Laidlaw Scholars Project Proposal 2021
An Observational Study on the Association Between Daily Hours of Sunlight and Incidence Rate of COVID-19

Despite nearly one third of the world population under quarantine and other major social distancing measures, coronavirus disease 2019 (COVID-19) continues to spread uncontrollably, indicating that an environmental component may play a role in its transmission.[9] When comparing sunlight to other environmental components, such as humidity and temperature, it may appear that these would have a greater impact on the transmission of COVID-19. However, a study examining physical factors on the survivability of an influenza virus with a ssRNA and lipid-containing envelope, which COVID-19 also contains, found that temperature and humidity did not influence influenza virus inactivation in a statistically significant way.[9] This indicates that sunlight may play a larger role than it originally appeared.

Sunlight synthesizes vitamin D in the human body which plays an essential role in the immune system.[1] Vitamin D has the potential to prevent at least one acute respiratory tract infection.[5] This indicates that there may be a protective effect from sufficient vitamin D status against respiratory viral infection.[1] COVID-19 is a viral respiratory infection, indicating that this protective effect could reduce the spread of the virus. Immune cells convert vitamin D from one form to another that acts in an autocrine and paracrine fashion to modulate innate and adaptive immune systems.[1] When there is a deficiency of vitamin D there is an increased risk for immune system dysregulation, which can have fatal consequences.[11] Vitamin D3 is produced when ultraviolet (UV) rays in sunlight contact with skin, while Vitamin D2 is found in yeast, sun-dried and ultraviolet irradiated mushrooms, and plants.[1] Both versions of vitamin D are metabolized into the same active form 1, 25(OH)2D.[1] Levels of the active form are the lowest during the winter and lower in the obese, the elderly, and people of color; groups who have been disproportionately affected by the pandemic.[1]

Sunlight also produces UV radiation which inactivates viruses in aerosol or skin surface by causing DNA or RNA damage to the virus by forming pyrimidine dimers, which interrupts the normal functioning of the DNA or RNA.[10] COVID-19 is stable on surfaces for 3 hours to three days, depending on the type of surface, and assumed to be readily re-aerosolized, which increases the infectivity and emphasizes the importance of finding a way to deactivate the virus.[9] When exposed to simulated sunlight and while in simulated saliva, 90% of infectious COVID-19 was found to be inactivated every 6.8 minutes.[8] However, this light corresponded to the light level of a summer solstice at sea level on a clear day.[8] Most days do not reflect this type of weather, but it suggests that even when the sunlight is at lower levels, there may still be significant inactivation. Another study found that 90% of coronaviruses were inactivated after 90 minutes when exposed to clear-sky midday levels of UVB light.[3] However, this study used calculations rather than live cells in a laboratory setting.

While much research has been performed on COVID-19, almost the entirety focuses on factors that affect severity and mortality. There has been less emphasis on factors that increase rates of incidence. One study focused on the sunlight UV radiation dose and percent positive of COVID-19 and four other coronaviruses. However, the data used in the analysis was only from April to July 2020 meaning there is insufficient exposure contrast.[10] In addition, this four-month period contains only the end of spring and beginning of summer, not an entire seasonal cycle. The study did not include any estimation of the number of unreported cases, and it divided the United States into four broad regions.[10] This prevents any regional fluctuations from being examined whether for rates of percent positive or for amount of sunlight. Examining the number of cases in a twelve-month period would allow for patterns to emerge that may have not been present in only one season. Focusing on the number of cases and sunlight at the county level would allow variations to be observed that may not have been in a more general approach.

The goal of this project is to assess if there is an association between daily hours of sunlight and the incidence of cases of COVID-19 in the United States. Daily total sunshine hours were collected from 28 stations across 26 countries from January 1, 2020, to August 17, 2020, and identified from the Global Historic Climate Network Station Inventory. Case counts data will be obtained from the public, free repository maintained by the New York Times.[7] This data will be confirmed by the public, free repository maintained by Johns Hopkins.[4] Location data to identify the zip code and unique identifier for geographic locations of COVID-19 positive patients will be accesses through the National COVID Cohort Collaborative (N3C).[6] I will use the case count data and amount of sunlight at the county level every day from January 2020-December 2020 using Kendall and Pearson rank correlation tests to measure the strength of the association between these two variables. I plan to use Stata when analyzing these factors.

I expect to find a negative correlation between hours of sunlight and COVID-19 cases. When there is a greater amount of sunlight, there will be more vitamin D3 would be produced, leading to a higher level of active vitamin D.[1] The protective effect of the vitamin would be able to take place. In addition, when there is more sunlight, the COVID-19 virus would be inactivated more quickly.[3] The research will assist public health officials in creating policies that reflect the findings by advising the general population to perform certain actions, such as taking vitamin D supplements, to limit the spread of COVID-19.

I will learn how to perform advanced epidemiology and how to apply the statistical techniques to a real-world application. I will do this by identifying various resources online, examining similar studies, and reaching out to my faculty mentor when I have questions that I am unable to answer. As a low-income student from South Carolina, I have had the opportunity to observe how different the environment and healthcare are within SC and across the United States. It gives me a passion to uncover which environmental factors have the greatest impact on health outcomes so that preventative care initiatives can be created and implemented regardless of a person's income level or geographic location. Environmental epidemiology is essential to use to identify these factors, and my project will give me the tools to continue researching how the environment impacts health, especially for lower-income groups. Additionally, I plan to apply these skills to my career as a primary care physician so that I can consider a patient's living and working environment, and tailor their care to address this in addition to their physical and mental health. I also hope to learn how to synthesize my knowledge from statistical and laboratory courses to gain a greater understanding of how COVID-19 impacts a person and a population. In addition to this, I would learn the steps to successfully perform observational studies and then apply them to future projects, especially in medical school.

I will have taken one semester of biostatistics and one semester of epidemiology. These classes were either partly online or fully, so I would have experience working independently and online. In addition, one of the courses is focused on epidemiology, which would prepare me for this research. Both classes also use Stata, which is what I will use for this project, so I will be comfortable working with the software. I am also excited to discover a relationship between sunlight and COVID-19, so I would have the drive to overcome any challenges I come across.

References

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