SPI-M-O Statement on population segmentation

Date: 15th July 2020

SIGNED OFF BY SPI-M CO-CHAIRS

Segmentation of the population for controlling transmission

1. 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. 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.

2. 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

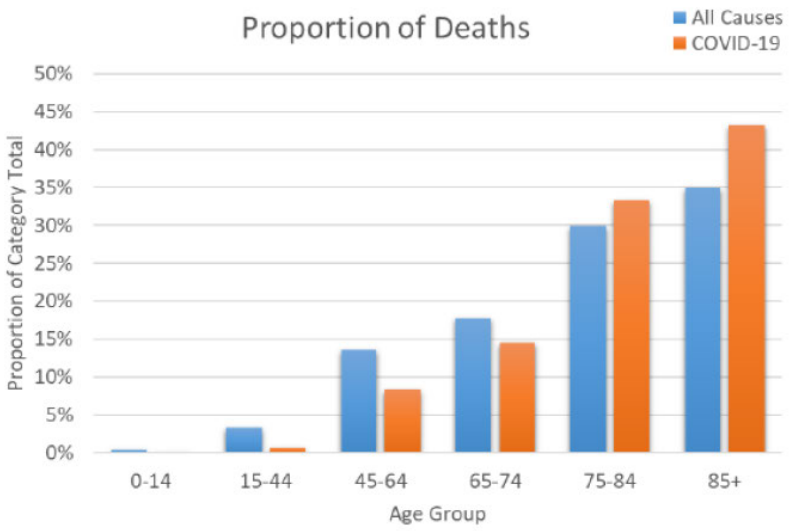
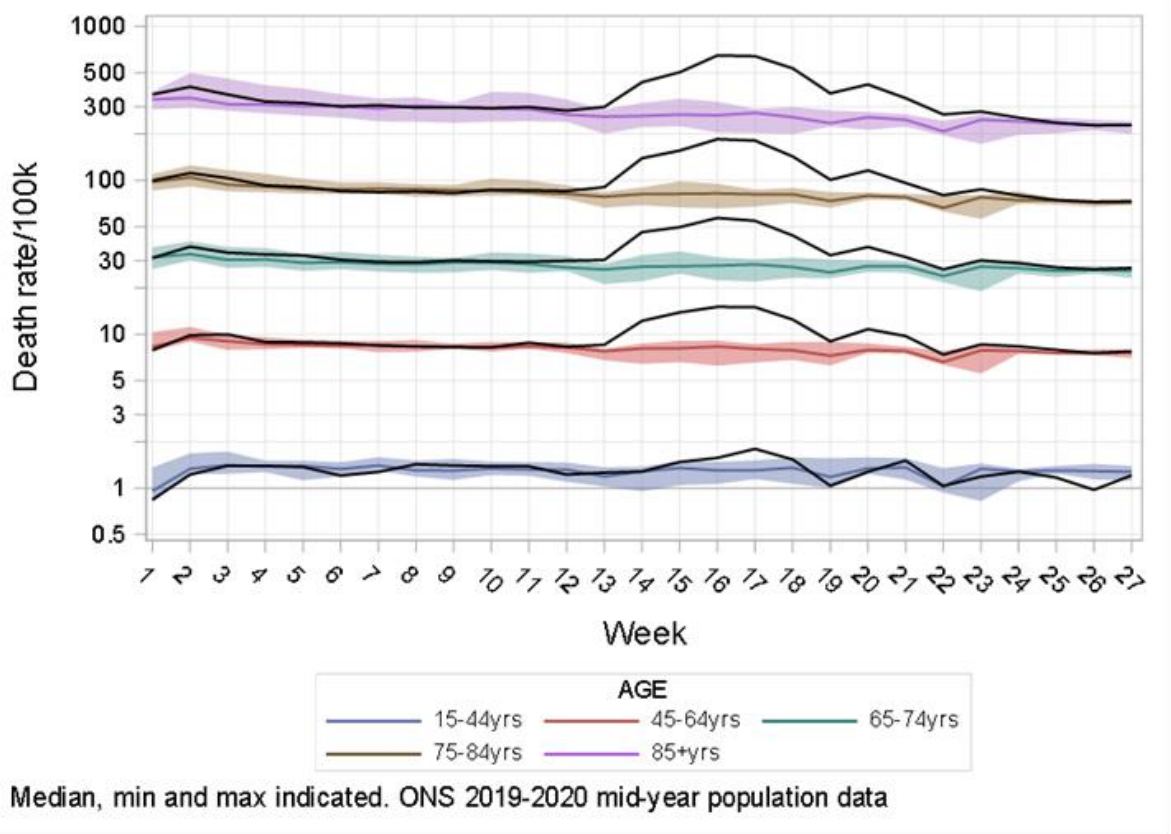


Figure 2: Comparison of death rates per 100k population for England and Wales by week of the year in 2020 by age groups, compared to 10-year historic range



3. Mixing patterns by age in our society show 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. Age-dependent contact pattern matrices from both POLYMOD (Figure 3) and BBC (Figure 4) studies therefore suggest that 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.

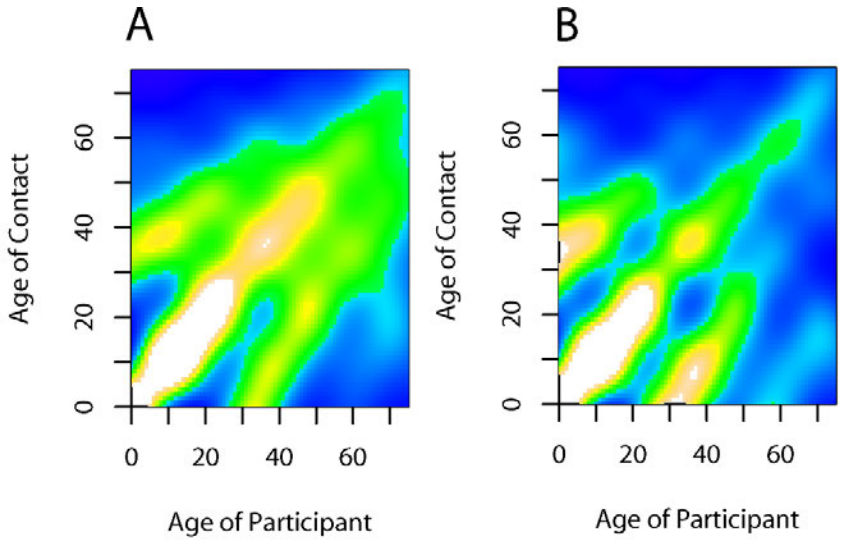
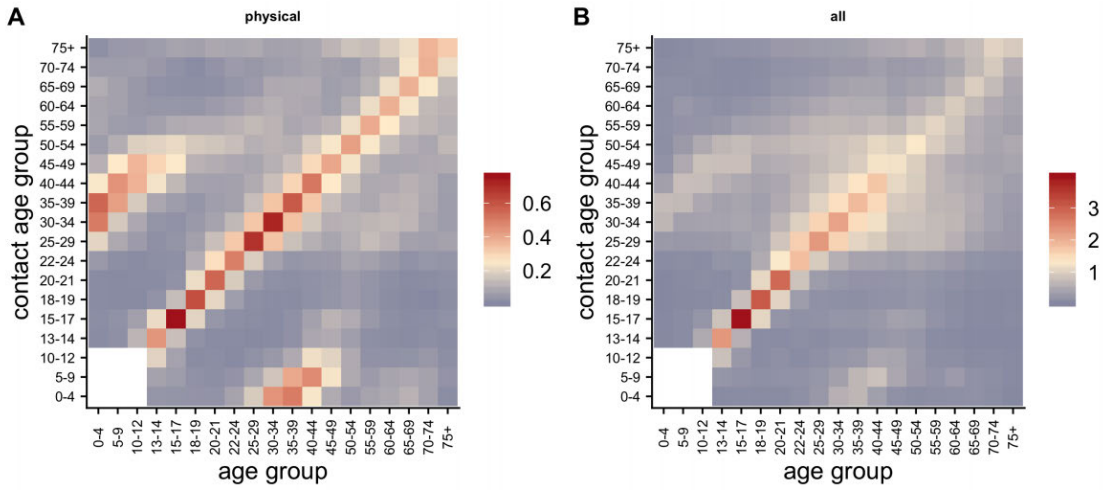


Figure 4: Population contact matrices inferred from all physical contacts (A) and capturing all conversational contacts (B) from the BBC Four Pandemic study, where white indicates missing values. Respective scales shows the mean number of contacts reported by participants of given age groups, adjusted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



Age-group dependent segmentation

4. 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 no one under 45 years old, and those where anyone aged 45 and over lived there. These analyses showed that age segmentation has only a minor effect on transmission compared to other interventions, such as the comparison between extensive social distancing compared to partial social distancing.

5. If an age-dependent segmentation approach were to be used, consideration 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). If the latter, effects described in previous SPI-M-O modelling would be further diminished.

Other options for segmentation – Vulnerable / "Shielders" / Everyone else

6. Another SPI-M-O group have presented a method for segmentation that splits the population into three groups – the highly vulnerable (particularly those over 70), "shielders" who have the most and closest contact with the vulnerable, and everyone else. By including this additional group, it is possible to allow for different contact behaviours between "shielders" and the other two groups. By targeting reduction in transmission rates to vulnerable and "shielder" segments, the immediate / imminent burden on the health and care sectors can potentially be reduced or managed better.

7. Segmentation for the vulnerable would not have to be as isolating as shielding was from March 2020. Instead, reducing transmission rates in the vulnerable **and** their "shielders" could focus on lowering risk per contact and be more comparable with strict COVID-security to ensure any contacts are very safe. This sort of segmentation using only the vulnerable and their "shielders" is more likely to be successful if R in the rest of the community is only a little above 1 (for example at R=1.2). This sort of approach is unlikely to succeed if R were much higher than 1.

8. One limitation to this approach is the lack of information on which to base assumptions for the contact patterns between these three groups (the vulnerable, their "shielders", and the wider community). Another unknown is how many people in the population might belong to the "shielders" – this could be a large number – and more research would be needed to clarify these points.

Other options for segmentation – Geographical segmentation

9. Another SPI-M-O group used the 2011 census data on commuting patterns at the electoral ward level in England and Wales. Network community detection algorithms were used to break up the network into partitions, minimising the numbers of links broken. This led to seven separate communities from an unweighted network that aligned with areas covering, approximately, the regions South West, South East, Wales, Midlands, East Midlands, Lancashire and Yorkshire and North of England. This finding could be very useful when considering how to manage different scales of outbreaks during the epidemic (e.g. local, regional, or national). The weighted network led to eight sub-networks, but these were less aligned with current administrative boundaries (e.g. Bristol and Cardiff are in the same sub-network). These communities represent natural divisions in the movement network, and so restrictions that exploit these will minimise the number of movements that need to be curtailed, while within community restrictions are likely to be more challenging to enforce. This sort of geographical segmentation might be a strategy to consider but further work is needed for its development. The granularity (community size) of segmentation could also be considered.

Discussion

10. Segmentation by age group seems sensible, given the strong age-dependency of mortality rates. Implementation issues and the large amount of mixing across age groups, however, would make it extremely difficult to prevent transmission between the segmented and locked-down age groups. 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.

11. Any age-dependent segmentation will likely change the distribution of cases and thus what happens to viral transmission in the community. 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. There will potentially be difficulties in policing such a policy, and colleagues from SPI-B may wish to comment on this.

12. Segmentation by risk group (shielding and “shielders”) would need to be highly (and potentially unfeasibly) effective to allow prevalence of infection to rise in the remainder of the population. Communicating how to segment the population to the public may also be

difficult as any marginal benefit could easily be lost in its implementation and, again, colleagues from SPI-B may wish to comment.

Annex: PHIA framework of language for discussing probabilities