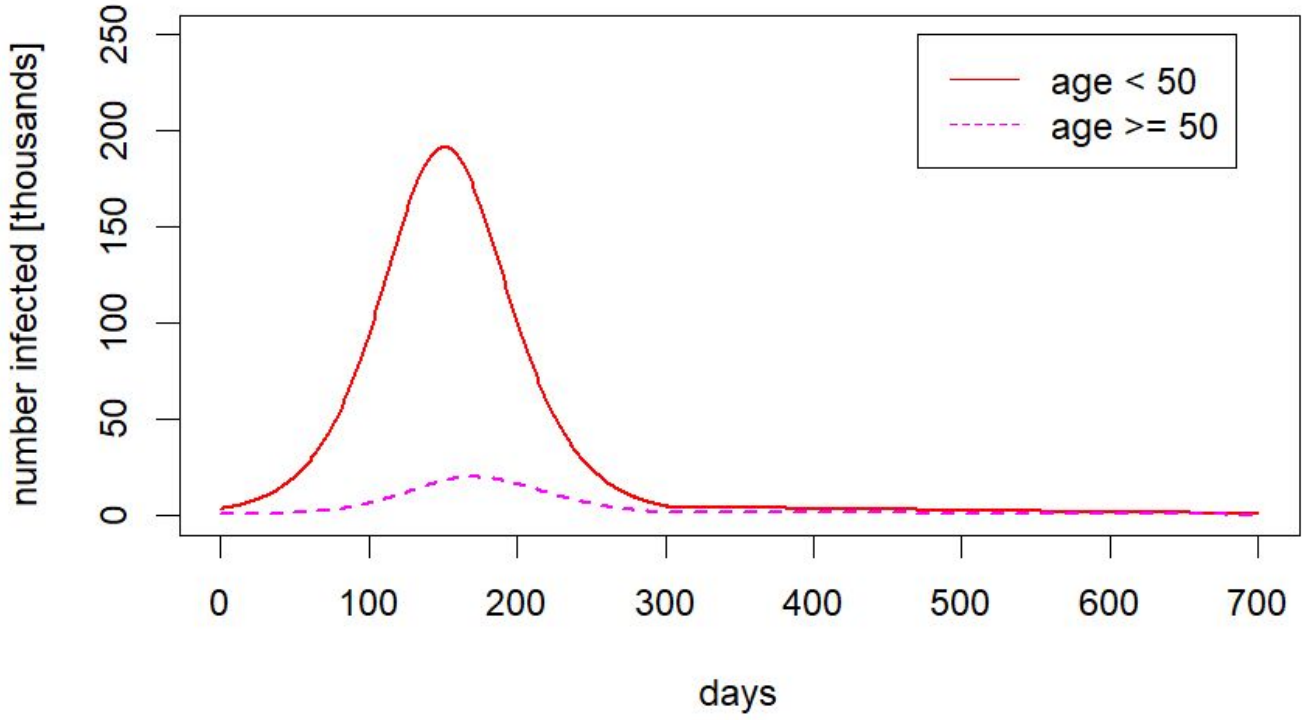
The basic values of the R0 (2.84 and 1.75) have been calculated based on an average R0 of 2.4 [1], age-dependent contact rates in the Netherlands [2] and the age structure of the Dutch population in 2019 (Statistics Netherlands).

The third measure in detail:

	age group	basic	intervention	after 300 days
fraction contacts with the other age group	<50	14%	3%	14%
fraction contacts with	50+	32%	6%	32%

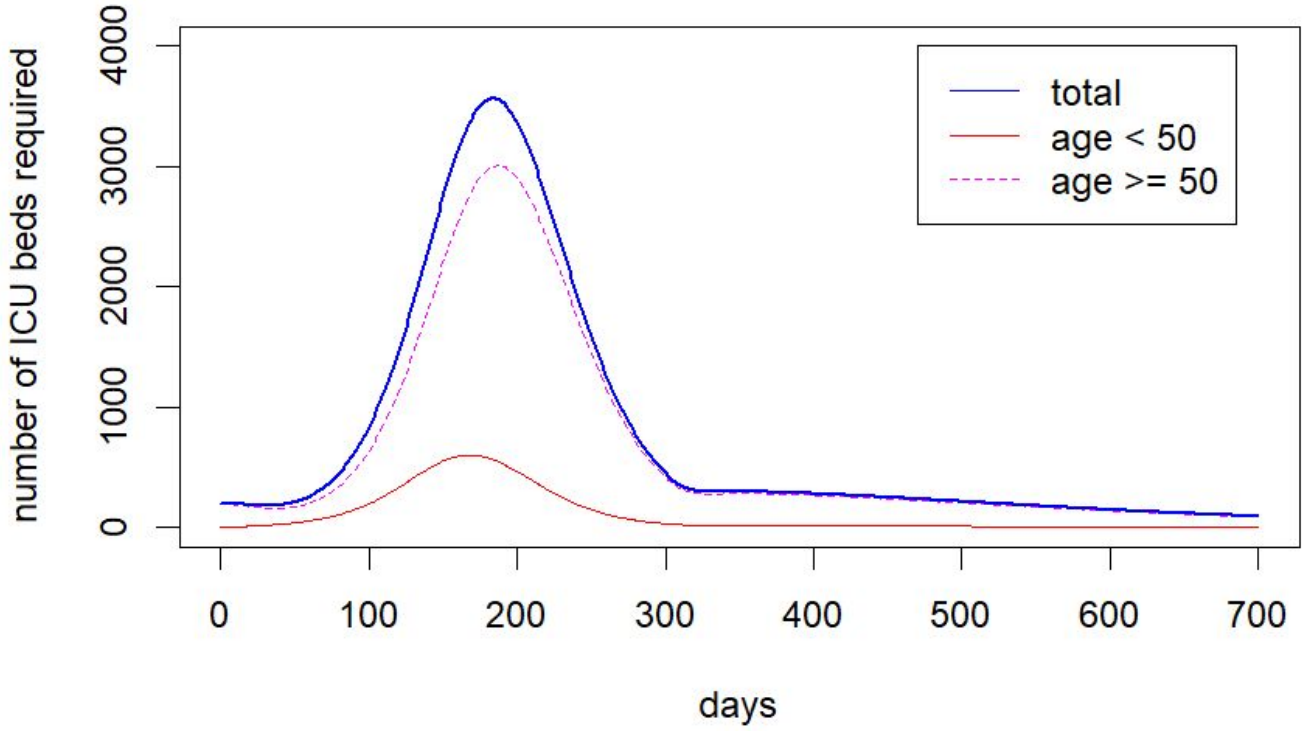
the other age group				

The figure below shows the time course of the number of infections in the two age groups:



After 150 days, there is a peak of 190,000 infections in the age group < 50 years. After 170 days there is a peak of 20,000 infections in the age group ≥ 50 years.

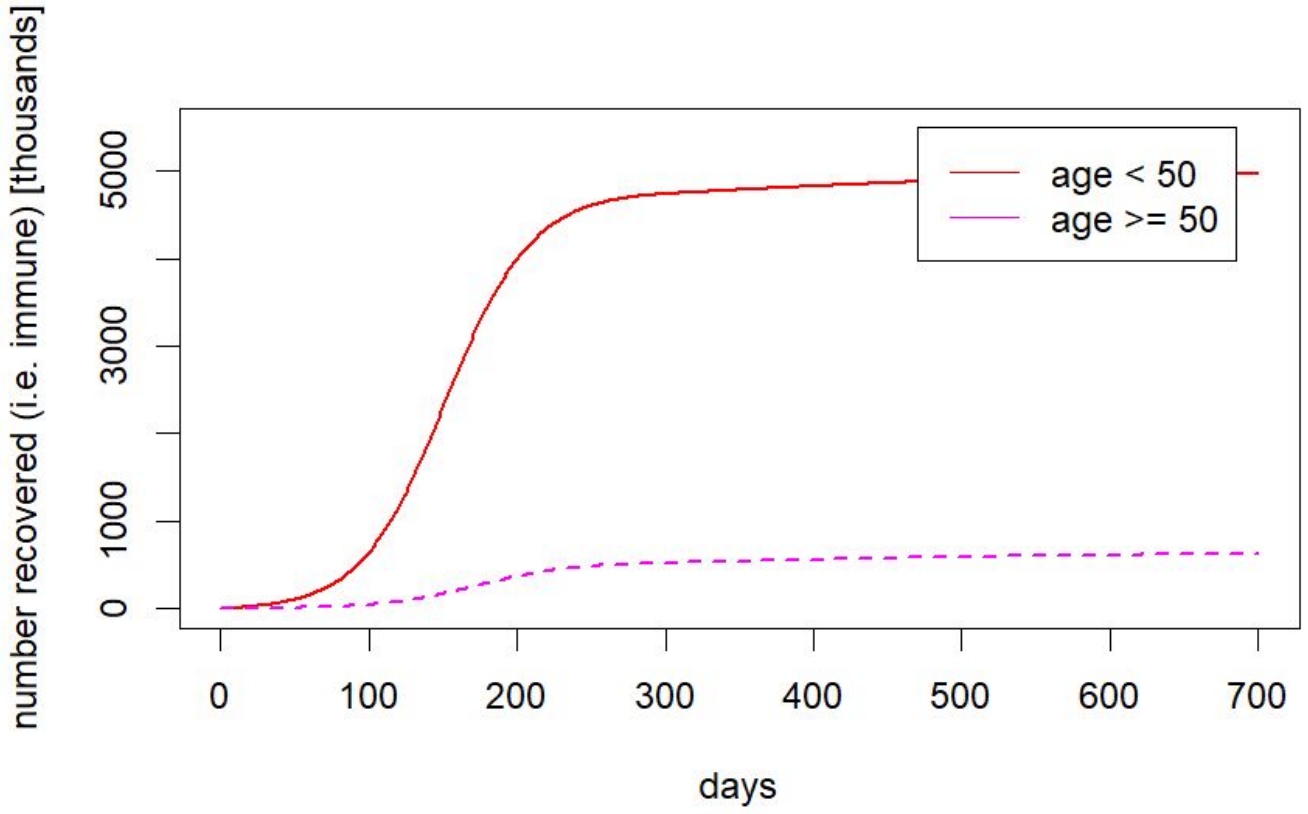
The number of ICU beds required is shown below:



The model assumes a hospital stay of 8 days if admission to intensive care is not required, and of 16 days (of which 10 days in

ICU) if admission to ICU is necessary. The fractions of hospital admissions per age group and the fractions that require admission to the ICU are taken from [1].

The number of people who have recovered from a corona virus infection:



In the age group < 50 years, about 5 million people (50%) have been infected and have recovered, and in the age group ≥ 50 this number is about 625,000 (9%). These people are immune to reinfection and protect the rest of the population against infection (it is not known exactly how long this immunity lasts, in the model we assume at least 2 years).

How long are measures required?

In the above scenarios, a large part of the measures are lifted after 300 days. Nevertheless, caution is advised because immunity among the 50+ population is low (only 9%). For this group, the R0 must remain <1 and the within group contact rate must be limited. For anyone and at all times, hand hygiene and keeping distance remains important.

Current measures

The current measures in the Netherlands (schools, pubs, and restaurants closed, many shops closed, no more visits to nursing homes) are not specifically aimed at group immunity.

The scenario simulated here would be aimed at allowing the virus to infect the younger generations (people < 50 years of age) causing immunity in this group and thereby protecting the people ≥ 50. If about 50% of the people who would need ICU admission would not survive, then this would cause about 3,500 deaths in the people < 50 years and 19,000 deaths in the 50+ age group. Without any interventions the number of deaths in group < 50 would be similar though the number of deaths in the 50+ age group would be about 100,000. Currently, the youngest victim of the new corona virus was 54 years old which may suggest that the fatality rate in the age group < 50 may be much lower than assumed so far.

Conclusion

It is of course an ethical question whether we could aim at having younger generations be infected with the virus in order to offer partial protection to the elderly.

Obviously, it would be much better if adequate treatment of corona patients would become available in the short term. A vaccine still seems a long way off.

With this article, I am not advocating one particular type of intervention. The aim of this article is to clarify the mechanism of group immunity.

The model used here is a rough approximation of reality and - also due to the uncertainty in parameters - undoubtedly incorrect on many points.

Nevertheless, these types of models can help determine the strategy against the corona virus epidemic. I think that we should make the best use of models to predict trends. Moreover, we must be open and transparent about this.

Model used

The code including documentation for the model used is available at:
https://github.com/roelb54/coronavirus

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This contribution reflects the personal opinion of the author. The author's knowledge and expertise is based on his work as a

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Literature

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2. Mossong J, Stephens N, Jit M, P Beutels, Auranen K, R Mikolajczyk, et al. (2008) Social and Contacts Mixing Patterns Relevant to the Spread of Infectious Diseases. PLoS Med 5 (3): e74. https://doi.org/10.1371/journal.pmed.0050074