In an attempt to control the spread of the coronavirus, governments around the world are implementing strategies to reduce something called the R0 value. But what exactly is the R0 value and how can our actions change it?

1. The basic reproduction number, R0 is described as;

   \[ R_0 = \text{the average number of cases of an infection directly generated by one case in a population, where all individuals are susceptible to infection.} \]

For every one person with the virus it is an indication of how many they will go on to infect.

For example if a virus has an R0 value of 2, after 3 transmissions 8 people \(2^3\) will be infected.

By reducing the R0 value below 1 the virus will eventually be eradicated.

a. If the R0 value in a population of 10 people known to be carrying the infection is reduced to 0.5, show diagrammatically that after 4 transmissions the number of people with the infection will be less than 1.

It is possible to calculate the number of people infected after \(t\) transmissions using the equation:

\[ N_t = N_0 \times R_0^t \]

where

\( N_t = \text{the number of people infected after } t \text{ transmissions} \)

\( N_0 = \text{the number of people infected initially} \)

\( R_0 = \text{the basic reproduction number} \)

\( t = \text{the number of transmissions} \)

b. If 150,000 people in a population are known to be infected calculate the number of people who will be infected, \(N_t\), after 10 transmissions when:

   i. \( R_0 = 0.8 \)
   ii. \( R_0 = 0.5 \)
   iii. \( R_0 = 0.2 \)
2. One simple way to estimate the $R_0$ value can be described using the equation:

$$R_0 = \beta \times \tau$$

where $\beta = \text{the average number of infection producing contacts per unit time}$

$\tau = \text{the mean length of time an individual is infectious}$

By reducing one or other of $\beta$ or $\tau$, or both of them, the $R_0$ value is reduced.

It is possible to reduce the average number of infection producing contacts per unit time, $\beta$, by either;

1. reducing the number of contacts per unit time
2. reducing the proportion of contacts that produces infection

a. Look at Table 1 which lists some of the interventions introduced around the world, each of which reduce $\beta$. For each intervention listed, decide if it reduces the number of contacts per unit time or reduces the proportion of contacts that produces infection.

Some extra rows have been left at the bottom of the table. Add in other interventions that you can think of that have been put in place to reduce $\beta$.

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Reduces the number of contacts per unit time</th>
<th>Reduces the proportion of contacts that produces infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancelling sporting events</td>
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<tr>
<td>Disinfecting trolley handles in the supermarket</td>
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<td>Closing schools</td>
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<tr>
<td>Limiting outdoor exercise to once a day</td>
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<td>Closing restaurants</td>
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<td>Handwashing</td>
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<tr>
<td>Finding a vaccine</td>
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</tbody>
</table>

b. Using the equation for calculating $R_0$ predict, and explain, the impact each of the changes below is likely to have on the $R_0$ value

i. introducing the compulsory wearing of face masks when outdoors

ii. relaxing lockdown rules to allow small group gatherings of 10 people or less

c. An alternative approach to fighting the virus is called herd immunity. Herd immunity refers to a situation where enough people have immunity to an infection to be able to effectively stop that disease from spreading.

Explain how herd immunity stops the virus spreading.