Contact matrix for camps

Req 550 Syria Team

June 15, 2020

1 Contact estimates

Based on Chamsy's slide, the population distribution in each zone follows Table 5

	Orange	Green
Young	$\frac{50}{85}$	0
Adult	$\frac{35}{85}$	$\frac{2}{3}$
Elderly	0	$\frac{1}{3}$

Table 1: Fractions of the population in each age group

Note that age-groups in Chamsey's estimates differ slightly from our age groups, therefore some of the fractions need to be adjusted.

Based on Chamsey's estimates (Slack), Table 2 summarises the number of contacts per day for each age group.

Age group	Contacts/day
Young	20
Adult	10
Elderly	10

Table 2: Average number of contacts per day for an individual in a given age group.

2 Contacts (perfect scenario)

Since we lack detailed information on the contact structure, we assume contacts for each age group are spread according to the population fractions. In the perfect scenario (no infections happening in the neutral zone), Table 3 shows the contacts between groups, per individual.

	O/Y	O/A	O/E	G/Y	G/A	G/E
Orange/Young	11.76	8.24	0	0	0	0
Orange/Adult	5.88	4.12	0	0	0	0
Orange/Elderly	0	0	0	0	0	0
Green/Young	0	0	0	0	0	0
Green/Adult	0	0	0	0	6.67	3.33
Green/Elderly	0	0	0	0	6.67	3.33

Table 3: Contacts / day / individual, between groups.

3 Contacts between zones

In the proposed scenario, there is no direct contact between orange and green zones. All the contacts happen through the neutral zone, that should have a reduced probability of infection due to the distancing measures and the personal protection equipment.

A conservative estimate for the interzonal contacts is the following. Assume that half of the carers in the green zone (about 5% of the green adult population) will have daily contacts with 3 orange adults in the neutral zone, to fulfill their caring duties (get products, discuss issues, etc). Furthermore, assume that about 10% of the green population will make use of the neutral zone daily, have 3 contacts there with orange adults. Finally, assume that effective (infectious) contacts in the neutral zone are only a fraction α of the actual contacts. The direct interpretation of α is that only $100\alpha\%$ of the meetings in the neutral zone include an actual contact, but note that α depends in a non-linear manner with the actual probability of infection. On the other hand, we assume that each person of the green zone using the neutral zone will meet with three individuals of the orange zone, distributed according to the fraction populations.

With this assumptions, we can update Table 3 to include the interzonal contacts. Table 4 contains the average contacts per day, individual.

	O/Y	O/A	O/E	G/Y	G/A	G/E
Orange/Young	11.76	8.24	0	0	0.0208α	0.01038α
Orange/Adult	5.88	4.12	0	0	0.01501α	0.00727α
Orange/Elderly	0	0	0	0	0	0
Green/Young	0	0	0	0	0	0
Green/Adult	0.1176α	0.232α	0	0	6.67	3.33
Green/Elderly	0.0588α	0.0412α	0	0	6.67	3.33

Table 4: Contacts / day / individual, between groups, including assumptions on the usage of neutral zone.

4 How to use this information

For each class of individuals X, from the expression for R_0 we will have an expression of the form (with more terms!)

$$\beta_{Y_1}[\ldots] + \beta_{Y_2}[\ldots].$$

Here, β_Y is defined as $\kappa_{XY} \log(1-c)$, where κ_{XY} is the number of contacts per individual, per unit time (the values in the table) from class X with individuals of class Y. c is the probability of becoming infected in a contact. Assuming that all contacts are comparable, we can take the common factor $\log(1-c)$ and factorize the expression as

$$\log(1-c)\left(\kappa_{XY_1}[\ldots] + \kappa_{XY_2}[\ldots]\right).$$

Now, κ's are known from Table 4, and with the assumptions on R_0 we will be able to find $\log(1-c)$. For example, $\kappa_{O/A,O/Y} = 5.88$.

5 External contacts

Using Chamsey's estimates, and denoting by ι_a, ι_c the fraction of infected individuals in the agricultural environment and the city environment, and by n_a, n_c the average number of external contacts of an orange adult working on agriculture, or working in the city, we obtain that the external force of infection for orange adults is

$$0.0412 n_c \iota_c + 0.137 n_a \iota_a.$$

We can assume that $n_c > n_a$ (more contacts in an urban environment).

6 Null model (well-mixed)

From Chamseys original slide, the overall distribution of the population is represented in Table **??**.

	Population fraction
Young	0.5
Adult	0.45
Elderly	0.05

Table 5: Fractions of the population in each age group, in a well-mixed scenario.

Using the assumption that contacts are distributed across the age groups according to the population, we get the contacts per day/person in Table 6.

	Young	Adult	Elderly
Young	10	9	1
Adult	5	4.5	1.5
Elderly	5	4.5	1.5

Table 6: Contacts per day/person between age groups.