Effects of COVID 19 on People Depending on Comorbidity Status in San Diego County

Dr. Naveen Vaidya, Rita Herfi

Abstract

COVID-19 is a new variant of coronavirus currently affecting the world with infection. The information in this report regards its effects on people with or without comorbidities. It discusses the susceptible population, rates of infection for symptomatic and asymptomatic people based on comorbidity status (people with or without comorbidities), and the amount of people who have recovered. The information is based on the population within San Diego County in California during the beginning of the pandemic in the United States in 2020.

Introduction

COVID-19, while originating in China, was first discovered in the United States in January 2020, in the state of Washington and later in every state. COVID-19 is now a continuous ongoing global pandemic, and we continue to learn new information about it everyday. This report focuses specifically on the impact of COVID-19 in San Diego county between a six month period, and is based on the status of the population having comorbidities or not (comorbidities vs. non-comorbidities). This includes if they were asymptomatic or symptomatic. Also to note, the information that was researched was in the beginning stages of COVID-19 and vaccines were not available at the time so it will not be included in the report. The information gathered is based on what was reported to San Diego County. The graphs in the report are based on the SEIAR model (Susceptible, Exposed, Infected, Asymptomatic, Recovered) and graphed and calculated in MATLAB.

Results

Figure 1 shows the number of infections over a six month period in San Diego County. Roughly 110 days were when the most infections occurred. This is probably due to new social distancing and masking recommendations, as well as open travel. Many people were traveling during the time since many public places closed down, and they needed to return home. It is shown that the most people with infections were symptomatic and did not have any comorbidities, however this can be false since not all infected people could have been reported. The same reasoning can be described for the other infection rates as well. The number of asymptomatic people with comorbidities comes out the least, which is usually the case since people with comorbidities experienced symptoms much more than people without comorbidities.

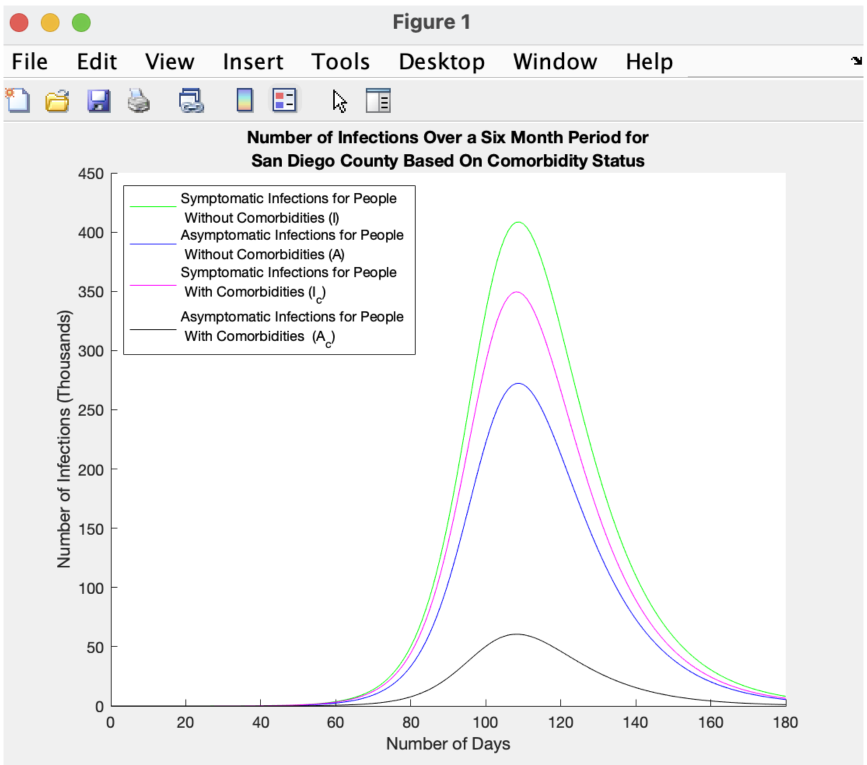


Figure 2 is a visual of the rate of new cases in San Diego County seperated by people with or without comorbidities and whether they were symptomatic or asymptomatic. It shows the number of new infections by the thousands. While it may seem like there are more infections with the non-comorbidity population the results from Figure 3 suggest otherwise.

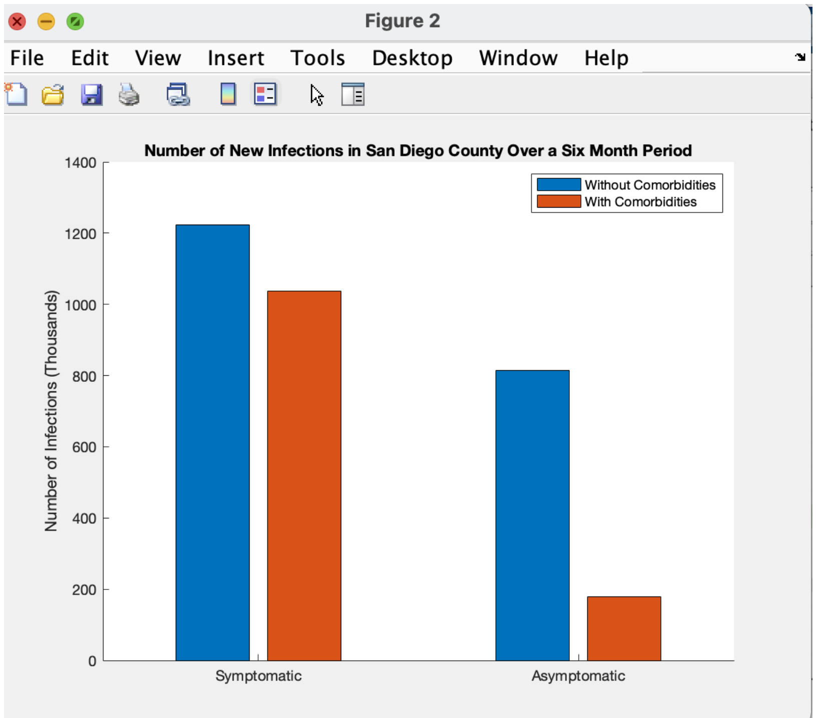
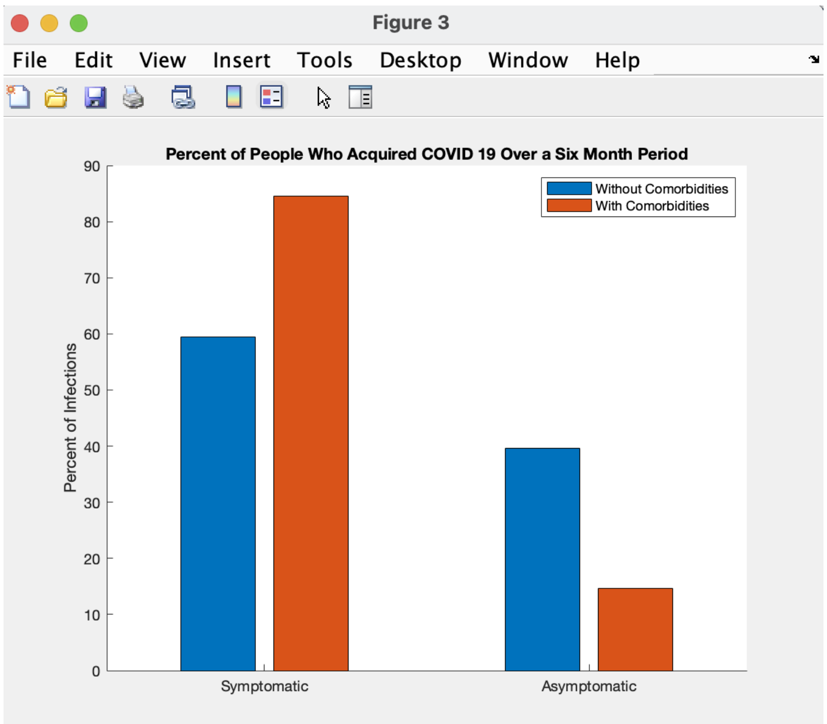
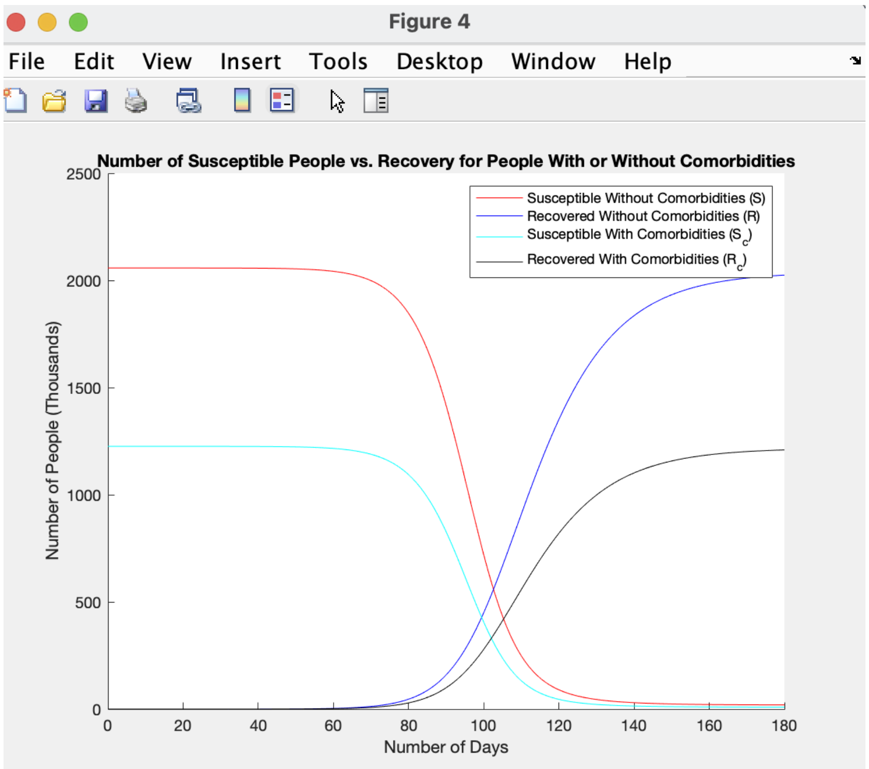


Figure 3 is the same graph as Figure 2, however it is measured by the percentage of each population that got infected. It is a better visual representation of how COVID-19 affected the comorbidity population vs. the non-comorbidity population. People with comorbidities were much more likely to develop symptoms at roughly around 85% of that population, while people who had symptoms without comorbidities were only around 60%. The amount of asymptomatic people with comorbidities was significantly lower than those without comorbidities. The comorbidity population was much more likely to develop symptoms because of pre-existing conditions.



Lastly, Figure 4 shows the amounts of susceptible individuals vs. the amounts of people who recovered based on comorbidity and symptom status. This report does not take into account hospitalizations or deaths, which could be possible cases as to why specific recovery rates would be lower.



Methods

As mentioned before in the Introduction, a susceptible-exposed-infected-asymptomatic-recovered (SEIAR) model was used to calculate the results over a six month period. The SEIAR model was used two times for people with and without comorbidities. It is split up by susceptible (people susceptible to the virus), exposed (people exposed to the virus but not yet knowing if they have it or not), infectious (having the virus, being transmittable, and having symptoms), asymptomatic (having the virus, being transmittable, and not having symptoms), and recovered (people who previously had the virus but have recovered and cannot transmit it anymore). The equations were taken from a previously published paper based on spring break periods of college students from varying universities and the amount of infections based on those results. Similarly, these are the parameters used: β_i, β_a, β_{i_c}, β_{a_c} which is used for successful transmission of the virus on the non-comorbidity population versus the comorbidity population (denoted by the c in the subscript), people who were exposed and remained exposed for $\frac{1}{\sigma}$ days on average. As for symptomatic people, $(1 - \theta)$, $(1 - \theta_c)$ and the θ represents asymptomatic people. After an average of $\frac{1}{\lambda}$ days the population recovers and temporarily becomes immune.

The equations used are as follows:

$$\frac{dS}{dt} = \frac{-(\beta_i I + \beta_a A + \beta_i I_c + \beta_a A_c)}{N} \times S$$

$$\frac{dE}{dt} = \frac{(\beta_i I + \beta_a A + \beta_i I_c + \beta_a A_c)}{N} \times S - \sigma E$$

$$\frac{dI}{dt} = (1 - \theta)\sigma E - \lambda I$$

$$\frac{dA}{dt} = \theta\sigma E - \lambda A$$

$$\frac{dR}{dt} = \lambda I + \lambda A$$

$$\frac{dS_c}{dt} = \frac{-(\beta_i I_c + \beta_{a_c} A + \beta_{i_c} I_c + \beta_{a_c} A_c)}{N} \times S_c$$

$$\frac{dE_c}{dt} = \frac{-(\beta_i I_c + \beta_{a_c} A + \beta_{i_c} I_c + \beta_{a_c} A_c)}{N} \times S_c - \sigma E_c$$

$$\frac{dI_c}{dt} = (1 - \theta_c)\sigma E_c - \lambda I_c$$

$$\frac{dA_c}{dt} = \theta_c \sigma E_c - \lambda A_c$$

$$\frac{dR_c}{dt} = \lambda I_c + \lambda A_c$$

Where S, E, I, A, R, and S_c , E_c, I_c, A_c , R_c are the size of the susceptible, exposed, infectious, asymptomatic, and recovered for non comorbidity and comorbidity populations, respectively, based on the San Diego County population in 2020.

As for values, many were similar to the spring break paper. The value β_i = 0.0366, is the transmission rate for the non-comorbidity population with symptoms, and $\beta_a = 0.75 * \beta_i$ for a 75% risk of infection from an asymptomatic individual relative to a symptomatic individual. Likewise, for the comorbidity population $\beta_{i_c} = 1.053 * \beta_i$ since the rate of infection is quicker for people with comorbidities and are likely to become symptomatic, while $\beta_{a_c} = 0.75 * \beta_{i_c}$ is assigned for the comorbidity population without symptoms which was much less likely to occur. The last few parameters are listed as follows, $\sigma = \frac{1}{5}$ which stands for a 5-day period in order for the infection to spread within the host. $\lambda = \frac{1}{14}$, a 14-day infectious period, usually long enough for the host to recover. $\theta = 0.4$, and $\theta_c = \frac{\theta}{2.709}$ for the number of possible asymptomatic infections for the non-comorbidity and comorbidity populations respectively. For convenience these parameters are also put into a table (Table 1).

Table 1
Values of Parameters

β_i	0.336
β_a	0.75
β_{i_c}	1.053
β_{a_c}	0.75
σ	$\frac{1}{5}$
λ	$\frac{1}{14}$
θ	0.4
θ_c	$\frac{1}{2.709}$

References

CDC (2022). Retrieved from https://www.cdc.gov/museum/timeline/covid19.html#:~:text=January%2020%2C%202020%20CDC,18%20in%20Washington%20state

Lehnig, C.L., Oren, E. & Vaidya, N.K. Effectiveness of alternative semester break schedules on reducing COVID-19 incidence on college campuses. *Sci Rep* **12,** 2116 (2022). https://doi.org/10.1038/s41598-022-06260-1

Khagendra Adhikari, Ramesh Gautam, Anjana Pokharel, Kedar Nath Uprety, Naveen K. Vaidya, Transmission dynamics of COVID-19 in Nepal: Mathematical model uncovering effective controls, Journal of Theoretical Biology, Volume 521, 2021, 110680, ISSN 0022-5193, https://doi.org/10.1016/j.jtbi.2021.110680

(Resources from Excel Sheet)

Data.sandiegocounty.gov. (2022). Retrieved from https://data.sandiegocounty.gov/Health/Diabetes/b5ck-9qfc.

Data.sandiegocounty.gov. (2022). Retrieved from https://data.sandiegocounty.gov/Health/Pulmonary-Disease/287g-w579.

Data.sandiegocounty.gov. (2022). Retrieved from https://data.sandiegocounty.gov/Health/Overall-Heart-Disease/q8nd-kvfu.

Data.sandiegocounty.gov. (2022). Retrieved from https://data.sandiegocounty.gov/Health/Overall-Hypertensive-Diseases/5wfq-adn9.

Data.sandiegocounty.gov. (2022). Retrieved from https://data.sandiegocounty.gov/Health/Kidney-Cancer/wsm2-6niu

Data.sandiegocounty.gov. (2022). Retrieved from https://data.sandiegocounty.gov/Health/Coronary-Heart-Disease-CHD-Stroke/5sib-ba59

Data.sandiegocounty.gov. (2022). Retrieved from https://data.sandiegocounty.gov/Health/Overall-Heart-Disease/q8nd-kvfu.

Data.sandiegocounty.gov. (2022). Retrieved from https://data.sandiegocounty.gov/Demographics/2017-San-Diego-County-Demographics-Seniors-by-Hous/9ydv-mmi8

Sandiegocounty.gov. 2022. *Local Situation*. [online] Available at: <https://www.sandiegocounty.gov/content/sdc/hhsa/programs/phs/community_epidemiology/dc/2019-nCoV/status.html>

These maps show who's most at risk of COVID-19 complications in San Diego County. inewsource. (2022). Retrieved from *These maps show who's most at risk of COVID-19 complications in San Diego County*. inewsource. (2022). Retrieved from https://inewsource.org/2020/04/02/mapping-vulnerable-communities-to-covid-19-san-diego-county/.