SPI-M-O Statement on population segmentation by age group

Date: 22nd July 2020

Summary

1. Surveys that analyse contact patterns show that there is much mixing between age groups with substantial contact across all age groups with those aged 45 or over.

2. As such, policies to segment the population by age, relaxing restrictions for younger groups while restricting them for older groups, are likely to fail. Increased transmission in the younger age groups is highly likely to result in an increase in incidence in older age groups.

3. The pattern of cases by age observed in Leicester is broadly consistent with the distribution expected, given the underlying demographic structure and the age-dependent mixing patterns assumed. As a result, there is no reason for complacency about the dangers of this outbreak to the older and more vulnerable people of Leicester.

Segmentation of the population for controlling transmission

4. Segmentation has the aim of dividing the population into groups that are relatively homogenous with regards to healthcare characteristics or needs, and to manage transmission within these groups separately. Shielding is a form of segmentation in which individuals who are especially vulnerable to severe COVID-19 outcomes minimise interactions and / or make interaction safer.

5. In order to investigate possible segmentation options, SPI-M-O groups have presented work focusing on segmenting by vulnerable individuals, those who care for them, and the general population; by age groups; and some initial work looking at by geography. This note focusses on segmentation by age group.

6. COVID-19 has a significantly skewed age distribution for mortality (Figures 1 and 2) and it is possible that other measures, such as frailty, comorbidities, or a concept of “COVID-age”, could skew this distribution even further. This makes population segmentation along these boundaries very appealing as it may, in theory, be possible to achieve a large impact on healthcare demand with restrictions affecting fewer people. Currently, however, measures for frailty or “COVID-age” do not exist, or are difficult to measure so demographics such as age, specific conditions that make individuals vulnerable,

occupation (for those in extended contact with the vulnerable), or geography are the only realistic possibilities.

Figure 1: Comparison of age-distribution for COVID-19 deaths and all-cause mortality in Scotland

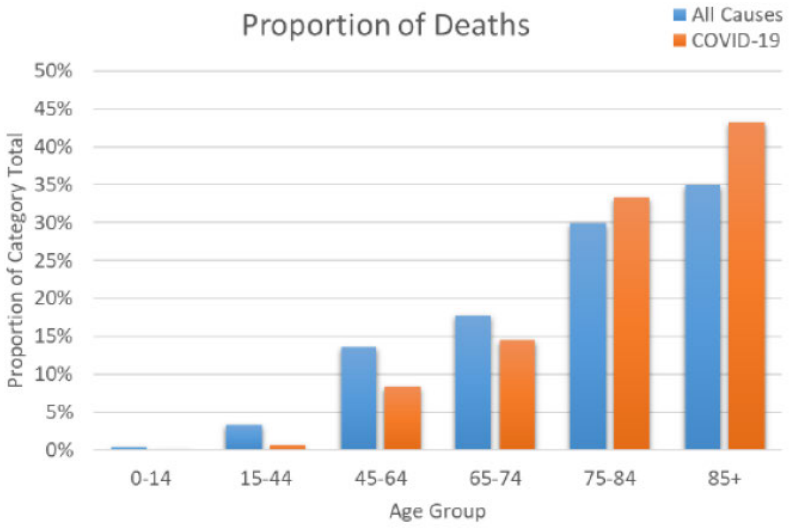
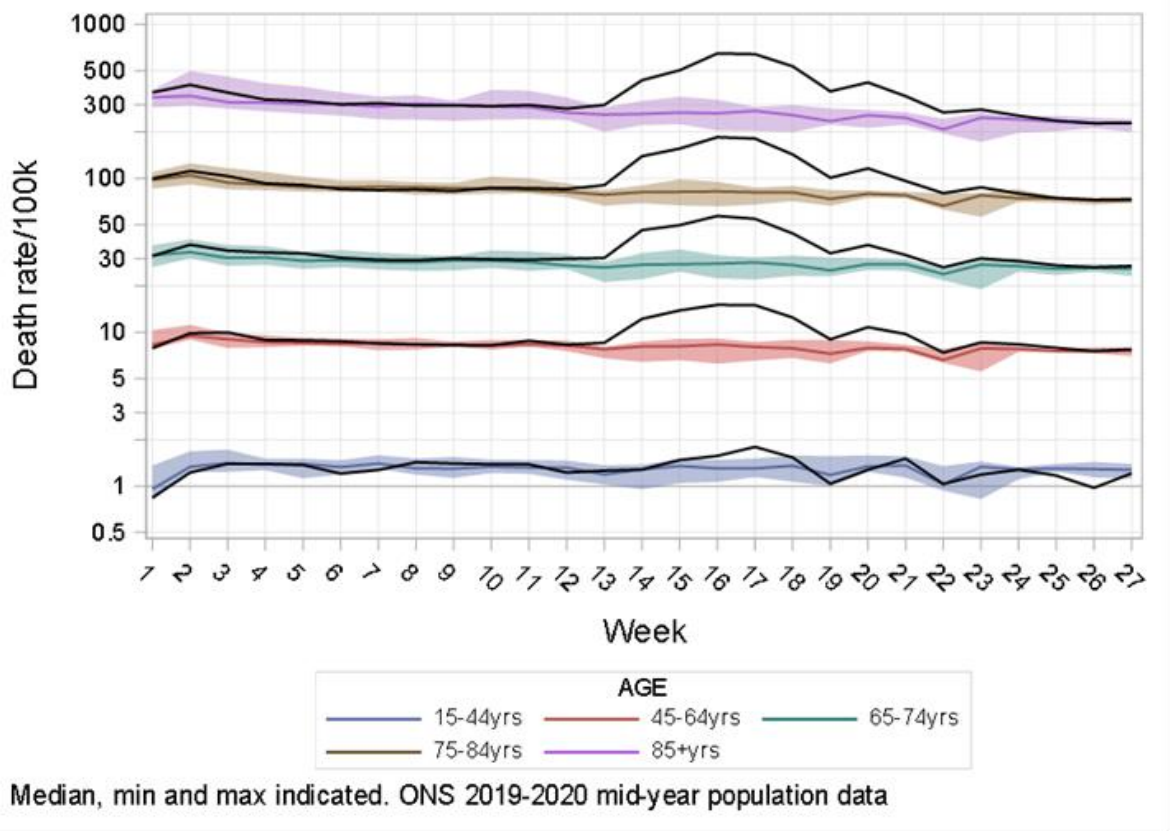


Figure 2: Comparison of death rates per 100k population for England and Wales by week of the year in 2020 by age groups, compared to 10-year historic range



Age-group dependent segmentation

7. Previous modelling by one SPI-M-O group has examined a variety of different scenarios comparing the impacts of a range of policies over time, one of which included splitting the population with different social distancing rules for those households with members over 45 years old, and those without. These analyses showed that age segmentation still leads to very many deaths in those over 45 under any plausible assumption about how tight a segregation could be imposed between the under 45s and the over 45s.

8. If an age-dependent segmentation approach were to be used, consideration is needed as to whether whole households with anyone aged 45 or over would need to have more stringent social distancing measures, or just individuals aged 45 or over (i.e. anyone in the household under 45 would be exempt). The former would affect the majority of the population. If the latter, effects described in previous SPI-M-O modelling would be further diminished.

Mixing patterns

9. Mixing patterns by age in our society, before COVID-19, showed lots of contacts across different age groups, with particularly strong patterns of contact between groups of the same age and groups about 20 - 30 years apart in age.

10. Age-dependent contact pattern matrices from both POLYMOD (Figure 3) and the BBC Pandemic study (Figure 4) studies suggest there is substantial contact between all age groups with individuals over 45 years of age. For participants over the age of 40 (x axis), there are still many contacts (lighter colours) below the age of 40; it is only for people over the age of 60 that physical contact is very focussed in people of their own age.

Figure 3: Smoothed contact matrices for Great Britain based on (A) all reported contacts and (B) physical contacts weighted by sampling weights from POLYMOD. White indicates high contact rates, green intermediate contact rates, and blue low contact rates, relative to the contact intensity.

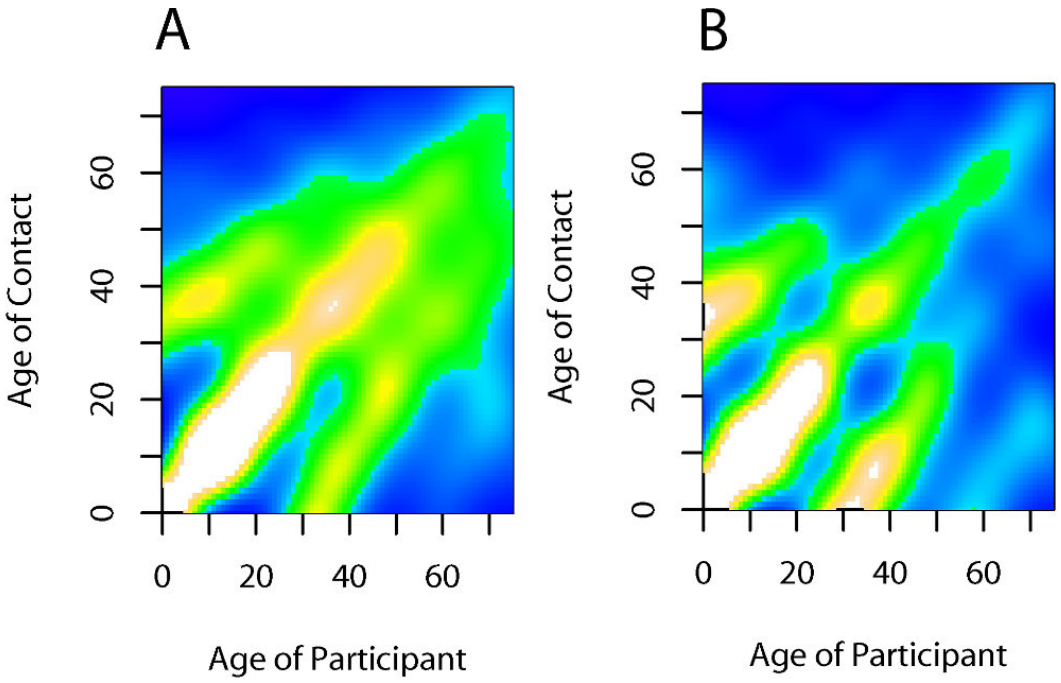
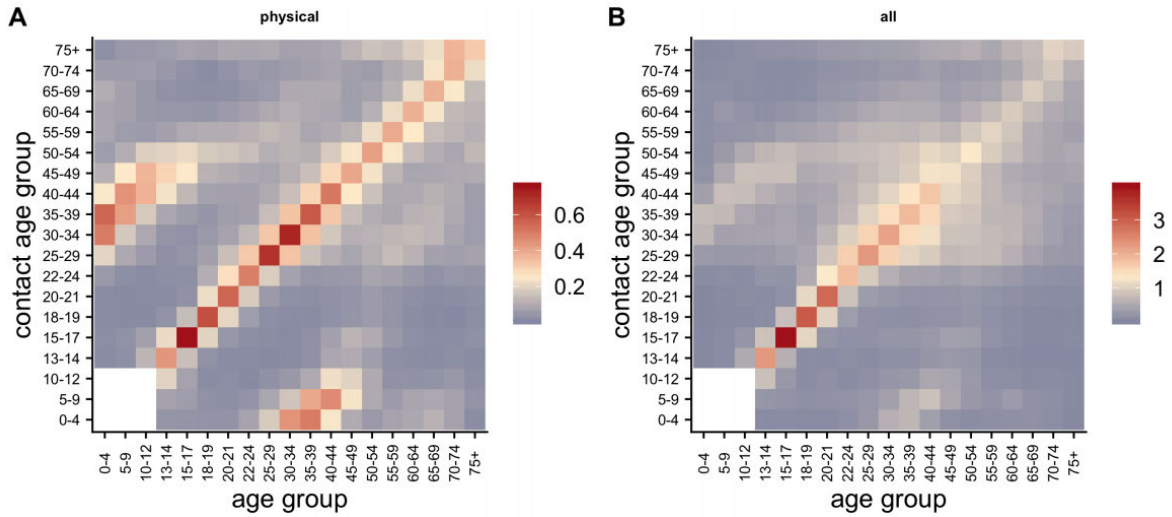
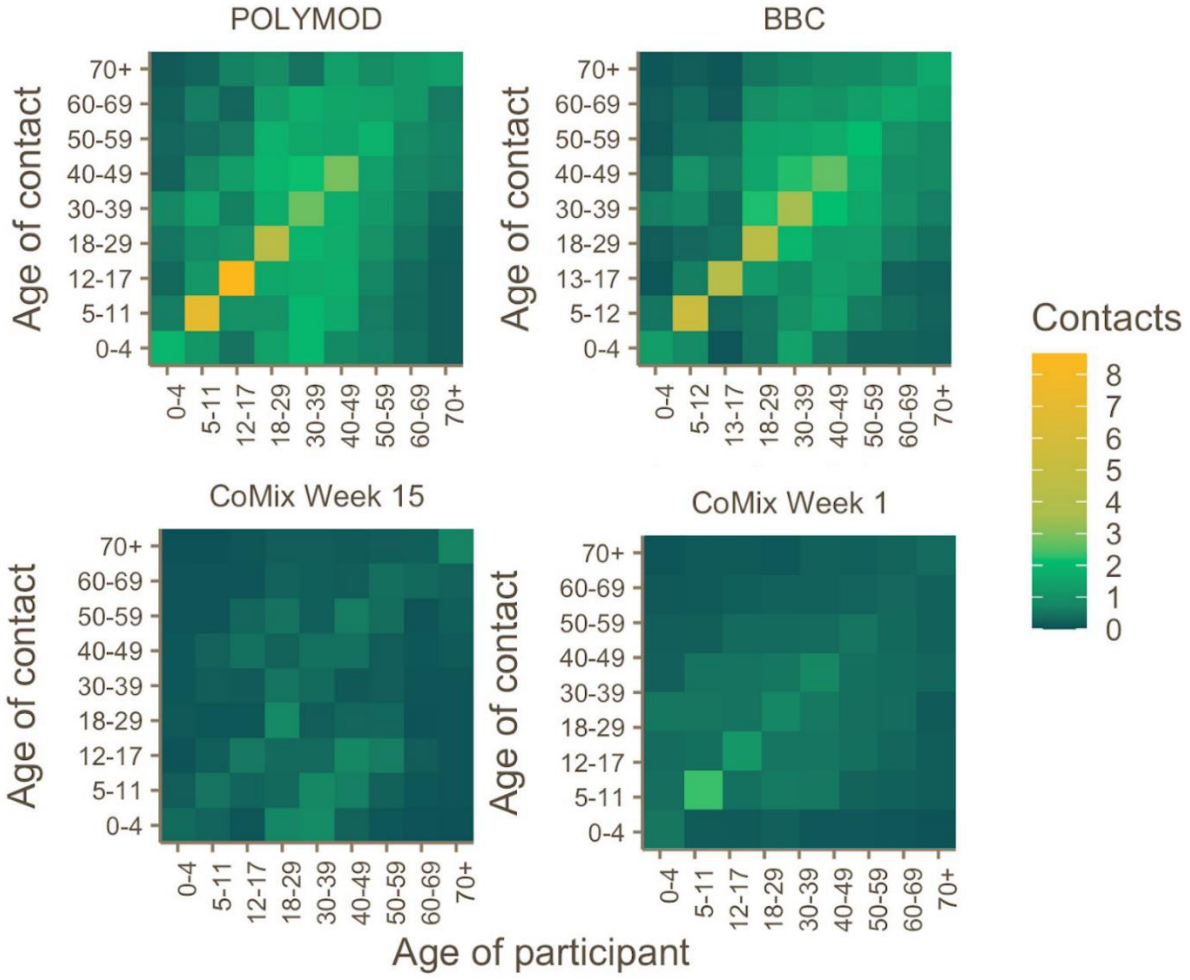


Figure 4: Population contact matrices inferred from all physical contacts (A) and capturing all reported contacts (B) from the BBC Pandemic study, where white indicates missing values. Respective scales show the mean number of contacts reported by participants of given age groups, adjusted for reciprocity of contacts.



11. The CoMix survey has monitored changes in contact patterns in the UK since the first week of lockdown at the end of March 2020 and has demonstrated a large reduction in contacts compared to both POLYMOD and BBC pre-pandemic studies (Figure 5). Despite this, the lighter coloured tiles demonstrate that people over 40 still have a relatively high proportion of their contacts with those under 40.

Figure 5: Contact matrices showing the average total number of daily reported contacts made by participants in different age groups with individuals in other age groups, with results shown for contacts reported in the CoMix (as of 28 March 2020 and 8 July 2020 – Week 1 and Week 15 respectively), POLYMOD and BBC Pandemic data. For CoMix week 1, child contacts data was not available; participants' contacts for age groups 0-4 and 5-17 are imputed using the POLYMOD data, and child-adult contacts reciprocated. Raw survey data was used for all ages in week 15, excluding contacts reported as mass contacts. Participants and contacts with unknown ages are not included.



12. **These results mean that policies to segment the population by age, relaxing restrictions for younger groups while restricting them for older groups are likely to fail. Increased transmission in the younger age groups is highly likely to result in an increase in incidence in older age groups.**

13. Contact patterns will partially reflect household composition, particularly when during a lockdown period or other stringent social distancing restrictions.

14. For the three broad age groups 0 – 44, 45 – 69 and 70+: 27% of households in the UK, corresponding to 38% of the population, live with at least one other person in a different age group.[1] This is broadly similar across the four nations and English regions. This will be higher for more granular working-age breakdowns, or if excluding those aged 70+. Around a third of people aged 70+ live in single-person households.[2]

Table 1: Estimates of the percentage of households (and people in households) by the mix of age groups, UK, 2019. Figures may not sum to 100% due to rounding. Office for National Statistics - Labour Force Survey

	Composition of household						
	Contains only 0-44	Contains only 45-69	Contains only 70+	Contains 0-44 and 45-69 only	Contains 0-44 and 70+ only	Contains 45-69 and 70+ only	Contains all three age groups
Percentage of households	30.9%	23.7%	18.4%	21.7%	0.7%	3.8%	0.8%
Percentage of people	36.9%	14.9%	10.6%	32.0%	0.9%	3.4%	1.4%

15. Approximately 69% of households in the UK contain at least one person aged 45 or older. This corresponds to 63% of people living in a household with at least one person aged 45+, compared to the 44% of people aged 45 or older in the UK.[3] 6% of households with a resident 70 or over also have residents under 45.

16. Household composition varies across demographic groups. For example, ethnic minority households are more likely to be multigenerational. Focusing on households where at least one person is aged over 70, there is large variation in the proportion of these households that also contained someone under age 50. Only 8% of households of those aged over 70 and White also contained someone aged under age 50. By comparison, the corresponding figure is 67% for Bangladeshi, 60% for Pakistani and 27%-36% for Black.[4]

[1] ONS (2020) User-requested data – Labour Force Survey. Not yet published
[2] ONS (2020) User-requested data - Annual Population Survey (APS) Household dataset January to December 2018. Not yet published
[3] ONS (2020) Mid-2019 population estimates
[4] ONS (2020) Ad hoc request - Households by age composition and ethnicity, UK, 2018.

Leicester

17. Pillar 1 and 2 testing data indicates that most confirmed cases in Leicester were driven by the under 18 and working age populations. This is consistent with the underlying age demographic structure. Relative to England, Leicester has a young population with a disproportionately higher proportion of people in their 20s (Figure 6).

Figure 6: ONS Mid-2019 population estimates for England and Leicester

18. Approximately 73,000 people in Leicester are aged between 20 and 29 years, but this is not solely driven by the area's student population. In 2019, 37,000 students (of all ages) had a term-term address in Leicester and provisional analysis from ONS suggests that the out-of-term population was approximately 13,000 fewer. This difference reflects both students in Leicester residing elsewhere outside of term-time, and students elsewhere in the country living in Leicester out-of-term. This pattern is typical of local authorities with large higher education institutions.

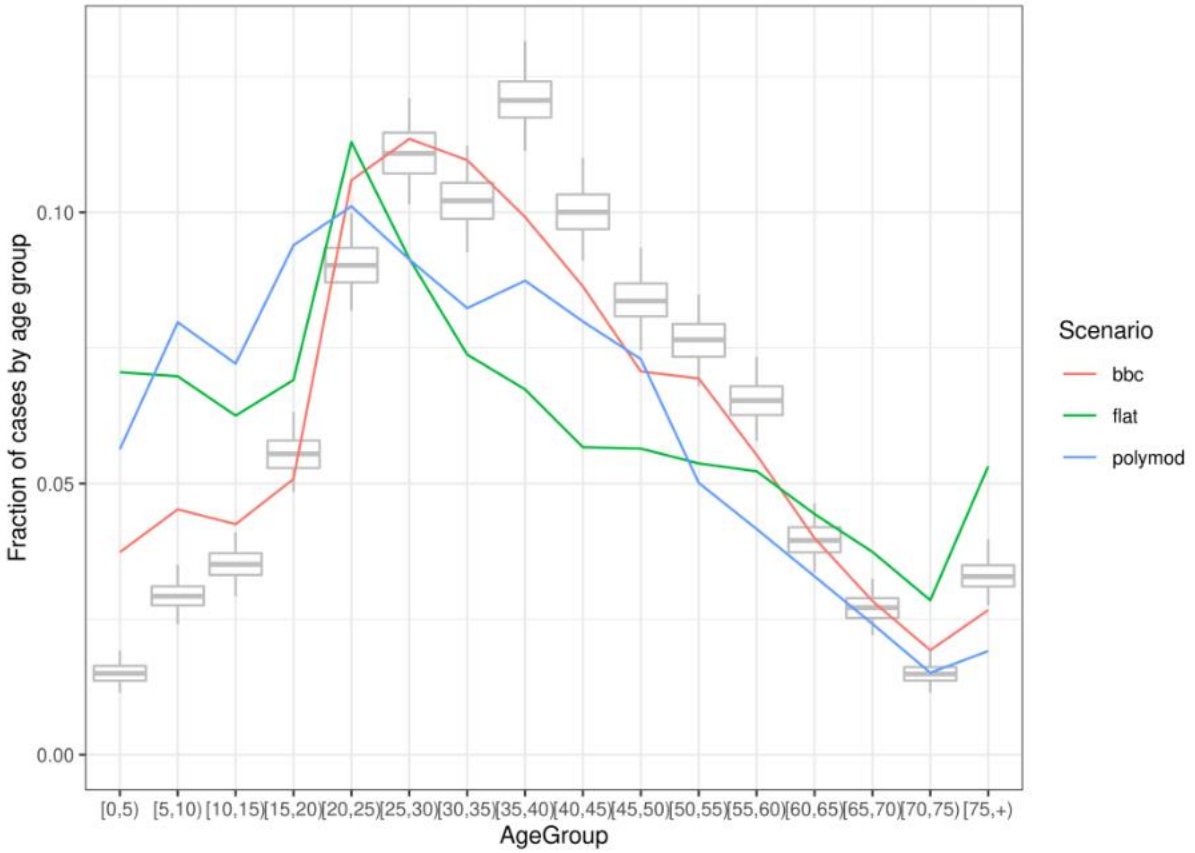
19. Analysis from PHE further show that the age distribution of positive Pillar 2 tests in Leicester is roughly what would be expected from age-dependent mixing patterns (Figure 7). The impact of the local age distribution alone is shown in green and does not fit the testing data as well. Age-structured mixing (shown in blue for POLYMOD and red for BBC, though both modified to simulate current interventions) better explains the higher proportion of cases in the broad working-age group. The proportion of cases in the age 75+ group is lower than would be expected by population distribution alone, but possibly

a bit higher than expected from age-structured mixing. The proportion of cases in children is lower than expected by population distribution or with population mixing.

Figure 7: Age distribution for positive tests in Leicester compared to modelled predictions (17 May 2020 – 17 July 2020).

The box plots show the results from Pillar 2 testing data. The green curve gives the expected age profile if positive tests were in proportion to Leicester's age distribution (i.e. corresponding to a flat mixing structure between age groups). If age-structured mixing between age groups are further taken into account, the predicted distribution would be as the red or blue curves (for BBC or POLYMOD mixing respectively). For these mixing models, adherence / COVID security is assumed to be equal to 60% and school attendance is set to around 3%.

The raw population demography alone accounts for the high fraction of cases in ages 20-30, and age-structured mixing can explain the continued high fraction among working-age adults. The lower proportion of cases in children compared to the predictions could be explained by their lower susceptibility (not accounted for here). The proportion of cases in 60-75 is well explained by the combination of demographics and mixing structure. The proportion of cases in the 75+ is between that predicted by population age distribution alone, and that predicted by age-structured mixing.



20. This implies that the age distribution of cases seen in Leicester (many cases in the young, and few in the old) is very close to what would be expected from the assumed age-dependent mixing patterns. In consequence, there is no reason to be complacent about the dangers of this outbreak to the older and more vulnerable people of Leicester.

Discussion

21. The large amount of mixing across age groups would make it extremely difficult to prevent transmission between segmented age groups, regardless of the ethical and practical questions involved. Approximately 65% of people in the UK live in a household with at least one person aged 45 or over. Successful implementation of an age-dependent segmentation policy targeted at people of working age would require radical changes to the age-dependent mixing patterns in our society.

22. The motivation for age segmentation is the age-dependency of mortality rates; however, this is not the only cost. Any age-dependent segmentation will likely change the distribution of cases and thus what happens to viral transmission in the community. Distribution of cases of COVID-19 treated in hospitals will also, therefore, change. Removing or reducing social distancing for the younger age group would likely lead to significantly more infections in these age groups as they have more and more varied contacts. The unknown, longer-term sequelae of infection is a danger for such a strategy. Further, any age segmentation policy will surely raise considerable social, ethical and practical issues not considered here, in addition to costs to wider wellbeing.

Annex: PHIA framework of language for discussing probabilities