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Estimating Population Immunity and Impact of COVID-19 Vaccination in Washington and Oregon

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BACKGROUND

Washington State and Oregon both had >75% uptake of at least one dose of an mRNA-based COVID vaccine. **But how effective was this campaign at averting hospitalizations?** Estimating the effectiveness of this vaccination campaign can be challenging given the

1. Buildup of immunity (infection + vaccination),
2. Emergence of new variants.
3. Changes in social distancing.

METHODS

We evaluated vaccine effectiveness with **model-based counterfactuals** with either **no vaccination** or more limited vaccination.

- We conducted a systematic review on vaccine- and infection acquired immunity (Moore, Vaccine, 2025).
- Created a compartmental model of population immunity (Figure 1).
- Calibrated our model to vaccination and hospitalization data from 16 regions in Washington and Oregon (Jan 2020-Dec 2022).
- We simulated infection and hospitalization from January 2020 until December 2022 (September 2022 in Oregon) in a counterfactual vaccine-free scenario.

Vaccination ***reduced COVID hospitalizations*** in Washington and Oregon by 74% from 2020 to 2022 overall and by ***87%*** during the Delta wave.

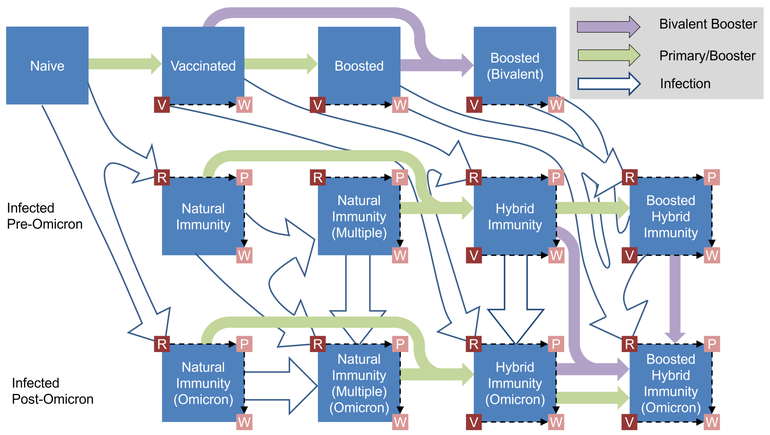


Figure 1: Compartmental model tracking COVID immunity. Each class (larger blue boxes) and subclass (smaller red boxes) has a different susceptibility to infection and severe disease based on our literature review. V: Recent Vaccination, R: Recent Infection, W: Waned Immunity P: Waned Immunity, and seropositive.

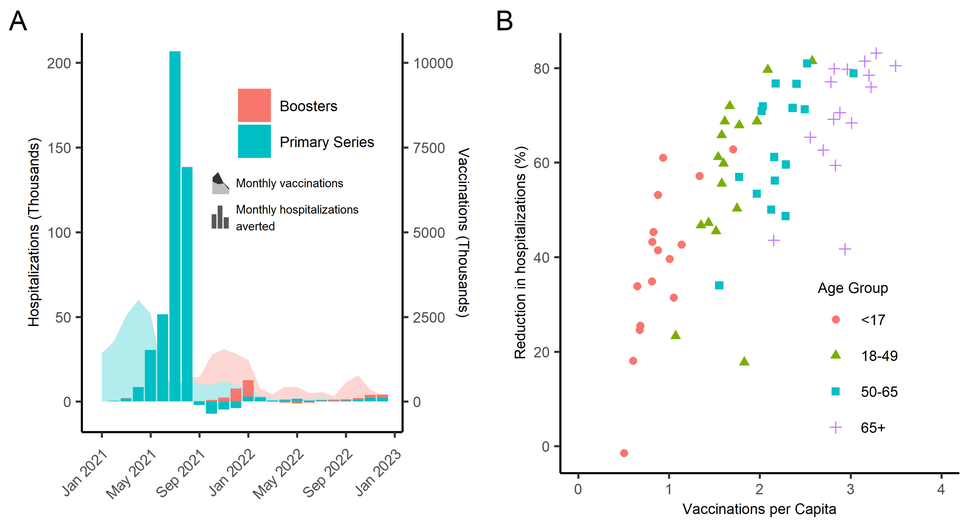


Figure 2: A) Monthly vaccinations (shaded areas) and hospitalizations averted (bars) in Washington State and Oregon Combined. B) Relationship between the per-capita number of vaccine doses in reduction in hospitalizations. Each dot represents a single age group within a health reporting region.

RESULTS

- Vaccination reduced hospitalizations by 74%. Booster doses alone reduced hospitalization by 15% (Table 1)
- Benefits of primary vaccination peaked in 2021 (Figure 1A), reducing hospitalization by 90% and 87% during the Alpha and Delta waves, respectively (Table 1).
- Vaccination had a larger impact in older age groups, which had higher uptake (Figure 2A, Table 1).
- Vaccination of individuals 18-49 had very large indirect benefits, averting 42.4% of hospitalizations (34.6% - 58.2%) among those aged 65+ compared to only vaccinating individuals 50+ (not shown).

Table 1: Absolute number of hospitalization in observed and counterfactual scenarios and percent hospitalizations averted. Median estimates with 95% credible interval

	Hospitalization (thousands)			Reduction(%) from	
	With Vaccination	No Vaccination	No Boosters	All Vaccination	Boosters Only
Age Group					
0-17	4 (4 - 4)	8 (7 - 9)	4 (4 - 5)	50.1 (40.4 - 57.3)	6.9 (1.5 - 11.6)
18-49	39 (39 - 39)	131 (95 - 159)	43 (41 - 44)	70.4 (60.0 - 75.4)	8.5 (5.2 - 11.7)
50-64	37 (36 - 37)	132 (104 - 165)	42 (40 - 43)	72.2 (65.2 - 77.7)	11.8 (7.9 - 15.5)
65+	74 (74 - 75)	330 (270 - 381)	92 (85 - 99)	77.5 (72.8 - 80.5)	19.4 (13.0 - 24.5)
Variant					
Ancestral	44 (44 - 44)	45 (45 - 46)	44 (44 - 44)	3.1 (2.5 - 3.5)	0.0 (0.0 - 0.0)
Alpha	10 (10 - 10)	106 (82 - 136)	10 (10 - 10)	90.4 (87.8 - 92.6)	0.5 (0.4 - 0.6)
Delta	50 (49 - 50)	383 (267 - 486)	60 (58 - 63)	87.0 (81.9 - 89.8)	17.6 (14.0 - 21.2)
Omicron	51 (50 - 51)	70 (54 - 87)	67 (57 - 77)	27.4 (6.5 - 41.9)	24.0 (11.8 - 34.0)
Combined	**154 (154 - 155)**	**599 (478 - 710)**	**180 (170 - 191)**	**74.3 (68.5 - 78.3)**	**14.6 (9.4 - 19.1)**

CONCLUSIONS

- The COVID-19 vaccination campaign was highly effective, particularly during the Alpha and Delta Waves
- Despite limited uptake, booster doses also averted a significant number of hospitalization during the Omicron Wave.
- Due to indirect effects, vaccinating adults ages 18-49 proved to be just as important as vaccinating individuals 50+.

ADDITIONAL INFORMATION

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