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Evaluating the Effectiveness of Social Distancing Interventions against Coronavirus Disease

Appendix

The Model

We considered an age-structured susceptible-exposed-infectious-removed (SEIR) model with 10 discrete age groups: 0–5, 6–9, 10–19, 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, and ≥80 years old. The equations for the model are as follows:

$$\frac{dS_i}{dt} = -\lambda S_i ,$$

$$\frac{dE_i}{dt} = \lambda S_i - \sigma E_i ,$$

$$\frac{dI_i}{dt} = \sigma E_i - \gamma I_i ,$$

$$\frac{dR_i}{dt} = \gamma I_i ,$$

where the state variables S_i, E_i, I_i, and R_i represent the numbers of susceptible, exposed, infectious, and removed persons in each age group *i*. Removed persons are those who can no longer infect others. The force of infection is represented by $\lambda = \sum_{j=1}^{10} \beta \frac{c_{ij}}{N} I_j$, where c_{ij} corresponds to the estimated number of contacts per day between age class *i* and *j* in a total population size *N*. Based on current estimates that put <1% of the infections as asymptomatic (*1*), we considered only symptomatic infections. Details of parameters values can be found in the Table of the main text.

To quantify the uncertainty around our results, we performed 1,000 simulations varying 3 parameters: the basic reproduction number, R_0; the latent period; and the duration of infectiousness. By using current estimates (*2*,*3*,*4*; L. Tindale, unpub. data, https://www.medrxiv.org/content/10.1101/2020.03.03.20029983v1), we sampled values of R_0

from a truncated normal distribution with mean 3 ranging from 2–4. We assumed that the latent period was similar to the incubation period and assumed a gamma distribution with mean 5.1 days and SD 0.7 (*5*). We sampled the duration of infectiousness from a truncated normal distribution with mean 5 days and SD 0.7 ranging from 3–9 (*6*; Q. Bi, unpub. data, https://www.medrxiv.org/content/10.1101/2020.03.03.20028423v3). For each R_0, infectious period, and latent period considered, we used the next-generation matrix approach (*7*) to calculate the transmission coefficient β.

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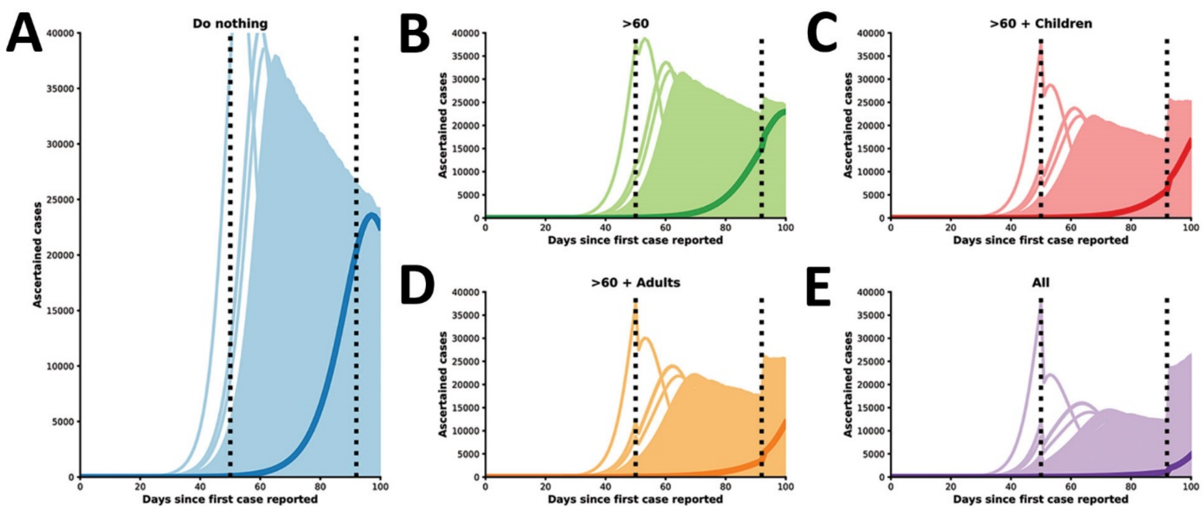
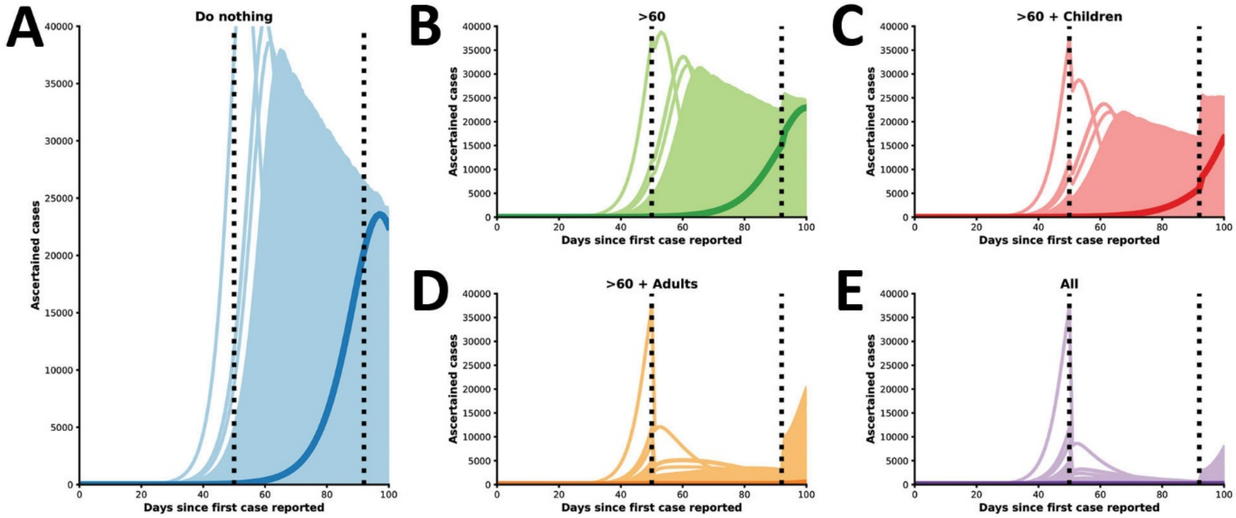
Appendix Table. Delay in coronavirus disease (COVID-19) epidemic peaks under different social distancing measures for varying infectious periods and age groups*

	Delay in epidemic peak, d (vs. no intervention, d)			
	Infectious period, d			
Persons limiting contact	5	6	7	8
None	100	110	118	128
≥60 y only	102 (2)	112 (2)	120 (2)	130 (2)
≥60 y and children	110 (10)	120 (10)	129 (11)	139 (11)
Adults only	139 (39)	149 (39)	159 (41)	169 (41)
All	152 (52)	161 (51)	171 (53)	>180 (>52)

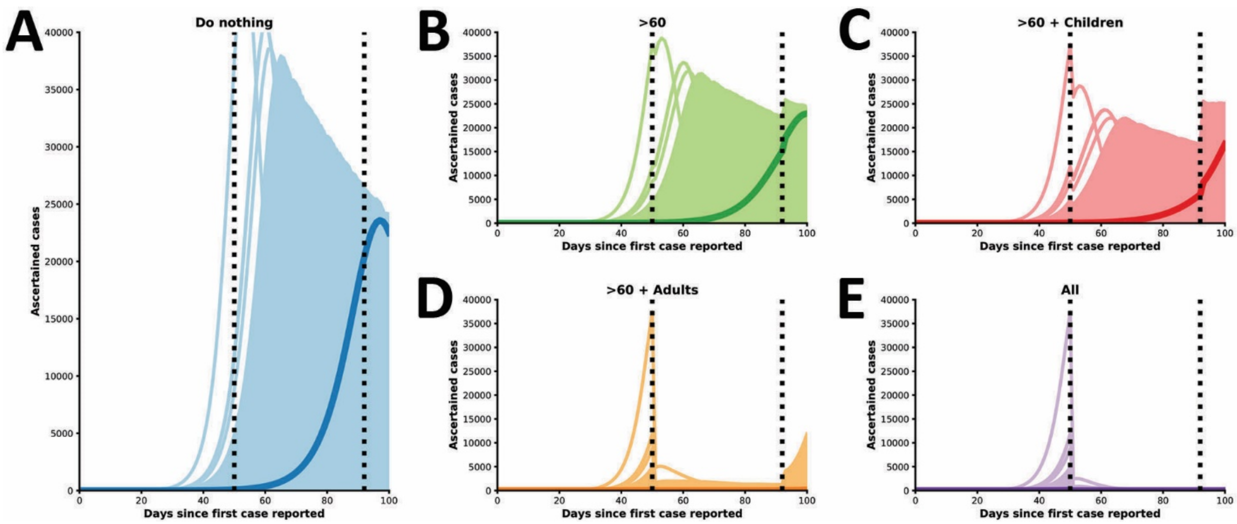
*This table corresponds to Figure 2 in the main text. Age groups are as follows: children, persons ≤19 years of age; adults, persons 20–59 years of age; and persons ≥60 years of age.



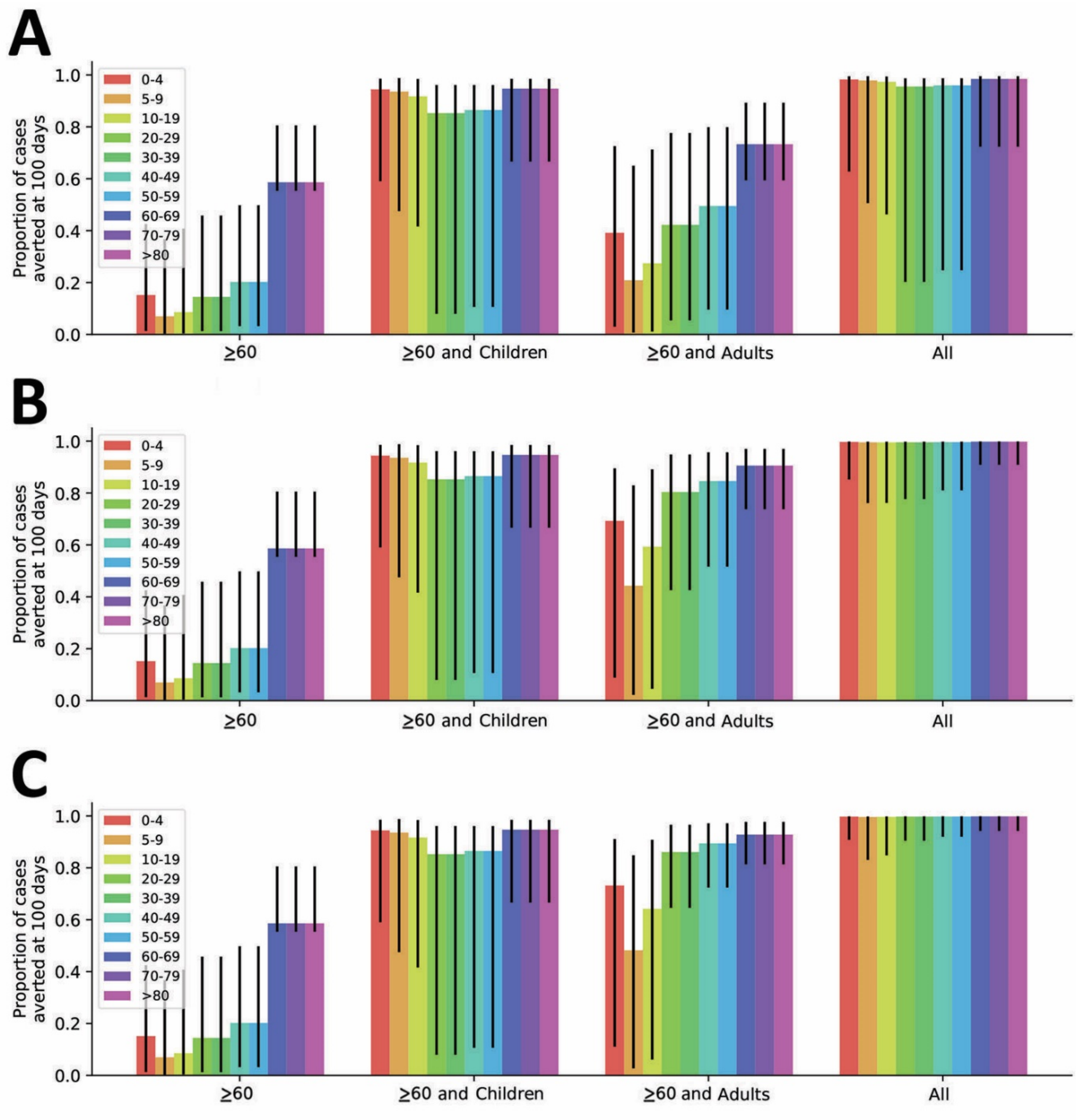
Appendix Figure 1. Number of ascertained coronavirus disease (COVID-19) cases for 5 scenarios of social distancing: A) no intervention; B) only persons ≥60 years of age; C) persons ≥60 years of age and children; D) adults only; and E) all groups. Thin lines show 1,000 realizations of varying parameters for R_0, γ, and σ (see Methods). Thick lines show the mean simulation, corresponding to $R_0 = 3$, $\gamma = 1/5.015$, $\sigma = 1/5.159$. We assume adults ≥60 years of age will reduce their contact by 95%, children by 85%, and adults by 25%. Dotted lines indicate the beginning of the social distancing intervention at 50 days and ending at 92 days. Age groups include children; persons ≤19 years of age; adults, persons 20–59 years of age; and persons ≥60 years of age.



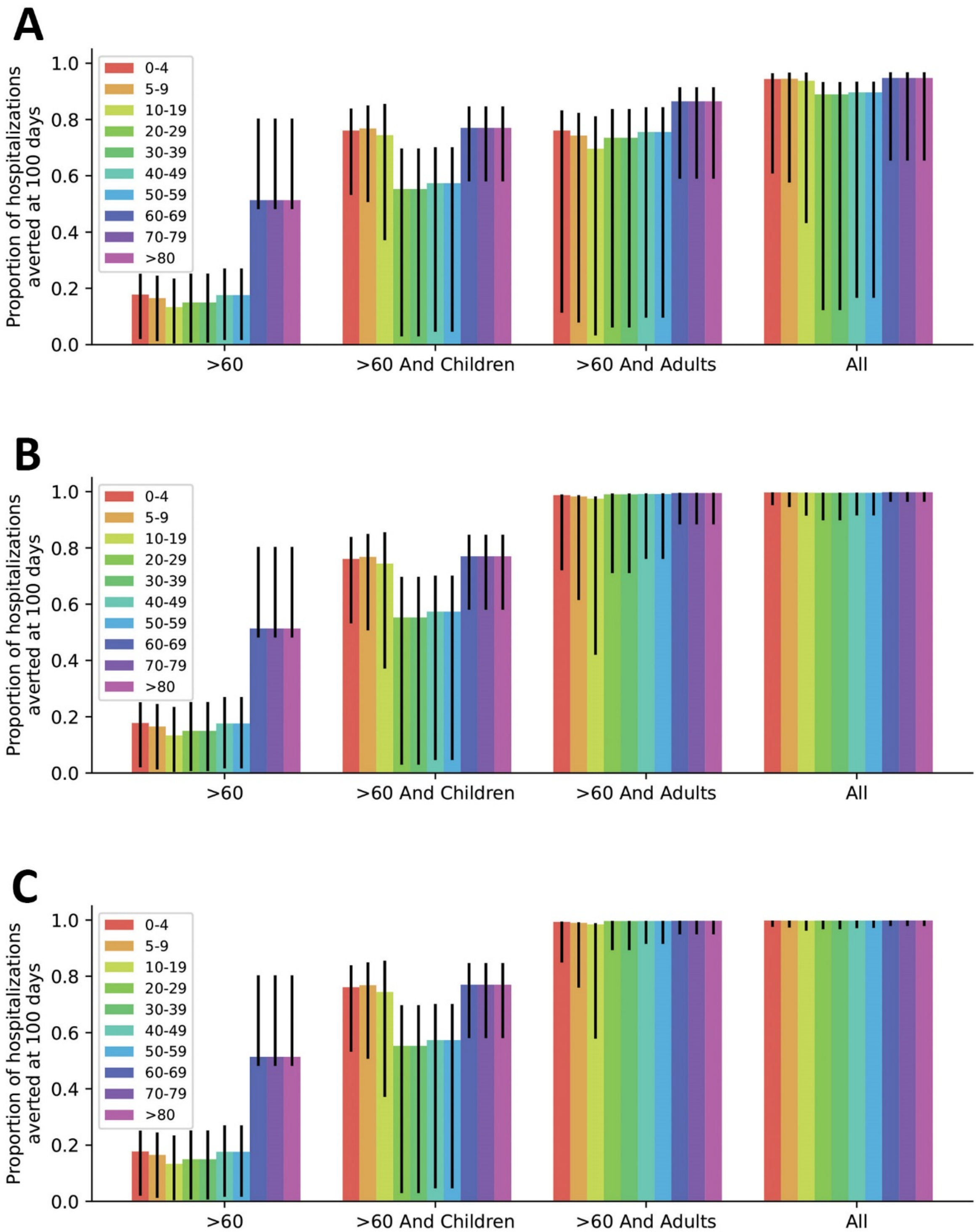
Appendix Figure 2. Number of ascertained coronavirus disease (COVID-19) cases for 5 scenarios of social distancing: A) no intervention; B) only persons >60 years of age; C) persons >60 years of age and children; D) adults only; and E) all groups. Thin lines show 1,000 realizations of varying parameters for R_0, γ, and σ (see Methods). Thick lines show the mean simulation, corresponding to $R_0 = 3$, $\gamma = 1/5.015$, $\sigma = 1/5.159$. We assume adults >60 years of age will reduce their contact by 95%, children by 85%, and adults by 75%. Dotted lines indicate the beginning of the social distancing intervention at 50 days and ending at 92 days. Age groups include children; persons <19 years of age; adults, persons 20–59 years of age; and persons >60 years of age.



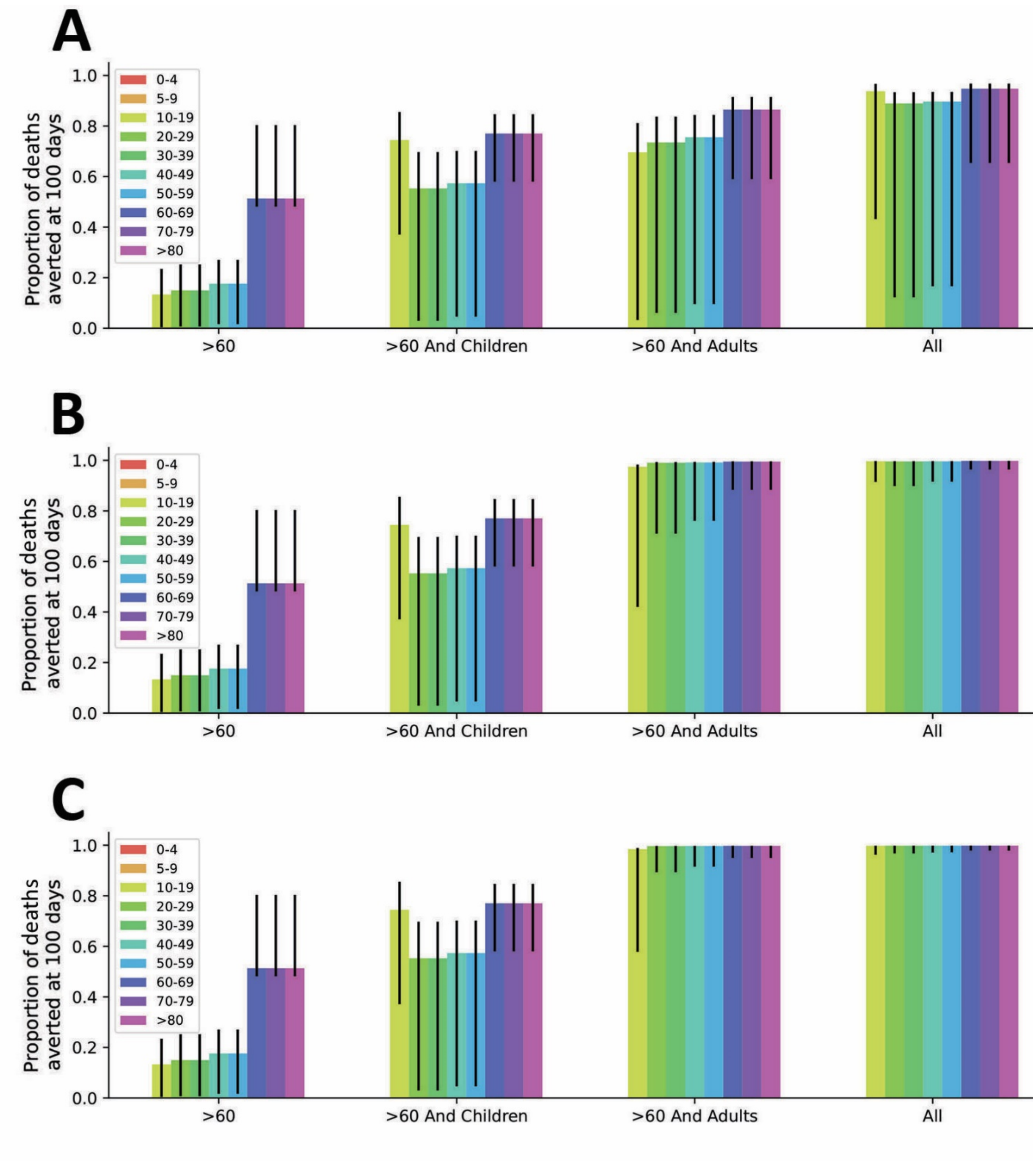
Appendix Figure 3. Number of ascertained coronavirus disease (COVID-19) cases for 5 scenarios of social distancing: A) no intervention; B) only persons ≥60 years of age; C) persons ≥60 years of age and children; D) adults only; and E) all groups. Thin lines show 1,000 realizations of varying parameters for R_0, γ, and σ (see Methods). Thick lines show the mean simulation, corresponding to $R_0 = 3$, $\gamma = 1/5.015$, $\sigma = 1/5.159$. We assume adults ≥60 years of age will reduce their contact by 95%, children by 85%, and adults by 95%. Dotted lines indicate the beginning of the social distancing intervention at 50 days and ending at 92 days. Age groups include children; persons ≤19 years of age; adults, persons 20–59 years of age; and persons ≥60 years of age.



Appendix Figure 4. Proportion of coronavirus disease (COVID-19) cases averted at 100 days under 4 scenarios of persons 20–59 years of age reducing their contact by A) 25%; B) 75%; and C) 95%.



Appendix Figure 5. Proportion of coronavirus disease (COVID-19) hospitalizations averted at 100 days under 4 scenarios of persons 20–59 years of age reducing their contact by A) 25%; B) 75%; and C) 95%.



Appendix Figure 6. Proportion of coronavirus disease (COVID-19) deaths averted at 100 days under 4 scenarios of persons 20–59 years of age reducing their contact by A) 25%; B) 75%; and C) 95%.