

Background Information

We all have the Angiotensin I converting gene (ACE) which provides instruction for making the Angiotensin-converting enzyme (ACE2). ACE2 is ubiquitous to the human body, but it is primarily expressed near the lung, heart, intestine, blood vessel, nose and mouth. The ACE gene allows the ACE2 enzyme to cut up proteins called Angiotensin I. By cutting up this protein the enzyme converts it to Angiotensin II (ANGII). ANGII increases blood pressure, cell growth, and inflames blood vessels. The ACE2 enzyme generates Almandine and Angiotensin (1-7) from ANGII. These two peptides help lower blood pressure and stop inflammation in blood vessels by regulating ANGII.

There is an ACE gene variant called the I/D (Insertion/Deletion) variant which produces 3 genotypes: II, DI, and DD. These differ among individuals because each genotype influences how much of the ACE enzyme the body produces. ACE2 acts as a receptor for SARS-CoV-2 as the virus is a spiked protein and it will be able to latch onto ACE2. This attachment initiates entry into the cells to become infected with SARS-CoV-2. When SARS-CoV-2 is bound to the ACE2 receptor, it prevents ACE2 from regulating ANGII. This allows ANGII to injure tissue and contribute to the lung and heart injuries that COVID-19 patients usually have. Since everyone has the ACE gene, but different genotypes of the I/D allele, people are unsure why they experience different symptoms when they have COVID. Do different various ACE2 genotypes cause different symptoms?

Hypothesis: If we are able to test people's DNA, who have had COVID-19 in the past, then we will see a pattern with how their symptoms affected them in relation to their ACE-2 genotypes. We will then be able to identify which people will have what symptom because of the data that was collected.

Expected Outcome: I think the expected outcome will be the variations of different people's ACE-2 receptors will cause a pattern and we'll see common side effect along with those repeating ACE-2 patterns based on the survey conducted. For example if there are more ACE2 receptors near the digestive system it will cause the symptom of vomiting for one patient compared to another patient that has more ACE2 receptors near their throat and mouth which causes the symptom of a sore throat and loss of taste

Part A: Preparation

- 1) Make a survey based on participants experience with COVID-19.
- 2) Collect salt water and insert less than 2 ml into 15ml Conical centrifuge tube.

Part B: Beginning Project

- 1) Hand out survey to participants
- 2) After completing survey ask participants to swish salt water in their mouth for 1 minute to spit into a dixie cup.
- 3) Transfer dixie cup into the 15ml Conical centrifuge tube.
- 4) Label each tube a number corresponding to participants survey.

Part C: Analyze and Assess

- 1) Test them in a BSL-2 Lab
- 2) Extract DNA from 15ml Conical centrifuge tubes using a pipette set to 1300 µl to eppy
- 3) Centrifuge samples at 13400 RPM (revolutions per minute) for 90 seconds
- 4) Take 800 µl of liquid off of the top of the tube
- 5) Take 700 µl of PBS and invert tubes
- 6) Remove supernatant to leave approximately 100 µl of liquid
- 7) Resuspend cell pellet using vortex
- 8) Put a 150 µl chelex into samples
- 9) Incubate samples for 56°C for 20 minutes
- 10) Place them into boiling water for 5 minutes
- 11) Remove 3.5 µl of DNA into an amplification tube
- 12) Add 21.5 µl of ACE2 primer onto the side of the amplification tube to amplify ACE2 gene.
- 13) Analyze ACE gene in a gel.

BSL-2 Lab Risk and Safety:

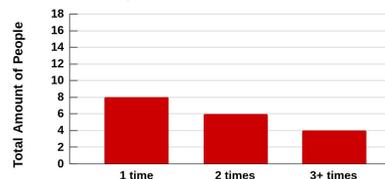
- a) Restricted area, biohazard signs, gloves and disposal of all waste under observation of Dr. Stark.

Methodology

Data Table: How Many Times Participants Have Had COVID

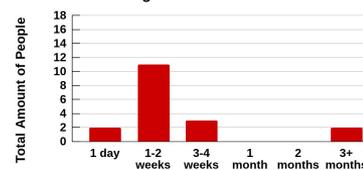
| 1 time | 2 times | 3+ times |
|--------|---------|----------|
| 1 | 2 | 6 |
| 3 | 4 | 7 |
| 5 | 9 | 10 |
| 8 | 15 | 12 |
| 11 | 17 | |
| 13 | | |
| 14 | | |
| 16 | | |

How Many Times Have You Had COVID?



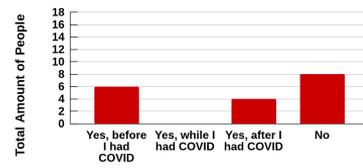
Cases of COVID Per Person

How Long Did You Have COVID?



Length of Time Someone Had COVID

Have You Ever Taken the Vaccine?



Vaccinated and Unvaccinated Individuals

Data Table: Participants Duration of Having COVID

| 1 day | 1-2 Weeks | 3-4 Weeks | 1 Month | 2 Months | 3+ Months |
|-------|-----------|-----------|---------|----------|-----------|
| 3 | 1 | 13 | | | 7 |
| 5 | 2 | 15 | | | 9 |
| | 4 | 17 | | | |
| | 6 | | | | |
| | 8 | | | | |
| | 10 | | | | |
| | 11 | | | | |
| | 12 | | | | |
| | 14 | | | | |
| | 16 | | | | |
| | 18 | | | | |

Data Table: Participants Who Took the Vaccine

| Yes, before I had COVID | Yes, while I had COVID | Yes, after I had COVID | No |
|-------------------------|------------------------|------------------------|----|
| 6 | | 1 | 2 |
| 7 | | 13 | 3 |
| 9 | | 16 | 4 |
| 10 | | 18 | 5 |
| 11 | | | 8 |
| 12 | | | 14 |
| | | | 15 |
| | | | 17 |

Conclusion: With my data so far I am able to see that participant #7 and #9 have two of the three symptoms in common so far with having COVID for over 3 months. Participants #3 and #5 also only had COVID for 1 day. This could indicate that these people could have the same ACE2 genotypes. With more information and data collecting later I will be able to see if my hypothesis is correct and if my data supports it.

G. Bibliography:

- 1) “COVID-19: angiotensin-converting enzyme 2 (ACE2) expression and tissue susceptibility to SARS-CoV-2 infection.” *PubMed Central*, 3 January 2021, <https://pmc.ncbi.nlm.nih.gov/articles/PMC7778857/>. Accessed 5 December 2025.
- 2) Hu, Pan et al. “Human ACE2 Polymorphisms from Different Human Populations Modulate SARS-CoV-2 Infection.” *Viruses* vol. 14,7 1451. 30 Jun. 2022, doi:10.3390/v14071451
- 3) Sriram, Krishna, et al. “What Is the ACE2 Receptor, How Is It Connected to Coronavirus and Why Might It Be Key to Treating COVID-19? The Experts Explain.” *The Conversation*, 14 May 2020, <https://doi.org/10.64628/AAI.r95ae53f4>.
- 4) Strafella, Claudia, et al. “Analysis of ACE2 Genetic Variability among Populations Highlights a Possible Link with COVID-19-Related Neurological Complications.” *Genes*, vol. 11, no. 7, July 2020, p. 741. *DOI.org (Crossref)*, <https://doi.org/10.3390/genes11070741>.
- 5) Oudit, Gavin Y., et al. “Angiotensin-Converting Enzyme 2—at the Heart of the COVID-19 Pandemic.” *Cell*, vol. 186, no. 5, Mar. 2023, pp. 906–22. *ScienceDirect*, <https://doi.org/10.1016/j.cell.2023.01.039>.
- 6) *ACE Gene: MedlinePlus Genetics*. 1 May 2013, <https://medlineplus.gov/genetics/gene/ace/>.