Supplementary Material for

Social heterogeneity drives complex patterns of the COVID-19 pandemic: insights from a novel Stochastic Heterogeneous Epidemic Model (SHEM)

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This PDF file includes:

Figures S1 – S3
Legends for Movies S1 and S2

Other supplementary materials for this manuscript include the following:

Movies S1 and S2

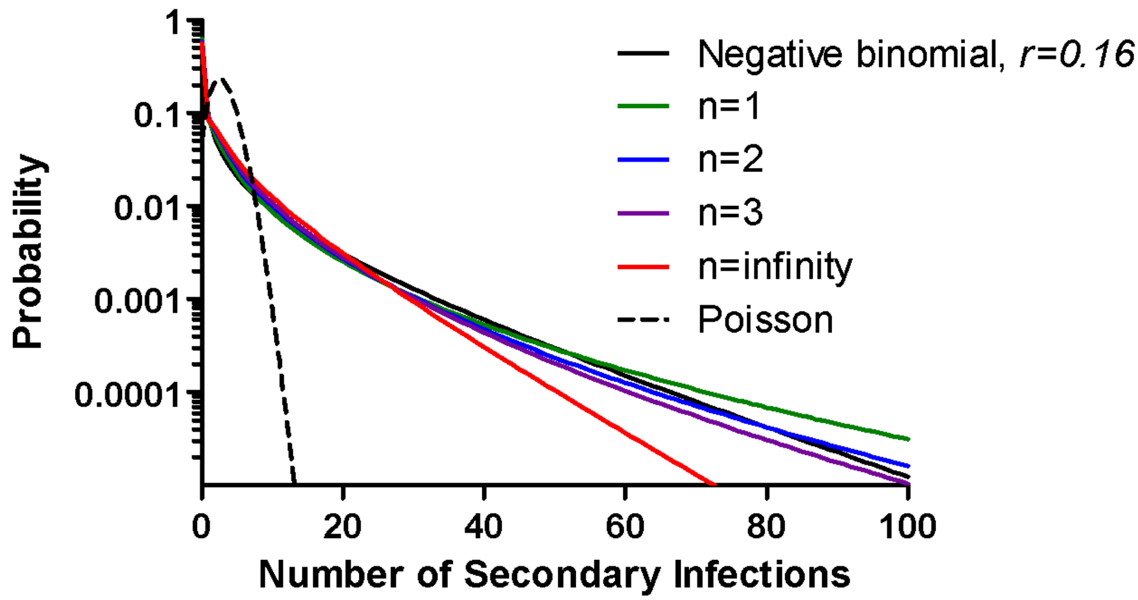

Fig. S1. The distribution of secondary infections generated by infectious individuals. Black: Observed negative binomial distribution (Althouse, B. M., et al. 2020; "Stochasticity and heterogeneity in the transmission dynamics of SARS-CoV-2." https://arxiv.org/abs/2005.13689); Green, blue, magenta, red: The actual realized number of secondary cases generated over the lifetime of one infection in the presence of n other infections individuals according to our scheme. All distributions have mean R0 =3.0. Dashed line: Poisson distribution with mean R0 as implicit in mean-field SEIR models.

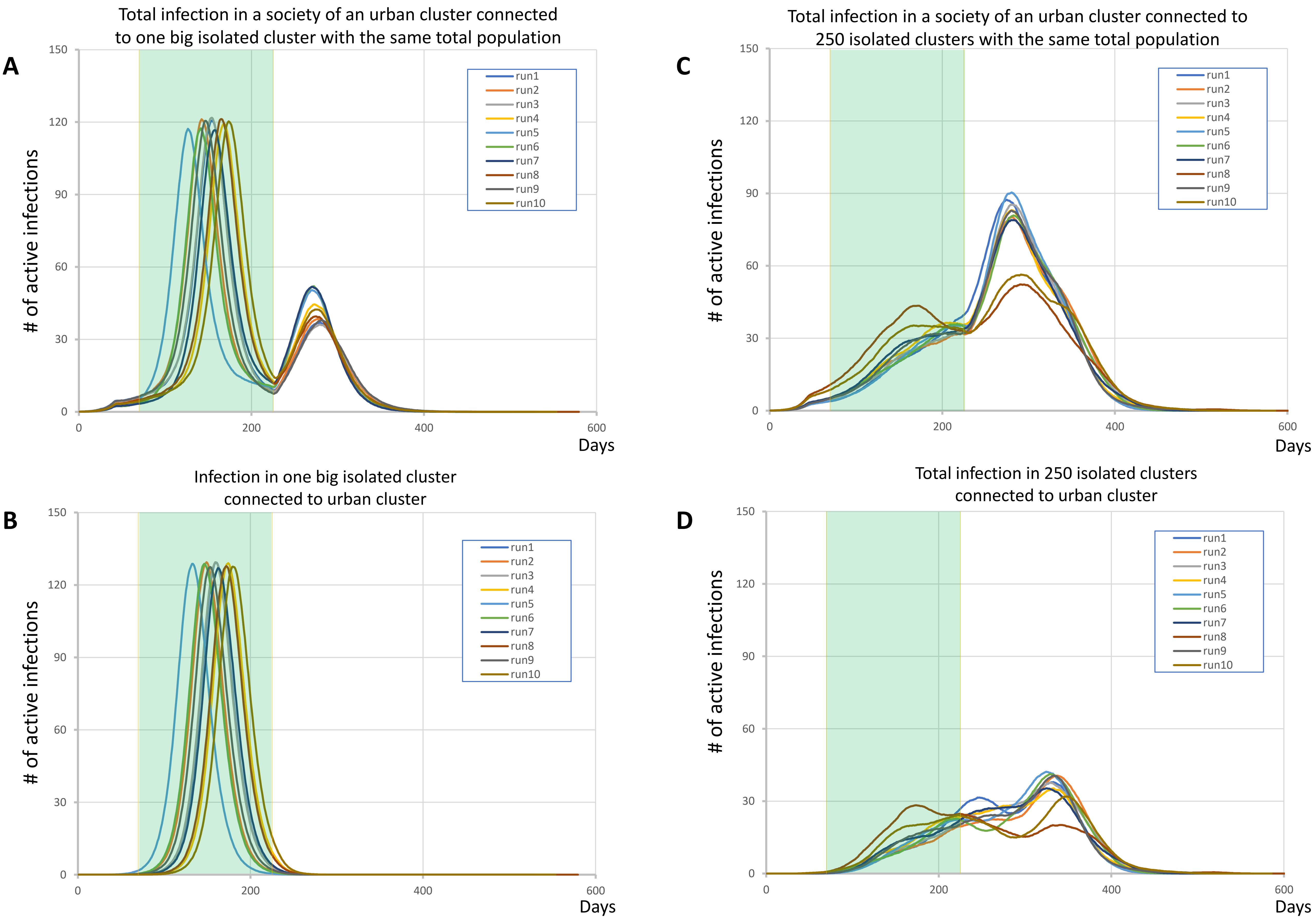

Fig. S2. Heterogeneity of isolated clusters is important for the infection pattern. In the most complex scenario of "moderate lockdown" (Fig. 1C in main text) we substituted 250 clusters by one big cluster with the same population of one million people keeping all other parameters the same. The big isolated cluster generated substantial and sharp infection peak (**panels A and B**) that is absent or very small in case of 250 isolated clusters (**panels C and D**). Each panel shows 10 simulation runs (overlapped multi-color curves). The lockdown period from day 40 to day 225 is shown by green shade.

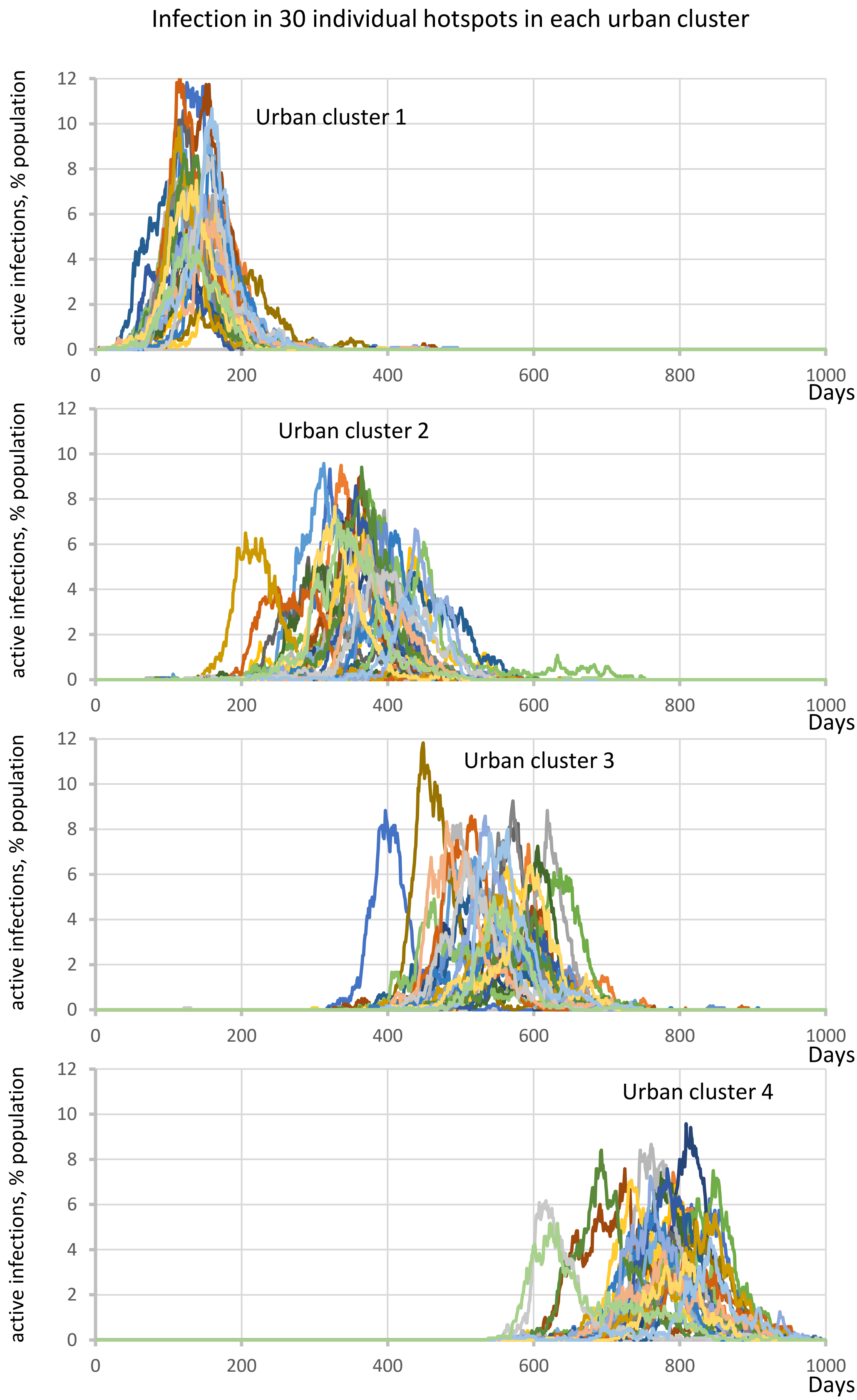

Fig. S3. Stochastic propagation of infection from one urban area to another via hotspots in a society of 4 connected urban areas, each in lockdown but having hotspots. Each plot from top to bottom shows infection explosions in each individual hotspot for each urban area (specified by labels). See main text for details and also Movie S2.

Movie S1 (separate file). Highly susceptible integrated clusters (hotspots) drive SARS-Cov2 infection in an urban cluster in stochastic simulations of SHEM model. Infection time-dependent changes in hotspots (small squares) are coded by red shades saturating (pure red) at 5% of infection in each individual cluster. Infection in the urban area (big square) are is coded by blue shades saturating (pure blue) at 5% of infection in the area. The time is shown in the left upper corner in number of days. Large urban cluster had 1 million individuals with $R_0 = 1.25$ while 250 hotspot clusters with 1200 +/- 500 people had the same internal $R_0 = 3.0$.

Movie S2 (separate file). Hotspots drive SARS-Cov2 infection in each urban cluster and infection propagation among urban clusters in stochastic simulations of SHEM model in a society of 4 connected urban areas. Time-dependent changes of infection in hotspots (small squares) are coded by red shades saturating (pure red) at 3% of infection in each individual cluster. Infection in the urban area (big square) is coded by blue shades saturating (pure blue) at 3% of infection in the area. The time is shown in the left upper corner in number of days. Each urban area of 100,000 people at day 40 became closed from $R_0 = 2.5$ to $R_0 = 1.25$ at day 40. Each urban area has 30 hotspots with 1200 +/- 500 people that avoid closing and keep the same internal $R_0 = 2$.