Estimation of infectivity from isolated population

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To estimate the infectivity of the population isolated we depart from the following assumptions. Firstly, the population class taking care of the isolated individuals belong to the one of adults with no comorbidities, and we considered a number N_{care} of carers having c_{care} contacts per day and carer with the isolated population. More specifically, these individuals should not be symptomatic nor death, and we denote the number of individuals fulfilling this required N_{exp} (number of exposed). To continue with, we considered that the number of symptomatic individuals exceeding the isolation capacity $\tilde{N}$ are fully infectious (note that we use a tilde to denote variables related to the isolated population). In addition, the occupancy of the isolation beds is distributed among classes proportionally to the number symptomatic individuals that each class contributes, i.e. $\tilde{N}_j = \tilde{N}\left(I_j / \sum_j I_j\right)$. Finally, symptomatic individuals developing symptoms that would require a hospitalization, are either evacuated or they become fully infectious. The rationale behind the latter choice is that, if an individual requires a more dedicated care, the available means in the camps to protect the population from these patients would be insufficient. We model the evacuation considering a parameter $\epsilon = 0$ if evacuation is put in place and $\epsilon = 1$ otherwise.

Given these assumptions, the number of contacts that the healthy adult population class will have with the isolated population will be $c_{\text{care}} N_{\text{care}} / N_{\text{exp}}$ per individual and day. The expression clearly shows that, increasing the number of carers, the number of isolated individuals, and the number of contacts per day between carers and individuals, will increase the rate of infection. Hence, we expect that, for fixed N_{care} and c_{care}, the positive effects coming from isolating individuals will be less pronounced for increasingly large $\tilde{N}$ values. We further assume that this interaction is regulated following the guidelines introduced for a safety zone, and the infectivity becomes thus reduced by a factor $\xi = 0.2$. Finally, we should note that the probability of finding an isolated individual belonging to class j is equal to $(N_j/N)(\tilde{N}_j/N_j)$, but this probability is equal to one for the healthy adult population (due to their role of carers) and equals zero for the remainer classes (since they have no access to the isolation area).

For simplicity, we assum that there is one carer for each infected person in the class j, $(N_{\text{care},j} = \tilde{N}_j)$, having only one contact per day (c_{care}). Note the convenience of this choice, since if the number of infectious is larger than the number of available individuals to be carers the ratio $\tilde{N}_j / N_{\text{exp}} > 1$, meaning that more than one contact per day is needed to care that population class. With these considerations, the rate of infection for the healthy adult population class (indexed k) becomes:

$$\lambda_k = \tau \sum_j \xi \frac{\tilde{N}_j}{N_{\text{exp}}} + C_{kj} \frac{P_j + A_j + \Theta(N_I - \tilde{N})(I_j - \tilde{I}_j) + \epsilon H_j}{N_j},$$

where Θ is the Heaviside function and N_I the total number of symptomatic individuals at time t. For the remainder classes ($i \neq k$) the rate of infection becomes:

$$\lambda_i = \tau \sum_j C_{ij} \frac{P_j + A_j + \Theta(N_I - \tilde{N})(I_j - \tilde{I}_j) + \epsilon H_j}{N_j}.$$