Vaccination Effectiveness against the Omicron COVID-19 Variant

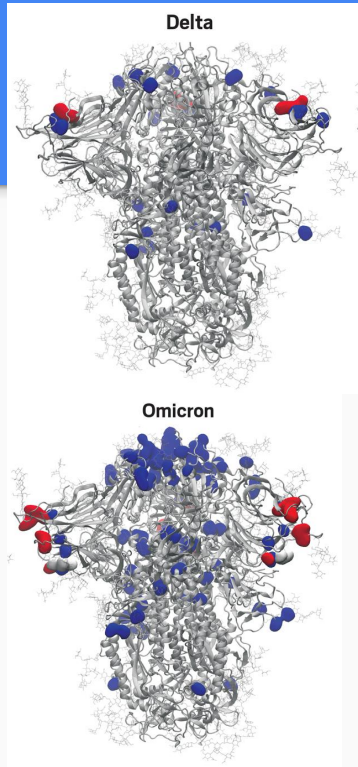
Brynn Brady

Background: The Omicron Variant

- COVID-19 omicron (B.1.1.529) variant
- First appeared in November 2021 in Botswana and South Africa
- Large concerns arose due to the severe acute respiratory syndromes in vaccinated populations
- Scientists and the community began questioning the vaccines' effectivenesses against the omicron variant, which led to initial molecular biology research on the variant

Initial Molecular and Structural Research

- In comparison to the delta variant, there were significantly more mutations in the omicron from the original virus
- Alarming number of mutations in receptor-binding domains in the spike protein (shown in the pictures to the right)
- These mutations have been associated with increased transmissibility and immune evasion
- We have a reduced neutralizing antibody response to omicron compared to delta
    - Neutralizing antibodies are important for protection against reinfection and initial vaccine effectiveness against infection
- Initial research suggests omicron will be more contagious



Cross 2021

Research Question: How does one's vaccination status affect their response to the COVID-19 omicron variant?

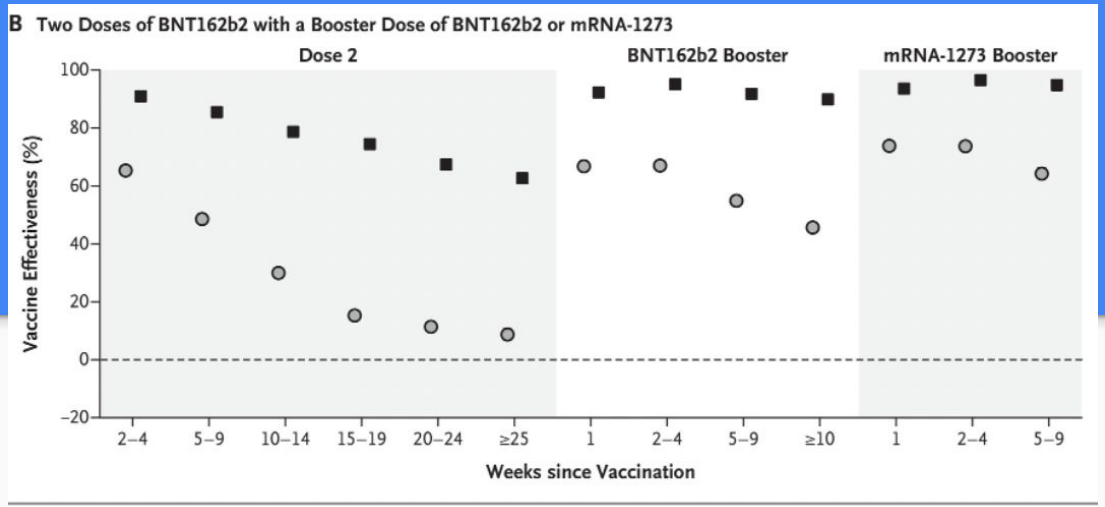
My hypothesis:

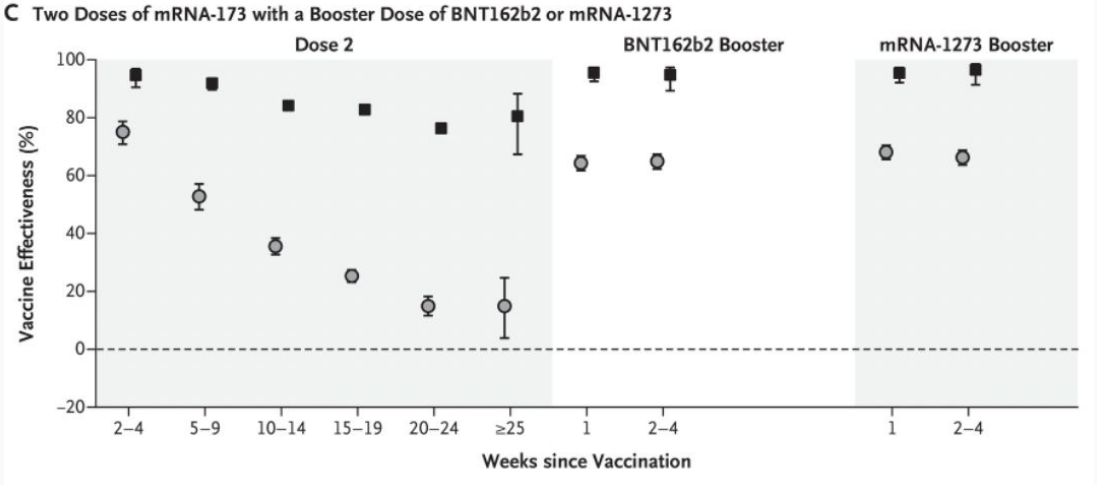
- Being boosted (3 shots) provides the most protection against severe and mild illness due to omicron
- Being fully vaccinated (2 shots) provides some protection, but this protection has likely waned since one's initial immunization
- No vaccination can provide as much protection against omicron as the other variants

Previous study: Vaccine effectiveness against symptomatic illness from delta and omicron variants

- Observational study conducted earlier this year (April 2022)
- Test-negative case-control design
- Vaccines provide more and longer protection against delta than omicron
- Primary immunization (2 shots) provides no protection against omicron
- Boosters provide substantial and rapid protection against omicron
- Protection from vaccine (primary vaccination or booster) wanes substantially against omicron compared to delta

Critical Findings





Andrews *et al.* 2022

Conclusion: vaccine is more effective and has longer protection against delta than omicron

Figure: Vaccine Effectiveness against Symptomatic Disease Caused by the Delta and Omicron Variants, According to the Period after the Second and Booster Doses

My Methodology

- Survey targeted at the portion of Menlo that has tested positive
- Questions asked:
  - Vaccination status
  - Date of infection (used to determine which variant infected them)
  - Symptom severity (scale from 1, no symptoms, to 4, hospitalization)
  - Symptom length
- Perform basic statistical analysis and chi-squared inference test for independence

Results

			Symptom Length			
		No symptoms	3 days or less	1 or 2 weeks	More than 2 weeks (lingering symptoms)	**Total**
	Unvaccinated	0	0	3	2	**5**
	Partially Vaccinated	0	2	1	0	**3**
Vaccination status	Fully Vaccinated	8	7	7	2	**24**
	Boosted	5	7	6	3	**21**
	Total	**13**	**16**	**17**	**7**	**53**

			Symptom Severity		
		No symptoms	Light symptoms	Mild Symptoms	**Total**
	Unvaccinated	0	3	2	**5**
	Partially Vaccinated	0	2	1	**3**
Vaccination status	Fully Vaccinated	8	9	7	**24**
	Boosted	5	9	7	**21**
	Total	**13**	**23**	**17**	**53**

Chi-square test for independence shows no statistical significance due to small sample size

Brady 2022

Results

Omicron Variant	
Vaccination Status	**Average Symptom Severity**
all	2.048
boosted	2.05
vaccinated	2.053
unvaccinated	NA

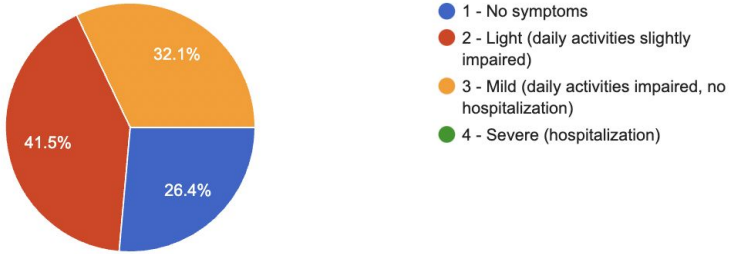
Non-omicron Variants	
Vaccination Status	**Average Symptom Severity**
all	2.091
boosted	NA
vaccinated	1.25
unvaccinated	2.4

Brady 2022

Interesting findings about the Menlo community

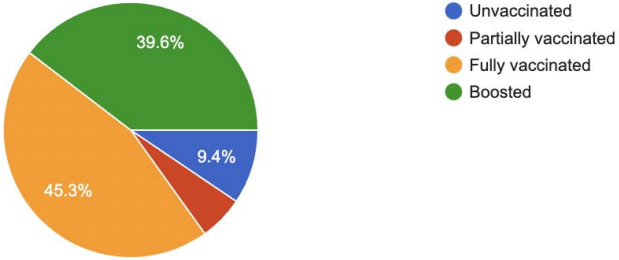
How severe were your COVID-19 symptoms?

53 responses



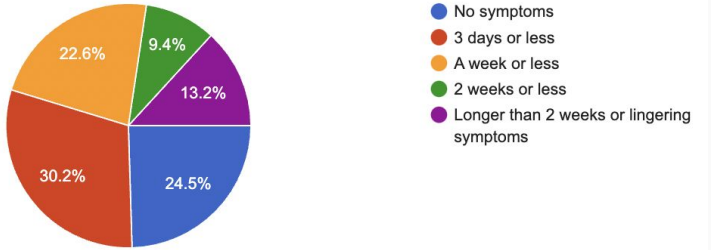
What was your vaccination status when you last tested positive for COVID-19?

53 responses



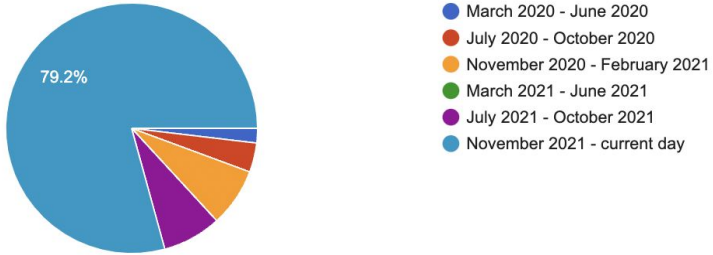
What was the length of your COVID-19 symptoms?

53 responses



When did you last test positive for COVID-19?

53 responses



Brady 2022

Conclusion

- Boosters are critical to protection against symptomatic disease from omicron (2 shots provides almost no protection)
- Vaccine effectiveness wanes dramatically more with omicron than other variants
- Did not gather a large enough sample size to find convincing statistical evidence for the importance of vaccination
- Target population in the study is the Menlo community, a highly vaccinated community, and thus, the impact of omicron on unvaccinated individuals could not be studied with much statistical power

Sources

Andrews, N., Stowe, J., Kirsebom, F., Toffa, S., Rickeard, T., Gallagher, E., Gower, C., Kall, M., Groves, N., O'Connell, A., Simons, D., Blomquist, P., Zaidi, A., Nash, S., Aziz, N. I. B. A., Thelwall, S., Dabrera, G., Myers, R., Amirthalingam, G., Gharbia, S., Barrett, J. C., Elson, R., Ladhani, S. N., Ferguson, N., Zambon, M., Campbell, C. N. J., Brown, K., Hopkins, S., Chand, M., Ramsay, M., Bernal, J. L. (2022). Covid-19 Vaccine Effectiveness against the Omicron (B.1.1.529) Variant. N Engl J Med 386, 1532-1546.

Image: https://cen.acs.org/pharmaceuticals/vaccines/Omicron-puts-scientists-red-alert/99/i44