Prevalence of SARS-CoV-2 Antibodies in Liberty University Student Population

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Honors Thesis

Outline

- Introduction & Background
- Research Question
- Study Design & Methods
- Results & Discussion
- Significant Conclusions
- Recommendations & Future Research

Introduction: Antibodies and Vaccines

Antibodies

- Produced by B cells in the human immune system
- Created for a specific antigen
- Types that respond to viruses
  - IgM – short-term for acute infections
  - IgG – long-term immunity

Vaccines

- Introduce a weakened version or piece of the virus
- The antigen is attacked and memory T cells are created
- New mRNA vaccines instead cause the body's cells to produce the antigens themselves, hoping for the same effect

Background: SARS-CoV-2

- SARS-CoV-2 causes COVID-19
- Antibodies to SARS-CoV-2 do not last as long as others
  - IgM – mean 35 days
  - IgG – mean 49 days
  - Reinfection is common and full immunity seems unlikely
- The COVID-19 vaccine uses mRNA
  - Does not prevent infections
  - May lower transmissibility and/or viral load
- Research is new and incomplete

Research Problem

Residential university students have many personal contacts and low rates of COVID-19 complications

During early 2021, COVID-19 tests were regularly given, antibody testing was common, and vaccines became available

Study Question: What is the prevalence of SARS-CoV-2 antibodies in the LU residential undergraduate student population and how does it correlate with vaccination status and antibody-type fluctuations?

Study Design

Longitudinal observational study

- Conducted by Dr. Rockabrand and Dr. DeWitt
- Method: Measured SARS-CoV-2 antibodies with Healgen Covid-19 IgG/IgM Rapid Test Cassette and gathered student information on a survey
- Test one: 02/08/2021 – 02/11/2021, test two: 04/14/2021– 04/22/2021
- Sample: 107 Liberty University undergraduate health sciences students

Statistical Analysis

- Used the R statistical programming language
- Extensive data cleaning to make the information usable
- Summarizing the data's important details
- Running ANOVA, *t*-tests, and GLMs to find significant correlations

Data Cleaning

Correcting syntactic and semantic errors

- There were inconsistencies in how various volunteers recorded the data
- Coding schemes were introduced to represent the information consistently

Correcting coverage anomalies

- Missing data points existed for many participants
- Any participant that did not have data for both time points was removed, as well as if they were missing a significant amount of information at either time

Challenges with using pre-existing data

- The data was collected without knowledge of its future usage
- Inconsistencies, lack of quantitative data, and convenience sampling occurred
- Thus, GLMs are not usable and assumptions may not be met

Results: General Seropositivity

	Survey 1 Administered 2/2021			Survey 2 Administered 4/2021		
	Total	Seropositive	Percent	Total	Seropositive	Percent
Overall	105	27	26%	105	38	36%
Male	16	7	44%	16	9	56%
Female	89	20	22%	89	28	31%
In a dorm	81	24	30%	81	30	37%
Off Campus	24	3	13%	24	7	29%
Positive Test	20	9	45%	8	4	50%
Negative Test	49	10	20%	26	8	31%
No COVID Test	33	8	24%	71	25	35%
Illness	19	6	32%	18	6	33%
No Illness	84	21	25%	85	30	35%
Had Close Contact	70	21	30%	49	18	37%
No Close Contact	26	5	19%	55	19	35%
Vaccinated	4	3	75%	22	15	68%
Unvaccinated	98	24	24%	83	22	27%

Results: ANOVA for IgG & IgM

ANOVA Table for IgG Antibodies in April

Factor	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Prior IgG Antibodies	1	8.103	8.103	66.08	1.13e-12
Older COVID-19 Infection	1	1.401	1.401	11.42	0.00103
Recent Vaccination	1	2.359	2.359	19.23	2.84e-05
Residuals	101	12.385	0.123		

ANOVA Table for IgM Antibodies in April

Factor	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Prior IgM Antibodies	1	1.847	1.8465	17.151	7.17e-05
Recent COVID-19 Infection	1	0.616	0.6165	5.726	0.01856
Recent Vaccination	1	0.911	0.9109	8.461	0.00446
Residuals	101	10.874	0.1077		

Discussion: Seropositivity Prevalence

- Both seropositivity and vaccination rates increased during the study but were well below national levels
- Having symptoms of illness or close contact with an ill person did not correlate with seropositivity
- Vaccination and positive COVID tests were correlated with seropositivity
- Antibodies fluctuated more than expected, with some antibodies disappearing altogether and others going from IgG to both types

Discussion: IgG & IgM ANOVA Results

It was shown that natural infection gives short-lived IgM antibodies quickly and long-lived IgG antibodies after a period, as expected

- This is the expected behavior
- However, seropositive participants could still be infected
- IgG did not persist as long as expected

Vaccination gives short-lived IgM and IgG antibodies rapidly

- Unexpected because IgG generally take longer to appear
- Explains the need for frequent boosters
- COVID-19 IgM antibodies may persist as long as IgG in some cases

Significant Conclusions

- SARS-CoV-2 antibodies have more fluctuations and significantly shorter durations than expected
- IgG antibodies are correlated with recent vaccination and older infection, while IgM are correlated with recent vaccination and recent infection
- Neither infection nor vaccination can guarantee seropositivity and it cannot guarantee protection from infection

Relevance & Recommendations

Field of Statistics

- This study follows best practices for using the data without misinterpreting results while using a variety of common biostatistical tests
- GLMs are uninterpretable without a continuous independent variable
- Data cleaning techniques must be tailored to each unique problem

Medical Field

- Contributes to the understanding that immunity to SARS-CoV-2 is unlikely, regardless of vaccination status or prior infections
- Continue to study university students because of their unique circumstances
- Recognize and study the differences between vaccine-initiated and infection-initiated antibodies

Future Research

Questions arising during the study

- Why does antibody production differ between infection and vaccination?
- Does vaccination give greater short-term protection from infection?
- Do LU students have the same general trends as students from other universities?

Ways to improve the study

- Increase the sample size and improve sampling techniques
- Collect more quantitative data about the timing of COVID infections and vaccinations
- Expand to more universities and/or other age groups

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Questions?