

COVID-19 Correlates of Risk Analysis Report
mock Study

USG COVID-19 Response Biostatistics Team

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Chapter 1

Summary Tables

Table 1. Demographic and Clinical Characteristics at Baseline in the Baseline SARS-CoV-2 Negative Per-Protocol Cohort

Characteristics	Vaccine (N = 914)	Placebo (N = 156)	Total (N = 1070)
Age			
Age < 65	441 (48.2%)	79 (50.6%)	520 (48.6%)
Age ≥ 65	473 (51.8%)	77 (49.4%)	550 (51.4%)
Mean (Range)	58.3 (18.0, 85.0)	59.9 (18.0, 85.0)	58.5 (18.0, 85.0)
BMI			
Mean ± SD	29.8 ± 7.0	29.8 ± 7.0	29.8 ± 7.0
Risk for Severe Covid-19			
At-risk	466 (51.0%)	77 (49.4%)	543 (50.7%)
Not at-risk	448 (49.0%)	79 (50.6%)	527 (49.3%)
Age, Risk for Severe Covid-19			
Age < 65 At-risk	220 (24.1%)	39 (25.0%)	259 (24.2%)
Age < 65 Not at-risk	221 (24.2%)	40 (25.6%)	261 (24.4%)
Age ≥ 65	473 (51.8%)	77 (49.4%)	550 (51.4%)
Sex			
Female	516 (56.5%)	93 (59.6%)	609 (56.9%)
Male	398 (43.5%)	63 (40.4%)	461 (43.1%)
Hispanic or Latino ethnicity			
Hispanic or Latino	118 (12.9%)	16 (10.3%)	134 (12.5%)
Not Hispanic or Latino	707 (77.4%)	122 (78.2%)	829 (77.5%)
Not reported and unknown	89 (9.7%)	18 (11.5%)	107 (10.0%)
Race			
White Non-Hispanic	373 (40.8%)	67 (42.9%)	440 (41.1%)
Black or African American	179 (19.6%)	30 (19.2%)	209 (19.5%)
Asian	84 (9.2%)	14 (9.0%)	98 (9.2%)
American Indian or Alaska Native	24 (2.6%)	4 (2.6%)	28 (2.6%)
Native Hawaiian or Other Pacific Islander	9 (1.0%)	1 (0.6%)	10 (0.9%)
Multiracial	52 (5.7%)	7 (4.5%)	59 (5.5%)
Other	29 (3.2%)	5 (3.2%)	34 (3.2%)
Not reported and unknown	88 (9.6%)	18 (11.5%)	106 (9.9%)
Communities of Color	414 (45.3%)	64 (41.0%)	478 (44.7%)

(continued)

Characteristics	Vaccine (N = 914)	Placebo (N = 156)	Total (N = 1070)
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This table summarizes the random subcohort, which was randomly sampled from the per-protocol cohort. The sampling was stratified by 24 strata defined by enrollment characteristics: Assigned treatment arm × Baseline SARS-CoV-2 naïve vs. non-naïve status (defined by serostatus and NAAT testing) × Randomization strata (Age < 65 and at-risk, Age < 65 and not at-risk, Age ≥ 65) × Communities of color (Yes/No) defined by White Non-Hispanic vs. all others (following the primary COVE trial paper).

Table 2. Demographic and Clinical Characteristics at Baseline in the Baseline SARS-CoV-2 Positive Per-Protocol Cohort

Characteristics	Vaccine (N = 285)	Placebo (N = 280)	Total (N = 565)
Age			
Age < 65	152 (53.3%)	149 (53.2%)	301 (53.3%)
Age ≥ 65	133 (46.7%)	131 (46.8%)	264 (46.7%)
Mean (Range)	55.9 (18.0, 85.0)	56.5 (18.0, 85.0)	56.2 (18.0, 85.0)
BMI			
Mean ± SD	29.9 ± 7.3	29.5 ± 6.5	29.7 ± 6.9
Risk for Severe Covid-19			
At-risk	133 (46.7%)	128 (45.7%)	261 (46.2%)
Not at-risk	152 (53.3%)	152 (54.3%)	304 (53.8%)
Age, Risk for Severe Covid-19			
Age < 65 At-risk	76 (26.7%)	75 (26.8%)	151 (26.7%)
Age < 65 Not at-risk	76 (26.7%)	74 (26.4%)	150 (26.5%)
Age ≥ 65	133 (46.7%)	131 (46.8%)	264 (46.7%)
Sex			
Female	168 (58.9%)	147 (52.5%)	315 (55.8%)
Male	117 (41.1%)	133 (47.5%)	250 (44.2%)
Hispanic or Latino ethnicity			
Hispanic or Latino	31 (10.9%)	27 (9.6%)	58 (10.3%)
Not Hispanic or Latino	220 (77.2%)	228 (81.4%)	448 (79.3%)
Not reported and unknown	34 (11.9%)	25 (8.9%)	59 (10.4%)
Race			
White Non-Hispanic	126 (44.2%)	124 (44.3%)	250 (44.2%)
Black or African American	50 (17.5%)	44 (15.7%)	94 (16.6%)
Asian	19 (6.7%)	24 (8.6%)	43 (7.6%)
American Indian or Alaska Native	8 (2.8%)	10 (3.6%)	18 (3.2%)
Native Hawaiian or Other Pacific Islander	5 (1.8%)	6 (2.1%)	11 (1.9%)
Multiracial	16 (5.6%)	14 (5.0%)	30 (5.3%)
Other	6 (2.1%)	7 (2.5%)	13 (2.3%)
Not reported and unknown	30 (10.5%)	31 (11.1%)	61 (10.8%)
Communities of Color	118 (41.4%)	112 (40.0%)	230 (40.7%)

This table summarizes the random subcohort, which was randomly sampled from the per-protocol cohort. The sampling was stratified by 24 strata defined by enrollment characteristics: Assigned treatment arm × Baseline SARS-CoV-2 naïve vs. non-naïve status (defined by serostatus and NAAT testing) × Randomization strata (Age < 65 and at-risk, Age < 65 and not at-risk, Age ≥ 65) × Communities of color (Yes/No) defined by White Non-Hispanic vs. all others (following the primary COVE trial paper).

Table 3. Antibody levels in the baseline SARS-CoV-2 negative per-protocol cohort (vaccine recipients)

Visit	Marker	Baseline SARS-CoV-2 Negative Vaccine Recipients						Comparison	
		Cases*			Non-Cases/Control			Resp Rate Difference	GMTR/GMCR
N	Resp rate	GMT/GMC	N	Resp rate	GMT/GMC				
Day 29	Pseudovirus-nAb ID80	51 48/51 = 94.1% (82.9%, 98.1%)	43.97 (35.67, 54.20)	759 10825.2/11177 = 96.9% (94.3%, 98.3%)	59.07 (54.60, 63.90)	-0.03 (-0.14, 0.02)	0.74 (0.60, 0.93)		
Day 29	Pseudovirus-nAb ID50	51 51/51 = 100.0% (100.0%, 100.0%)	146.33 (117.72, 181.90)	759 11158.3/11177 = 99.8% (99.3%, 100.0%)	259.24 (237.94, 282.45)	0 (0, 0.01)	0.56 (0.45, 0.71)		
Day 29	Anti RBD IgG (IU/ml)	51 51/51 = 100.0% (100.0%, 100.0%)	424.70 (272.93, 660.87)	759 11167.6/11177 = 99.9% (99.4%, 100.0%)	480.37 (412.32, 559.66)	0 (0, 0.01)	0.88 (0.55, 1.41)		
Day 29	Anti Spike IgG (IU/ml)	51 51/51 = 100.0% (100.0%, 100.0%)	199.31 (139.24, 285.30)	759 11177/11177 = 100.0% (100.0%, 100.0%)	307.86 (271.30, 349.34)	0 (0, 0)	0.65 (0.44, 0.95)		
Day 29	Anti N IgG (IU/ml)	51 51/51 = 100.0% (100.0%, 100.0%)	25.06 (15.27, 41.12)	759 10946.7/11177 = 97.9% (95.7%, 99.0%)	43.67 (36.20, 52.68)	0.02 (0.01, 0.04)	0.57 (0.34, 0.97)		
Day 57	Pseudovirus-nAb ID80	51 51/51 = 100.0% (100.0%, 100.0%)	817.23 (671.68, 994.32)	746 11123/11123 = 100.0% (100.0%, 100.0%)	1343.71 (1248.80, 1445.83)	0 (0, 0)	0.61 (0.49, 0.75)		
Day 57	Pseudovirus-nAb ID50	51 51/51 = 100.0% (100.0%, 100.0%)	3595.84 (2844.47, 4545.67)	746 11123/11123 = 100.0% (100.0%, 100.0%)	5838.96 (5400.96, 6312.47)	0 (0, 0)	0.62 (0.48, 0.79)		
Day 57	Anti RBD IgG (IU/ml)	51 51/51 = 100.0% (100.0%, 100.0%)	10654.37 (6524.76, 17397.65)	746 11123/11123 = 100.0% (100.0%, 100.0%)	15585.81 (13056.73, 18604.76)	0 (0, 0)	0.68 (0.41, 1.15)		
Day 57	Anti Spike IgG (IU/ml)	51 51/51 = 100.0% (100.0%, 100.0%)	4680.49 (3271.09, 6697.15)	746 11123/11123 = 100.0% (100.0%, 100.0%)	9122.73 (7812.78, 10652.33)	0 (0, 0)	0.51 (0.35, 0.76)		
Day 57	Anti N IgG (IU/ml)	51 51/51 = 100.0% (100.0%, 100.0%)	410.50 (218.31, 771.89)	746 11123/11123 = 100.0% (100.0%, 100.0%)	443.60 (355.51, 553.53)	0 (0, 0)	0.93 (0.47, 1.81)		

*Cases are baseline negative per-protocol vaccine recipients with the symptomatic infection COVID-19 primary endpoint diagnosed starting 7 days after the Day 57 study visit. Non-cases/Controls are baseline negative per-protocol vaccine recipients sampled into the random subcohort with no evidence of SARS-CoV-2 infection up to the time of data cut.

Table 4. Antibody levels in the baseline SARS-CoV-2 positive per-protocol cohort (vaccine recipients)

Visit	Marker	Baseline SARS-CoV-2 Positive Vaccine Recipients						Comparison	
		Cases*			Non-Cases/Control			Resp Rate Difference	GMTR/GMCR
N	Resp rate	GMT/GMC	N	Resp rate	GMT/GMC				
Day 29	Pseudovirus-nAb ID80	5 5/5 = 100.0% (100.0%, 100.0%)	57.80 (31.67, 105.49)	229 1138.4/1145 = 99.4% (97.7%, 99.9%)	96.08 (85.12, 108.46)	0.01 (0, 0.02)	0.60 (0.33, 1.11)		
Day 29	Pseudovirus-nAb ID50	5 5/5 = 100.0% (100.0%, 100.0%)	311.11 (180.17, 537.23)	229 1145/1145 = 100.0% (100.0%, 100.0%)	415.31 (362.35, 476.02)	0 (0, 0)	0.75 (0.43, 1.32)		
Day 29	Anti RBD IgG (IU/ml)	5 5/5 = 100.0% (100.0%, 100.0%)	486.71 (287.89, 822.84)	229 1145/1145 = 100.0% (100.0%, 100.0%)	814.72 (594.26, 1116.96)	0 (0, 0)	0.60 (0.32, 1.10)		
Day 29	Anti Spike IgG (IU/ml)	5 5/5 = 100.0% (100.0%, 100.0%)	209.86 (80.48, 547.24)	229 1145/1145 = 100.0% (100.0%, 100.0%)	418.61 (327.58, 534.94)	0 (0, 0)	0.50 (0.19, 1.35)		
Day 29	Anti N IgG (IU/ml)	5 5/5 = 100.0% (100.0%, 100.0%)	38.97 (21.50, 70.62)	229 1145/1145 = 100.0% (100.0%, 100.0%)	64.06 (47.26, 86.83)	0 (0, 0)	0.61 (0.31, 1.19)		
Day 57	Pseudovirus-nAb ID80	5 5/5 = 100.0% (100.0%, 100.0%)	1691.61 (720.34, 3972.49)	229 1143/1143 = 100.0% (100.0%, 100.0%)	3022.95 (2642.20, 3458.57)	0 (0, 0)	0.56 (0.24, 1.33)		
Day 57	Pseudovirus-nAb ID50	5 5/5 = 100.0% (100.0%, 100.0%)	5900.11 (4211.01, 8266.73)	229 1143/1143 = 100.0% (100.0%, 100.0%)	14890.68 (12949.37, 17123.02)	0 (0, 0)	0.40 (0.28, 0.57)		
Day 57	Anti RBD IgG (IU/ml)	5 5/5 = 100.0% (100.0%, 100.0%)	20514.88 (11253.40, 37398.50)	229 1143/1143 = 100.0% (100.0%, 100.0%)	35079.58 (26763.73, 45979.27)	0 (0, 0)	0.58 (0.30, 1.13)		
Day 57	Anti Spike IgG (IU/ml)	5 5/5 = 100.0% (100.0%, 100.0%)	6762.11 (2828.05, 16168.78)	229 1143/1143 = 100.0% (100.0%, 100.0%)	26157.90 (20081.62, 34072.73)	0 (0, 0)	0.26 (0.10, 0.64)		
Day 57	Anti N IgG (IU/ml)	5 5/5 = 100.0% (100.0%, 100.0%)	1795.69 (369.41, 8728.76)	229 1143/1143 = 100.0% (100.0%, 100.0%)	1034.16 (688.86, 1552.53)	0 (0, 0)	1.74 (0.34, 8.89)		

*Cases are baseline positive per-protocol vaccine recipients with the symptomatic infection COVID-19 primary endpoint diagnosed starting 7 days after the Day 57 study visit. Non-cases/Controls are baseline negative per-protocol vaccine recipients sampled into the random subcohort with no evidence of SARS-CoV-2 infection up to the time of data cut.

Table 5. Antibody levels in the baseline SARS-CoV-2 positive per-protocol cohort (placebo recipients)

Visit	Marker	Baseline SARS-CoV-2 Positive Placebo Recipients							
		Cases*				Non-Cases/Control			Comparison
		N	Resp rate	GMT/GMC	N	Resp rate	GMT/GMC	Resp Rate Difference	GMTR/GMCR
Day 29	Pseudovirus-nAb ID80	5	3/5 = 60.0% (10.6%, 95.0%)	23.91 (10.34, 55.27)	225	974.9/1056 = 92.3% (85.8%, 96.0%)	40.71 (36.13, 45.87)	-0.32 (-0.82, 0.03)	0.59 (0.25, 1.37)
Day 29	Pseudovirus-nAb ID50	5	5/5 = 100.0% (100.0%, 100.0%)	127.77 (52.66, 309.97)	225	1056/1056 = 100.0% (100.0%, 100.0%)	180.45 (158.26, 205.74)	0 (0, 0)	0.71 (0.29, 1.73)
Day 29	Anti RBD IgG (IU/ml)	5	5/5 = 100.0% (100.0%, 100.0%)	341.51 (39.73, 2935.73)	225	1045.1/1056 = 99.0% (93.0%, 99.9%)	381.70 (290.52, 501.50)	0.01 (0, 0.07)	0.89 (0.10, 7.83)
Day 29	Anti Spike IgG (IU/ml)	5	5/5 = 100.0% (100.0%, 100.0%)	160.79 (41.02, 630.32)	225	1056/1056 = 100.0% (100.0%, 100.0%)	175.50 (140.32, 219.50)	0 (0, 0)	0.92 (0.23, 3.66)
Day 29	Anti N IgG (IU/ml)	5	5/5 = 100.0% (100.0%, 100.0%)	23.30 (5.45, 99.68)	225	1054.2/1056 = 99.8% (98.8%, 100.0%)	32.14 (23.77, 43.47)	0 (0, 0.01)	0.72 (0.16, 3.20)
Day 57	Pseudovirus-nAb ID80	5	5/5 = 100.0% (100.0%, 100.0%)	1242.45 (493.77, 3126.34)	225	1055/1055 = 100.0% (100.0%, 100.0%)	1060.96 (936.81, 1201.56)	0 (0, 0)	1.17 (0.46, 2.97)
Day 57	Pseudovirus-nAb ID50	5	5/5 = 100.0% (100.0%, 100.0%)	3977.77 (1326.22, 11930.65)	225	1055/1055 = 100.0% (100.0%, 100.0%)	4484.18 (3820.16, 5263.63)	0 (0, 0)	0.89 (0.29, 2.69)
Day 57	Anti RBD IgG (IU/ml)	5	5/5 = 100.0% (100.0%, 100.0%)	15491.34 (2083.50, 115182.03)	225	1055/1055 = 100.0% (100.0%, 100.0%)	10747.31 (7832.92, 14746.04)	0 (0, 0)	1.44 (0.19, 10.99)
Day 57	Anti Spike IgG (IU/ml)	5	5/5 = 100.0% (100.0%, 100.0%)	8737.81 (1343.16, 56842.85)	225	1055/1055 = 100.0% (100.0%, 100.0%)	7188.56 (5611.06, 9209.56)	0 (0, 0)	1.22 (0.18, 8.04)
Day 57	Anti N IgG (IU/ml)	5	5/5 = 100.0% (100.0%, 100.0%)	241.79 (13.99, 4178.36)	225	1055/1055 = 100.0% (100.0%, 100.0%)	346.96 (241.86, 497.72)	0 (0, 0)	0.70 (0.04, 12.32)

*Cases are baseline negative per-protocol vaccine recipients with the symptomatic infection COVID-19 primary endpoint diagnosed starting 7 days after the Day 57 study visit. Non-cases/Controls are baseline negative per-protocol vaccine recipients sampled into the random subcohort with no evidence of SARS-CoV-2 infection up to the time of data cut.

Chapter 2

Graphical Descriptions of Antibody Marker Data

2.1 Boxplots

2.1.1 Baseline seronegative

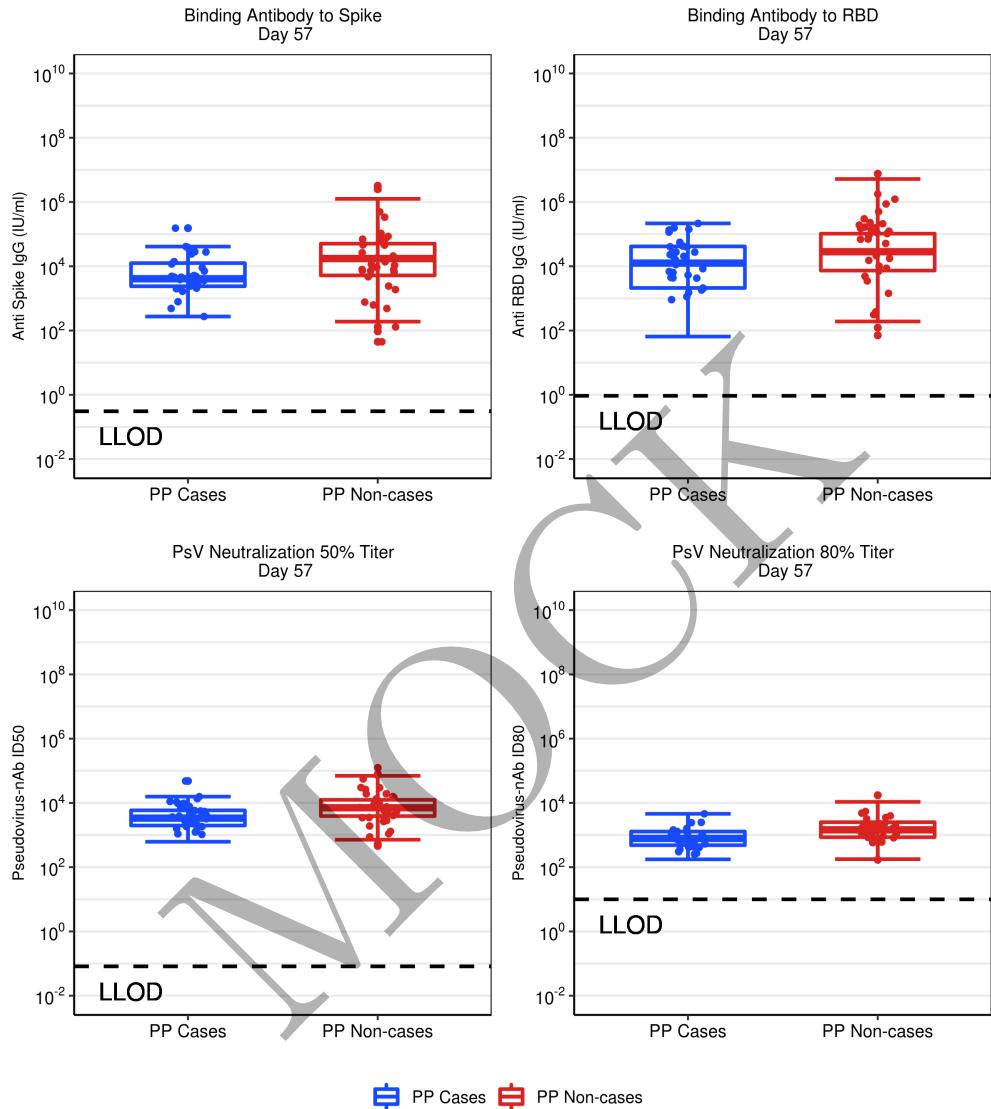


Figure 2.1: Boxplots of D57 Ab markers: baseline negative vaccine arm.

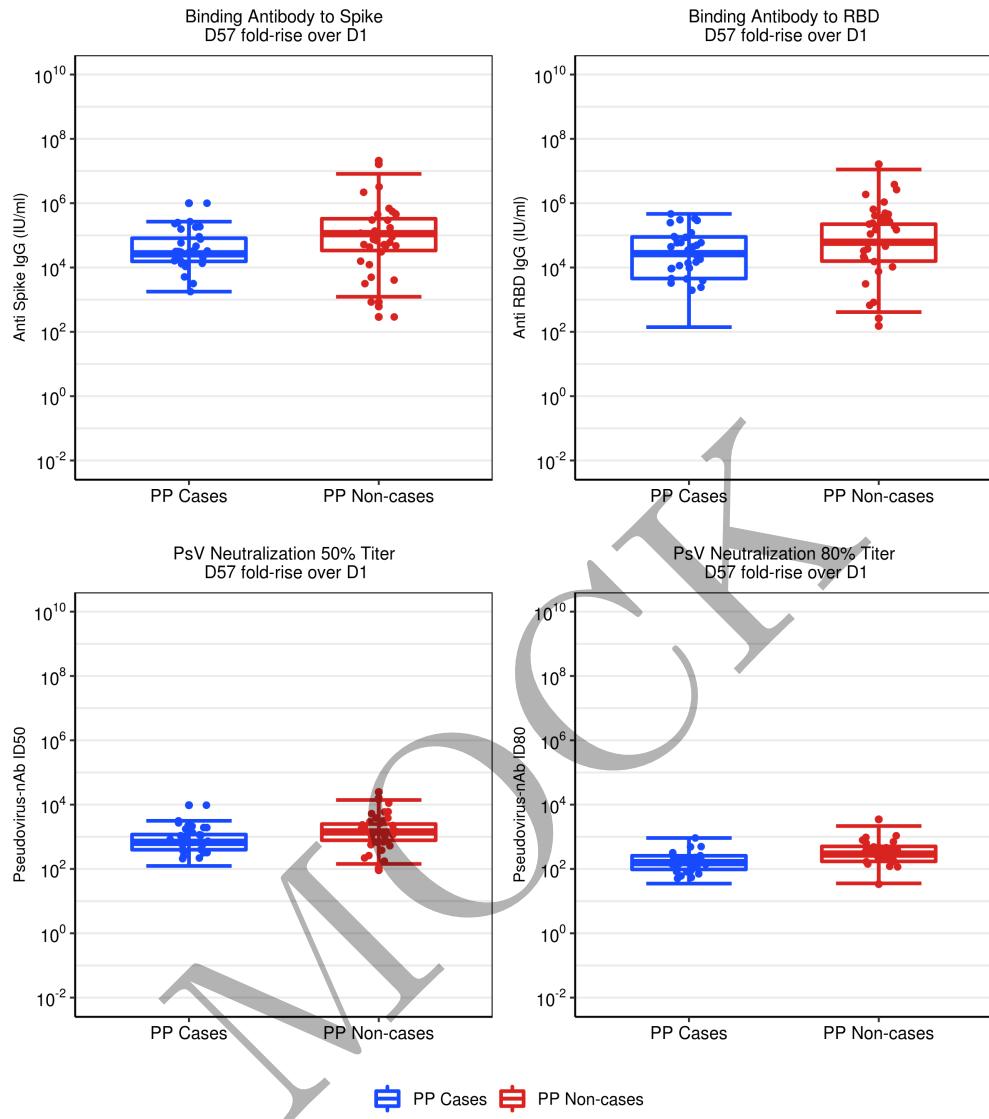


Figure 2.2: Boxplots of D57 fold-rise over D1 Ab markers: baseline negative vaccine arm.

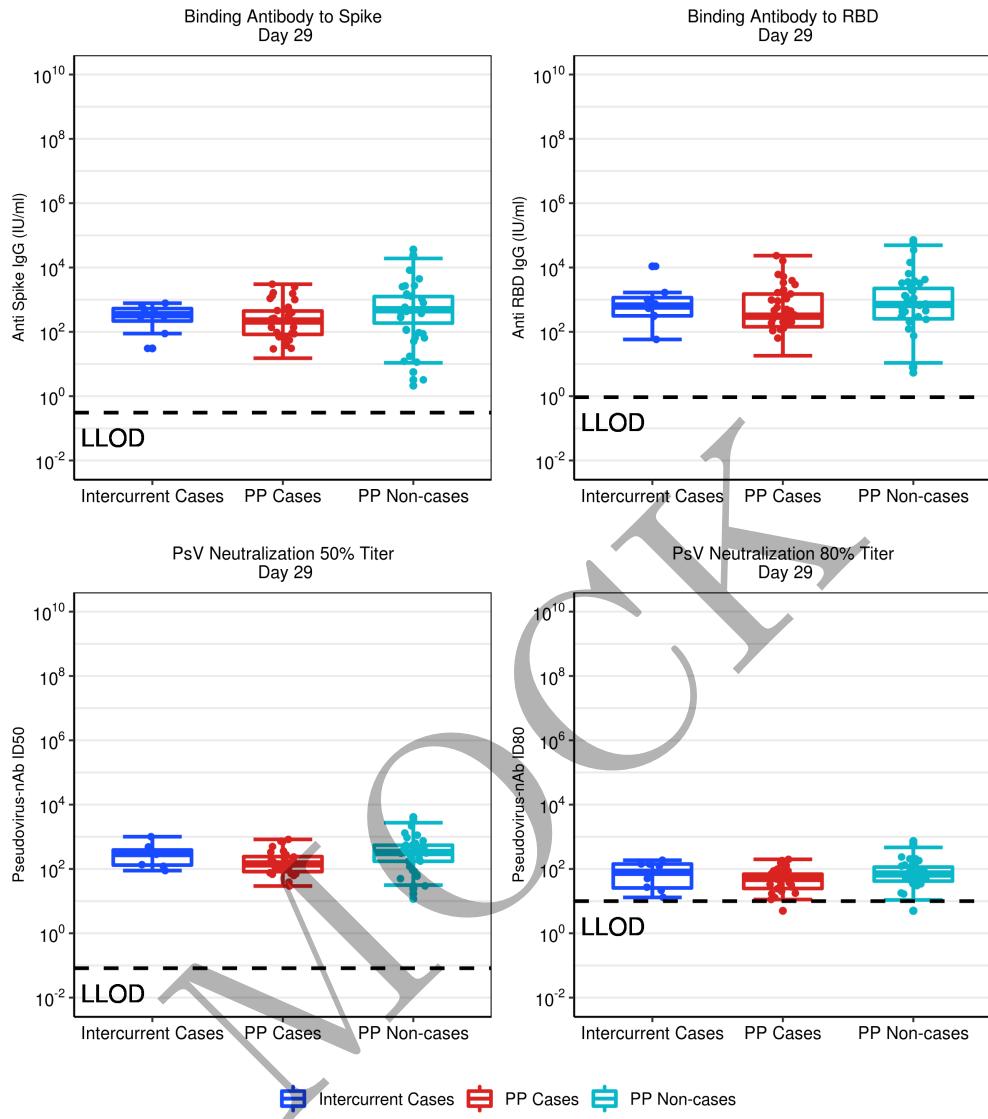


Figure 2.3: Boxplots of D29 Ab markers: baseline negative vaccine arm.

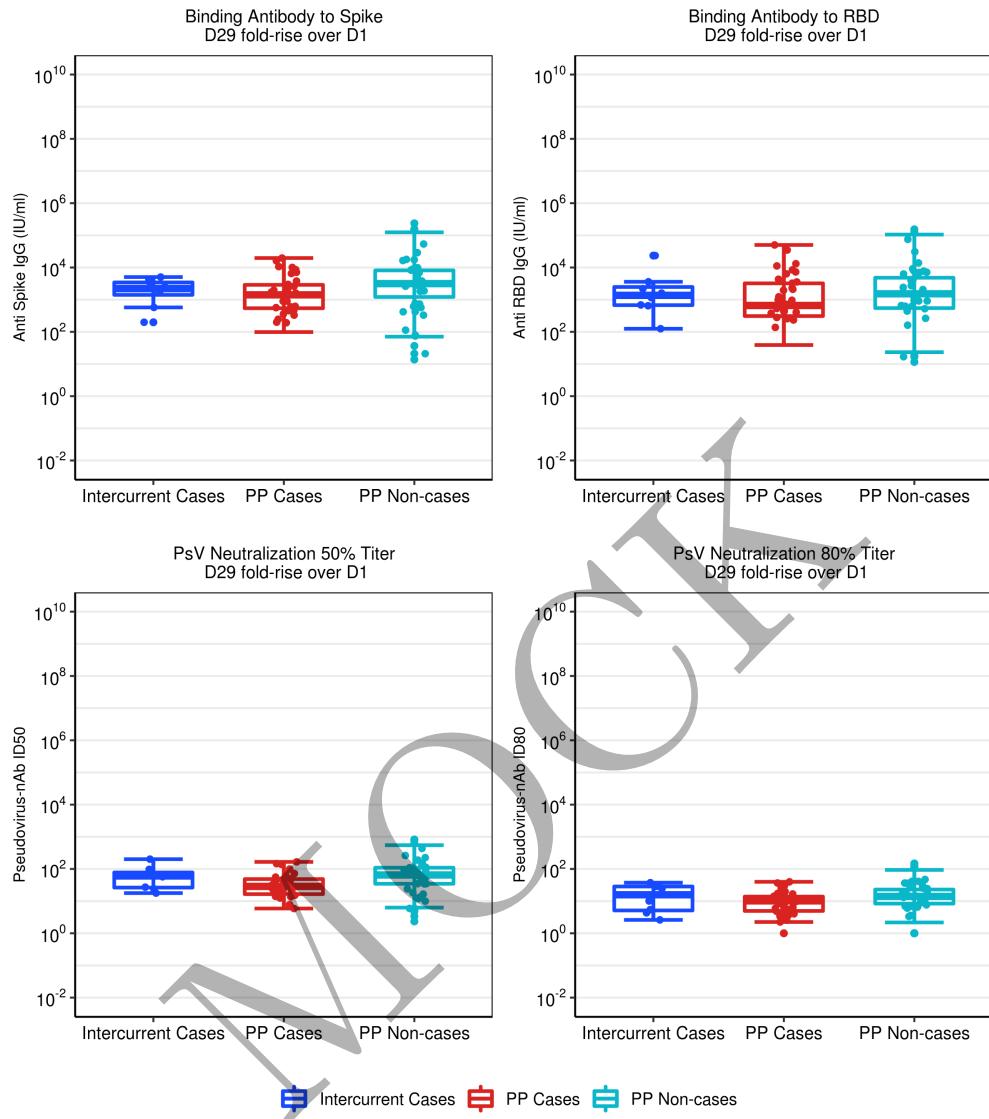


Figure 2.4: Boxplots of D29 fold-rise over D1 Ab markers: baseline negative vaccine arm.

2.1.2 Baseline seropositive

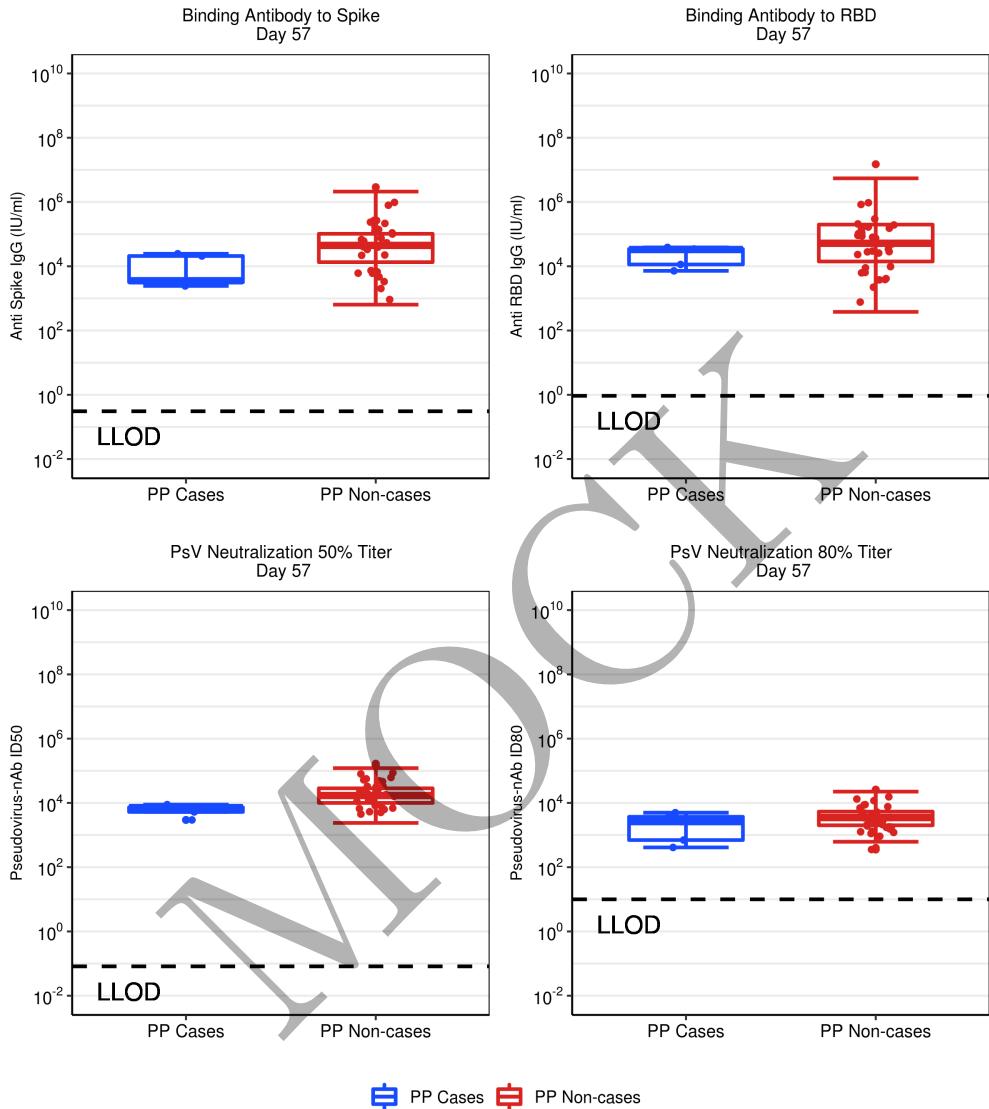


Figure 2.5: Boxplots of D57 Ab markers: baseline positive vaccine arm.

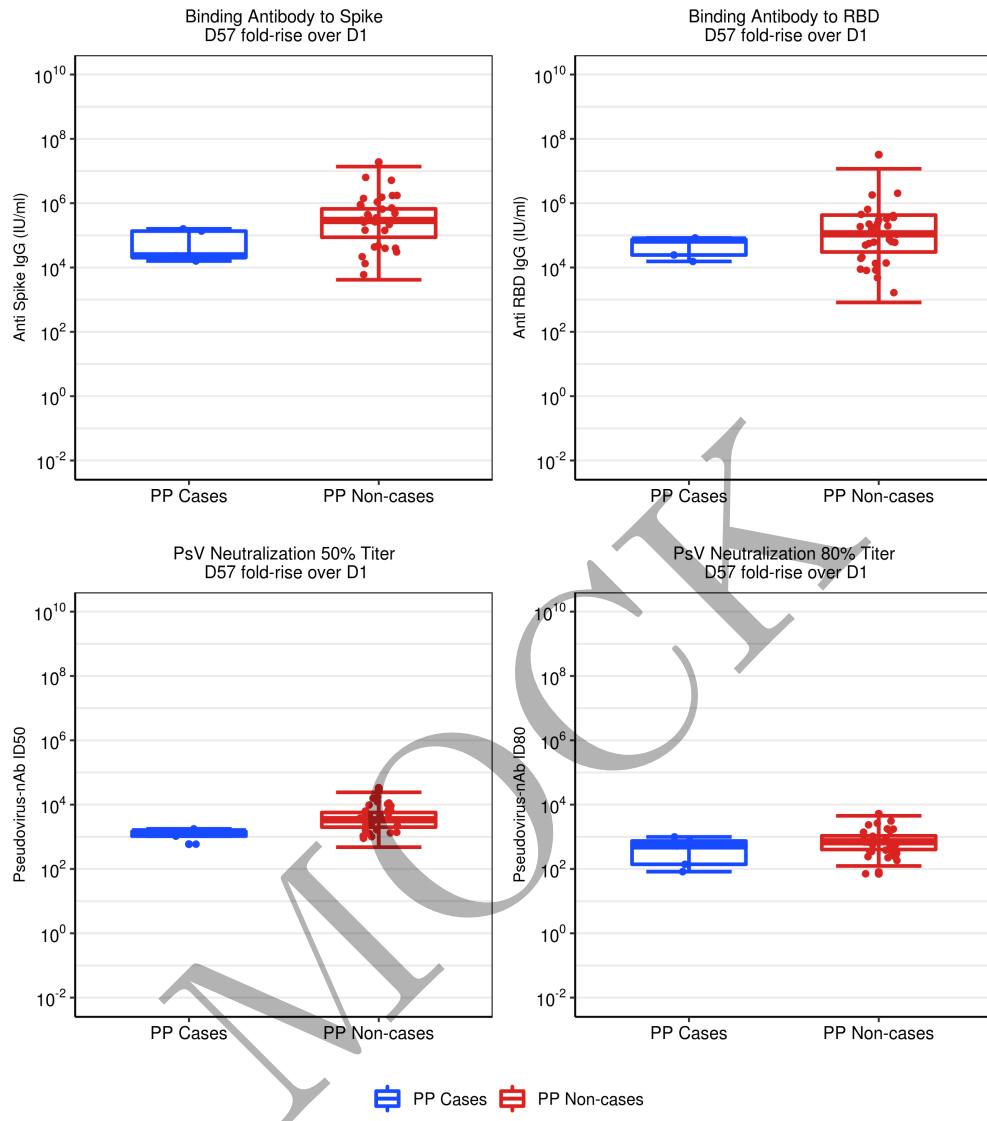


Figure 2.6: Boxplots of D57 fold-rise over D1 Ab markers: baseline positive vaccine arm.

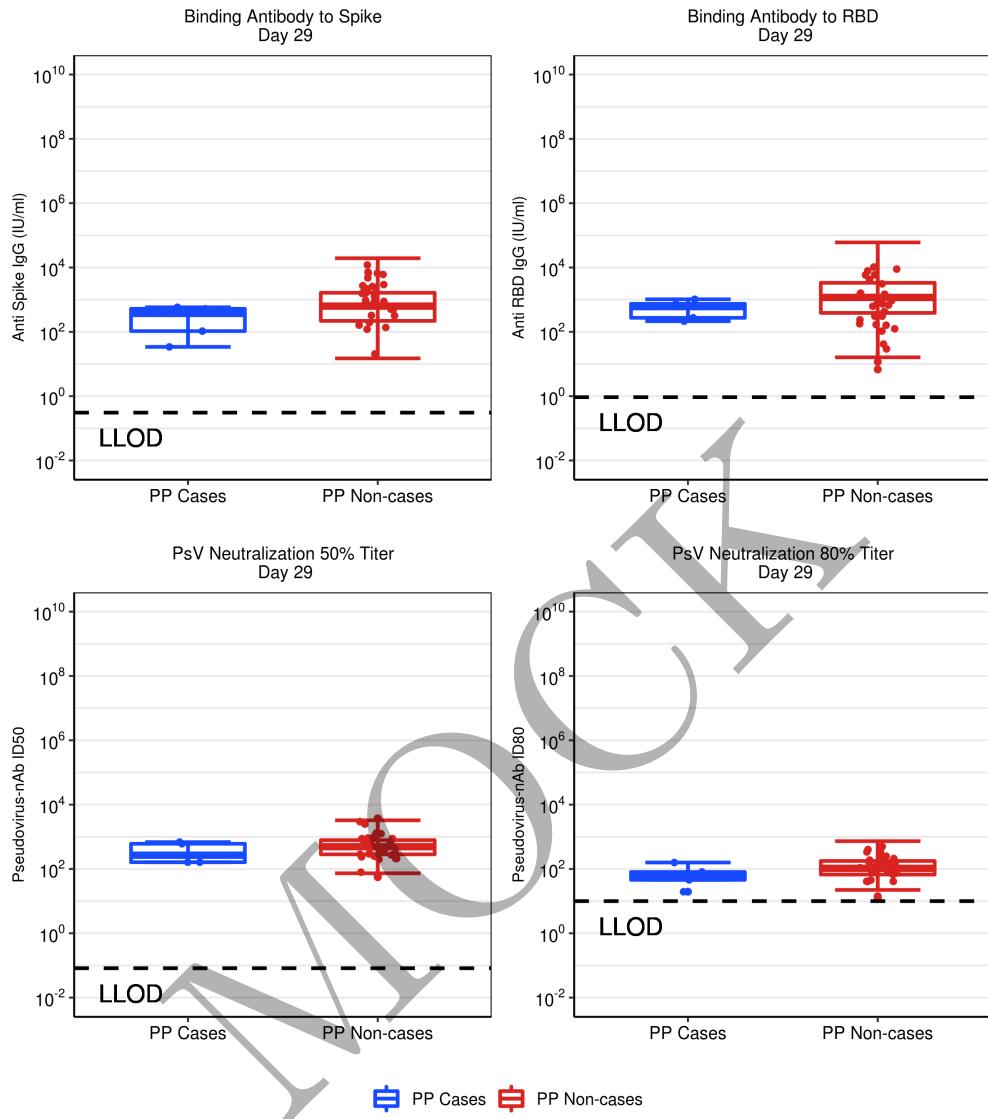


Figure 2.7: Boxplots of D29 Ab markers: baseline positive vaccine arm.

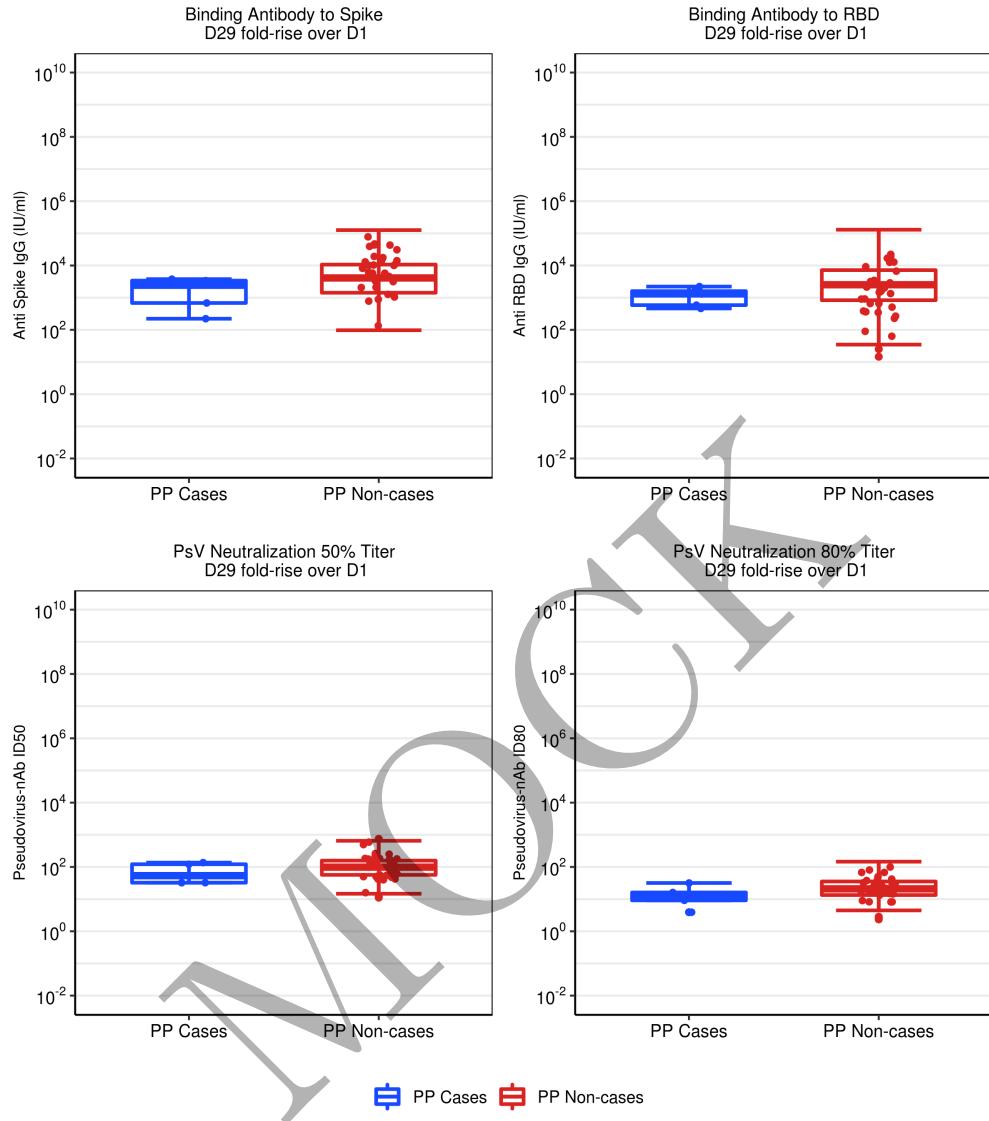


Figure 2.8: Boxplots of D29 fold-rise over D1 Ab markers: baseline positive vaccine arm.

2.2 Weighted RCDF plots

2.2.1 Baseline seronegative

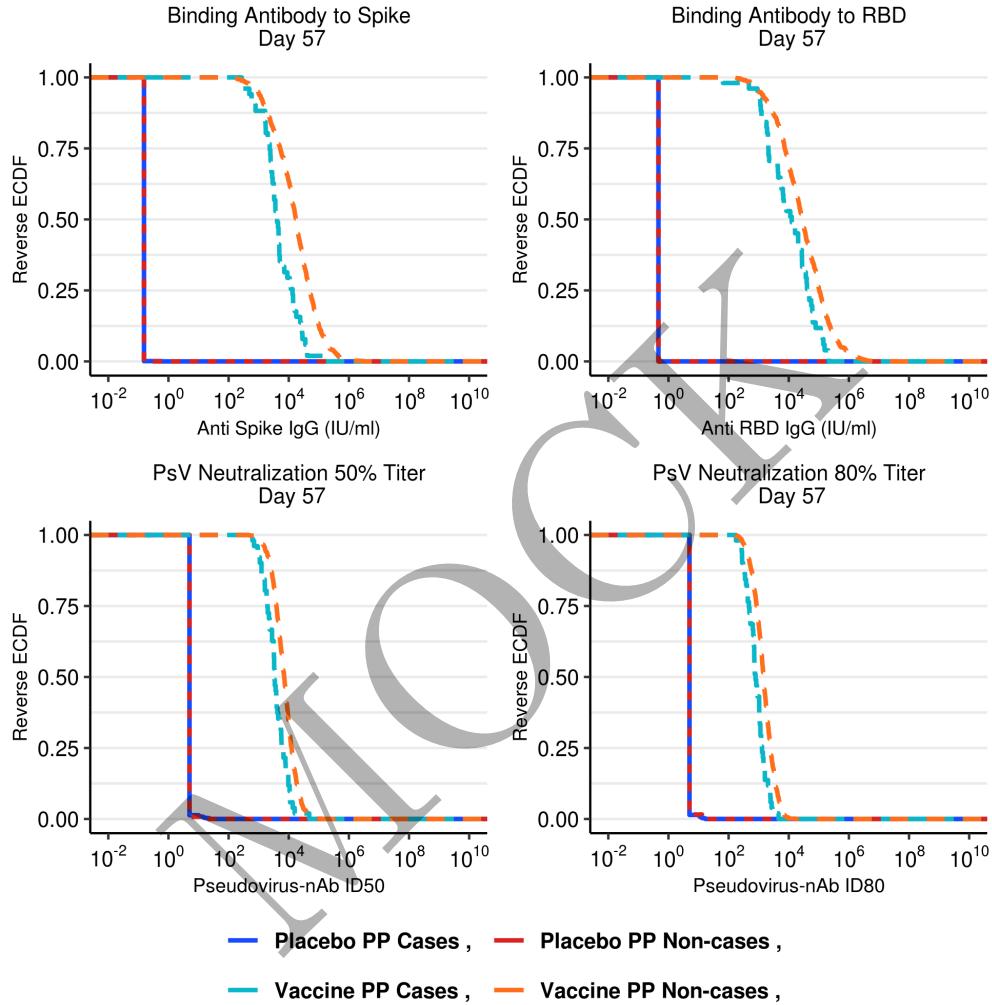


Figure 2.9: RCDF plots for D57 Ab markers: baseline negative by treatment arm.

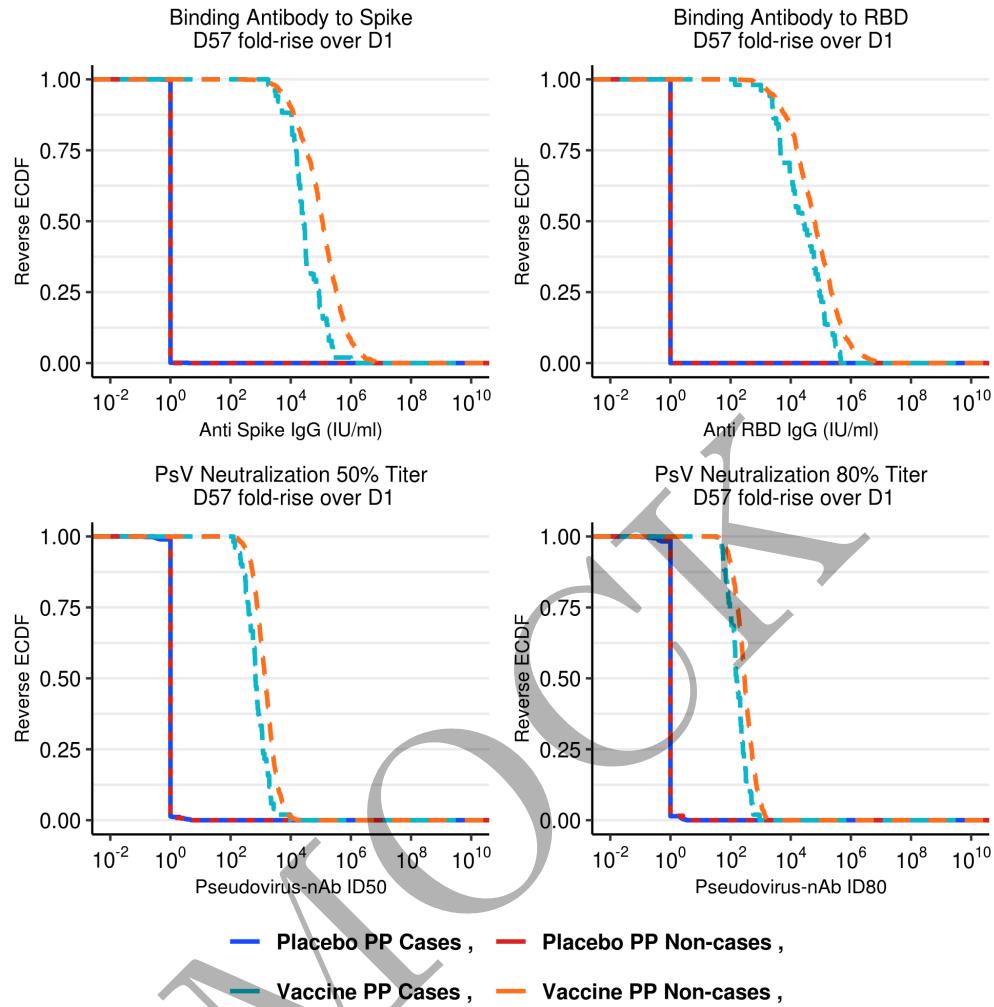


Figure 2.10: RCDF plots for D57 fold-rise over D1 Ab markers: baseline negative by treatment arm.

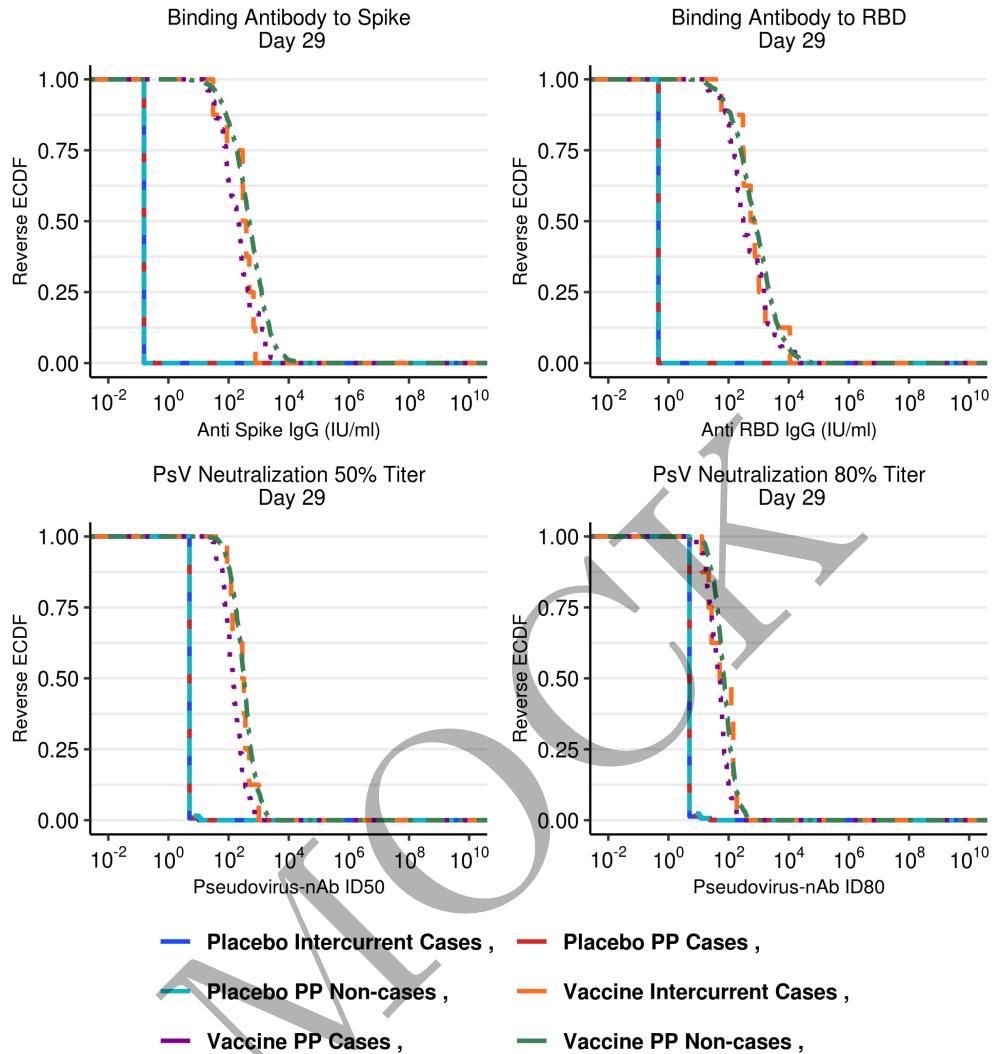


Figure 2.11: RCDF plots for D29 Ab markers: baseline negative by treatment arm.

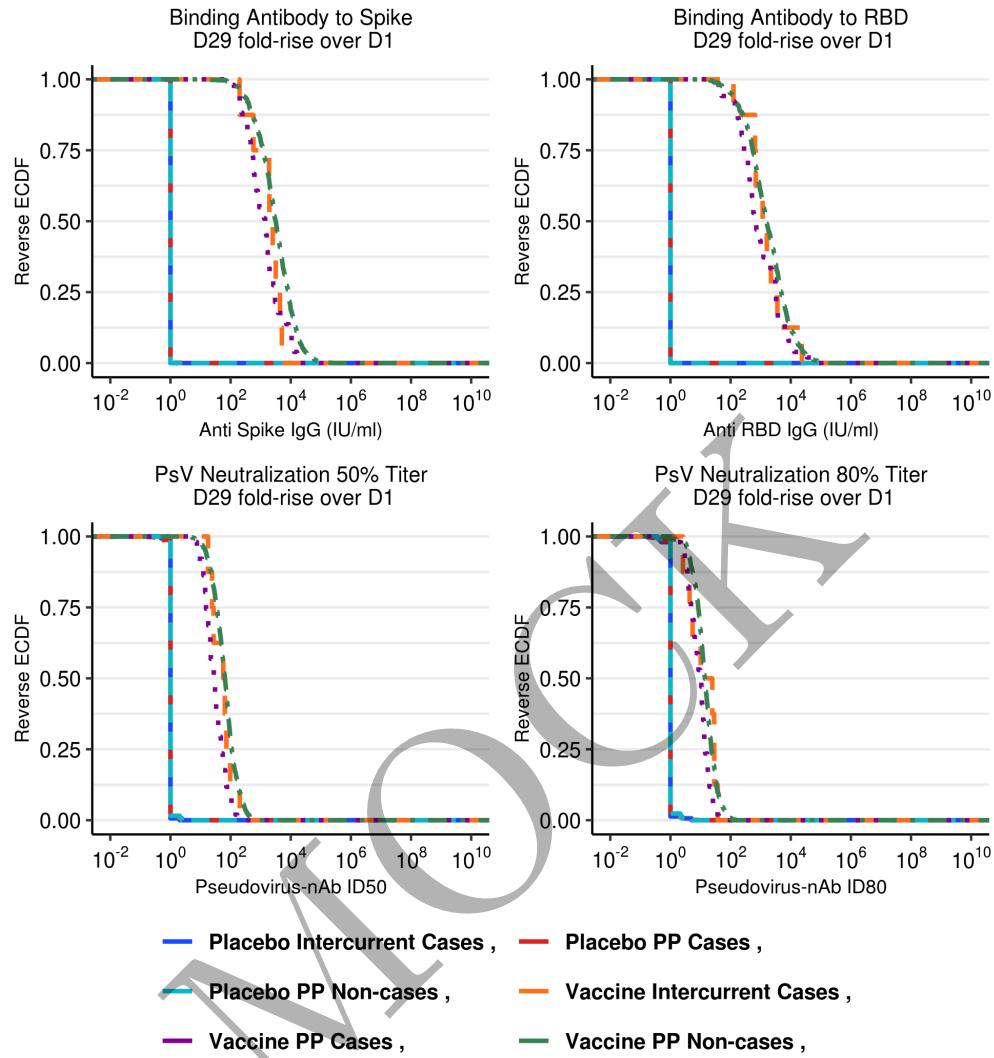


Figure 2.12: RCDF plots for D29 fold-rise over D1 Ab markers: baseline negative by treatment arm.

2.2.2 Baseline seropositive

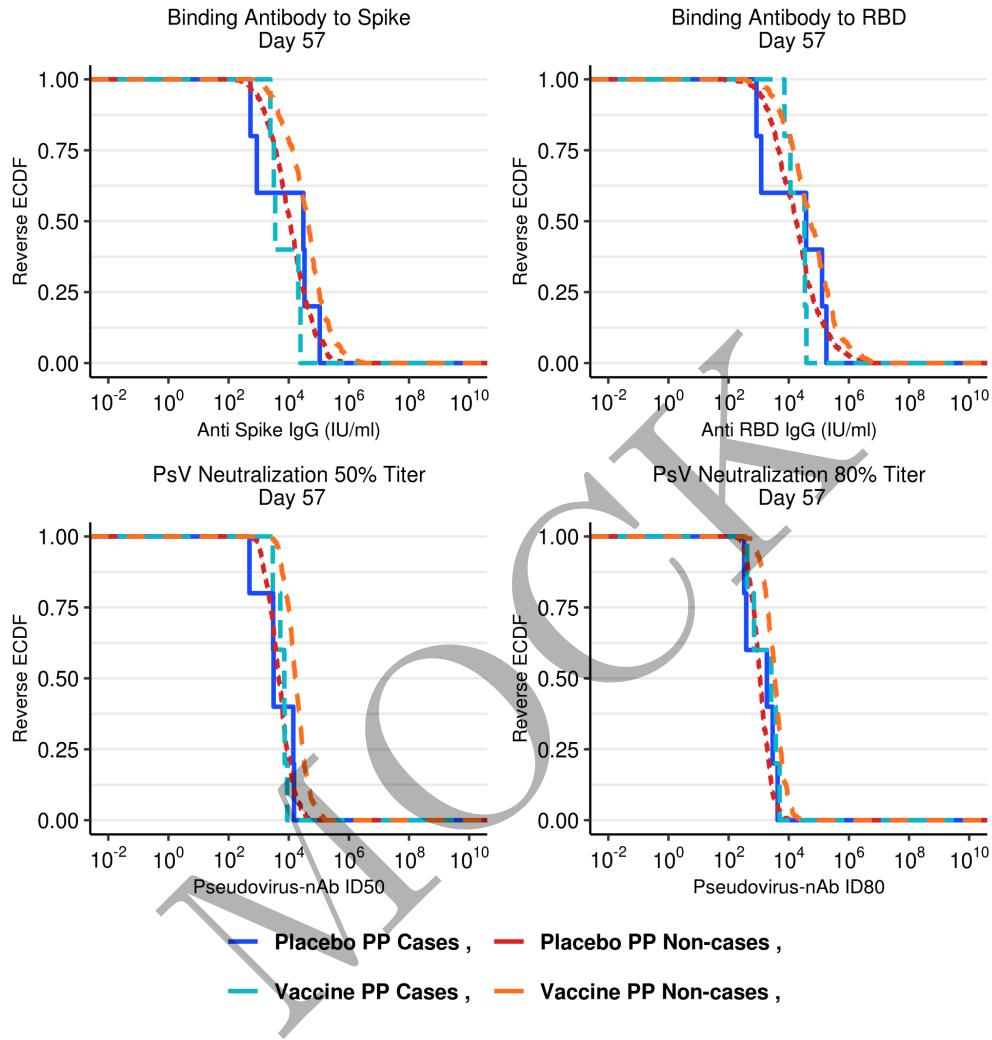


Figure 2.13: RCDF plots for D57 Ab markers: baseline positive by treatment arm.

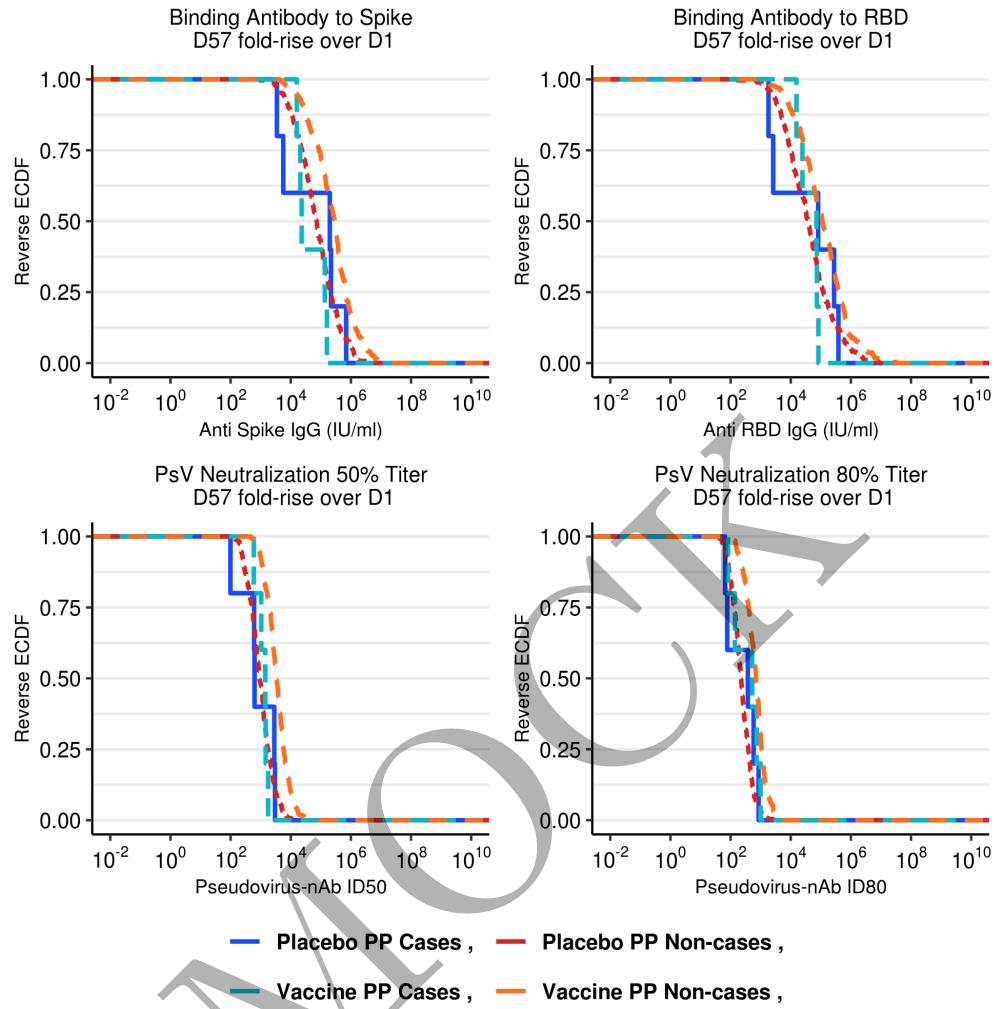


Figure 2.14: RCDF plots for D57 fold-rise over D1 Ab markers: baseline positive by treatment arm.

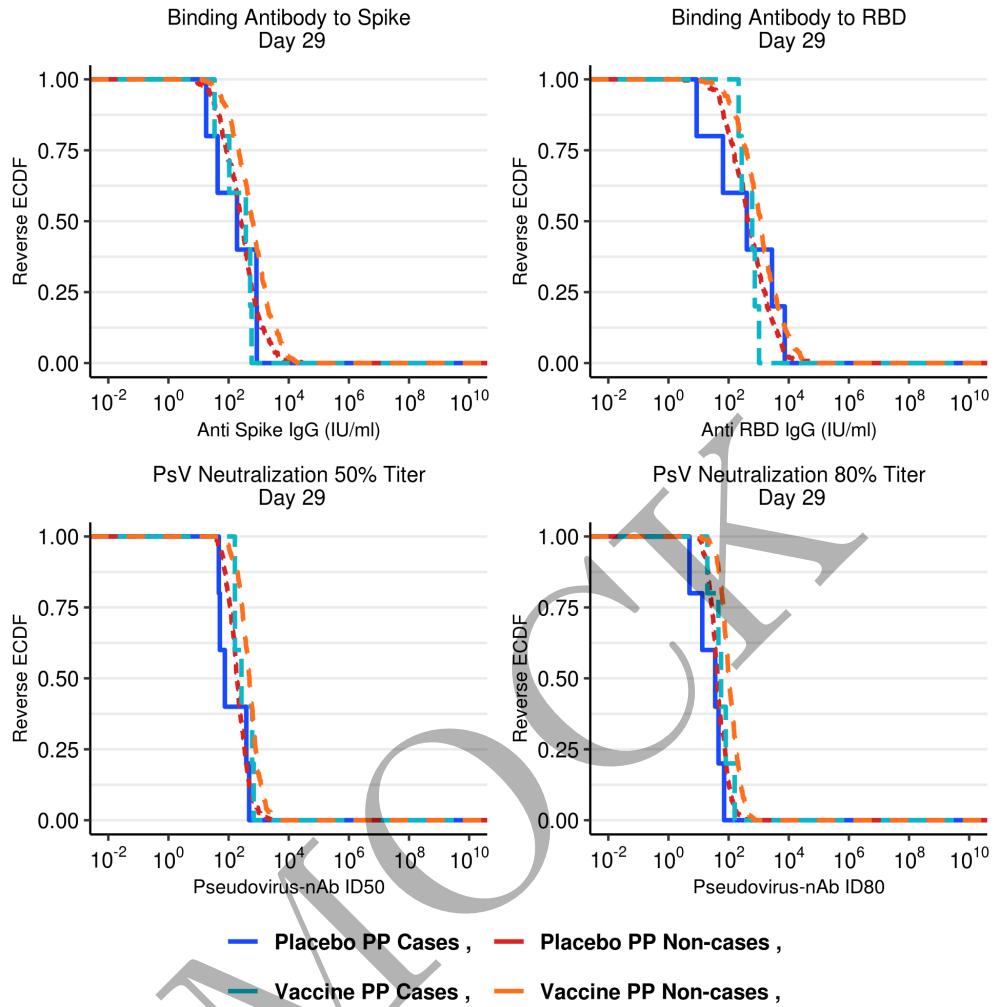


Figure 2.15: RCDF plots for D29 Ab markers: baseline positive by treatment arm.

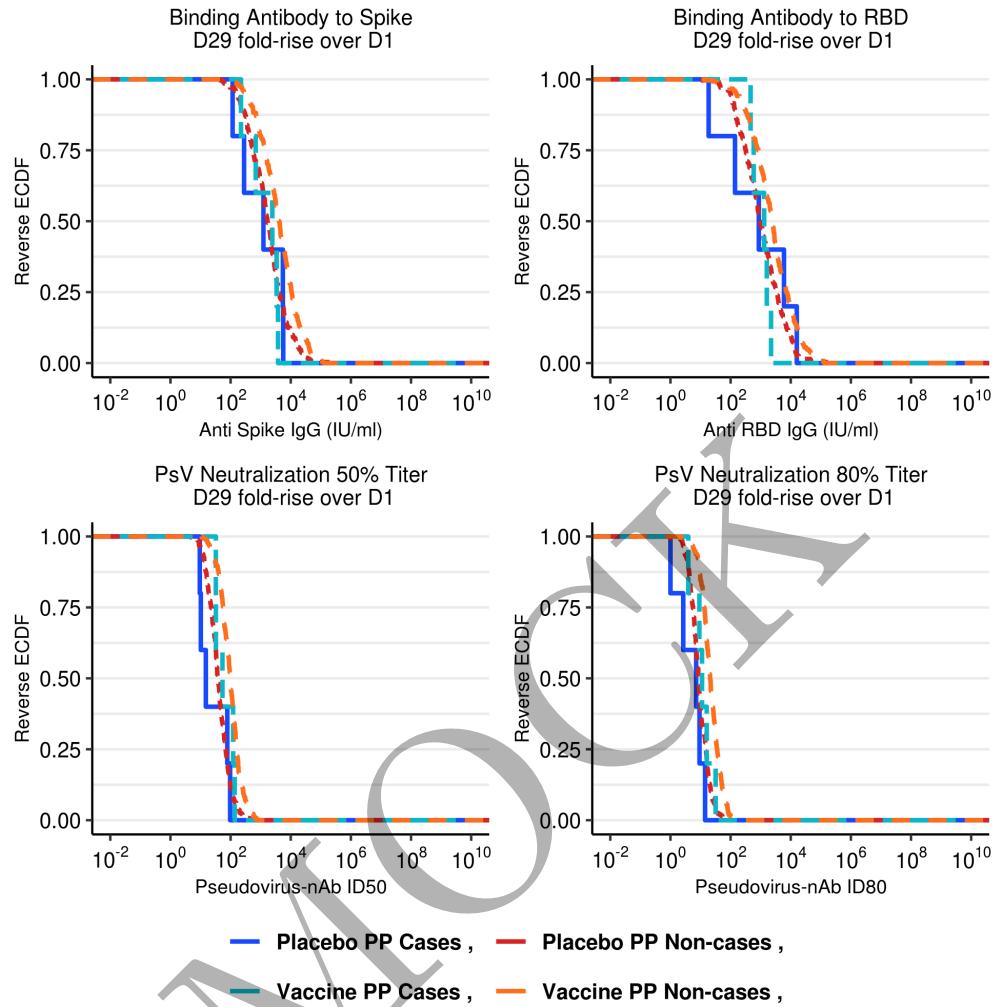


Figure 2.16: RCDF plots for D29 fold-rise over D1 Ab markers: baseline positive by treatment arm.

2.3 Weighted RCDF plots of threshold correlate concentration for vaccine efficacy

2.3.1 Baseline seronegative

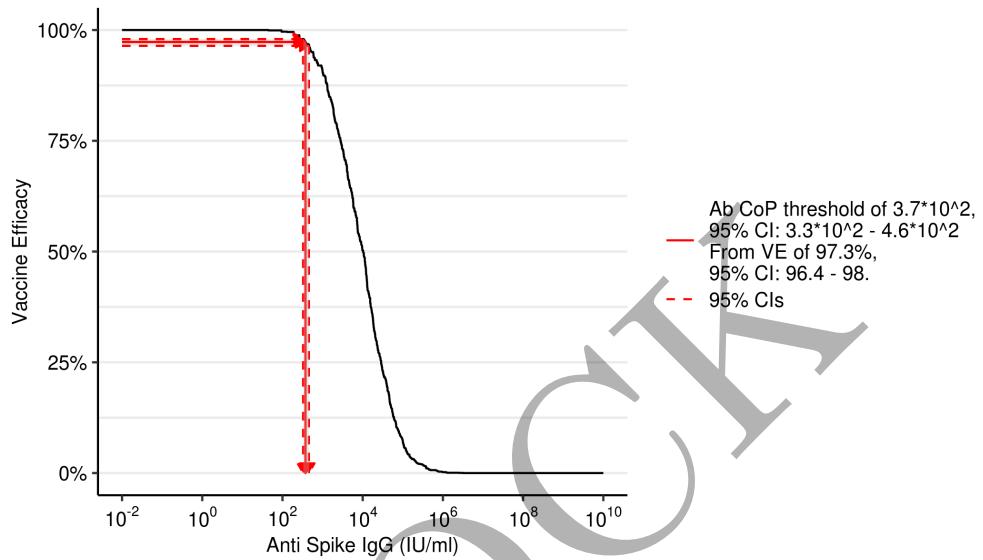


Figure 2.17: Marker RCDF of D57 anti-Spike binding Ab: baseline negative vaccine arm

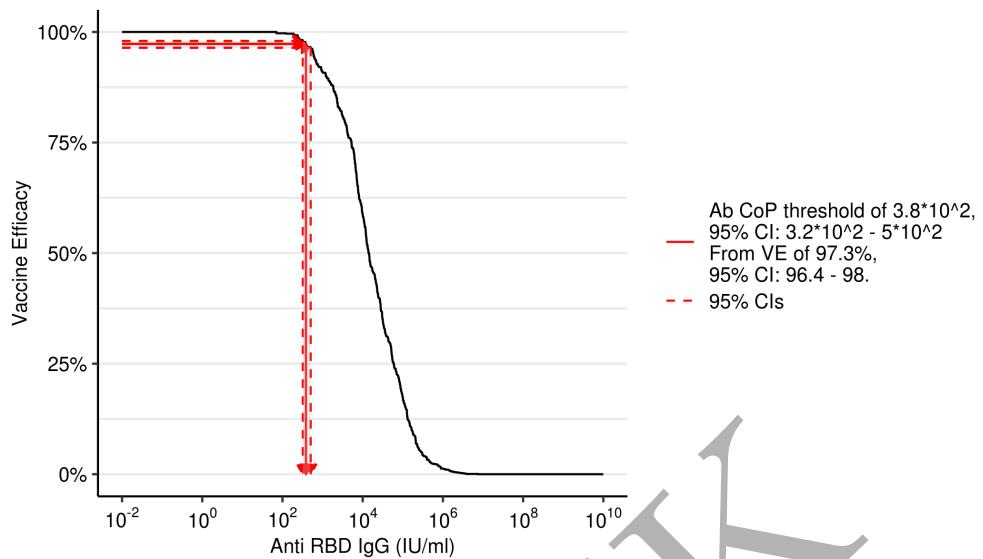


Figure 2.18: Marker RCDF of D57 anti-RBD binding Ab: baseline negative vaccine arm

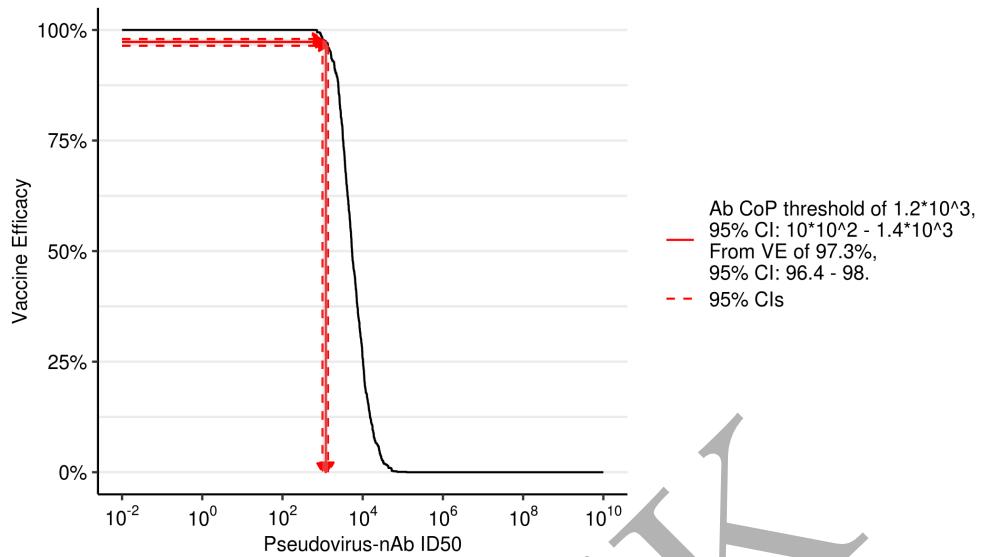


Figure 2.19: Marker RCDF of D57 PsV-nAb ID50: baseline negative vaccine arm

2.3. WEIGHTED RCDF PLOTS OF THRESHOLD CORRELATE CONCENTRATION FOR VACCINE EFFICACY51

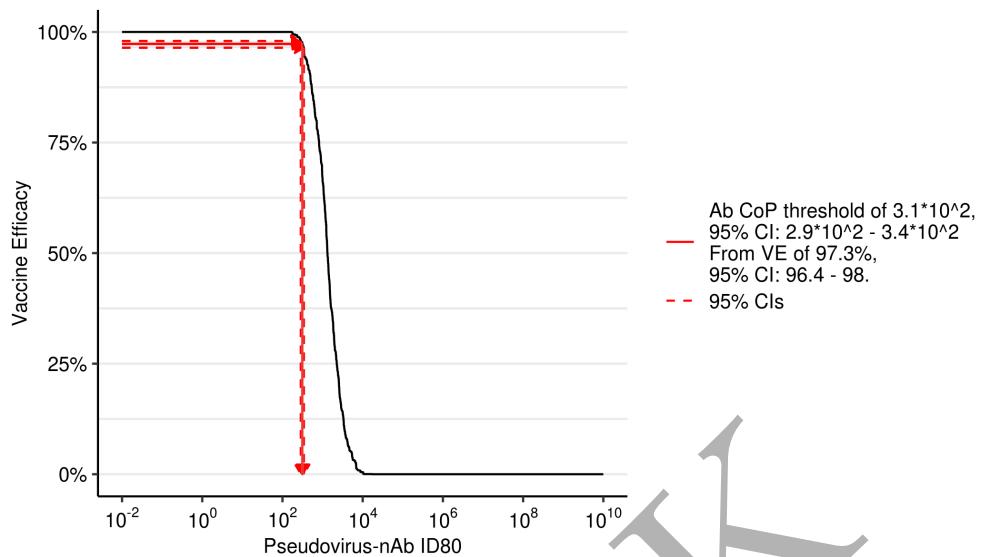


Figure 2.20: Marker RCDF of D57 PsV-nAb ID80: baseline negative vaccine arm

2.4 Spaghetti plots

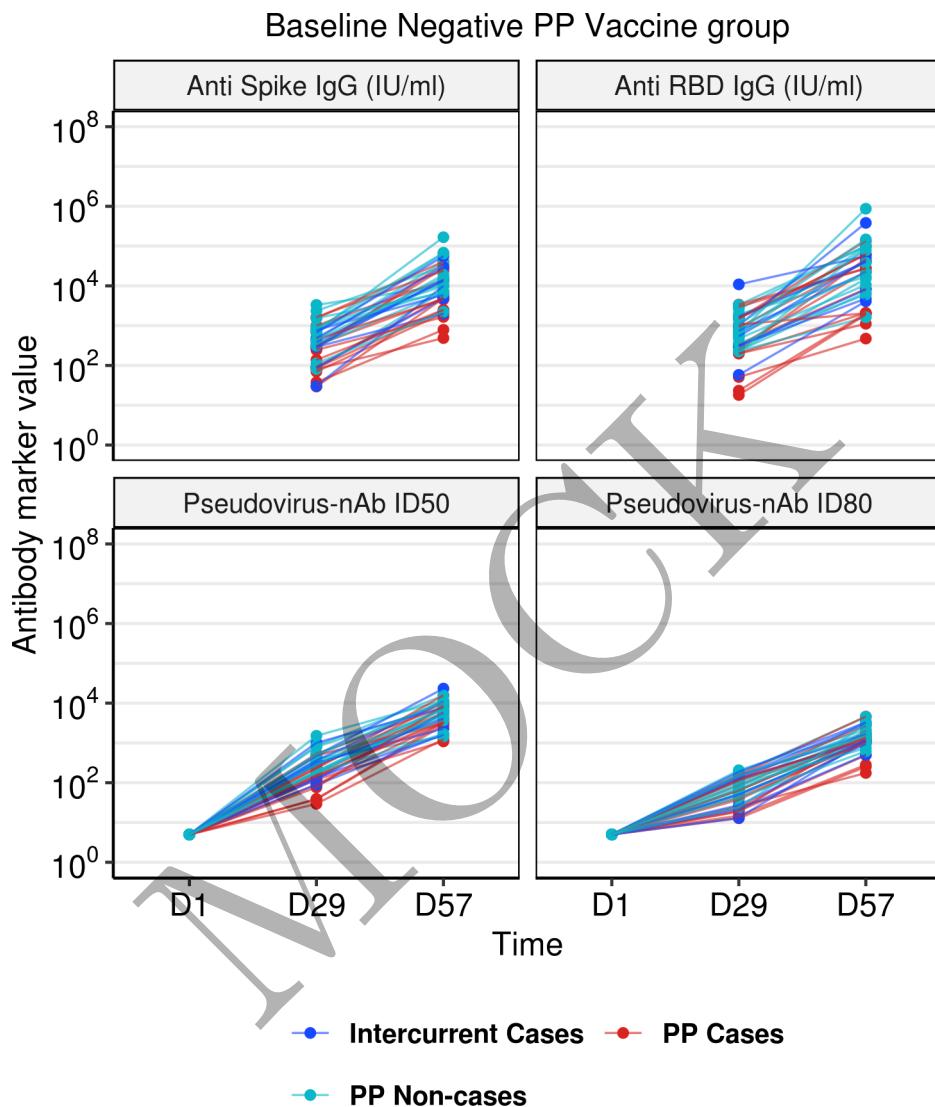


Figure 2.21: Spaghetti Plots of Marker Trajectory: baseline negative vaccine arm

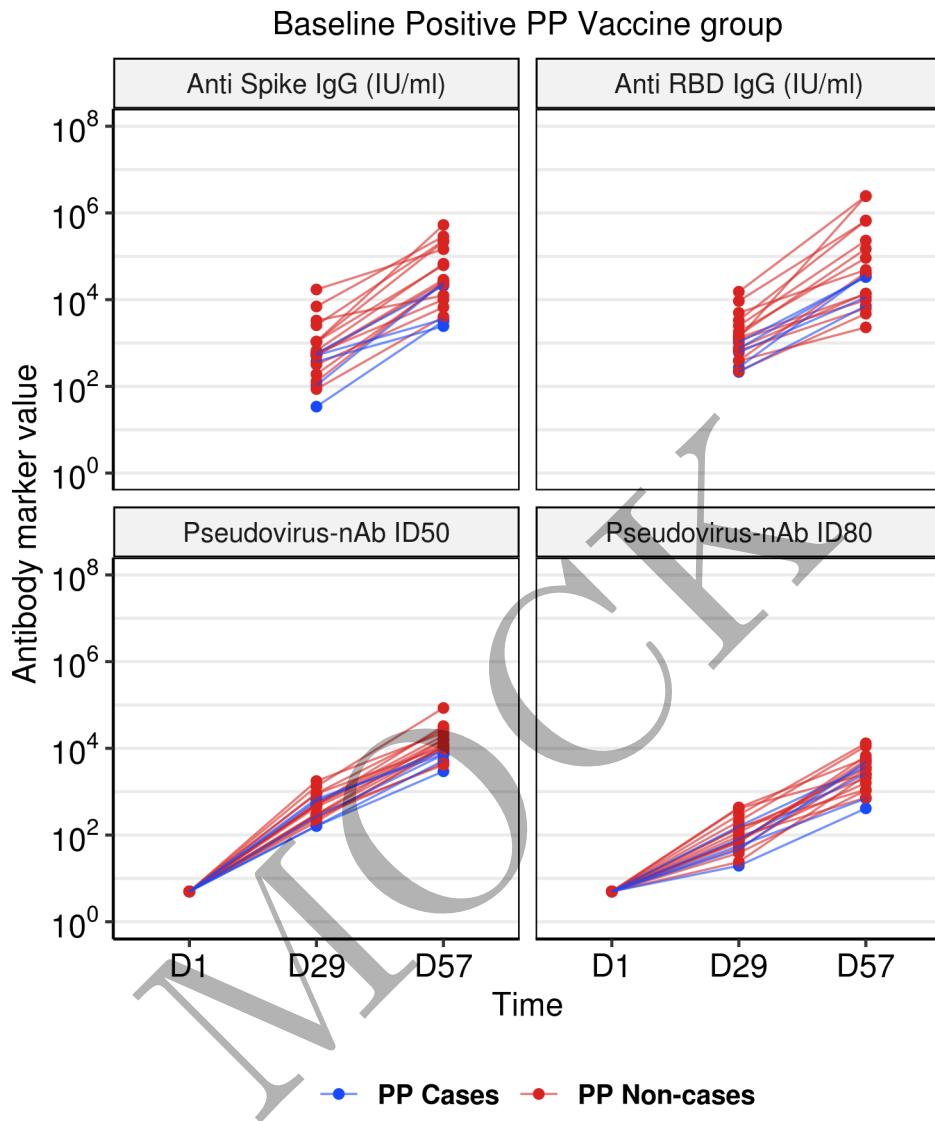


Figure 2.22: Spaghetti Plots of Marker Trajectory: baseline positive vaccine arm

2.5 Violin and line plots

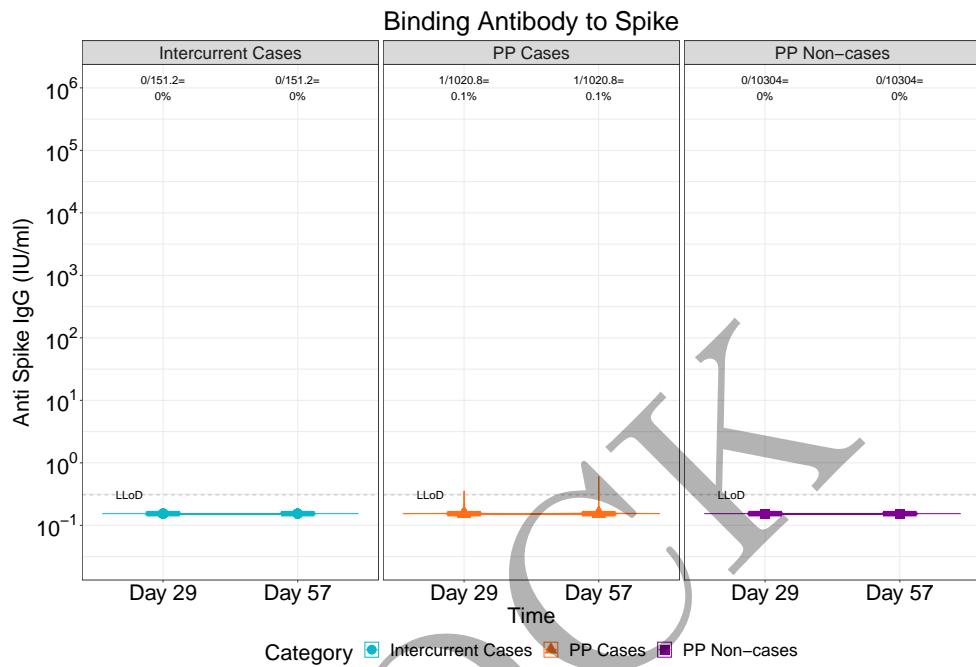


Figure 2.23: lineplots of Binding Antibody to Spike: baseline negative placebo arm (version 1)

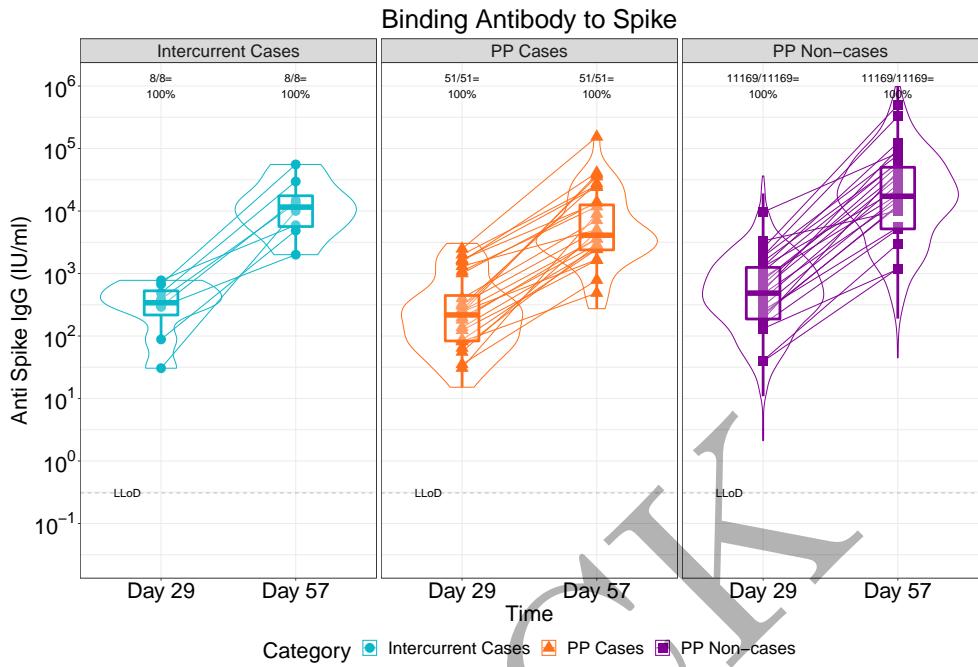


Figure 2.24: lineplots of Binding Antibody to Spike: baseline negative vaccine arm (version 1)

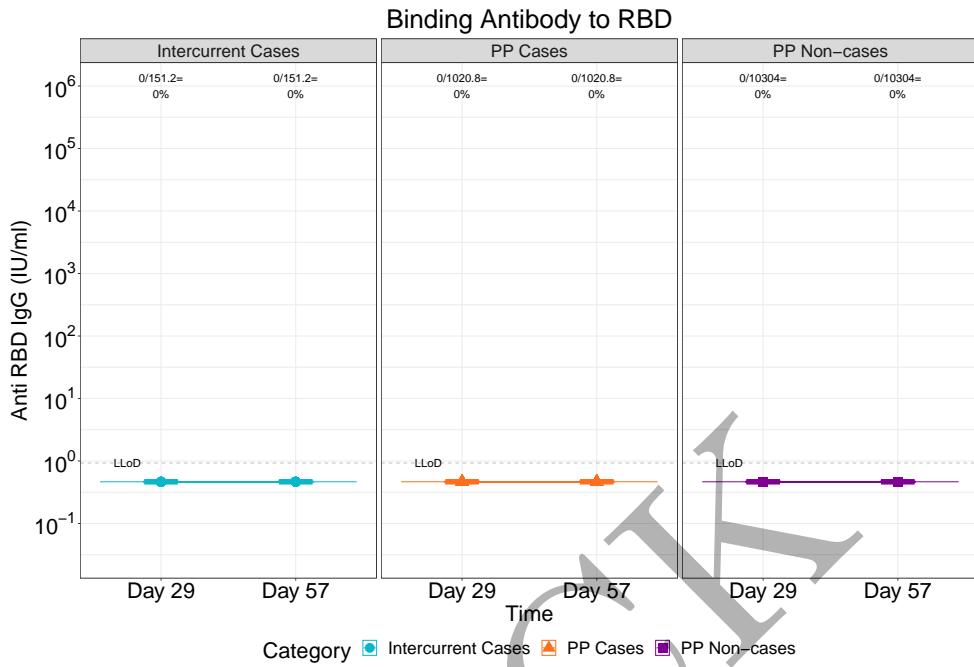


Figure 2.25: lineplots of Binding Antibody to RBD: baseline negative placebo arm (version 1)

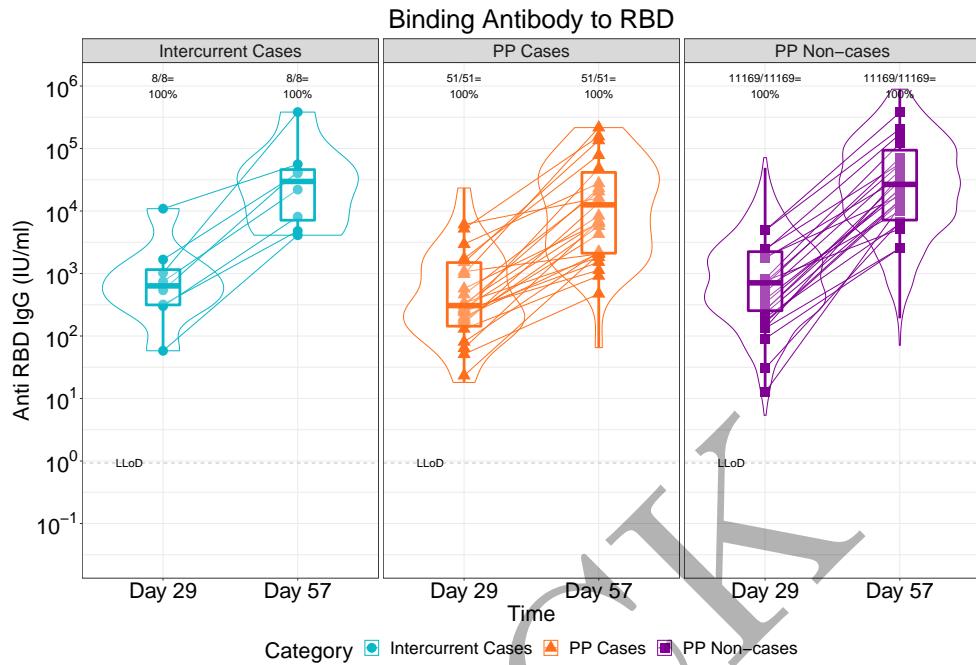


Figure 2.26: lineplots of Binding Antibody to RBD: baseline negative vaccine arm (version 1)

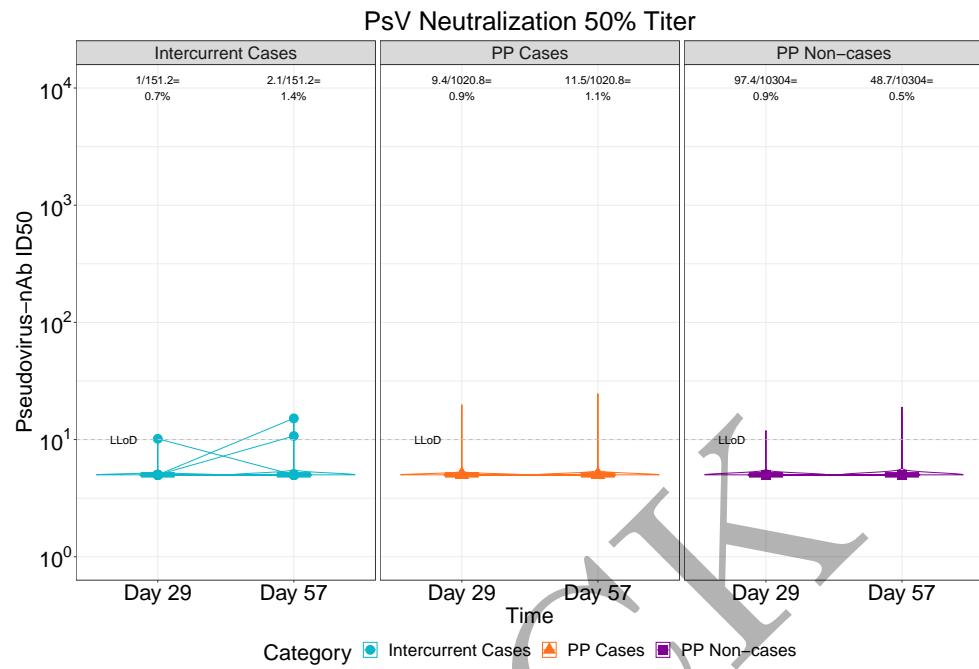


Figure 2.27: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm (version 1)

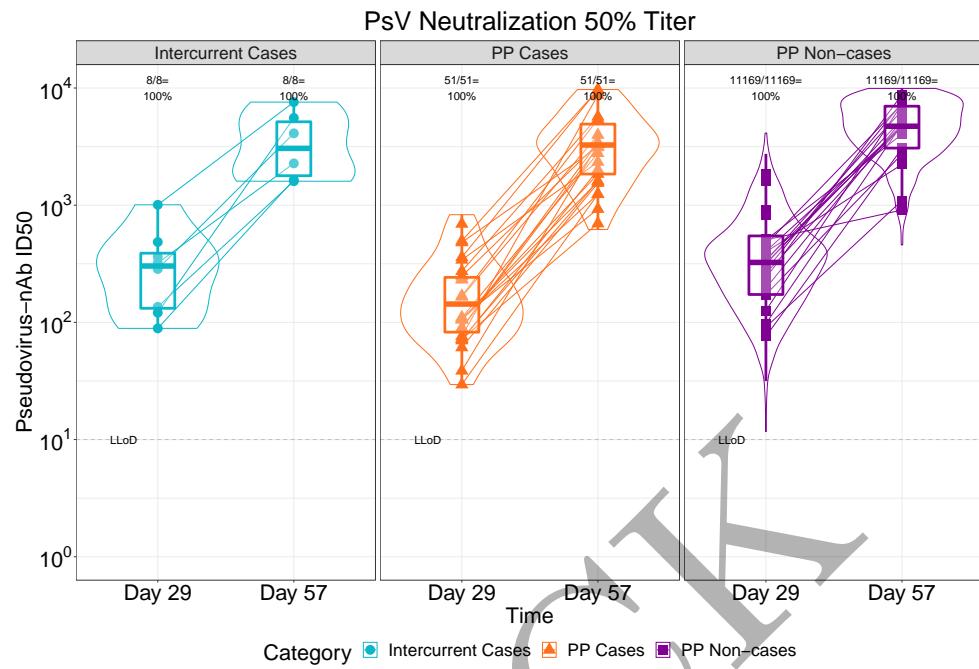


Figure 2.28: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm (version 1)

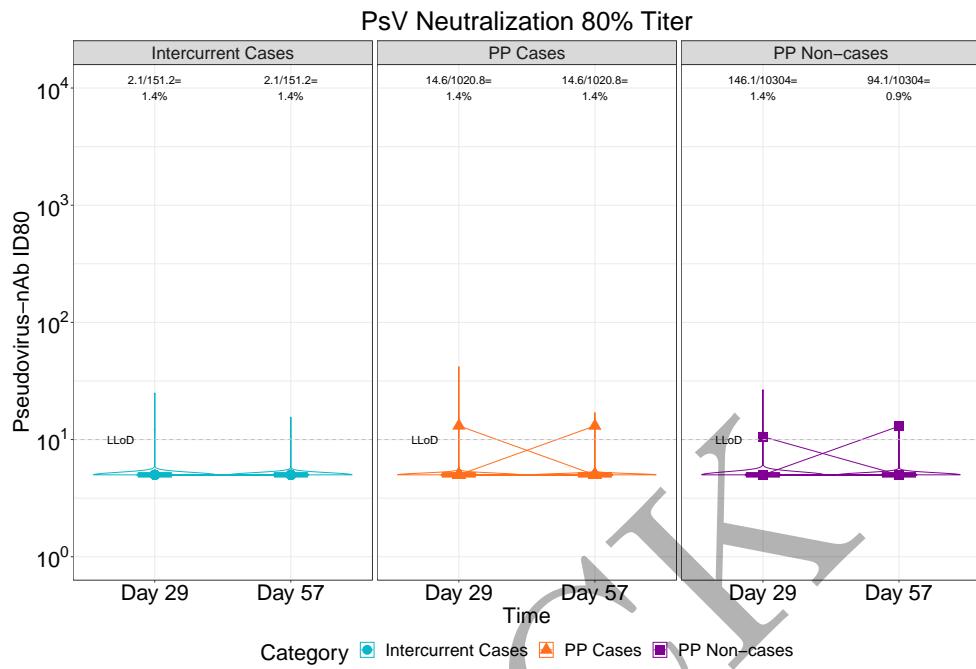


Figure 2.29: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm (version 1)

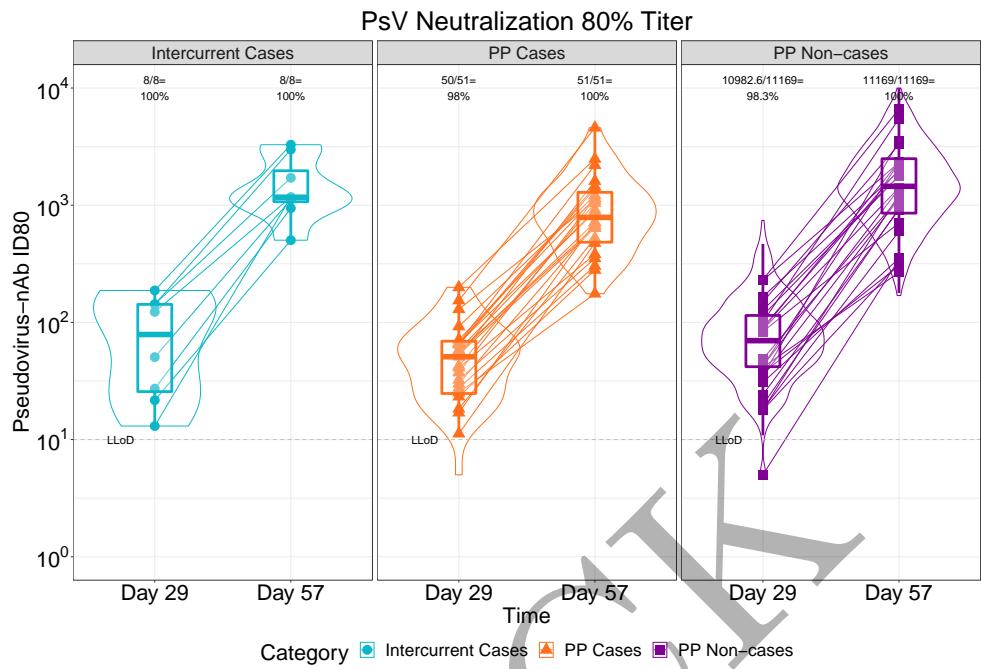


Figure 2.30: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm (version 1)

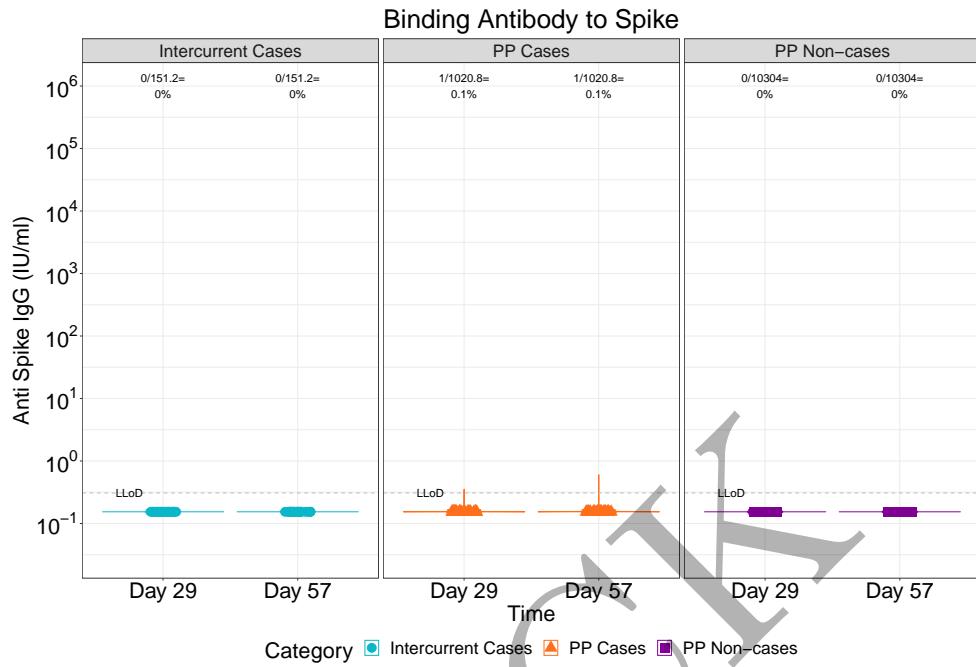


Figure 2.31: violinplots of Binding Antibody to Spike: baseline negative placebo arm (version 1)

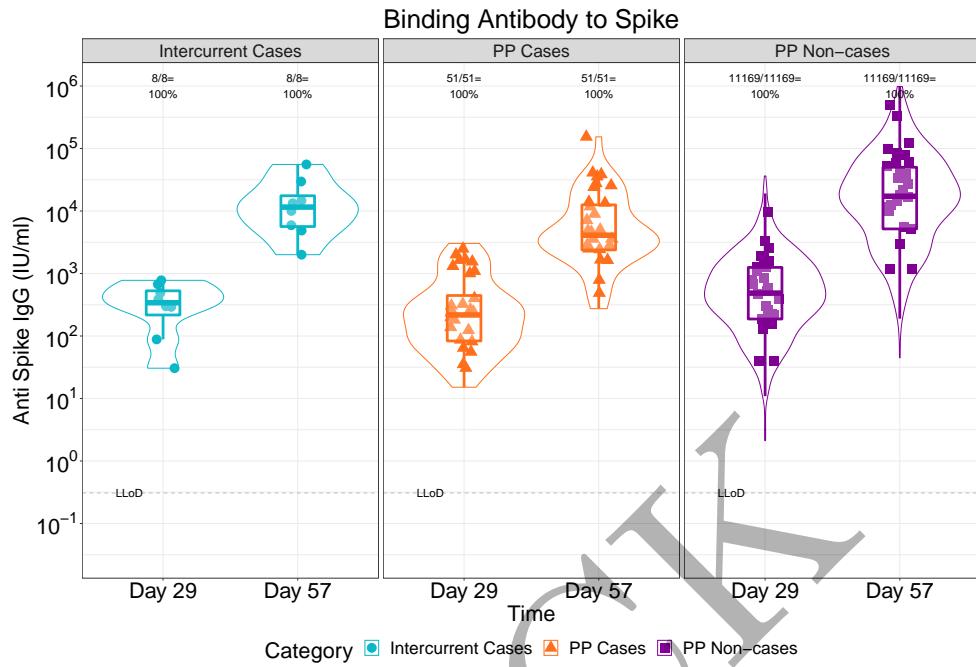


Figure 2.32: violinplots of Binding Antibody to Spike: baseline negative vaccine arm (version 1)

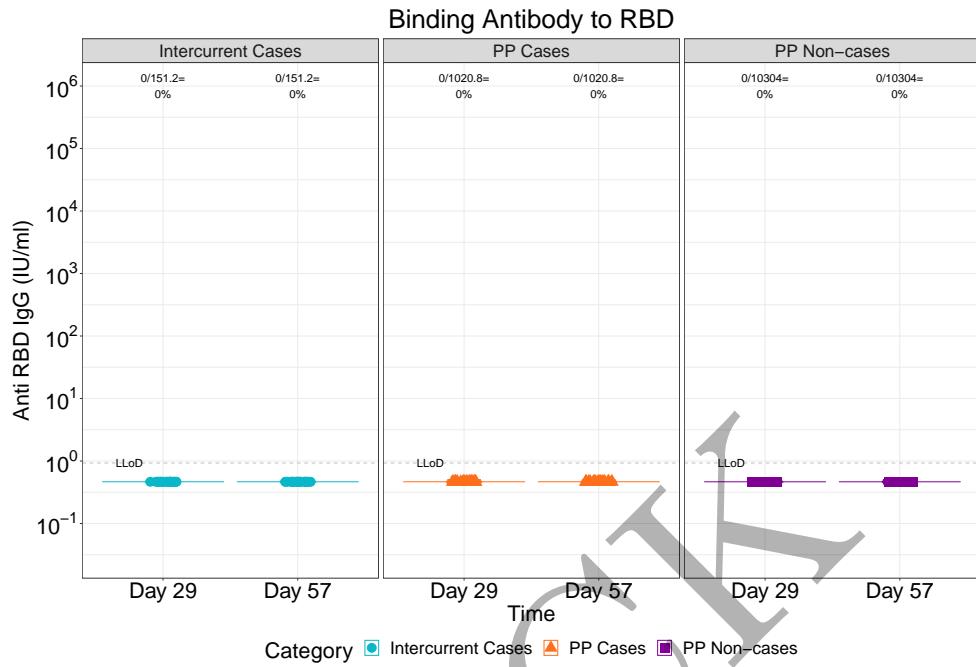


Figure 2.33: violinplots of Binding Antibody to RBD: baseline negative placebo arm (version 1)

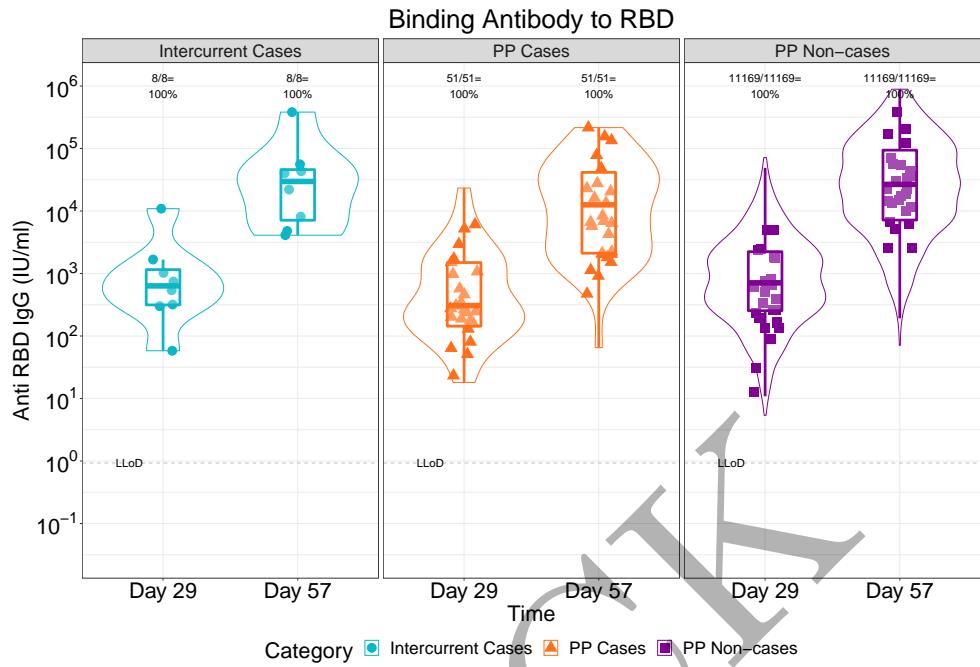


Figure 2.34: violinplots of Binding Antibody to RBD: baseline negative vaccine arm (version 1)

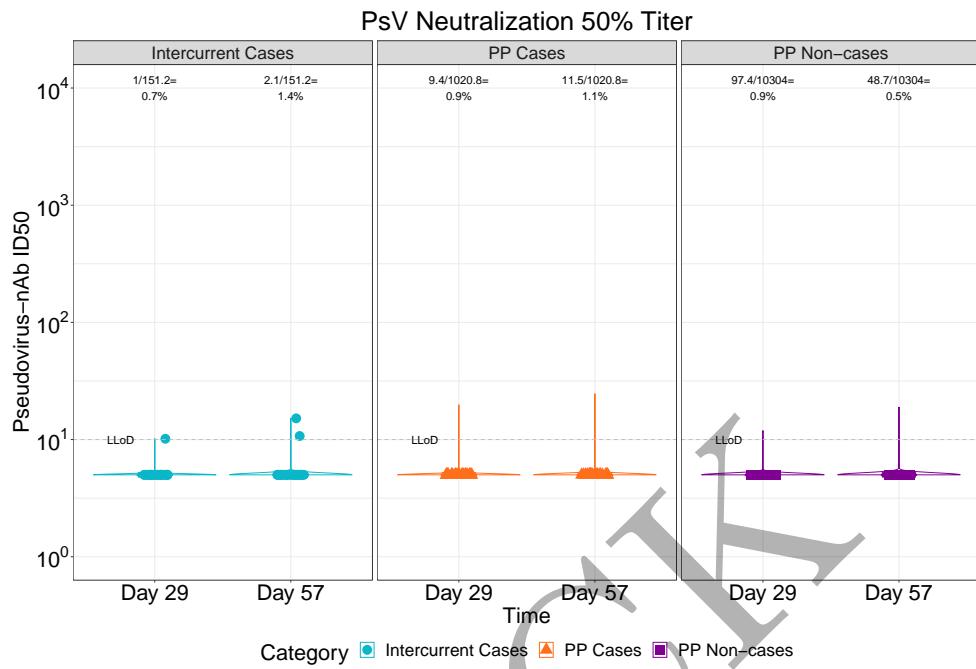


Figure 2.35: violinplots of Pseudovirus Neutralization ID₅₀: baseline negative placebo arm (version 1)

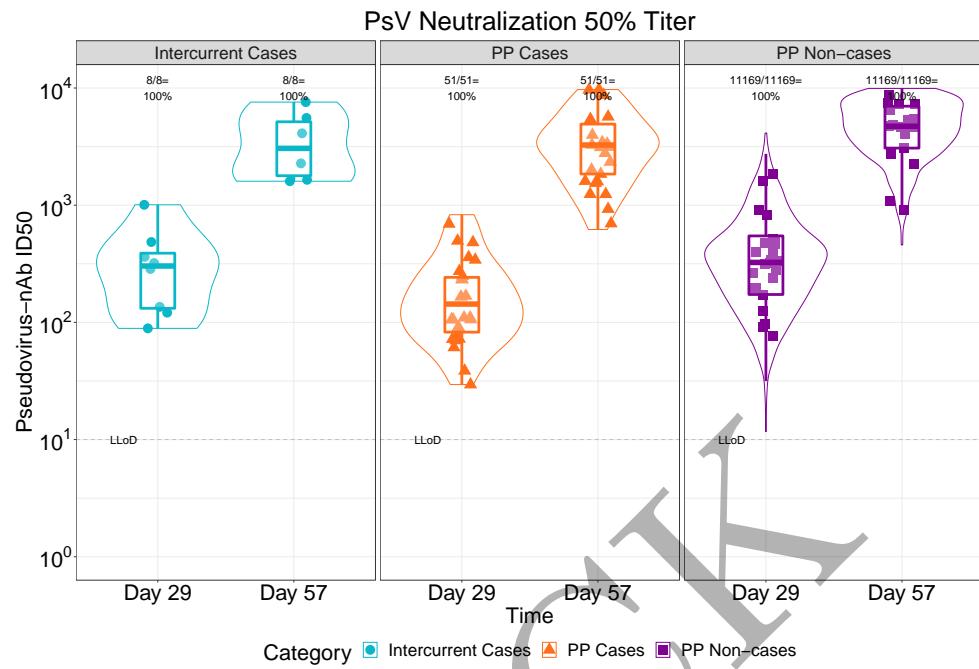


Figure 2.36: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm (version 1)

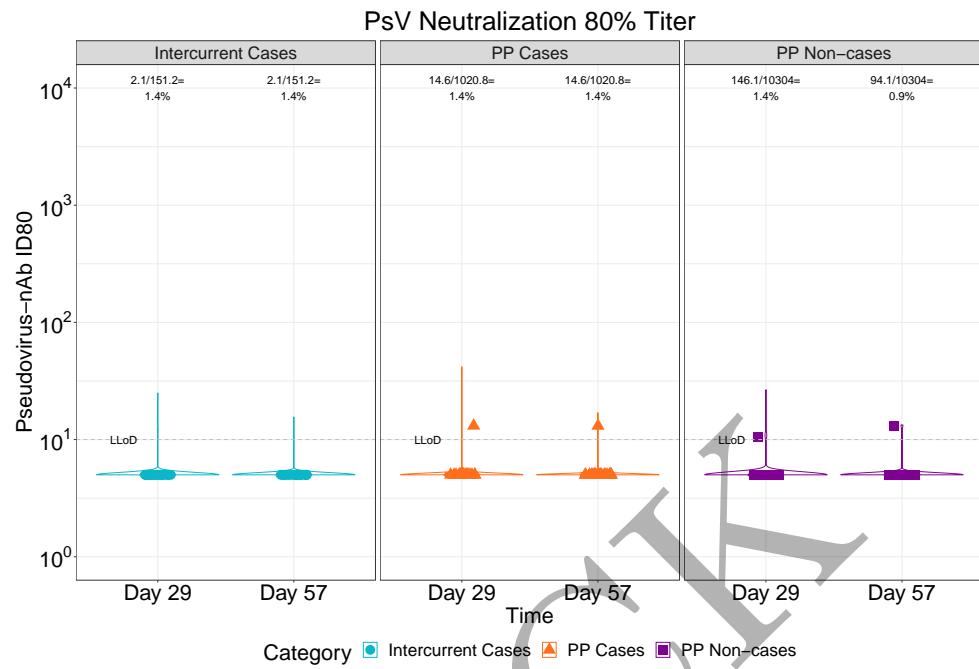


Figure 2.37: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm (version 1)

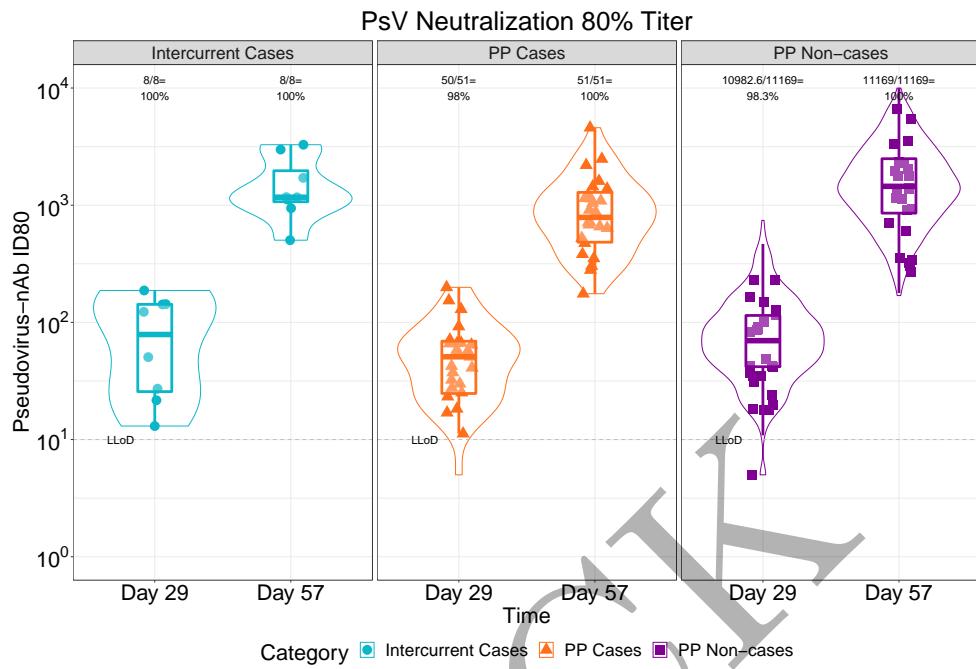


Figure 2.38: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm (version 1)

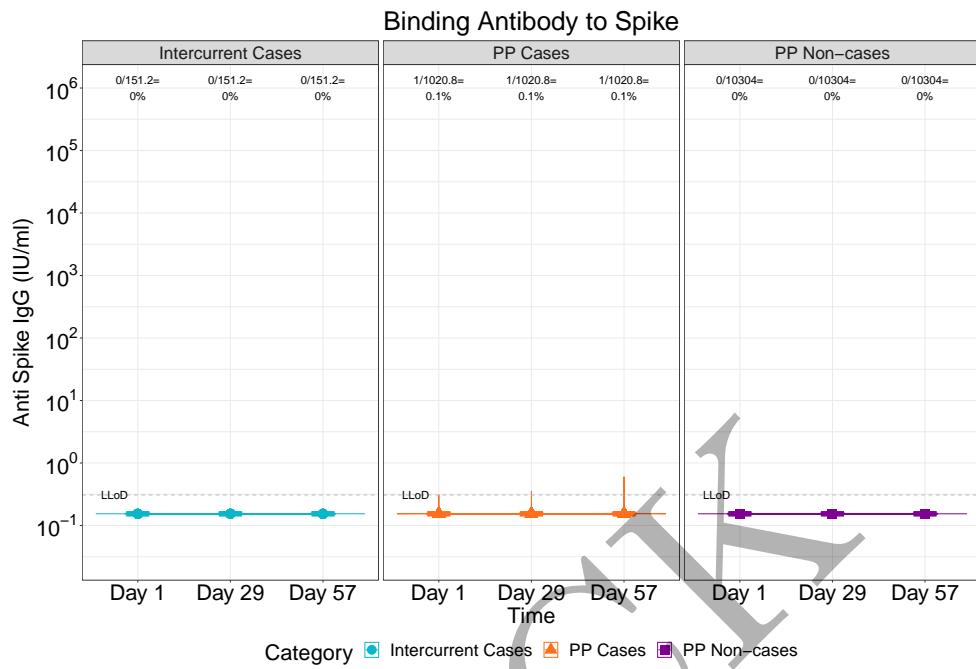


Figure 2.39: lineplots of Binding Antibody to Spike: baseline negative placebo arm (version 2)

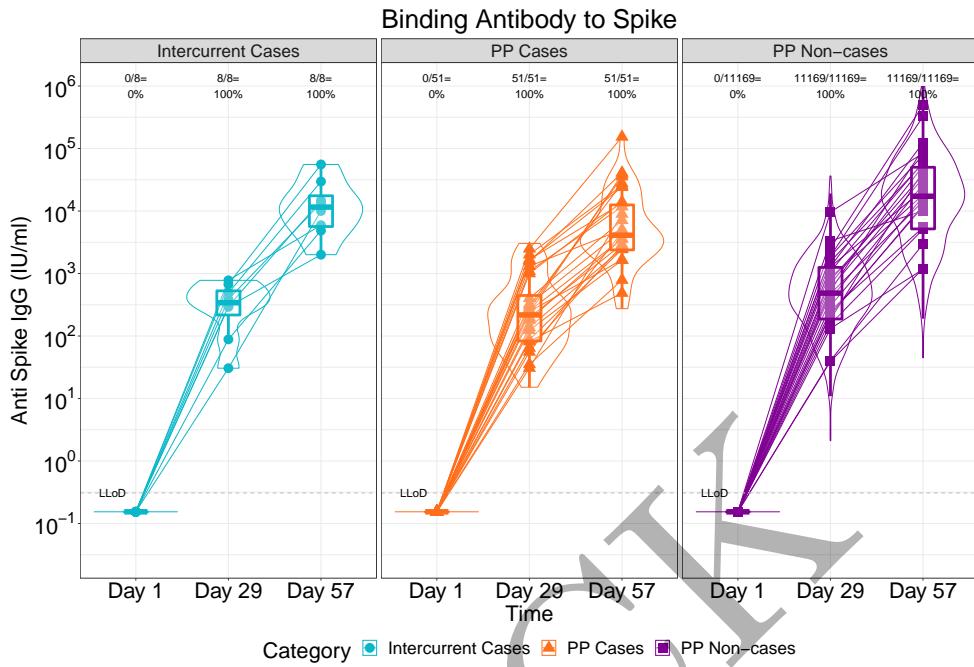


Figure 2.40: lineplots of Binding Antibody to Spike: baseline negative vaccine arm (version 2)

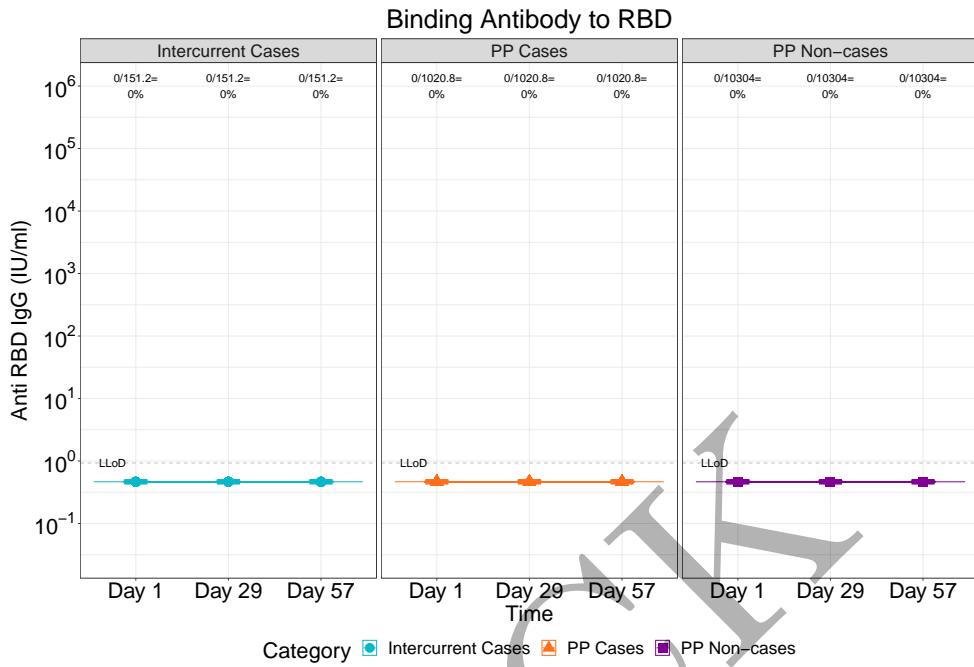


Figure 2.41: lineplots of Binding Antibody to RBD: baseline negative placebo arm (version 2)

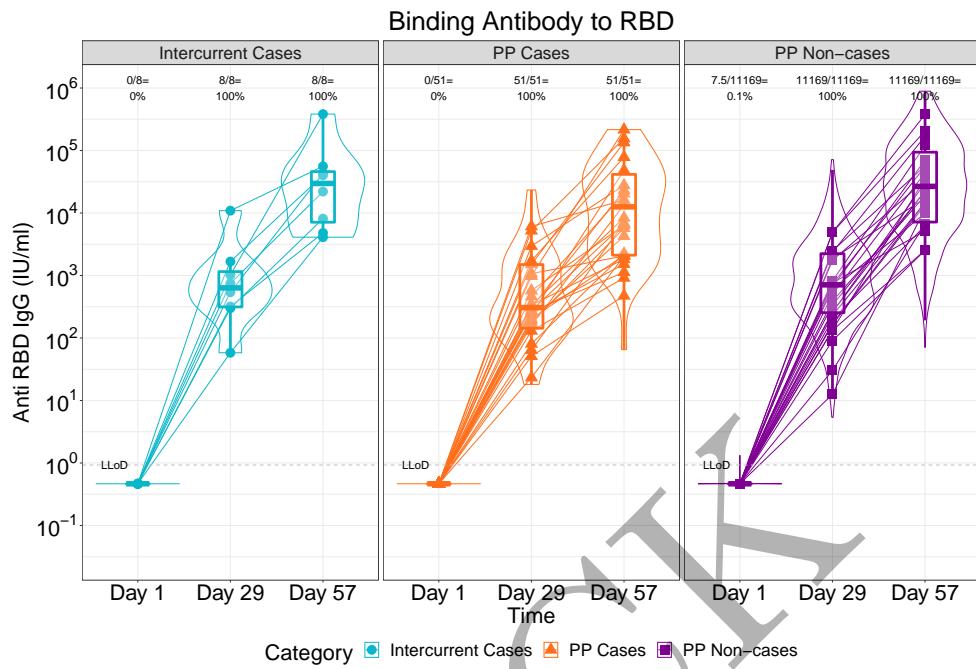


Figure 2.42: lineplots of Binding Antibody to RBD: baseline negative vaccine arm (version 2)

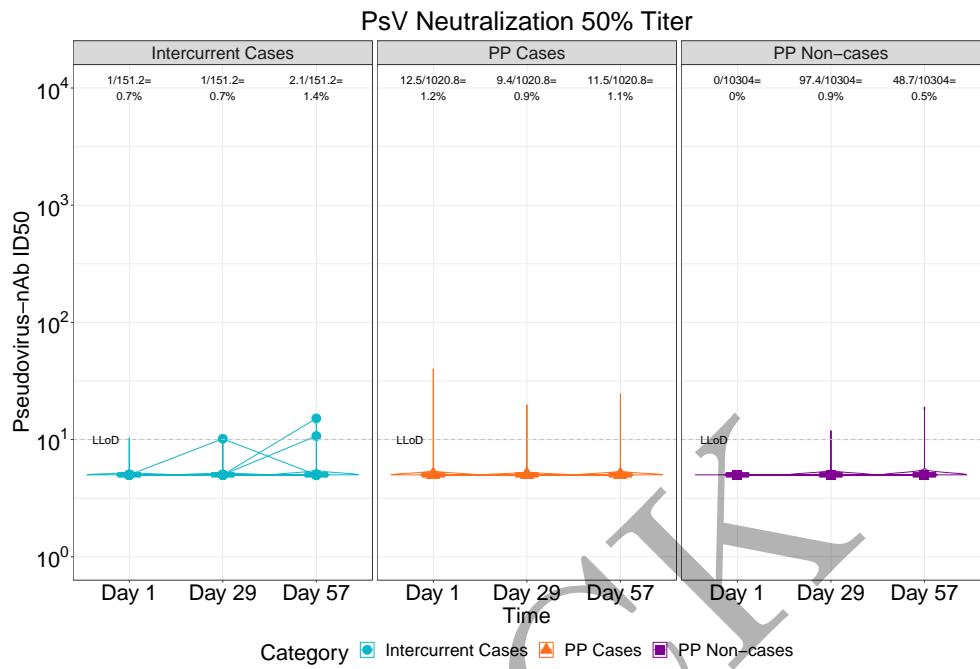


Figure 2.43: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm (version 2)

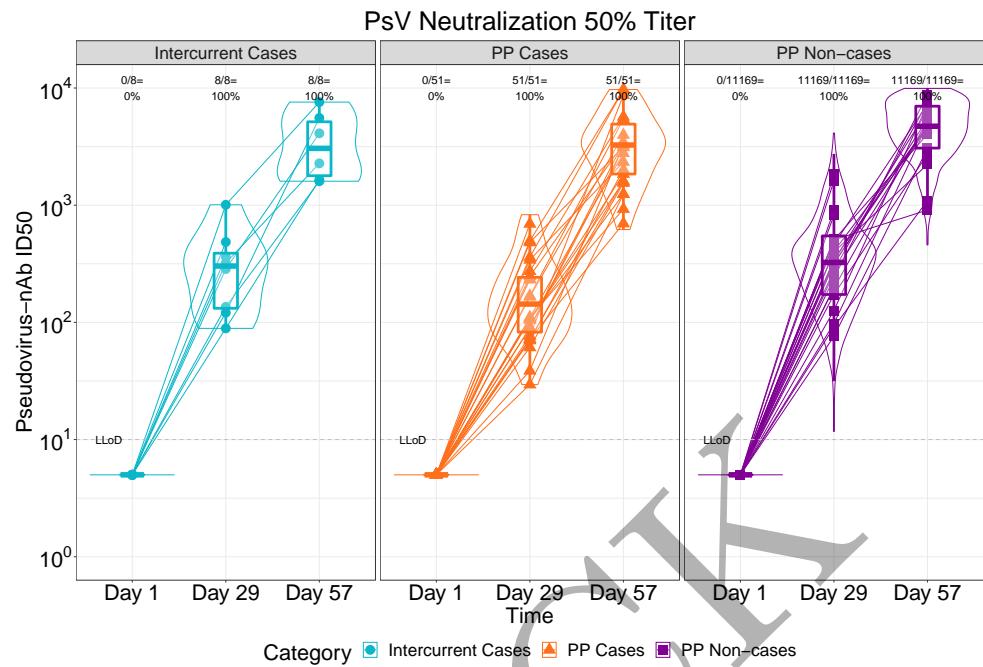


Figure 2.44: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm (version 2)

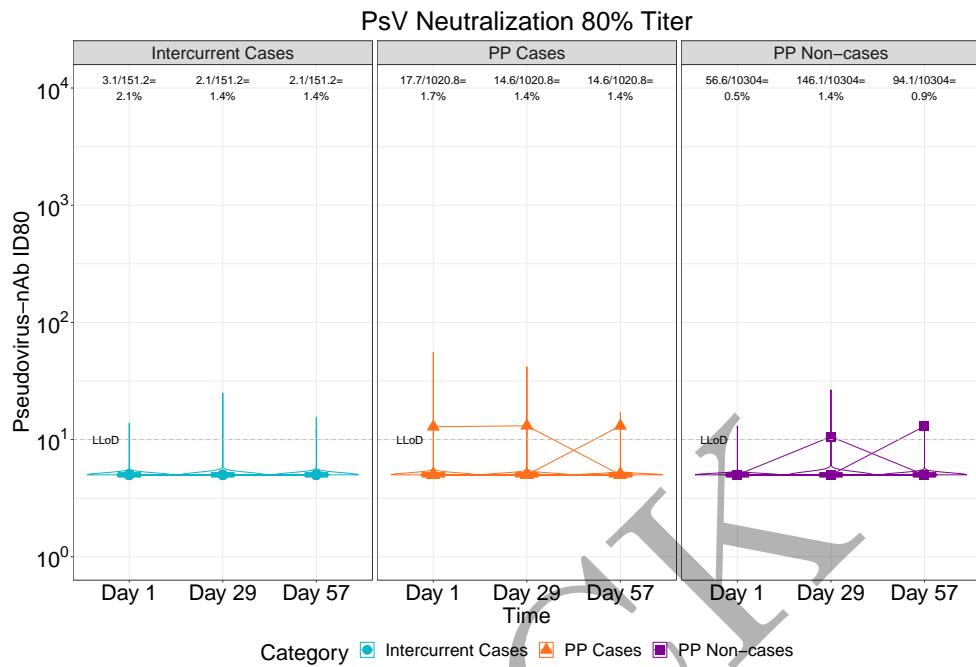


Figure 2.45: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm (version 2)

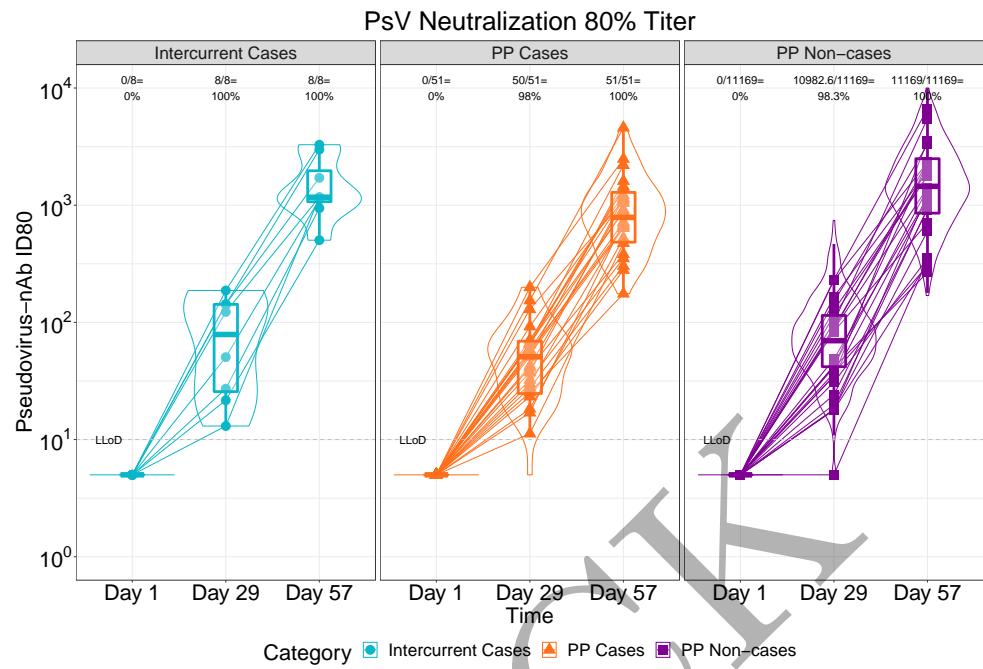


Figure 2.46: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm (version 2)

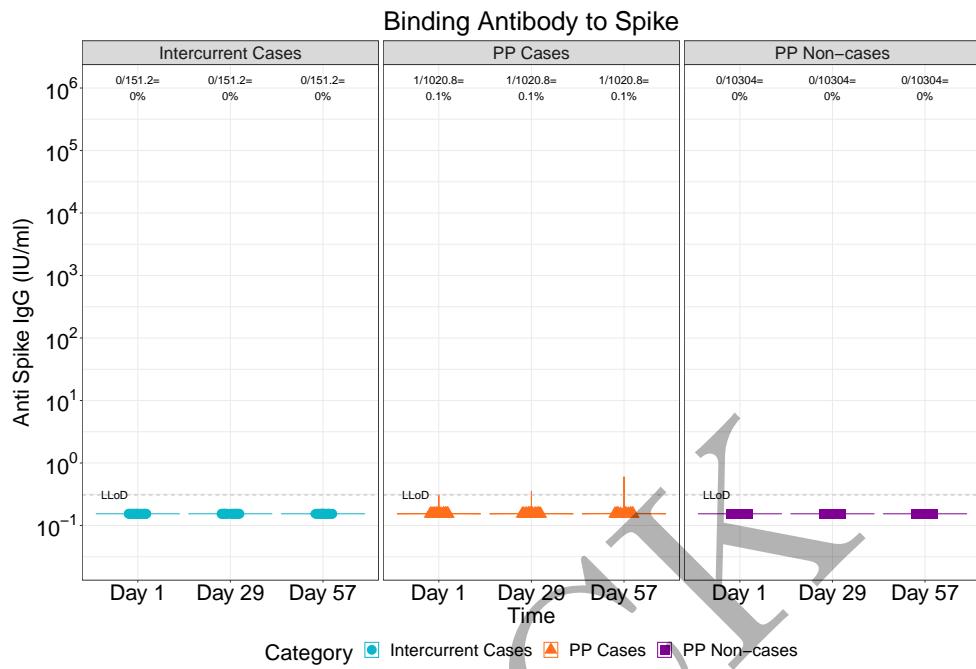


Figure 2.47: violinplots of Binding Antibody to Spike: baseline negative placebo arm (version 2)

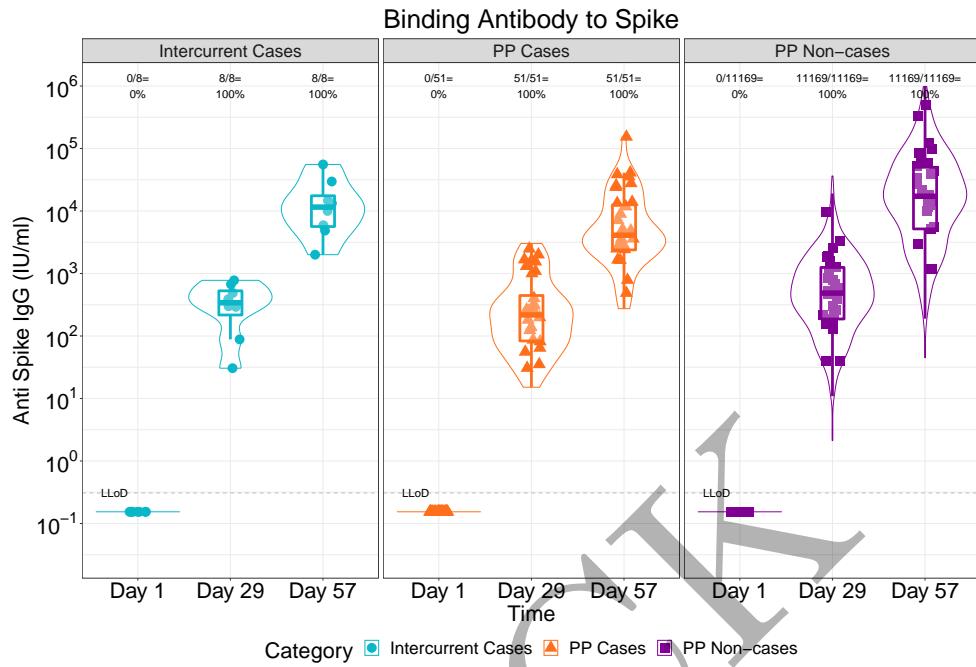


Figure 2.48: violinplots of Binding Antibody to Spike: baseline negative vaccine arm (version 2)

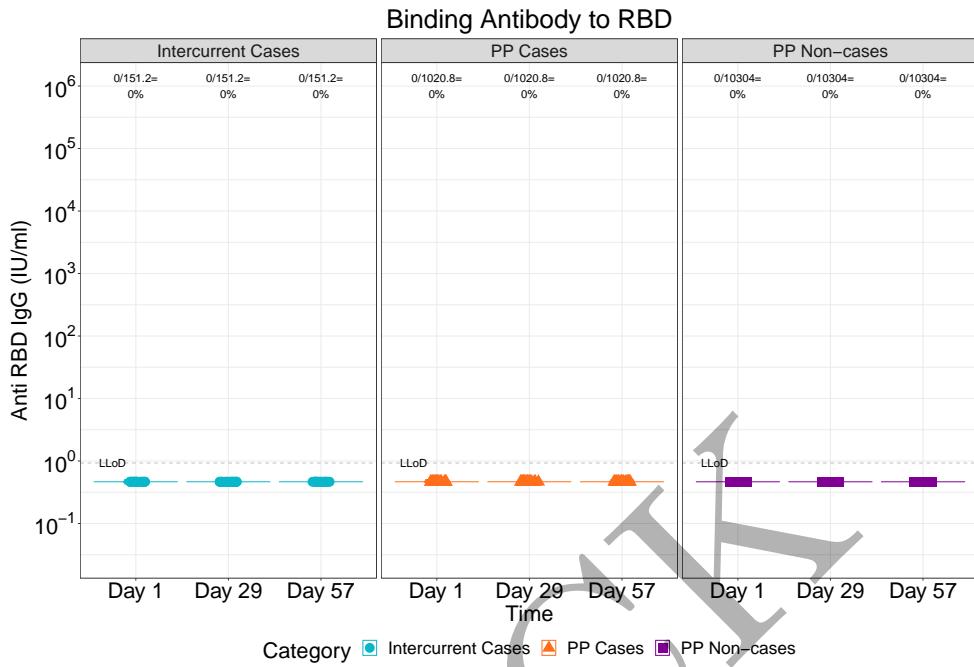


Figure 2.49: violinplots of Binding Antibody to RBD: baseline negative placebo arm (version 2)

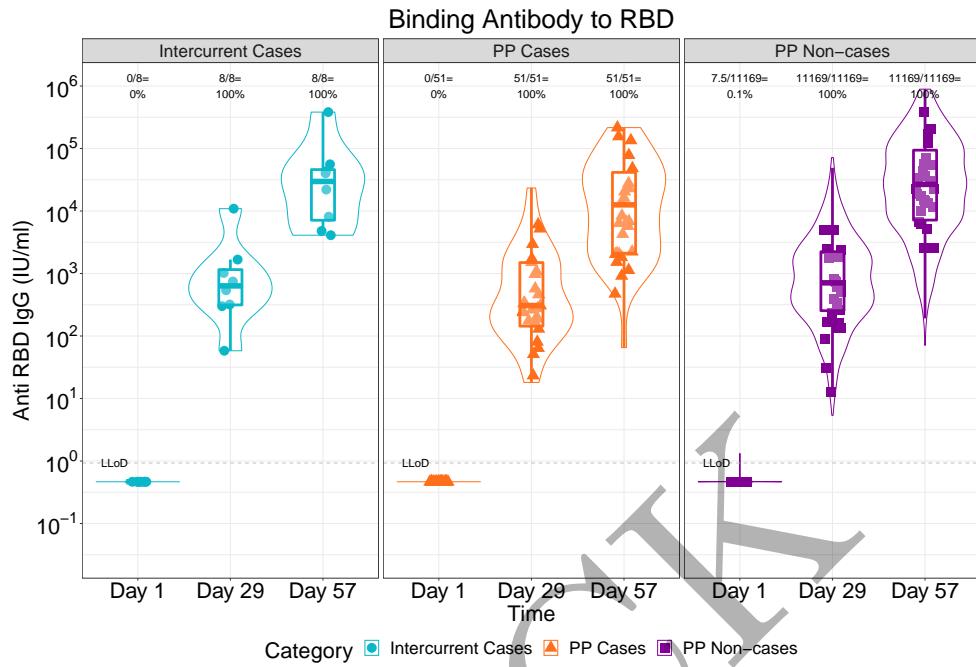


Figure 2.50: violinplots of Binding Antibody to RBD: baseline negative vaccine arm (version 2)

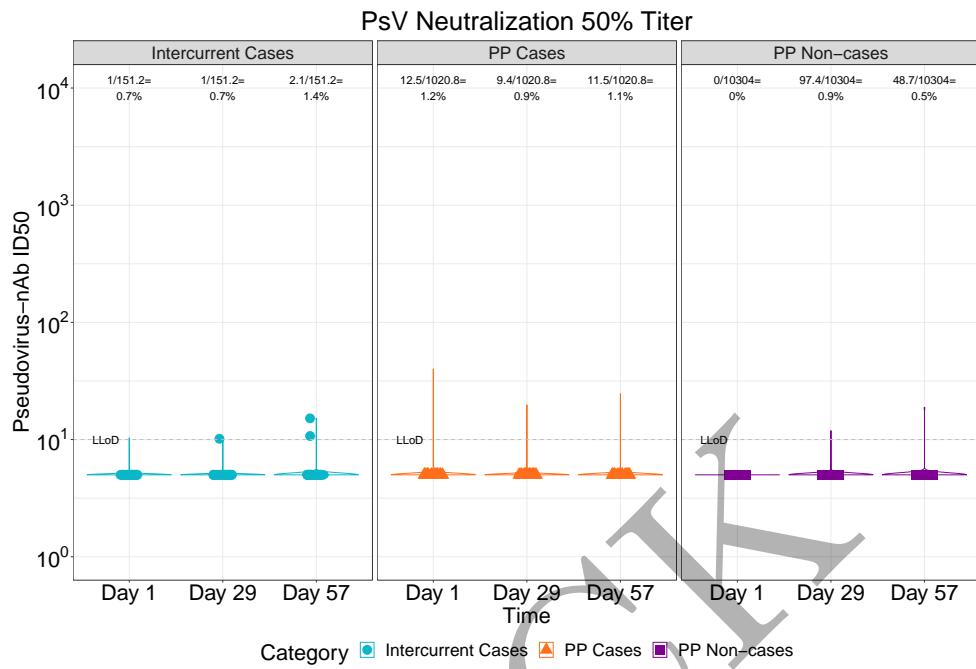


Figure 2.51: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm (version 2)

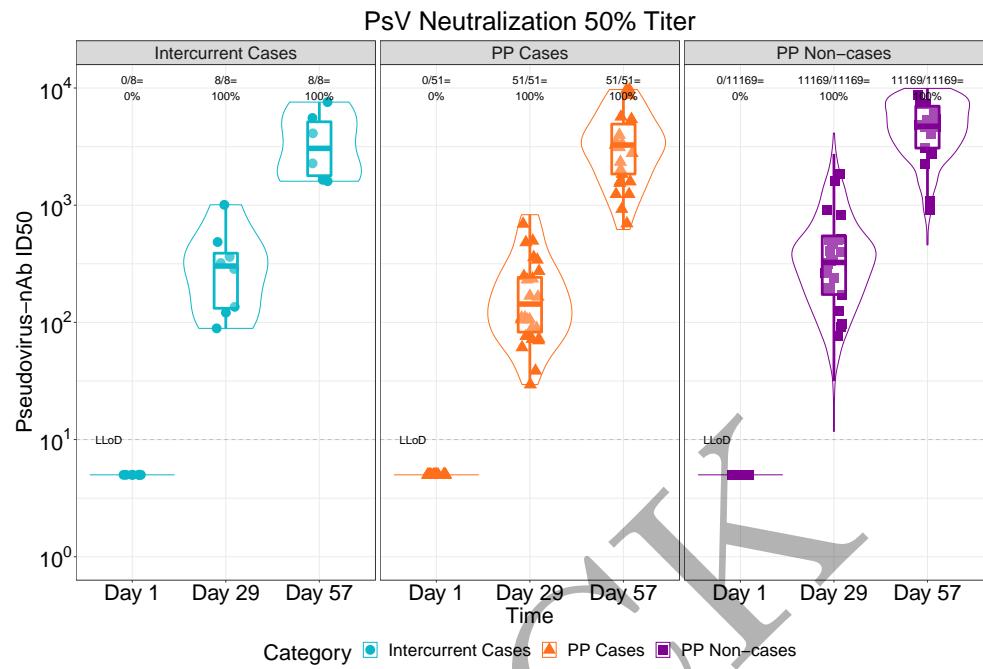


Figure 2.52: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm (version 2)

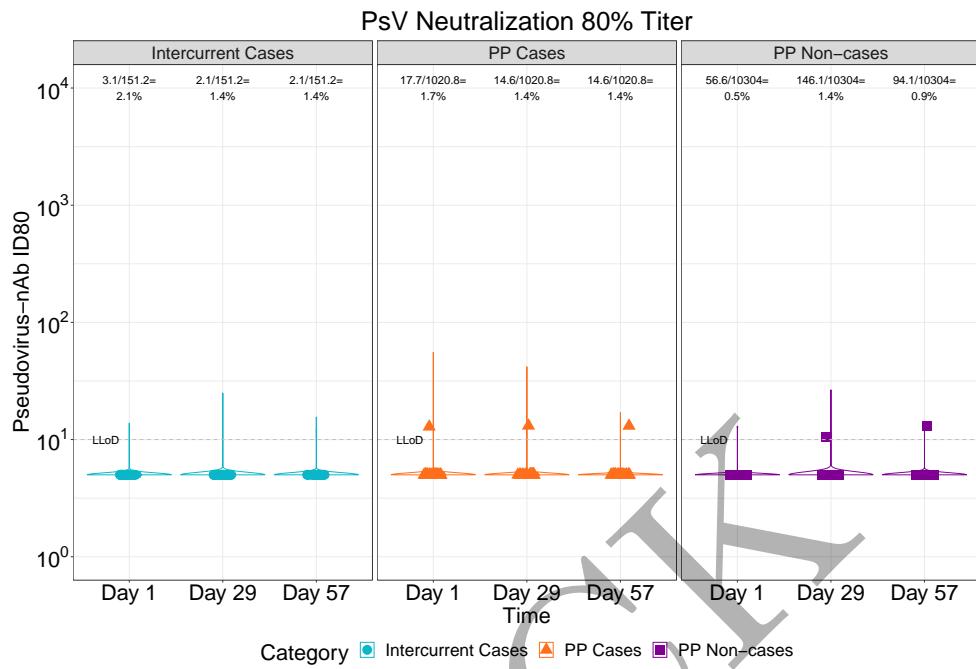


Figure 2.53: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm (version 2)

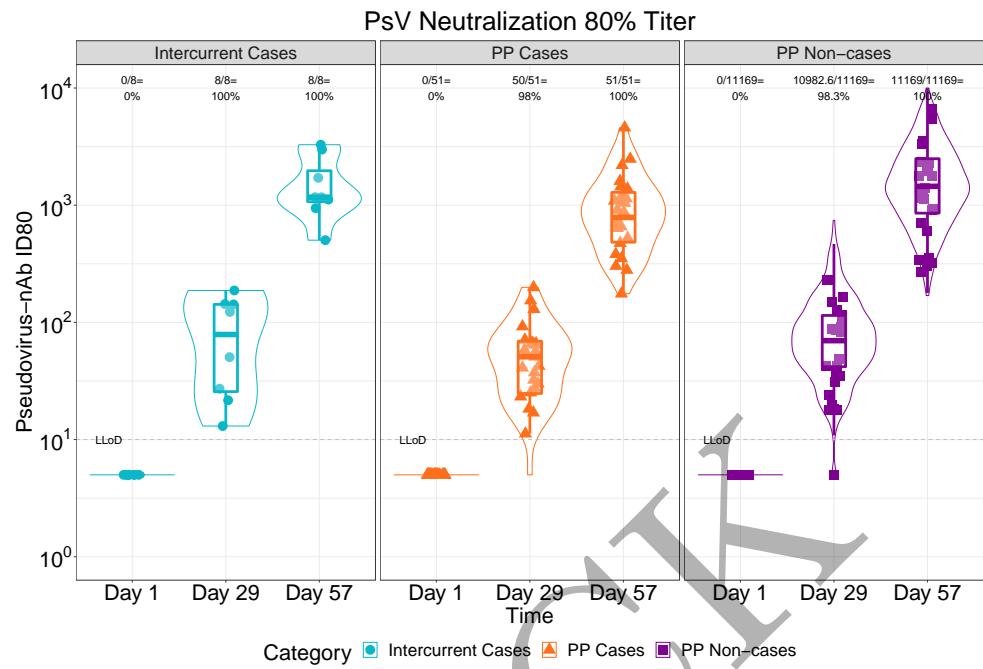


Figure 2.54: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm (version 2)

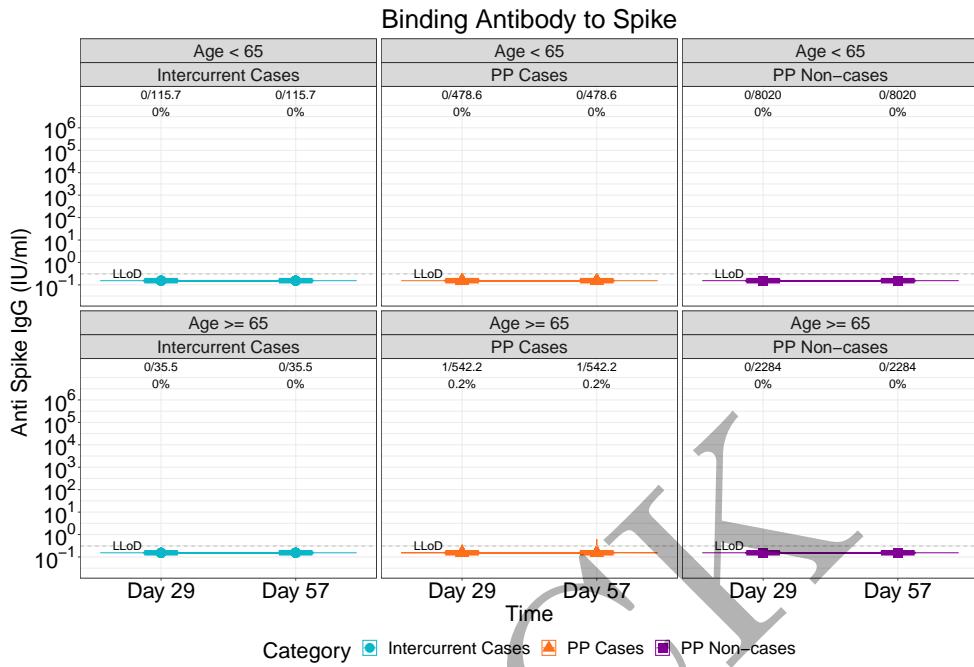


Figure 2.55: lineplots of Binding Antibody to Spike: baseline negative placebo arm by age (version 1)

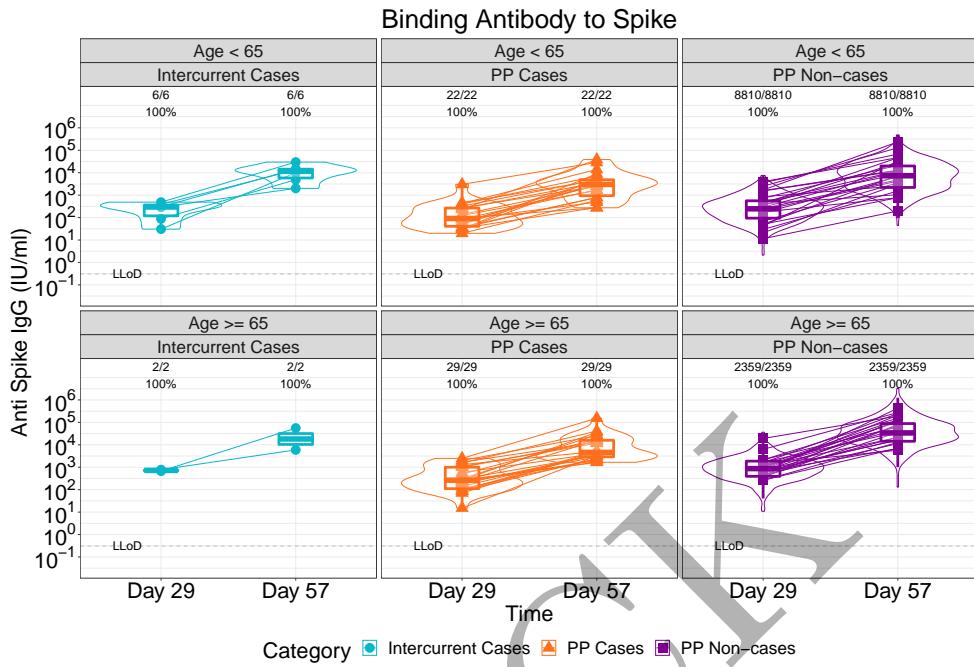


Figure 2.56: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by age (version 1)

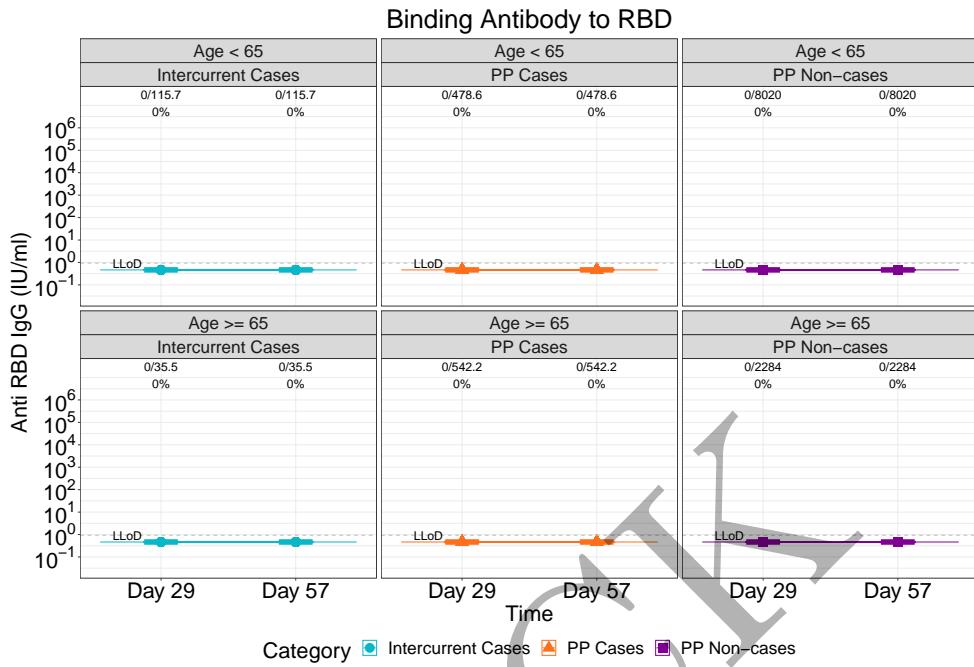


Figure 2.57: lineplots of Binding Antibody to RBD: baseline negative placebo arm by age (version 1)

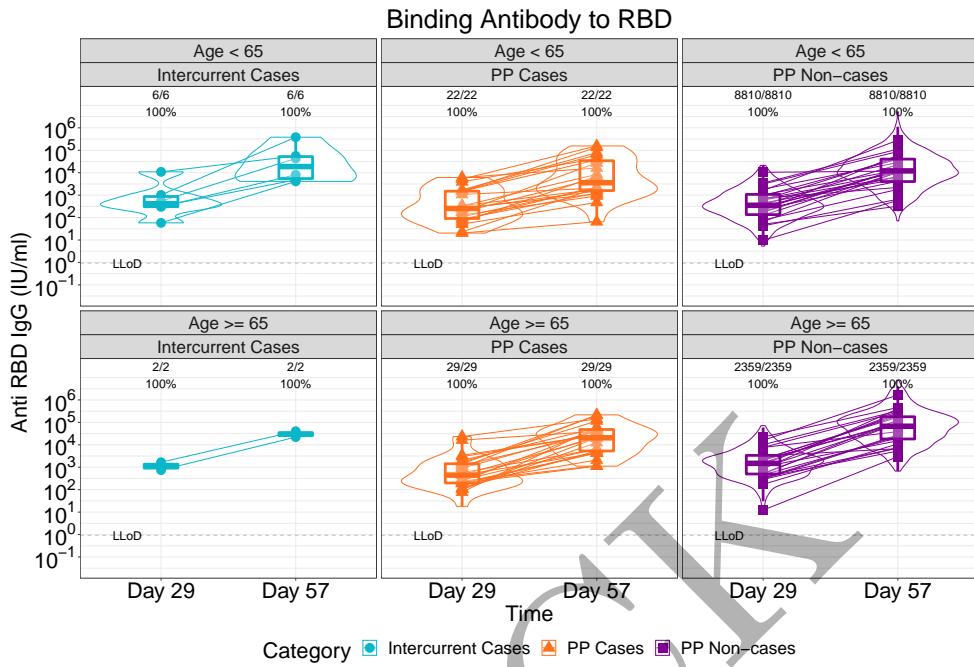


Figure 2.58: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by age (version 1)

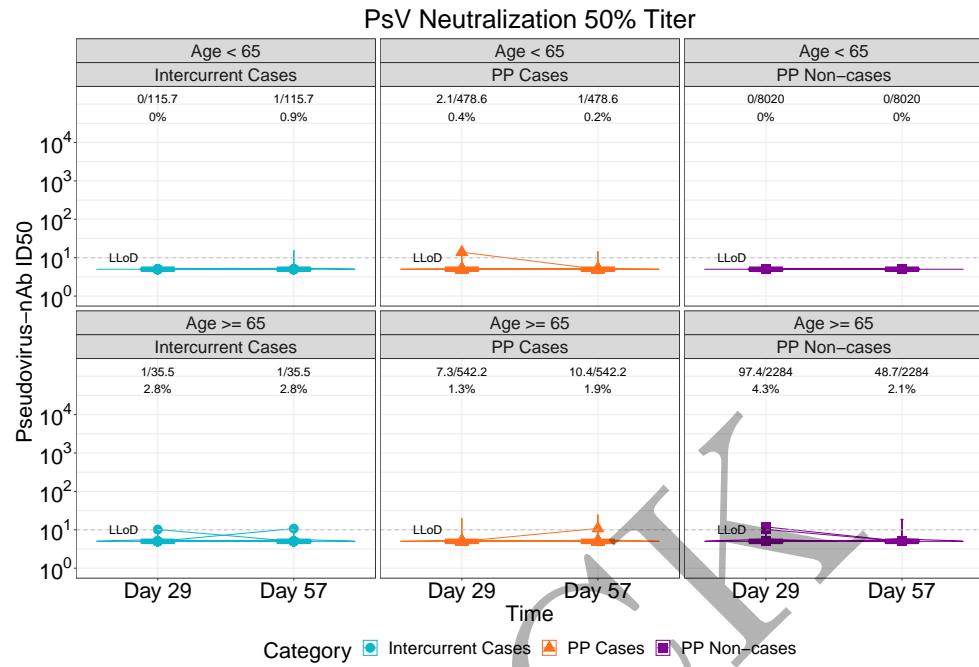


Figure 2.59: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age (version 1)

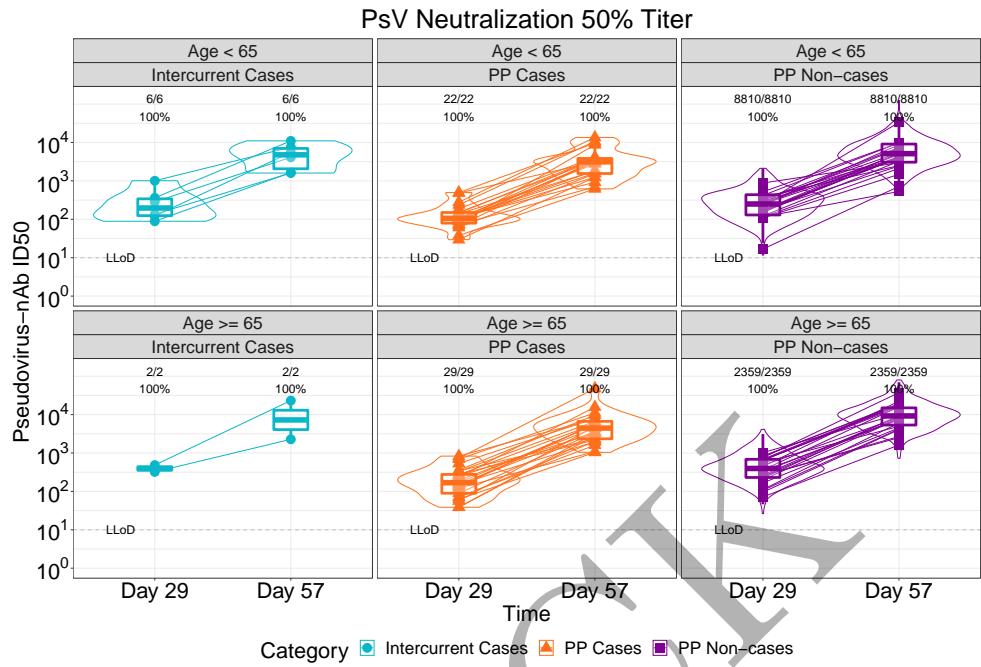


Figure 2.60: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age (version 1)

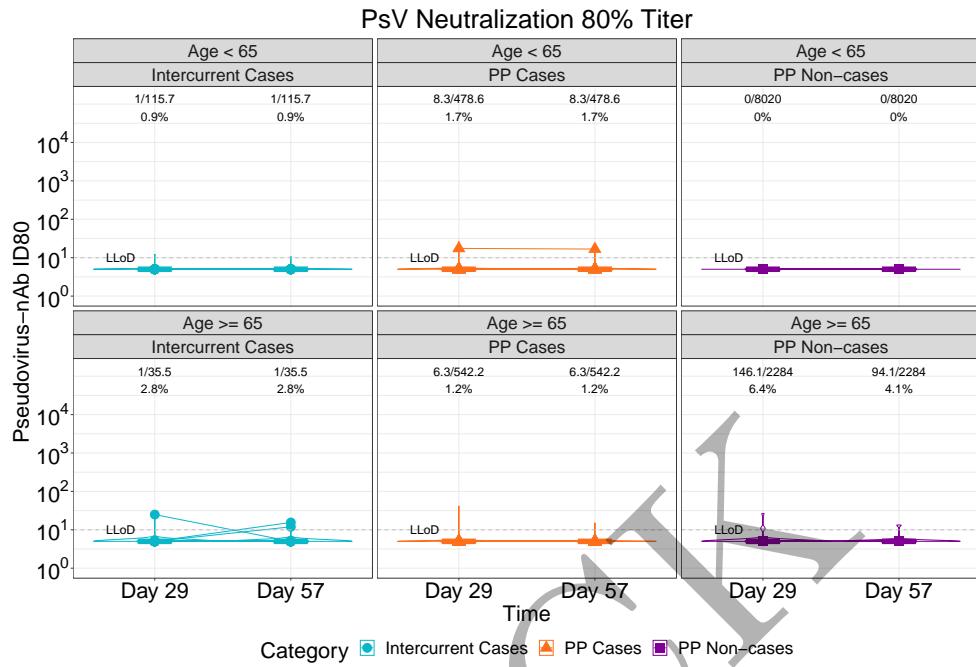


Figure 2.61: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age (version 1)

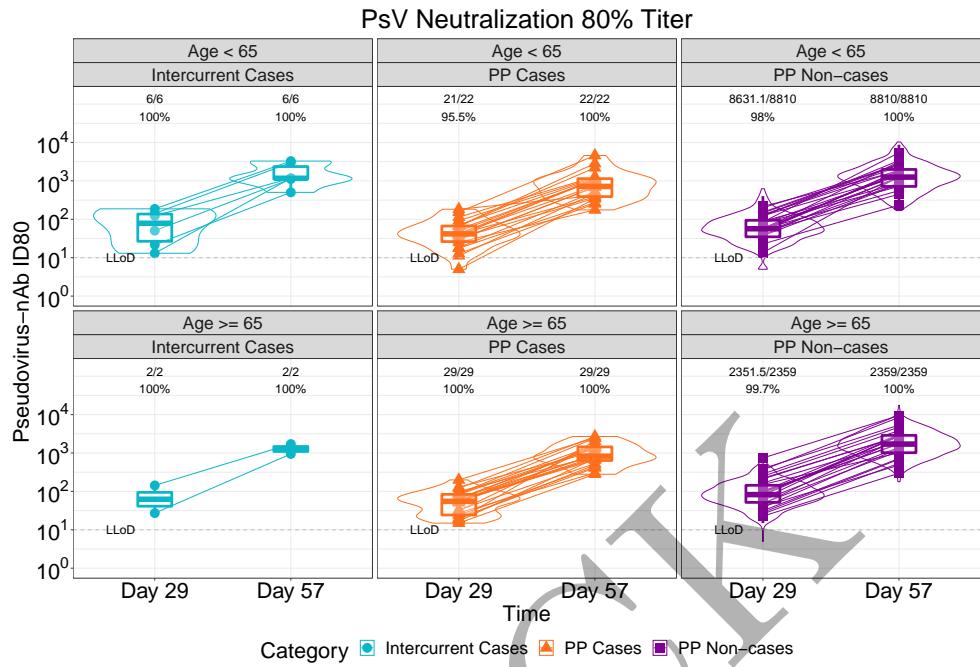


Figure 2.62: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age (version 1)

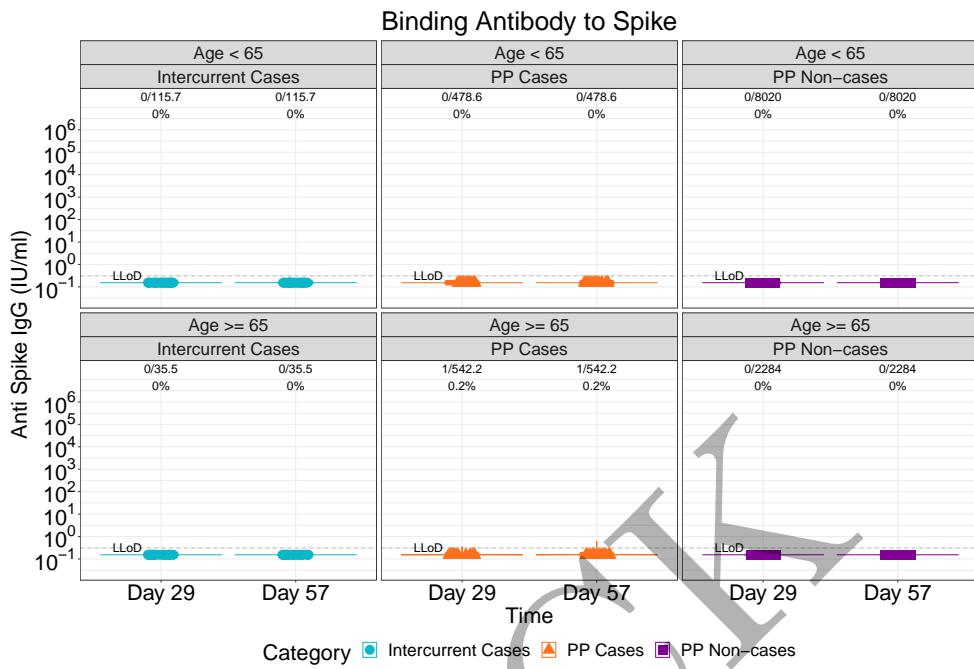


Figure 2.63: violinplots of Binding Antibody to Spike: baseline negative placebo arm by age (version 1)

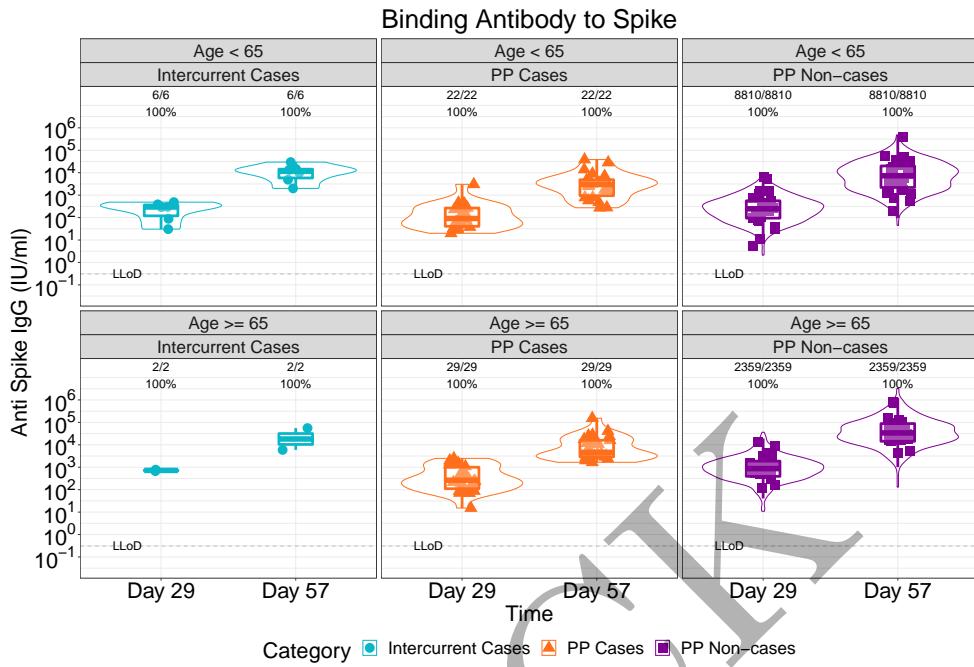


Figure 2.64: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by age (version 1)

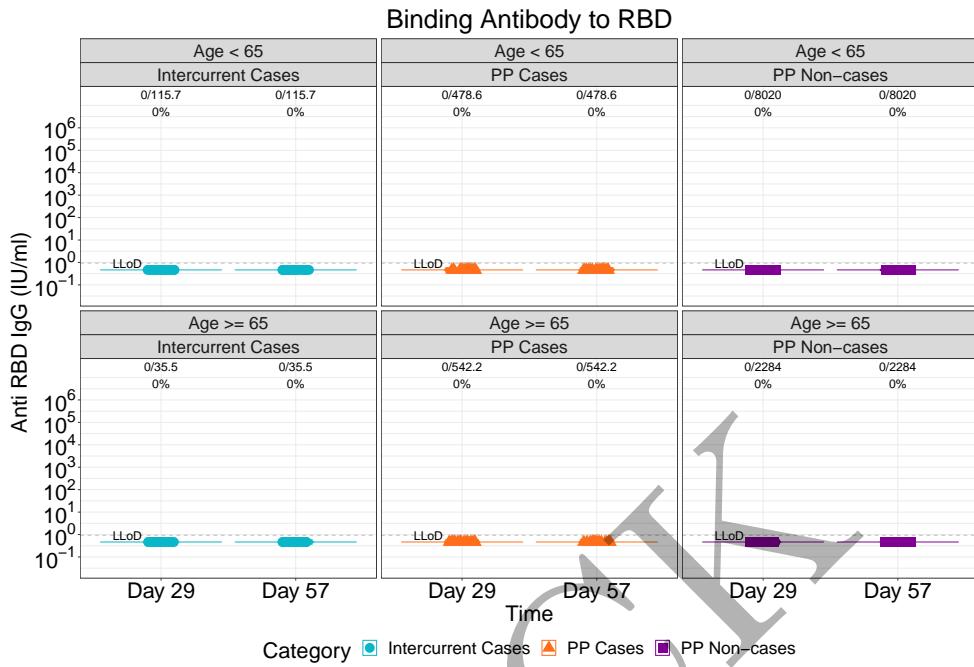


Figure 2.65: violinplots of Binding Antibody to RBD: baseline negative placebo arm by age (version 1)

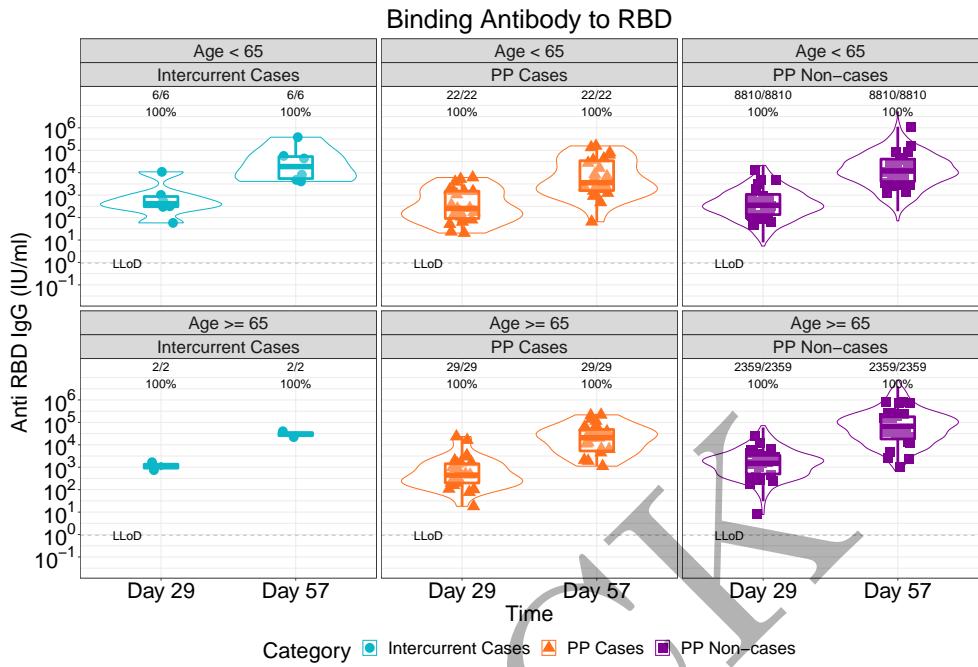


Figure 2.66: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by age (version 1)

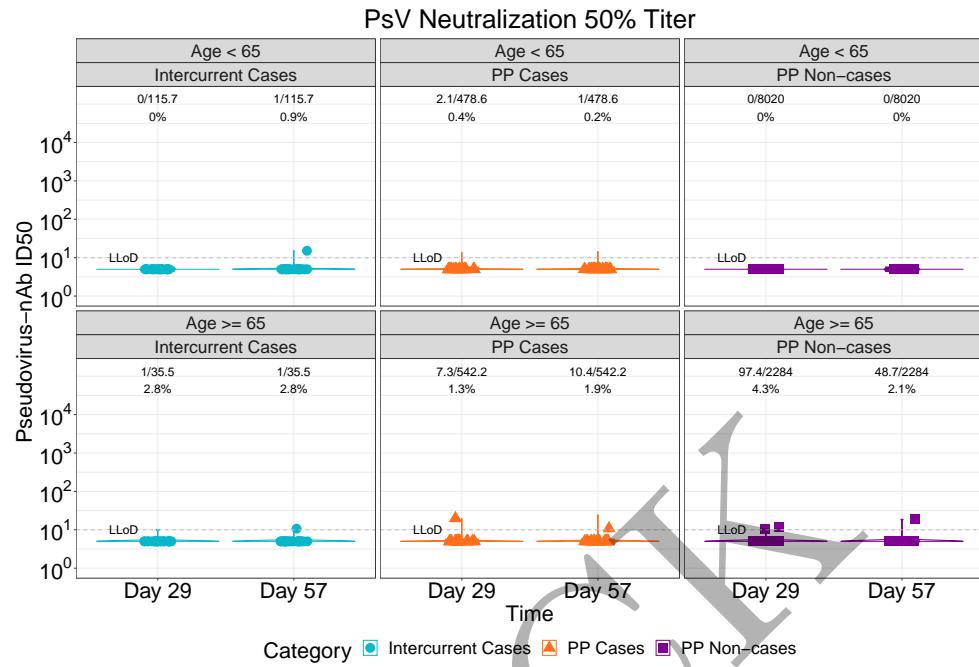


Figure 2.67: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age (version 1)

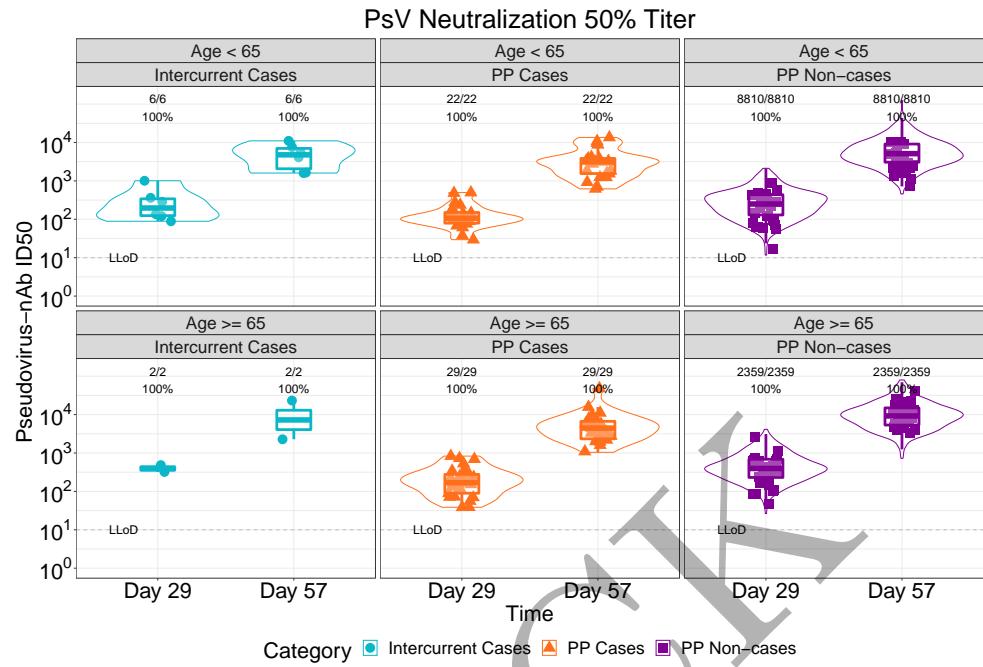


Figure 2.68: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age (version 1)

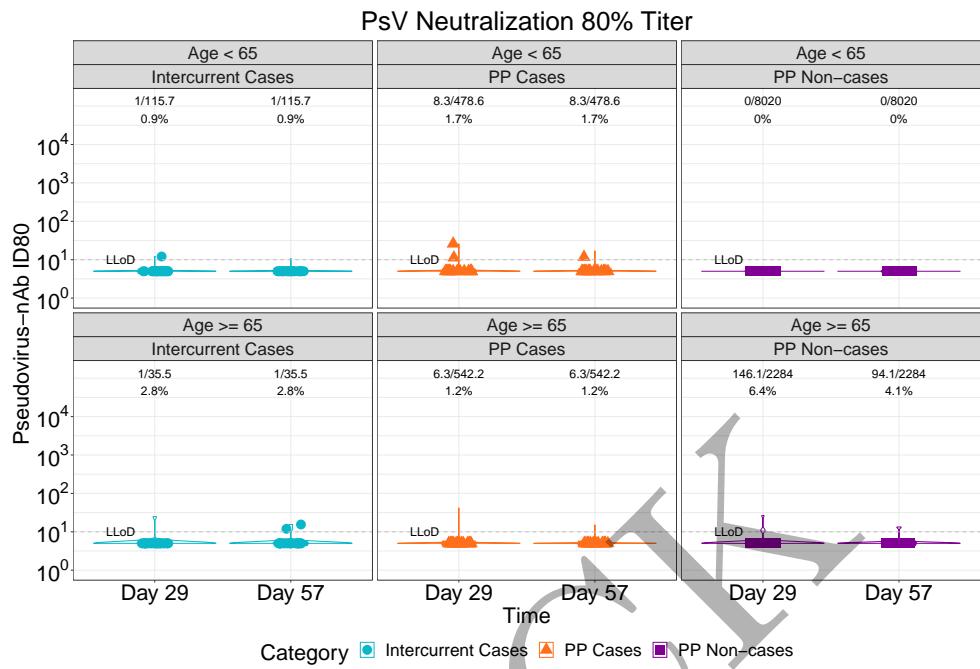


Figure 2.69: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age (version 1)

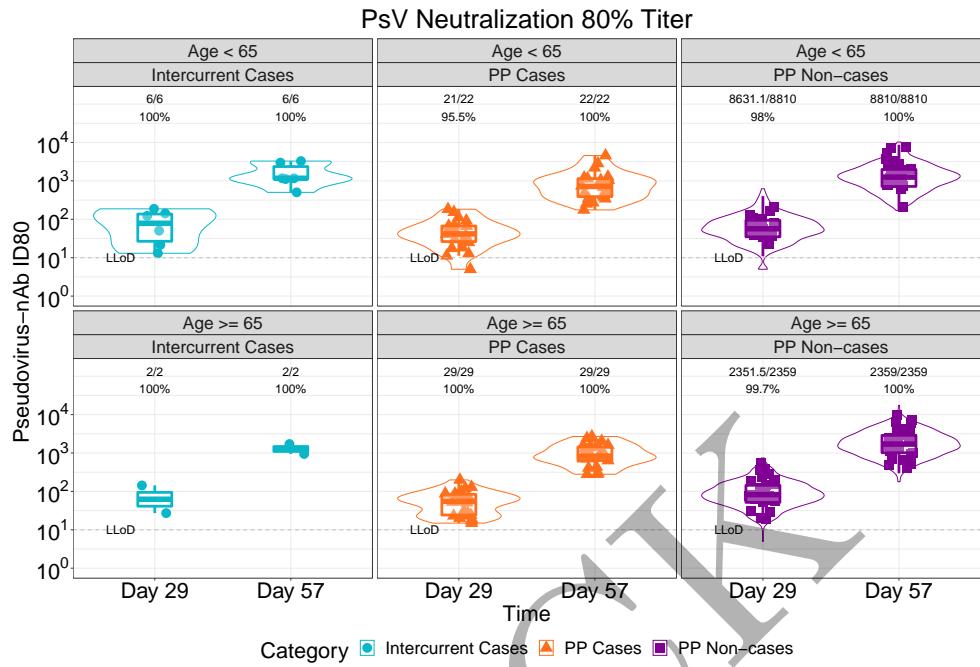


Figure 2.70: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age (version 1)

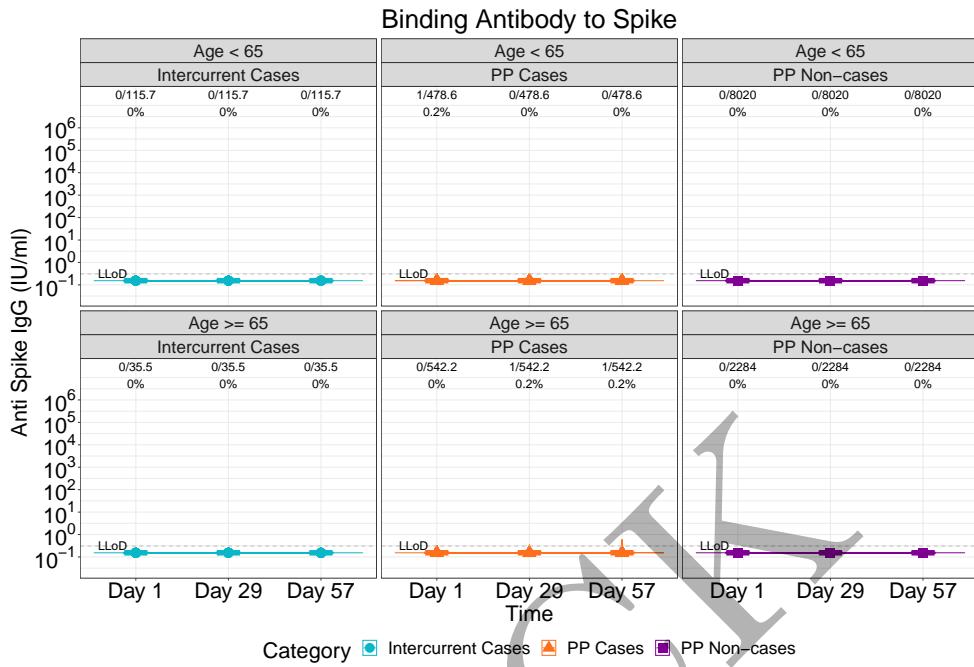


Figure 2.71: lineplots of Binding Antibody to Spike: baseline negative placebo arm by age (version 2)

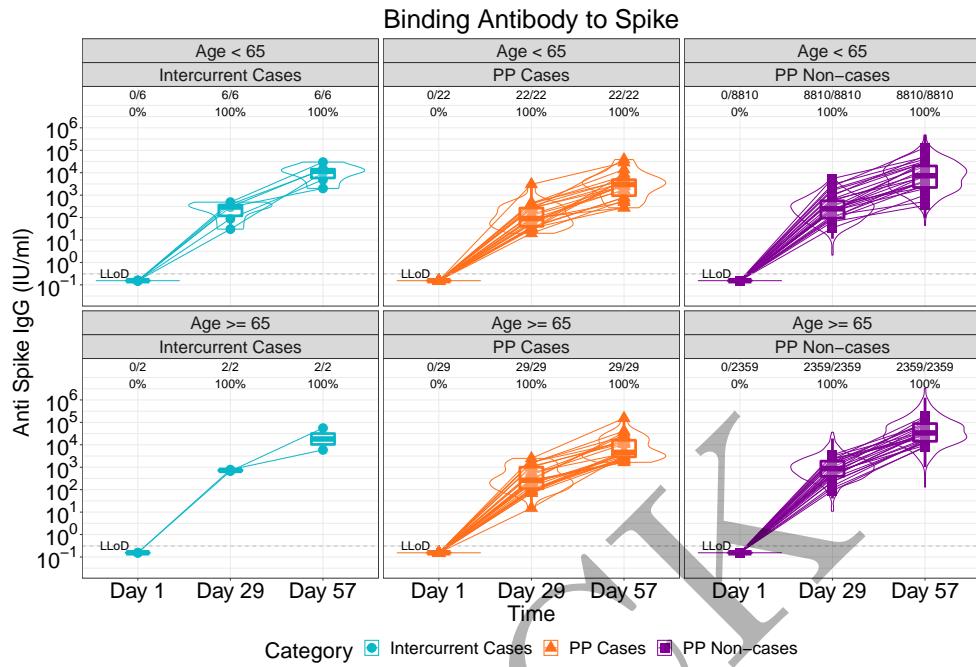


Figure 2.72: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by age (version 2)

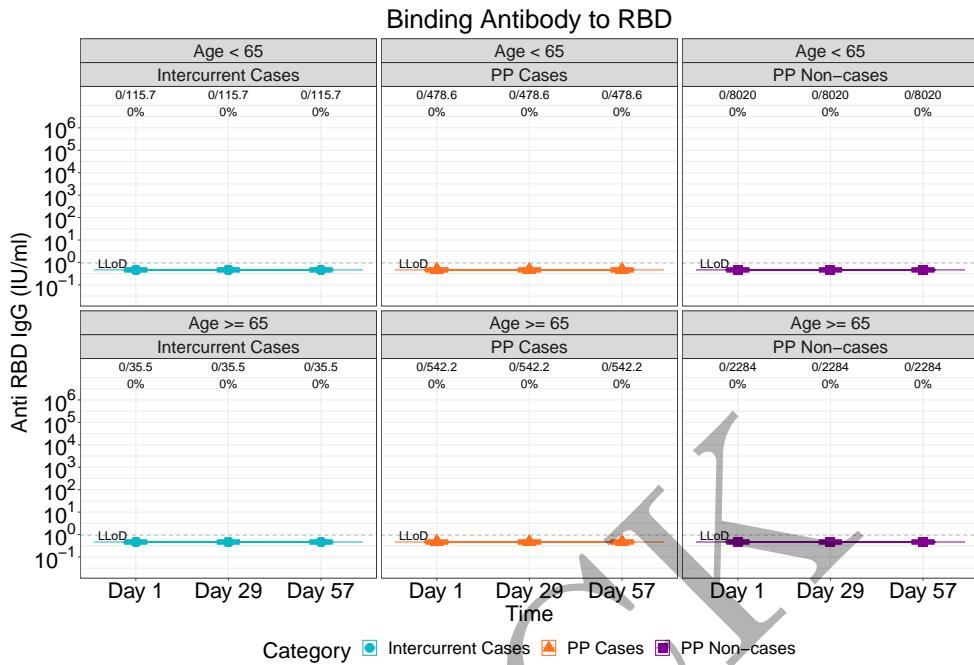


Figure 2.73: lineplots of Binding Antibody to RBD: baseline negative placebo arm by age (version 2)

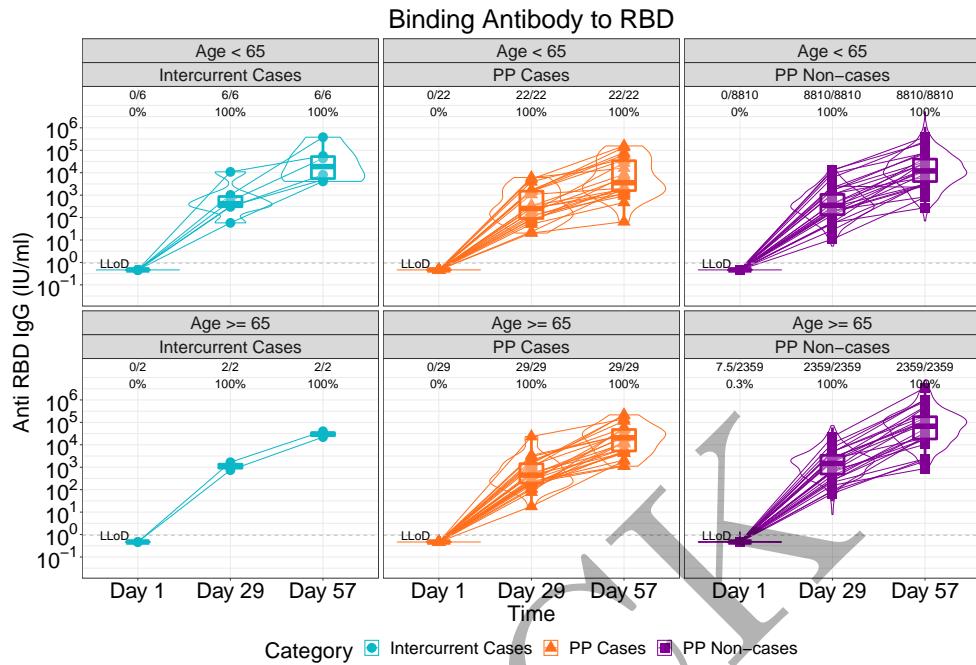


Figure 2.74: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by age (version 2)

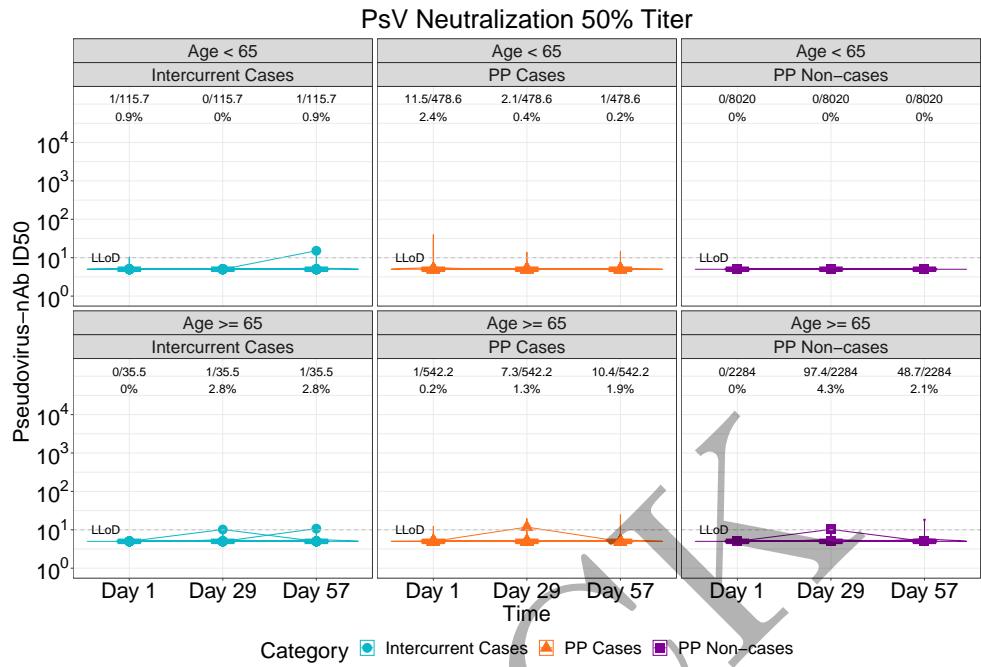


Figure 2.75: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age (version 2)

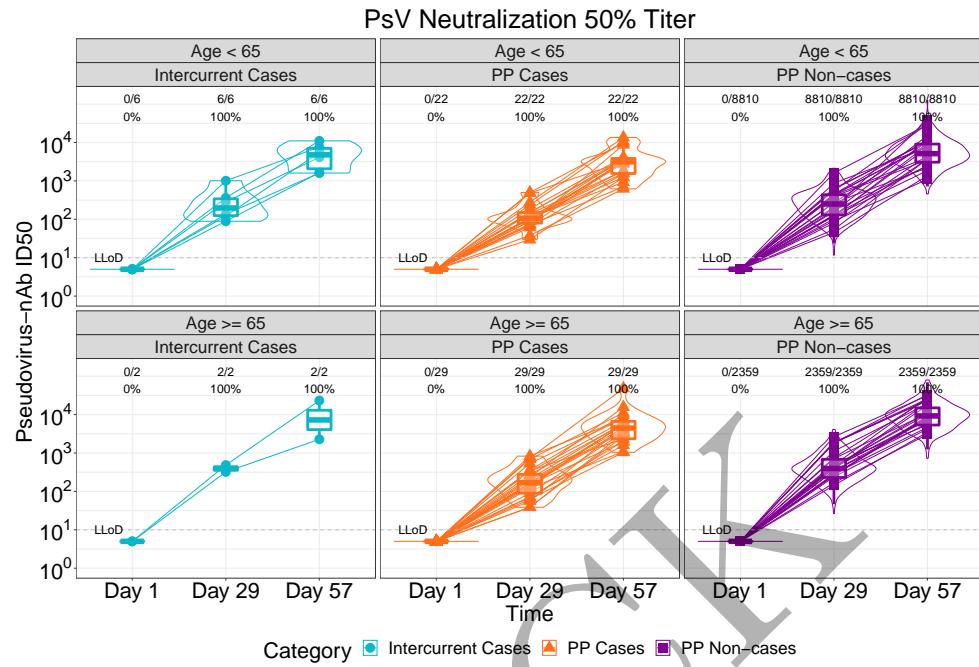


Figure 2.76: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age (version 2)

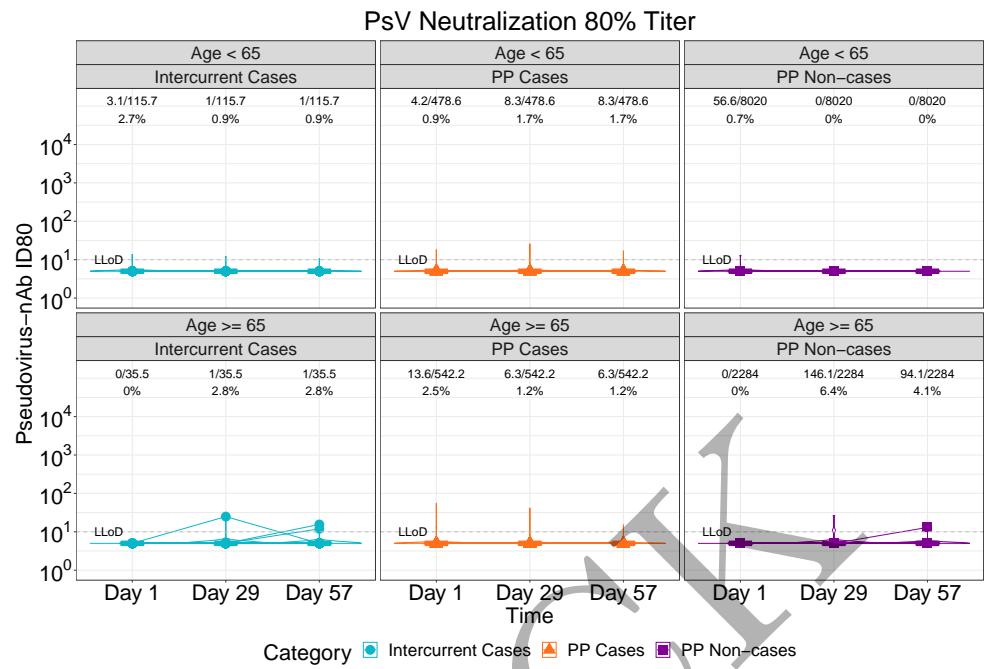


Figure 2.77: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age (version 2)

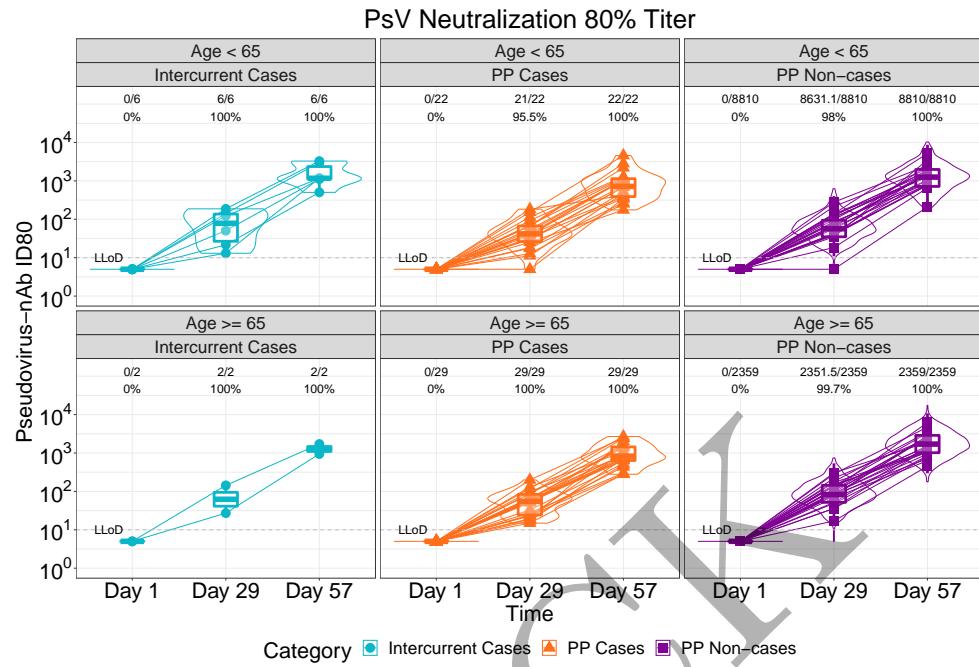


Figure 2.78: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age (version 2)

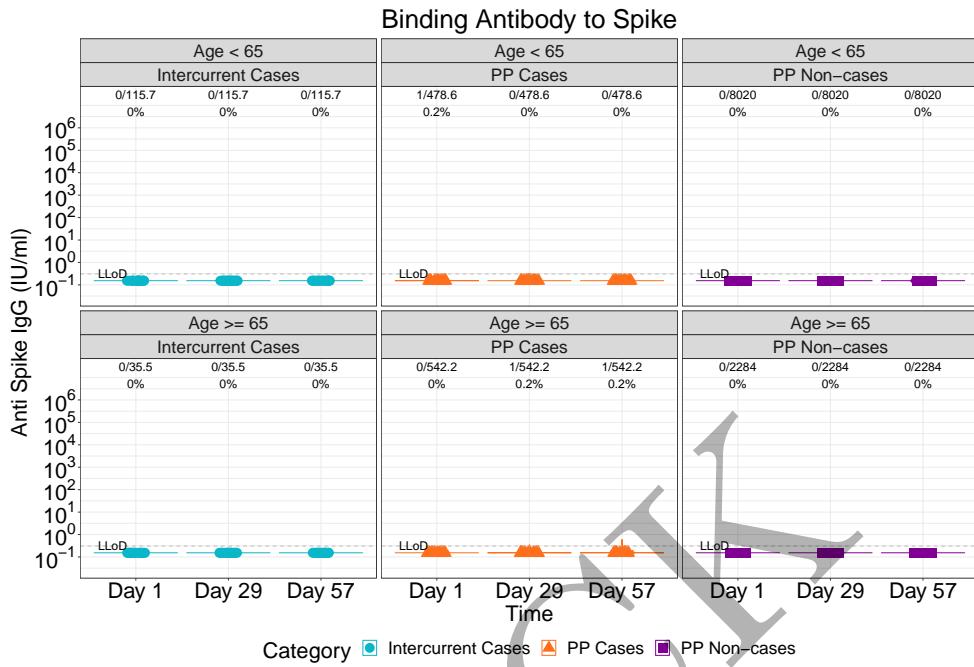


Figure 2.79: violinplots of Binding Antibody to Spike: baseline negative placebo arm by age (version 2)

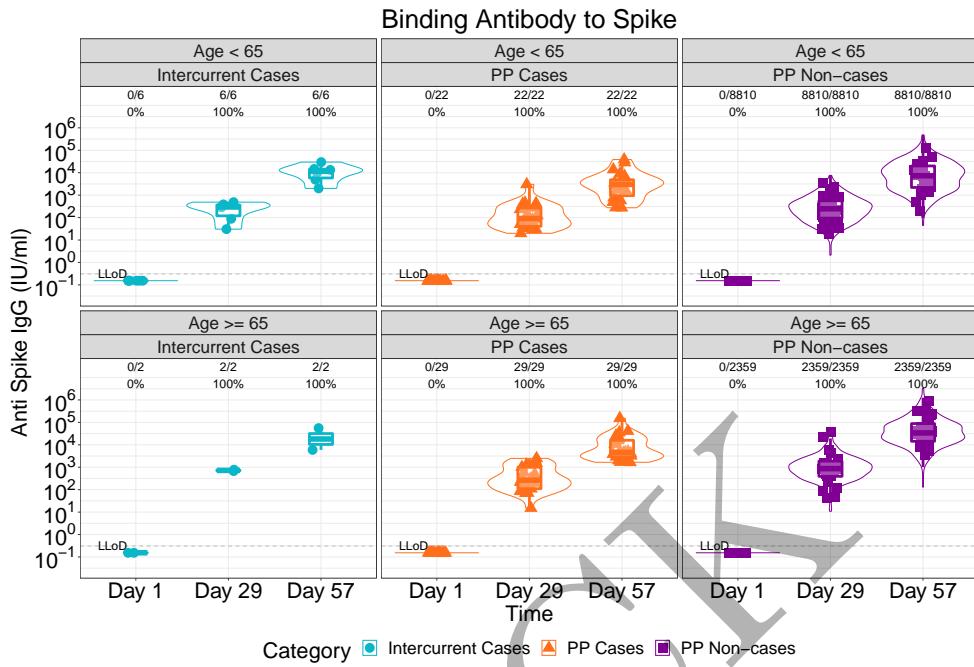


Figure 2.80: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by age (version 2)

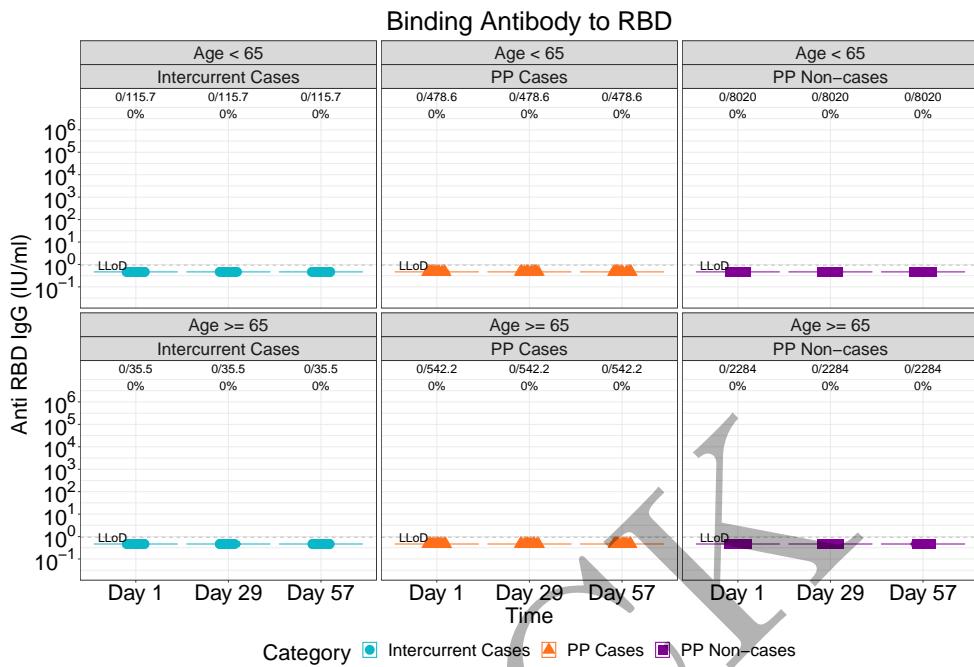


Figure 2.81: violinplots of Binding Antibody to RBD: baseline negative placebo arm by age (version 2)

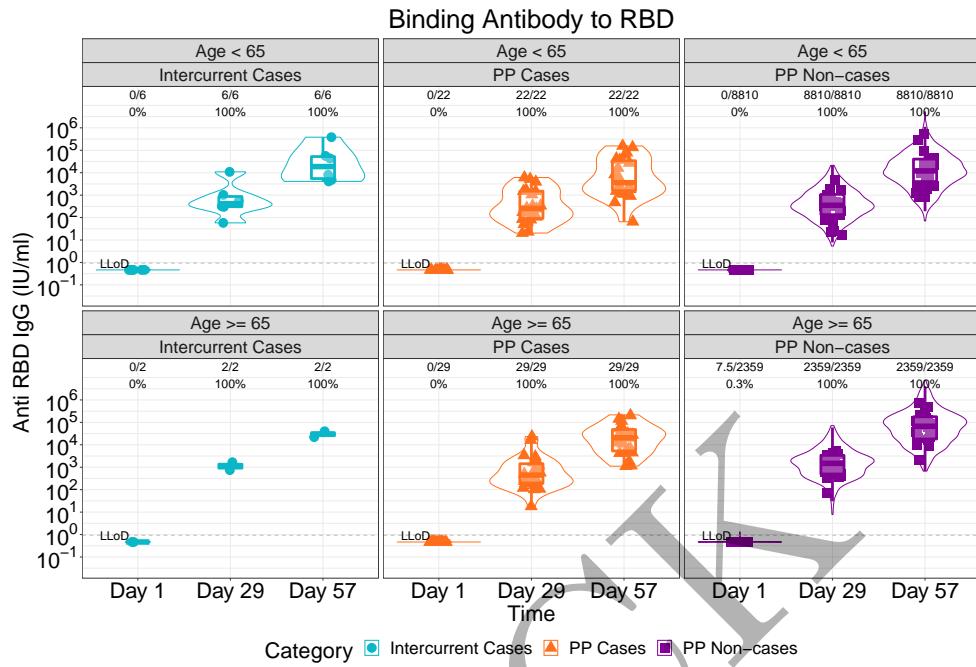


Figure 2.82: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by age (version 2)

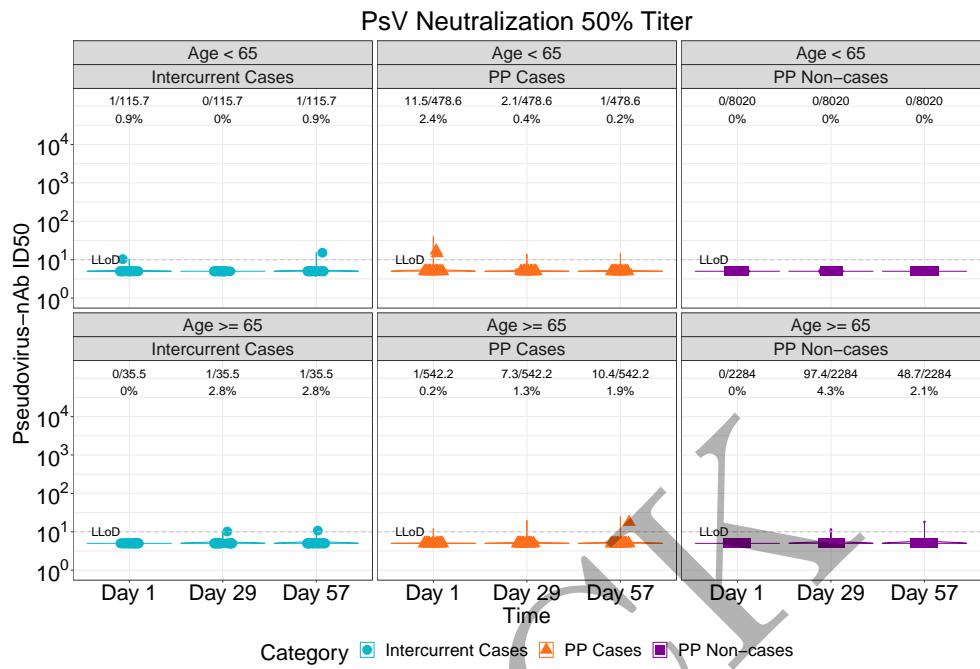


Figure 2.83: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age (version 2)

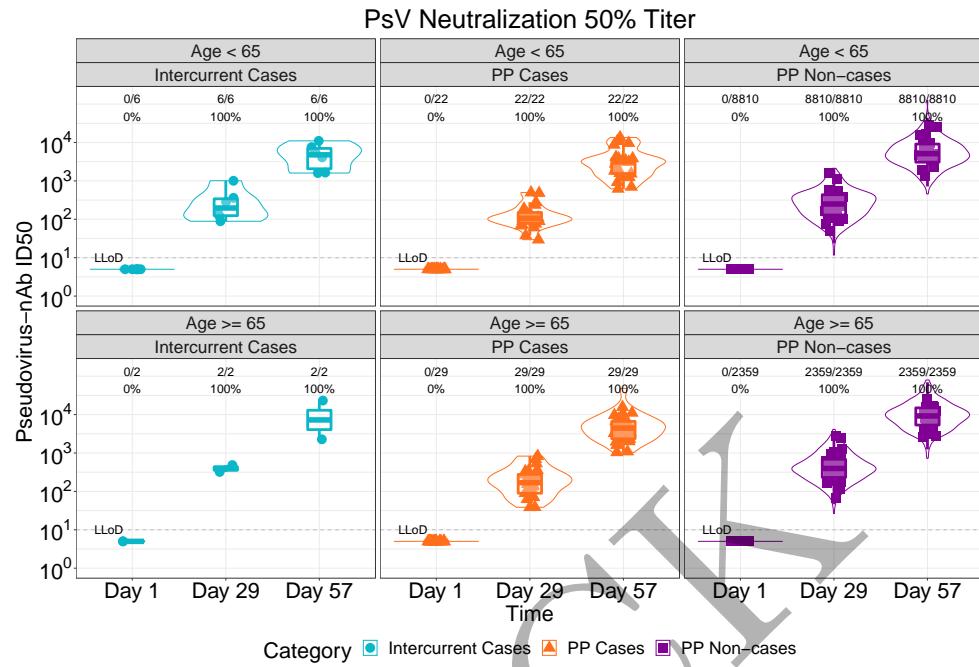


Figure 2.84: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age (version 2)

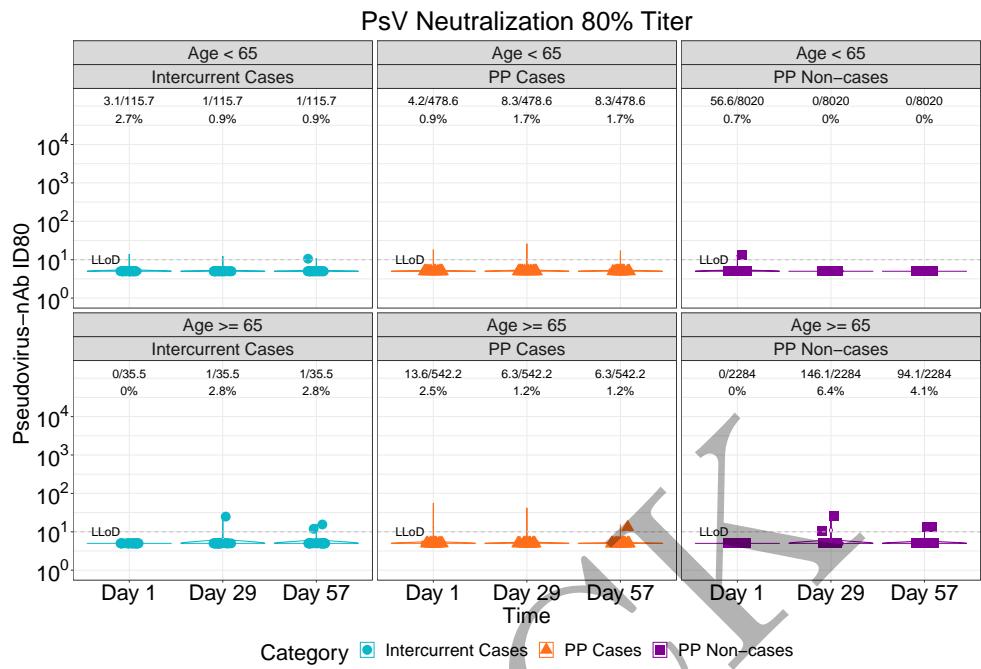


Figure 2.85: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age (version 2)

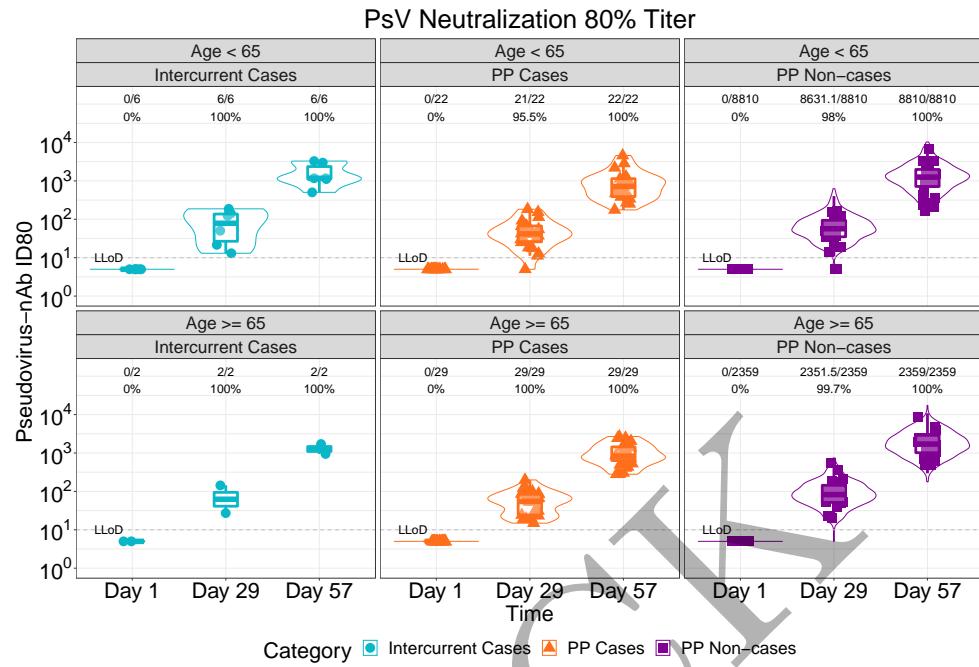


Figure 2.86: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age (version 2)

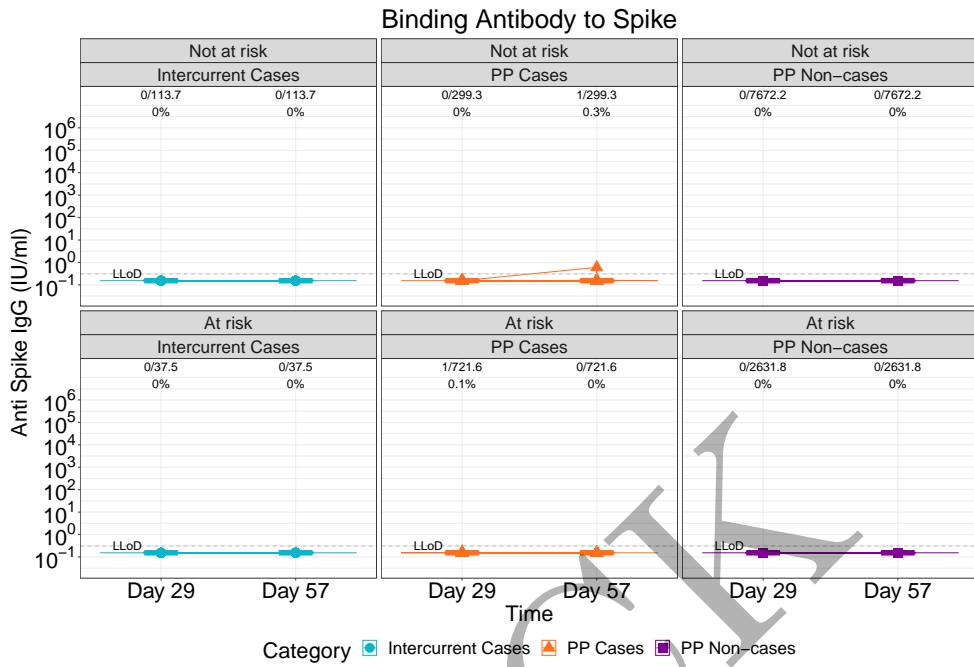


Figure 2.87: lineplots of Binding Antibody to Spike: baseline negative placebo arm by risk condition (version 1)

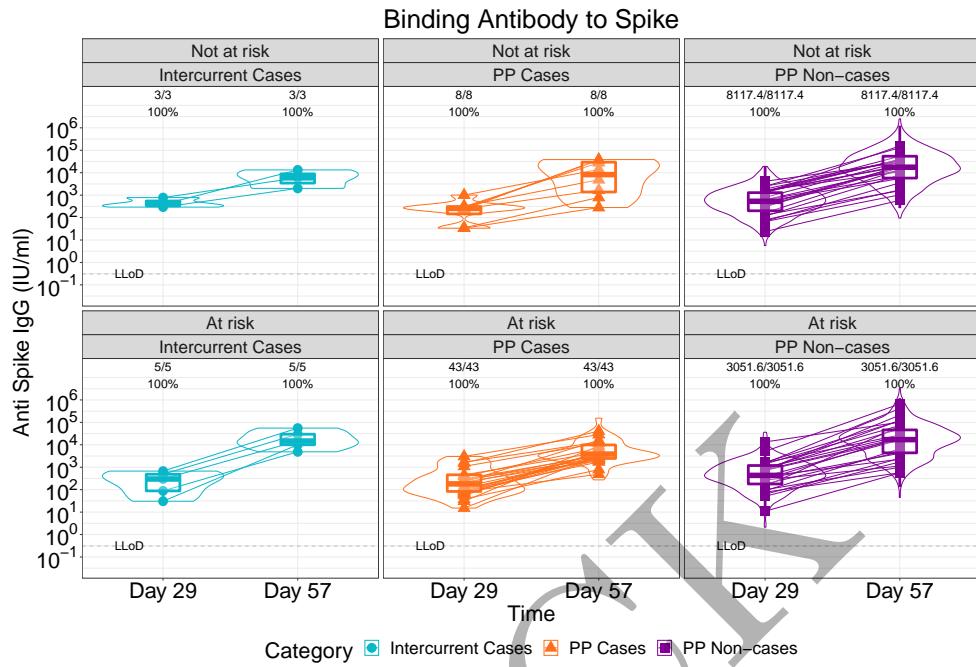


Figure 2.88: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by risk condition (version 1)

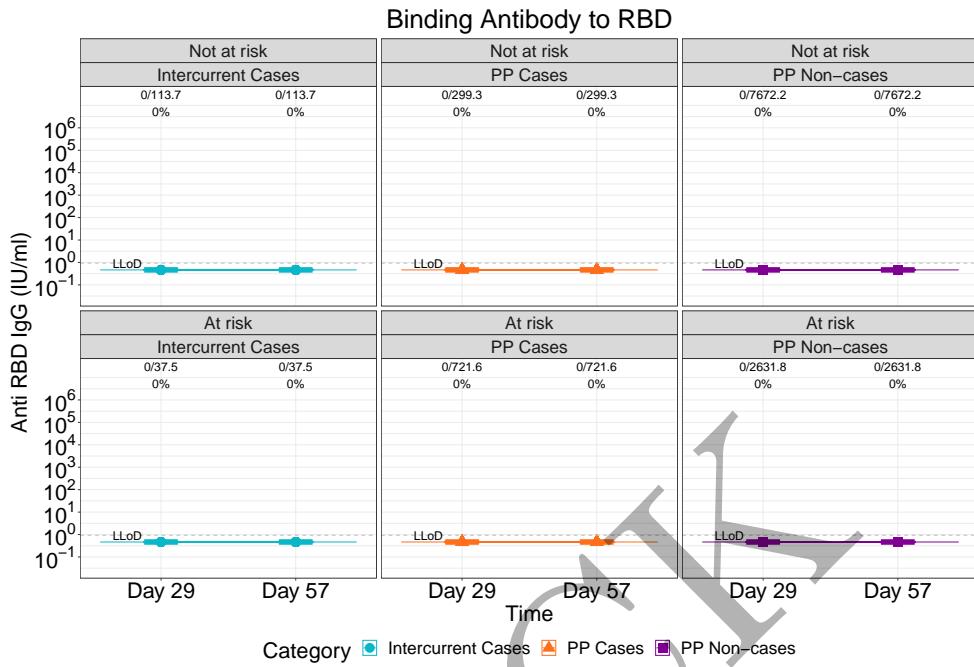


Figure 2.89: lineplots of Binding Antibody to RBD: baseline negative placebo arm by risk condition (version 1)

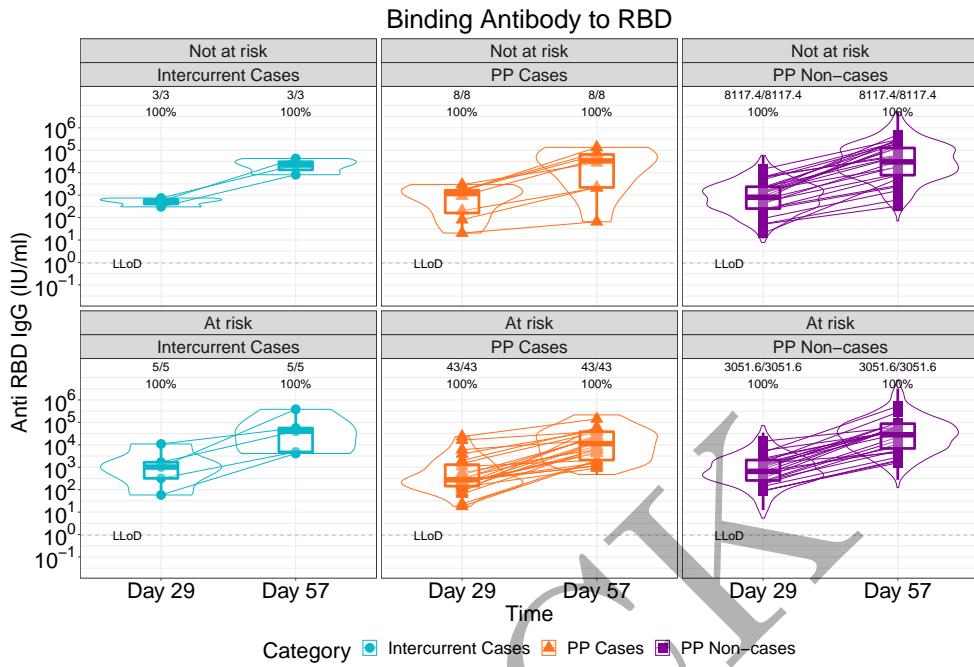


Figure 2.90: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by risk condition (version 1)

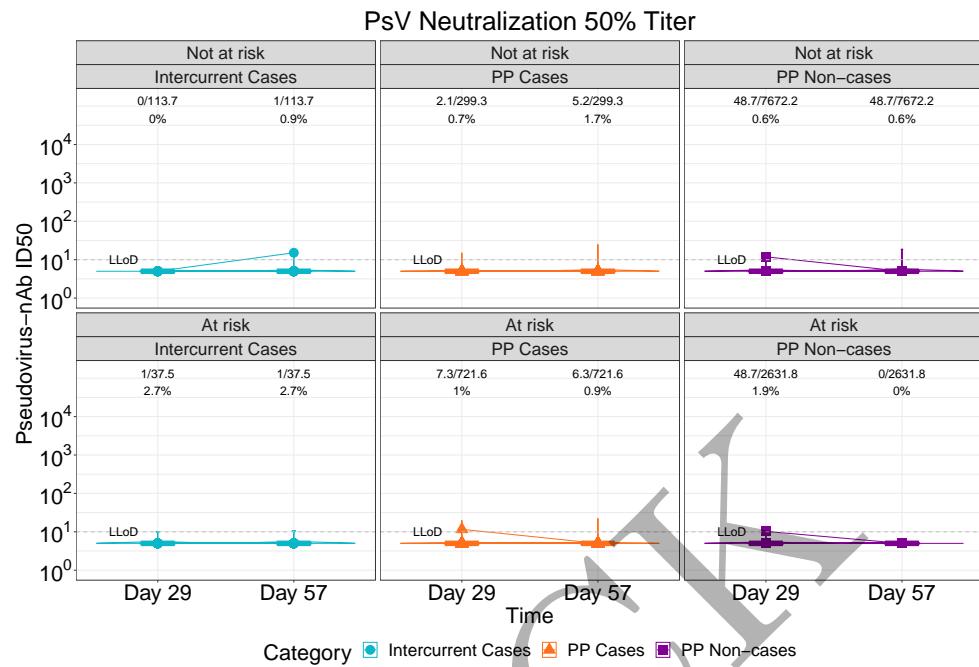


Figure 2.91: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by risk condition (version 1)

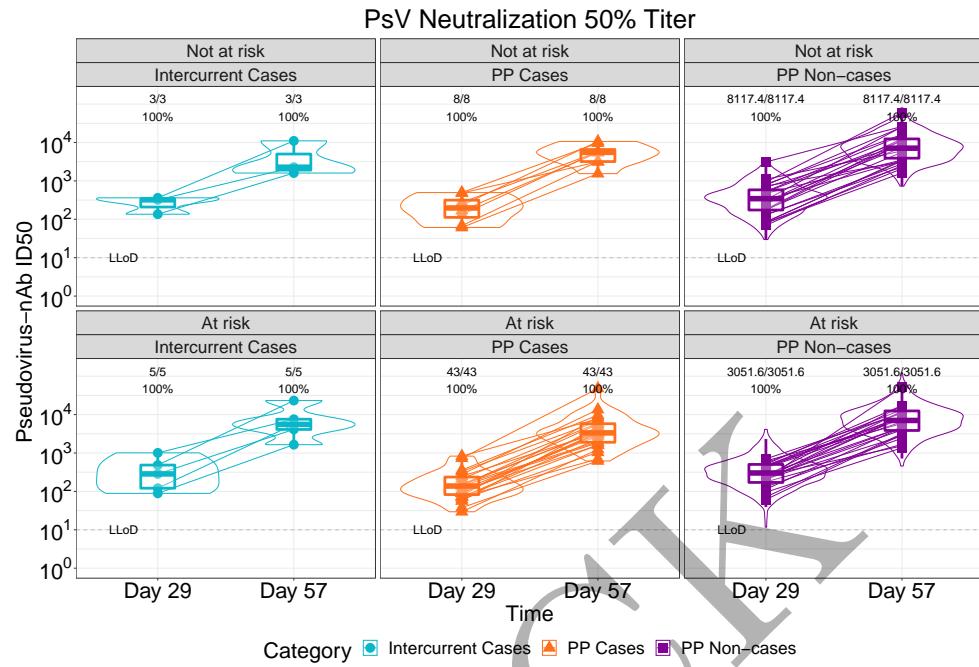


Figure 2.92: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by risk condition (version 1)

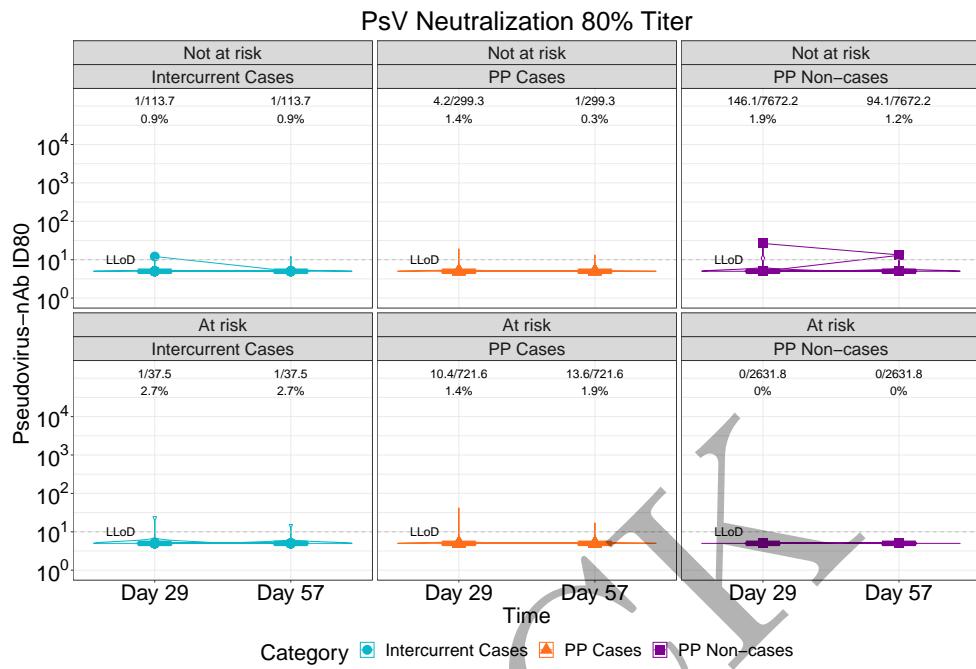


Figure 2.93: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by risk condition (version 1)

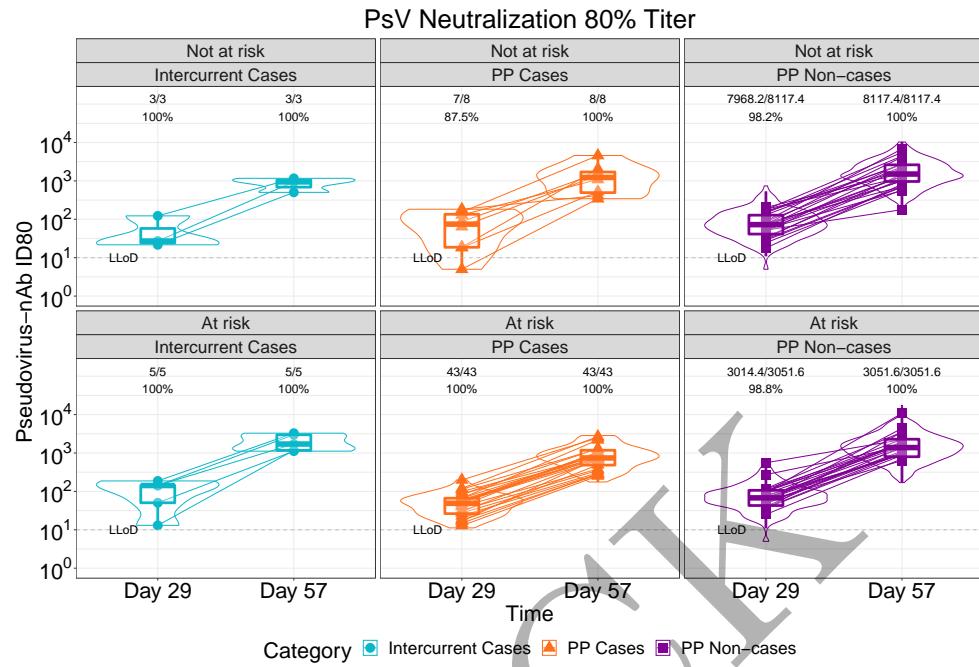


Figure 2.94: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by risk condition (version 1)

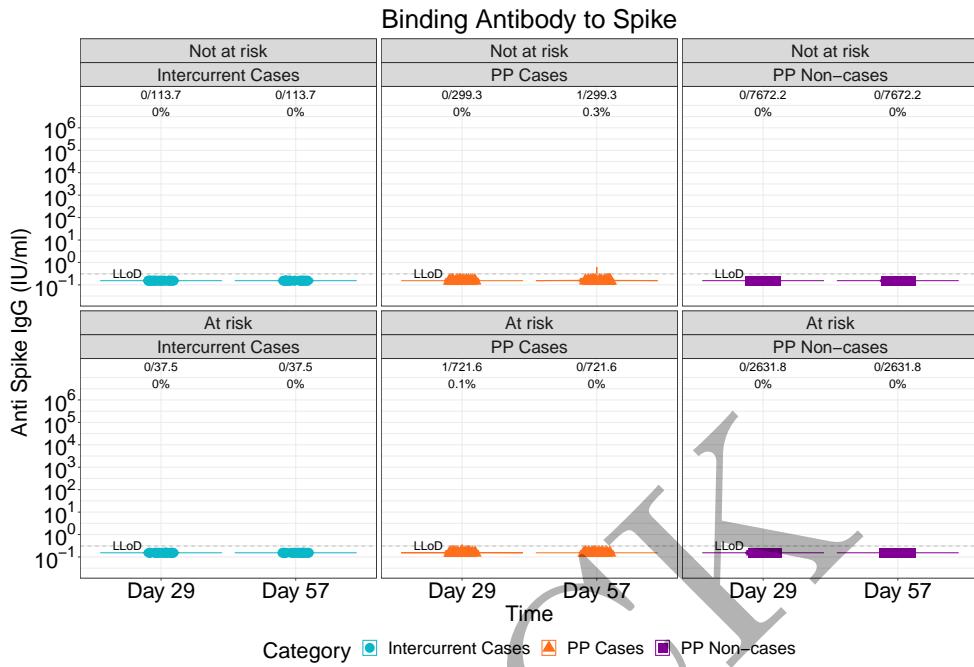


Figure 2.95: violinplots of Binding Antibody to Spike: baseline negative placebo arm by risk condition (version 1)

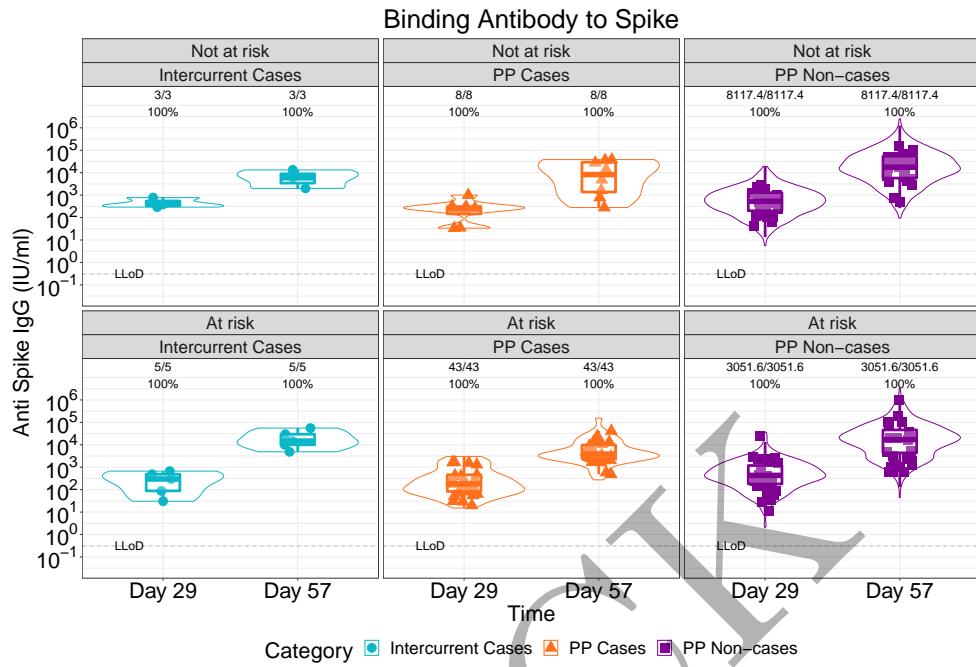


Figure 2.96: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by risk condition (version 1)

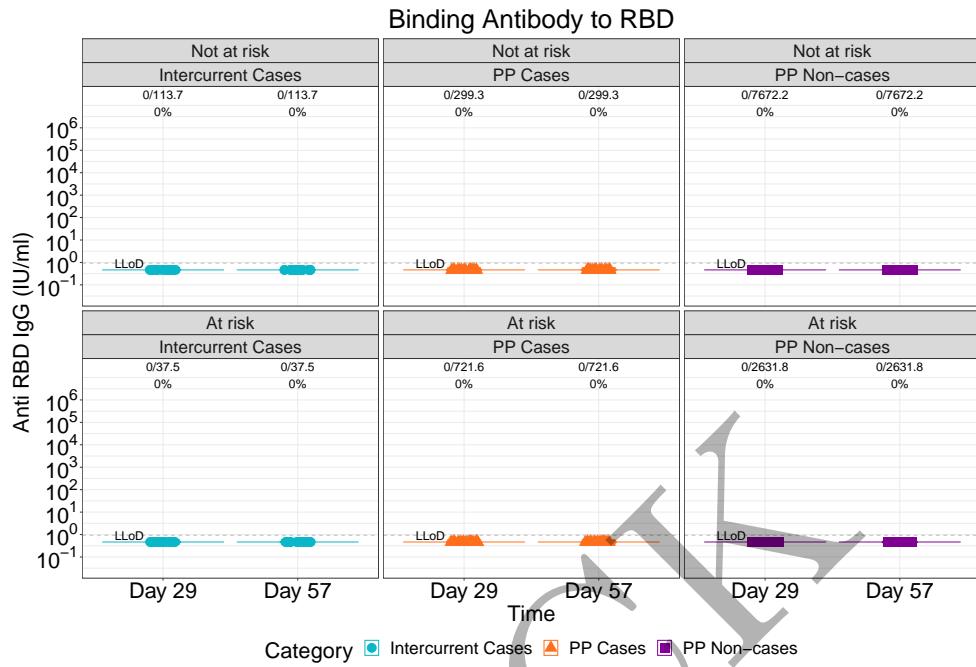


Figure 2.97: violinplots of Binding Antibody to RBD: baseline negative placebo arm by risk condition (version 1)

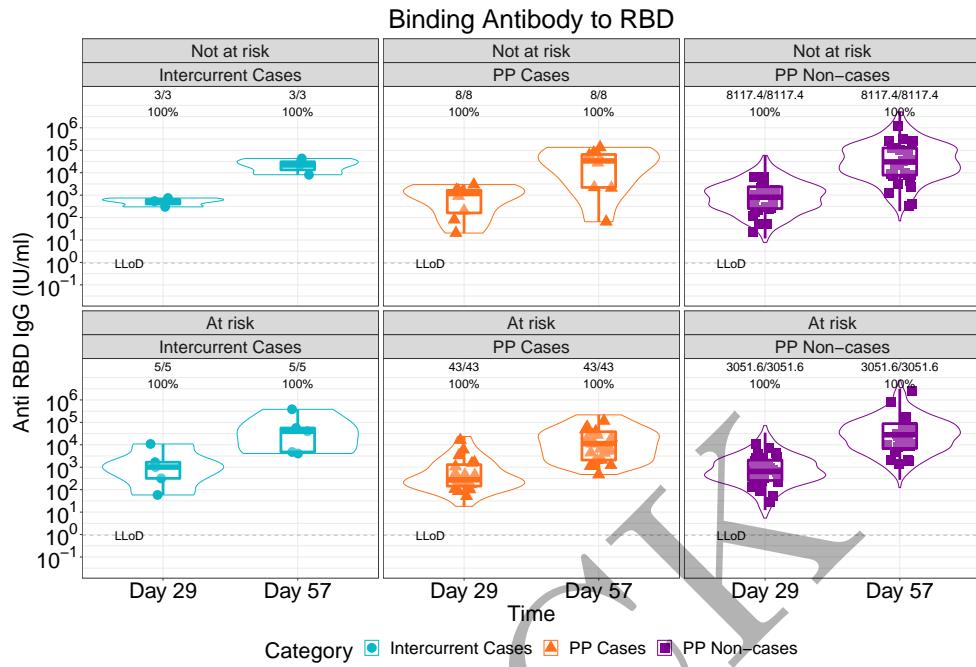


Figure 2.98: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by risk condition (version 1)

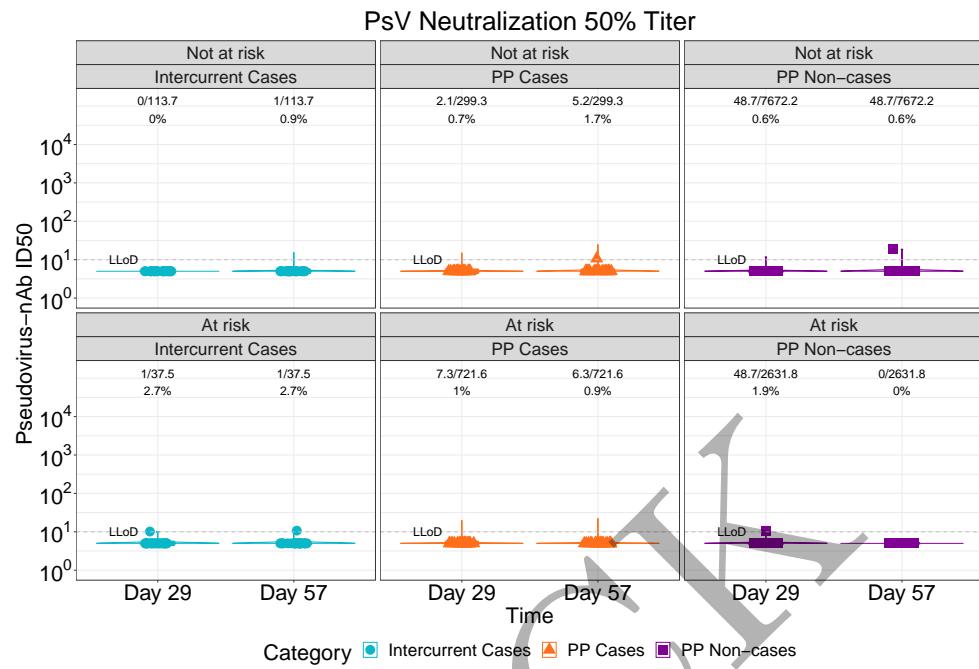


Figure 2.99: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by risk condition (version 1)

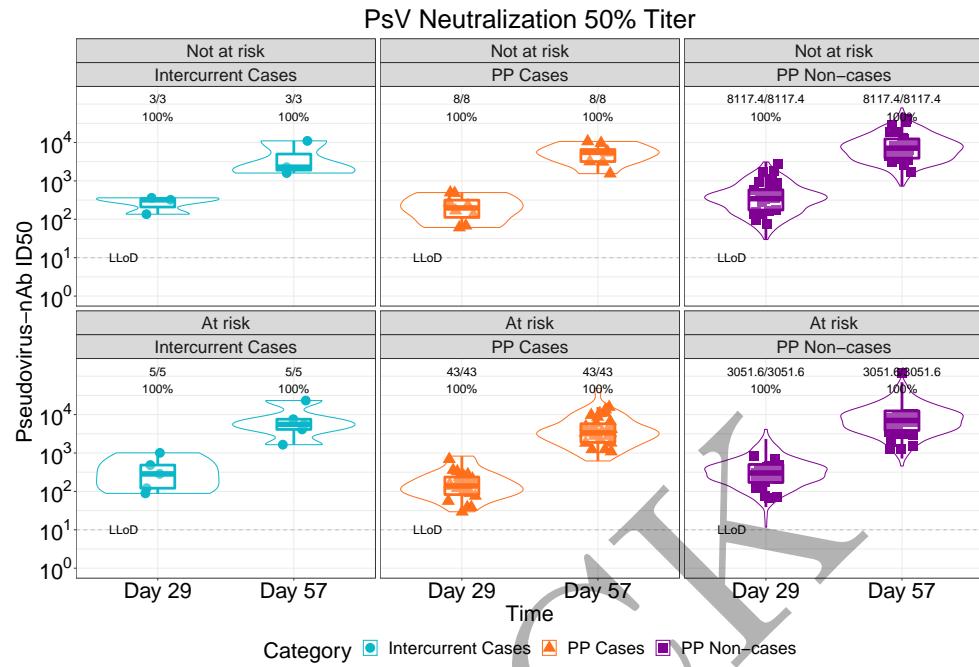


Figure 2.100: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by risk condition (version 1)

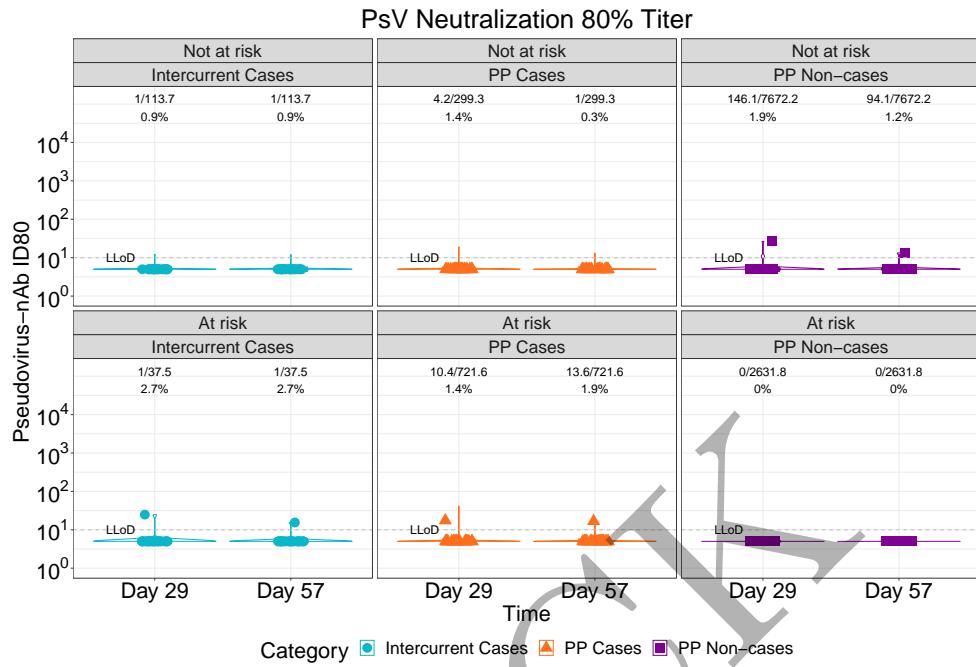


Figure 2.101: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by risk condition (version 1)

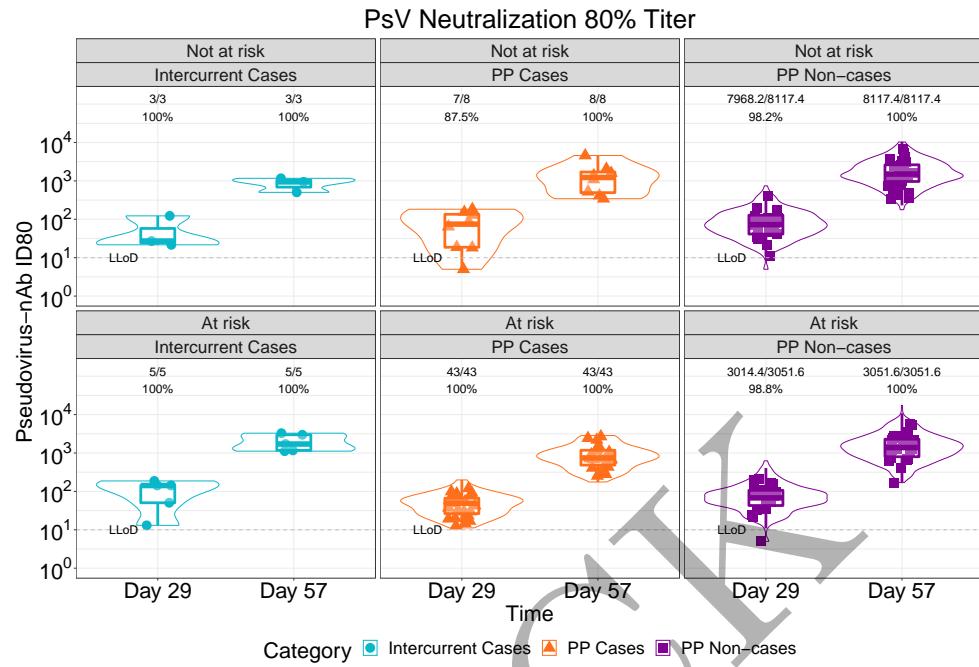


Figure 2.102: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by risk condition (version 1)

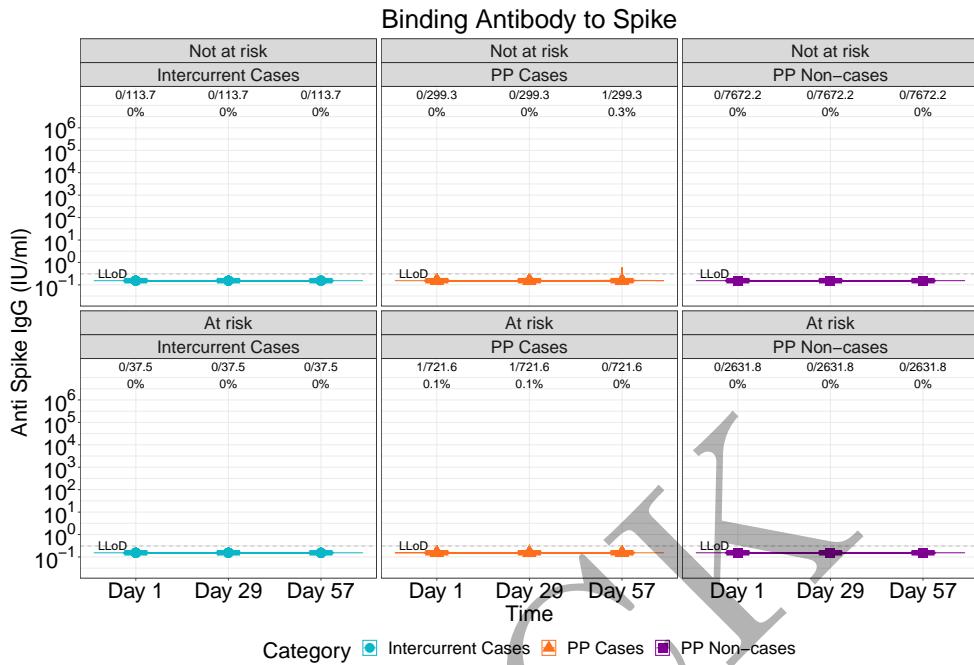


Figure 2.103: lineplots of Binding Antibody to Spike: baseline negative placebo arm by risk condition (version 2)

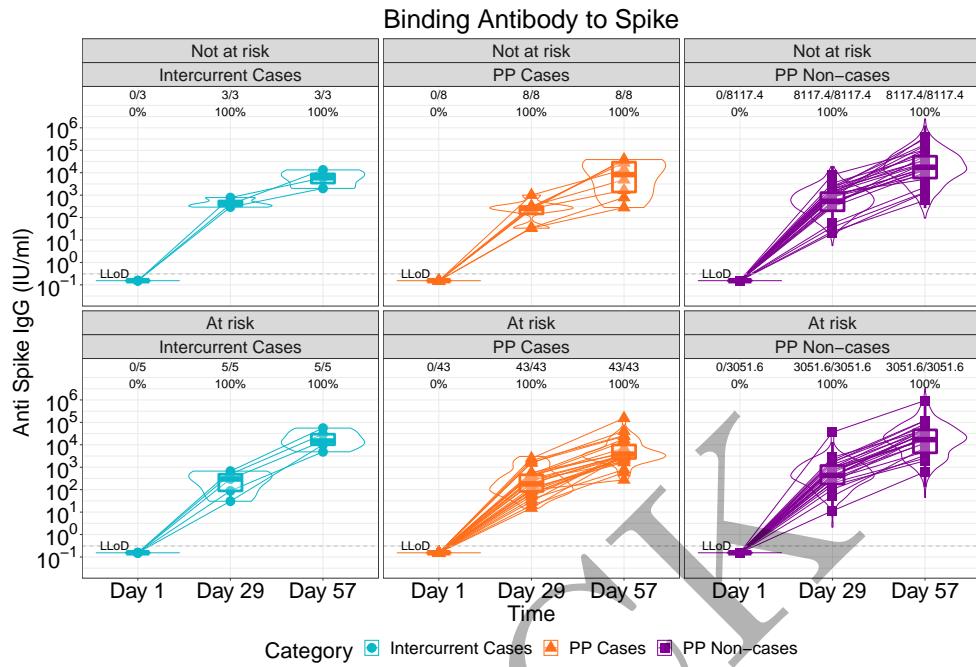


Figure 2.104: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by risk condition (version 2)

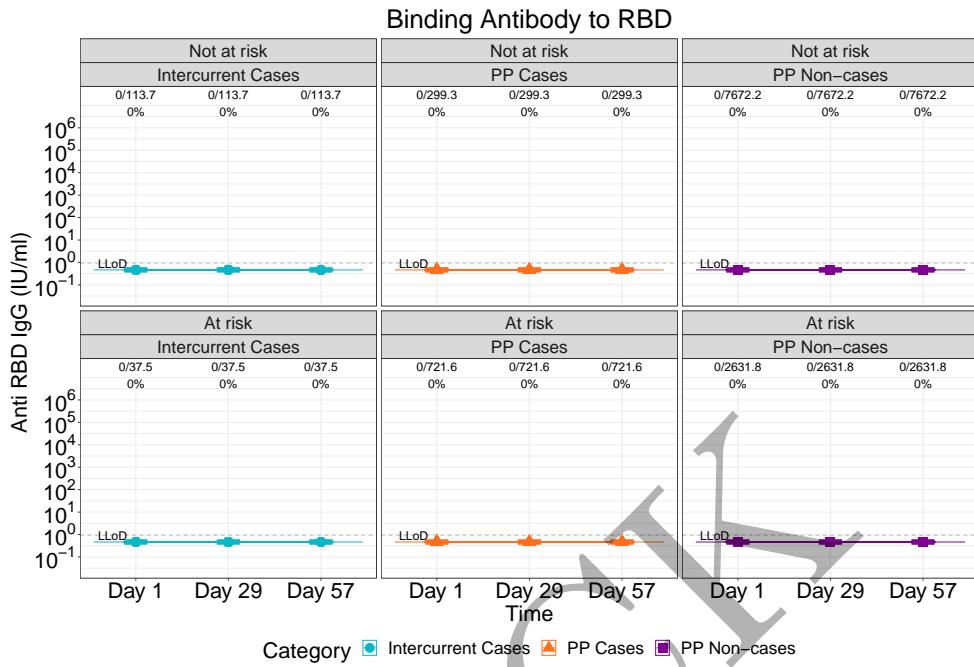


Figure 2.105: lineplots of Binding Antibody to RBD: baseline negative placebo arm by risk condition (version 2)

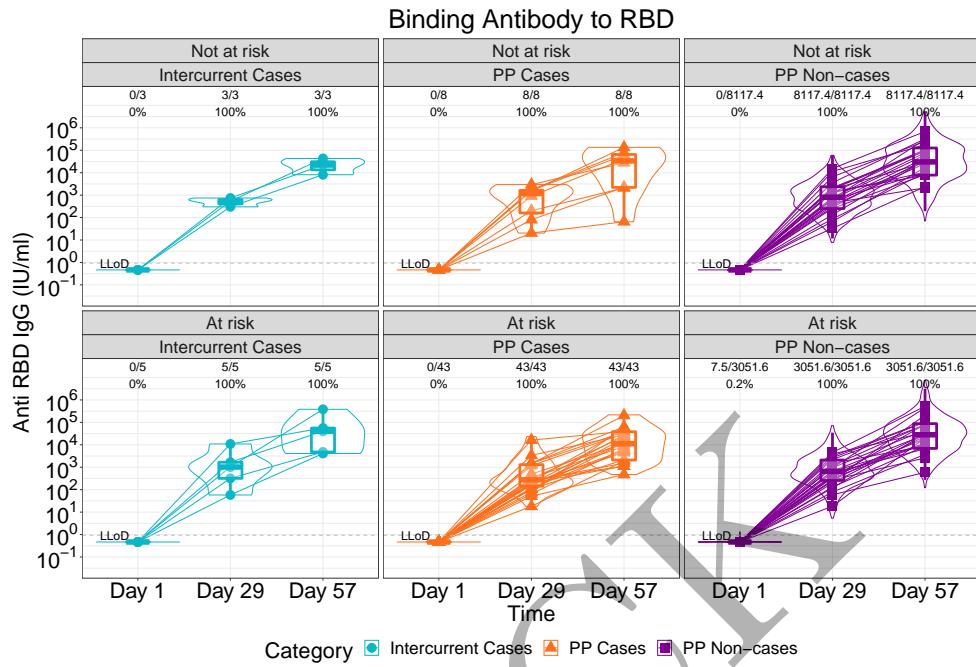


Figure 2.106: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by risk condition (version 2)

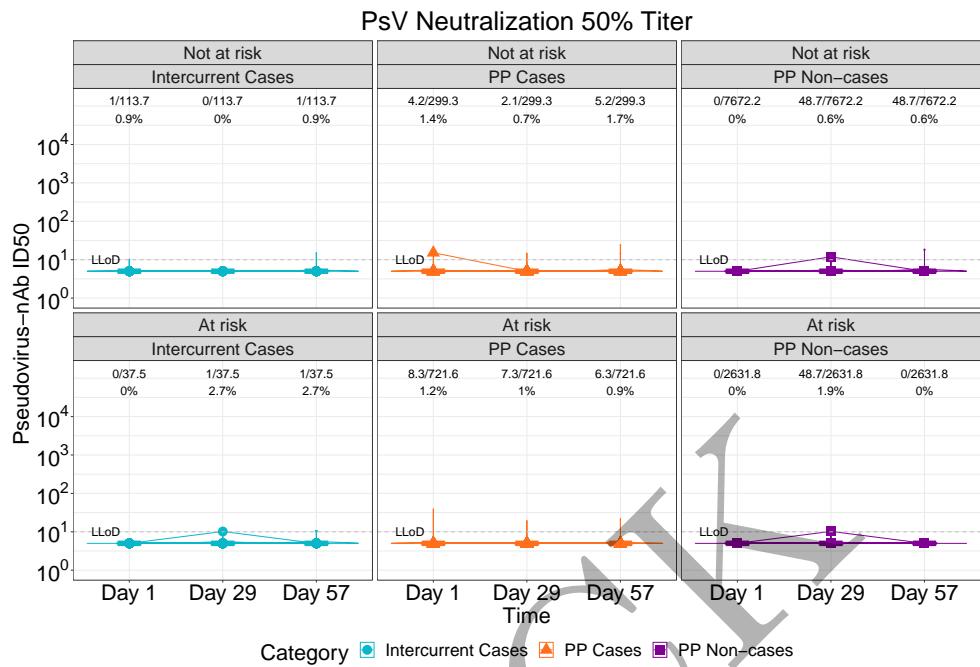


Figure 2.107: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by risk condition (version 2)

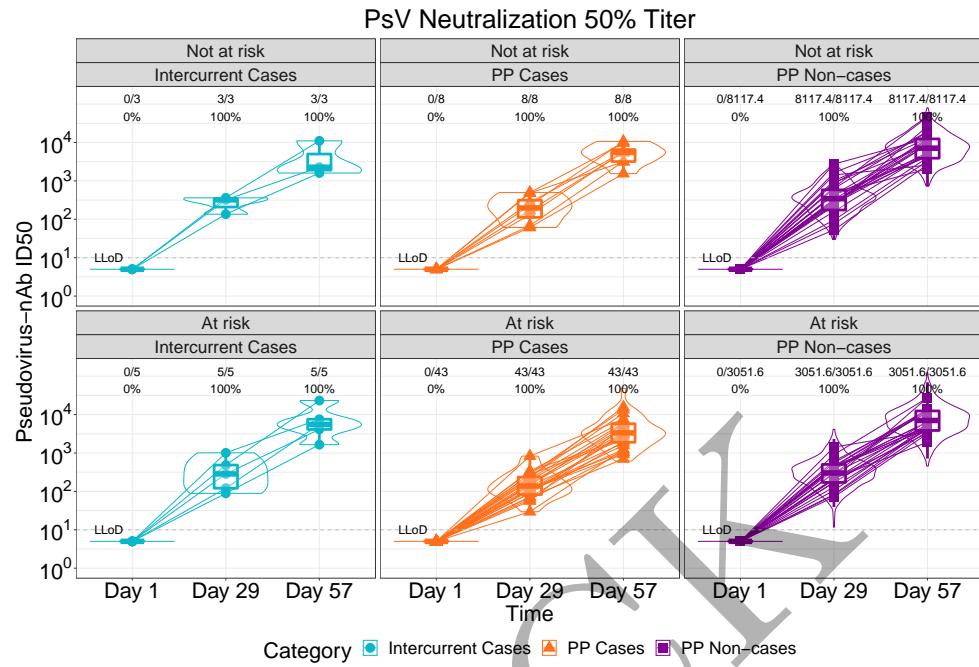


Figure 2.108: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by risk condition (version 2)

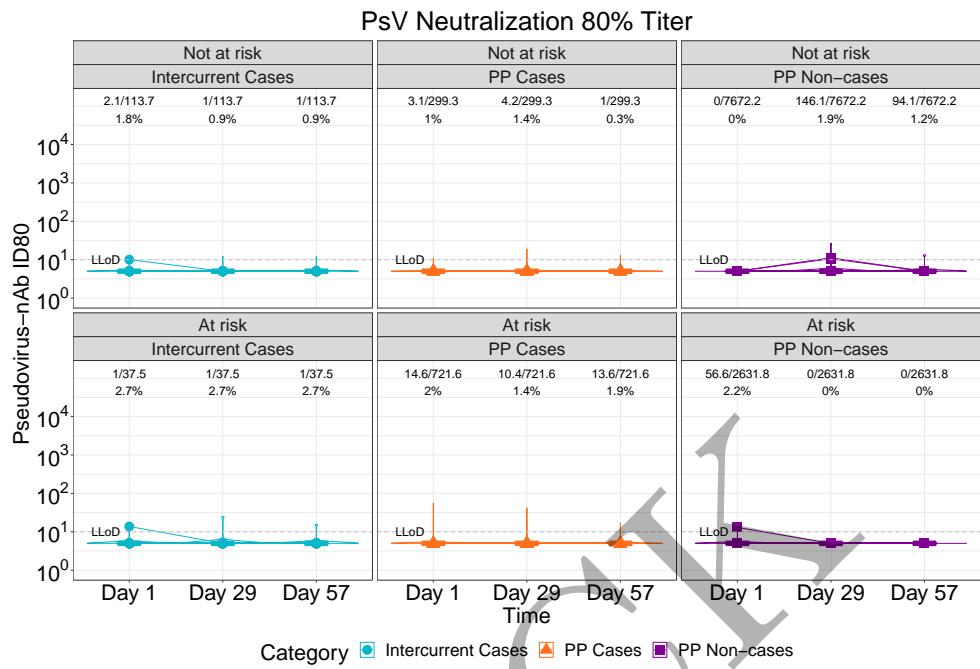


Figure 2.109: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by risk condition (version 2)

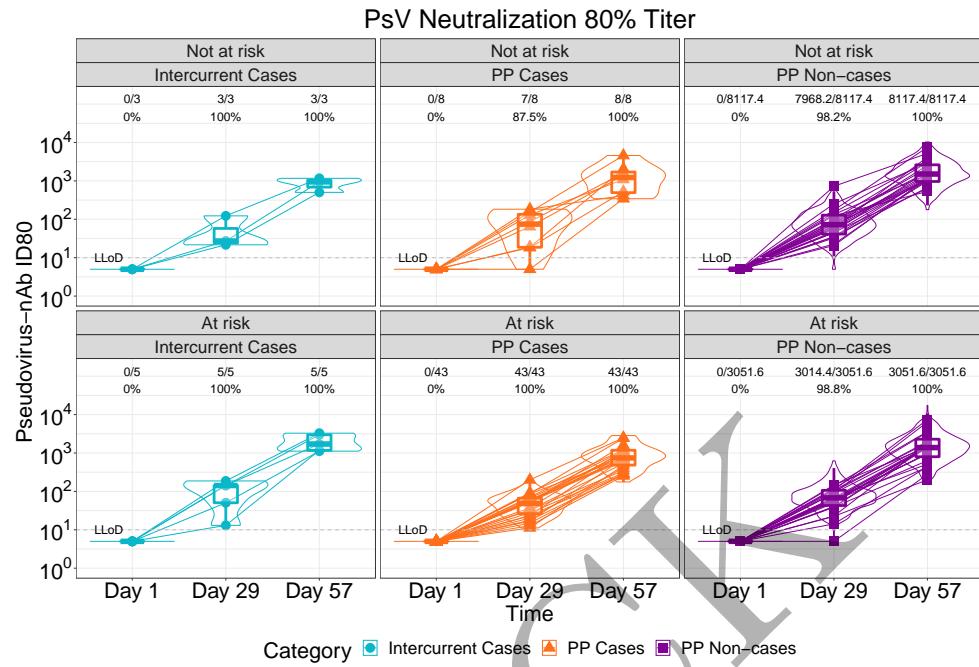


Figure 2.110: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by risk condition (version 2)

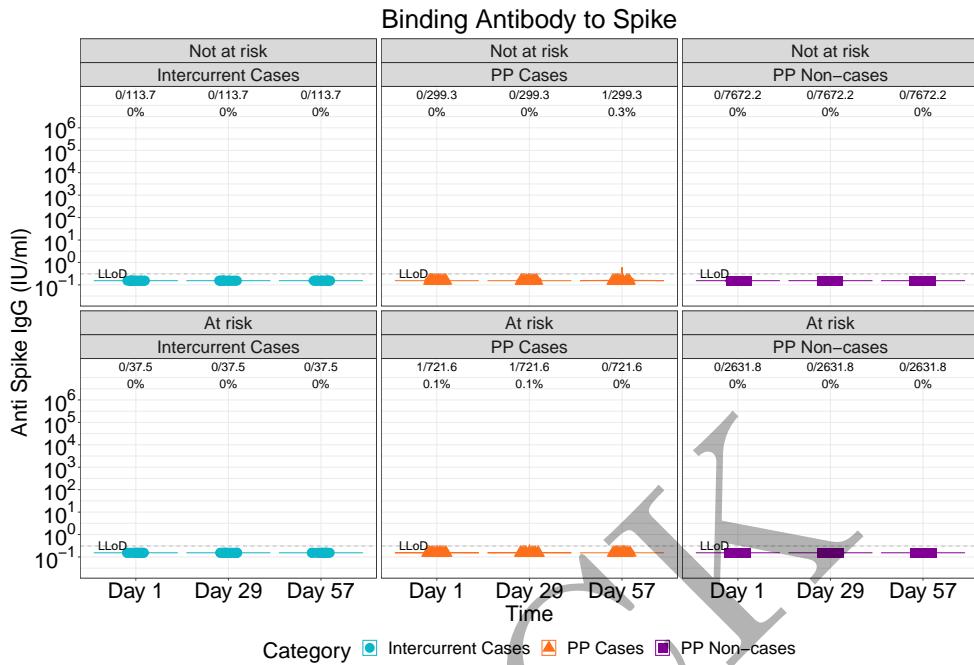


Figure 2.111: violinplots of Binding Antibody to Spike: baseline negative placebo arm by risk condition (version 2)

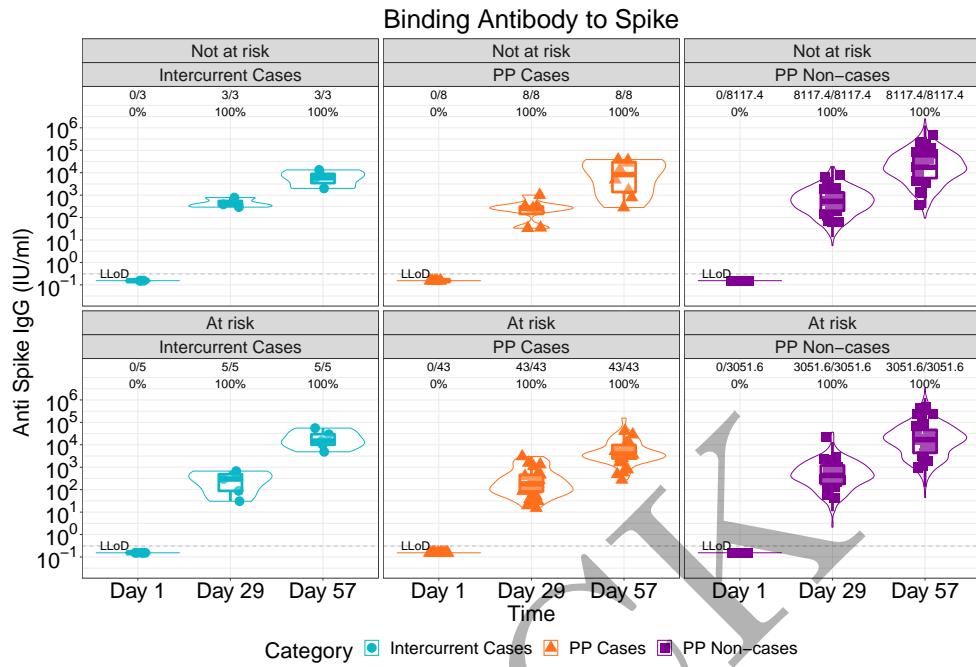


Figure 2.112: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by risk condition (version 2)

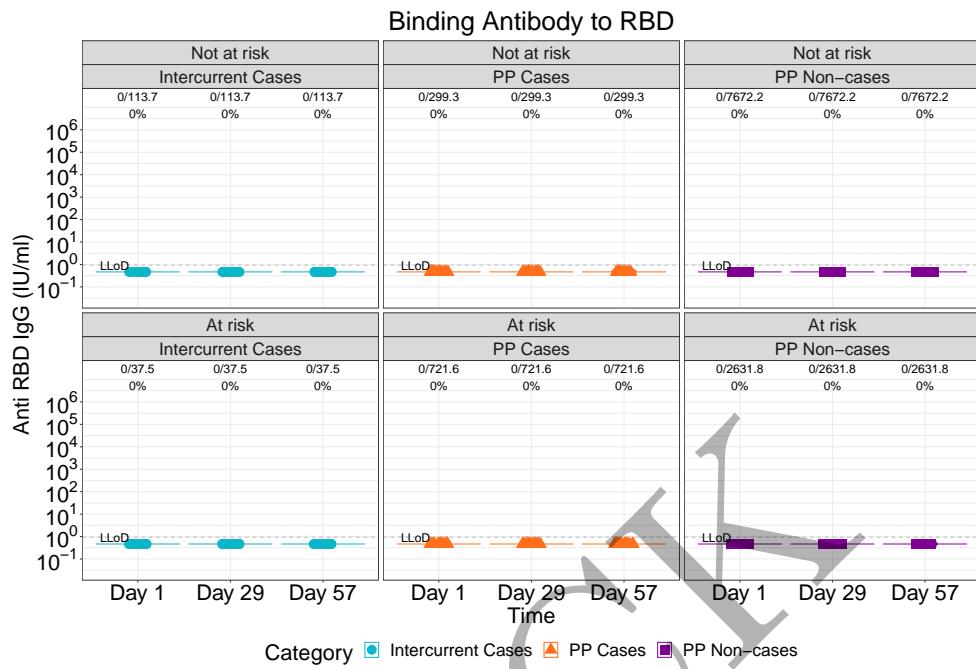


Figure 2.113: violinplots of Binding Antibody to RBD: baseline negative placebo arm by risk condition (version 2)

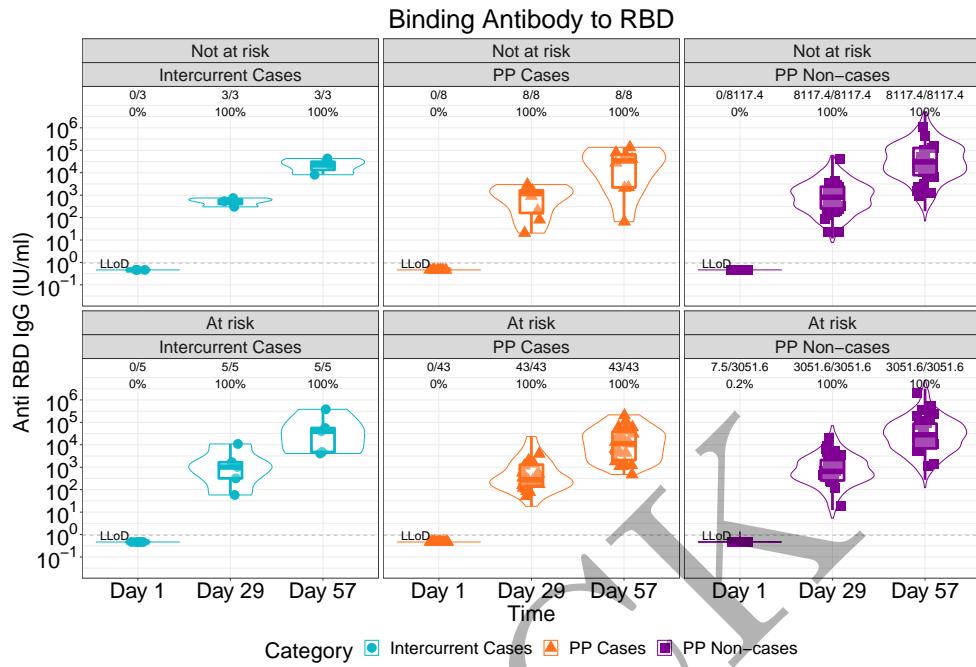


Figure 2.114: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by risk condition (version 2)

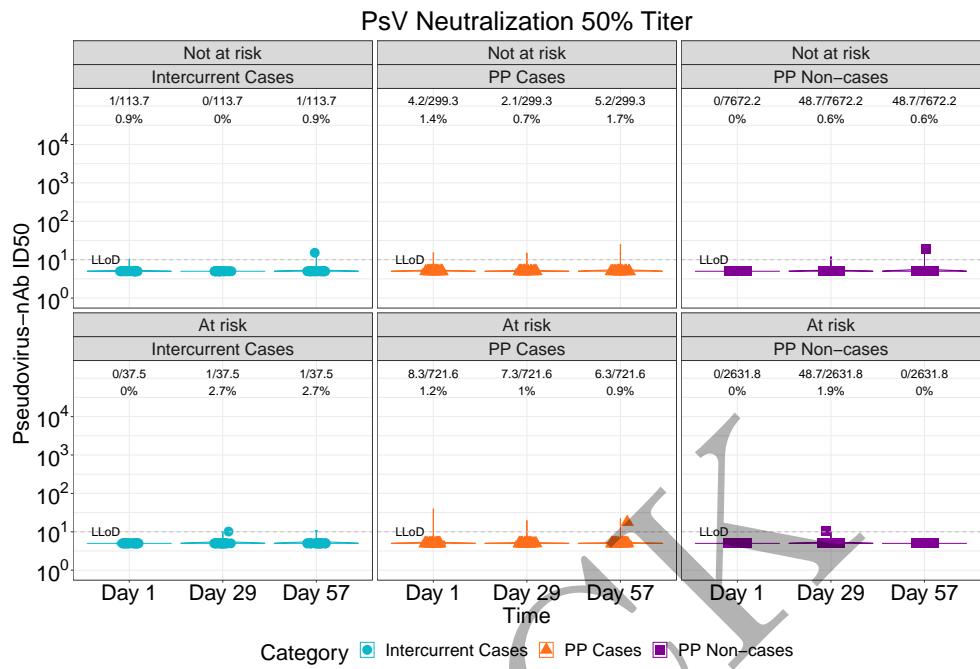


Figure 2.115: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by risk condition (version 2)

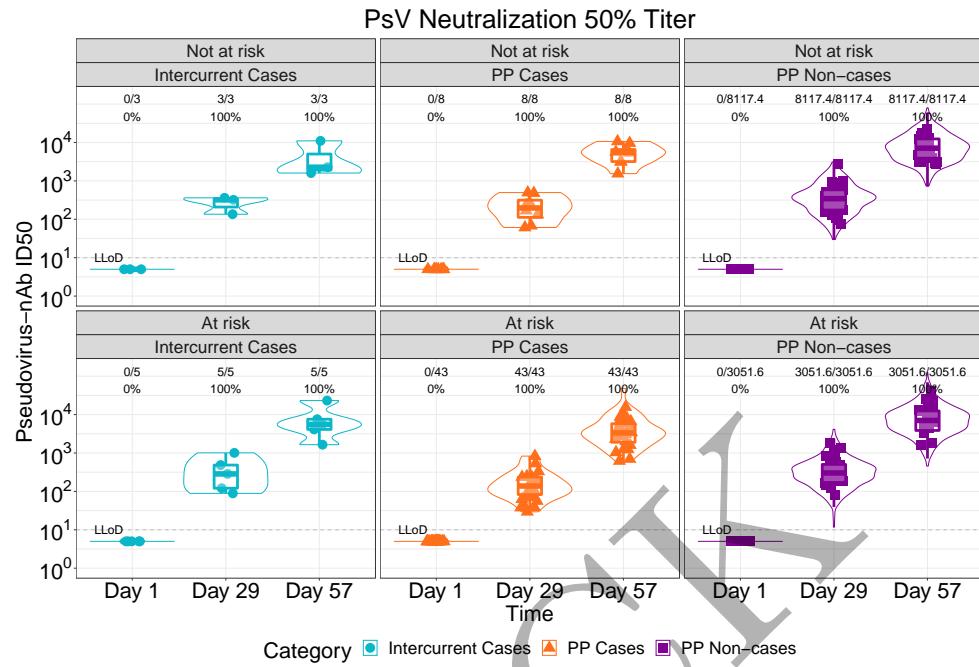


Figure 2.116: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by risk condition (version 2)

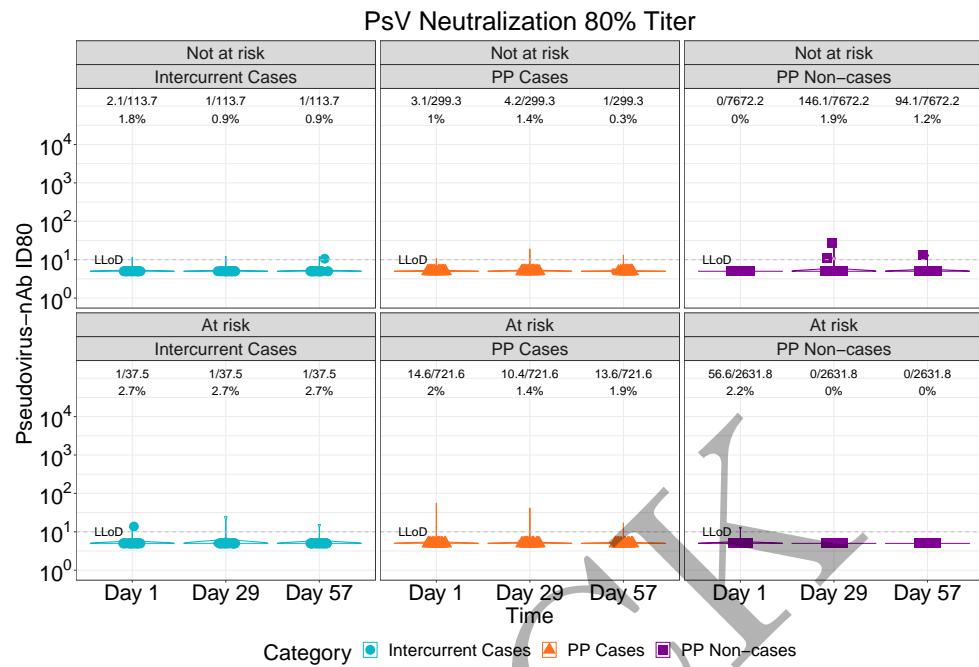


Figure 2.117: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by risk condition (version 2)

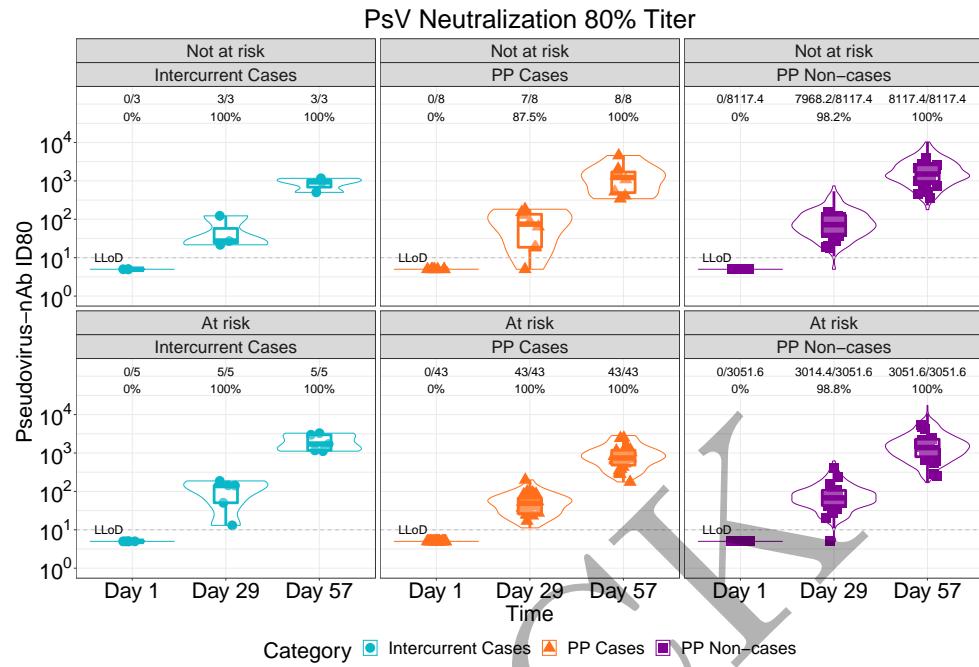


Figure 2.118: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by risk condition (version 2)

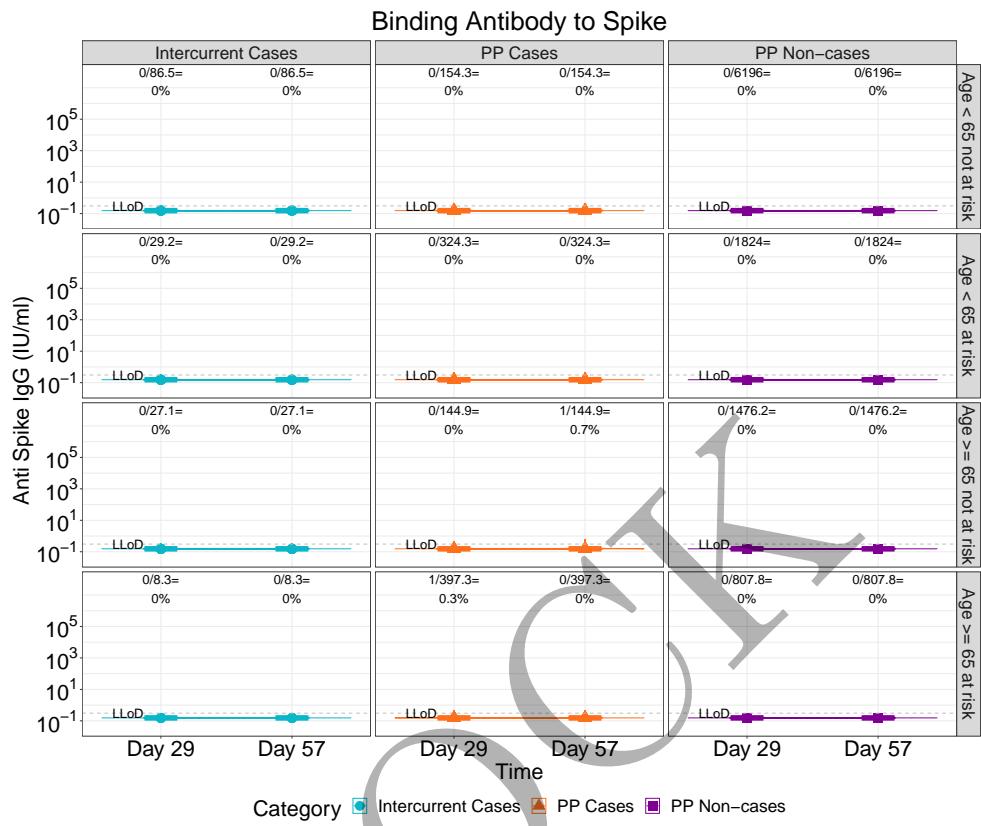


Figure 2.119: lineplots of Binding Antibody to Spike: baseline negative placebo arm by age and risk condition (version 1)

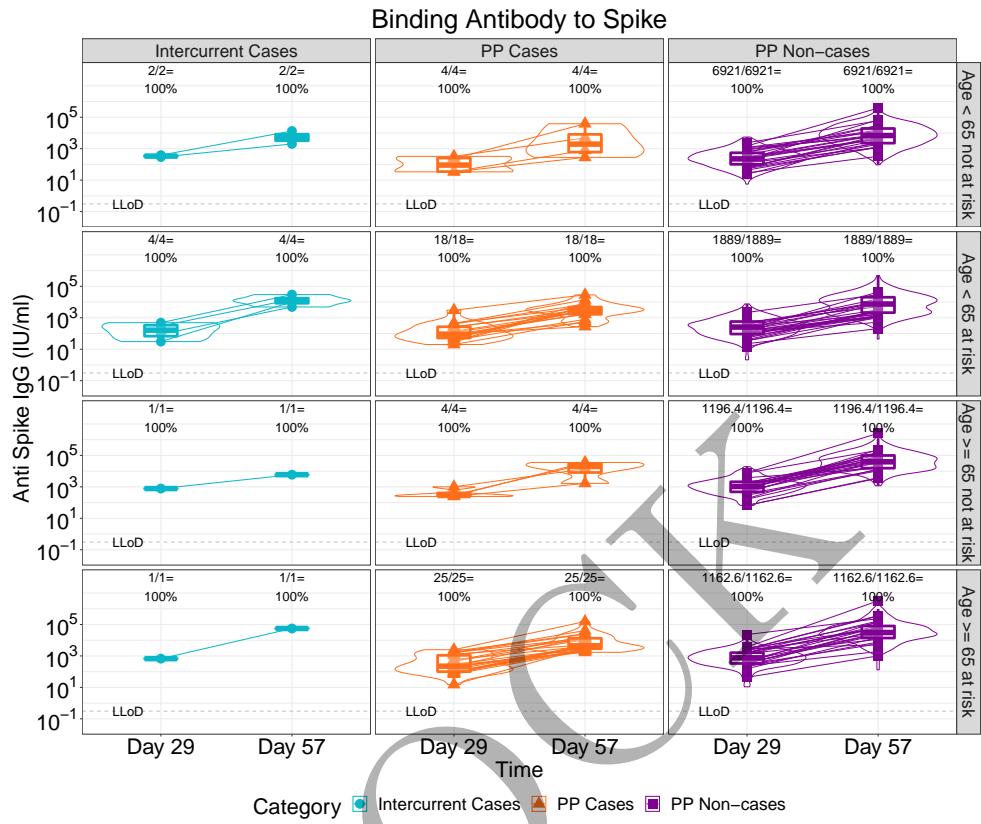


Figure 2.120: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by age and risk condition (version 1)

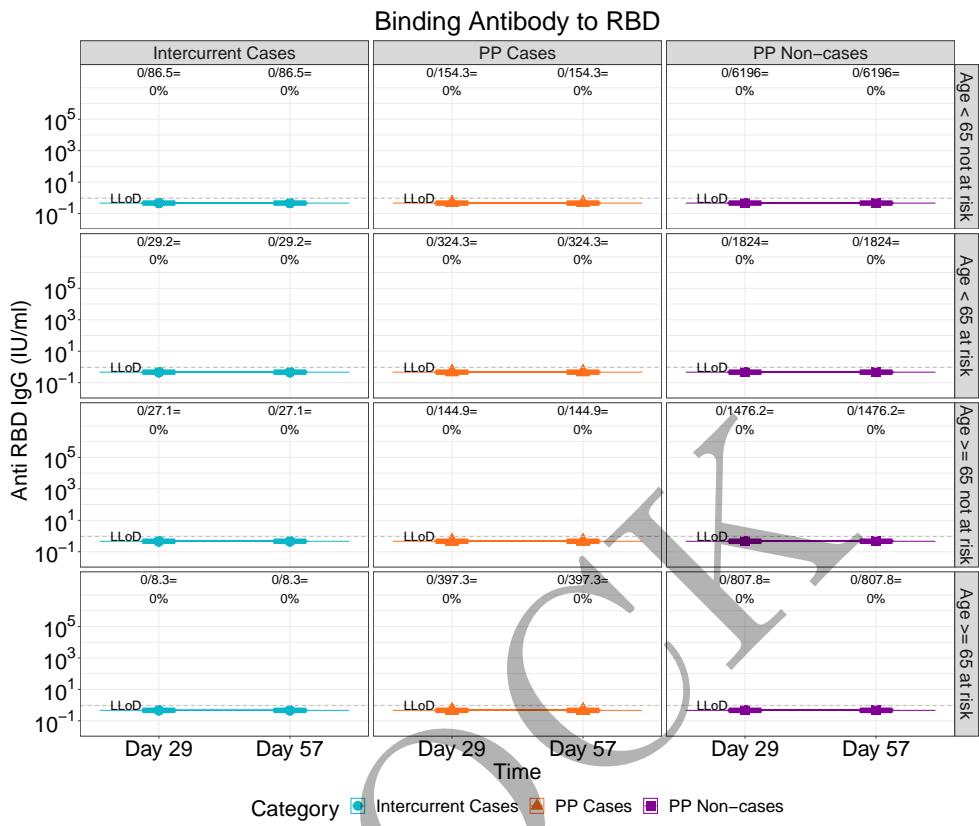


Figure 2.121: lineplots of Binding Antibody to RBD: baseline negative placebo arm by age and risk condition (version 1)

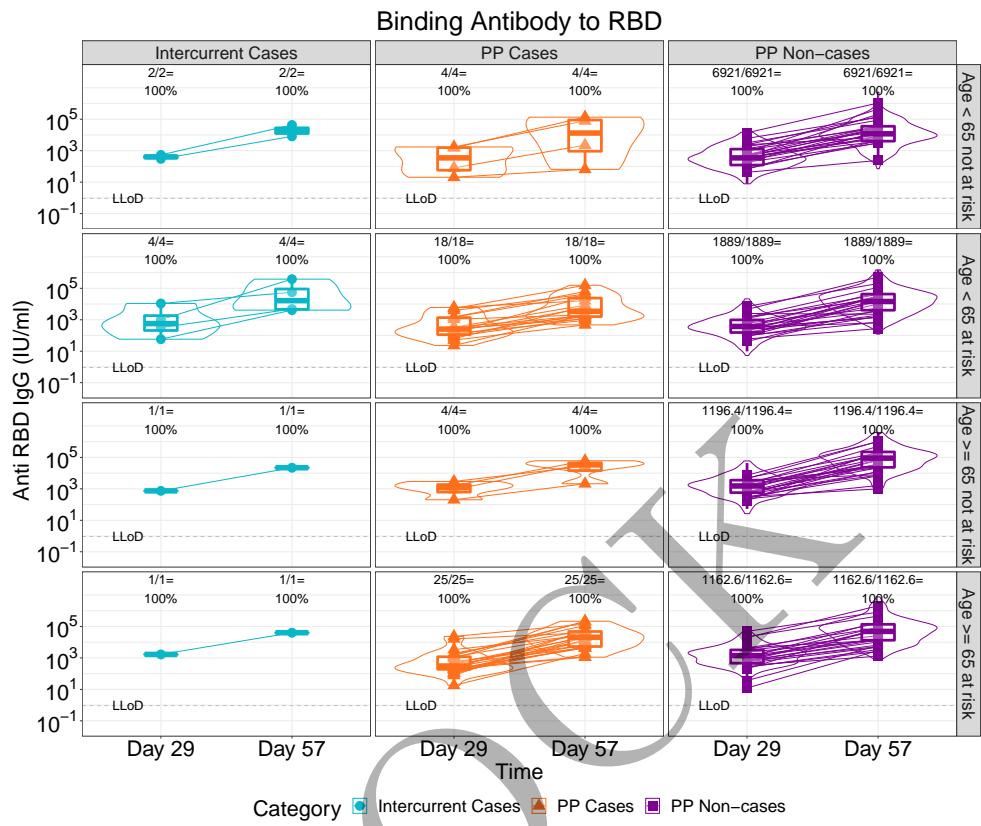


Figure 2.122: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by age and risk condition (version 1)

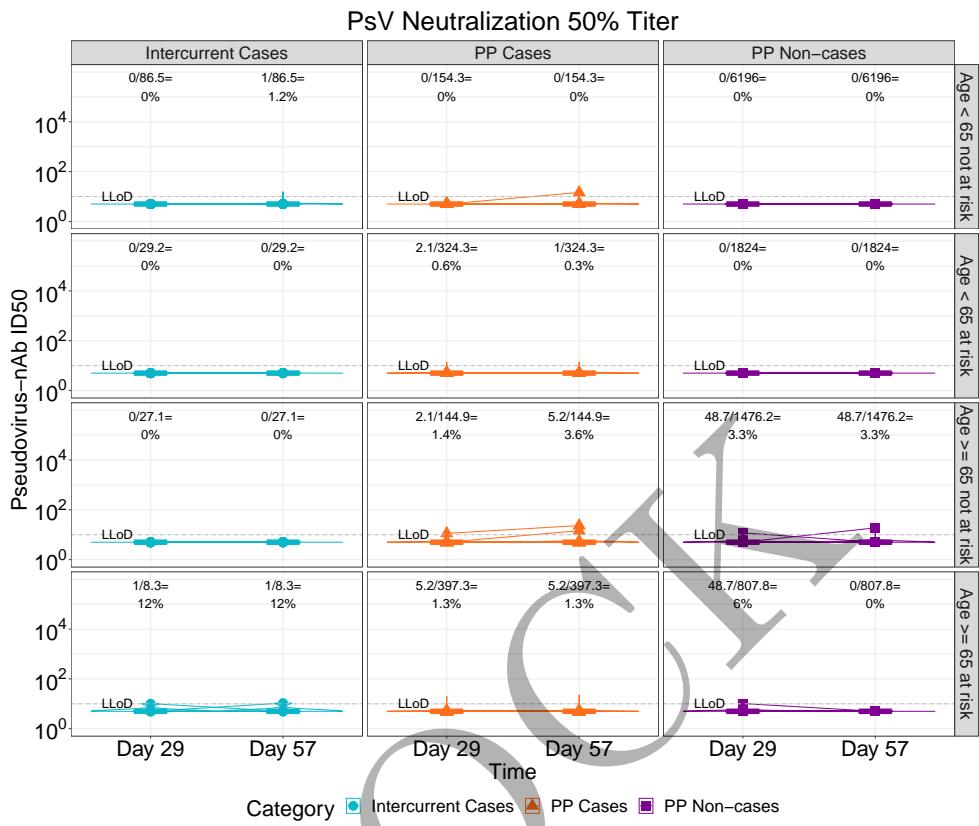


Figure 2.123: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age and risk condition (version 1)

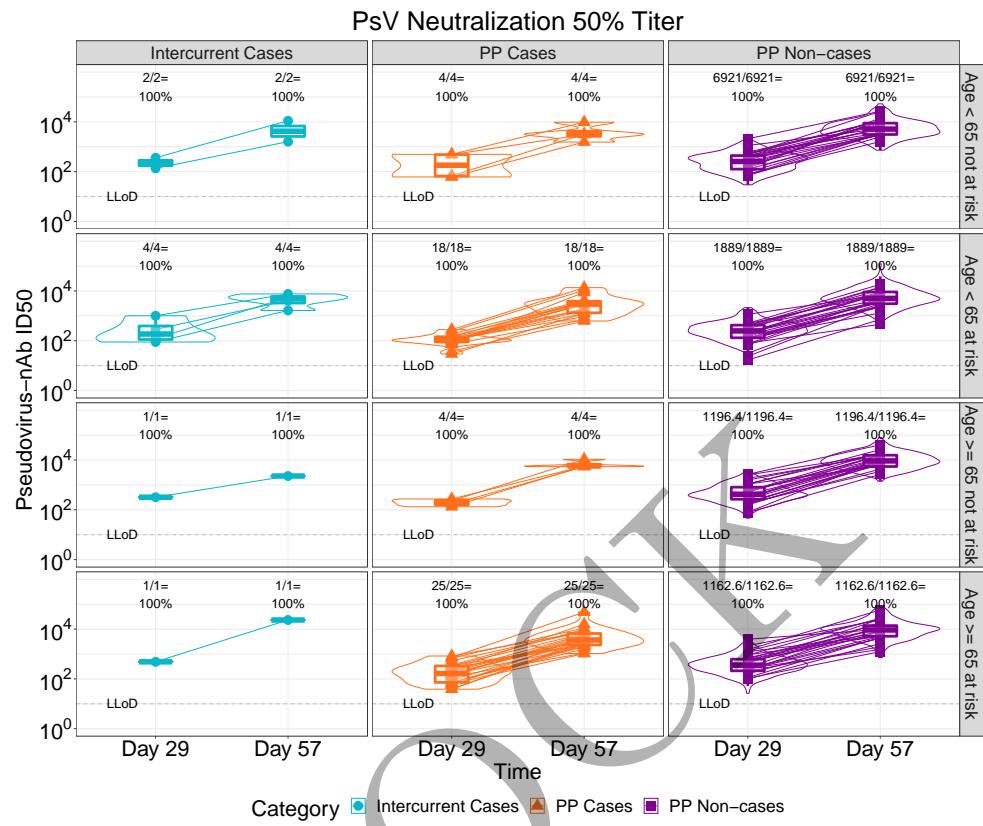


Figure 2.124: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age and risk condition (version 1)

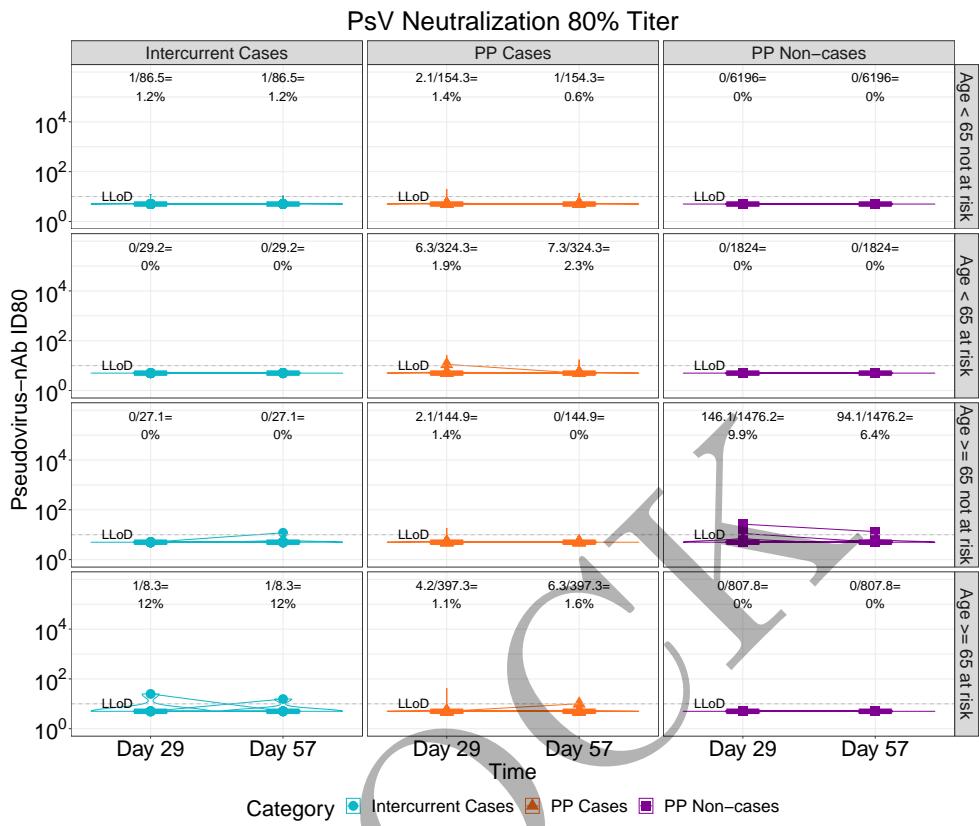


Figure 2.125: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age and risk condition (version 1)

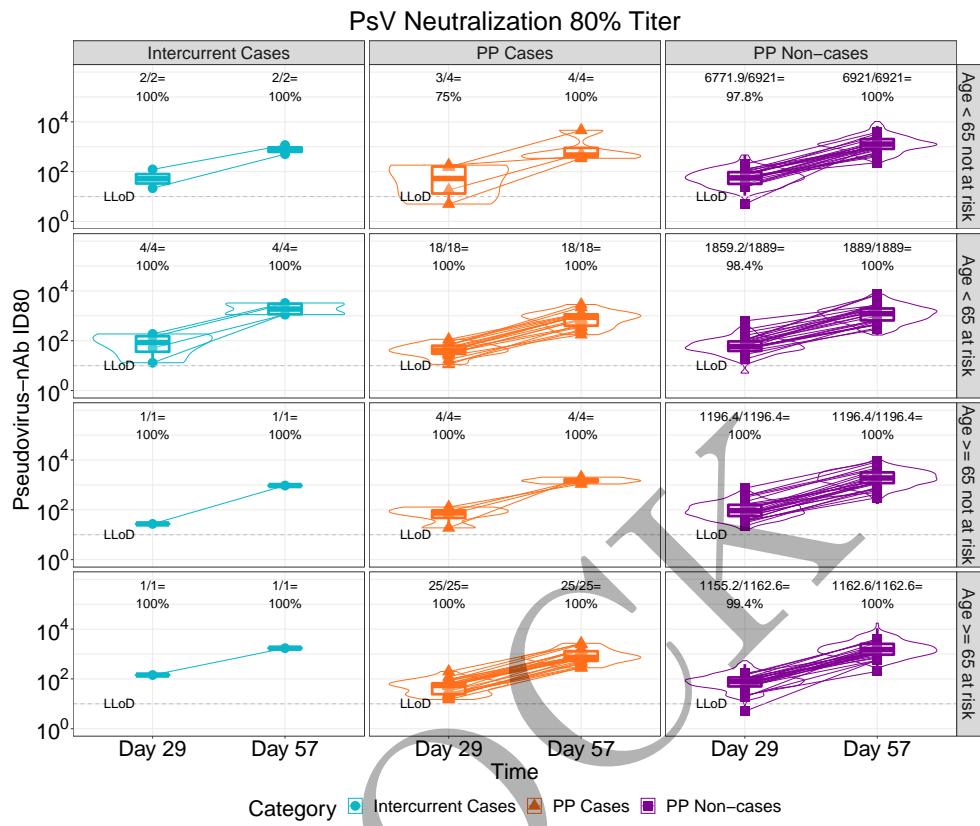


Figure 2.126: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age and risk condition (version 1)

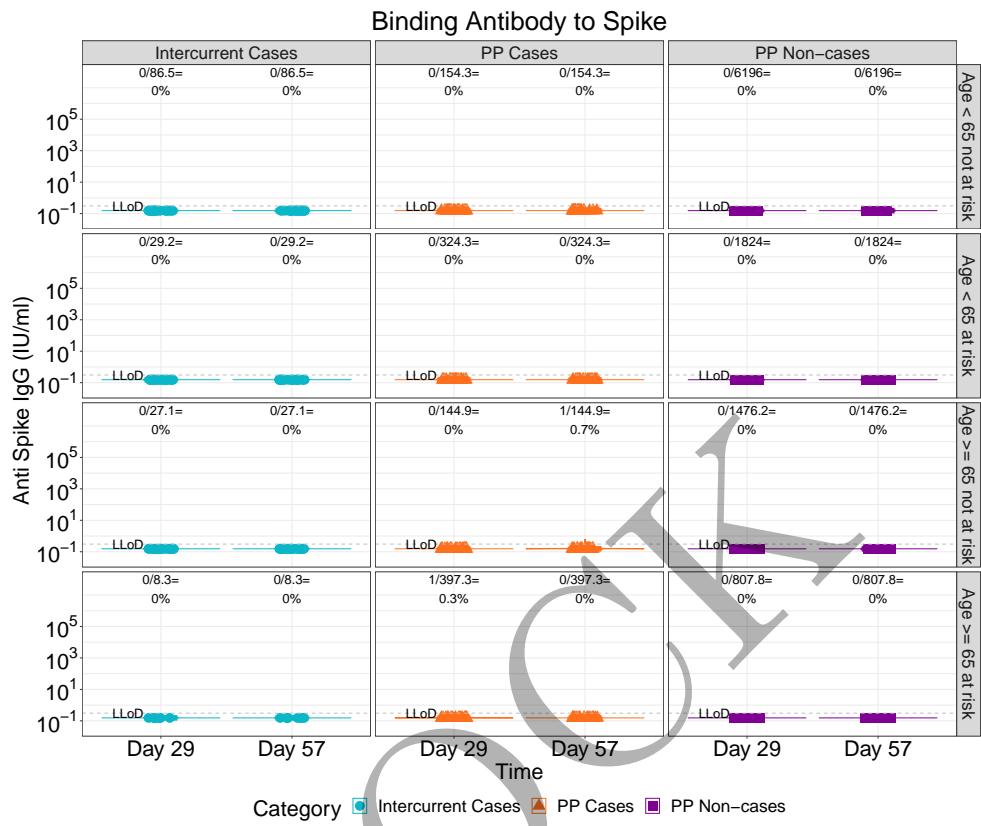


Figure 2.127: violinplots of Binding Antibody to Spike: baseline negative placebo arm by age and risk condition (version 1)

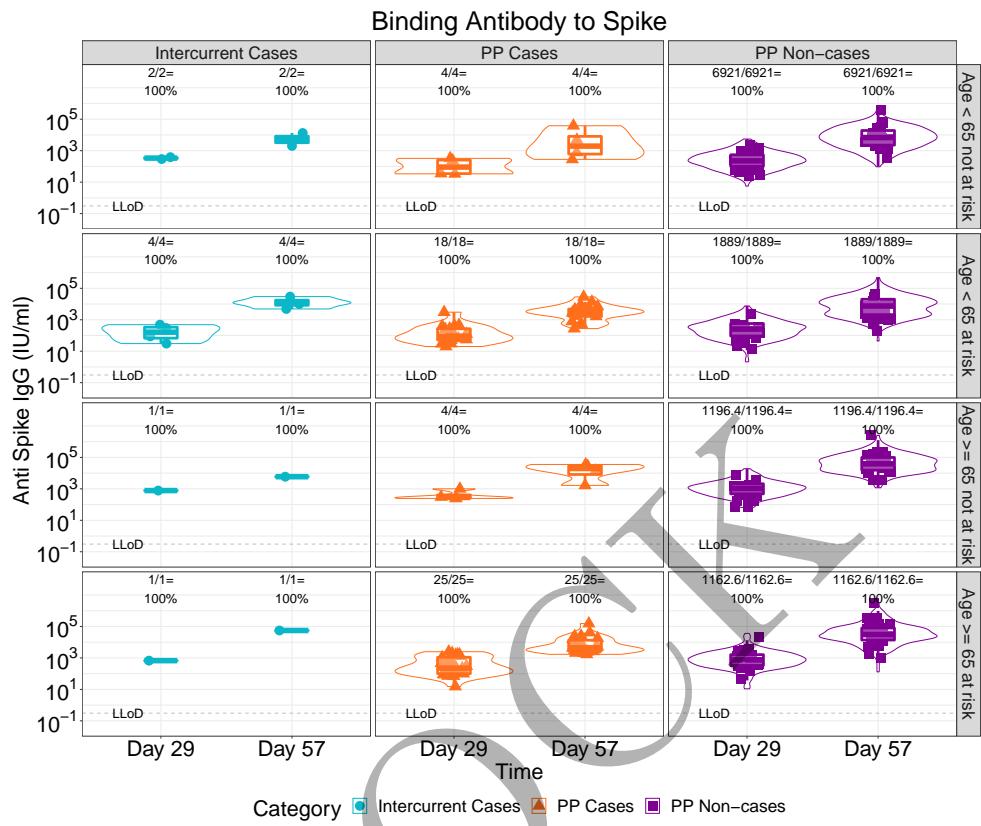


Figure 2.128: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by age and risk condition (version 1)

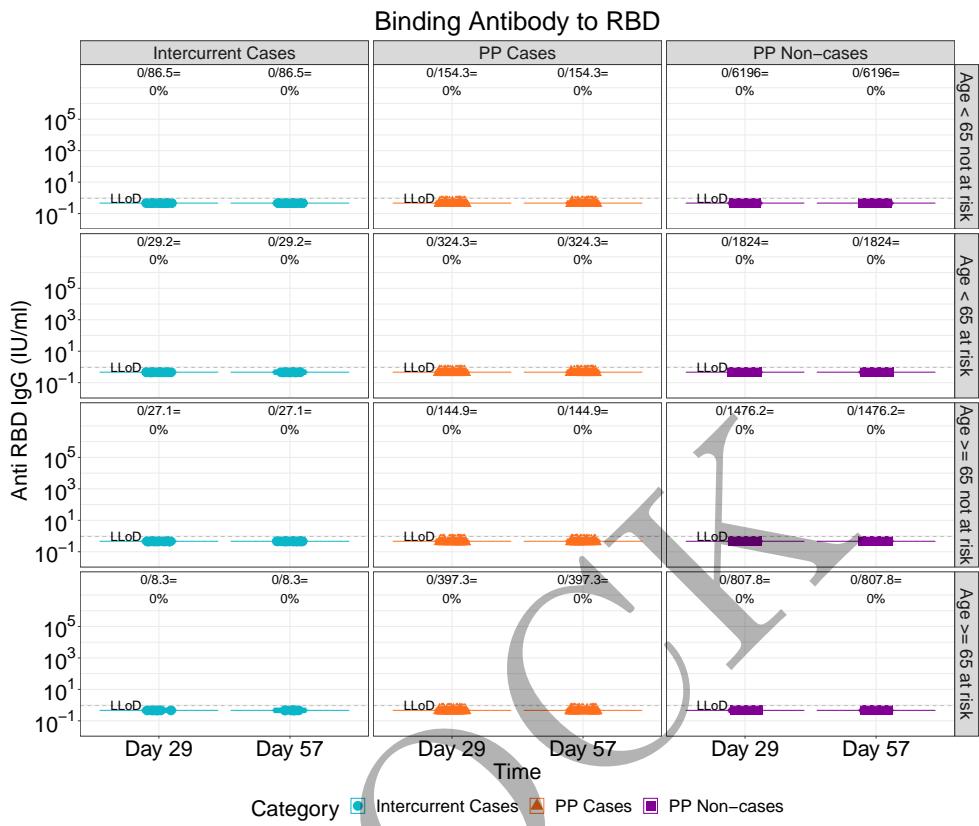


Figure 2.129: violinplots of Binding Antibody to RBD: baseline negative placebo arm by age and risk condition (version 1)

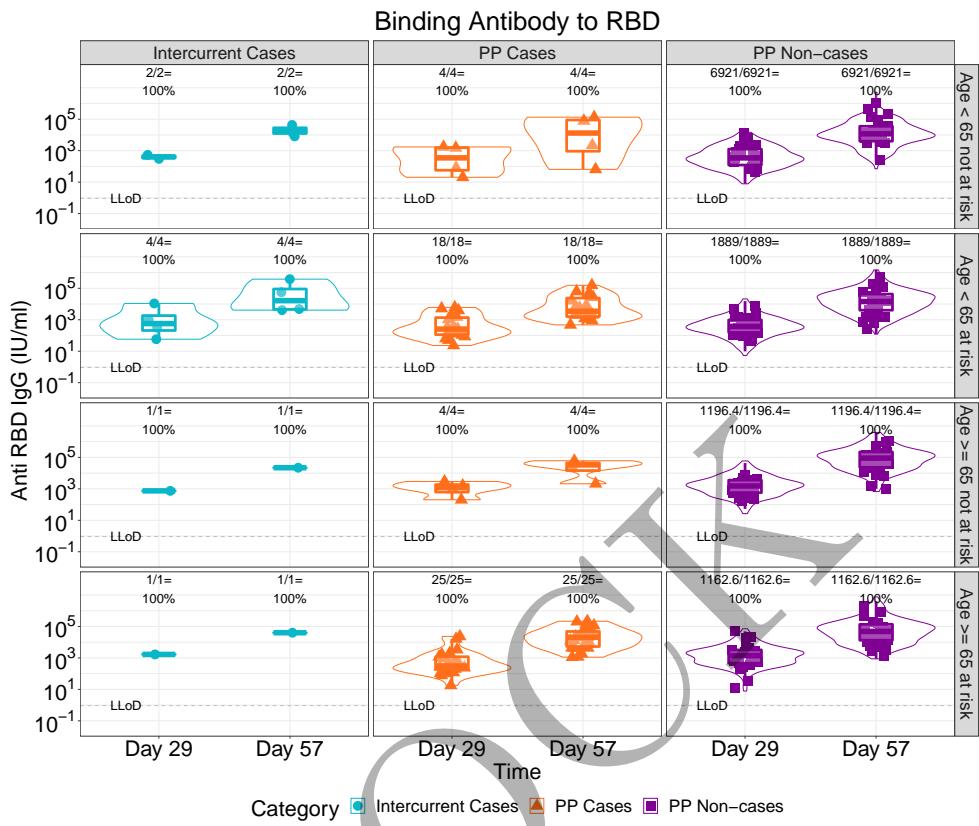


Figure 2.130: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by age and risk condition (version 1)

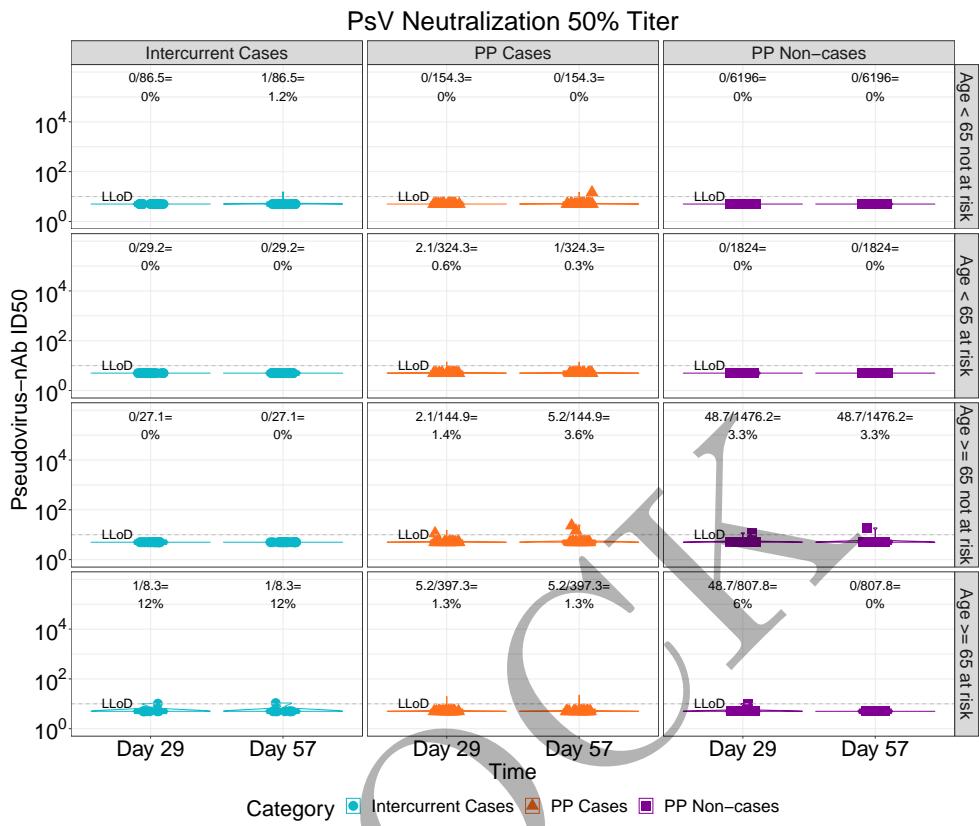


Figure 2.131: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age and risk condition (version 1)

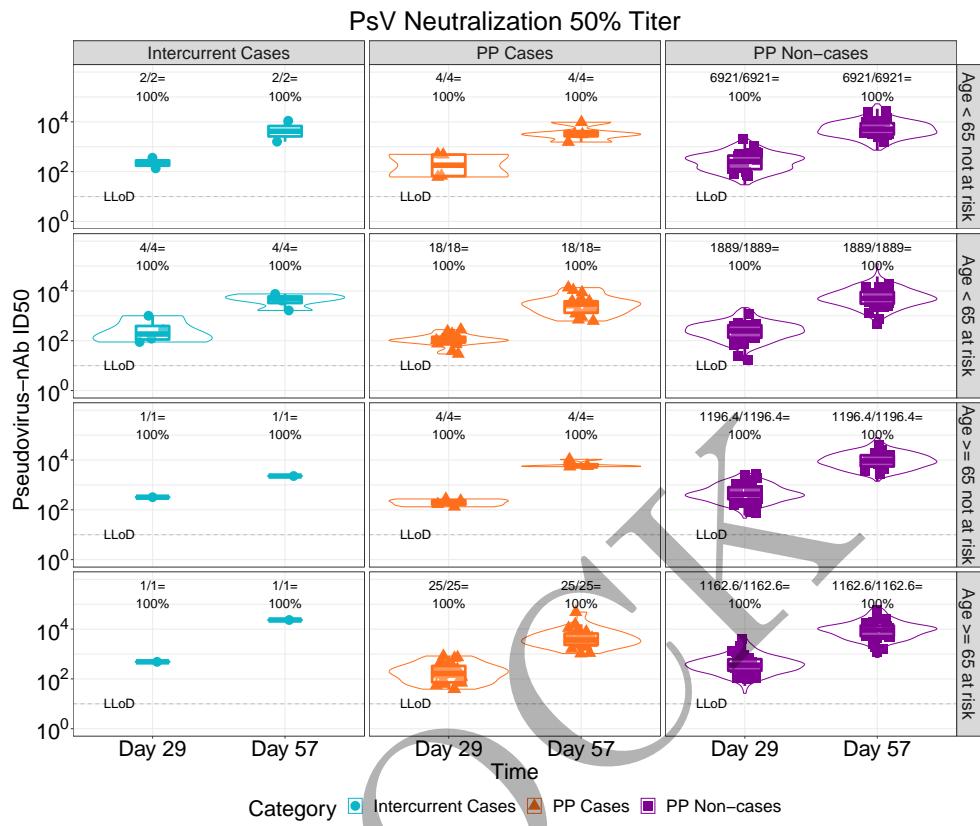


Figure 2.132: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age and risk condition (version 1)

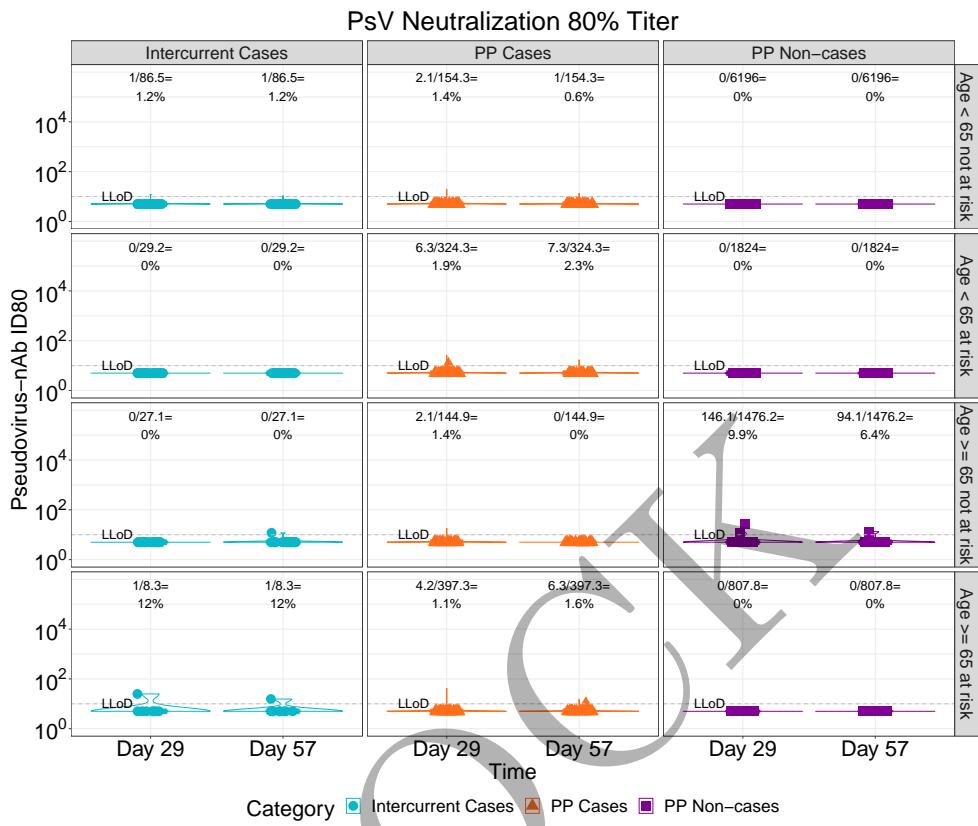


Figure 2.133: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age and risk condition (version 1)

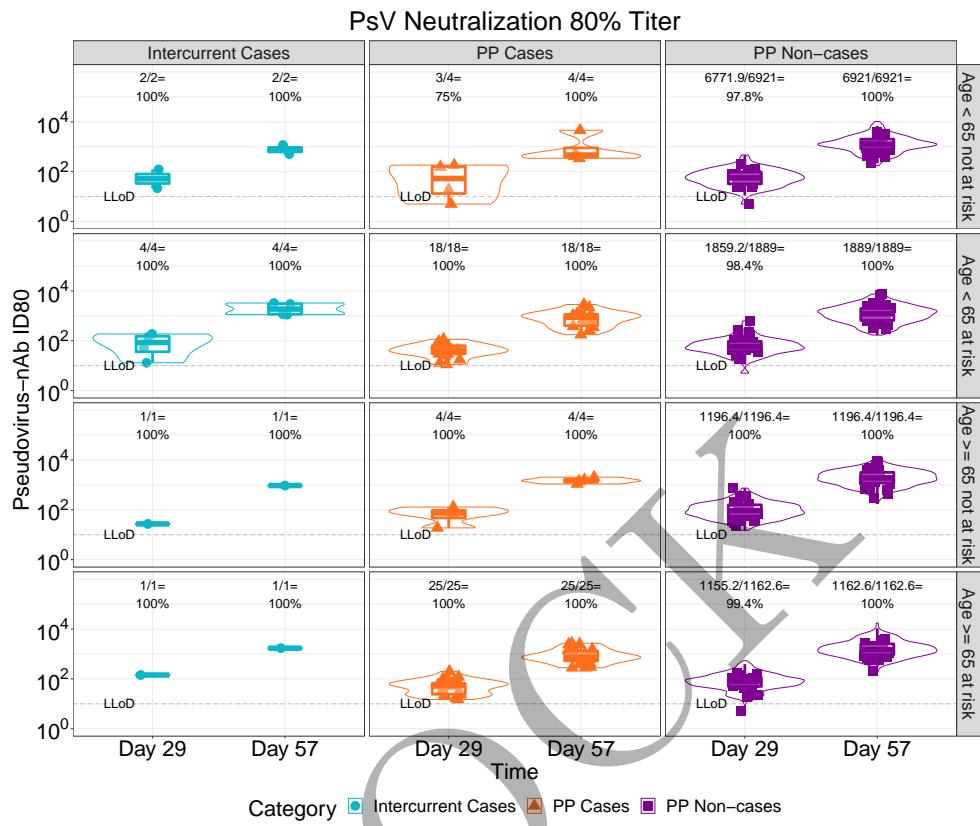


Figure 2.134: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age and risk condition (version 1)

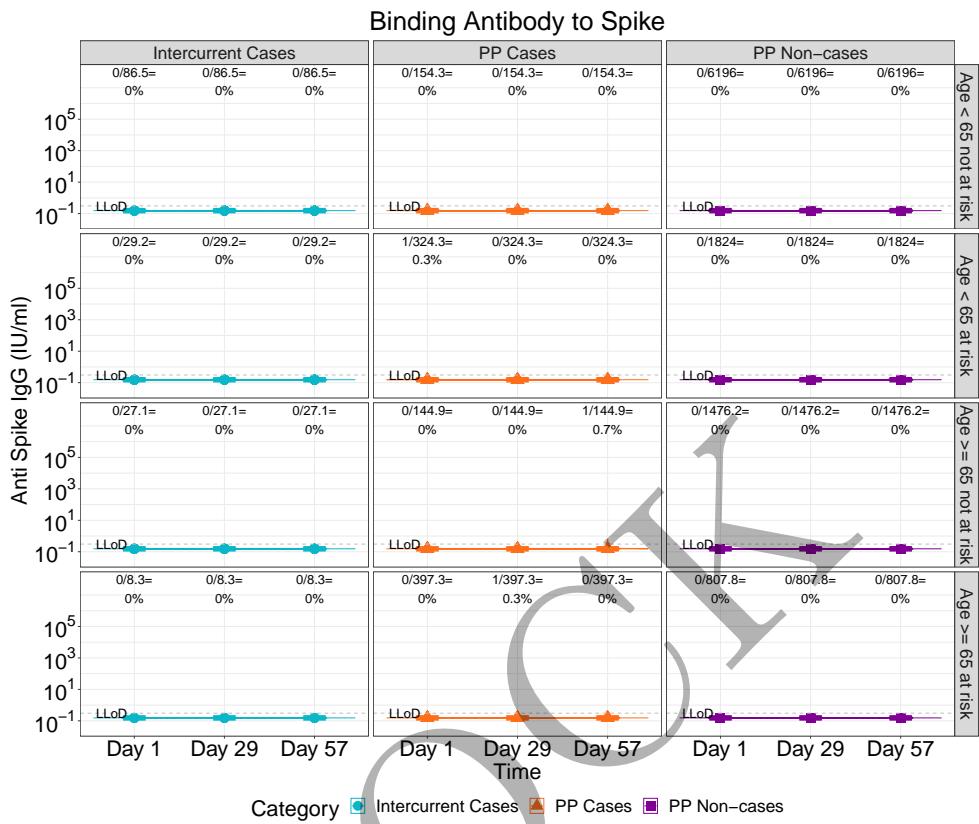


Figure 2.135: lineplots of Binding Antibody to Spike: baseline negative placebo arm by age and risk condition (version 2)

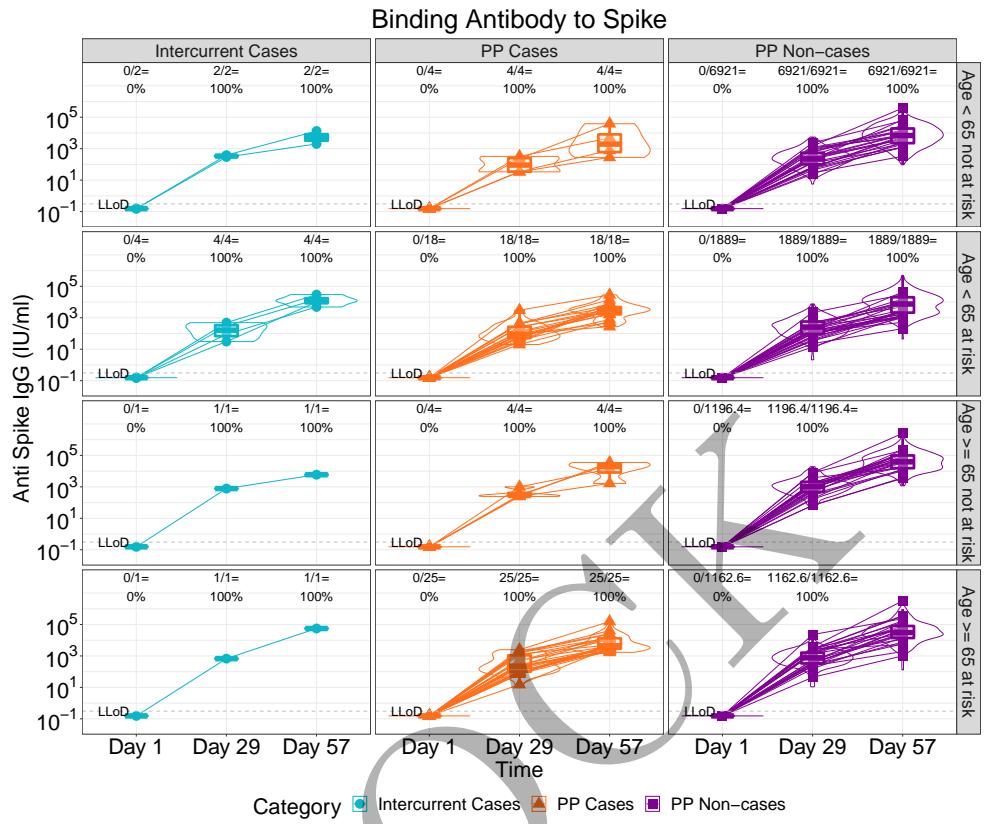


Figure 2.136: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by age and risk condition (version 2)

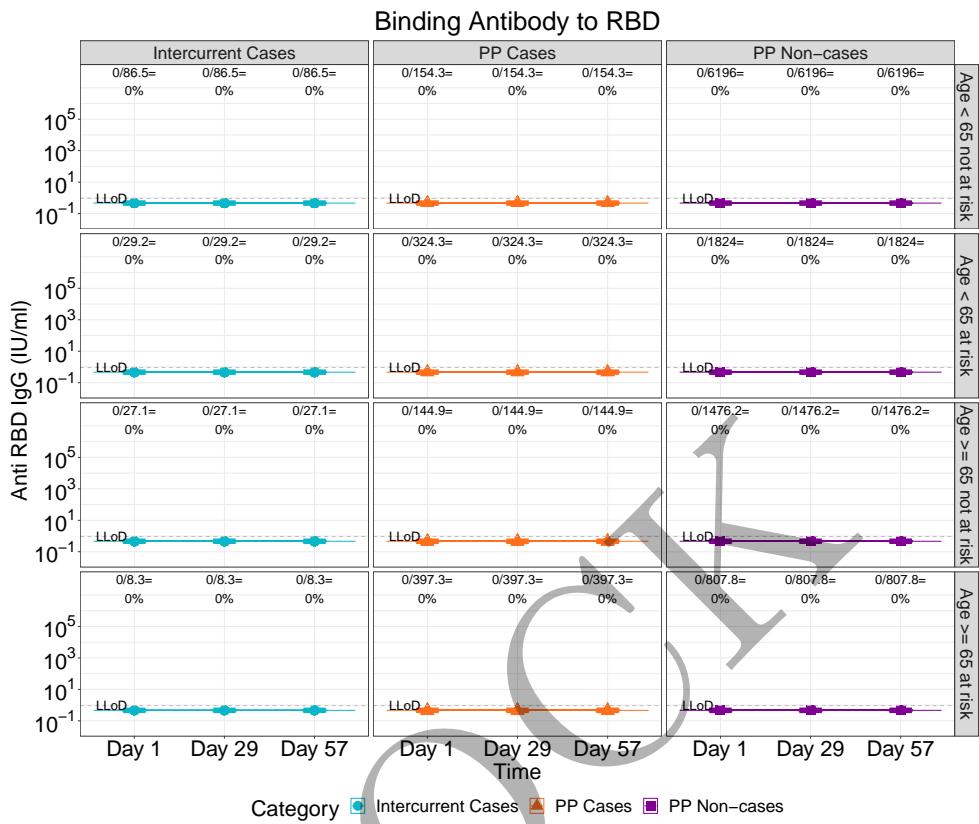


Figure 2.137: lineplots of Binding Antibody to RBD: baseline negative placebo arm by age and risk condition (version 2)

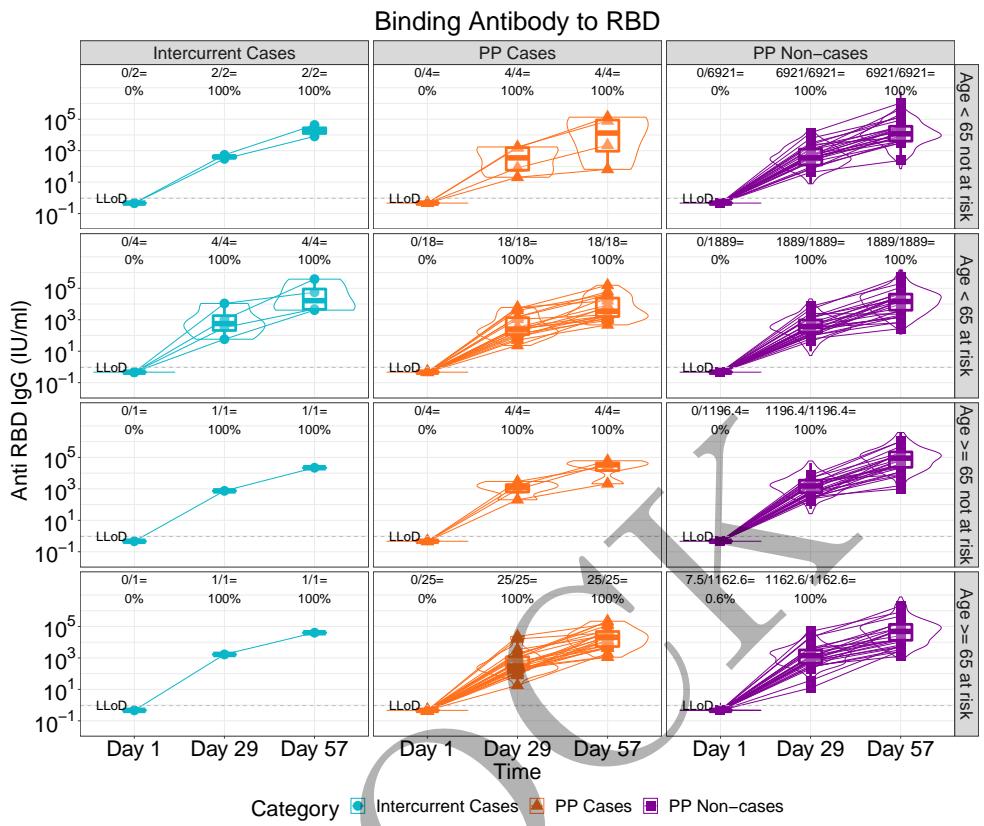


Figure 2.138: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by age and risk condition (version 2)

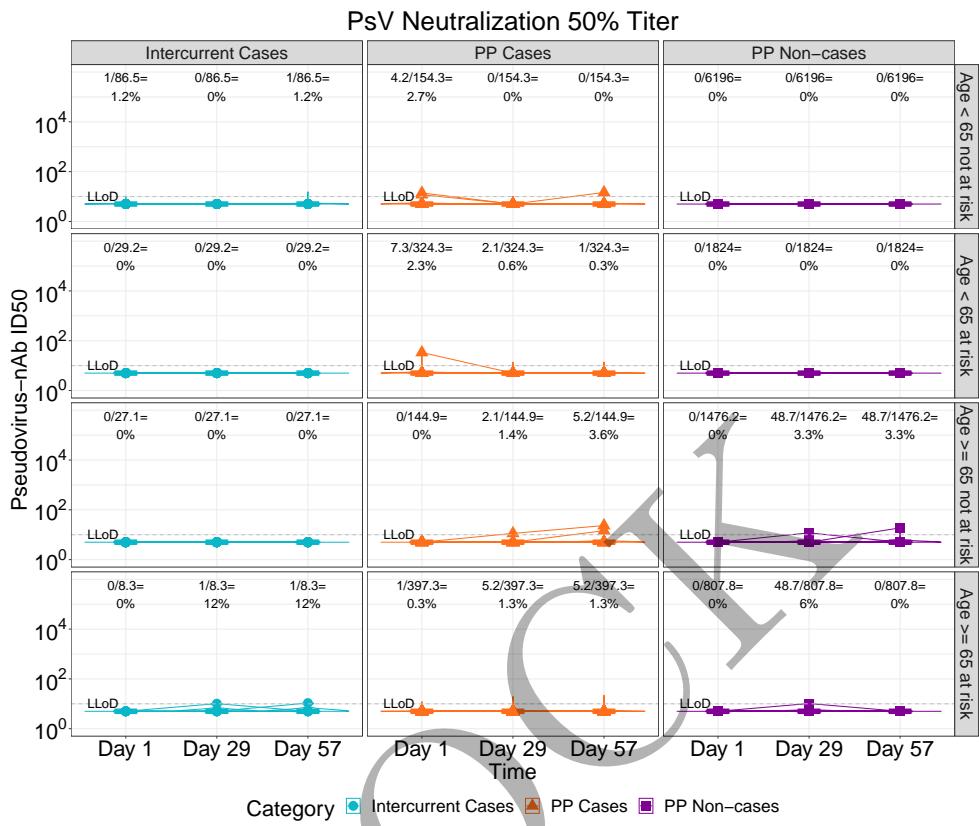


Figure 2.139: lineplots of Pseudovirus Neutralization ID₅₀: baseline negative placebo arm by age and risk condition (version 2)

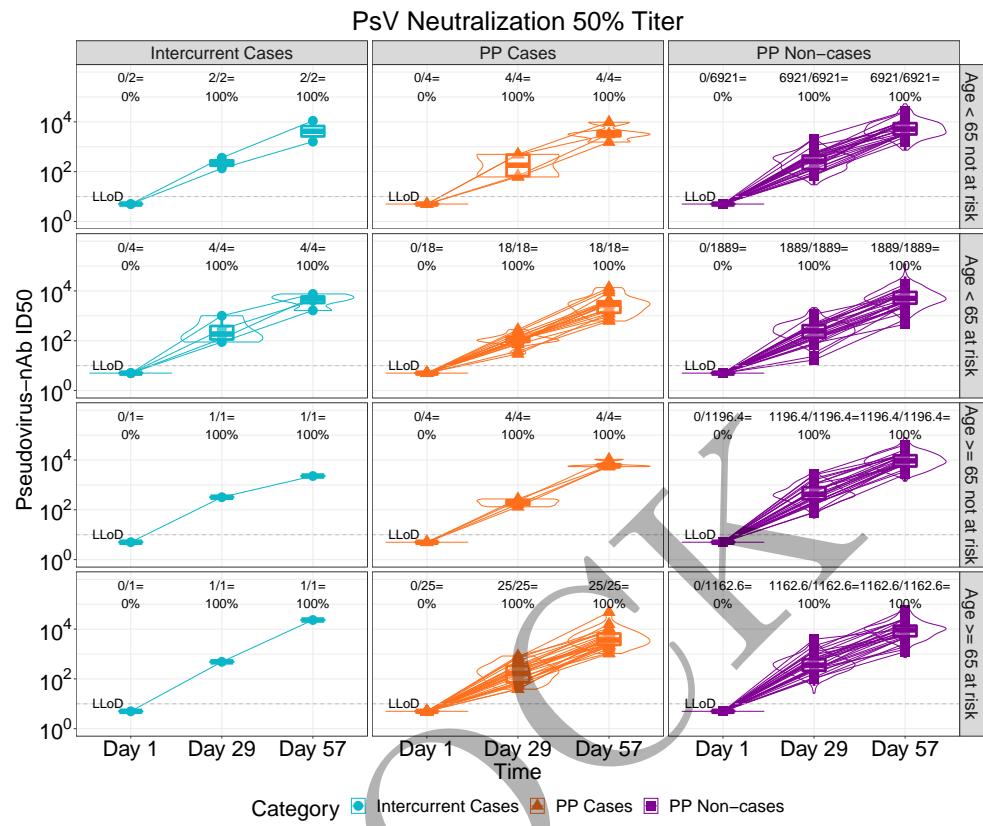


Figure 2.140: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age and risk condition (version 2)

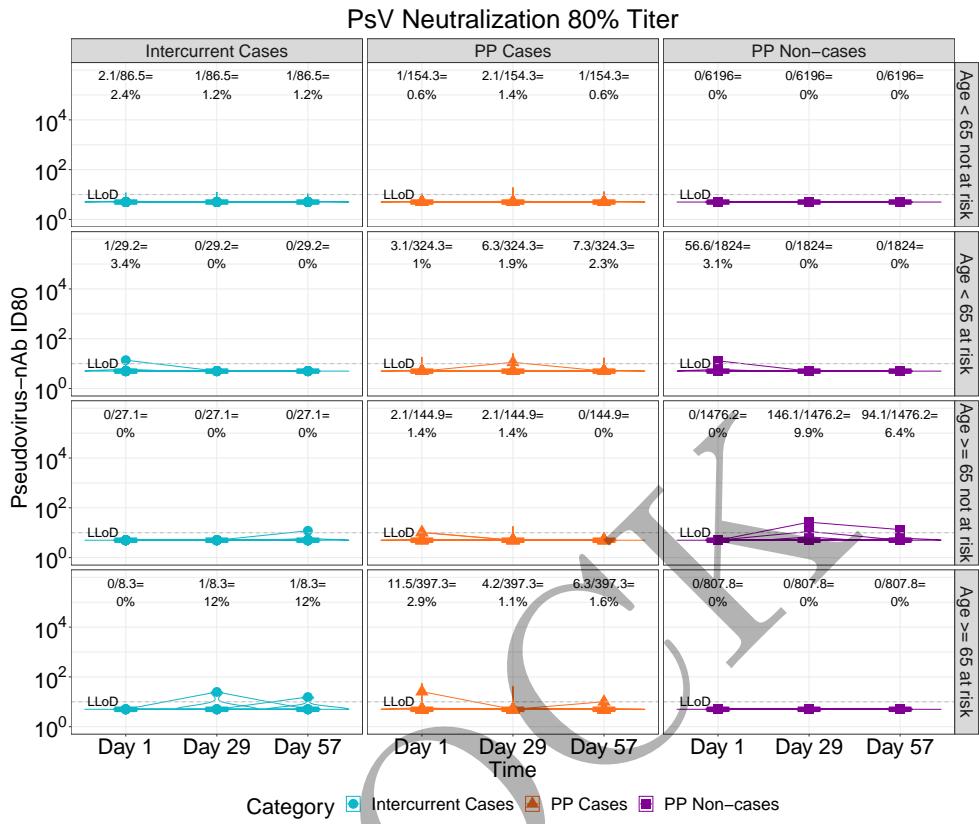


Figure 2.141: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age and risk condition (version 2)

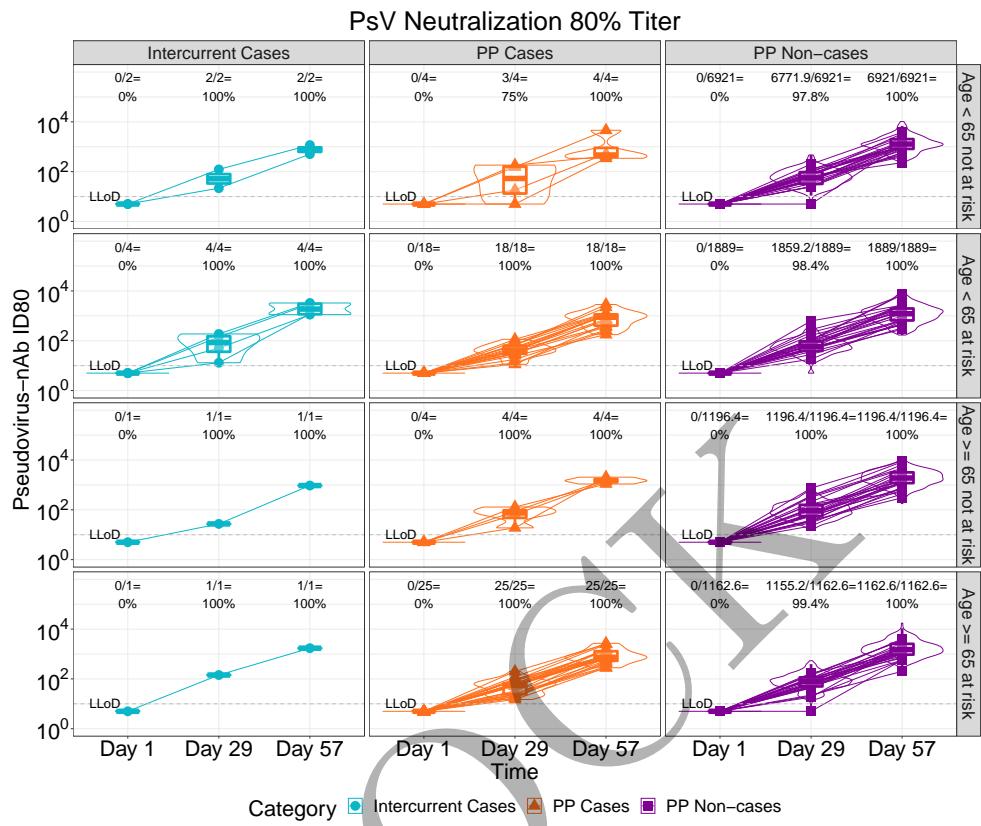


Figure 2.142: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age and risk condition (version 2)

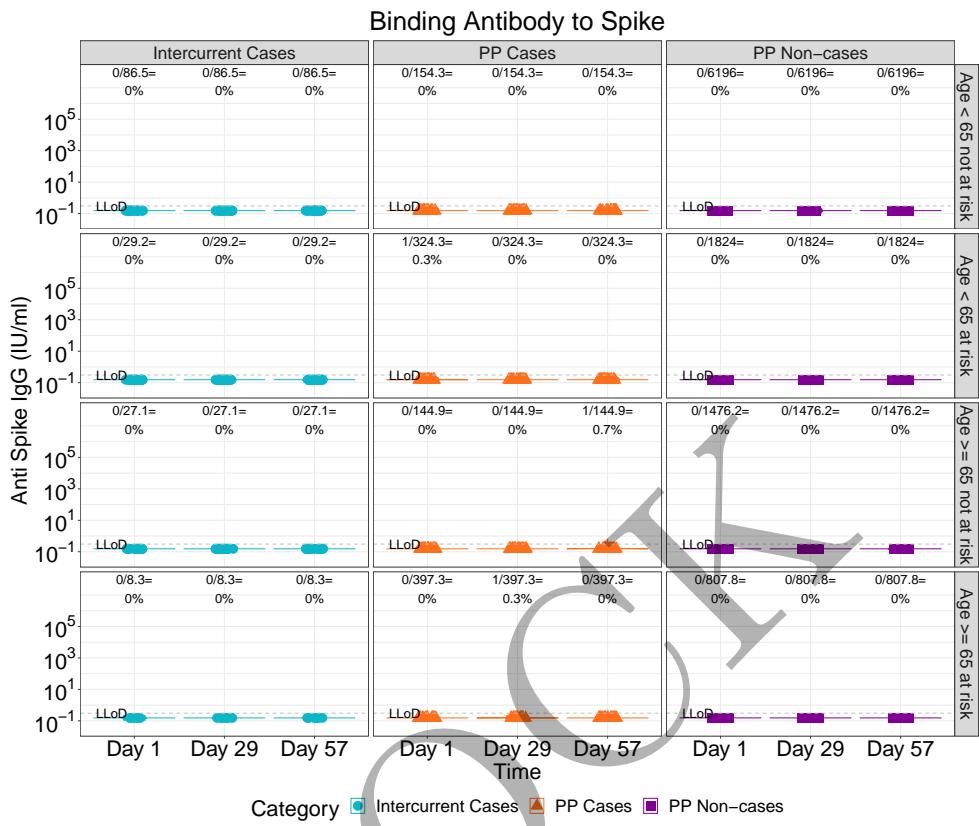


Figure 2.143: violinplots of Binding Antibody to Spike: baseline negative placebo arm by age and risk condition (version 2)

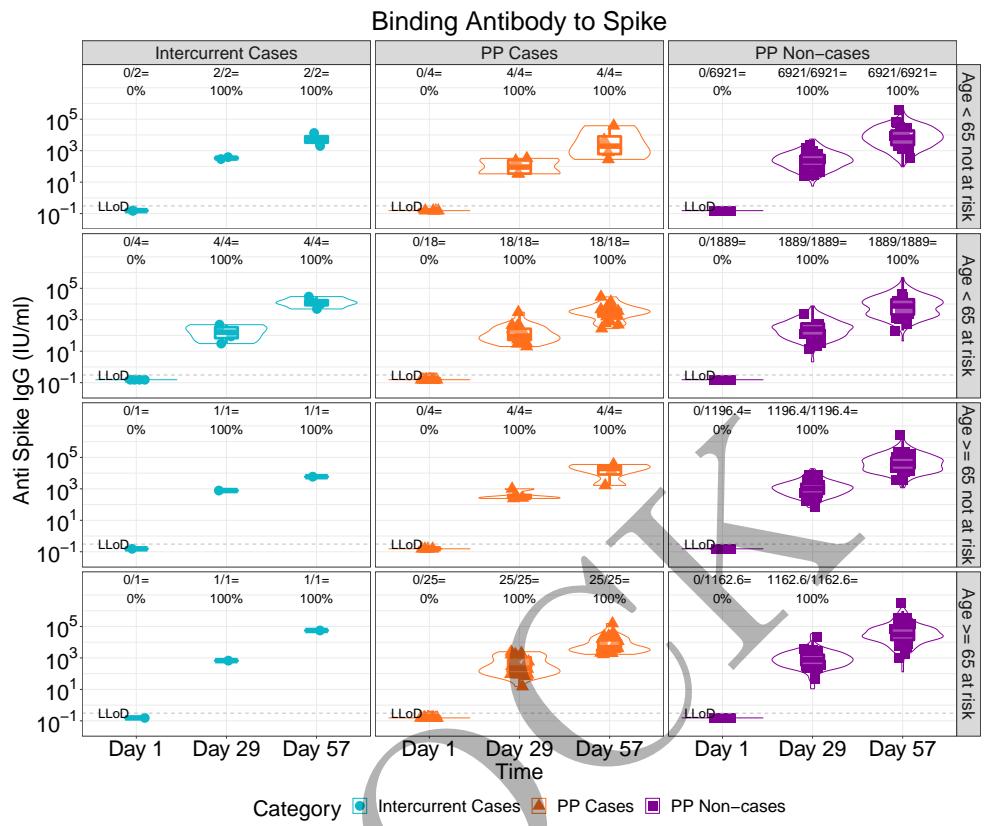


Figure 2.144: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by age and risk condition (version 2)

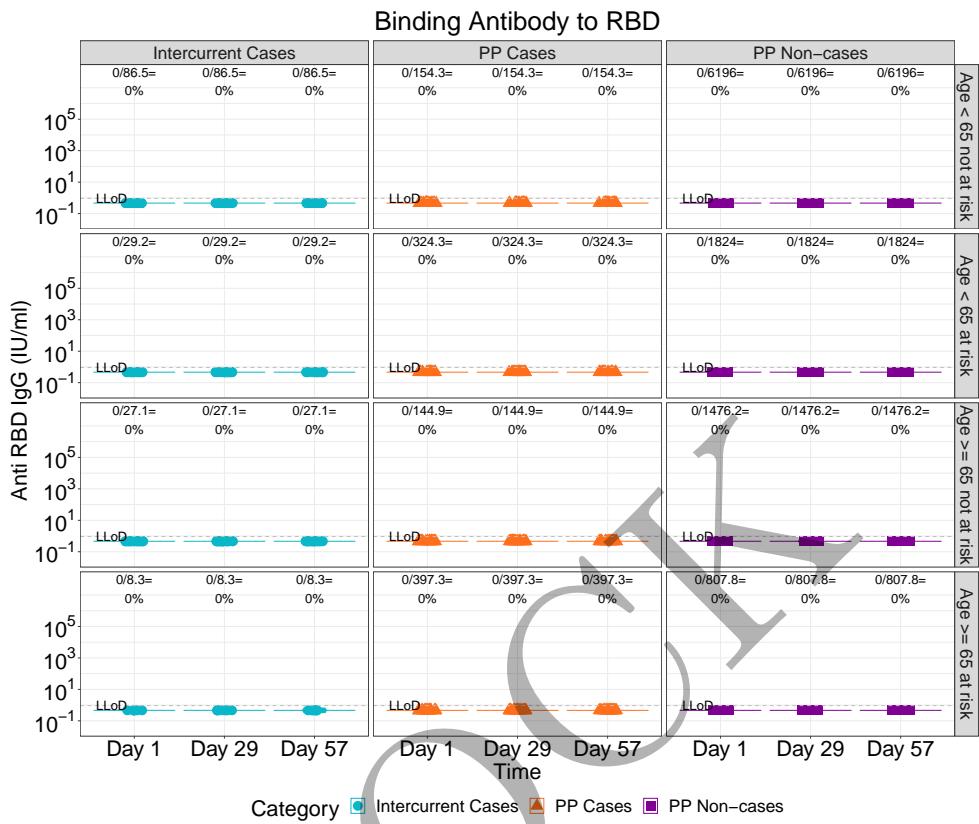


Figure 2.145: violinplots of Binding Antibody to RBD: baseline negative placebo arm by age and risk condition (version 2)

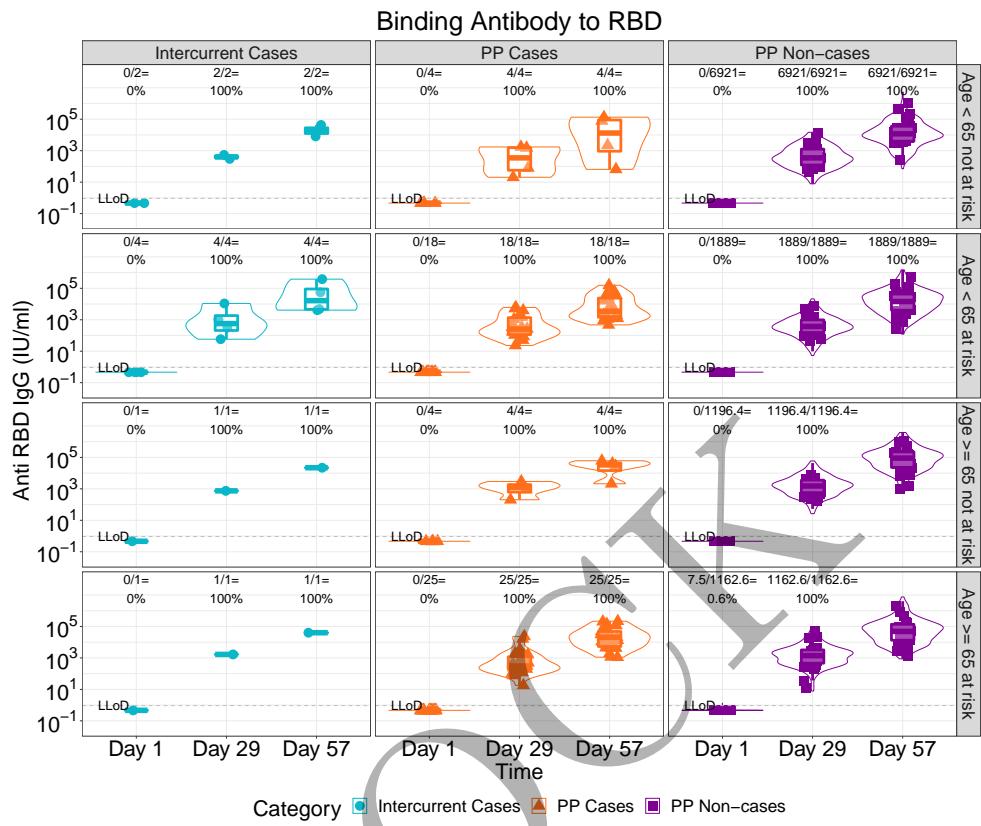


Figure 2.146: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by age and risk condition (version 2)

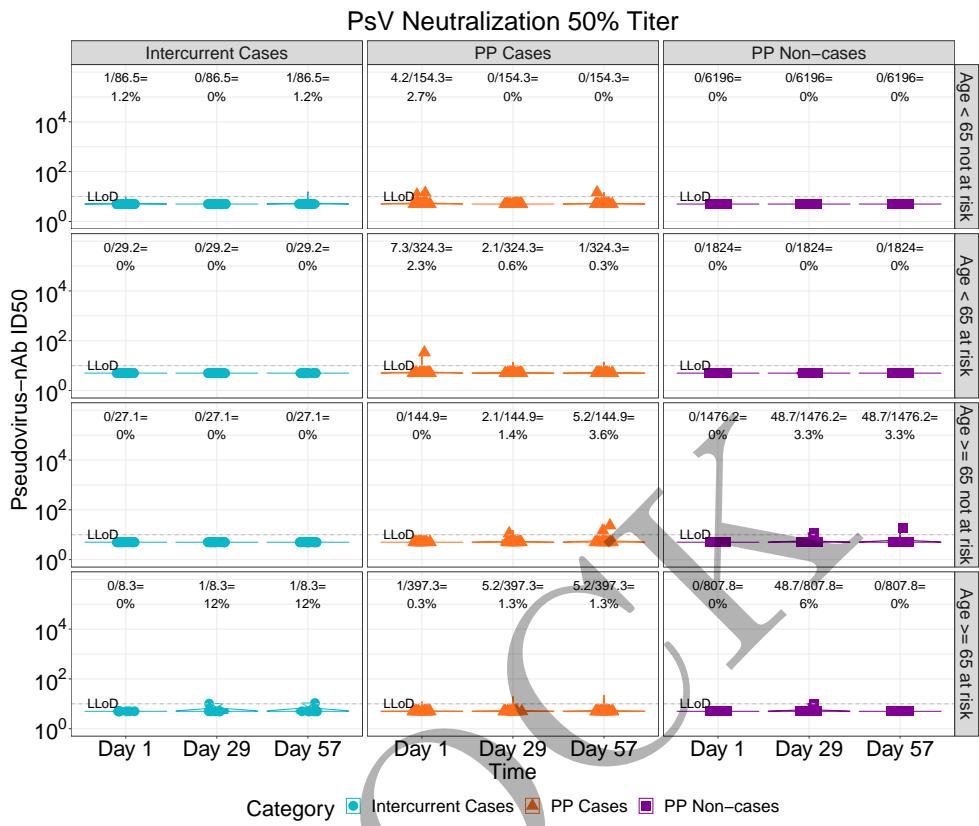


Figure 2.147: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age and risk condition (version 2)

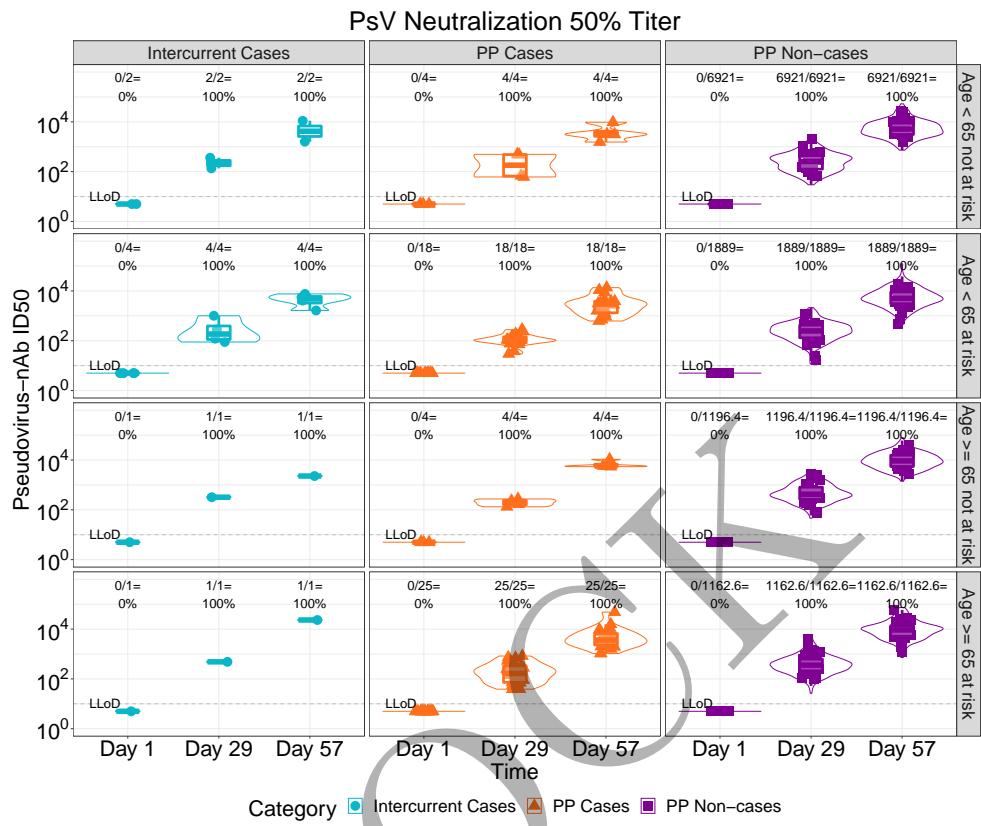


Figure 2.148: violinplots of Pseudovirus Neutralization ID₅₀: baseline negative vaccine arm by age and risk condition (version 2)

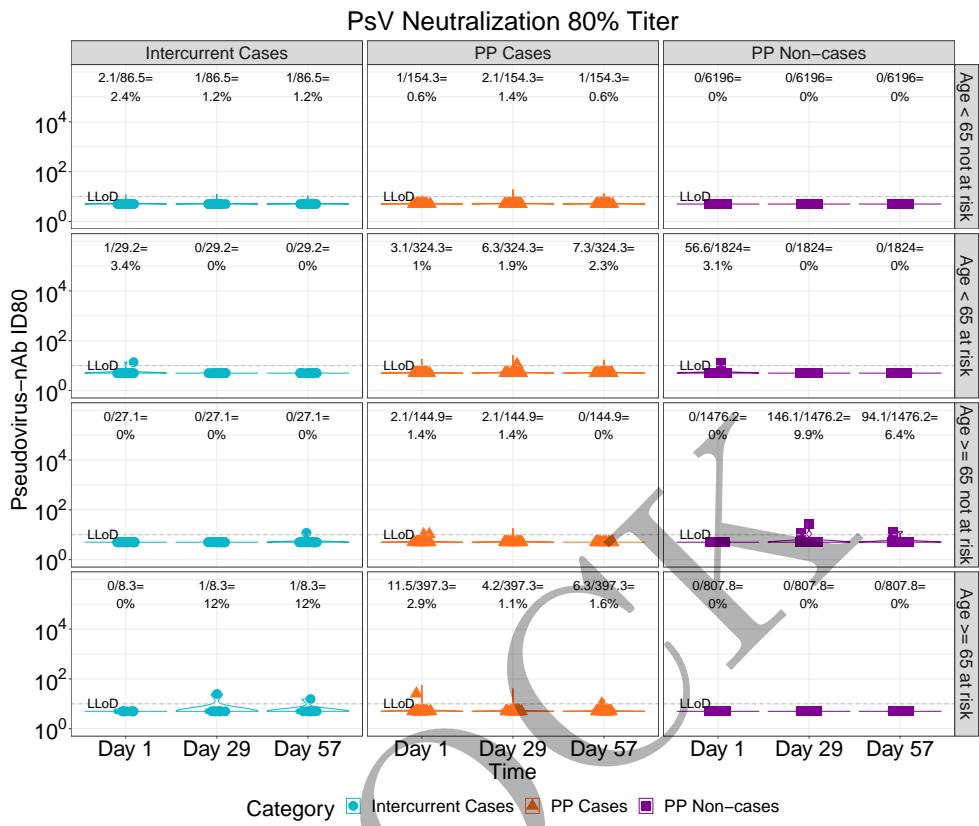


Figure 2.149: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age and risk condition (version 2)

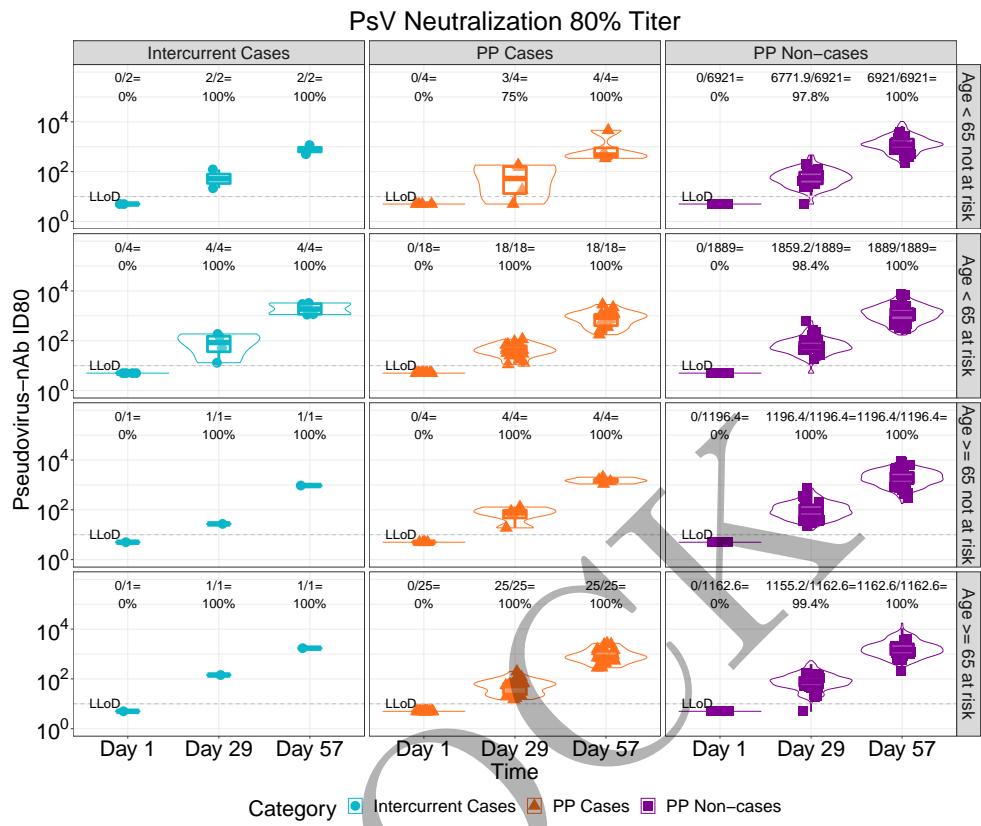


Figure 2.150: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age and risk condition (version 2)

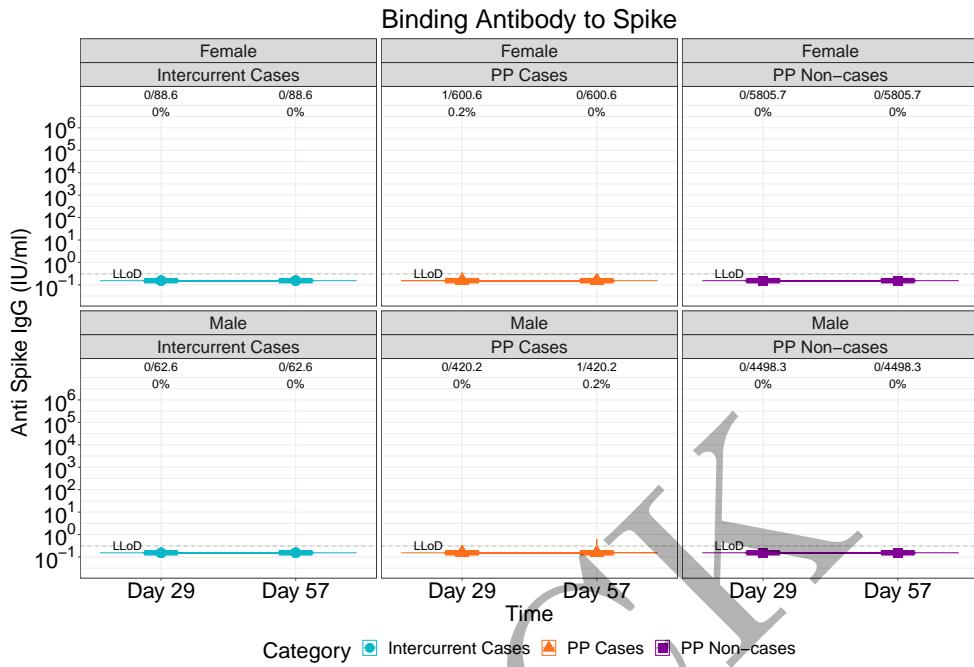


Figure 2.151: lineplots of Binding Antibody to Spike: baseline negative placebo arm by sex assigned at birth (version 1)

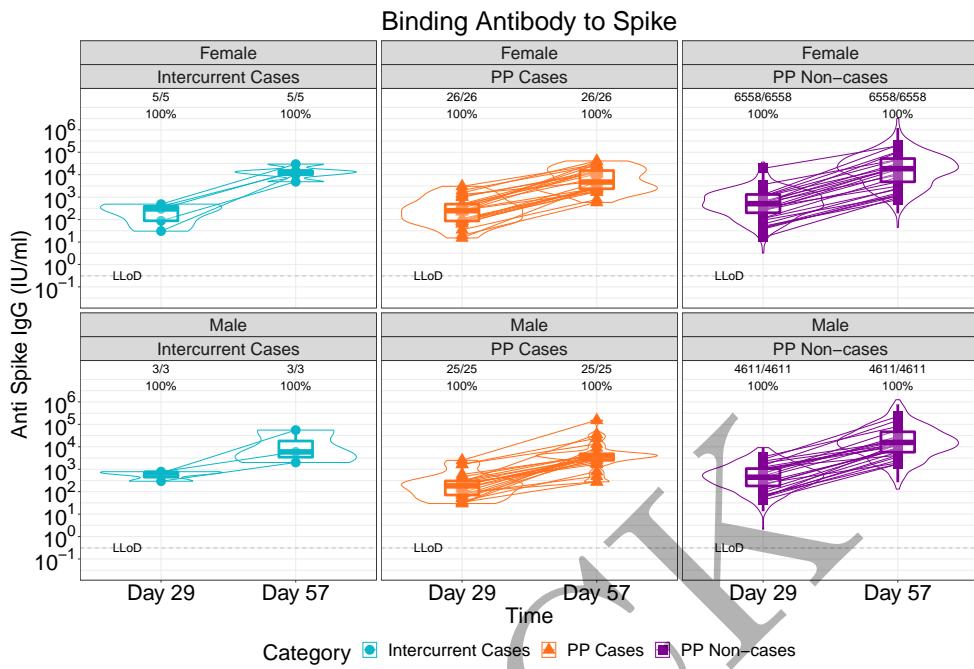


Figure 2.152: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by sex assigned at birth (version 1)

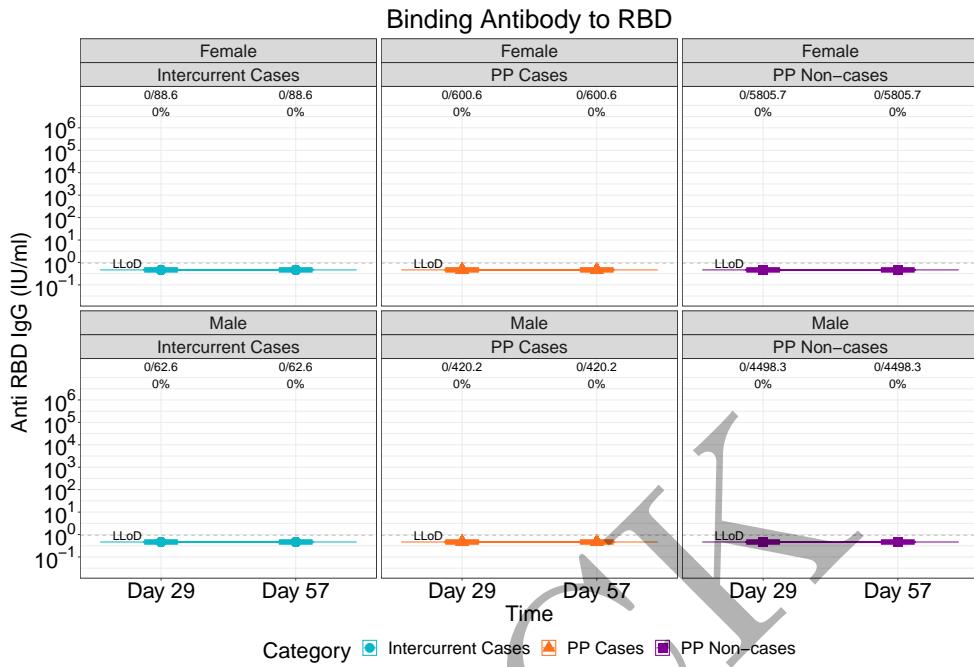


Figure 2.153: lineplots of Binding Antibody to RBD: baseline negative placebo arm by sex assigned at birth (version 1)

Binding Antibody to RBD

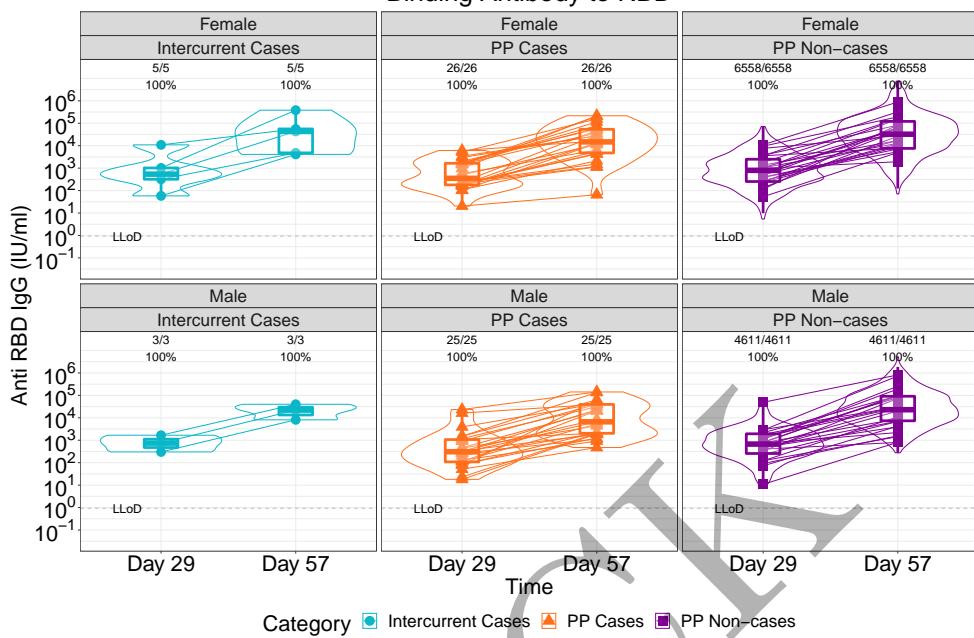


Figure 2.154: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by sex assigned at birth (version 1)

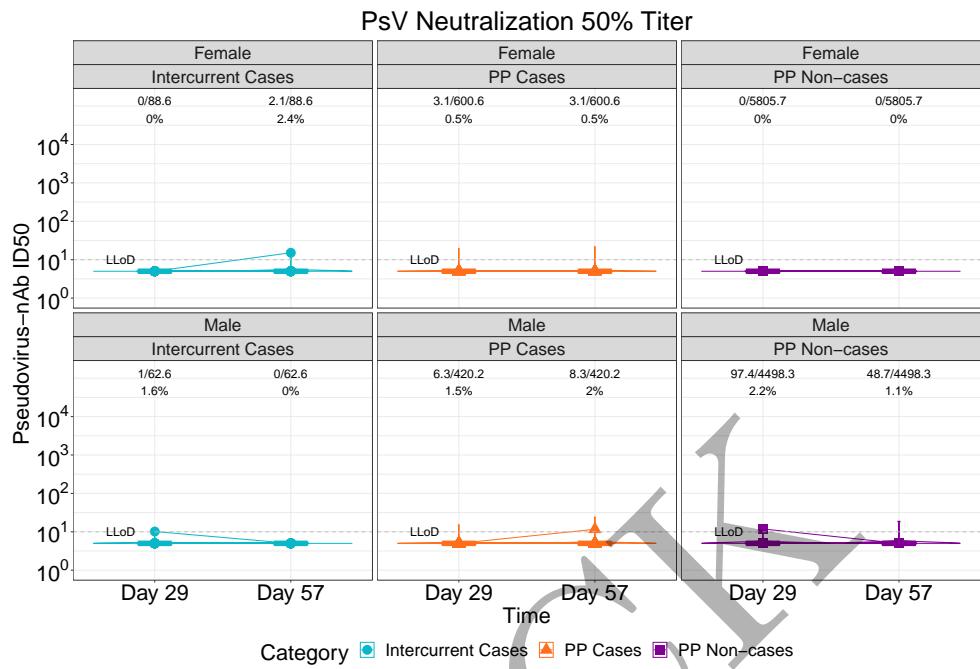


Figure 2.155: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by sex assigned at birth (version 1)

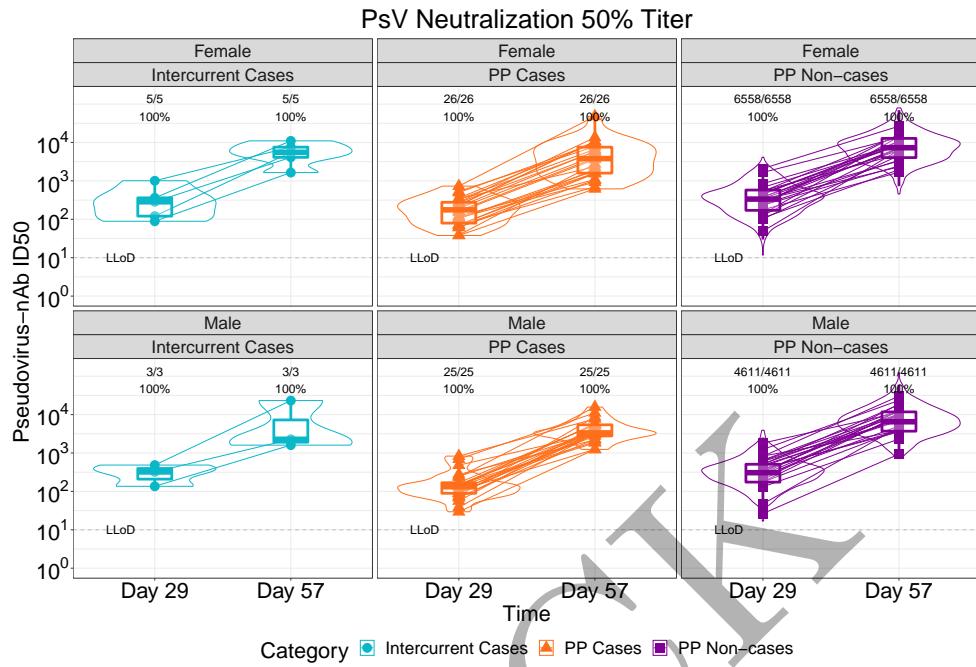


Figure 2.156: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by sex assigned at birth (version 1)

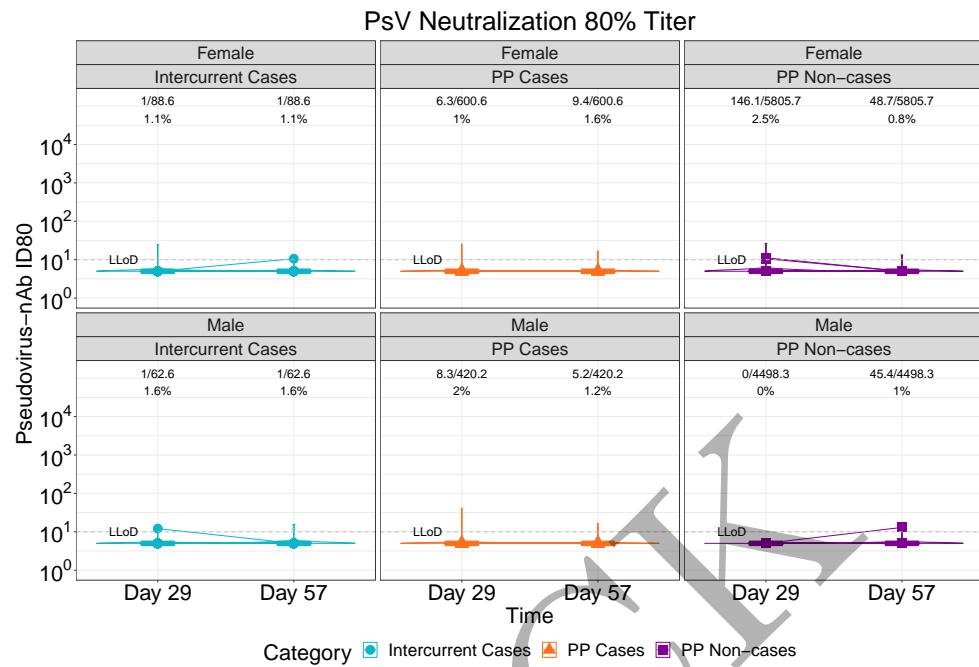


Figure 2.157: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by sex assigned at birth (version 1)

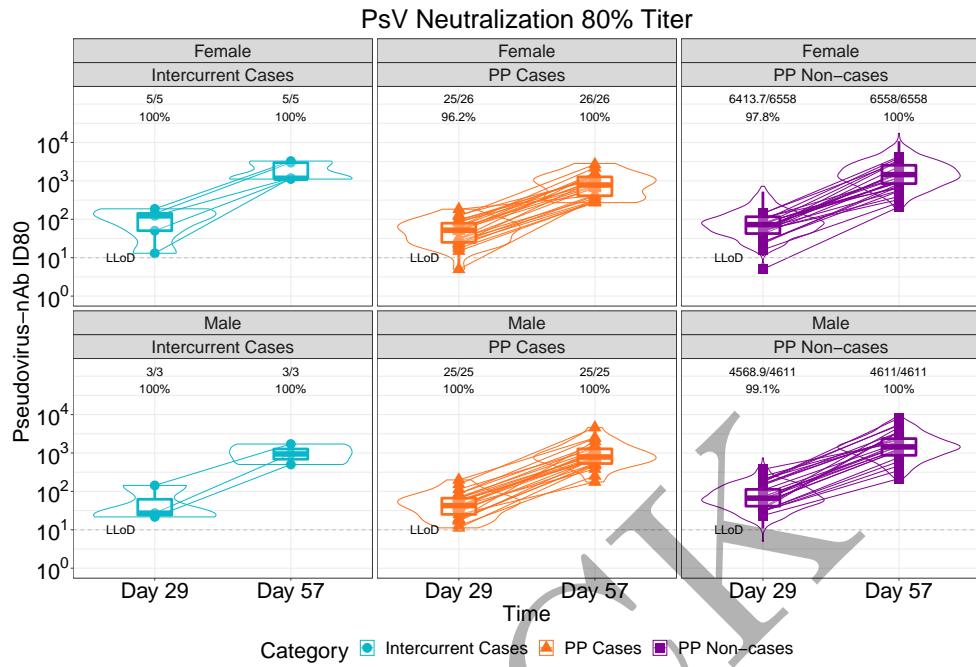


Figure 2.158: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by sex assigned at birth (version 1)

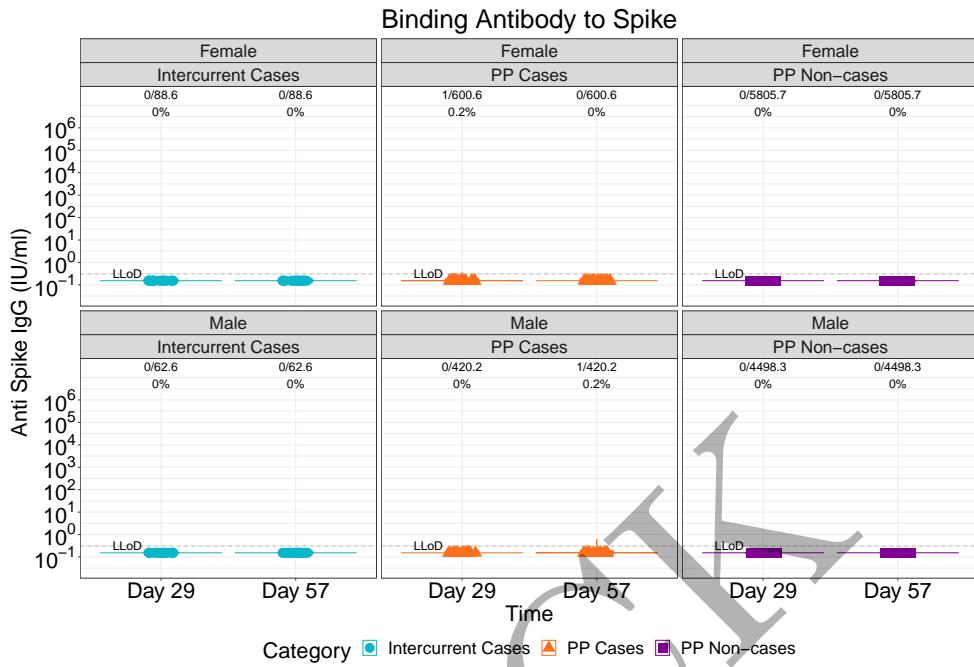


Figure 2.159: violinplots of Binding Antibody to Spike: baseline negative placebo arm by sex assigned at birth (version 1)

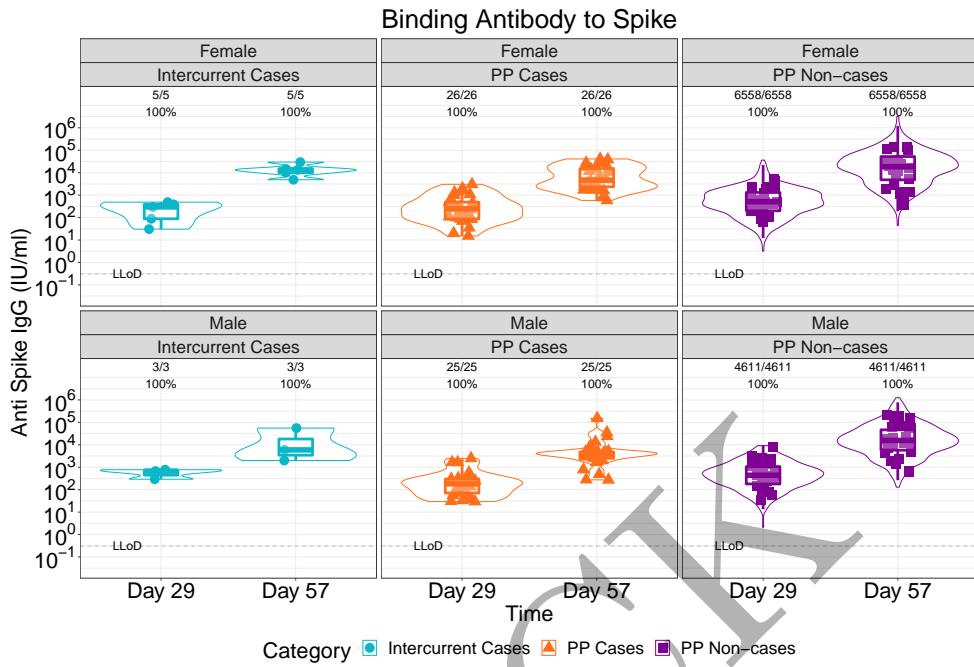


Figure 2.160: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by sex assigned at birth (version 1)

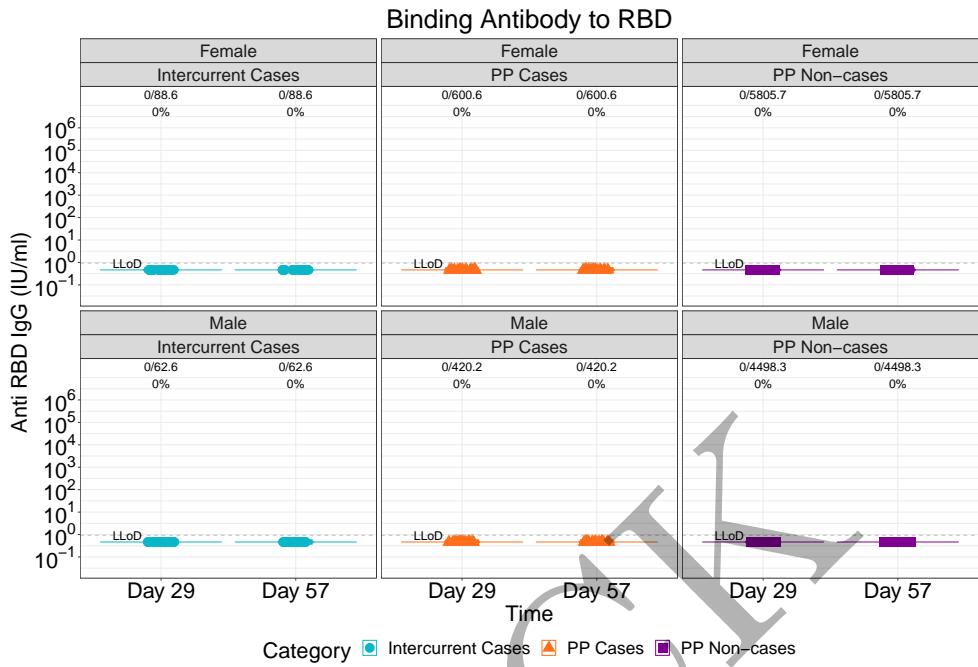


Figure 2.161: violinplots of Binding Antibody to RBD: baseline negative placebo arm by sex assigned at birth (version 1)

Binding Antibody to RBD

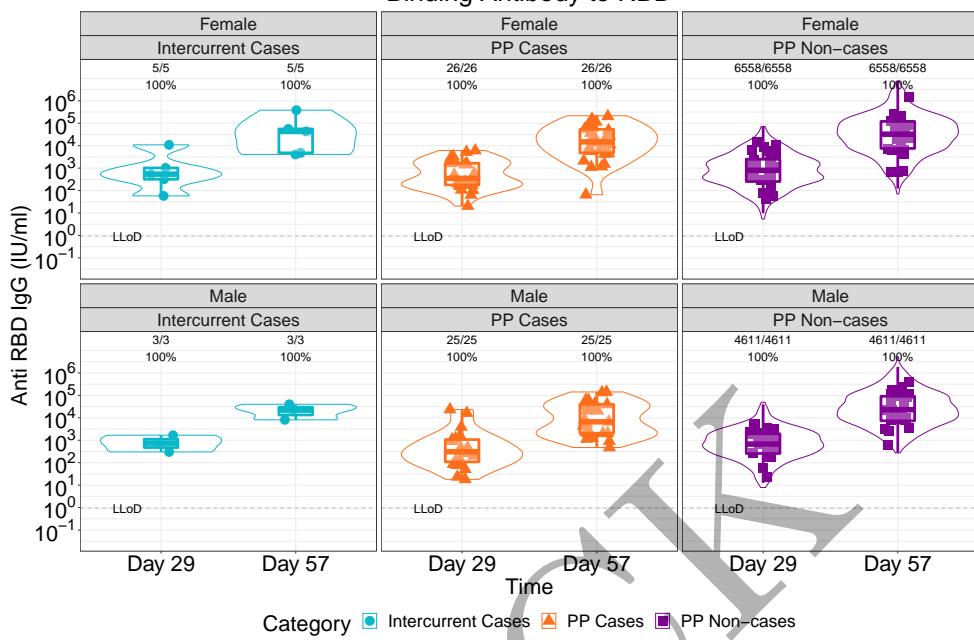


Figure 2.162: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by sex assigned at birth (version 1)

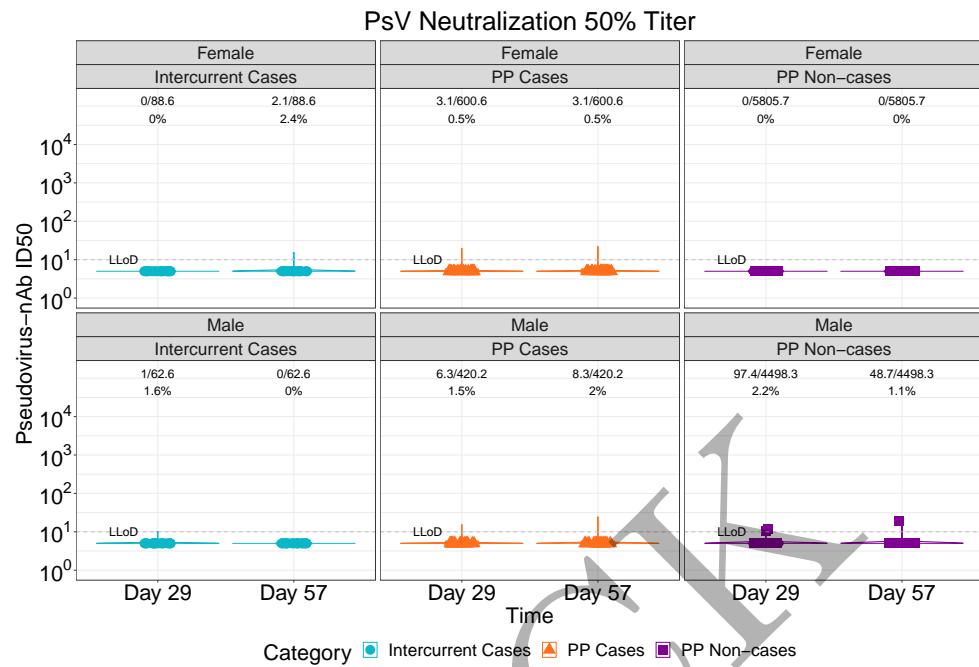


Figure 2.163: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by sex assigned at birth (version 1)

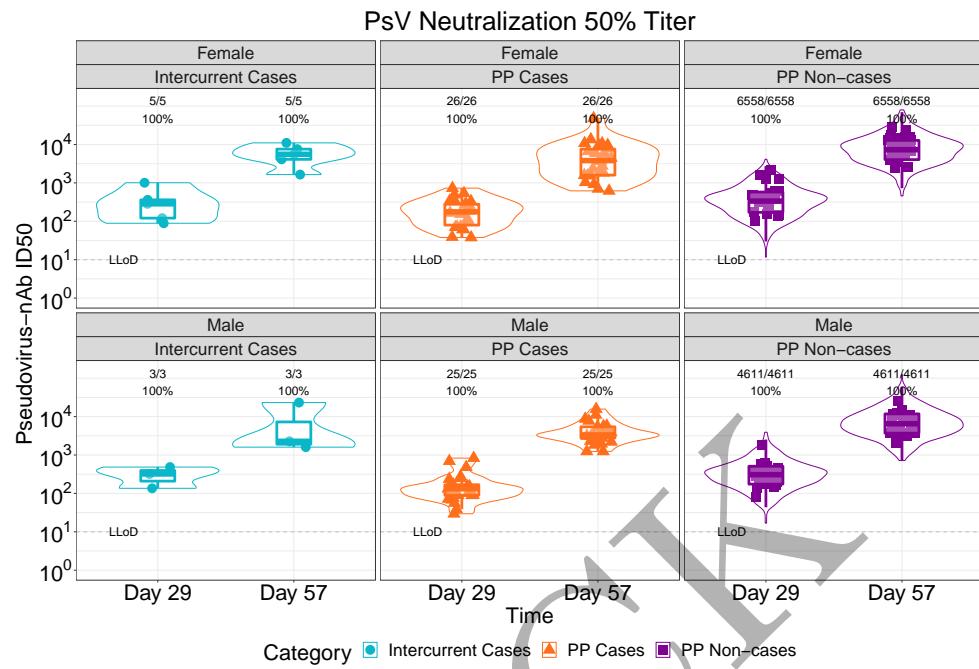


Figure 2.164: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by sex assigned at birth (version 1)

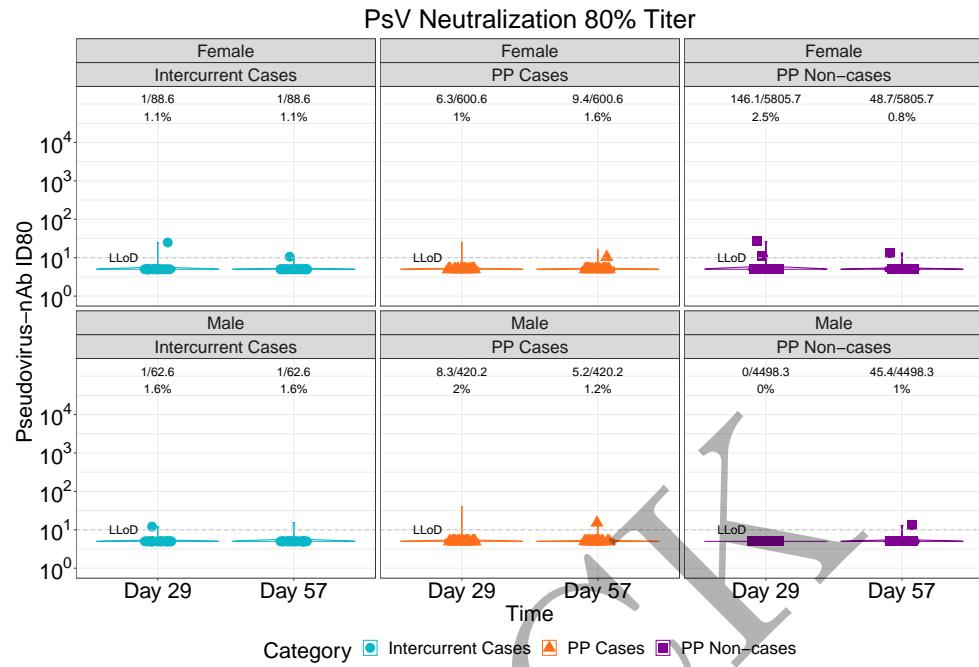


Figure 2.165: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by sex assigned at birth (version 1)

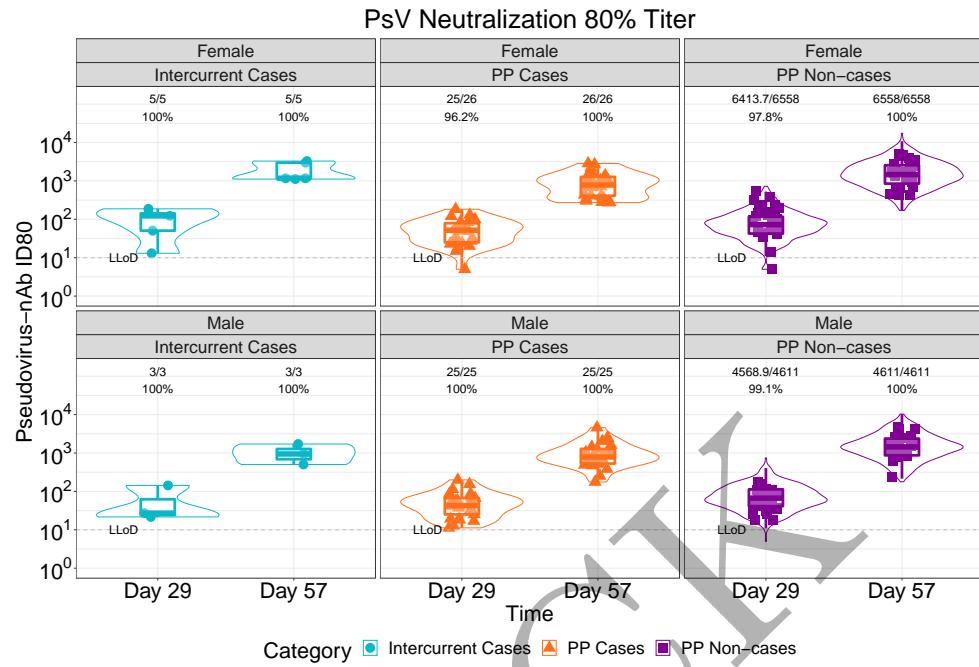


Figure 2.166: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by sex assigned at birth (version 1)

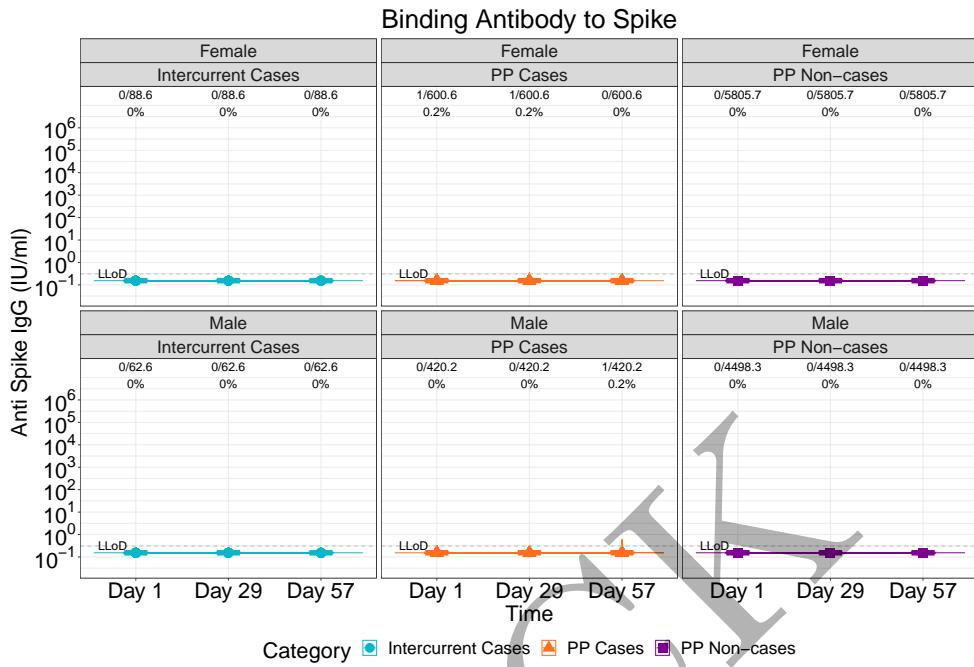


Figure 2.167: lineplots of Binding Antibody to Spike: baseline negative placebo arm by sex assigned at birth (version 2)

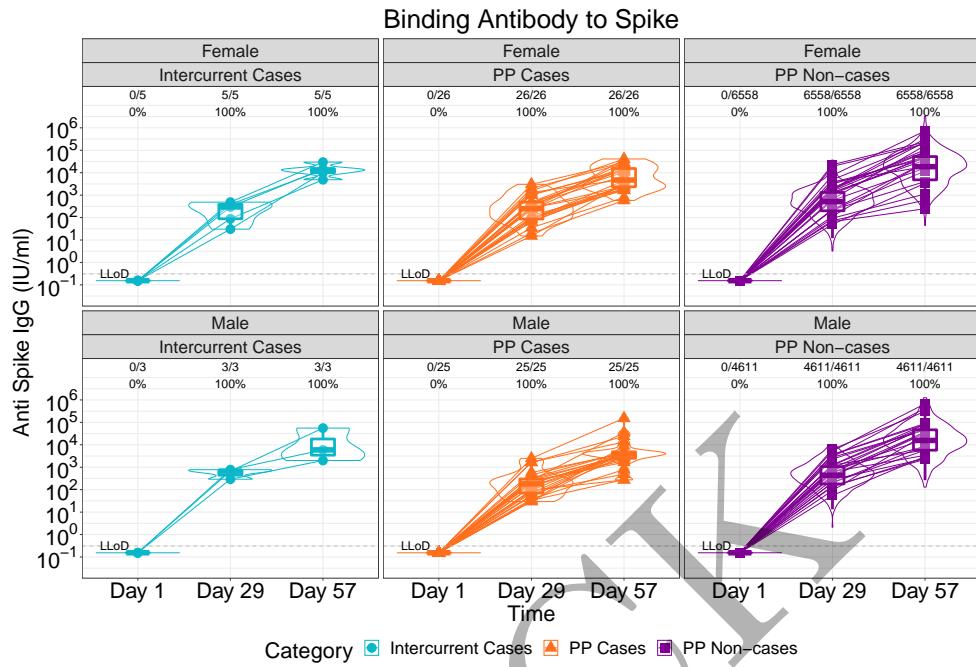


Figure 2.168: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by sex assigned at birth (version 2)

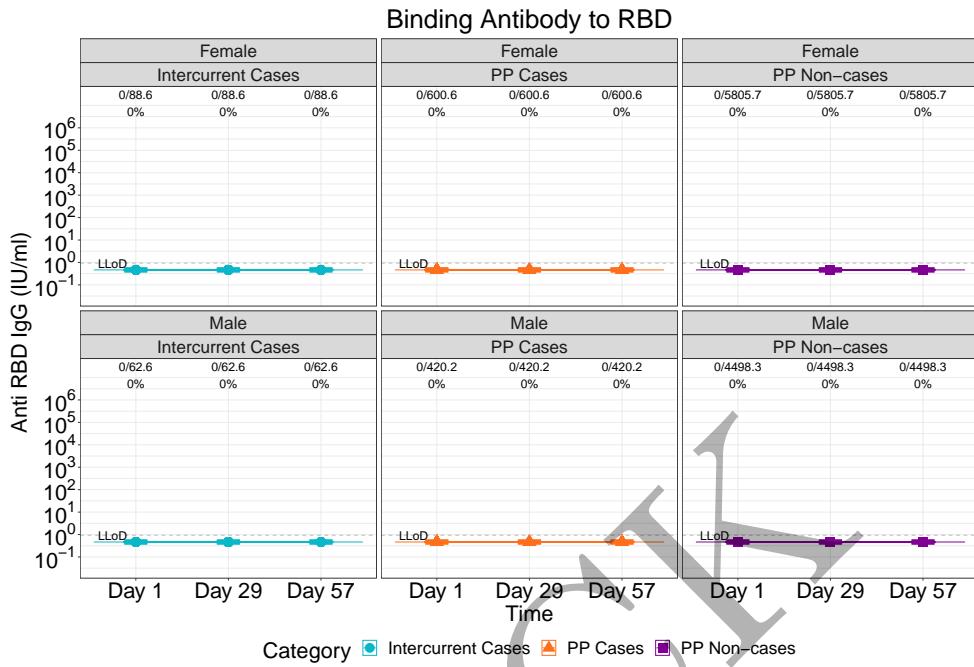


Figure 2.169: lineplots of Binding Antibody to RBD: baseline negative placebo arm by sex assigned at birth (version 2)

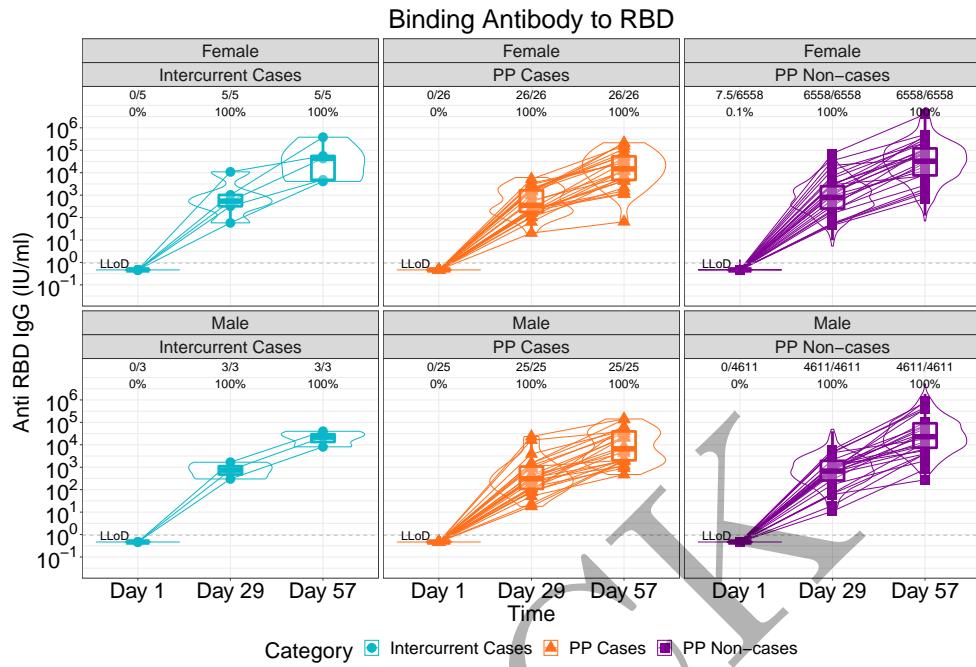


Figure 2.170: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by sex assigned at birth (version 2)

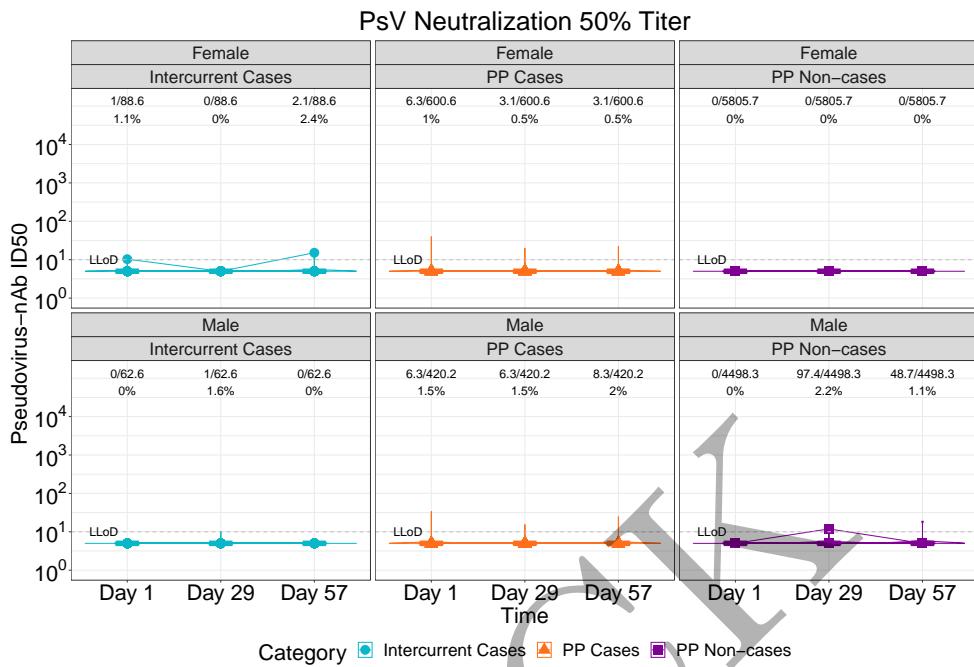


Figure 2.171: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by sex assigned at birth (version 2)

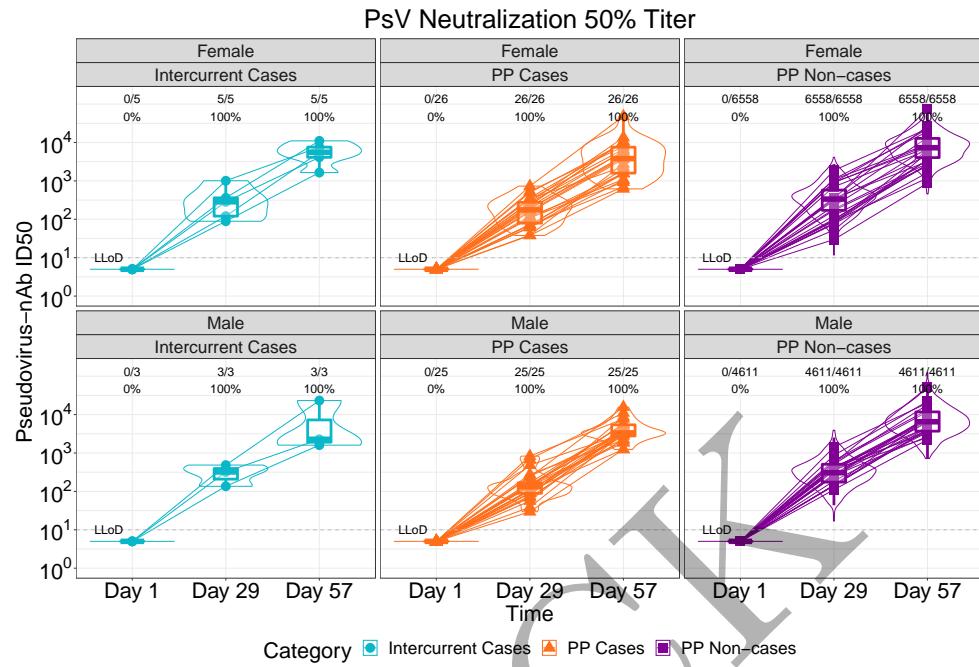


Figure 2.172: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by sex assigned at birth (version 2)

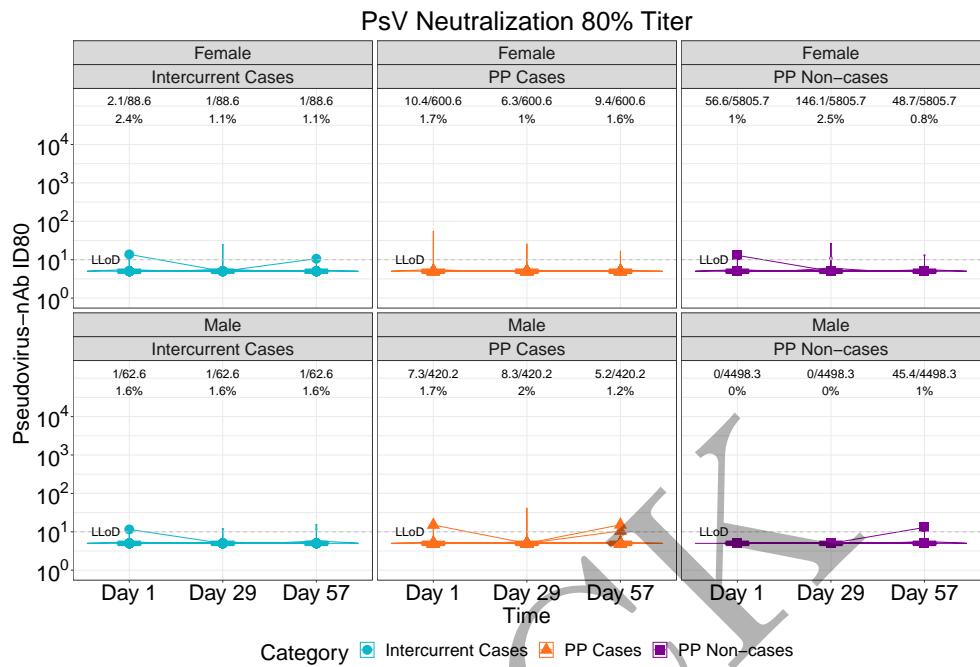


Figure 2.173: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by sex assigned at birth (version 2)

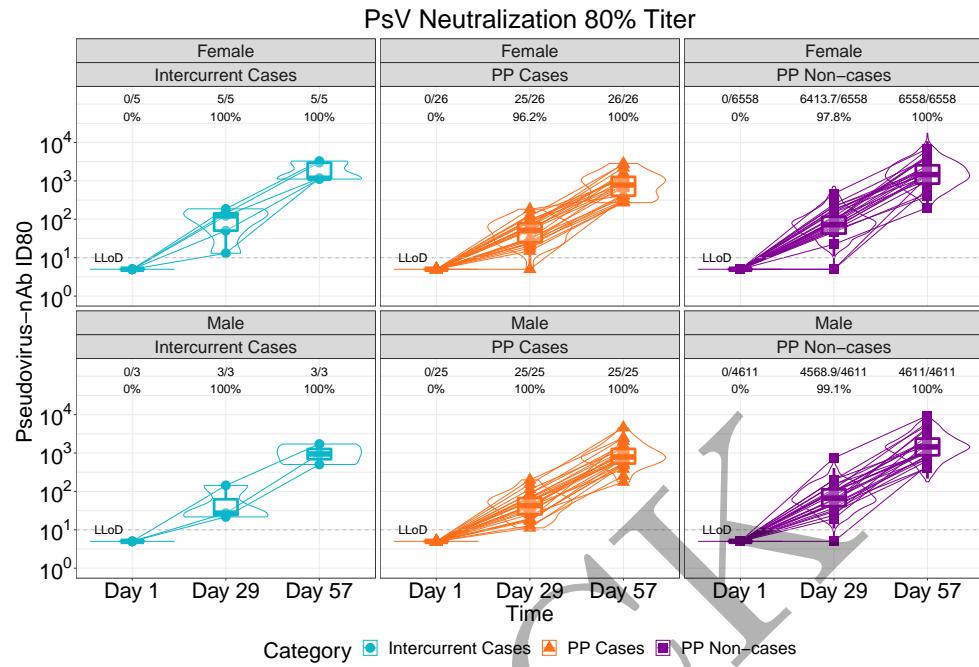


Figure 2.174: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by sex assigned at birth (version 2)

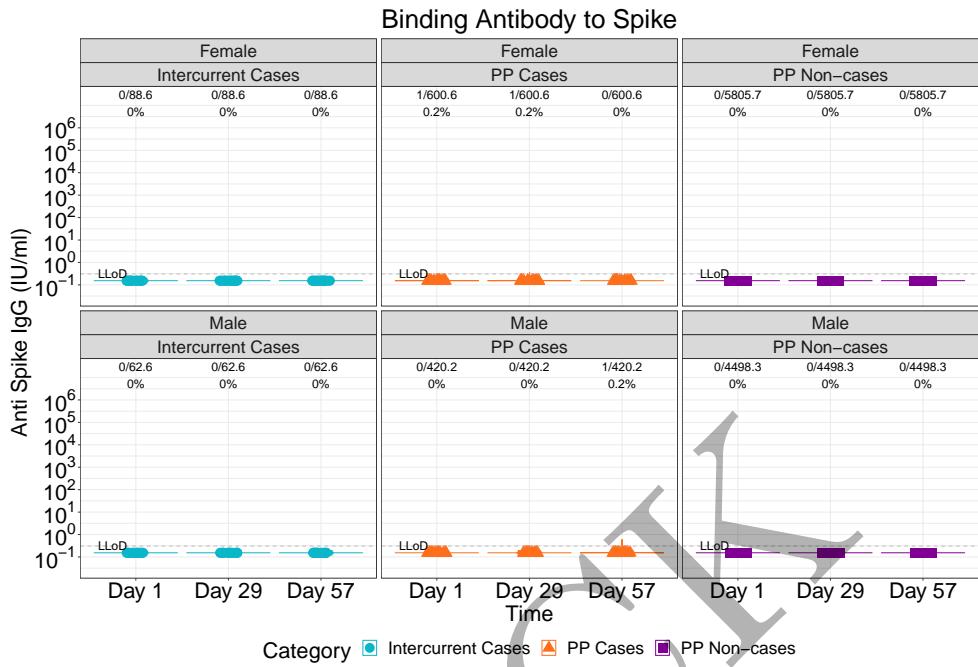


Figure 2.175: violinplots of Binding Antibody to Spike: baseline negative placebo arm by sex assigned at birth (version 2)

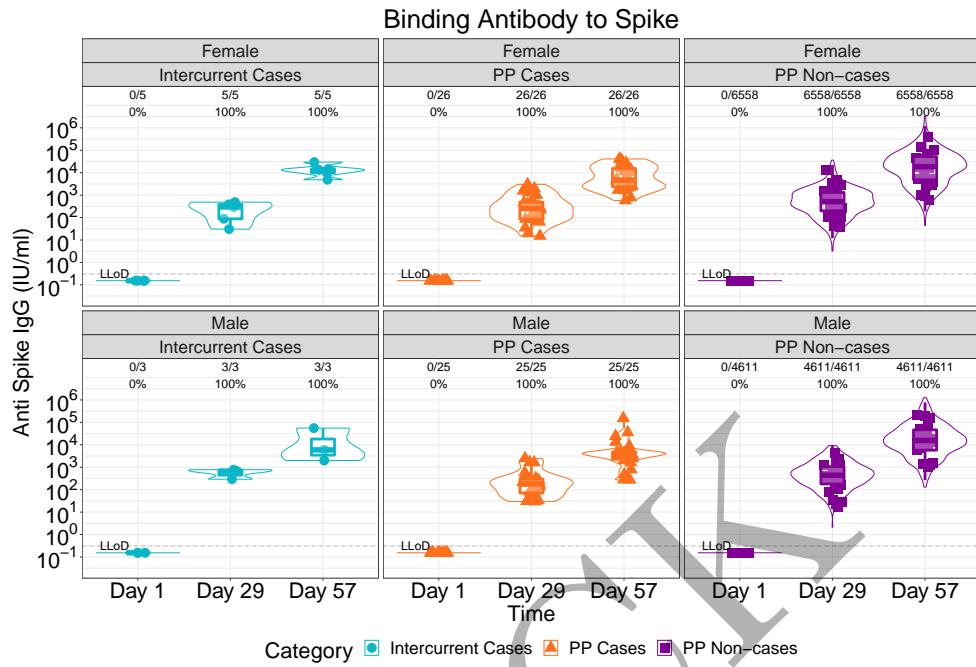


Figure 2.176: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by sex assigned at birth (version 2)

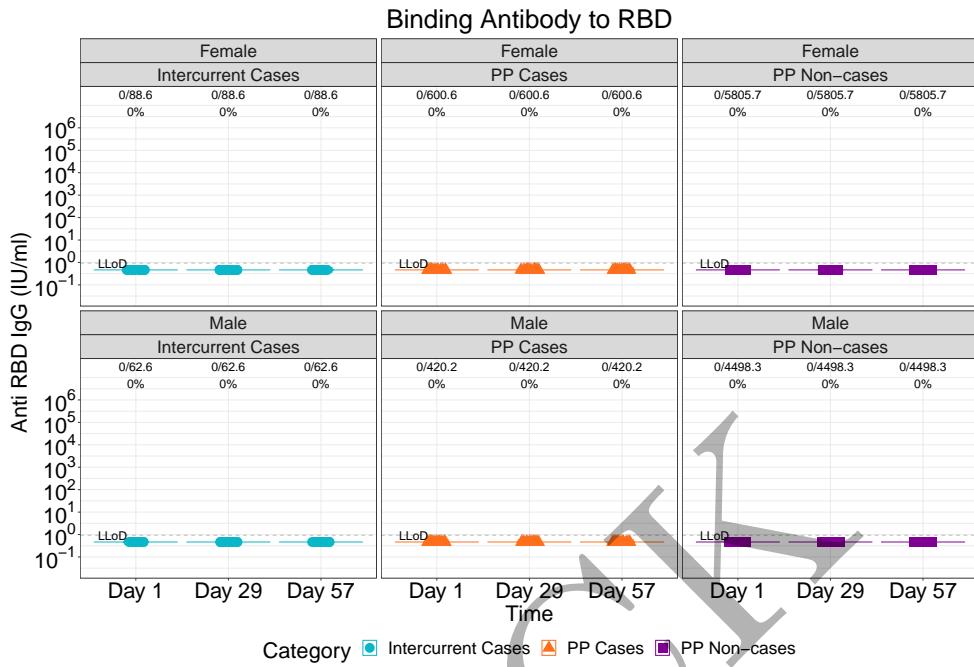


Figure 2.177: violinplots of Binding Antibody to RBD: baseline negative placebo arm by sex assigned at birth (version 2)

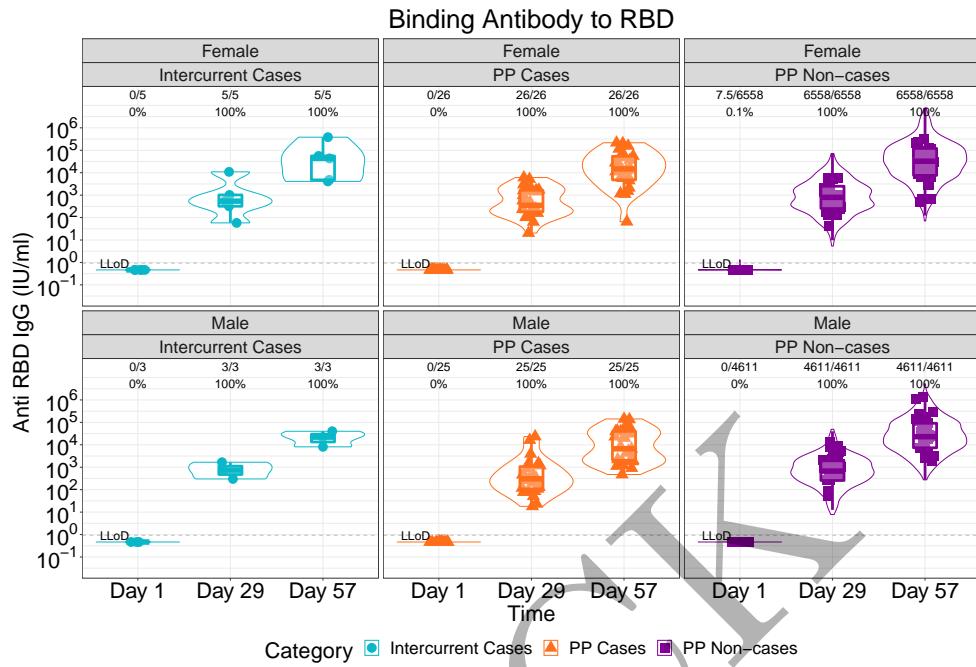


Figure 2.178: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by sex assigned at birth (version 2)

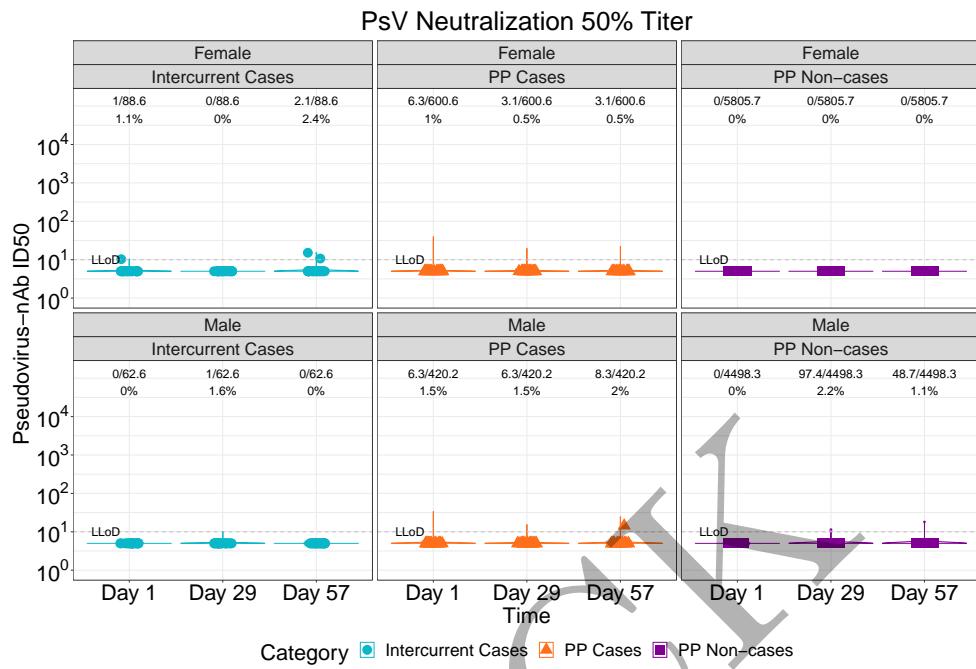


Figure 2.179: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by sex assigned at birth (version 2)

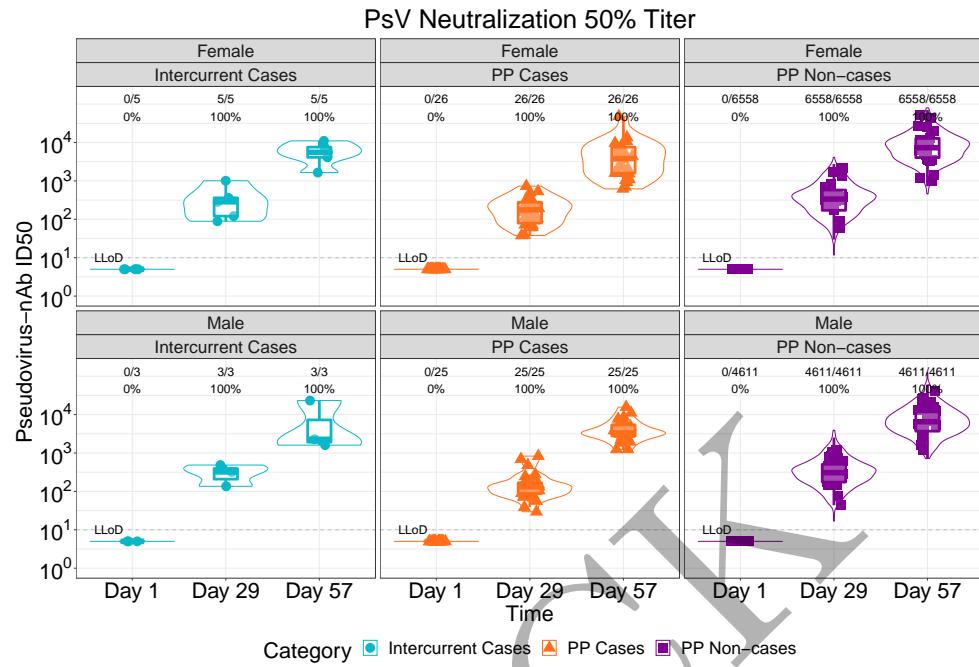


Figure 2.180: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by sex assigned at birth (version 2)

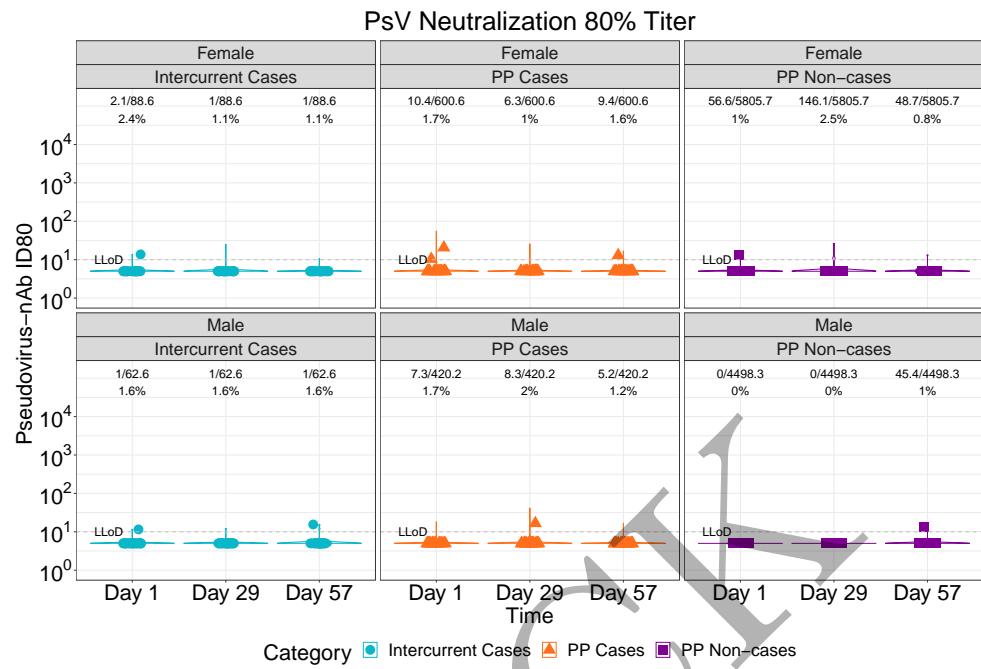


Figure 2.181: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by sex assigned at birth (version 2)

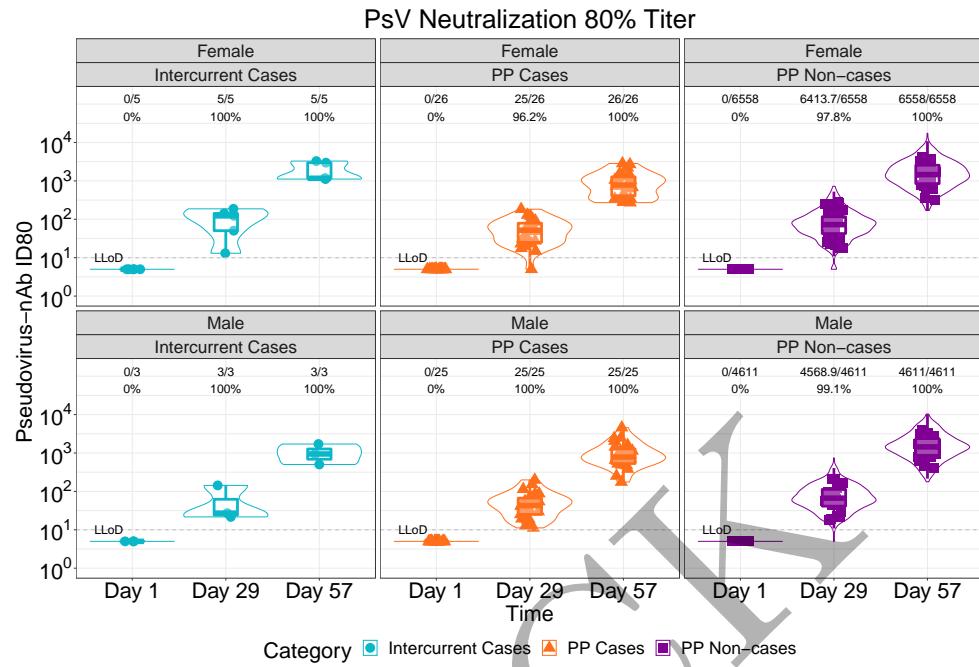


Figure 2.182: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by sex assigned at birth (version 2)

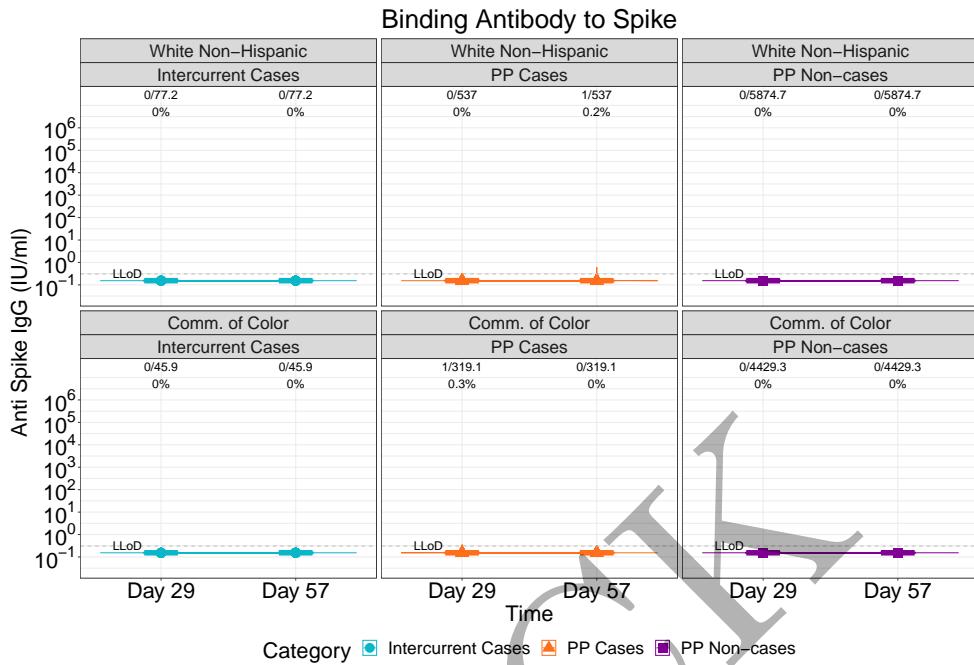


Figure 2.183: lineplots of Binding Antibody to Spike: baseline negative placebo arm by race and ethnic group (version 1)

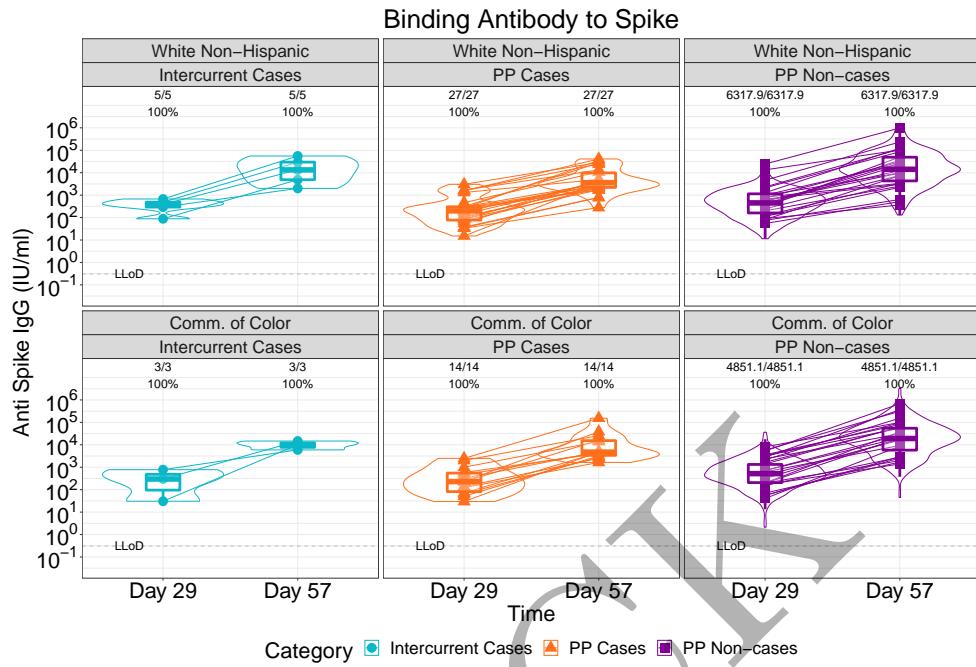


Figure 2.184: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by race and ethnic group (version 1)

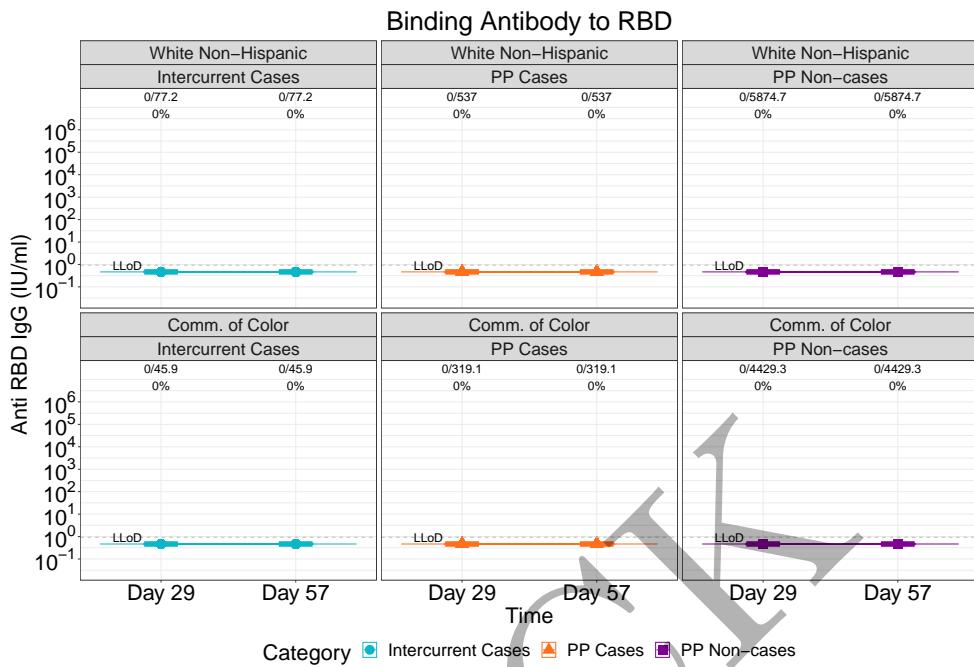


Figure 2.185: lineplots of Binding Antibody to RBD: baseline negative placebo arm by race and ethnic group (version 1)

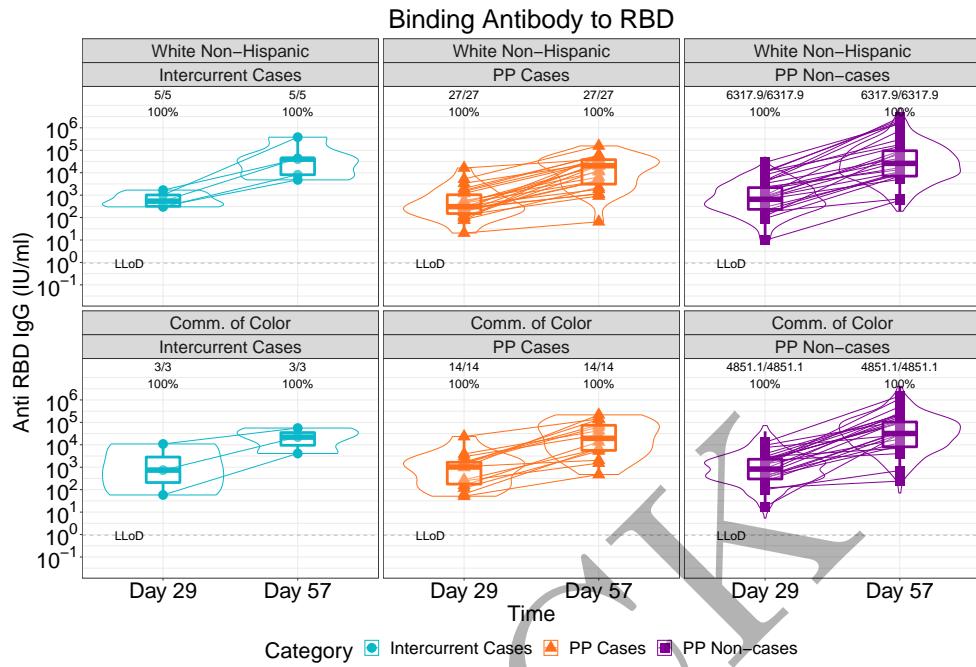


Figure 2.186: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by race and ethnic group (version 1)

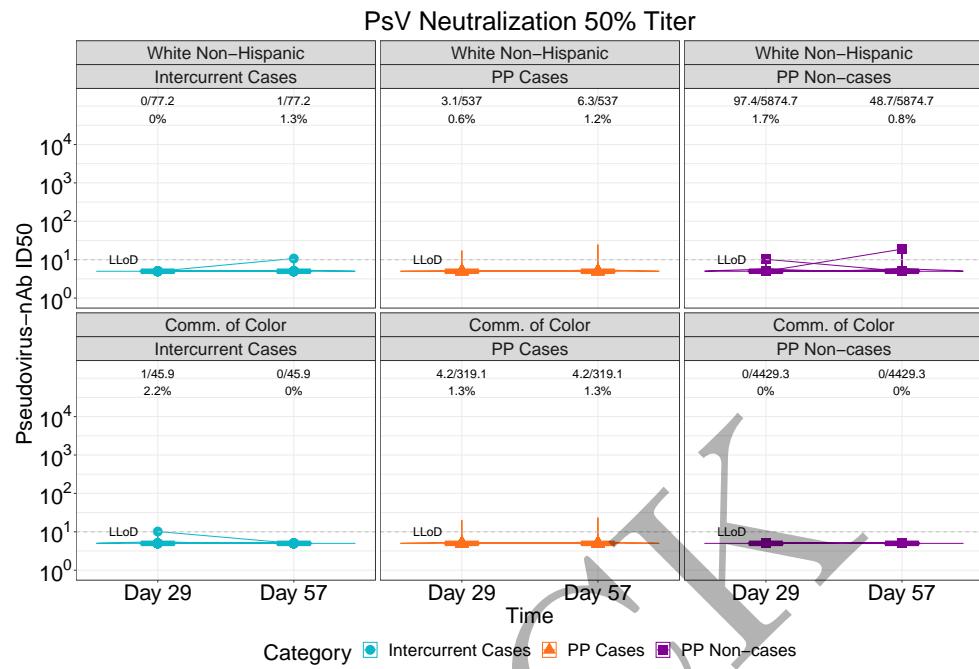


Figure 2.187: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by race and ethnic group (version 1)

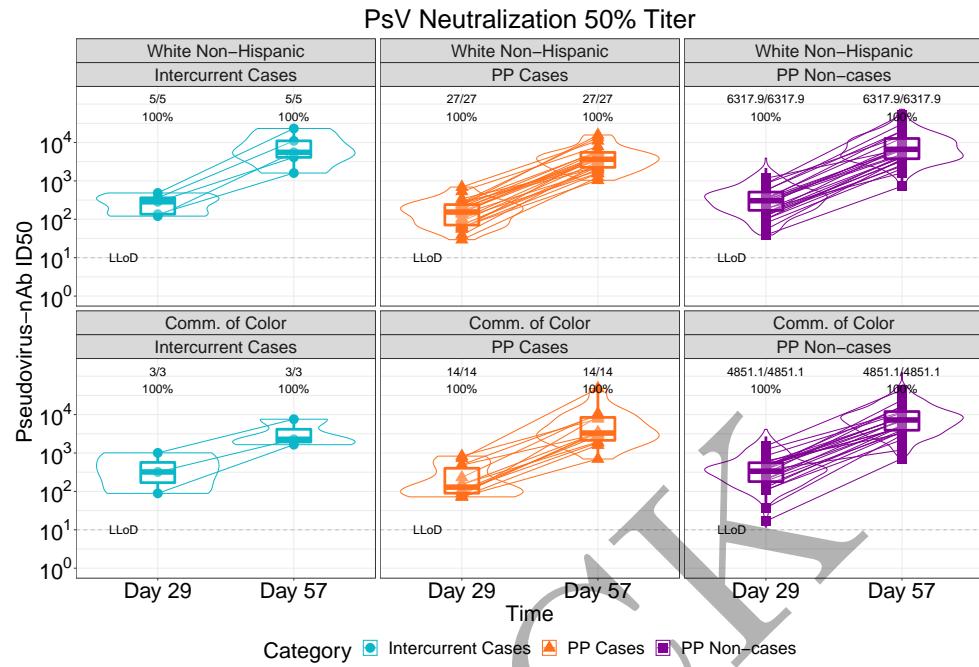


Figure 2.188: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by race and ethnic group (version 1)

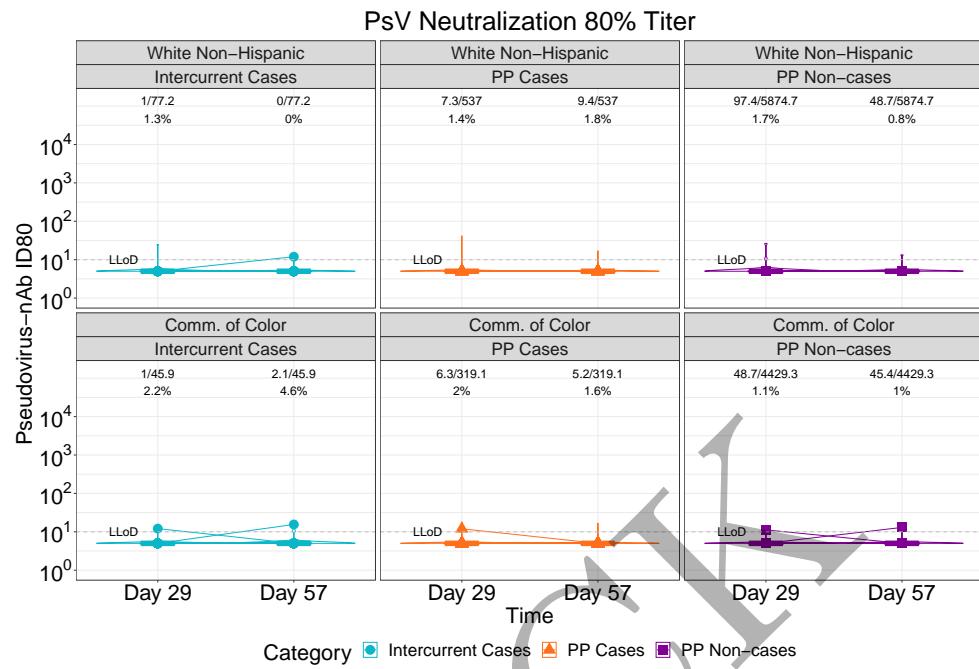


Figure 2.189: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by race and ethnic group (version 1)

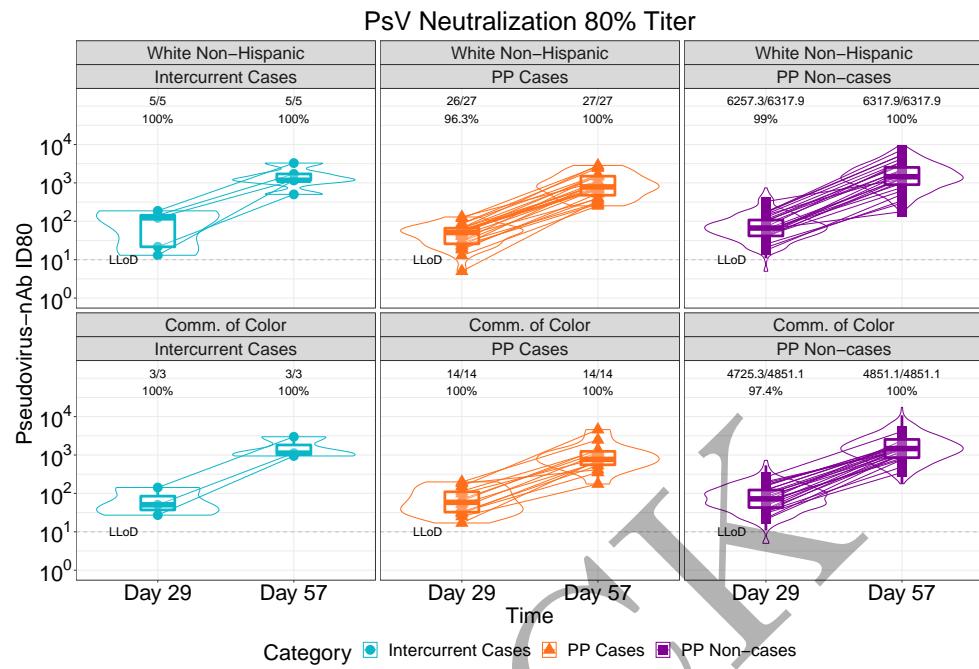


Figure 2.190: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by race and ethnic group (version 1)

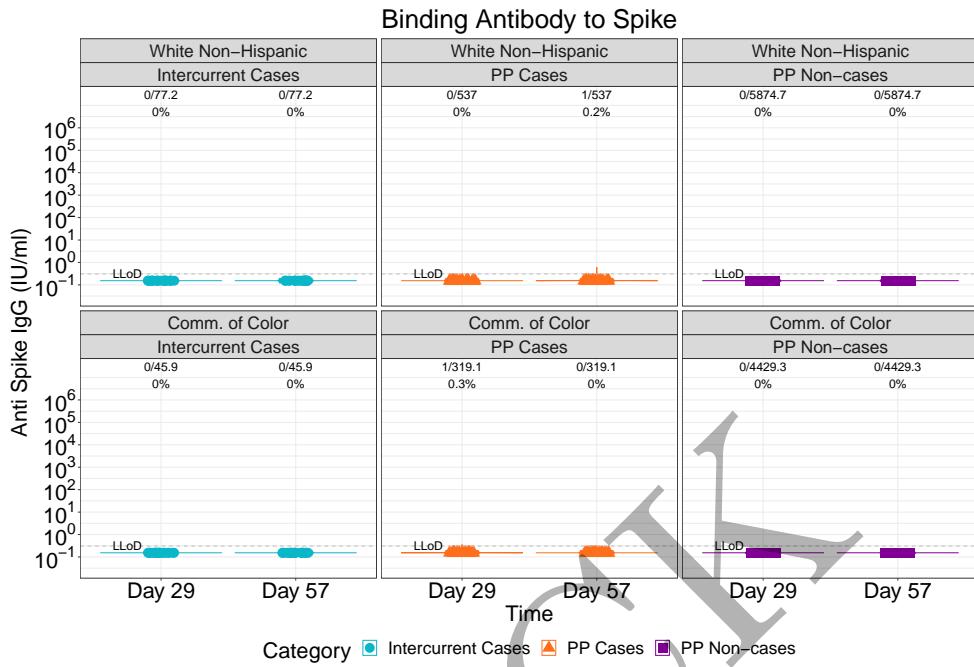


Figure 2.191: violinplots of Binding Antibody to Spike: baseline negative placebo arm by race and ethnic group (version 1)

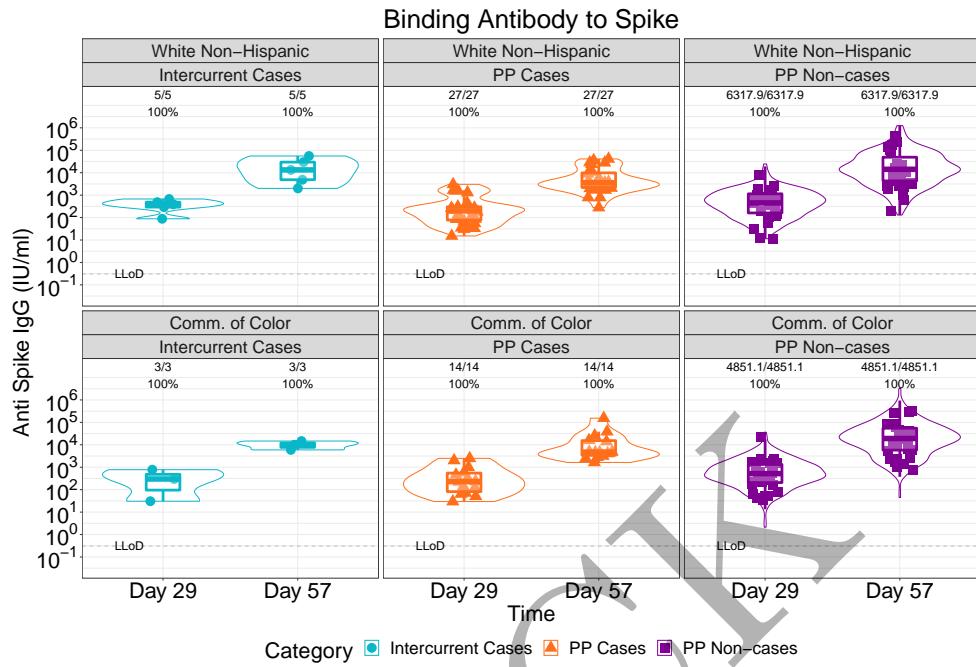


Figure 2.192: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by race and ethnic group (version 1)

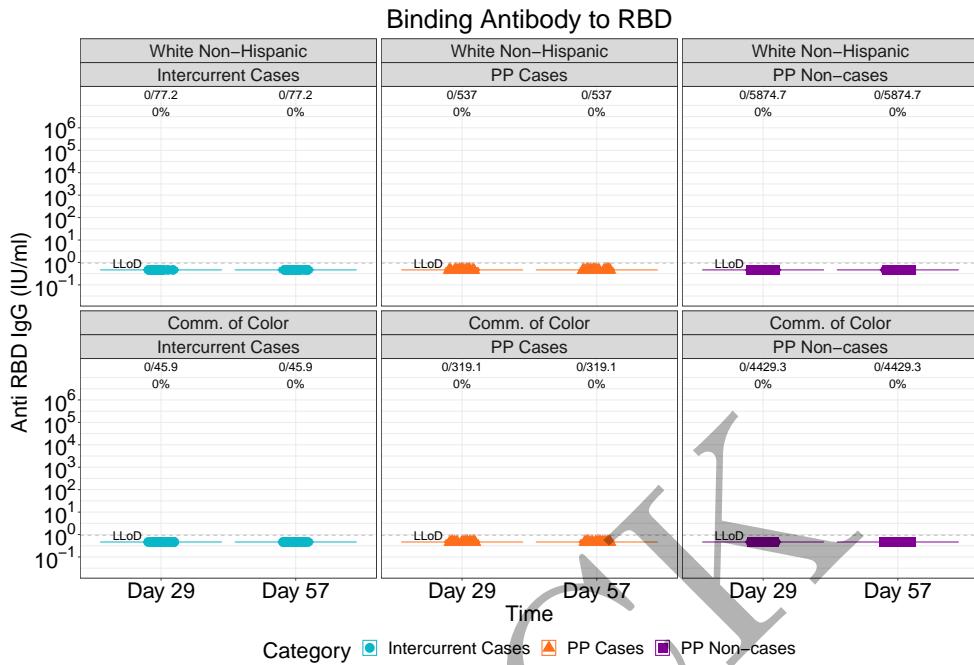


Figure 2.193: violinplots of Binding Antibody to RBD: baseline negative placebo arm by race and ethnic group (version 1)

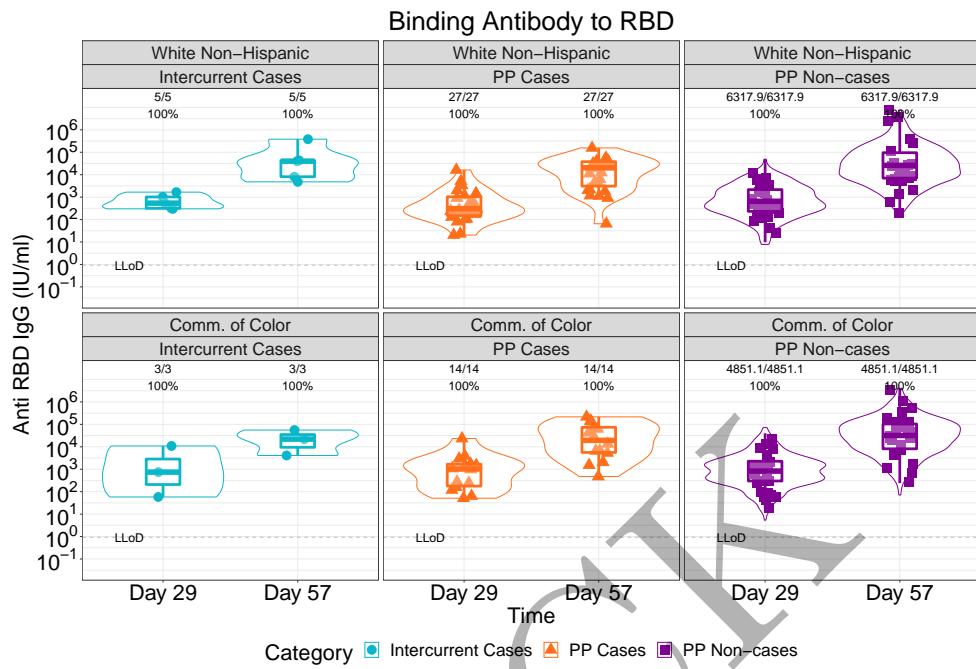


Figure 2.194: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by race and ethnic group (version 1)

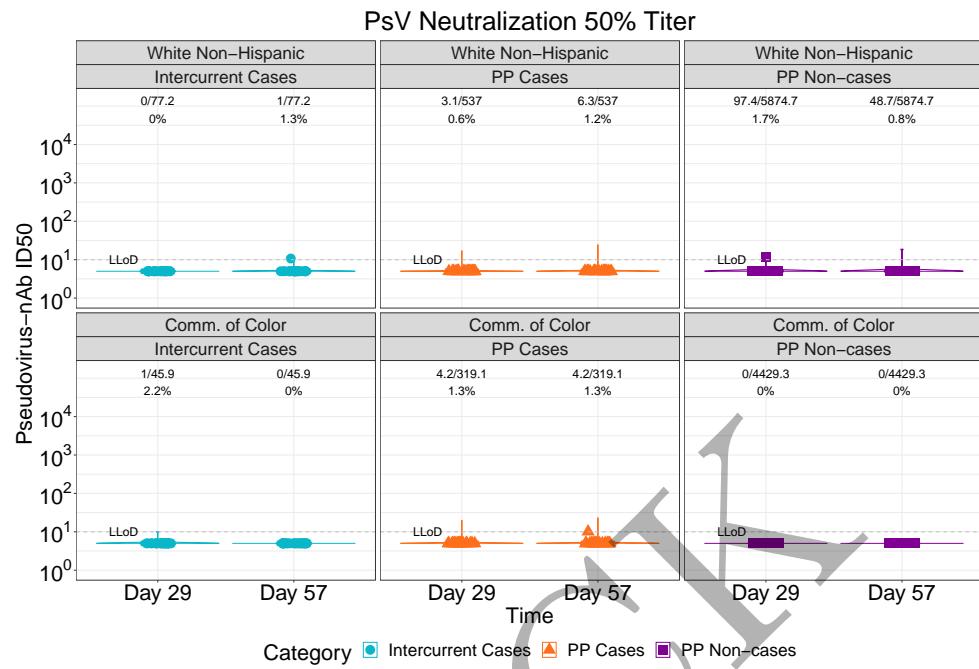


Figure 2.195: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by race and ethnic group (version 1)

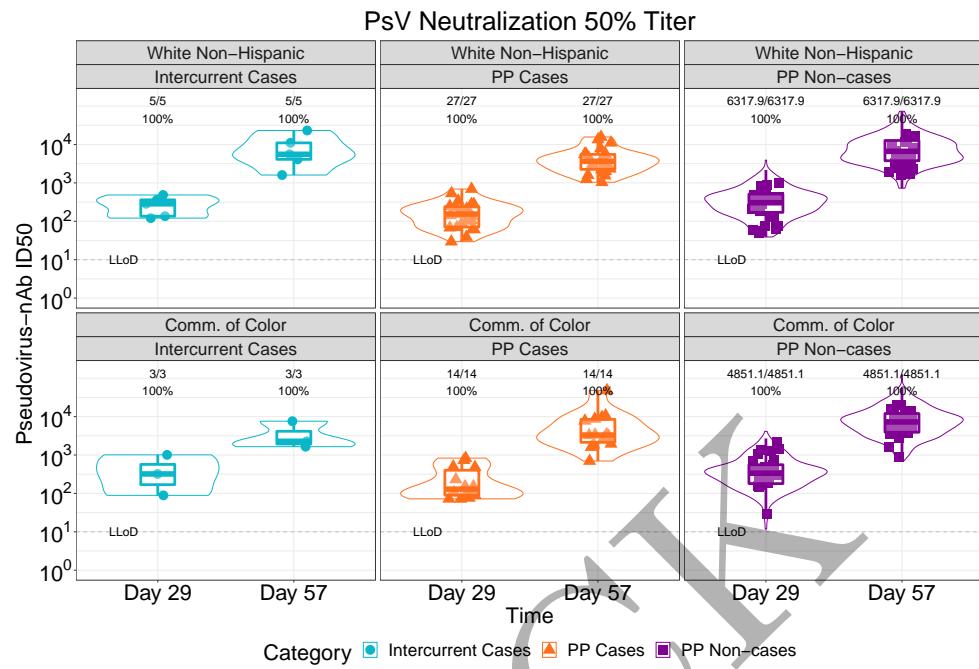


Figure 2.196: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by race and ethnic group (version 1)

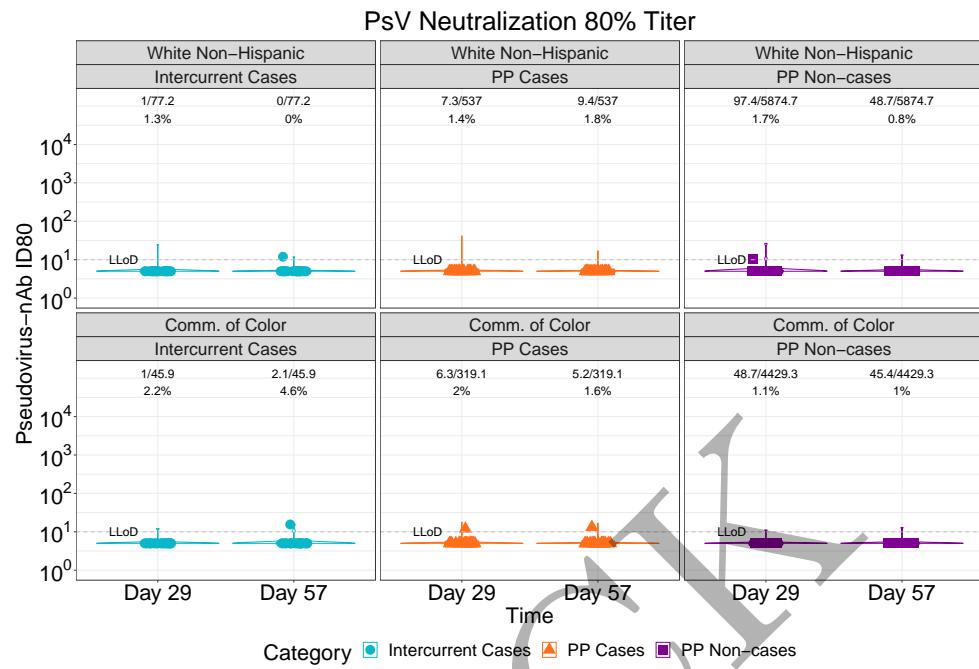


Figure 2.197: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by race and ethnic group (version 1)

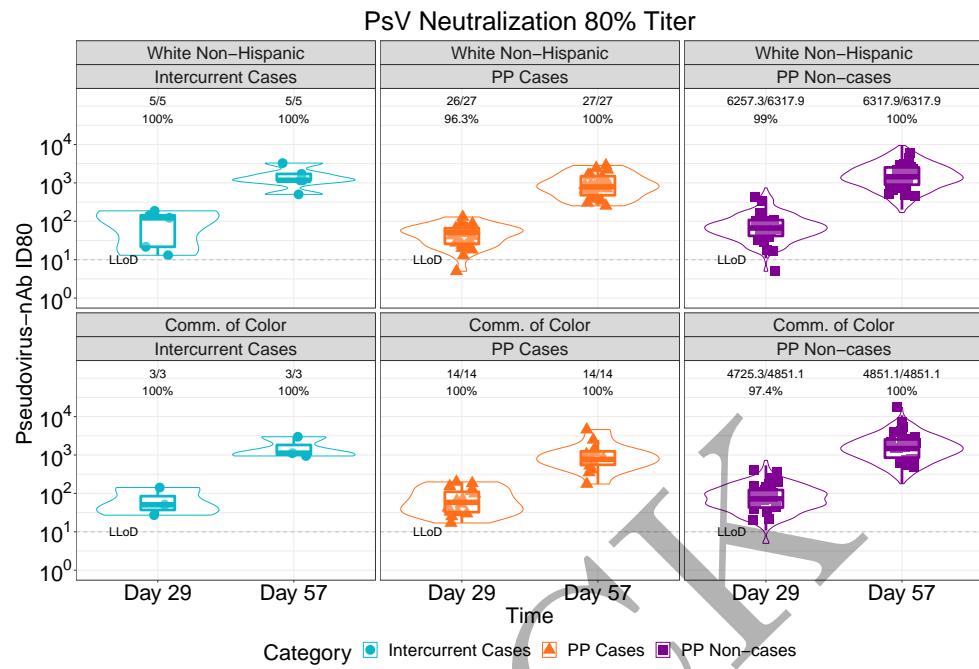


Figure 2.198: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by race and ethnic group (version 1)

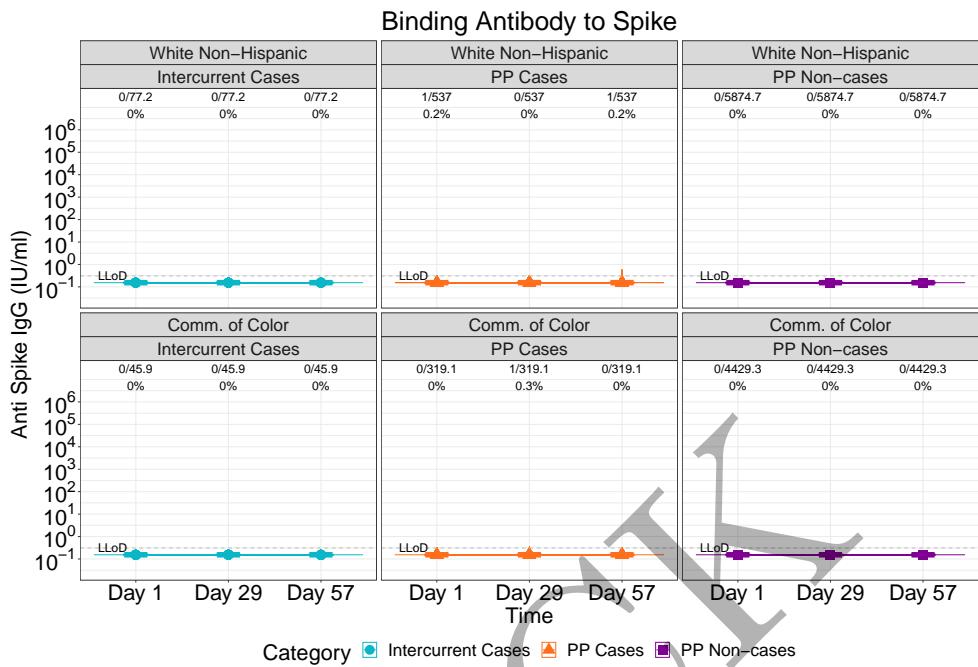


Figure 2.199: lineplots of Binding Antibody to Spike: baseline negative placebo arm by race and ethnic group (version 2)

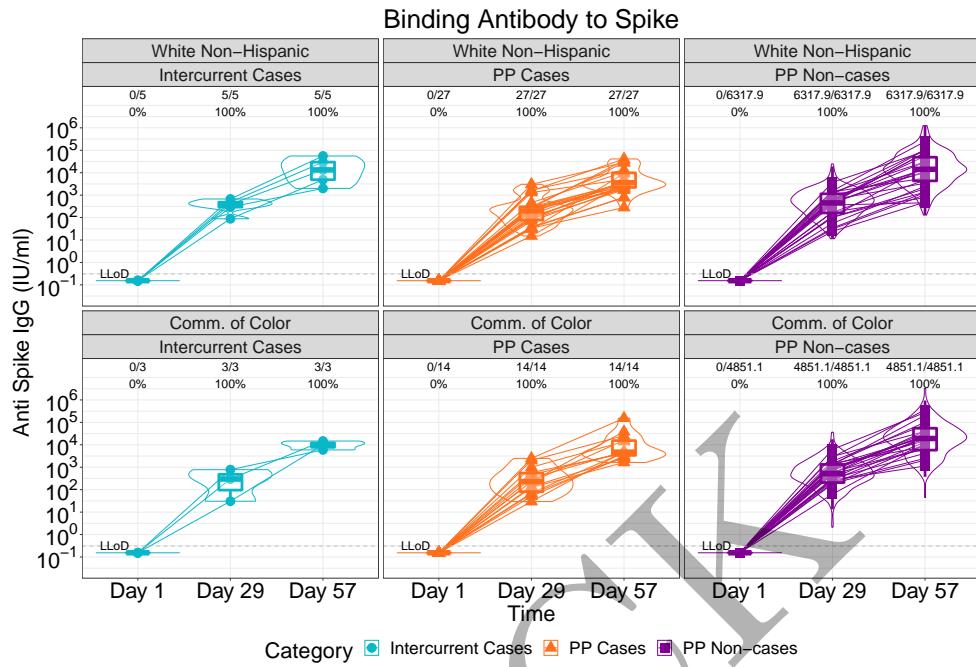


Figure 2.200: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by race and ethnic group (version 2)

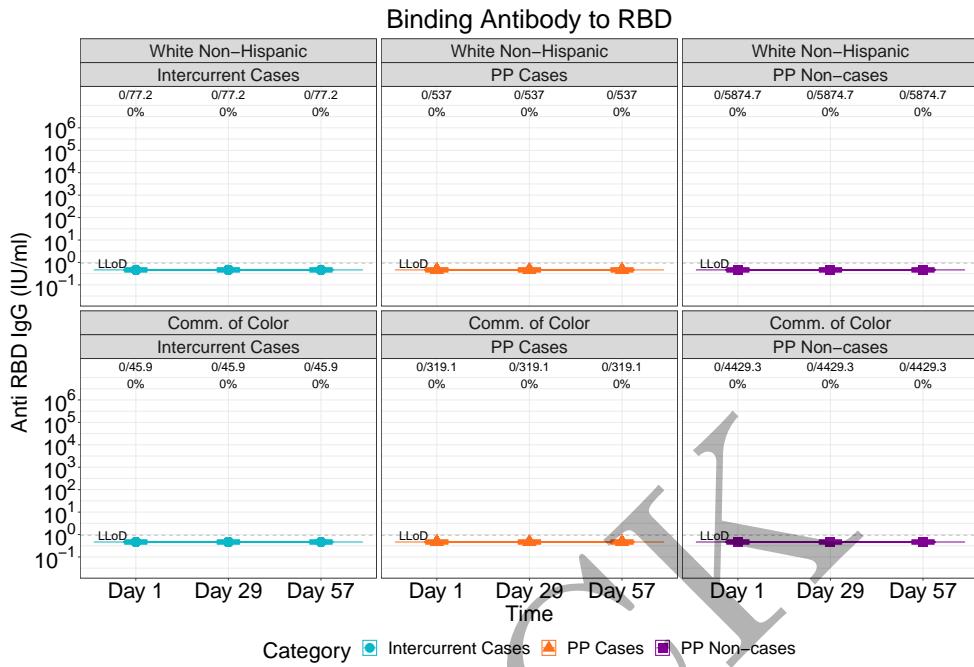


Figure 2.201: lineplots of Binding Antibody to RBD: baseline negative placebo arm by race and ethnic group (version 2)

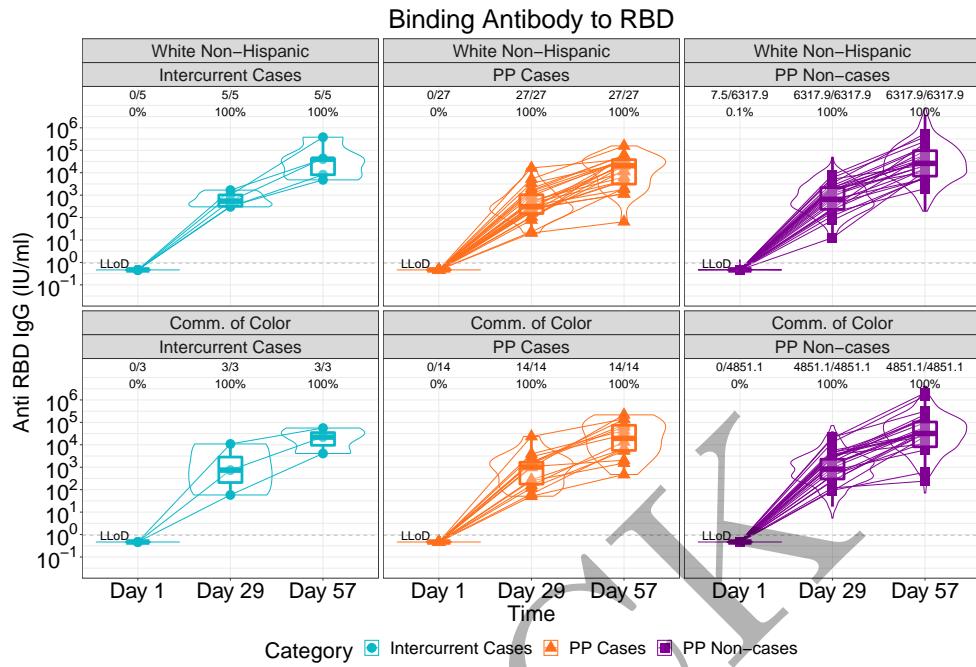


Figure 2.202: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by race and ethnic group (version 2)

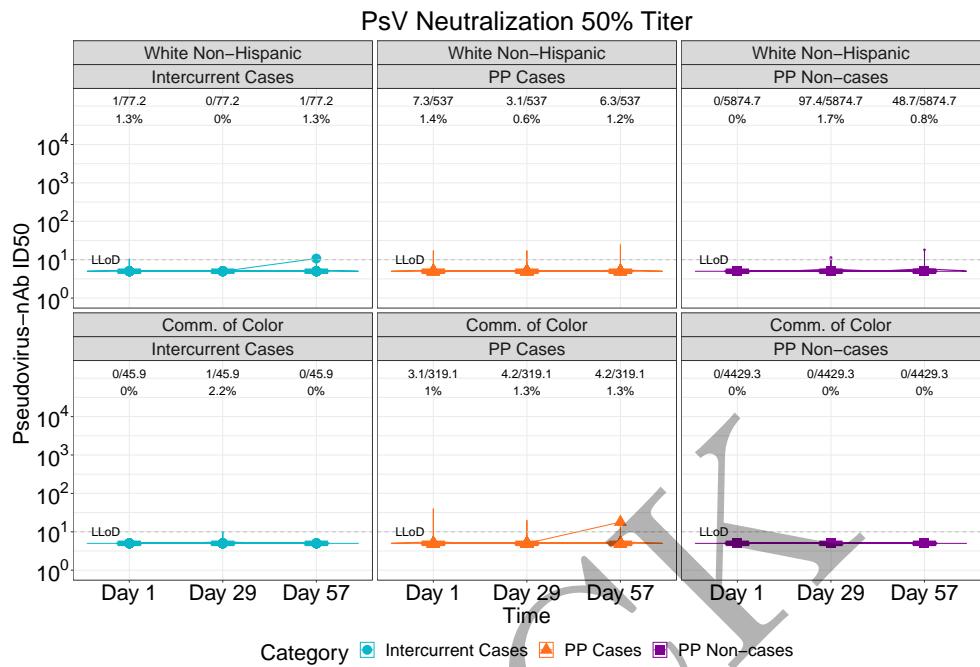


Figure 2.203: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by race and ethnic group (version 2)

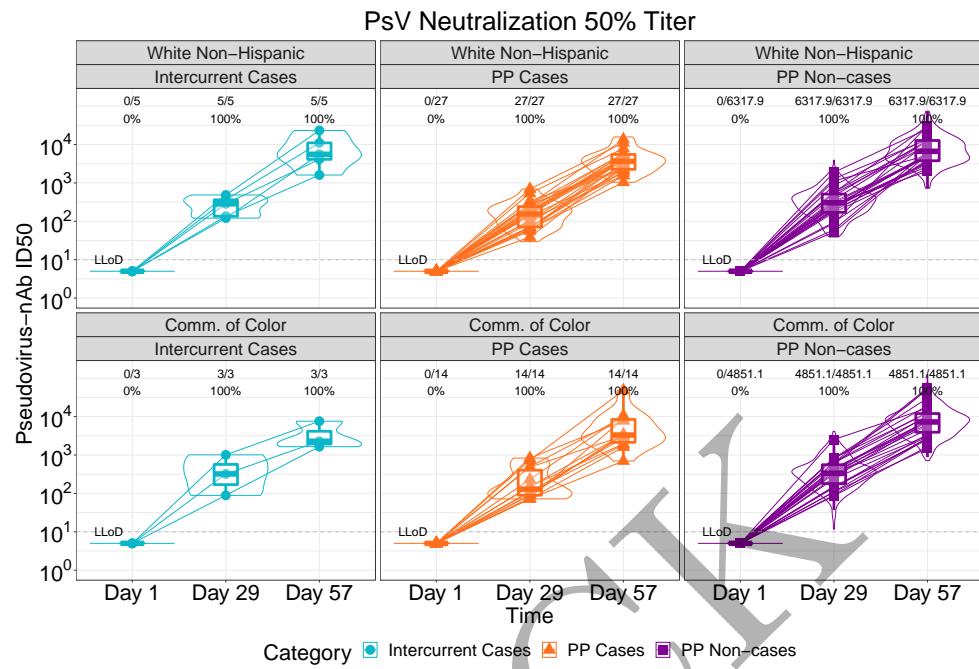


Figure 2.204: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by race and ethnic group (version 2)

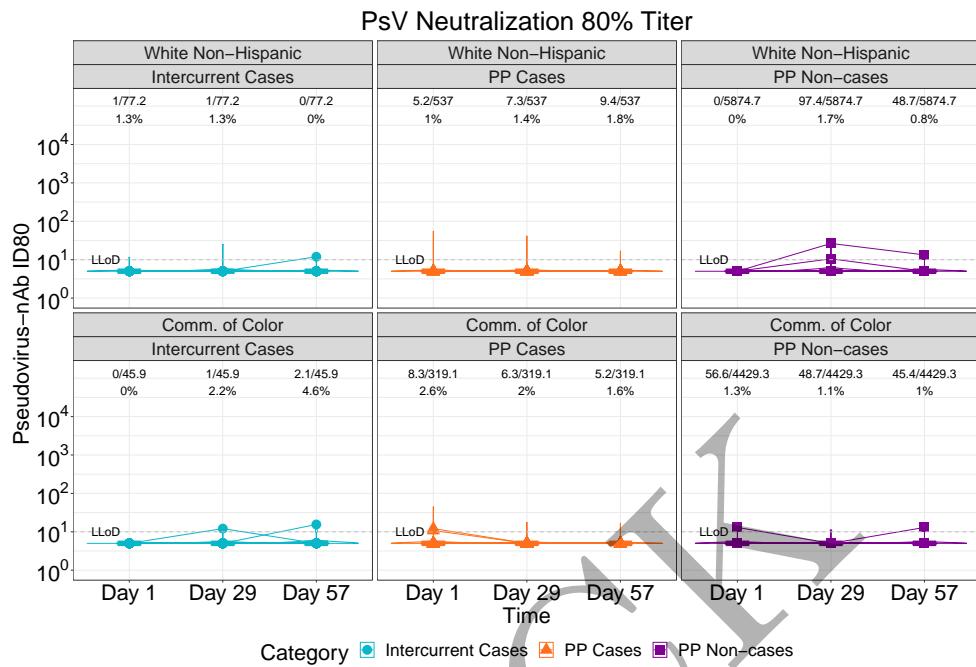


Figure 2.205: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by race and ethnic group (version 2)

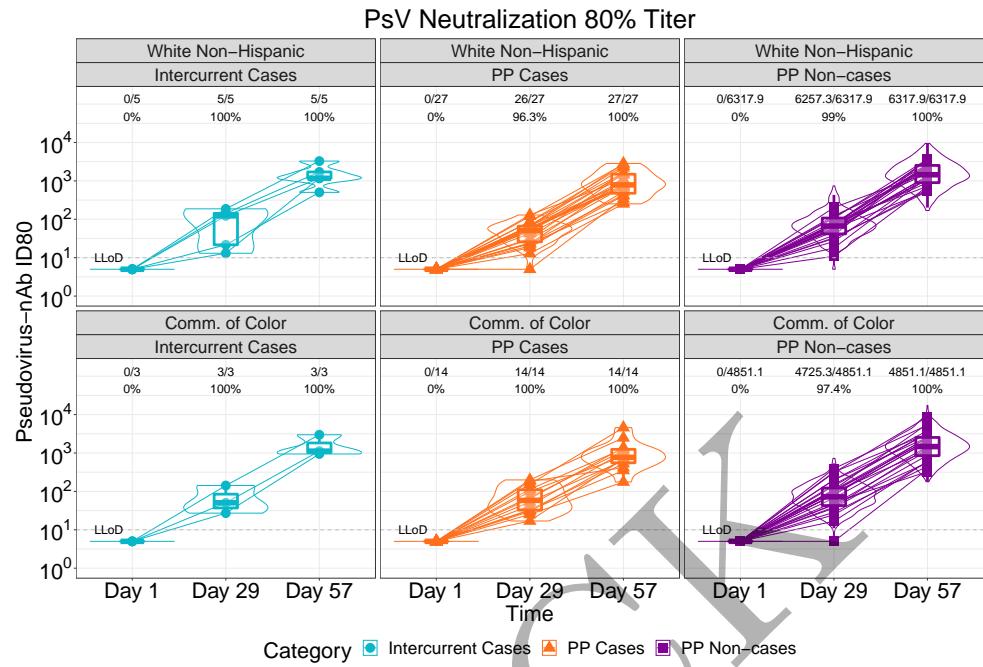


Figure 2.206: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by race and ethnic group (version 2)

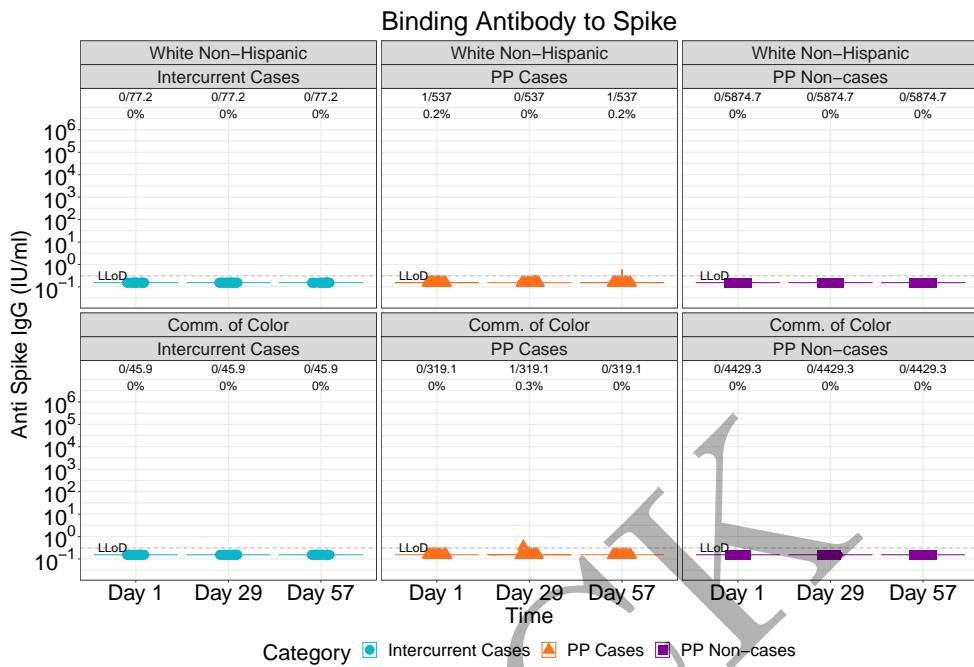


Figure 2.207: violinplots of Binding Antibody to Spike: baseline negative placebo arm by race and ethnic group (version 2)

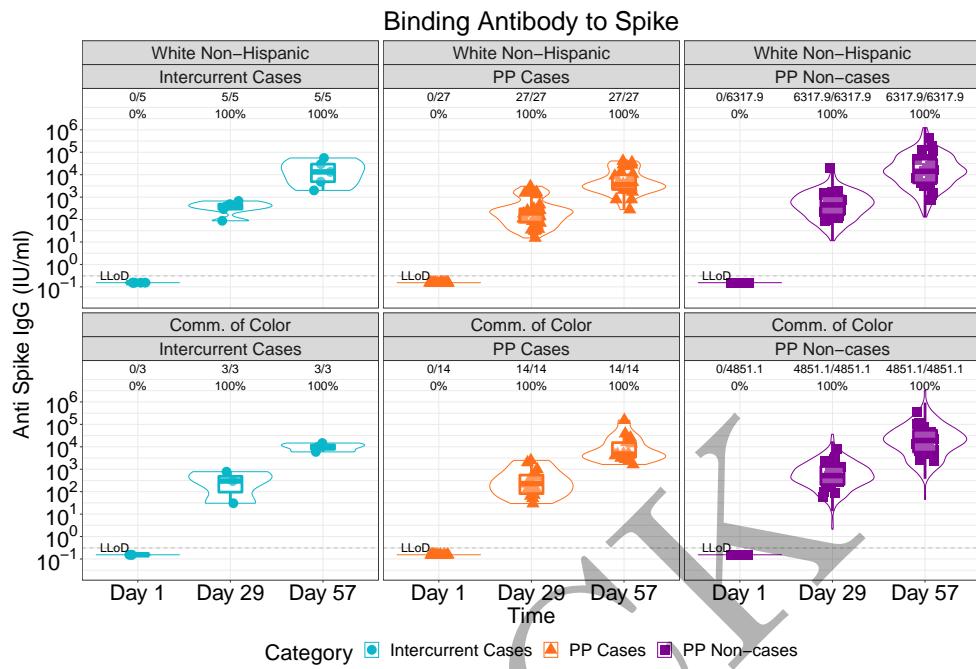


Figure 2.208: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by race and ethnic group (version 2)

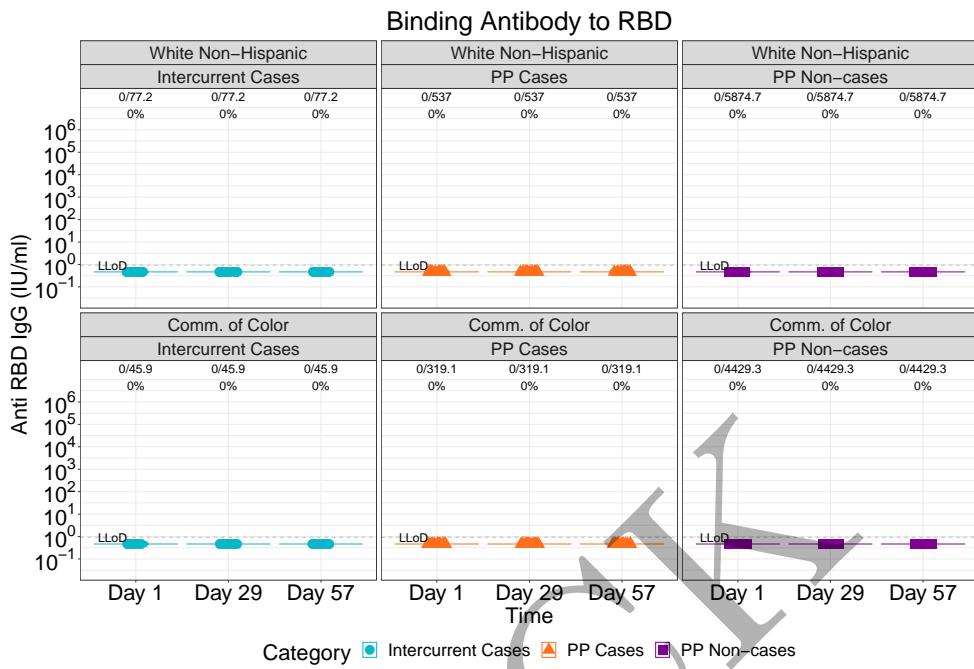


Figure 2.209: violinplots of Binding Antibody to RBD: baseline negative placebo arm by race and ethnic group (version 2)

Binding Antibody to RBD

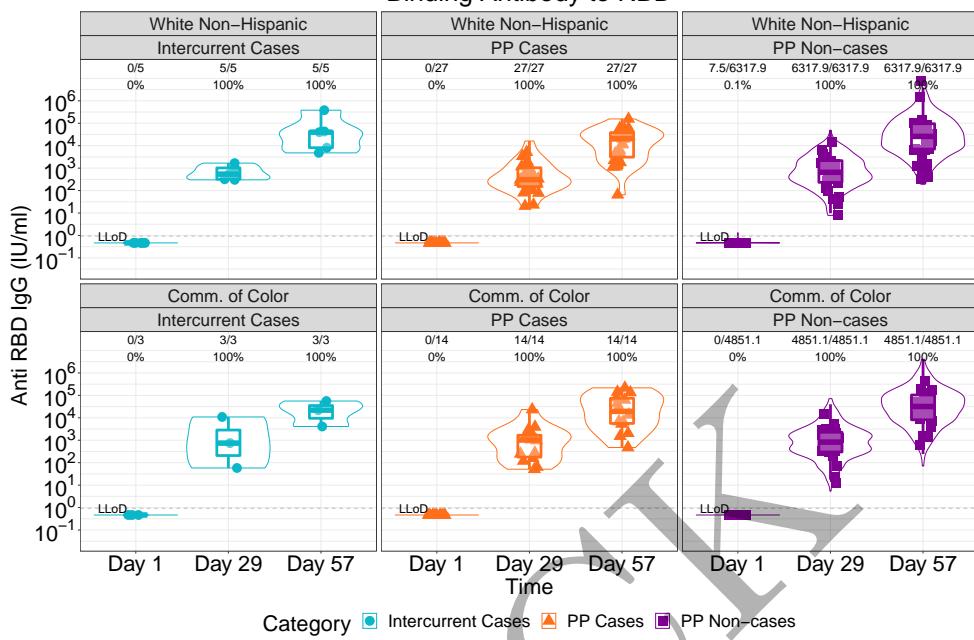


Figure 2.210: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by race and ethnic group (version 2)

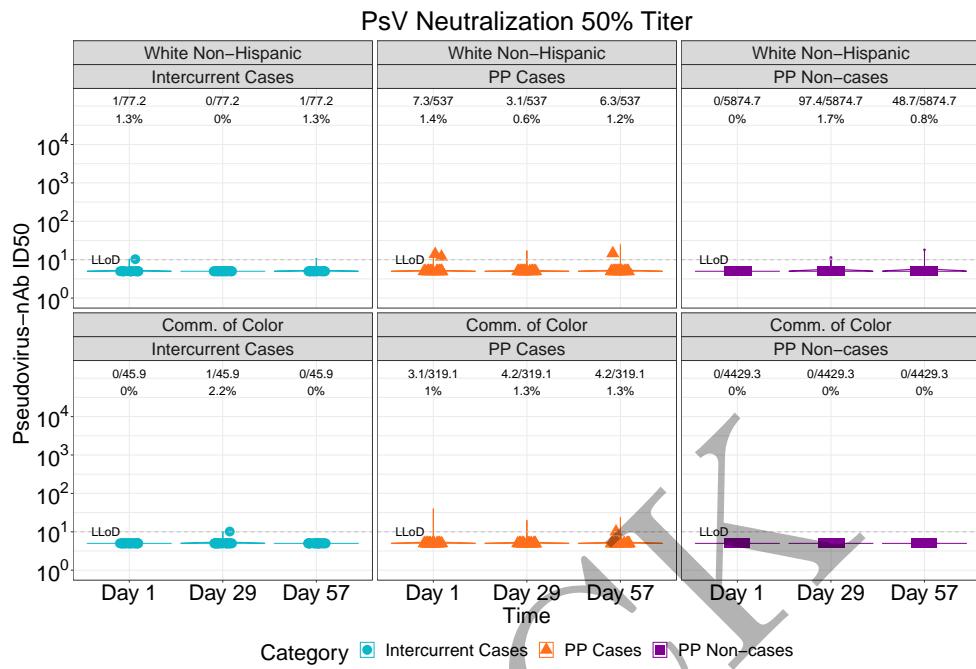


Figure 2.211: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by race and ethnic group (version 2)

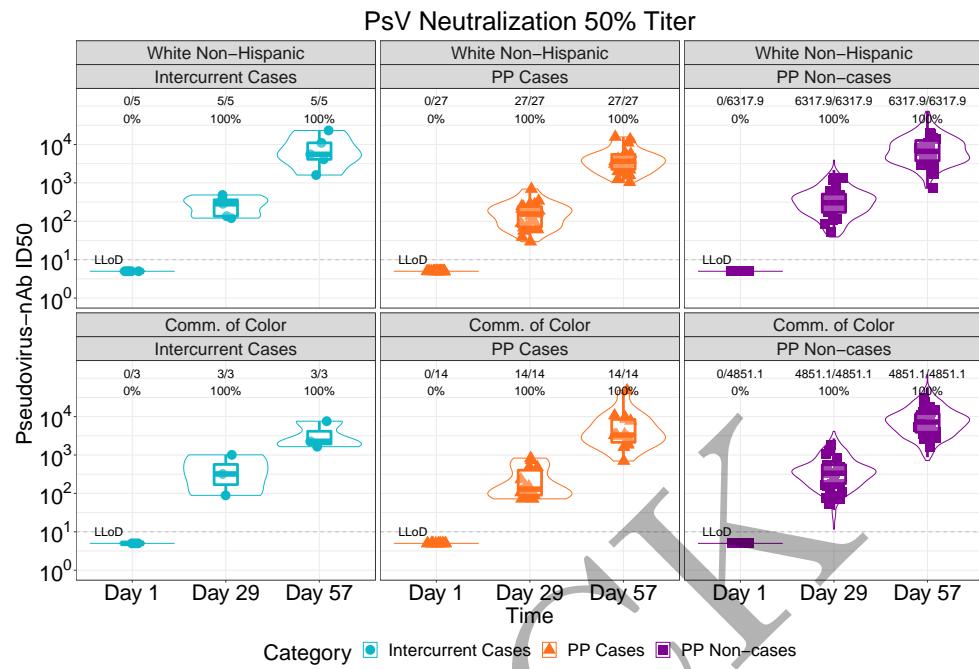


Figure 2.212: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by race and ethnic group (version 2)

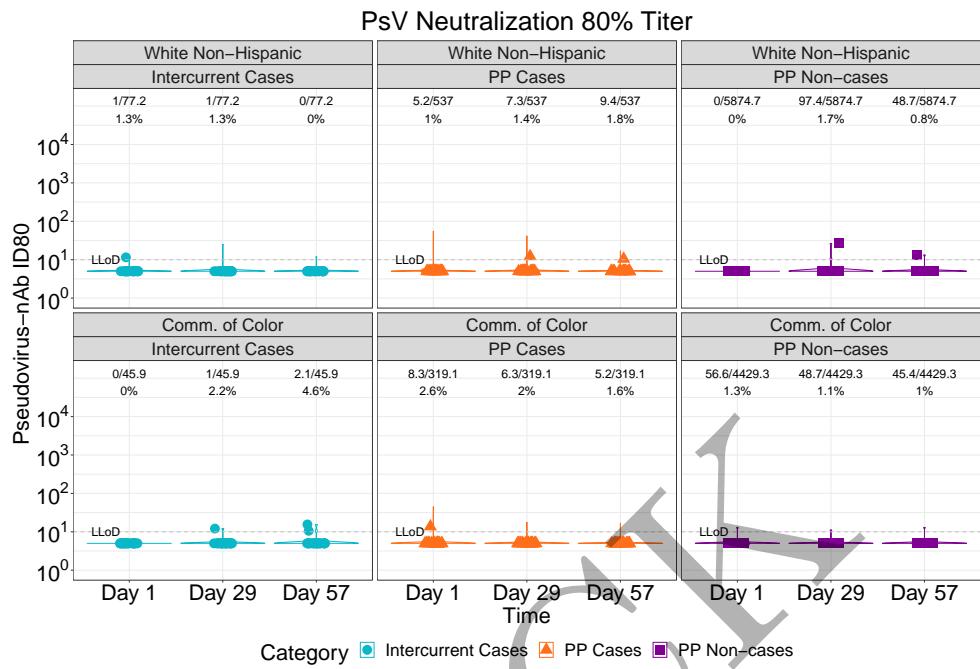


Figure 2.213: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by race and ethnic group (version 2)

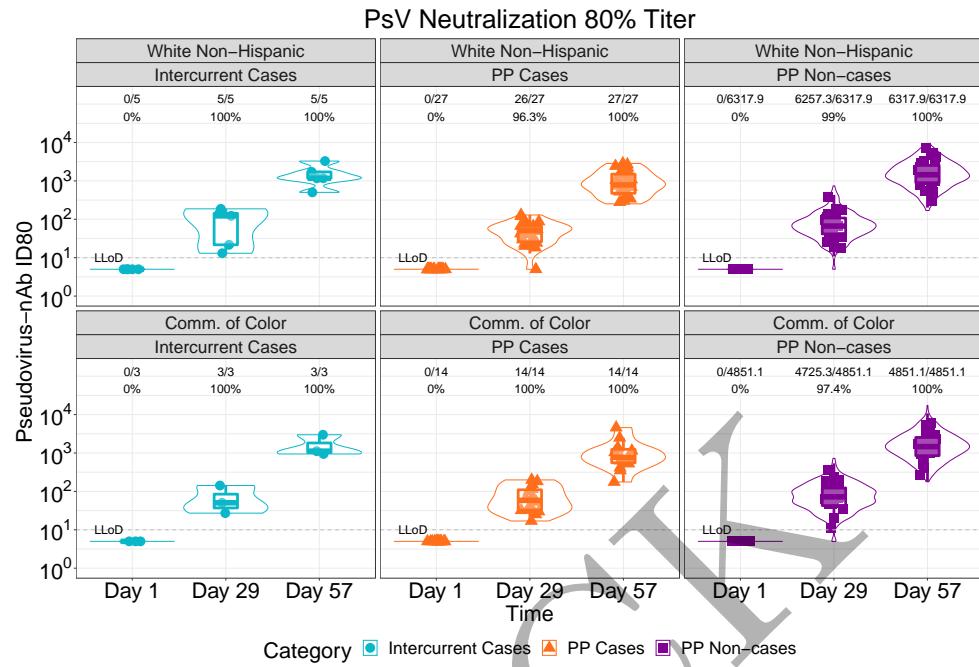


Figure 2.214: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by race and ethnic group (version 2)

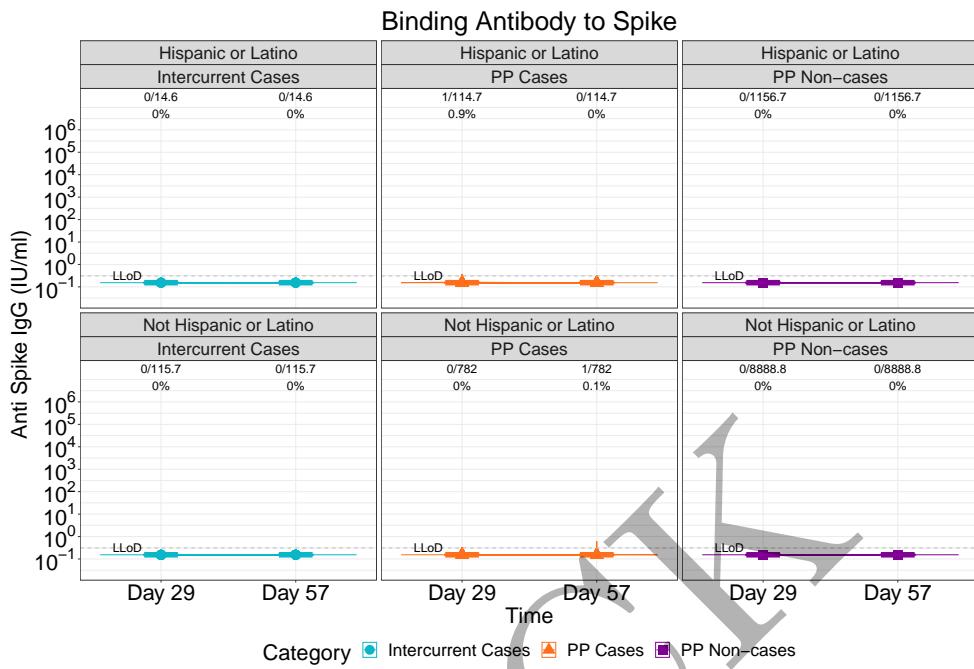


Figure 2.215: lineplots of Binding Antibody to Spike: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)

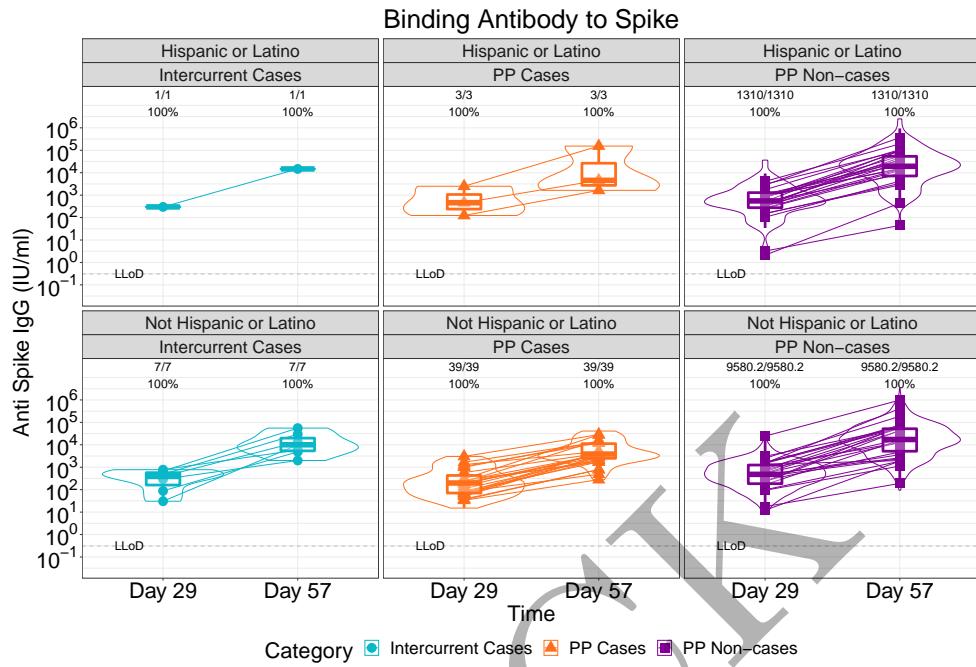


Figure 2.216: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)

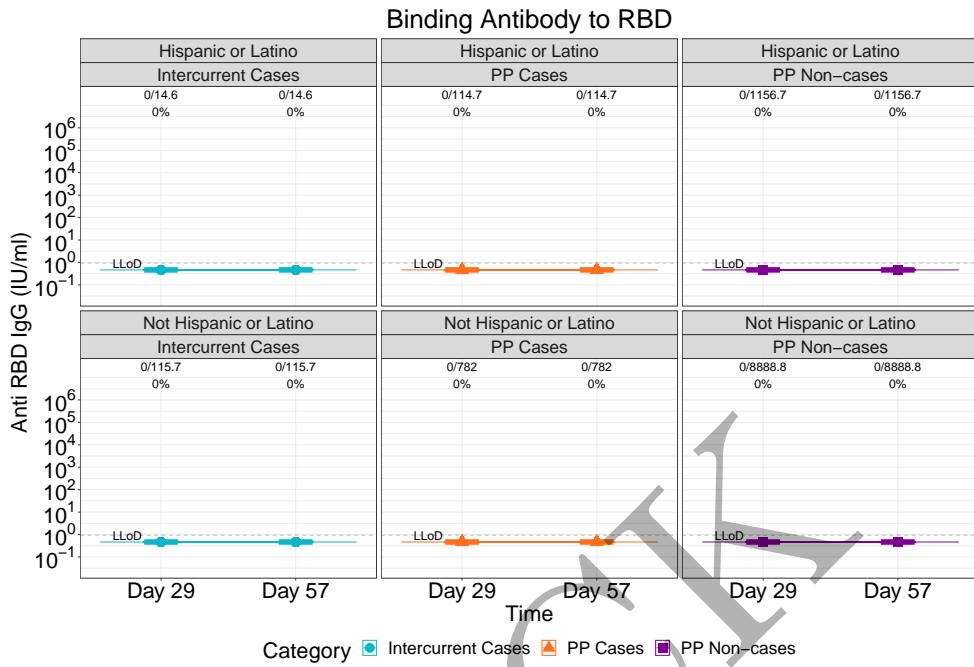


Figure 2.217: lineplots of Binding Antibody to RBD: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)

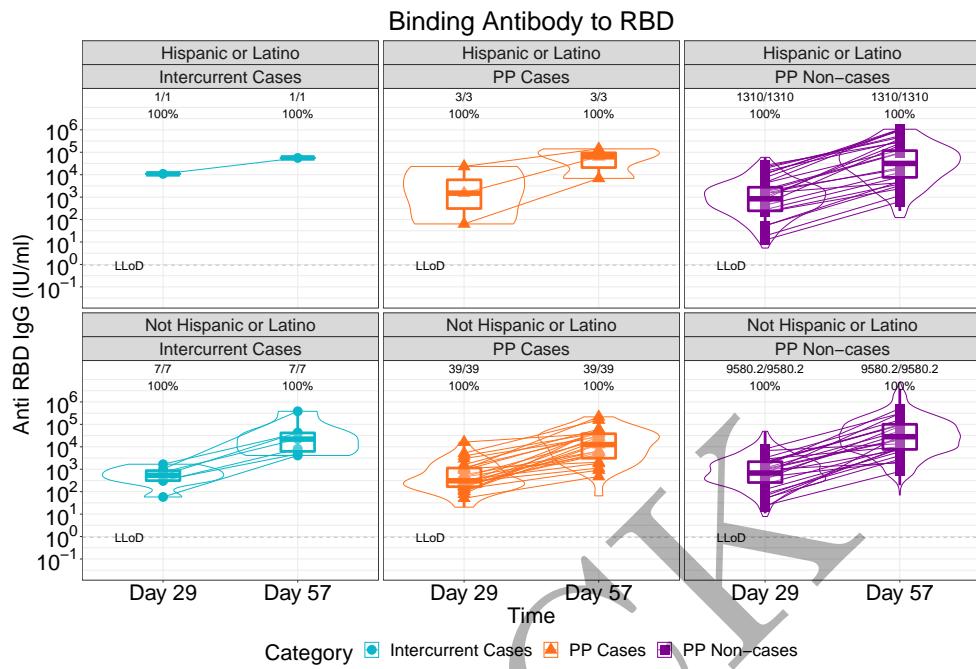


Figure 2.218: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)

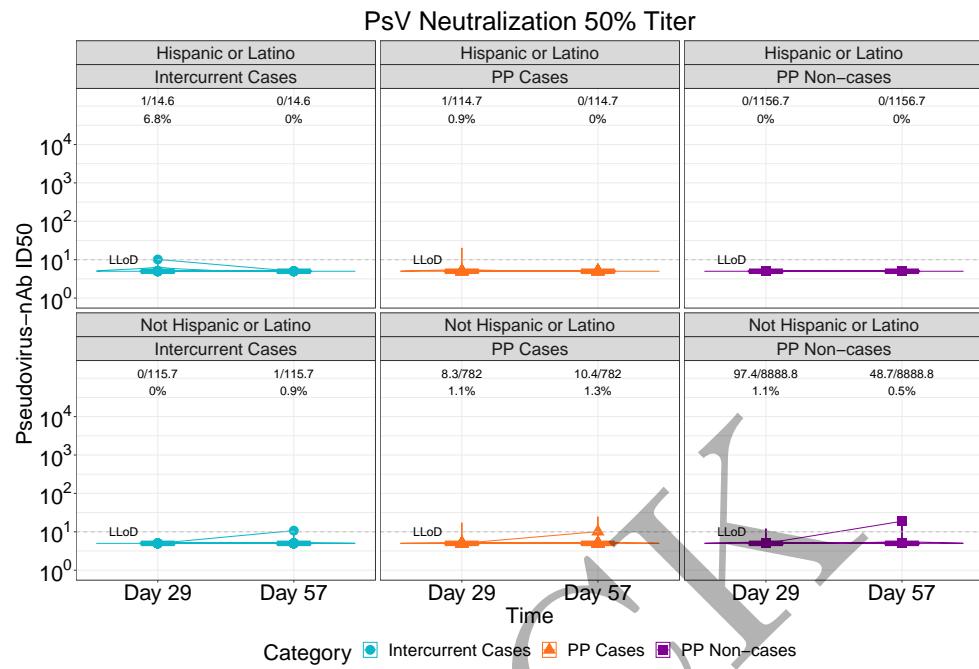


Figure 2.219: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)

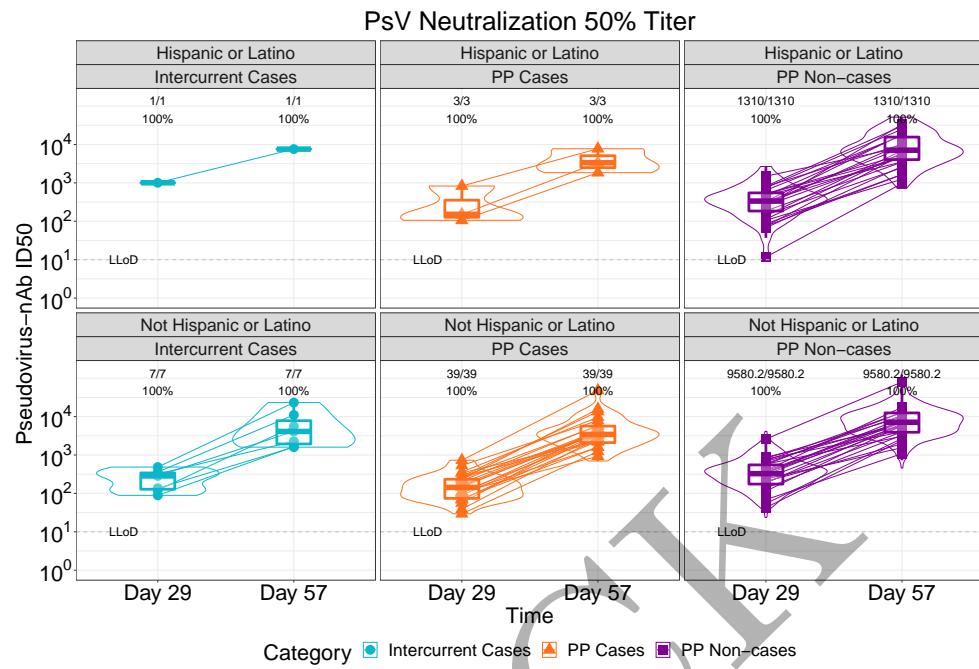


Figure 2.220: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)

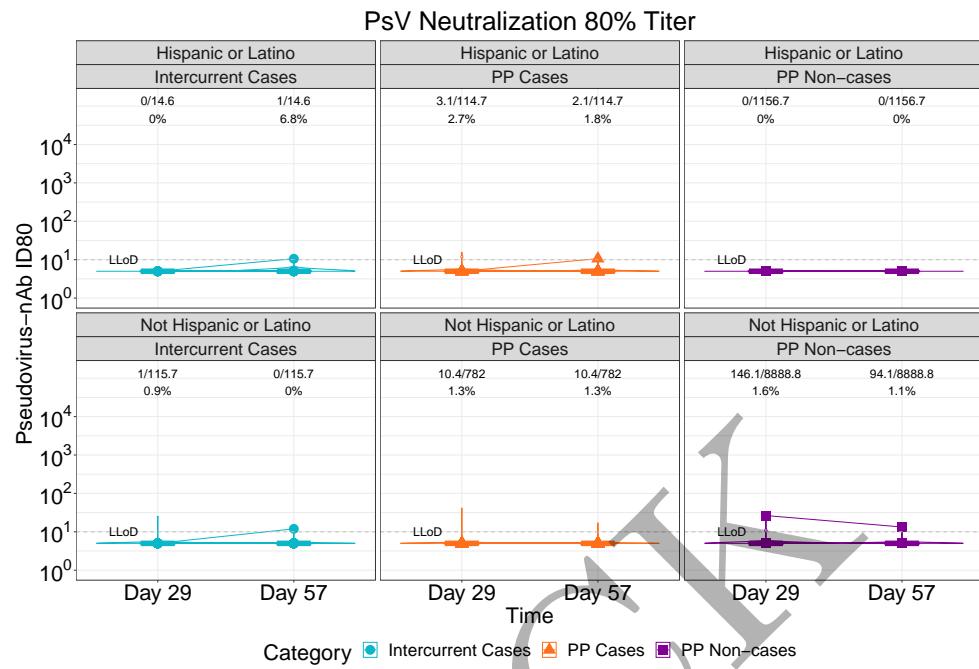


Figure 2.221: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)

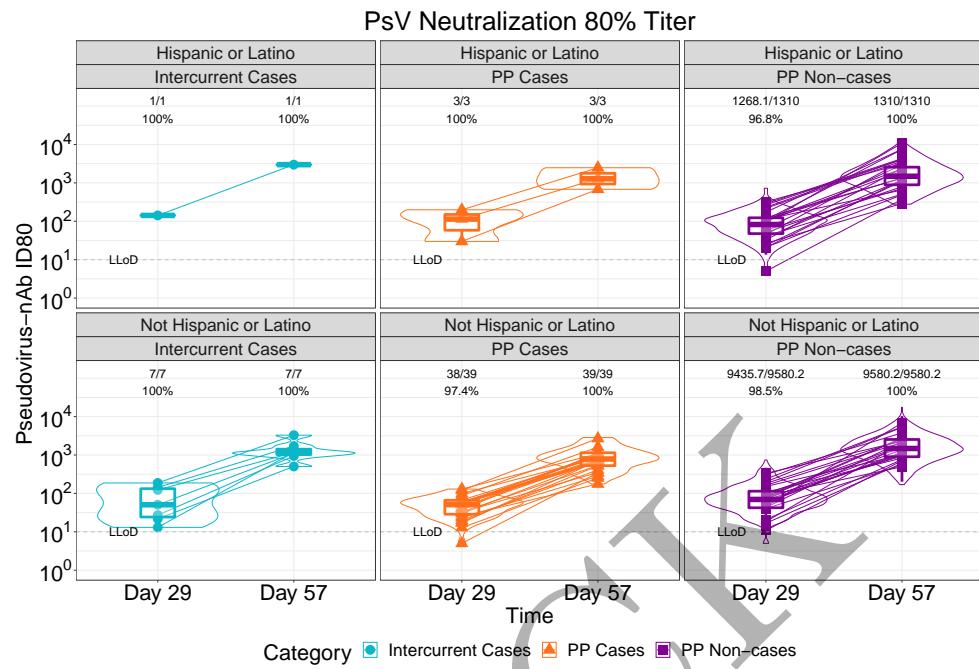


Figure 2.222: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)

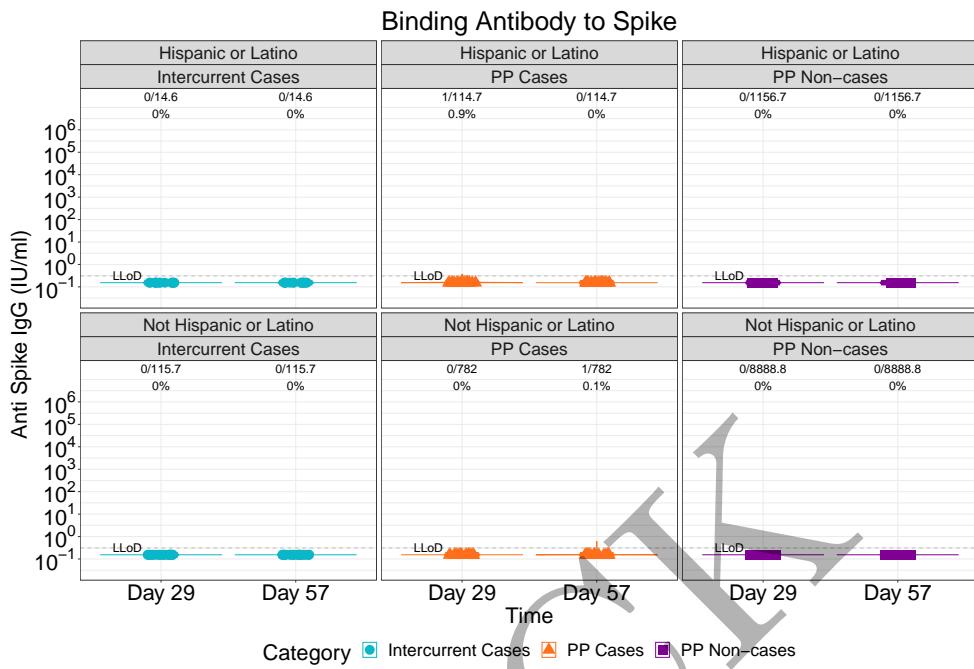


Figure 2.223: violinplots of Binding Antibody to Spike: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)

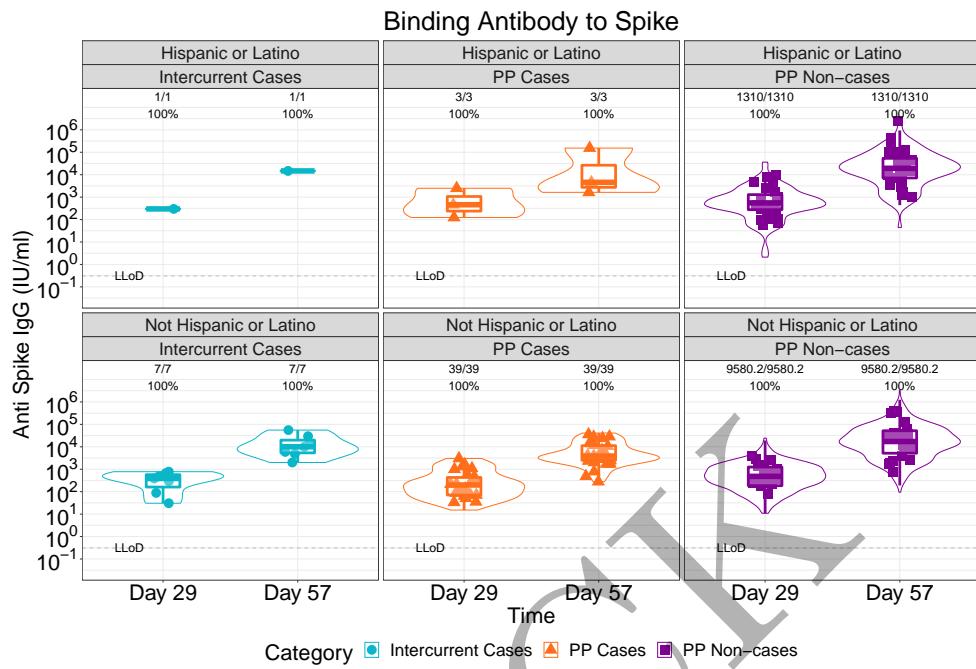


Figure 2.224: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)

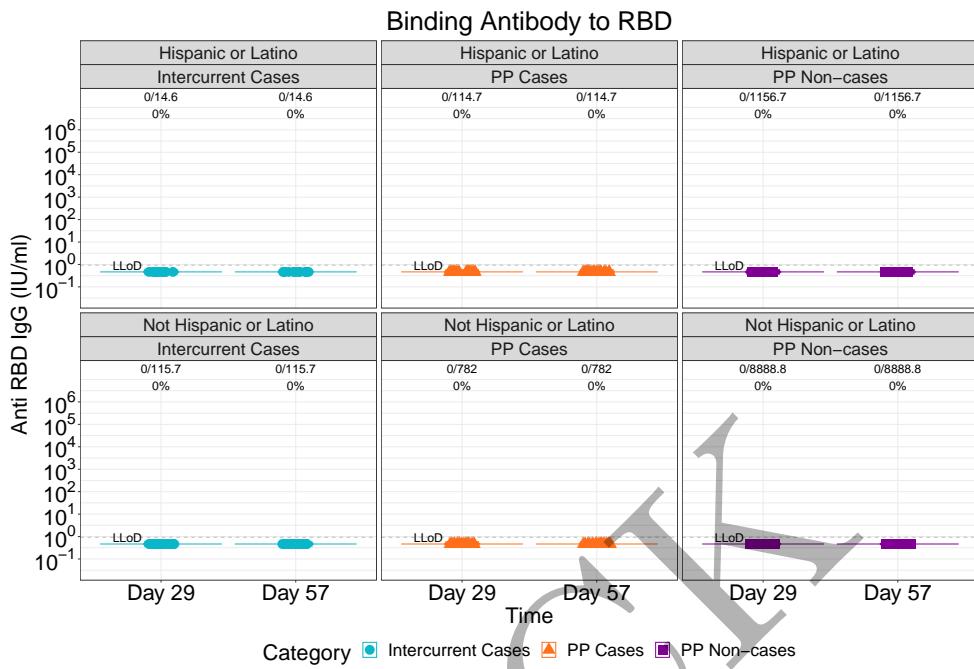


Figure 2.225: violinplots of Binding Antibody to RBD: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)

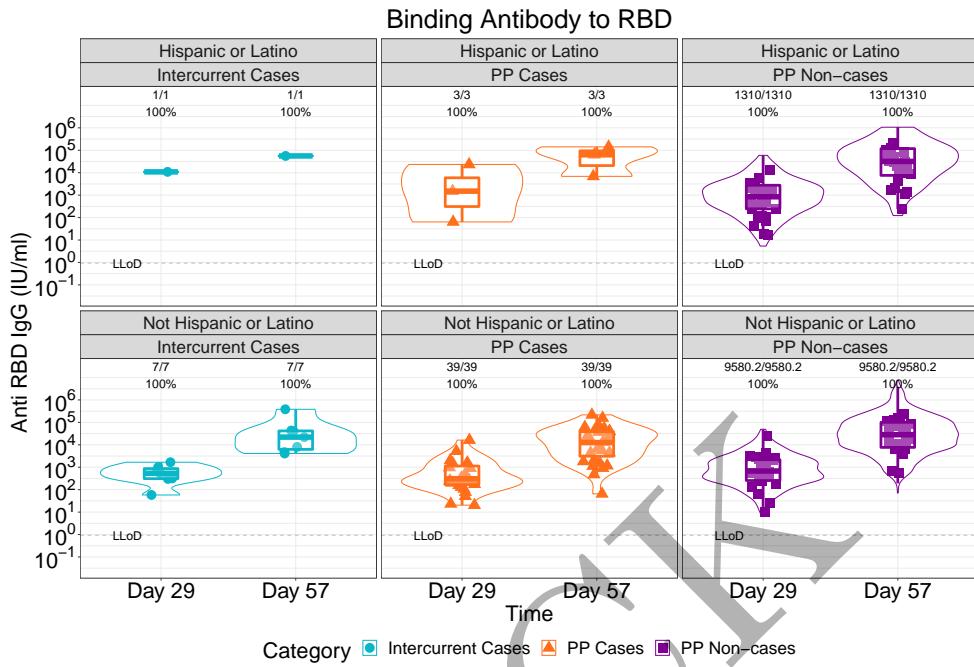


Figure 2.226: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)

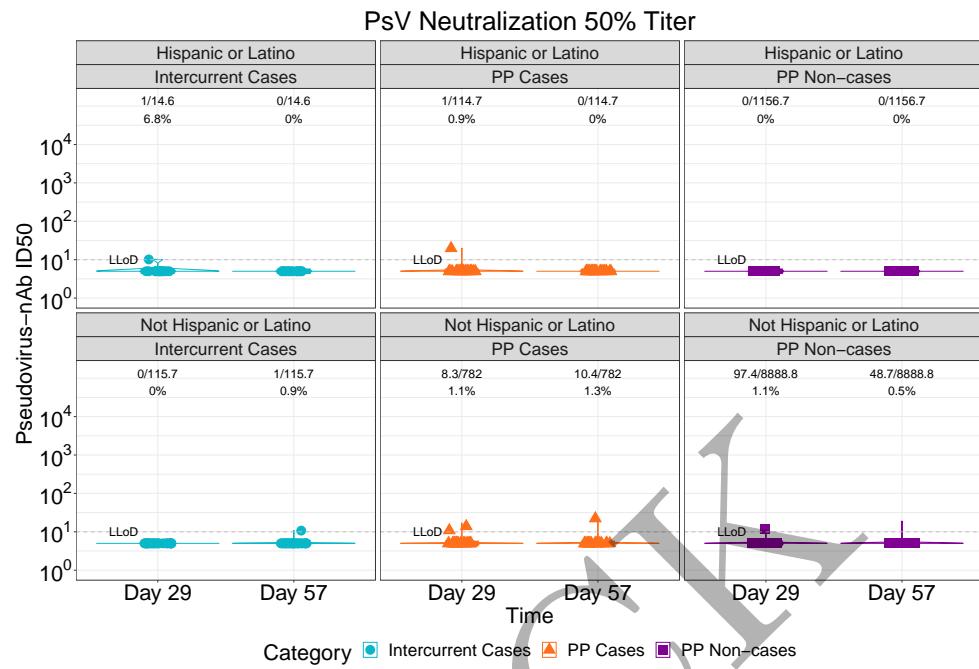


Figure 2.227: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)

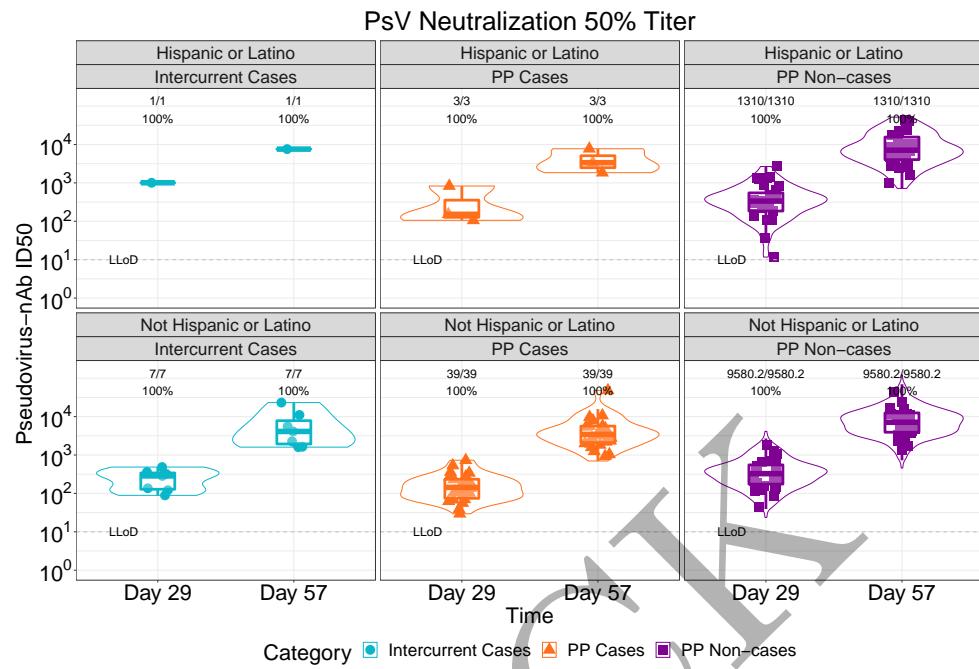


Figure 2.228: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)

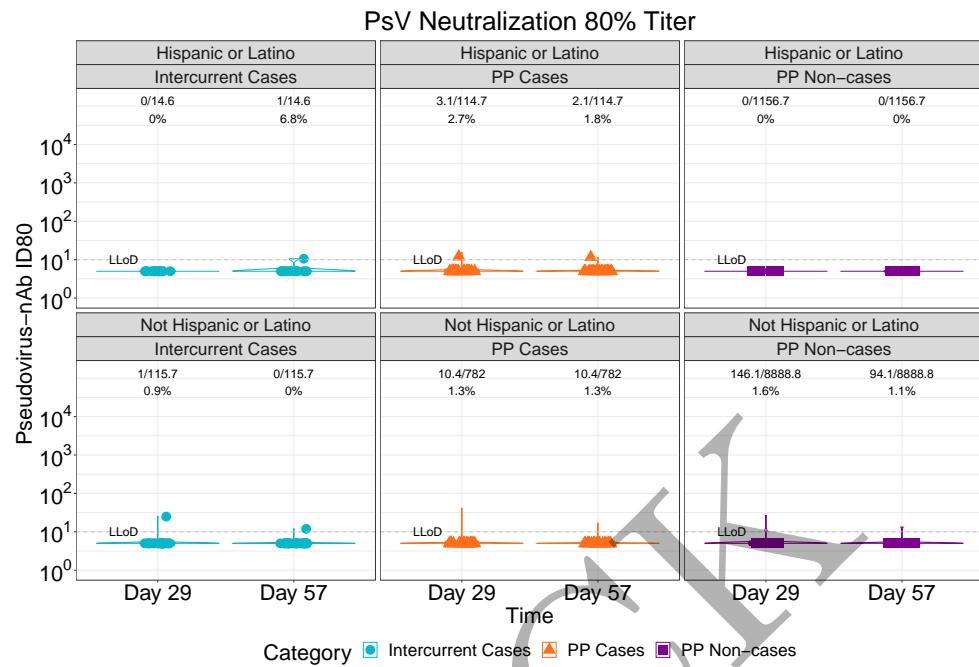


Figure 2.229: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)

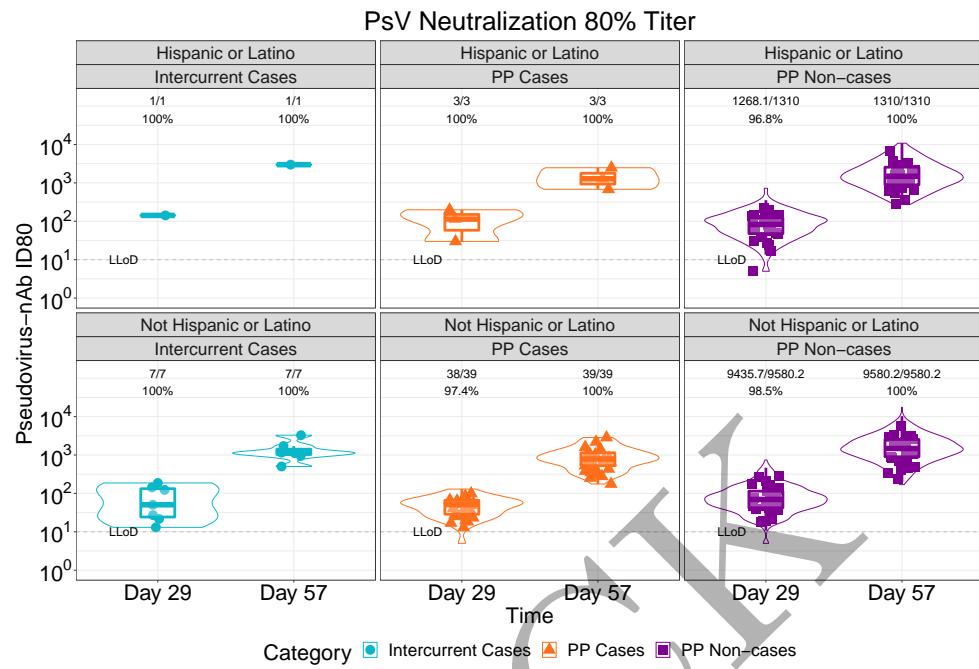


Figure 2.230: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)

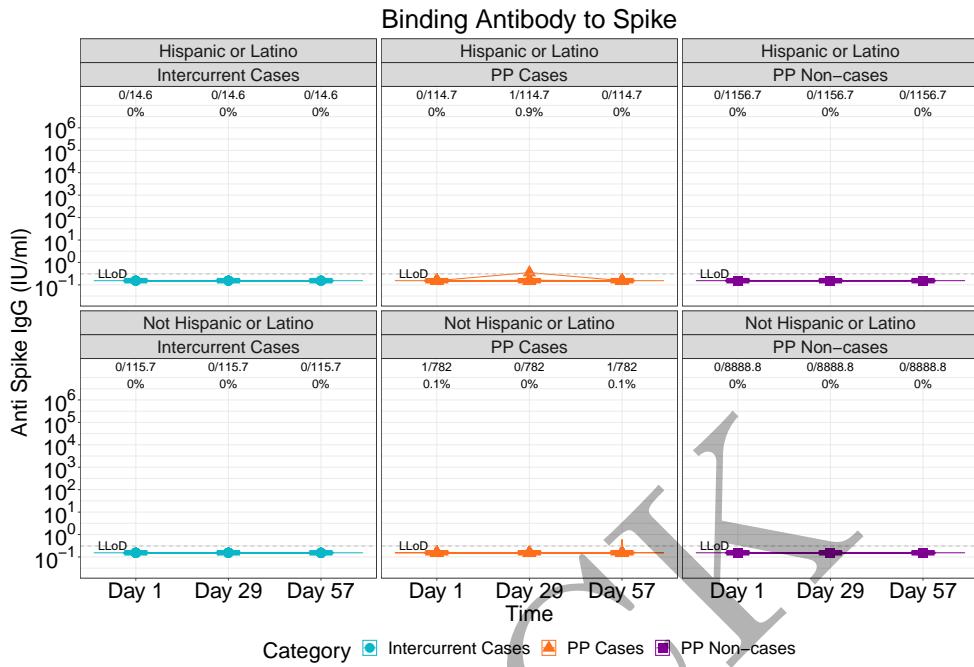


Figure 2.231: lineplots of Binding Antibody to Spike: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)

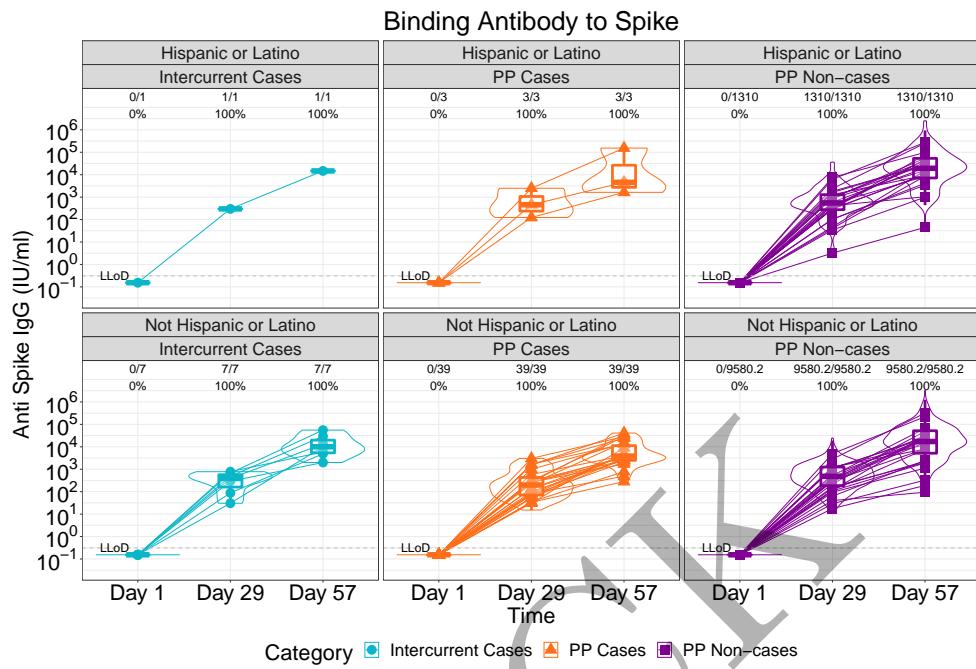


Figure 2.232: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)

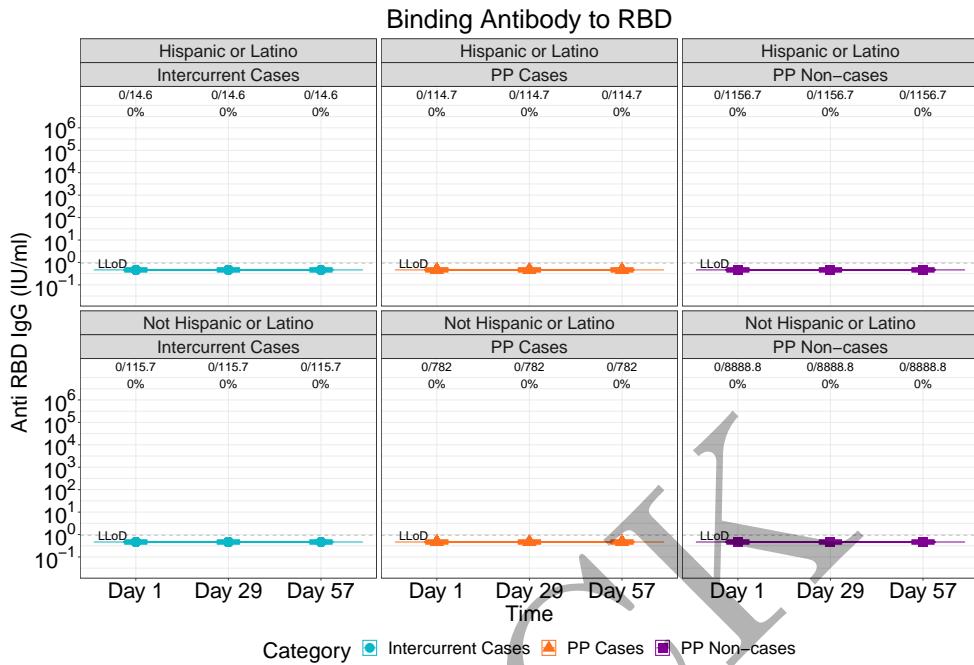


Figure 2.233: lineplots of Binding Antibody to RBD: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)

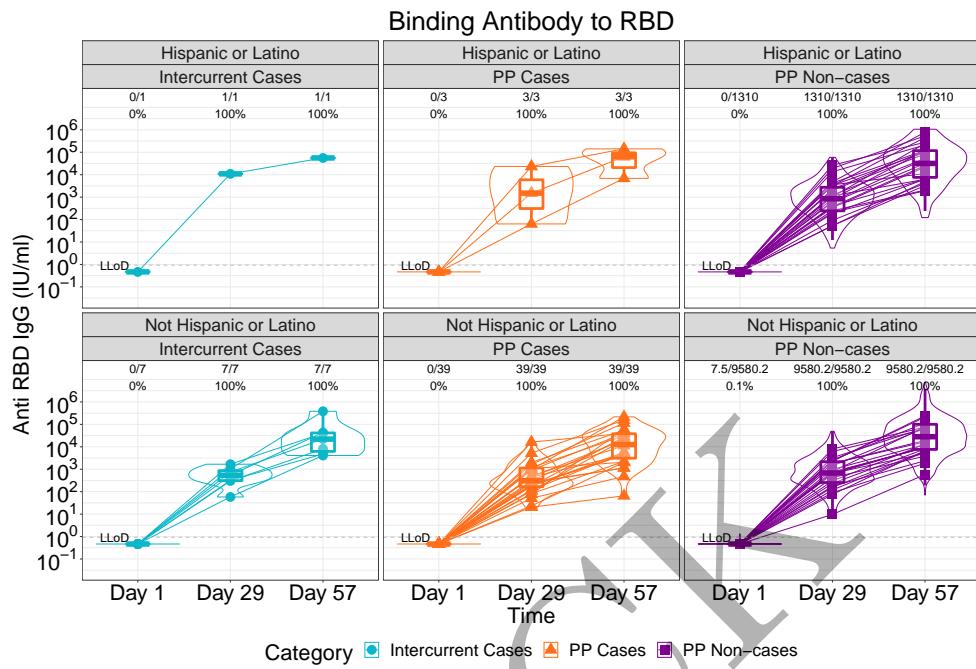


Figure 2.234: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)

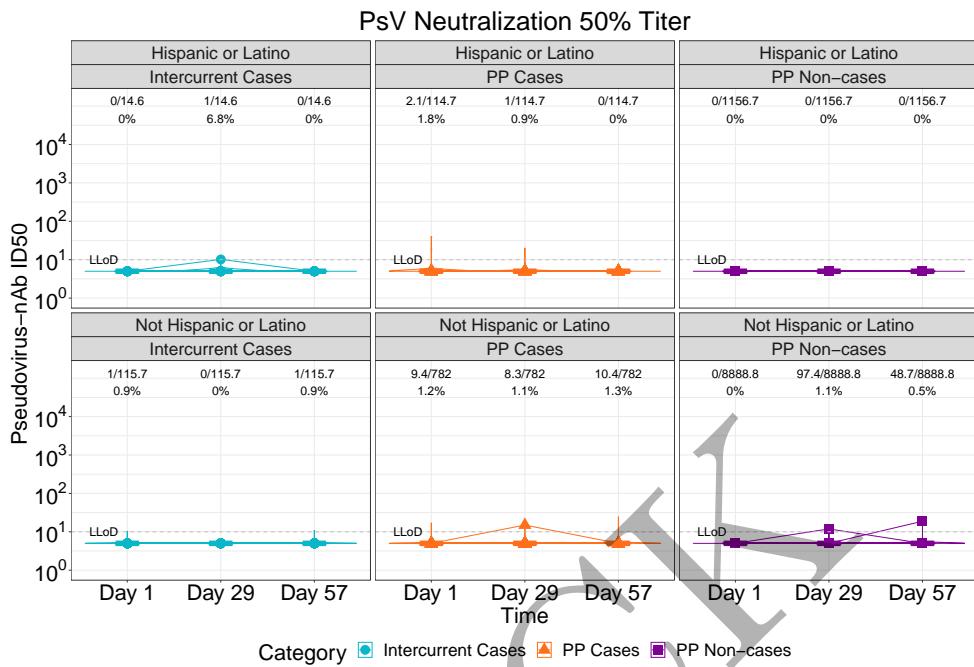


Figure 2.235: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)

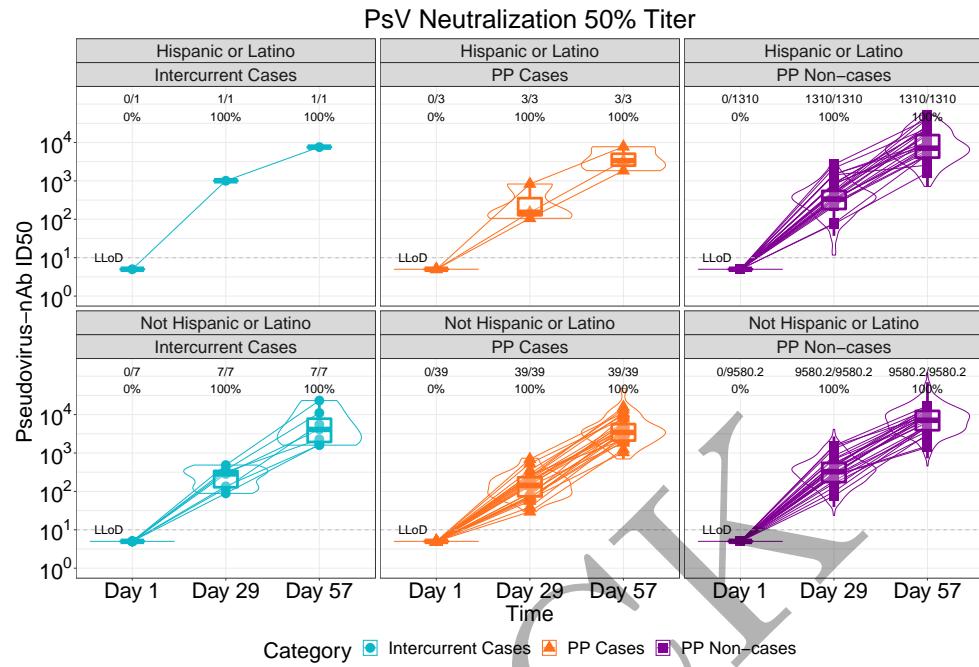


Figure 2.236: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)

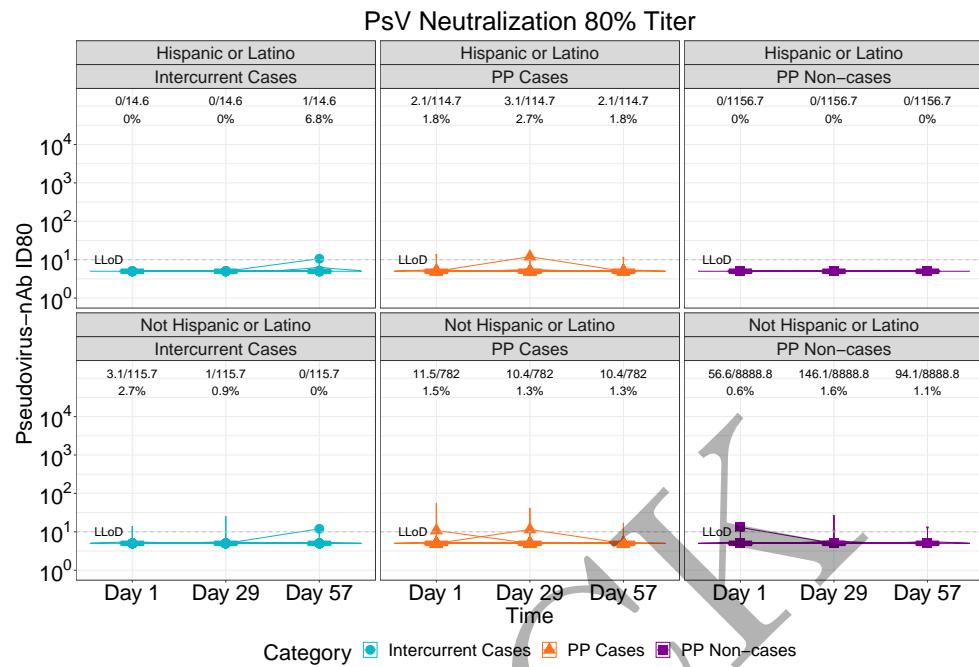


Figure 2.237: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)

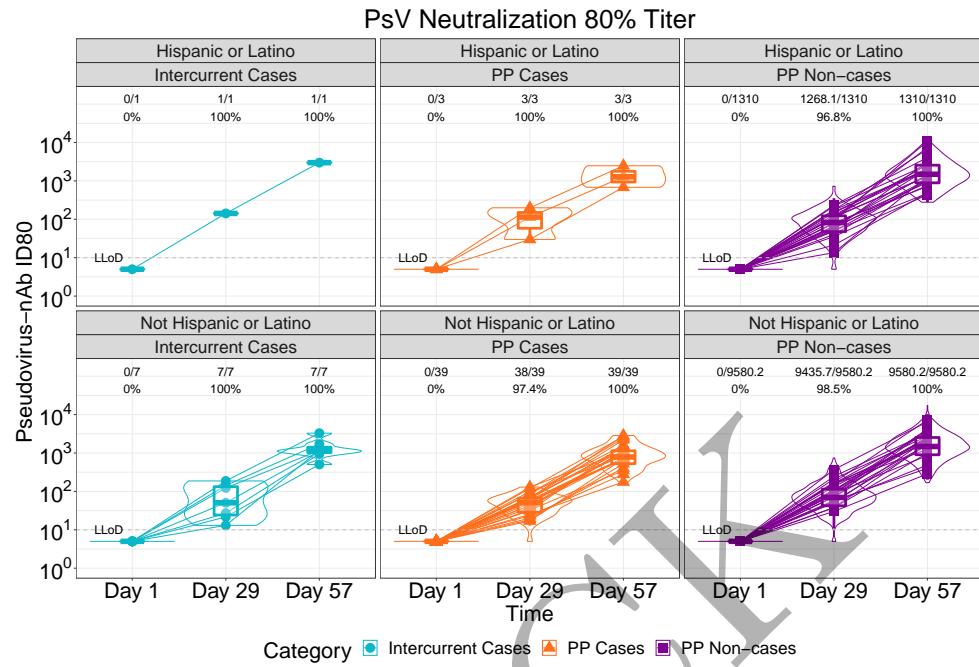


Figure 2.238: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)

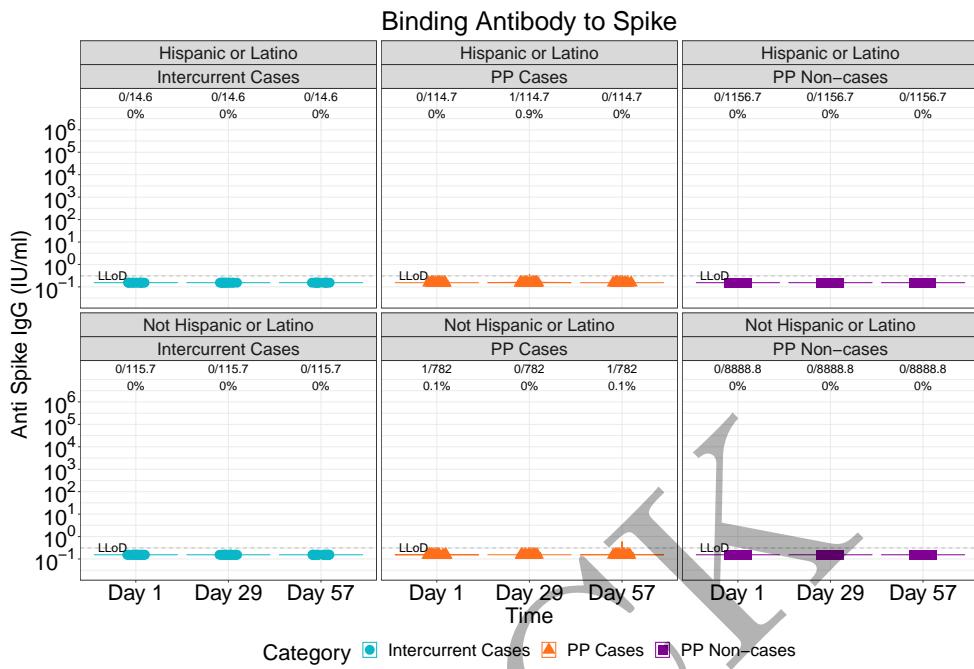


Figure 2.239: violinplots of Binding Antibody to Spike: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)

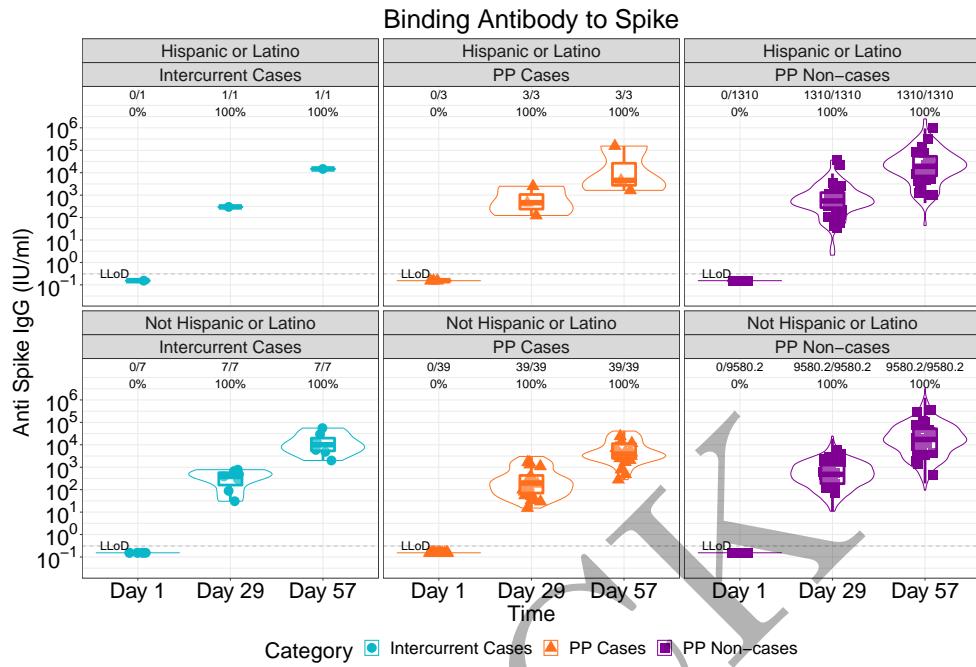


Figure 2.240: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)

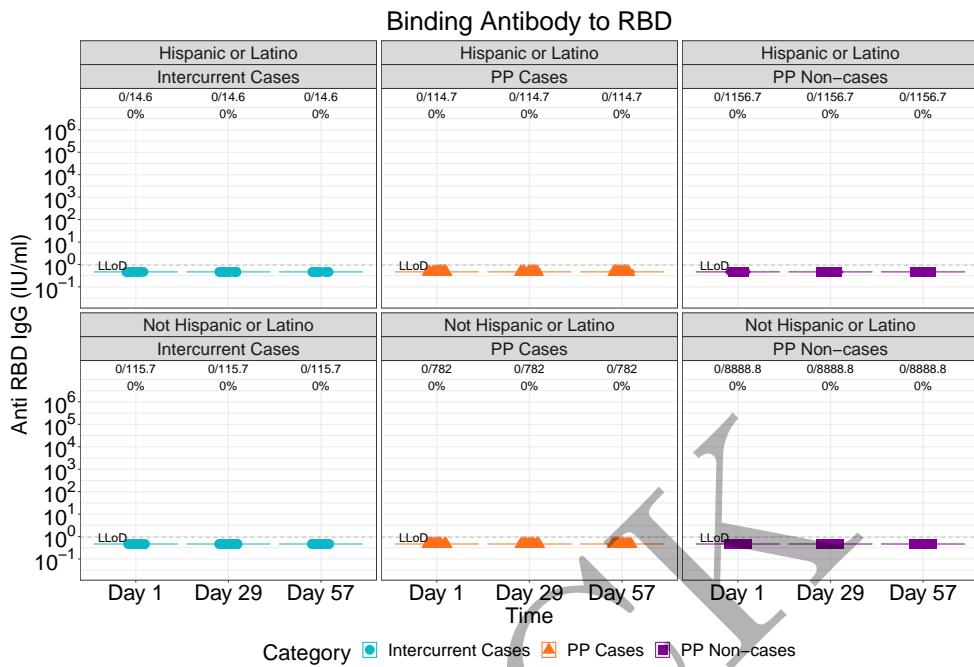


Figure 2.241: violinplots of Binding Antibody to RBD: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)

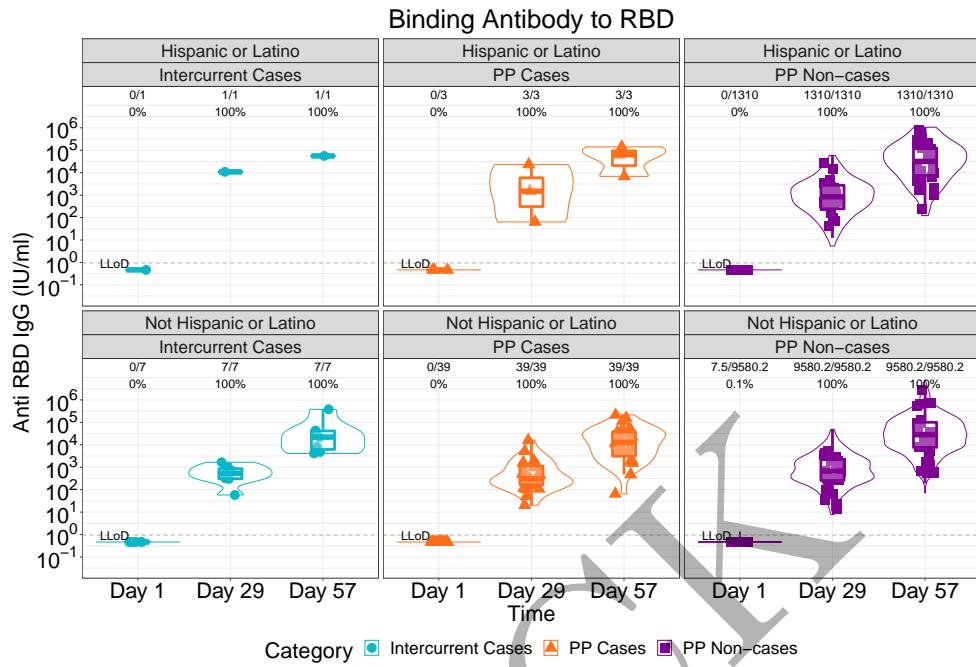


Figure 2.242: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)

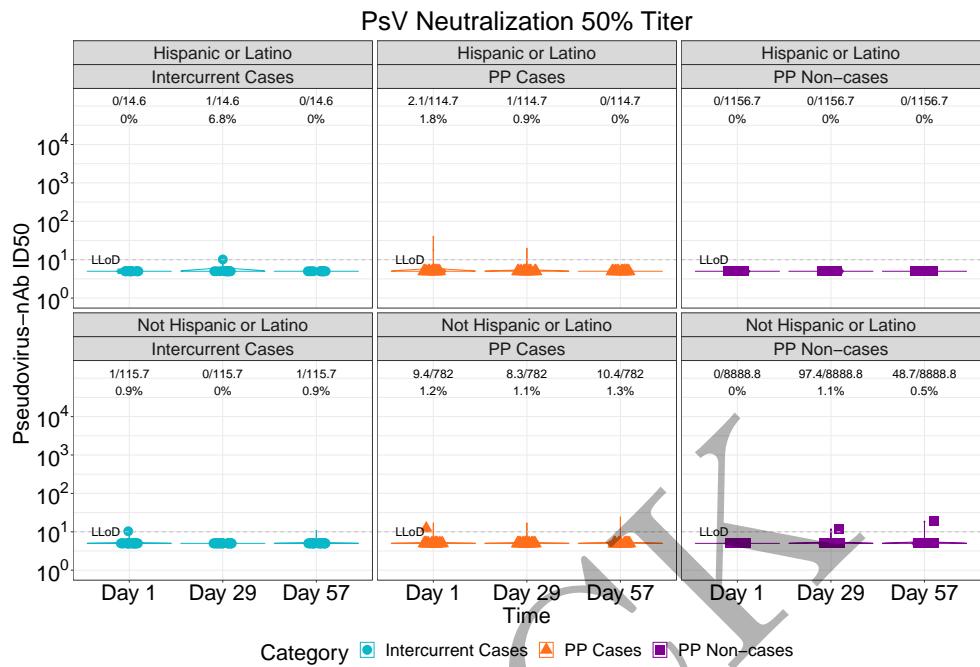


Figure 2.243: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)

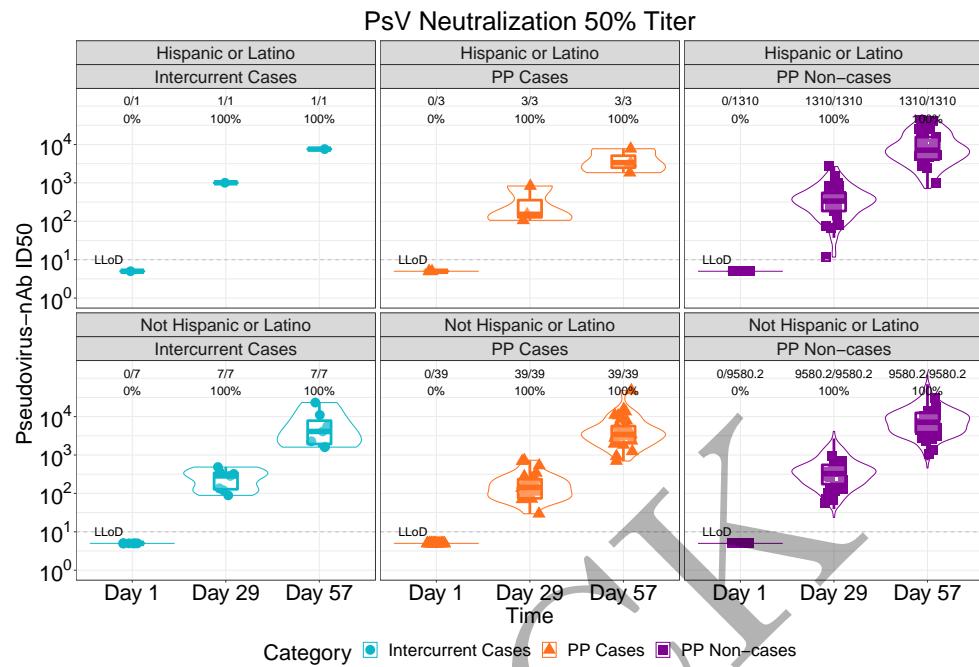


Figure 2.244: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)

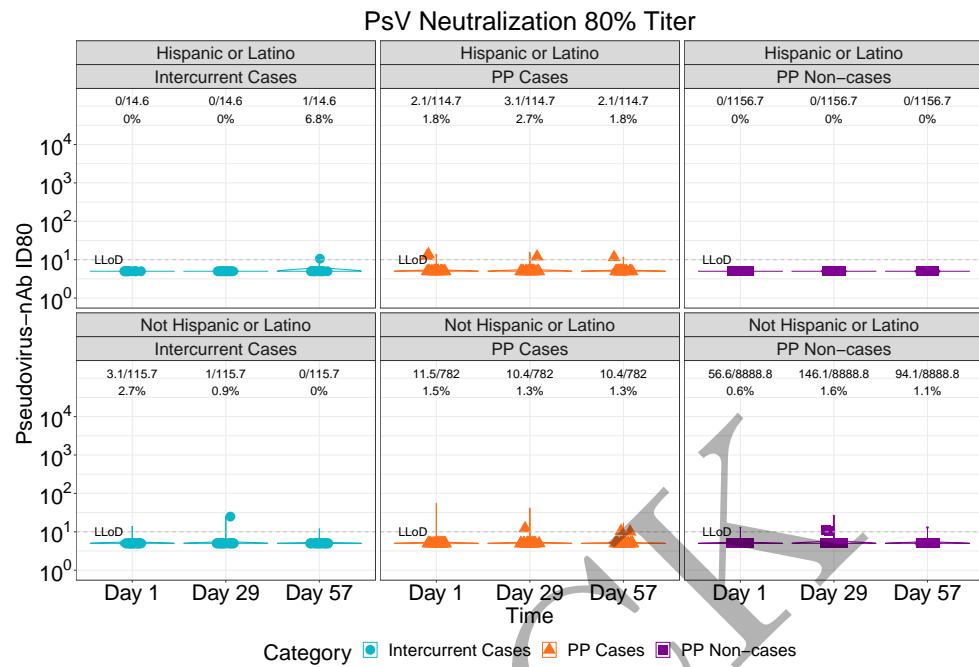


Figure 2.245: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)

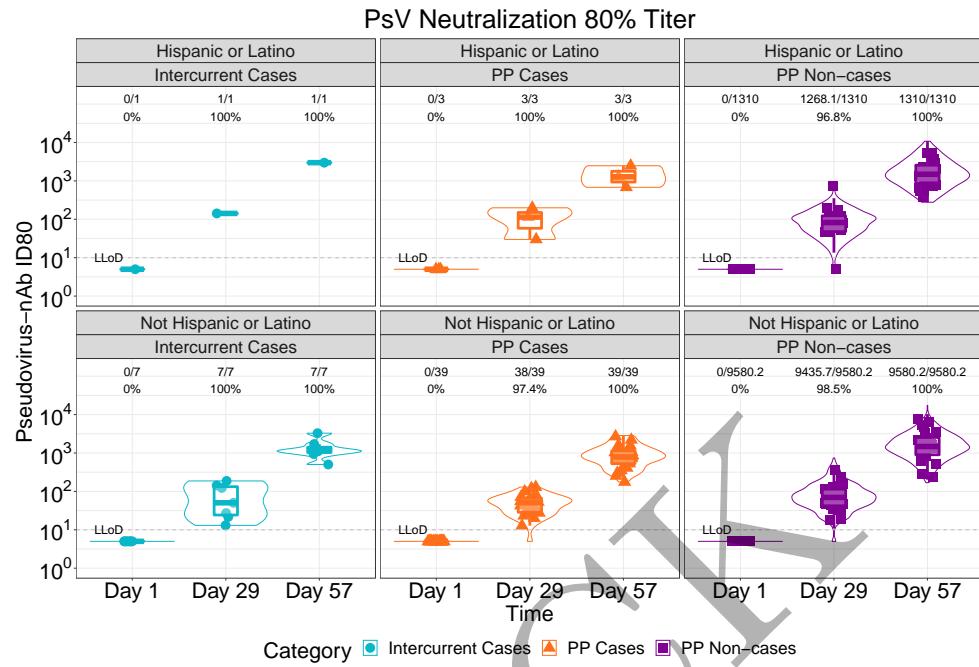


Figure 2.246: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)

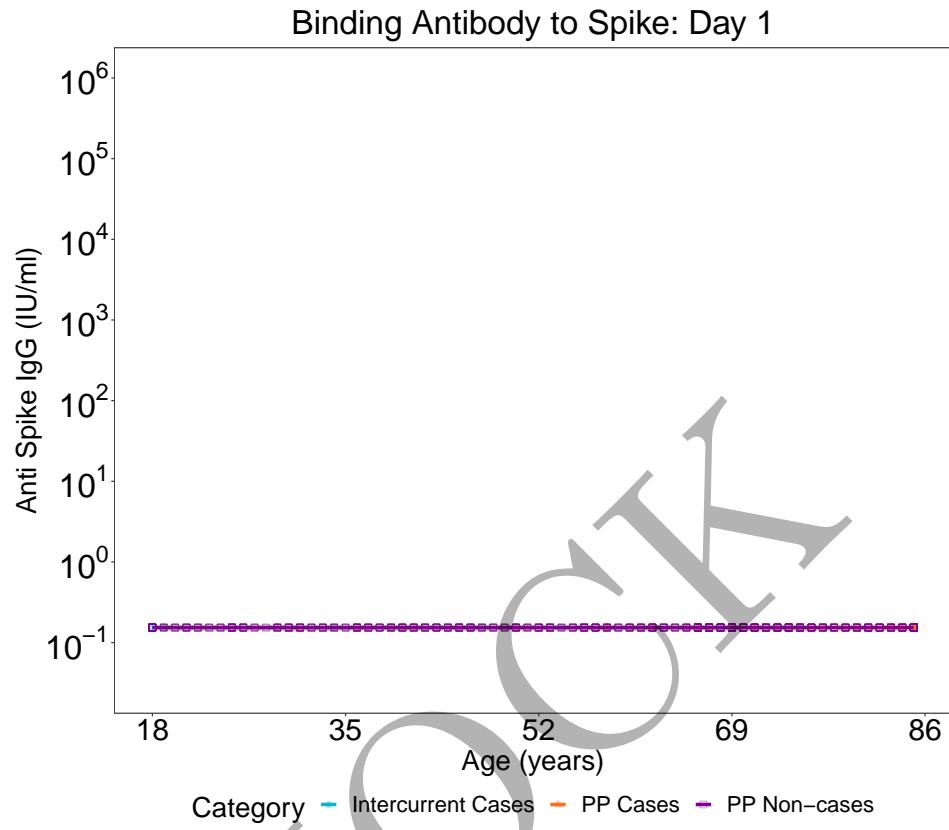


Figure 2.247: scatterplots of Binding Antibody to Spike: baseline negative vaccine arm at day 1

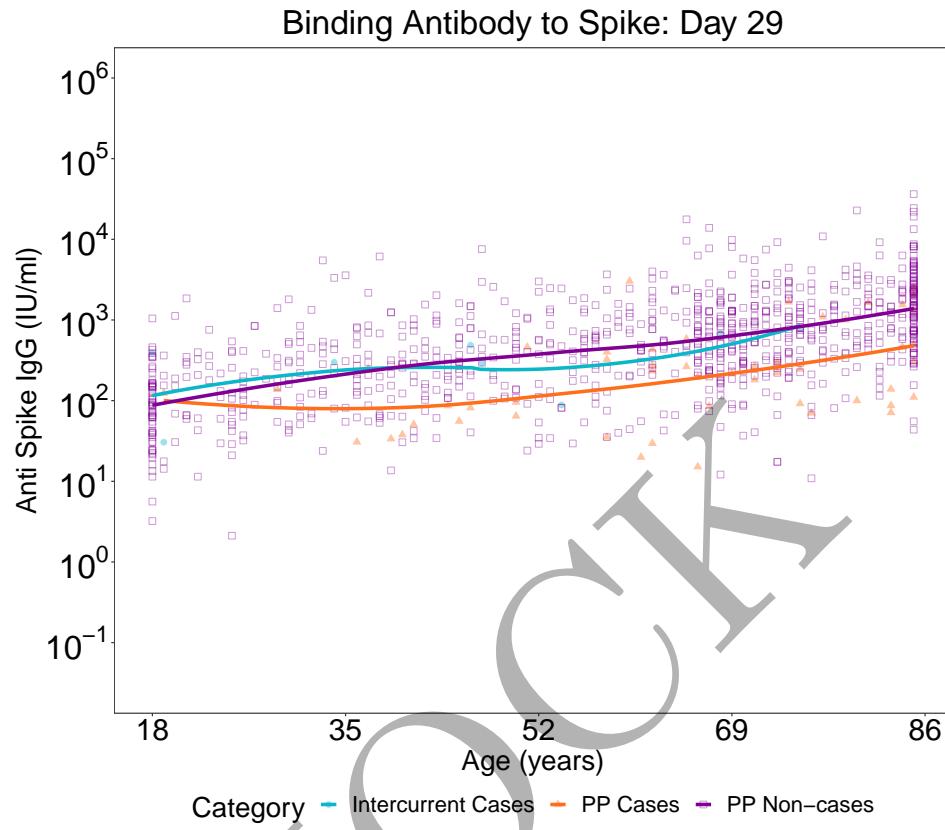


Figure 2.248: scatterplots of Binding Antibody to Spike: baseline negative vaccine arm at day 29

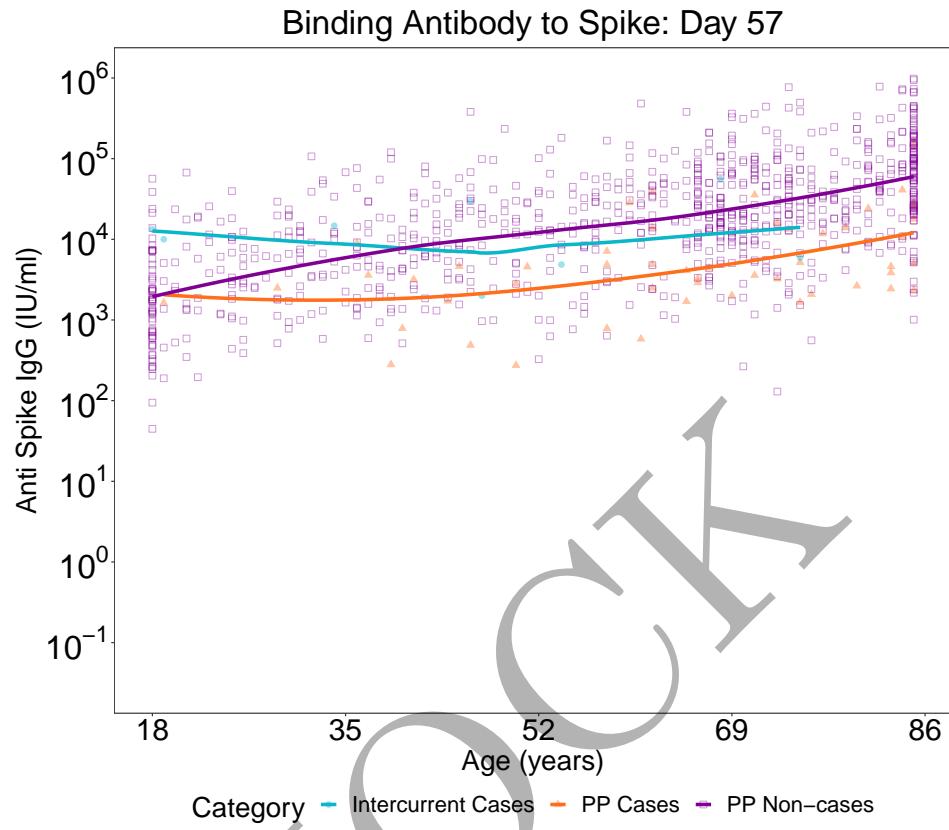


Figure 2.249: scatterplots of Binding Antibody to Spike: baseline negative vaccine arm at day 57

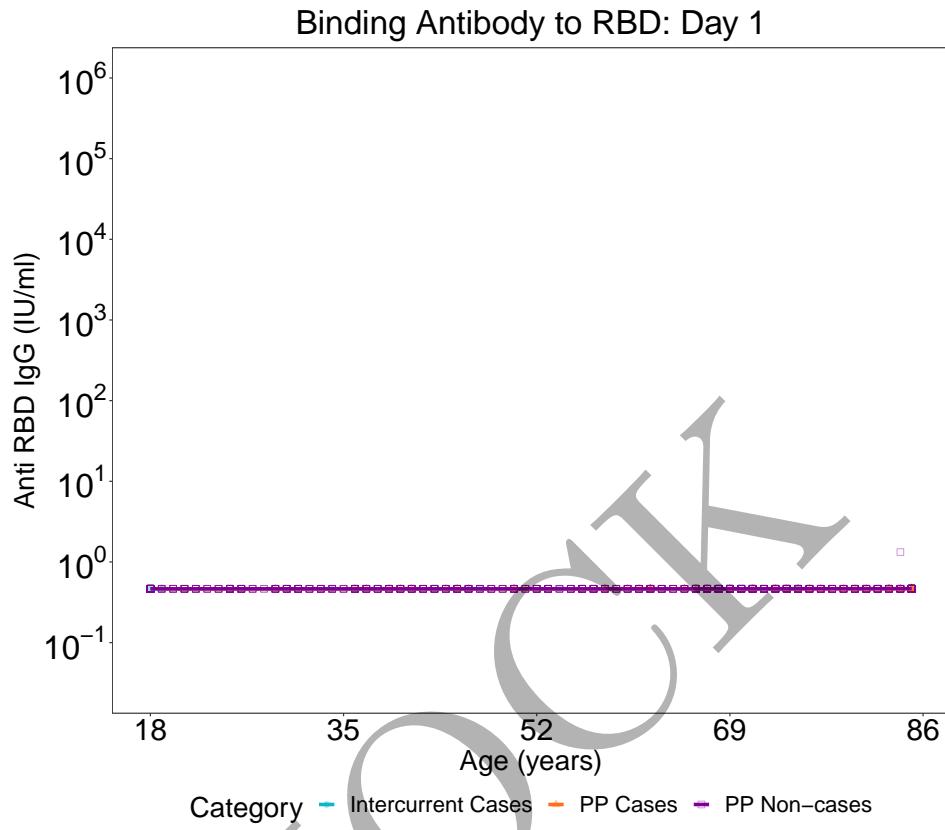


Figure 2.250: scatterplots of Binding Antibody to RBD: baseline negative vaccine arm at day 1

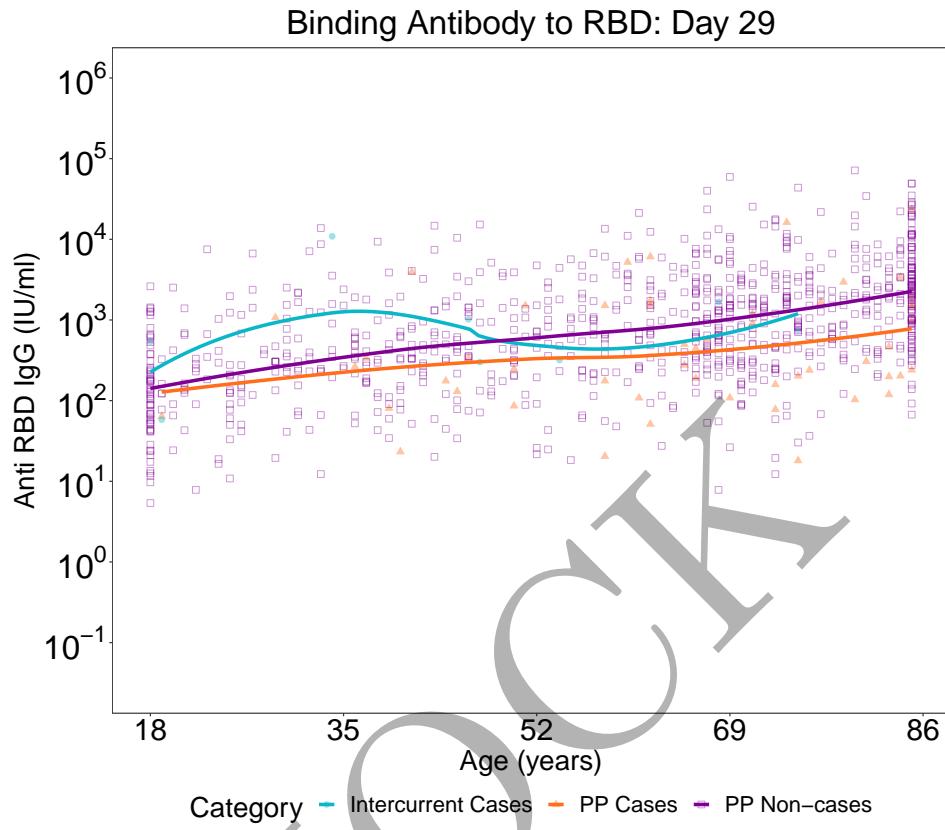


Figure 2.251: scatterplots of Binding Antibody to RBD: baseline negative vaccine arm at day 29

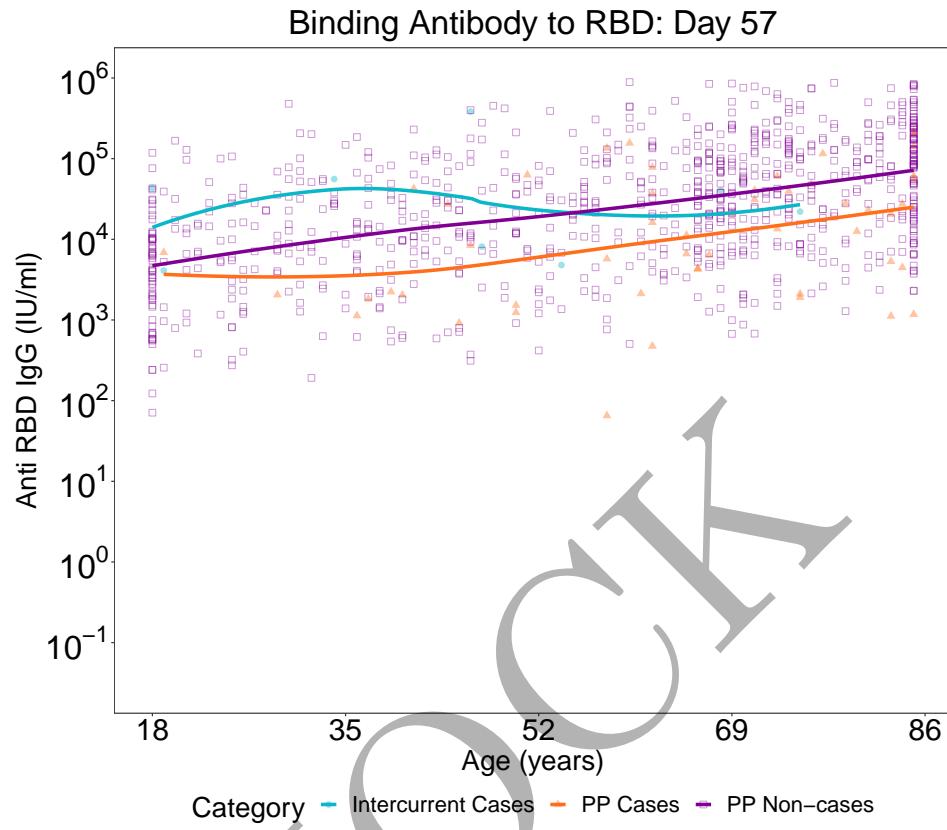


Figure 2.252: scatterplots of Binding Antibody to RBD: baseline negative vaccine arm at day 57

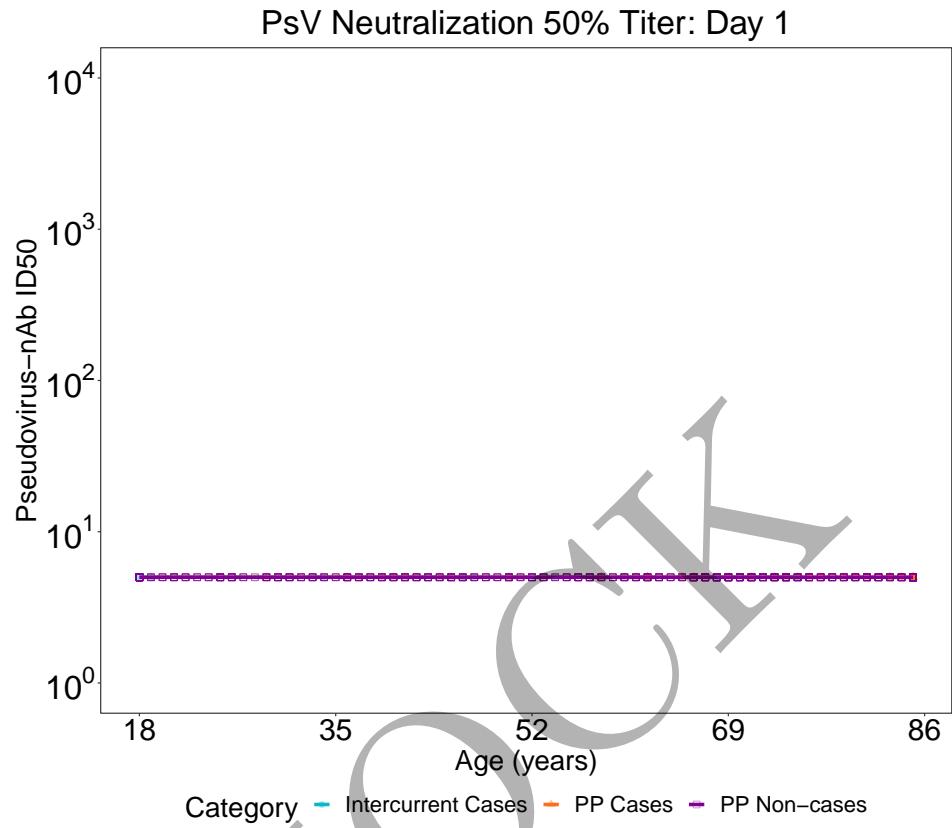


Figure 2.253: scatterplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm at day 1

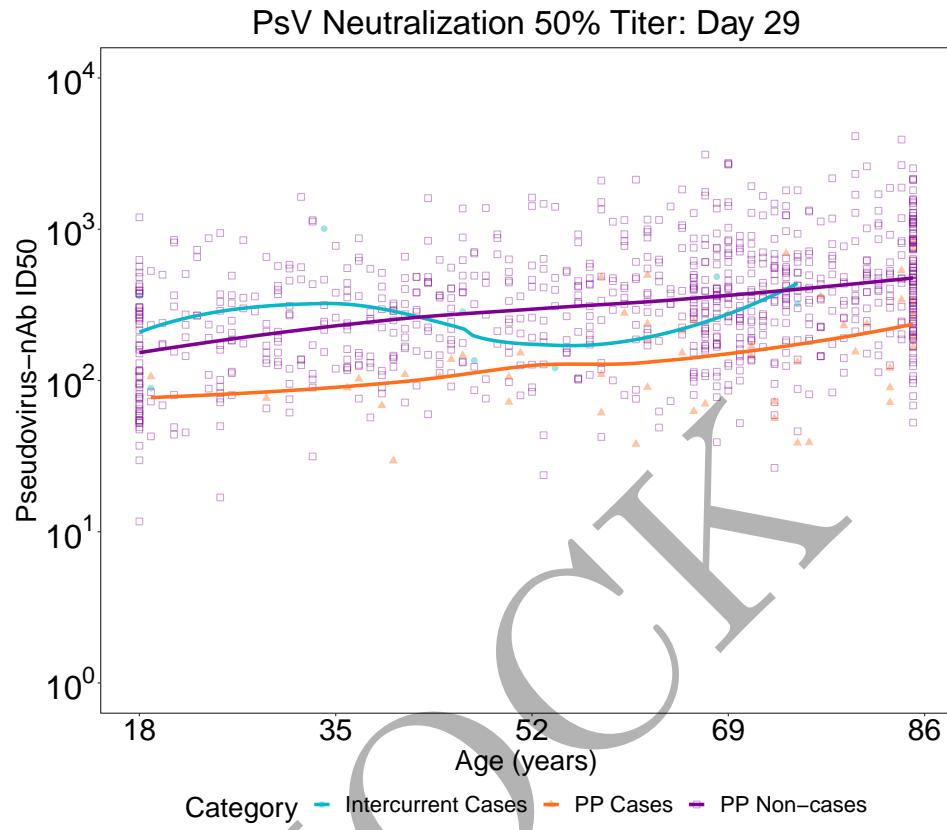


Figure 2.254: scatterplots of Pseudovirus Neutralization ID₅₀: baseline negative vaccine arm at day 29

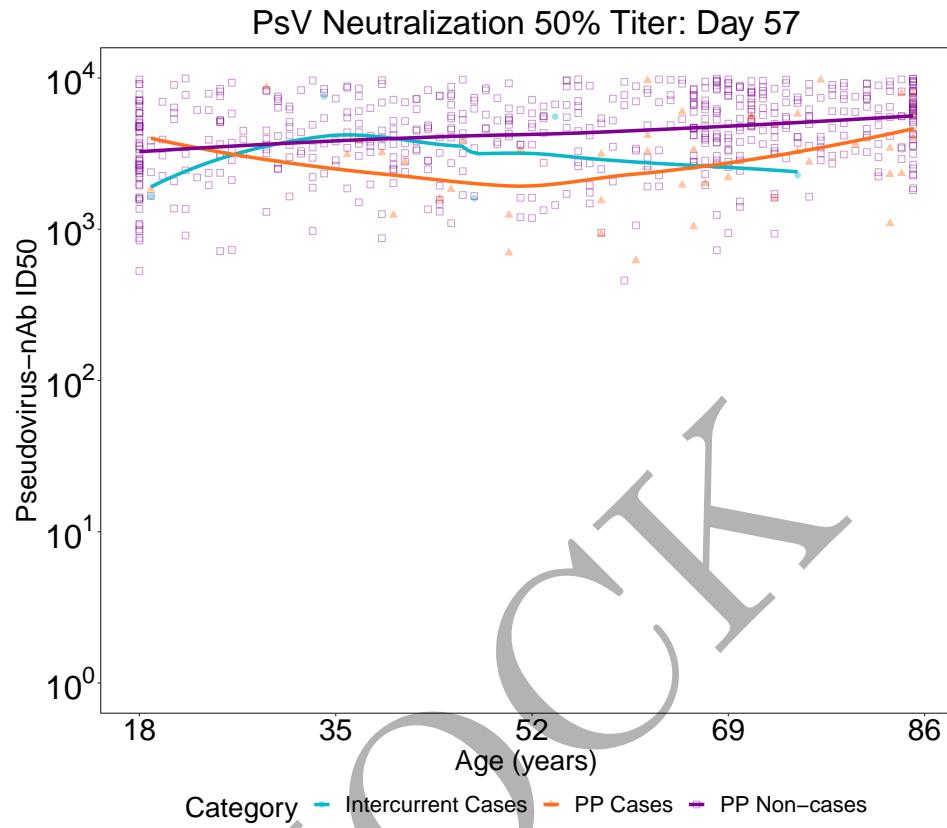


Figure 2.255: scatterplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm at day 57

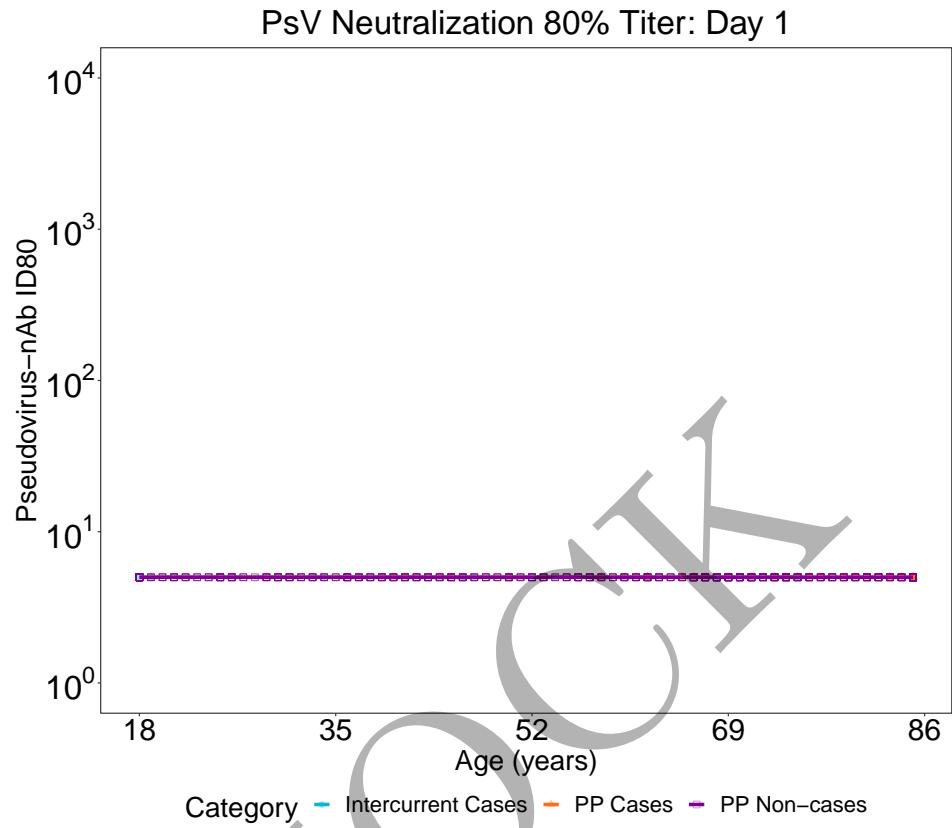


Figure 2.256: scatterplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm at day 1

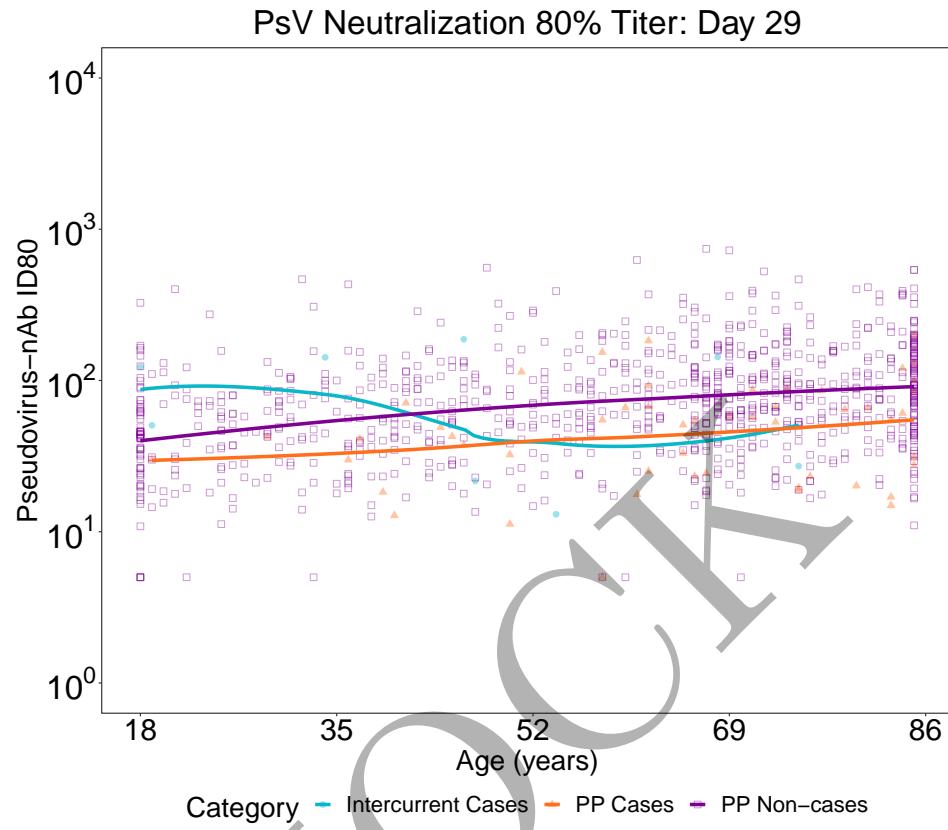


Figure 2.257: scatterplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm at day 29

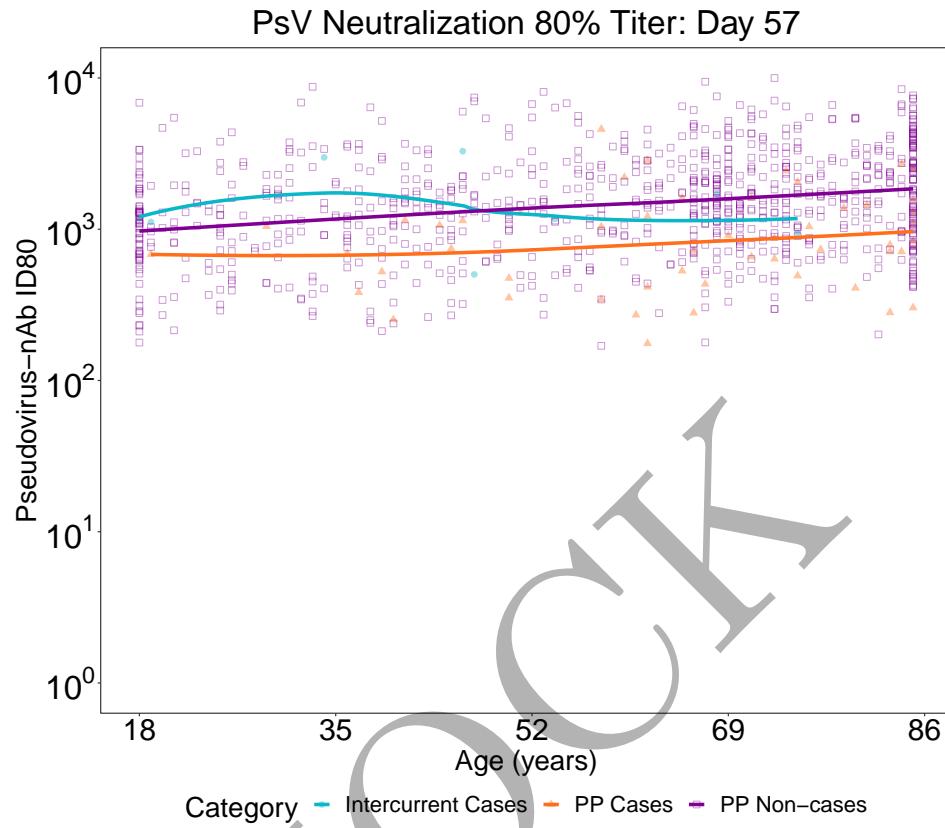


Figure 2.258: scatterplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm at day 57

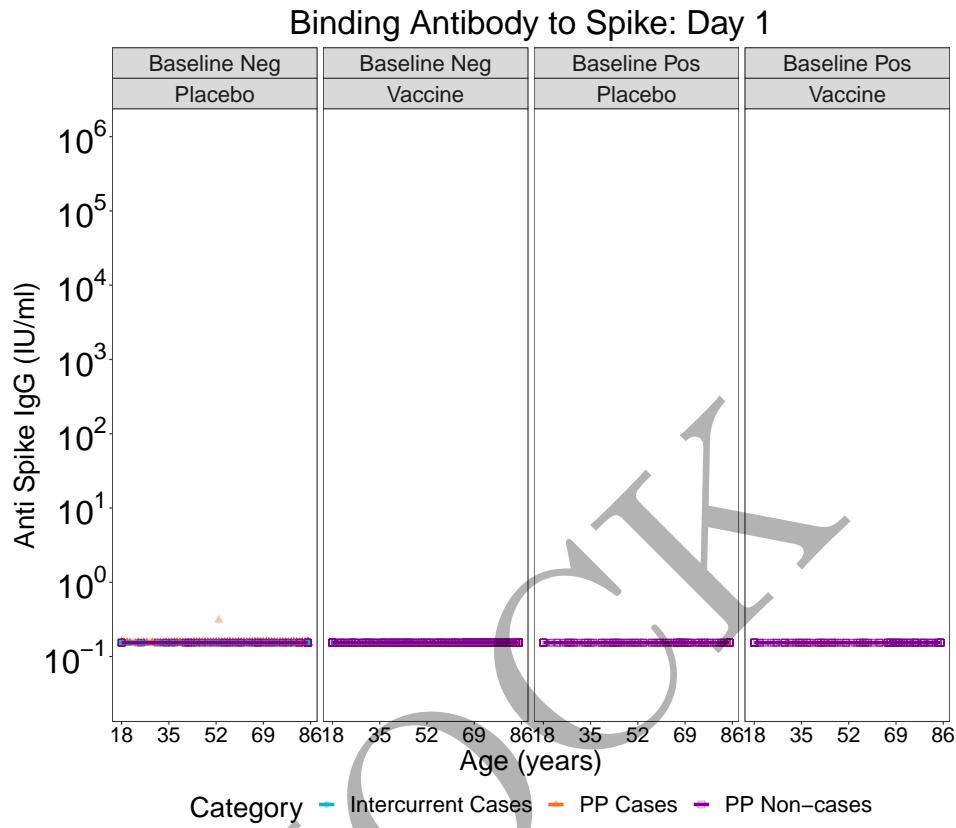


Figure 2.259: scatterplots of Binding Antibody to Spike: by arm at day 1

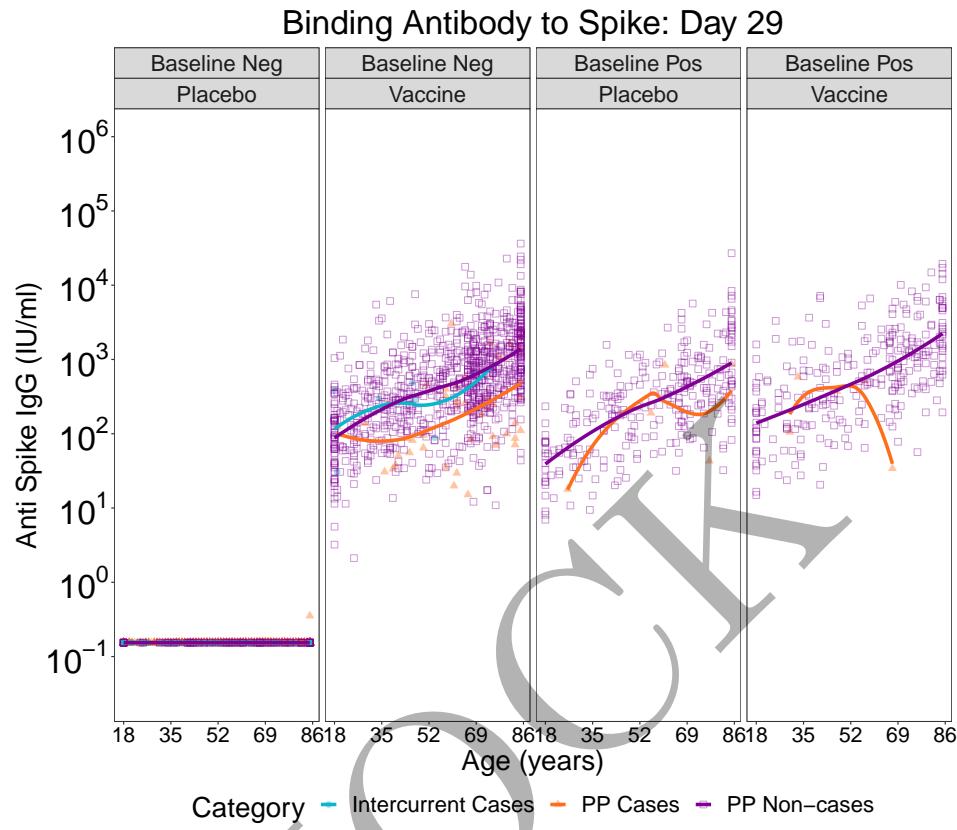


Figure 2.260: scatterplots of Binding Antibody to Spike: by arm at day 29

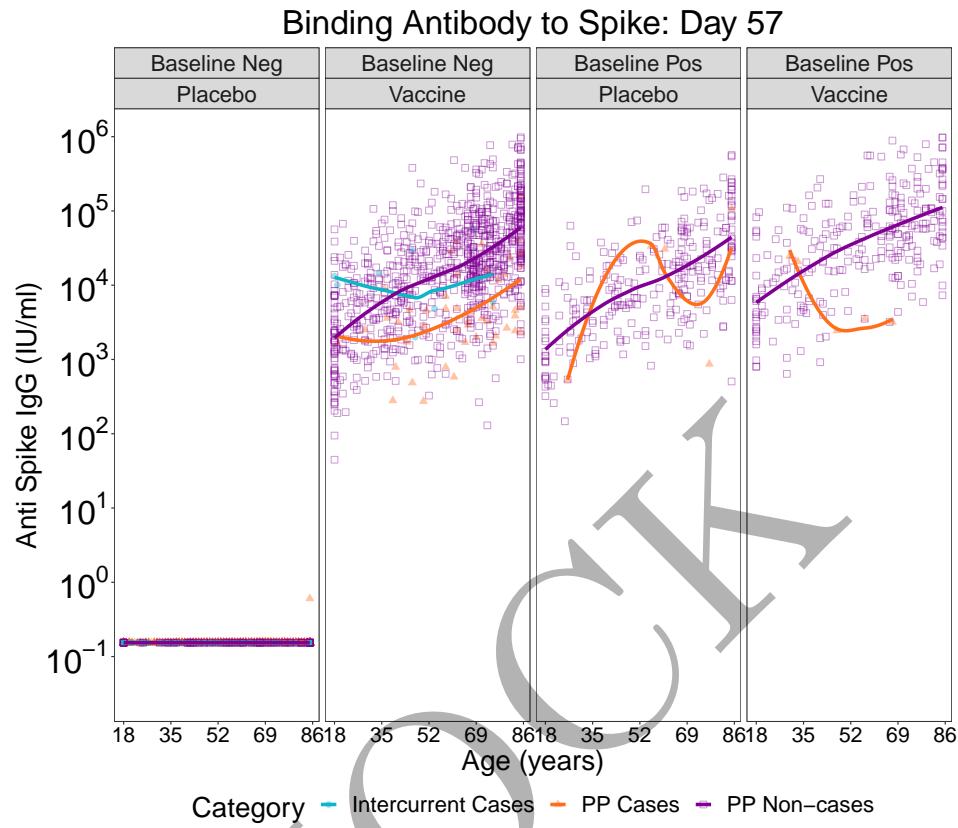


Figure 2.261: scatterplots of Binding Antibody to Spike: by arm at day 57

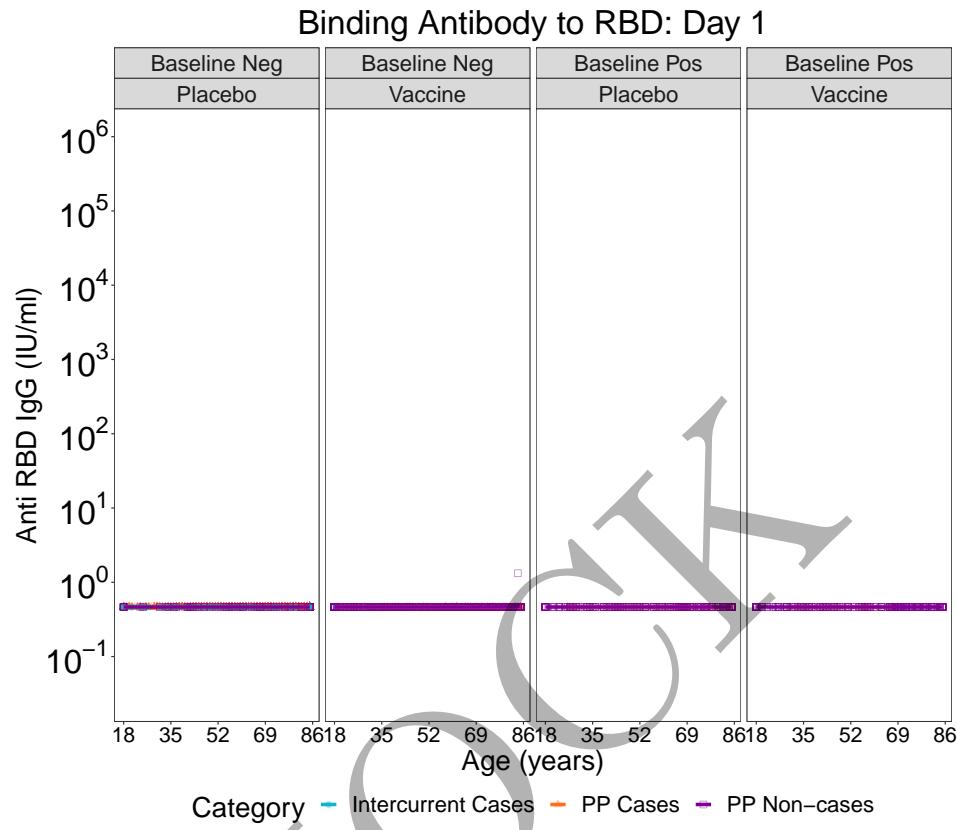


Figure 2.262: scatterplots of Binding Antibody to RBD: by arm at day 1

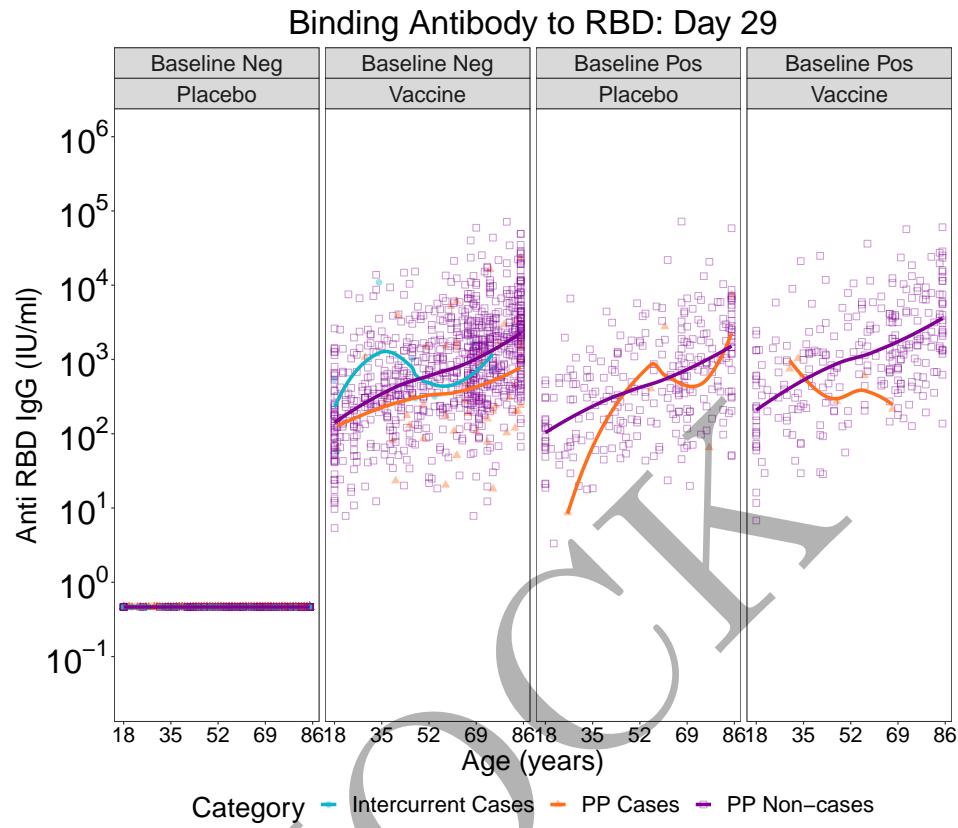


Figure 2.263: scatterplots of Binding Antibody to RBD: by arm at day 29

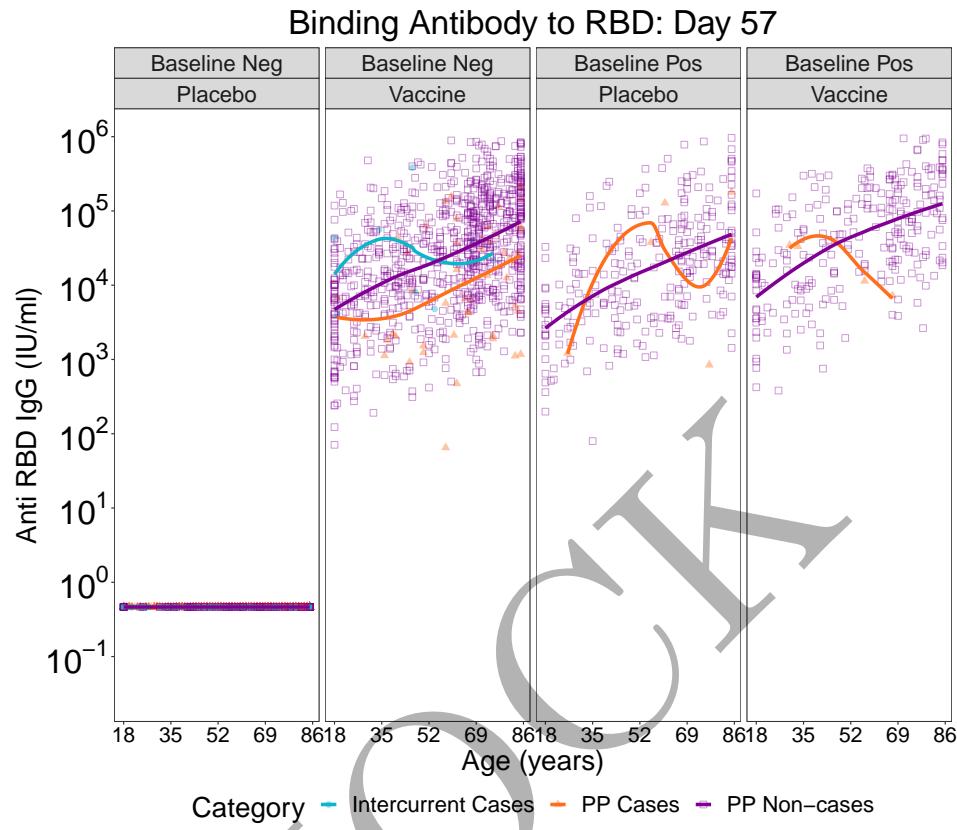


Figure 2.264: scatterplots of Binding Antibody to RBD: by arm at day 57

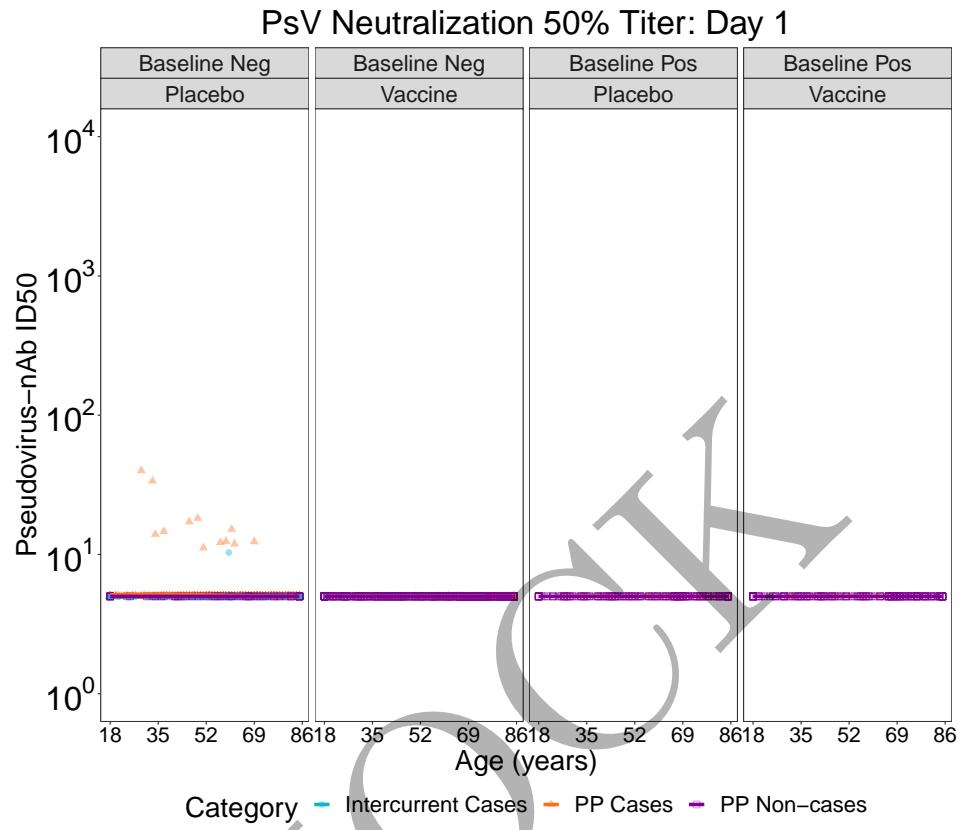


Figure 2.265: scatterplots of Pseudovirus Neutralization ID50: by arm at day 1

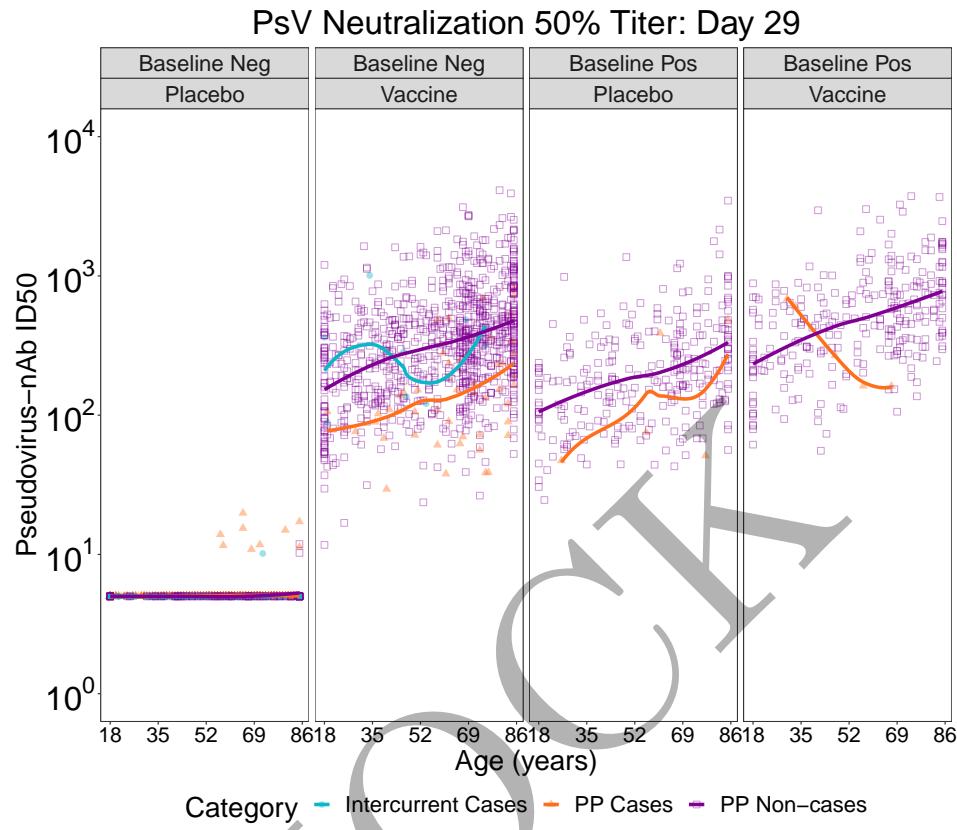


Figure 2.266: scatterplots of Pseudovirus Neutralization ID50: by arm at day 29

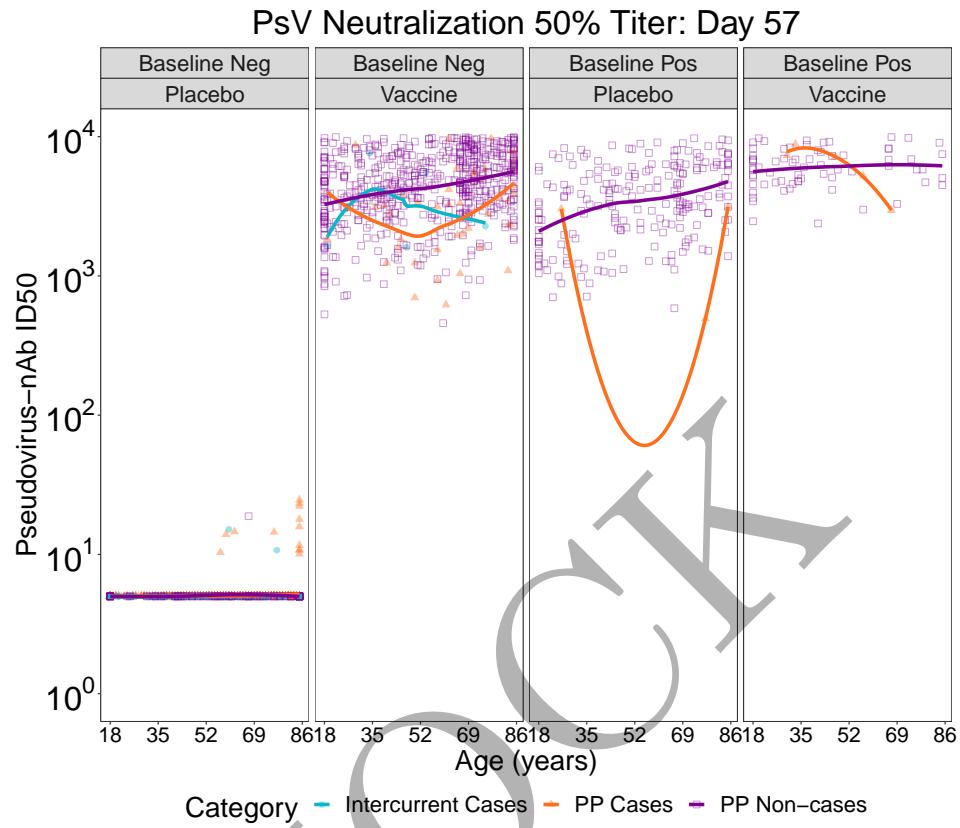


Figure 2.267: scatterplots of Pseudovirus Neutralization ID50: by arm at day 57

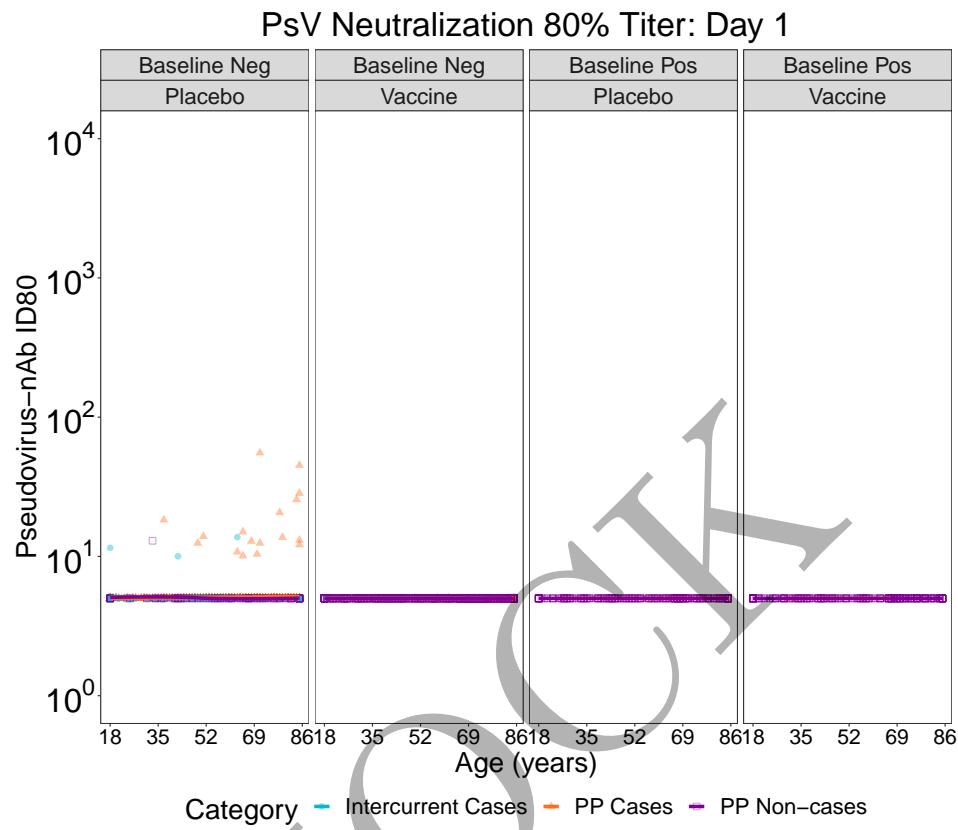


Figure 2.268: scatterplots of Pseudovirus Neutralization ID80: by arm at day 1

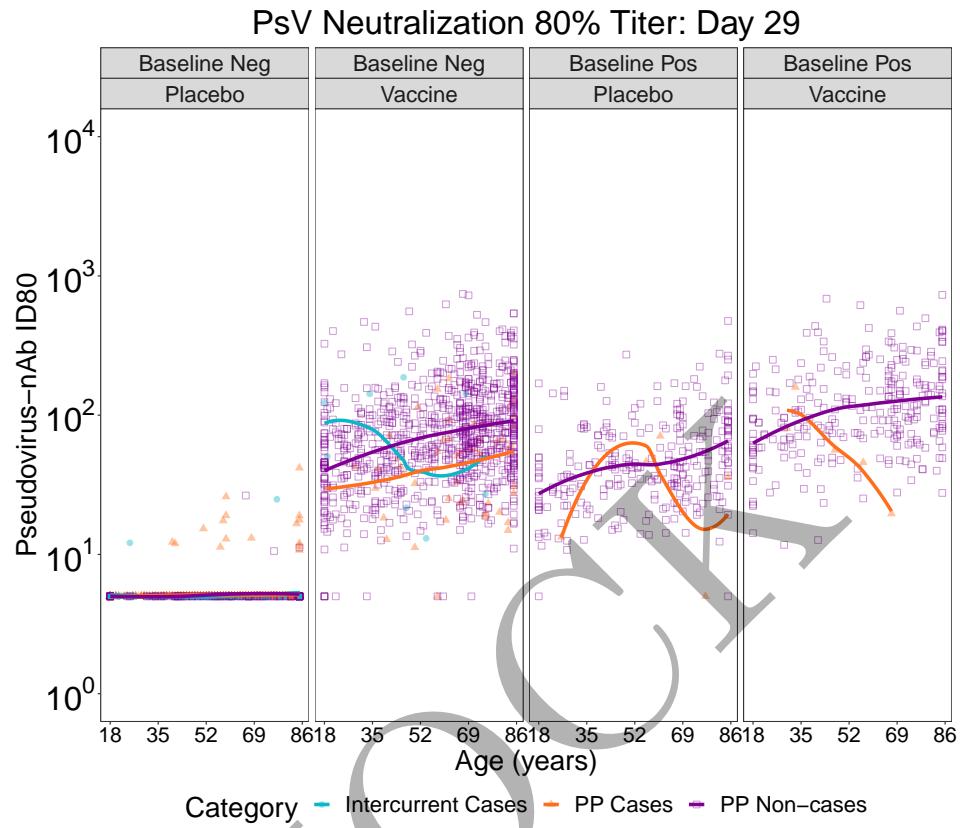


Figure 2.269: scatterplots of Pseudovirus Neutralization ID80: by arm at day 29

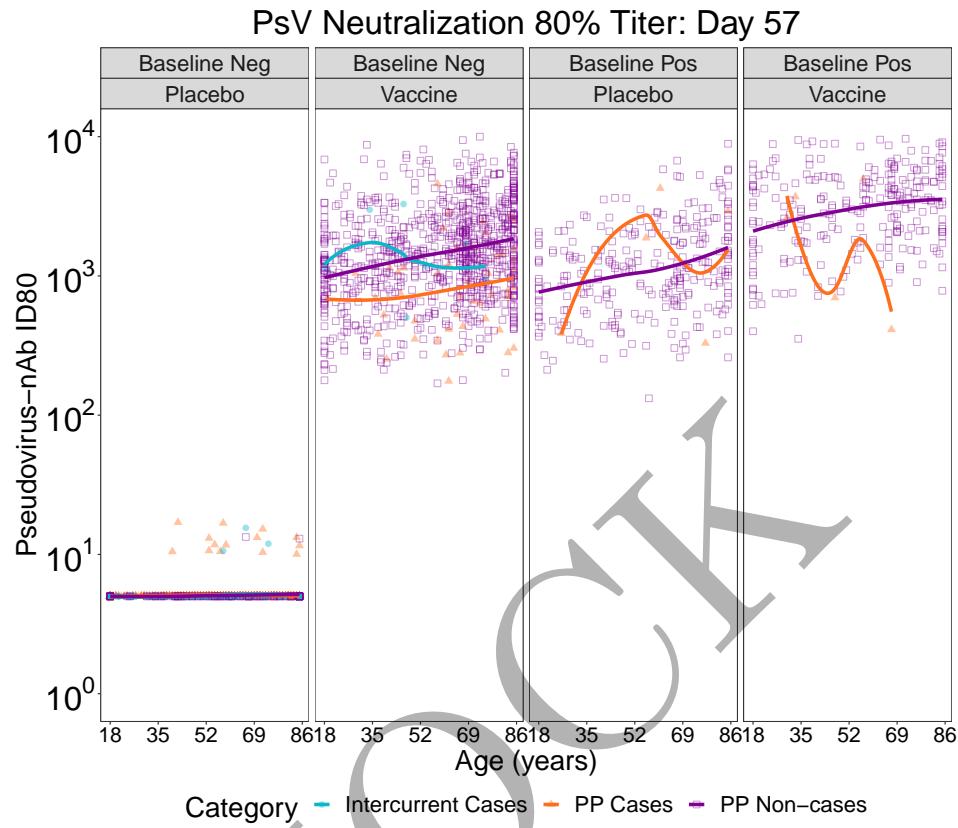


Figure 2.270: scatterplots of Pseudovirus Neutralization ID80: by arm at day 57

MOCK

Chapter 3

Day 57 Univariate CoR: Cox Models of Risk

The main regression model is the Cox proportional hazards model. All plots are made with Cox models fit unless specified otherwise.

3.1 Hazard ratios

Inference for Day 57 antibody marker covariate-adjusted correlates of risk of COVID in the vaccine group:
Hazard ratios per 10-fold increment in the marker*

Mock Immunologic Marker	No. cases / No. at-risk**	HR per 10-fold incr. Pt. Est.	95% CI	P-value (2-sided)	q-value	FWER
Anti Spike IgG (IU/ml)	51/11,174	0.21	(0.11-0.40)	<0.001	<0.001	<0.001
Anti RBD IgG (IU/ml)	51/11,174	0.27	(0.14-0.53)	<0.001	<0.001	<0.001
Pseudovirus-nAb ID50	51/11,174	0.02	(0.00-0.09)	<0.001	<0.001	<0.001
Pseudovirus-nAb ID80	51/11,174	0.05	(0.02-0.19)	<0.001	<0.001	<0.001

*Baseline covariates adjusted for: baseline risk score, at risk or not, community of color or not. Average follow-up time 173 days, maximum follow-up time 185 days.

**No. at-risk = number of per-protocol baseline negative vaccine recipients at-risk for COVID; no. cases = number of this cohort with an observed COVID endpoints starting 7 days post Day 57 visit.

Inference for Day 57 antibody marker covariate-adjusted correlates of risk of COVID in the vaccine group:
Hazard ratios for Middle vs. Upper tertile vs. Lower tertile*

Mock Immunologic Marker	Tertile	No. cases / No. at-risk**	Attack rate	Haz. Ratio Pt. Est.	95% CI	P-value (2-sided)	Overall P- value***	Overall q- value	Overall FWER
Anti Spike IgG (IU/ml)	Lower	17/2,765	0.0061	1	N/A	N/A	<0.001	<0.001	<0.001
	Middle	19/2,794	0.0068	0.61	(0.26-1.42)	0.251			
	Upper	15/5,616	0.0027	0.08	(0.03-0.19)	<0.001			
Anti RBD IgG (IU/ml)	Lower	23/3,626	0.0063	1	N/A	N/A	<0.001	<0.001	<0.001
	Middle	11/3,596	0.0031	0.34	(0.15-0.73)	0.006			
	Upper	17/3,953	0.0043	0.23	(0.11-0.48)	<0.001			
Pseudovirus-nAb ID50	Lower	19/2,214	0.0086	1	N/A	N/A	<0.001	<0.001	<0.001
	Middle	13/2,200	0.0059	0.73	(0.32-1.66)	0.454			
	Upper	19/6,760	0.0028	0.14	(0.07-0.29)	<0.001			
Pseudovirus-nAb ID80	Lower	26/2,690	0.0097	1	N/A	N/A	<0.001	<0.001	<0.001
	Middle	12/2,681	0.0045	0.38	(0.18-0.84)	0.016			
	Upper	13/5,803	0.0022	0.16	(0.08-0.33)	<0.001			
Placebo		1013/11,267	0.0899						

*Baseline covariates adjusted for: baseline risk score, at risk or not, community of color or not. Average follow-up time 173 days, maximum follow-up time 185 days. Cutpoints: Anti Spike IgG (IU/ml) [3.45, 4.01), Anti RBD IgG (IU/ml) [3.85, 4.49), Pseudovirus-nAb ID50 [3.46, 3.64), Pseudovirus-nAb ID80 [2.9, 3.11).

**No. at-risk = number of per-protocol baseline negative vaccine recipients at-risk for COVID at 7 days post Day 57 visit; no. cases = number of this cohort with an observed COVID endpoints.

***Generalized Wald-test p-value of the null hypothesis that the hazard rate is constant across the Lower, Middle, and Upper tertile groups.

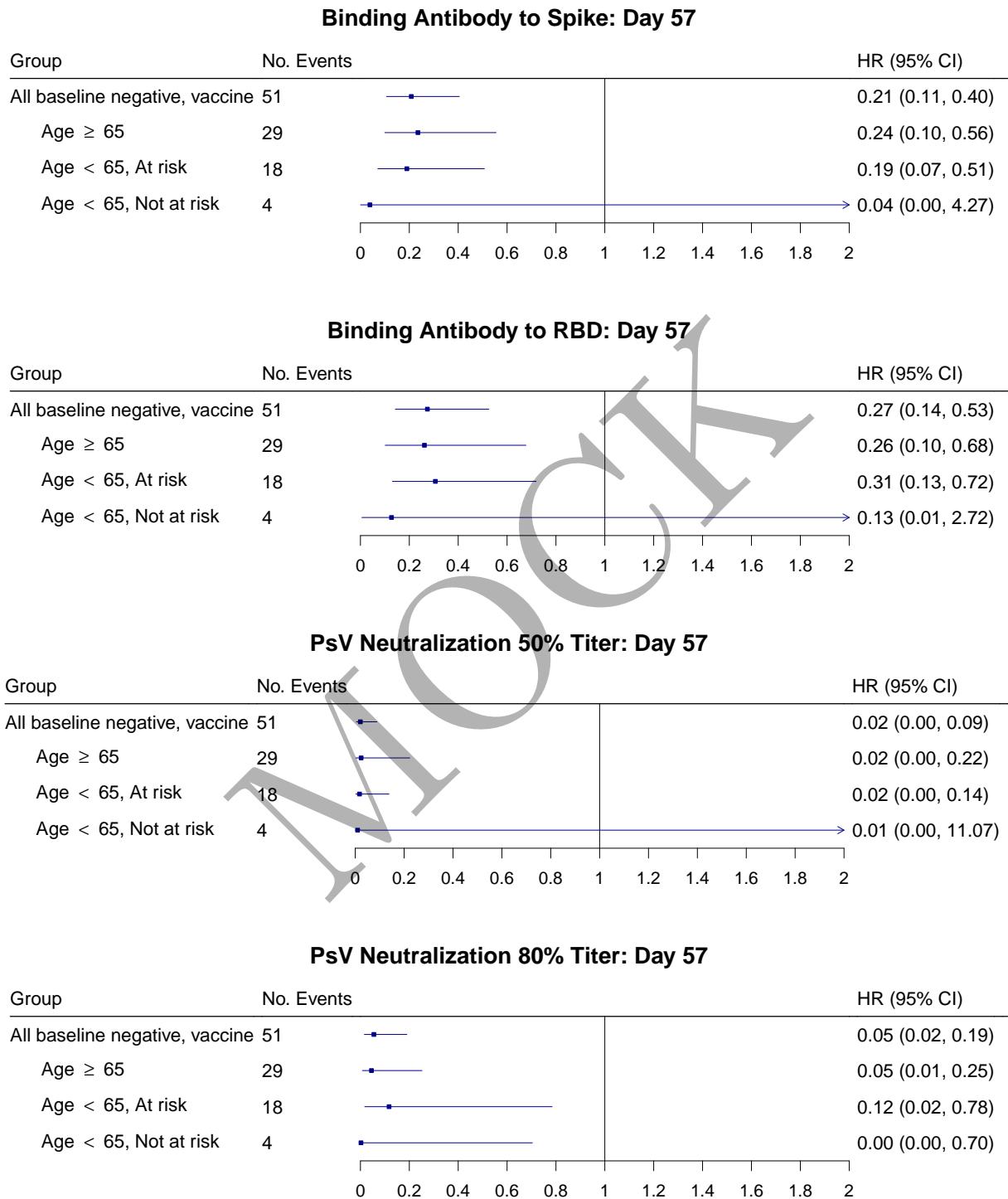


Figure 3.1: Forest plots of hazard ratios per 10-fold increase in the marker among baseline seronegative vaccine recipients and subgroups with 95% point-wise confidence intervals.

Binding Antibody to Spike: Day 57

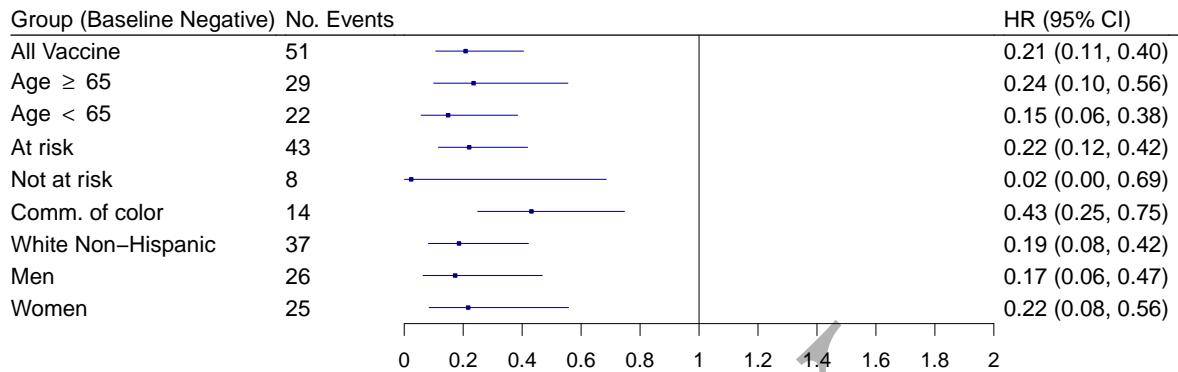


Figure 3.2: Forest plots of hazard ratios per 10-fold increase in the Day 57 binding Ab to spike markers among baseline seronegative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

Binding Antibody to RBD: Day 57

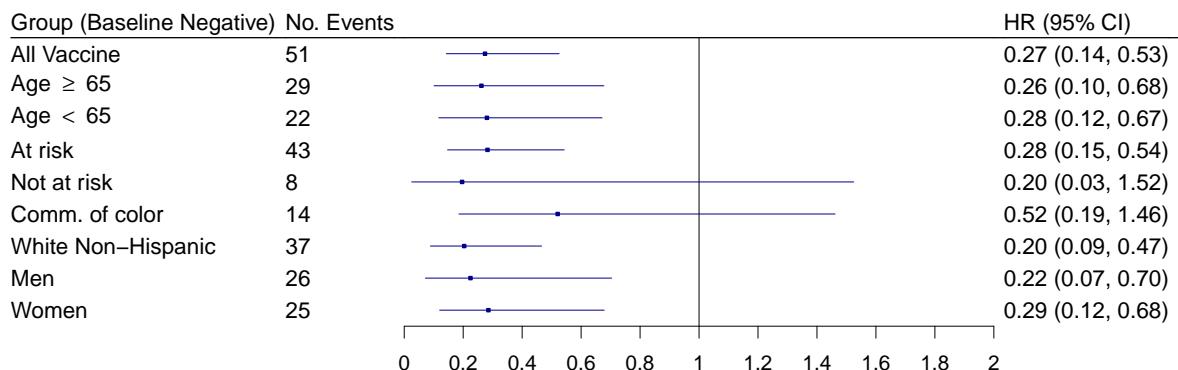


Figure 3.3: Forest plots of hazard ratios per 10-fold increase in the Day 57 binding Ab to RBD markers among baseline seronegative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

PsV Neutralization 50% Titer: Day 57

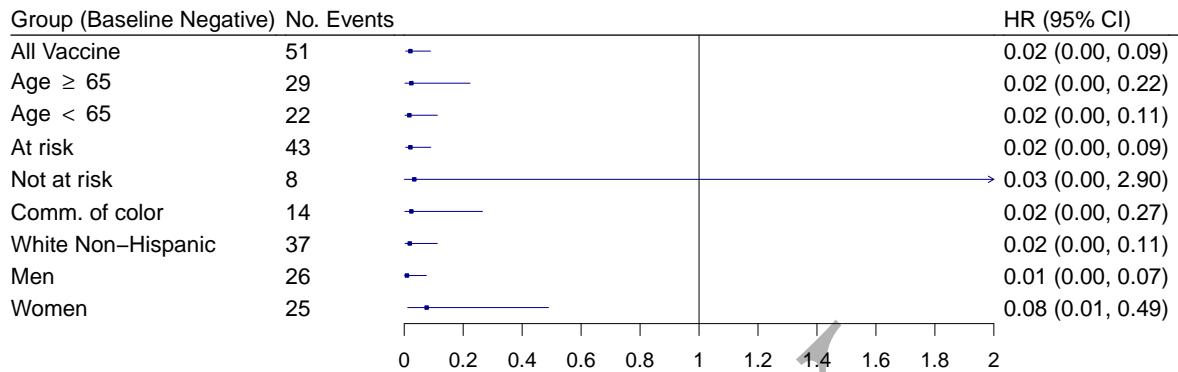


Figure 3.4: Forest plots of hazard ratios per 10-fold increase in the Day 57 pseudo neut ID50 markers among baseline seronegative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

PsV Neutralization 80% Titer: Day 57

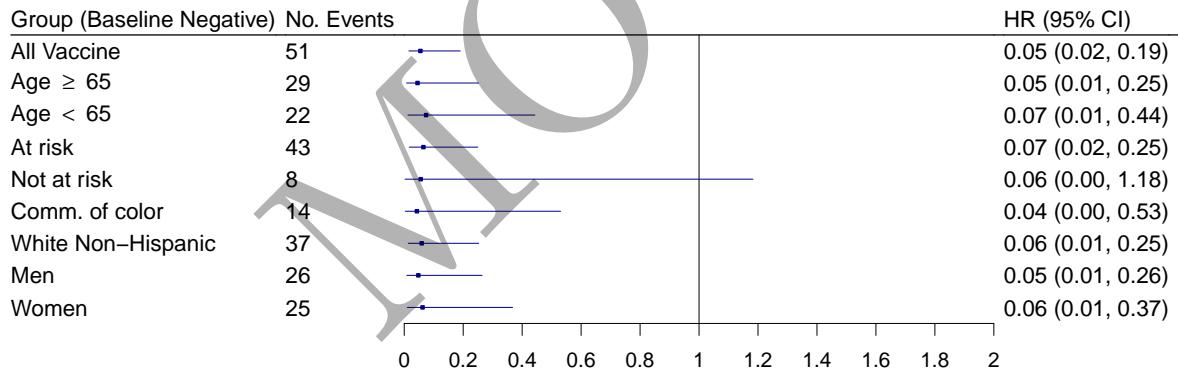


Figure 3.5: Forest plots of hazard ratios per 10-fold increase in the Day 57 pseudo neut ID80 markers among baseline seronegative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

3.2 Marginalized risk and controlled vaccine efficacy plots

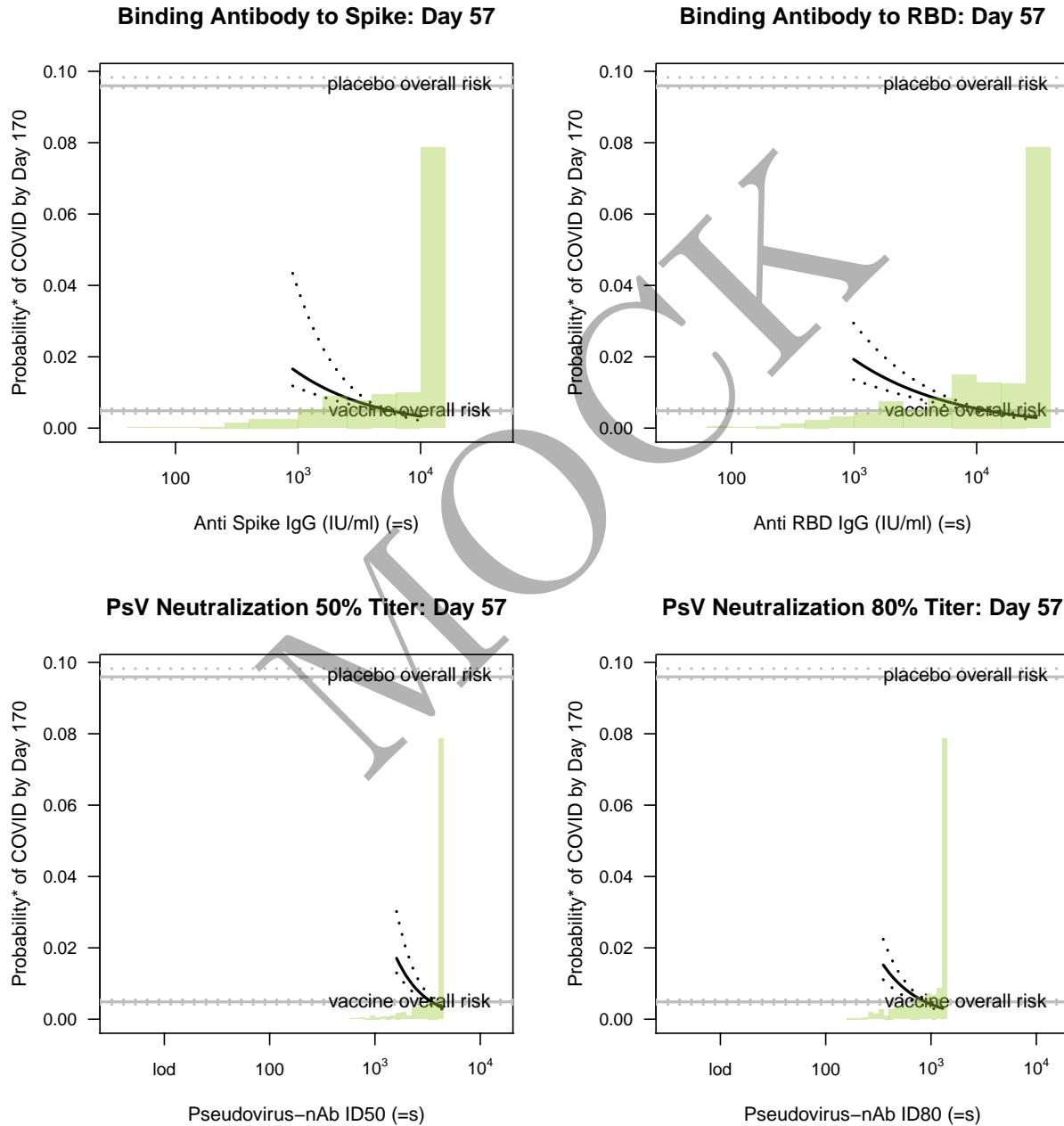


Figure 3.6: Marginalized cumulative risk by Day 170 as functions of Day 57 markers (=s) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands. The horizontal lines indicate the overall cumulative risk of the placebo and vaccine arms by Day 170 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod: lower limit of detection.

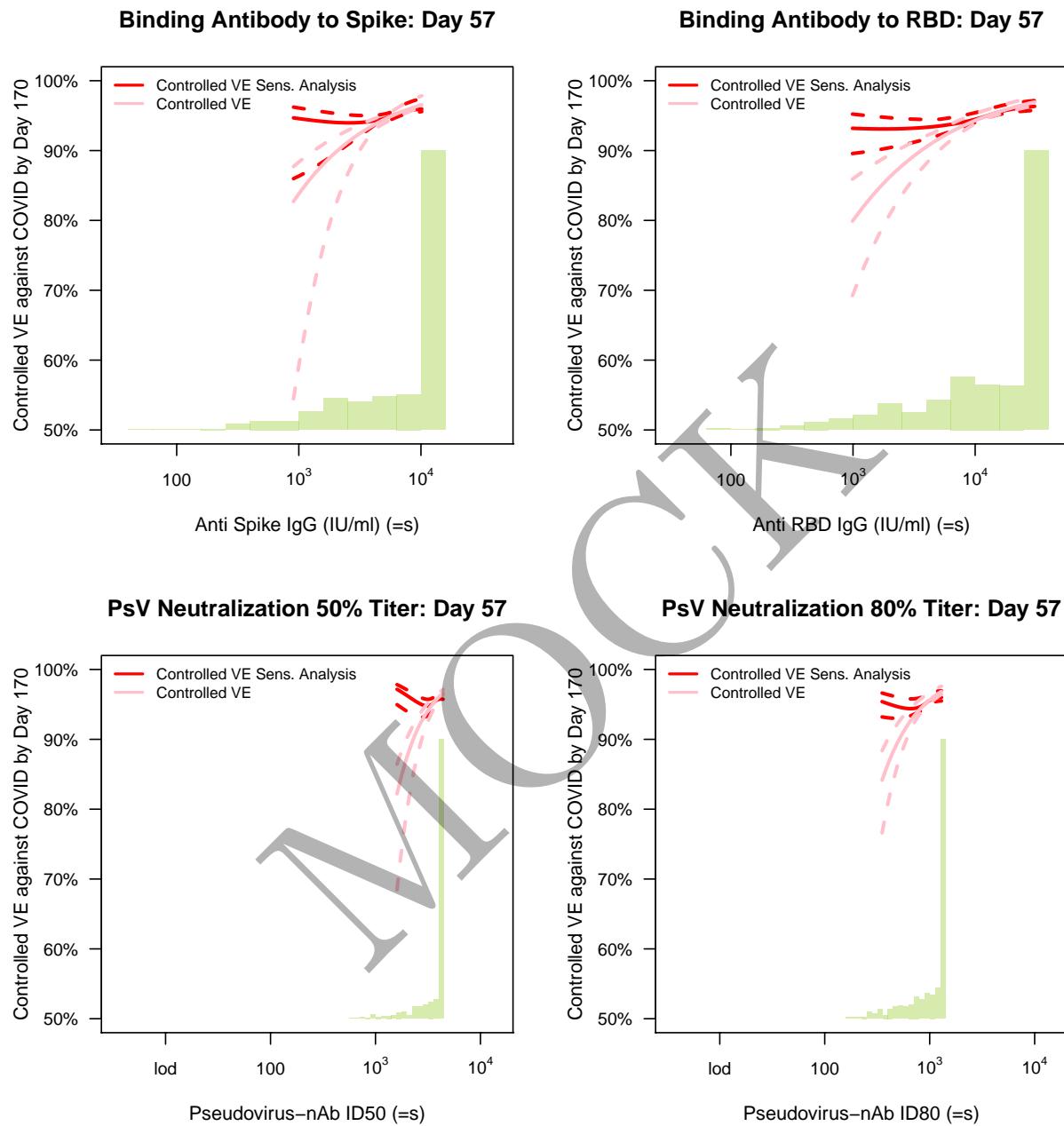


Figure 3.7: Controlled VE with sensitivity analysis as functions of Day 57 markers (=s) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands. Histograms of the immunological markers in the vaccine arm are overlaid. lod: lower limit of detection.

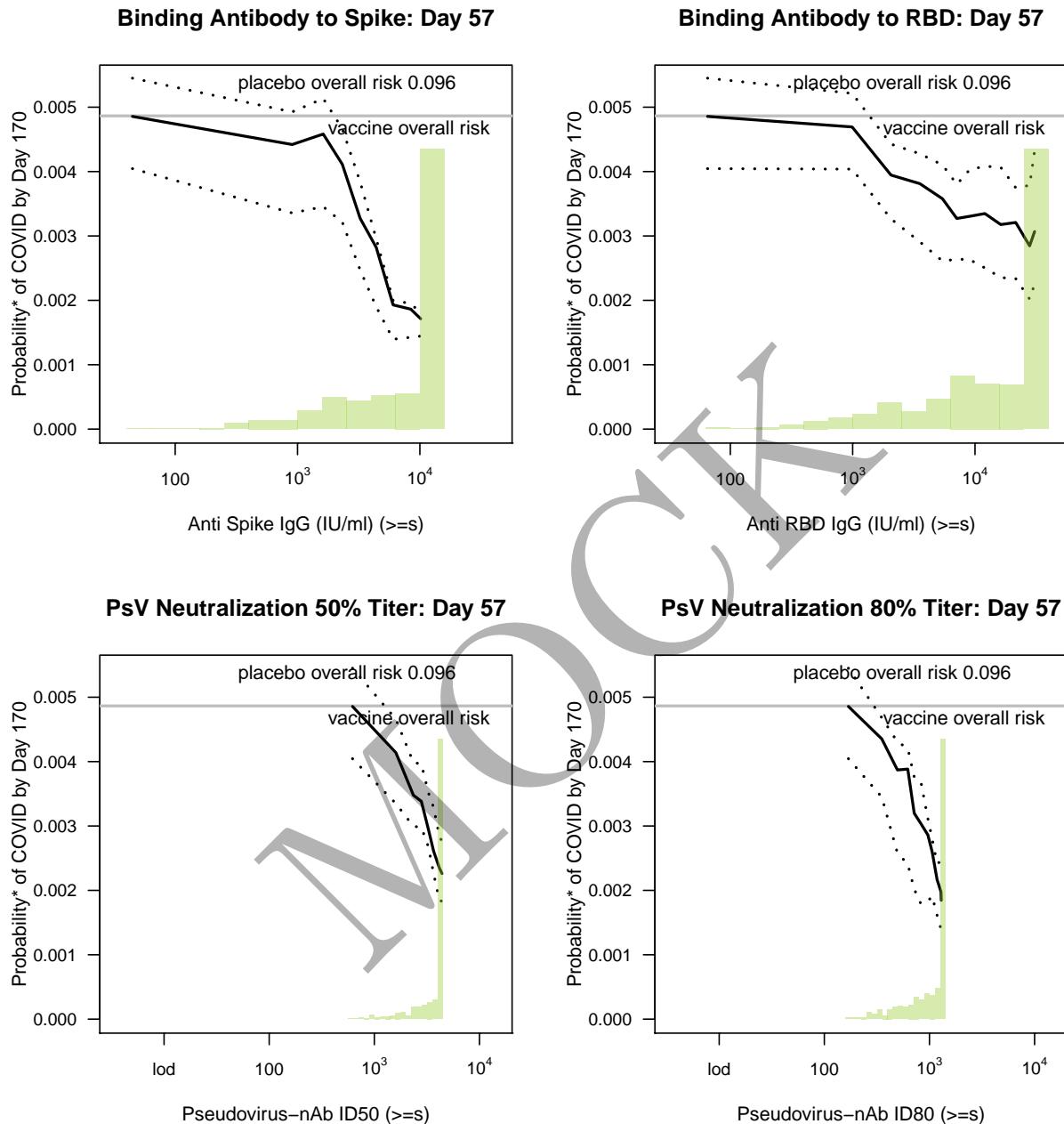


Figure 3.8: Marginalized cumulative risk by Day 170 as functions of Day 57 markers above a threshold ($\geq s$) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands (at least 5 cases are required). The horizontal lines indicate the overall cumulative risk of the vaccine arm by Day 170 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod: lower limit of detection.

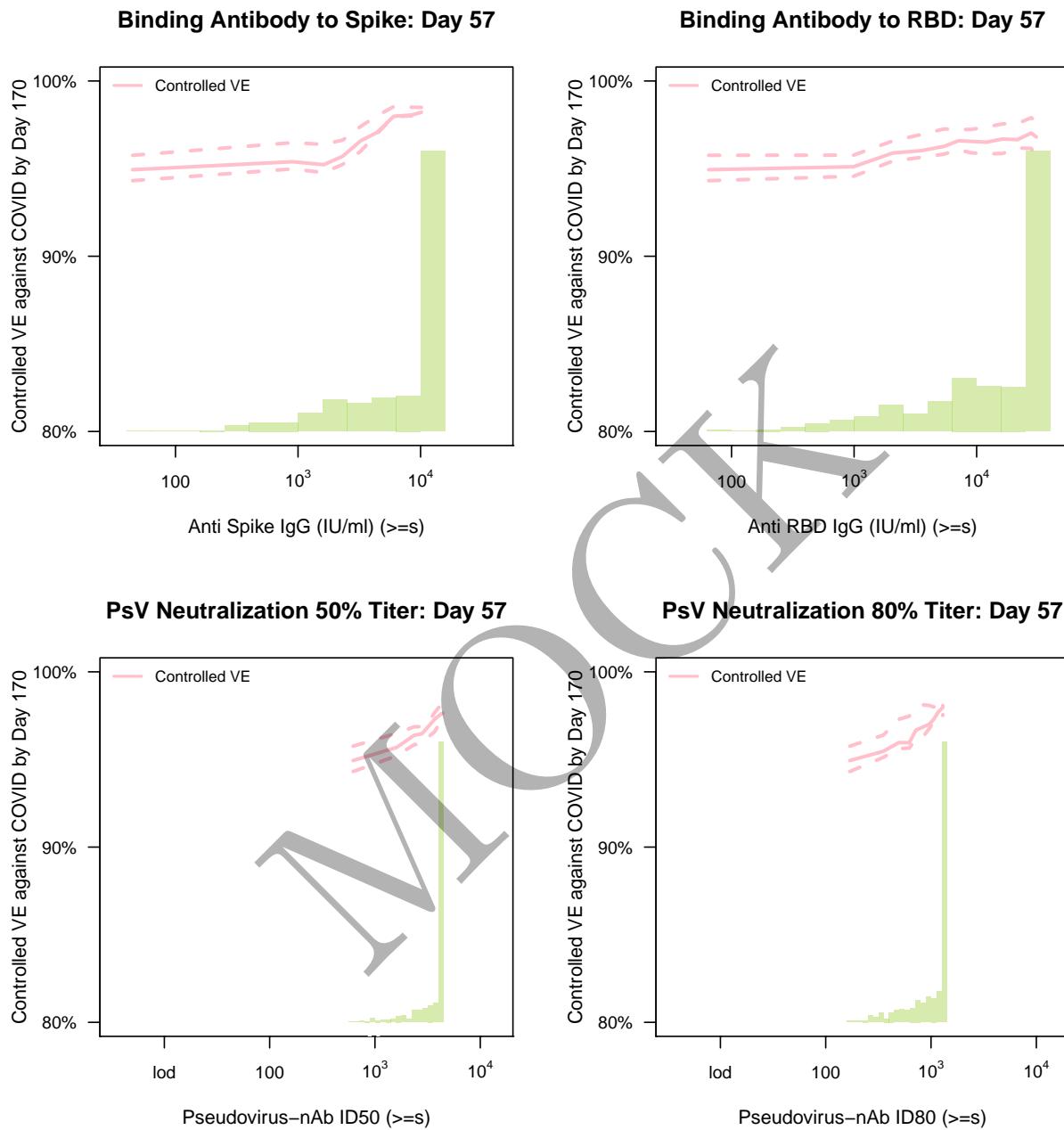


Figure 3.9: Controlled VE as functions of Day 57 markers ($\geq s$) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands. Histograms of the immunological markers in the vaccine arm are overlaid. lod: lower limit of detection.

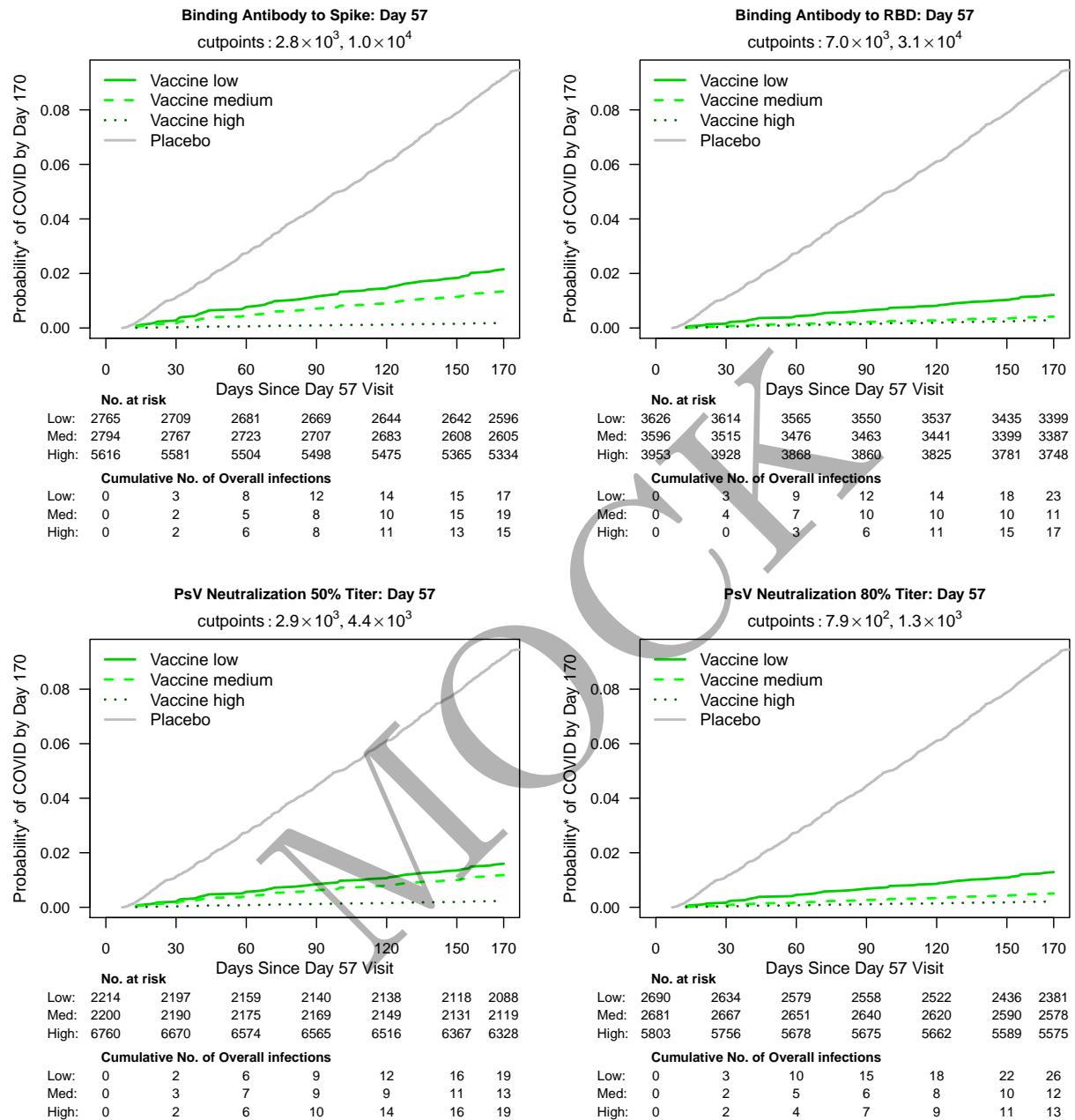


Figure 3.10: Marginalized cumulative incidence rate curves for trichotomized Day 57 markers among baseline seronegative vaccine recipients. The gray line is the overall cumulative incidence rate curve in the placebo arm.

Chapter 4

Day 29 Univariate CoR: Cox Models of Risk

The main regression model is the Cox proportional hazards model. All plots are made with Cox models fit unless specified otherwise.

4.1 Hazard ratios

Inference for Day 29 antibody marker covariate-adjusted correlates of risk of COVID in the vaccine group:
Hazard ratios per 10-fold increment in the marker*

Mock Immunologic Marker	No. cases / No. at-risk**	HR per 10-fold incr. Pt. Est.	95% CI	P-value (2-sided)	q-value	FWER
Anti Spike IgG (IU/ml)	59/11,228	0.25	(0.15-0.41)	<0.001	<0.001	<0.001
Anti RBD IgG (IU/ml)	59/11,228	0.47	(0.29-0.76)	0.002	<0.001	<0.001
Pseudovirus-nAb ID50	59/11,228	0.10	(0.05-0.20)	<0.001	<0.001	<0.001
Pseudovirus-nAb ID80	59/11,228	0.21	(0.10-0.47)	<0.001	<0.001	<0.001

*Baseline covariates adjusted for: baseline risk score, at risk or not, community of color or not. Average follow-up time 201 days, maximum follow-up time 213 days.

**No. at-risk = number of per-protocol baseline negative vaccine recipients at-risk for COVID; no. cases = number of this cohort with an observed COVID endpoints starting 7 days post Day 29 visit.

Inference for Day 29 antibody marker covariate-adjusted correlates of risk of COVID in the vaccine group:
Hazard ratios for Middle vs. Upper tertile vs. Lower tertile*

Mock Immunologic Marker	Tertile	No. cases / No. at-risk**	Attack rate	Pt. Est.	Haz. Ratio 95% CI	P-value (2-sided)	Overall P- value***	Overall q- value	Overall FWER
Anti Spike IgG (IU/ml)	Lower	25/3,724	0.0067	1	N/A	N/A	<0.001	<0.001	<0.001
	Middle	22/3,732	0.0059	0.55	(0.29-1.07)	0.078			
	Upper	12/3,773	0.0032	0.11	(0.05-0.25)	<0.001			
Anti RBD IgG (IU/ml)	Lower	21/3,747	0.0056	1	N/A	N/A	0.018	<0.001	.100
	Middle	19/3,753	0.0051	0.42	(0.20-0.91)	0.028			
	Upper	19/3,728	0.0051	0.28	(0.12-0.69)	0.005			
Pseudovirus-nAb ID50	Lower	35/3,768	0.0093	1	N/A	N/A	<0.001	<0.001	<0.001
	Middle	16/3,719	0.0043	0.27	(0.14-0.52)	<0.001			
	Upper	8/3,741	0.0021	0.09	(0.04-0.20)	<0.001			
Pseudovirus-nAb ID80	Lower	26/3,743	0.0069	1	N/A	N/A	0.003	<0.001	<0.001
	Middle	18/3,762	0.0048	0.43	(0.23-0.84)	0.013			
	Upper	15/3,722	0.0040	0.31	(0.15-0.64)	0.001			
Placebo		1172/11,476	0.1021						

*Baseline covariates adjusted for: baseline risk score, at risk or not, community of color or not. Average follow-up time 201 days, maximum follow-up time 213 days. Cutpoints: Anti Spike IgG (IU/ml) [2.26, 2.75], Anti RBD IgG (IU/ml) [2.38, 3.02], Pseudovirus-nAb ID50 [2.24, 2.58], Pseudovirus-nAb ID80 [1.63, 1.93].

**No. at-risk = number of per-protocol baseline negative vaccine recipients at-risk for COVID at 7 days post Day 29 visit; no. cases = number of this cohort with an observed COVID endpoints.

***Generalized Wald-test p-value of the null hypothesis that the hazard rate is constant across the Lower, Middle, and Upper tertile groups.

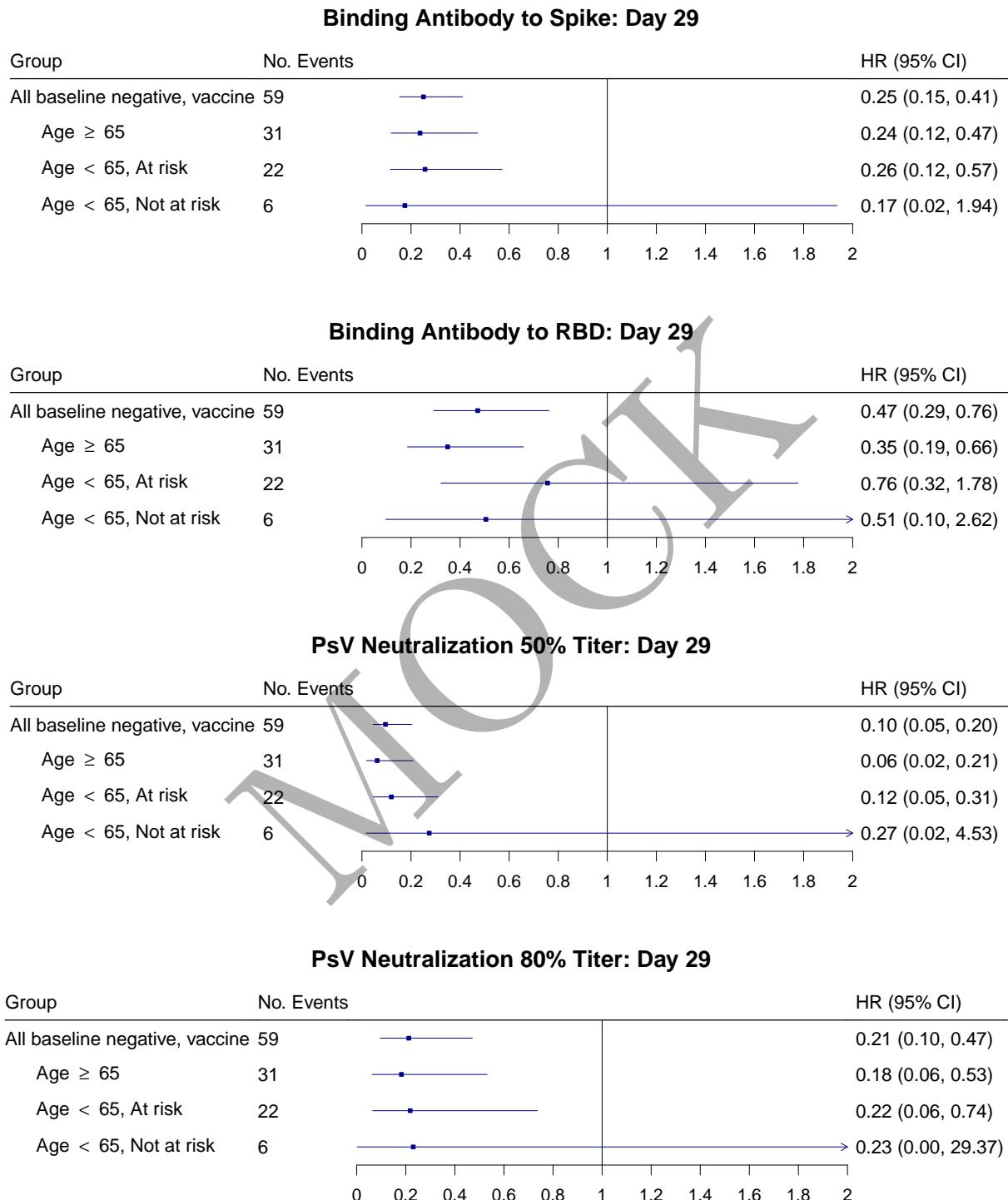


Figure 4.1: Forest plots of hazard ratios per 10-fold increase in the marker among baseline seronegative vaccine recipients and subgroups with 95% point-wise confidence intervals.

Binding Antibody to Spike: Day 29

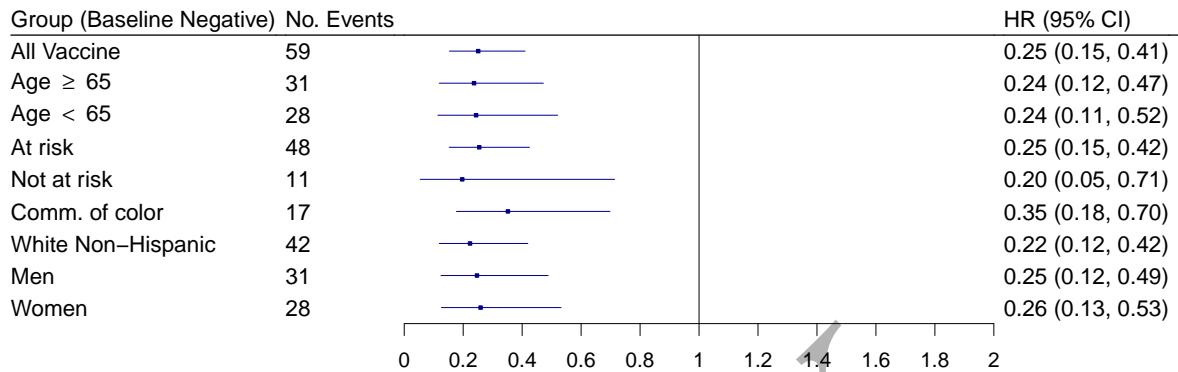


Figure 4.2: Forest plots of hazard ratios per 10-fold increase in the Day 29 binding Ab to spike markers among baseline seronegative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

Binding Antibody to RBD: Day 29

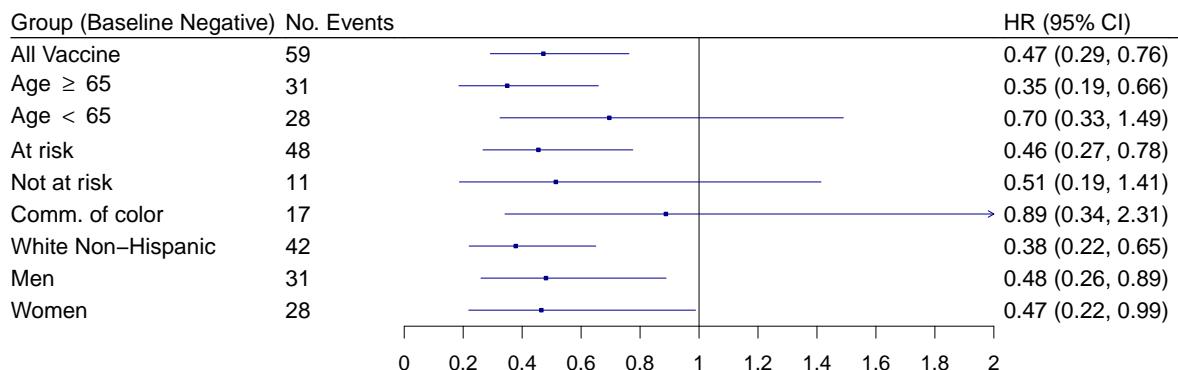


Figure 4.3: Forest plots of hazard ratios per 10-fold increase in the Day 29 binding Ab to RBD markers among baseline seronegative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

PsV Neutralization 50% Titer: Day 29

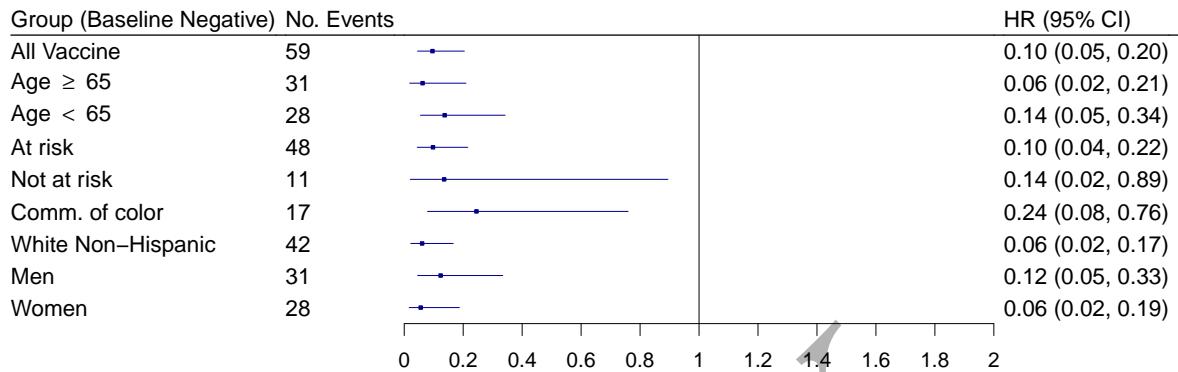


Figure 4.4: Forest plots of hazard ratios per 10-fold increase in the Day 29 pseudo neut ID50 markers among baseline seronegative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

PsV Neutralization 80% Titer: Day 29

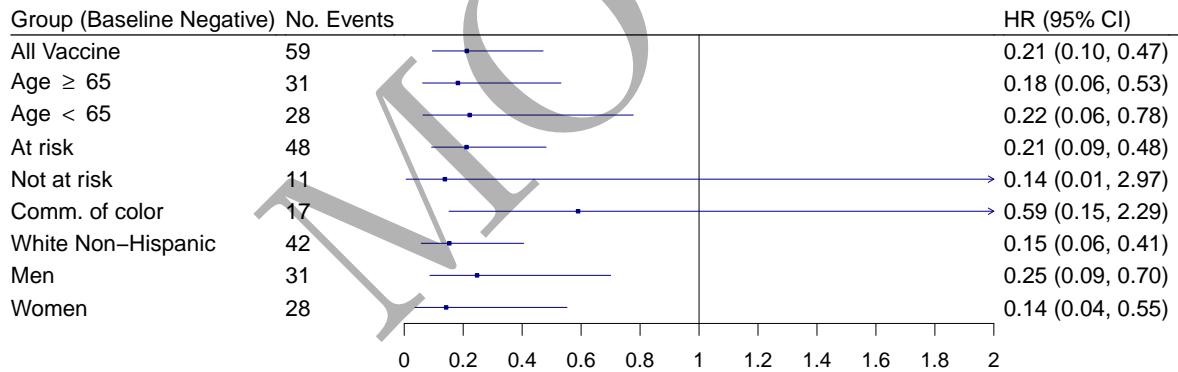


Figure 4.5: Forest plots of hazard ratios per 10-fold increase in the Day 29 pseudo neut ID80 markers among baseline seronegative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

4.2 Marginalized risk and controlled vaccine efficacy plots

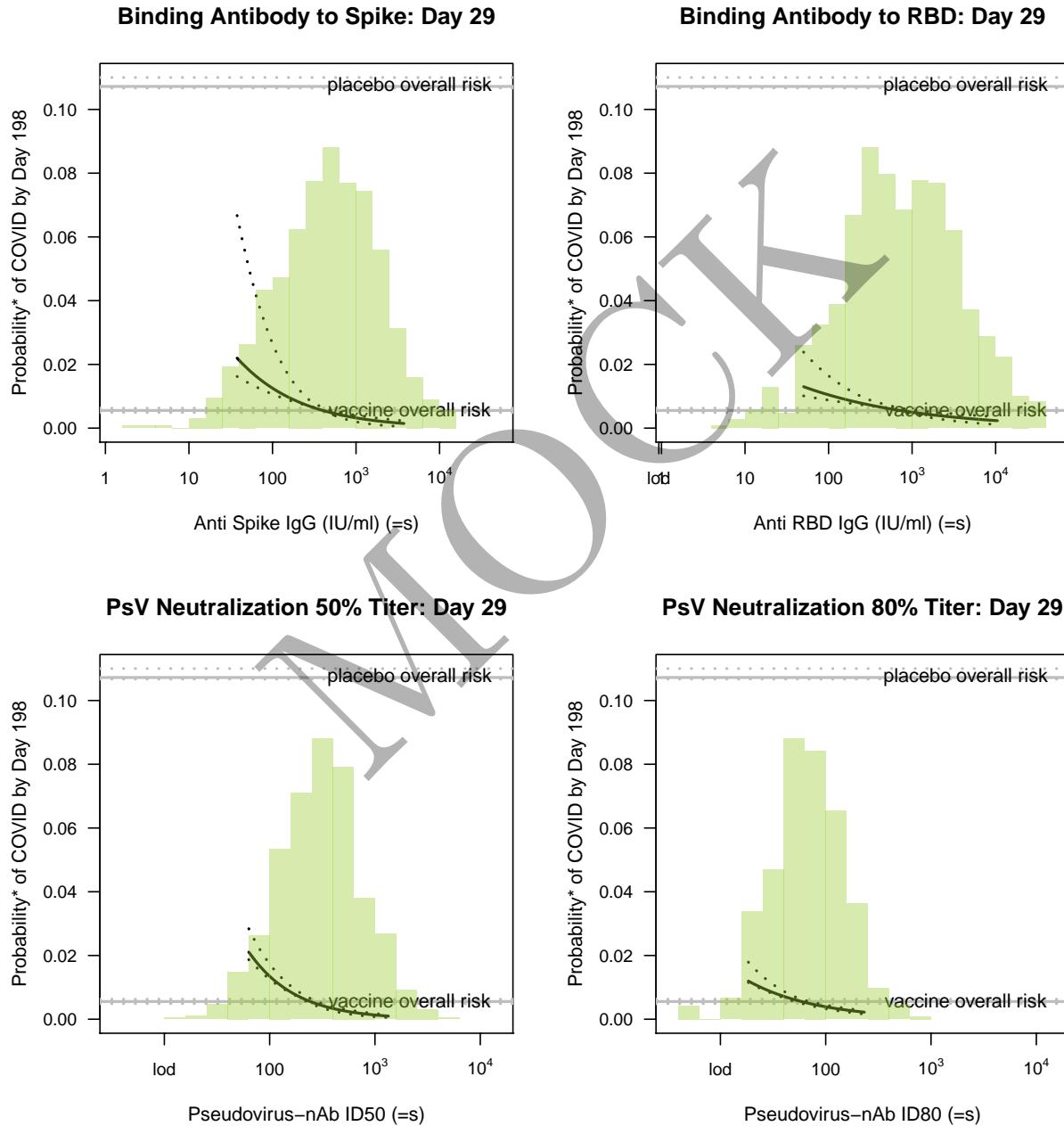


Figure 4.6: Marginalized cumulative risk by Day 198 as functions of Day 29 markers ($=s$) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands. The horizontal lines indicate the overall cumulative risk of the placebo and vaccine arms by Day 198 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod: lower limit of detection.

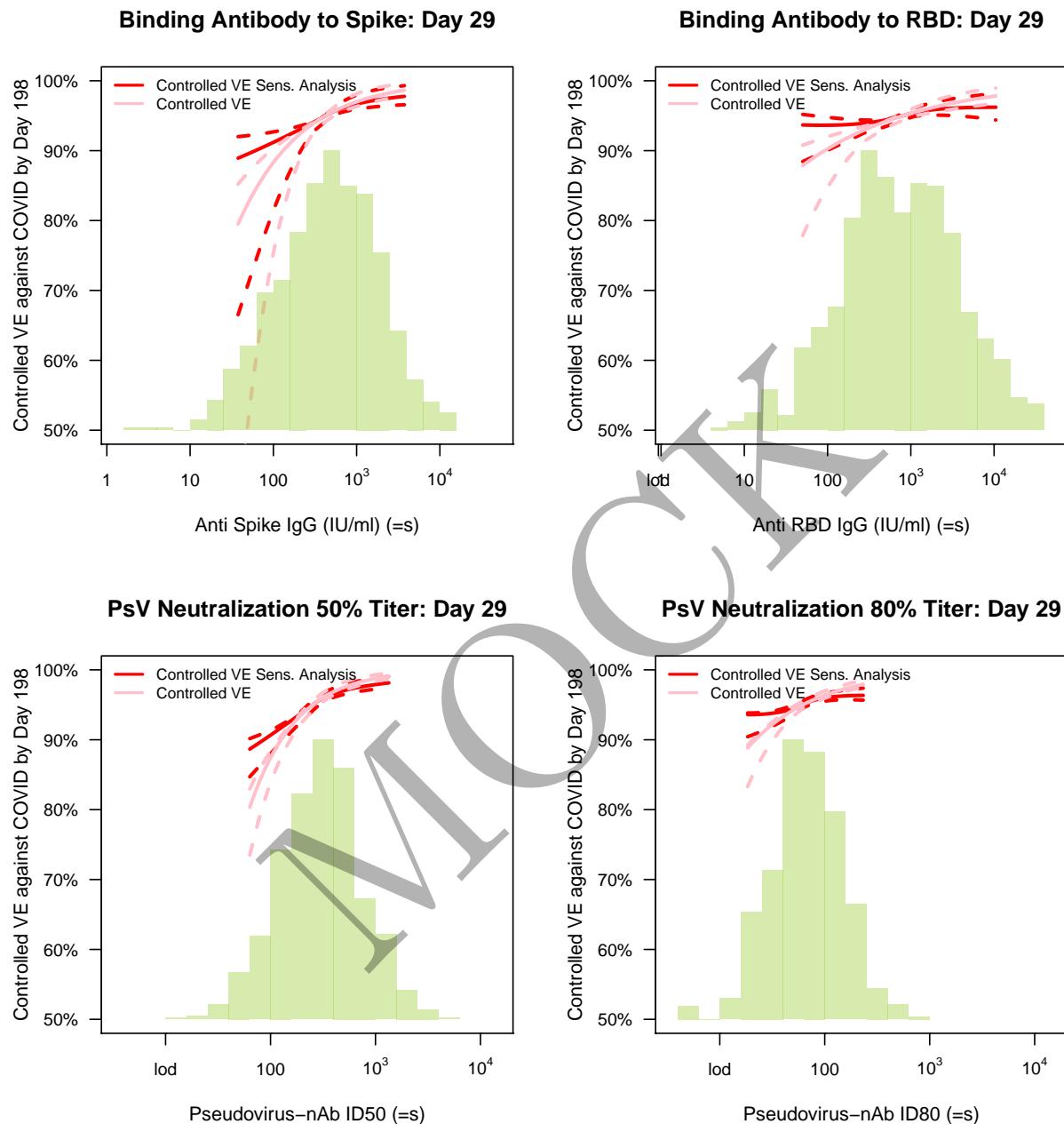


Figure 4.7: Controlled VE with sensitivity analysis as functions of Day 29 markers (=s) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands. Histograms of the immunological markers in the vaccine arm are overlaid. lod: lower limit of detection.

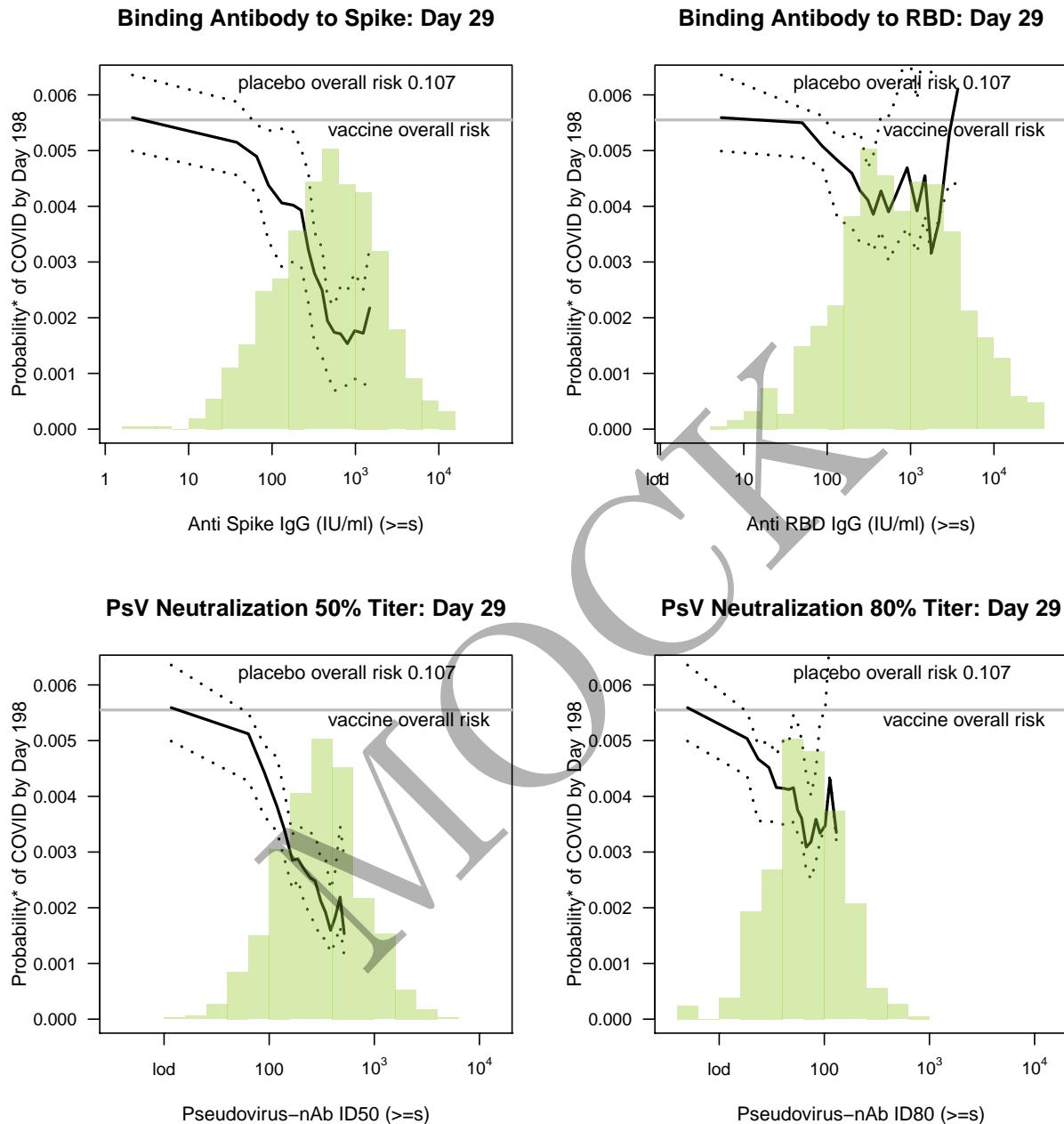


Figure 4.8: Marginalized cumulative risk by Day 198 as functions of Day 29 markers above a threshold ($\geq s$) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands (at least 5 cases are required). The horizontal lines indicate the overall cumulative risk of the vaccine arm by Day 198 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod: lower limit of detection.

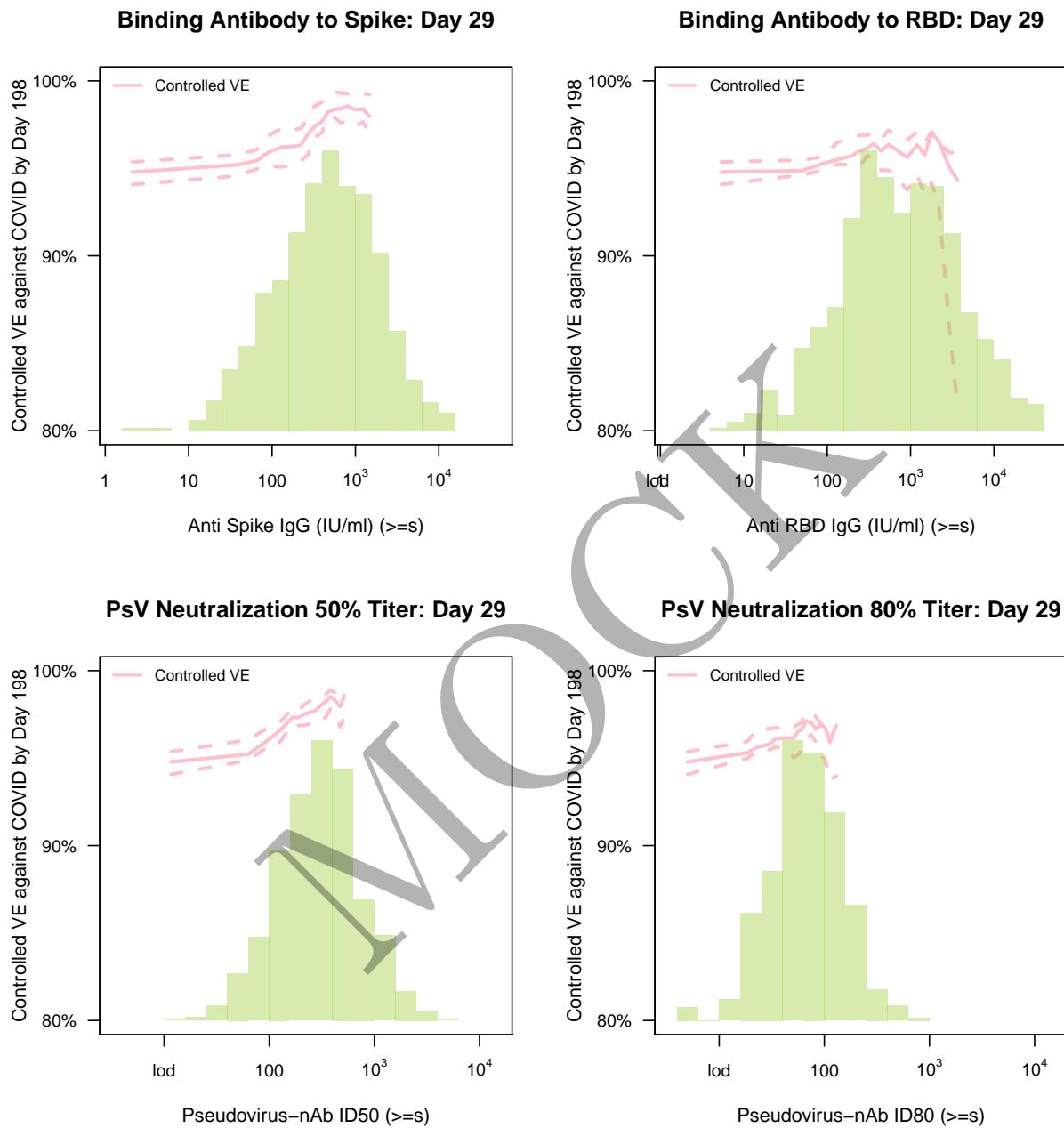


Figure 4.9: Controlled VE as functions of Day 29 markers ($\geq s$) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands. Histograms of the immunological markers in the vaccine arm are overlaid. lod: lower limit of detection.

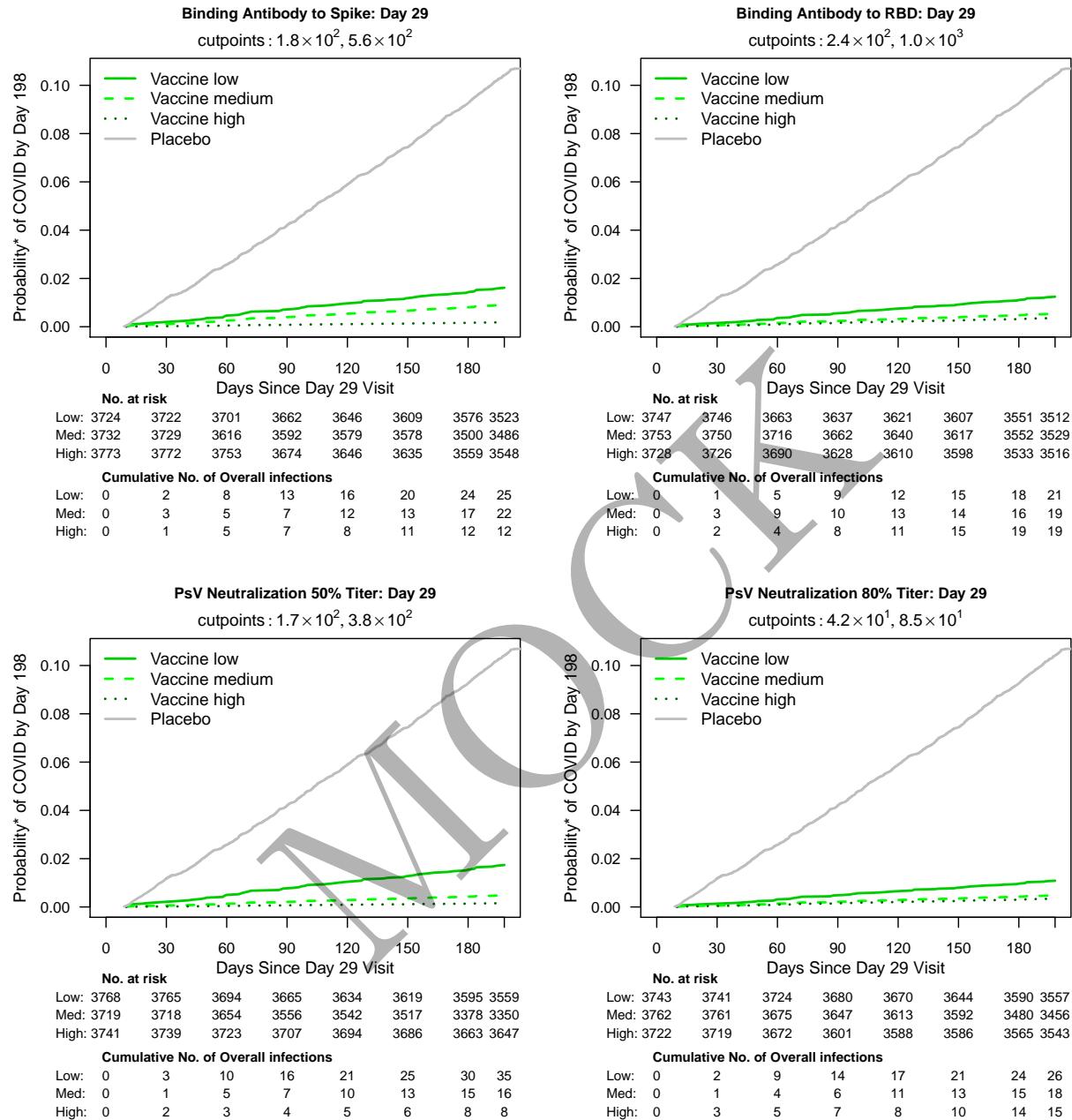


Figure 4.10: Marginalized cumulative incidence rate curves for trichotomized Day 29 markers among baseline seronegative vaccine recipients. The gray line is the overall cumulative incidence rate curve in the placebo arm.

Chapter 5

Univariate CoR: Nonparametric Threshold Modeling

An extension of the unadjusted nonparametric threshold-searching approach developed in Donovan, Hudgens, and Gilbert (2019), the covariate-adjusted TMLE-based approach developed by van der Laan, Zhang, Gilbert (submitted) is used to estimate the so-called threshold-response function $E_X[E[Y | S \geq s, X, A = 1] | A = 1]$ for a range of thresholds s . Here, X is a set of baseline characteristics, $A = 1$ represents the vaccine group, S is the biomarker/immune-response/correlate of interest, and Y is the indicator of COVID disease before some time point t_f . This parameter can be viewed as a causal/covariate-adjusted version of the parameter $P(Y = 1 | S \geq s, A = 1)$. Intuitively, the threshold-response at a given threshold is the expected probability of obtaining COVID disease if one experiences a marker/immune-response value above that threshold. The threshold-response function is estimated for each of the four Day 57 antibody markers, in each case adjusting for the baseline covariates: baseline risk score, high risk indicator, and underrepresented minority status. A parametric learner, selected via cross-validation, is used for the covariate adjustment. A number of plots and tables are reported:

1. A plot and table with risk estimates and point-wise 95% confidence intervals
2. A plot and table with risk estimates and simultaneous 95% confidence bands
3. Monotone-corrected versions of 1 and 2.

A reverse cumulative distribution function curve estimated by the IPW NPMLE of the marker values is superimposed on the threshold-response plots and a dashed red line is added to mark the threshold value after which no more events are observed.

5.1 Plots and Tables with estimates and pointwise confidence interval for Day 57

MOCK

5.1.1 Day 57 Spike protein binding antibody

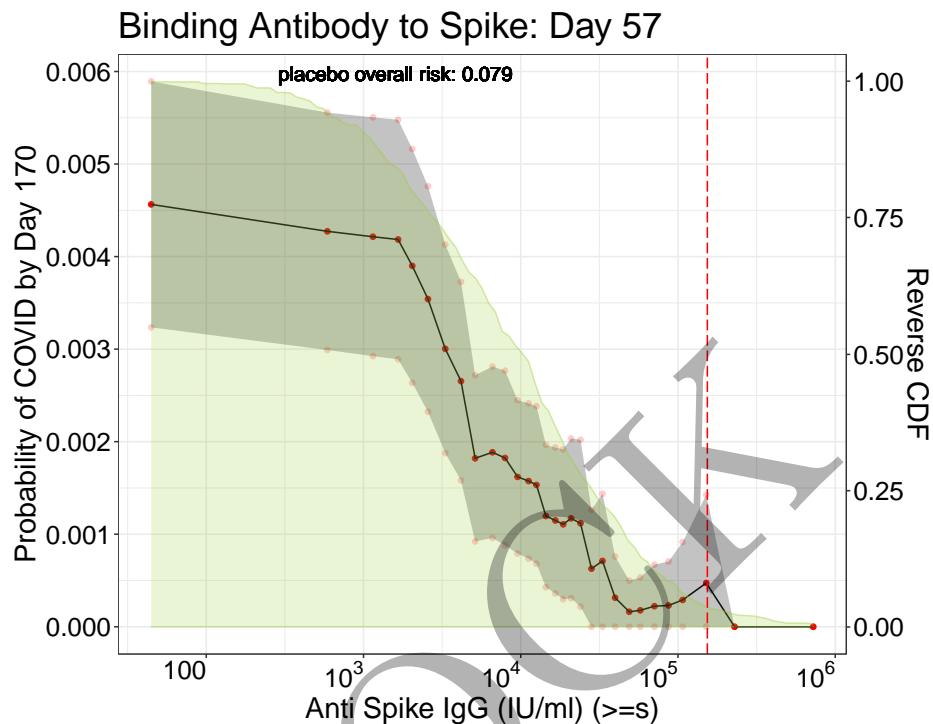


Figure 5.1: Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table of risk estimates for a range of thresholds of Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.650	$4.47 * 10^1$	0.00456	0.00324	0.00589
3.218	$1.65 * 10^3$	0.00418	0.00289	0.00548
3.521	$3.32 * 10^3$	0.00300	0.00188	0.00413
3.899	$7.93 * 10^3$	0.00182	0.00088	0.00277
4.104	$1.27 * 10^4$	0.00153	0.00068	0.00238
4.270	$1.86 * 10^4$	0.00111	0.00030	0.00192
4.454	$2.84 * 10^4$	0.00063	0.00000	0.00126
4.760	$5.75 * 10^4$	0.00018	0.00000	0.00053
5.028	$1.07 * 10^5$	0.00029	0.00000	0.00091
5.864	$7.31 * 10^5$	0.00000	0.00000	NA

5.1.2 Day 57 RBD binding antibody

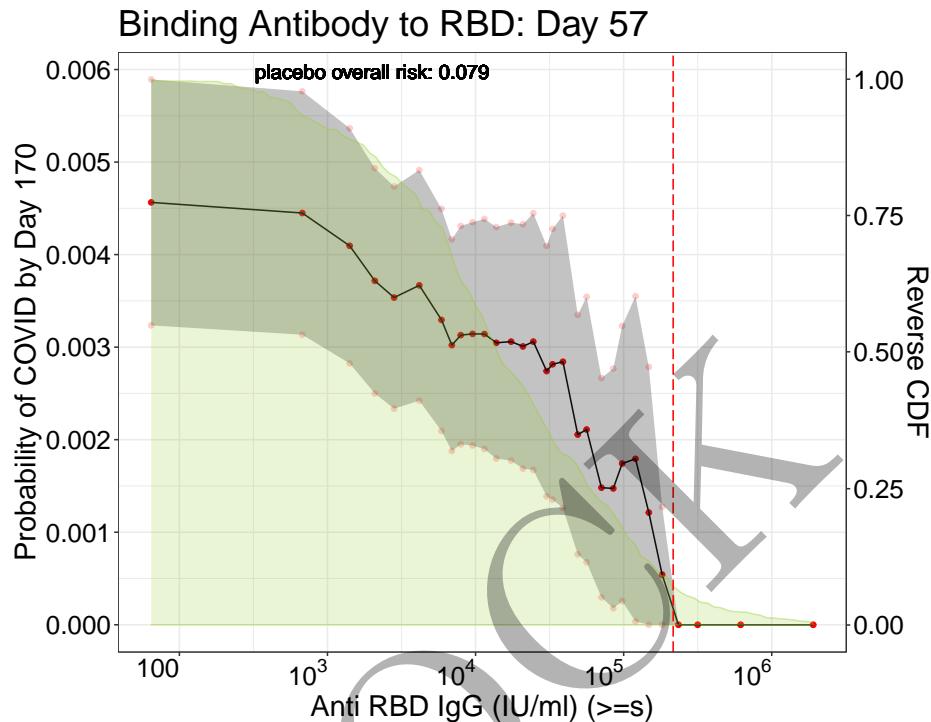


Figure 5.2: Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table of risk estimates for a range of thresholds of Day 57 RBD binding antibody levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.814	$6.52 * 10^1$	0.00456	0.00324	0.00589
3.316	$2.07 * 10^3$	0.00372	0.00250	0.00493
3.771	$5.90 * 10^3$	0.00329	0.00209	0.00450
4.064	$1.16 * 10^4$	0.00314	0.00190	0.00438
4.320	$2.09 * 10^4$	0.00301	0.00169	0.00433
4.523	$3.33 * 10^4$	0.00281	0.00135	0.00428
4.752	$5.65 * 10^4$	0.00211	0.00068	0.00354
5.080	$1.20 * 10^5$	0.00179	0.00004	0.00355
5.368	$2.33 * 10^5$	0.00000	0.00000	NA
6.276	$1.89 * 10^6$	0.00000	0.00000	NA

5.1.3 Day 57 Pseudo virus-neutralizing antibody (50% titer)

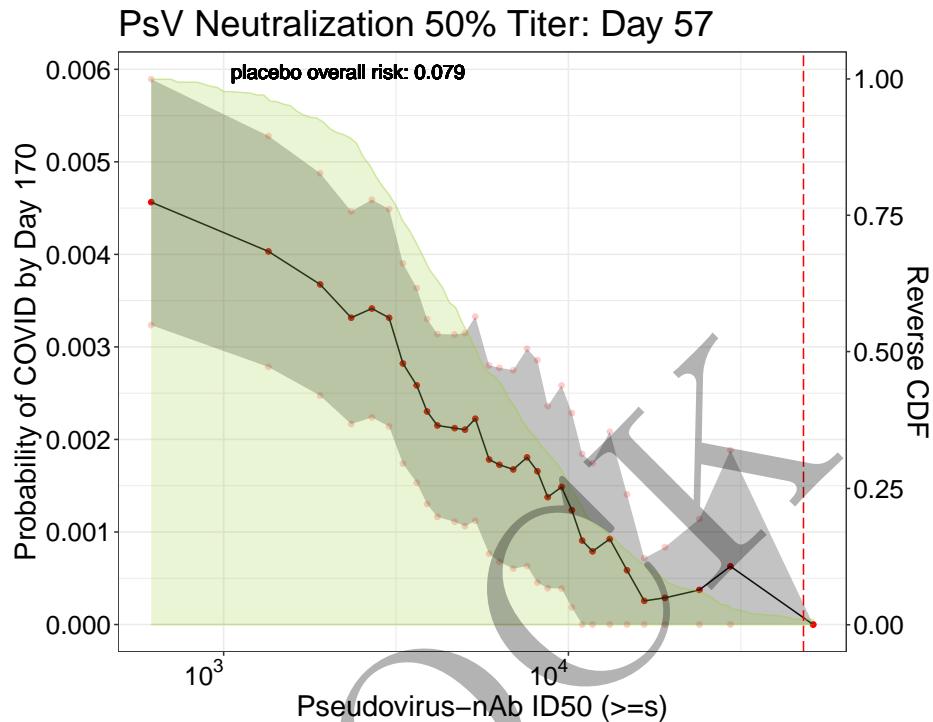


Figure 5.3: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table of risk estimates for a range of thresholds of Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
2.792	$6.19 * 10^2$	0.00456	0.00324	0.00589
3.375	$2.37 * 10^3$	0.00332	0.00217	0.00446
3.519	$3.30 * 10^3$	0.00282	0.00174	0.00390
3.669	$4.67 * 10^3$	0.00212	0.00111	0.00313
3.768	$5.86 * 10^3$	0.00178	0.00077	0.00280
3.878	$7.55 * 10^3$	0.00181	0.00063	0.00298
3.979	$9.53 * 10^3$	0.00149	0.00039	0.00258
4.122	$1.32 * 10^4$	0.00092	0.00000	0.00208
4.281	$1.91 * 10^4$	0.00029	0.00000	0.00084
4.713	$5.16 * 10^4$	0.00000	0.00000	NA

5.1.4 Day 57 Pseudo virus-neutralizing antibody (80% titer)

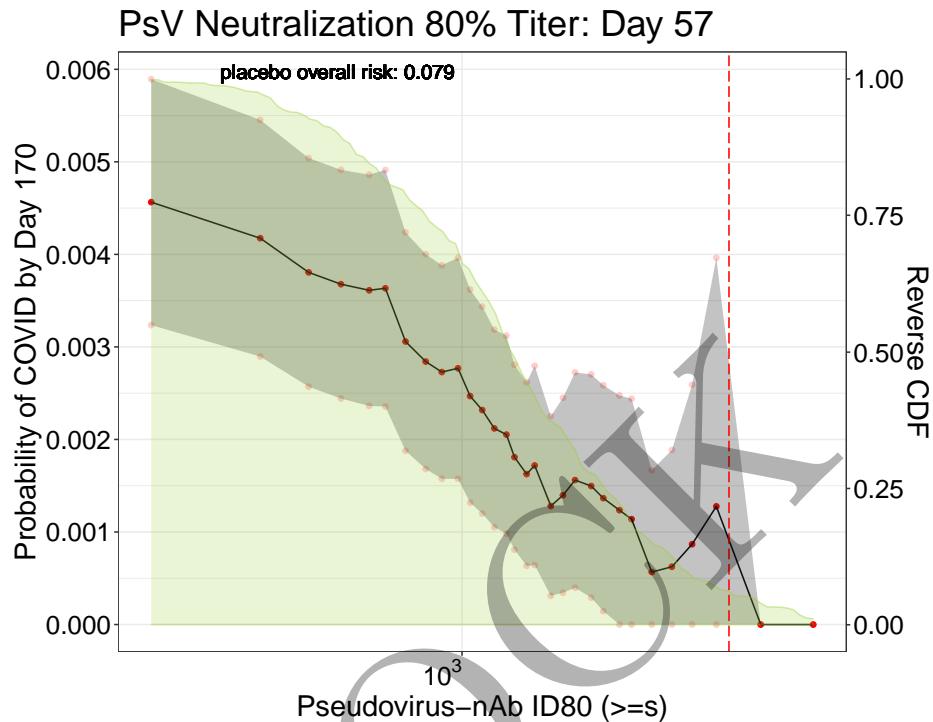


Figure 5.4: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table of risk estimates for a range of thresholds of Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
2.229	$1.69 * 10^2$	0.00456	0.00324	0.00589
2.697	$4.98 * 10^2$	0.00368	0.00244	0.00491
2.859	$7.23 * 10^2$	0.00306	0.00188	0.00424
3.020	$1.05 * 10^3$	0.00247	0.00132	0.00362
3.107	$1.28 * 10^3$	0.00205	0.00098	0.00312
3.184	$1.53 * 10^3$	0.00172	0.00064	0.00280
3.284	$1.92 * 10^3$	0.00156	0.00040	0.00272
3.421	$2.64 * 10^3$	0.00114	0.00000	0.00244
3.565	$3.67 * 10^3$	0.00087	0.00000	0.00259
3.871	$7.43 * 10^3$	0.00000	0.00000	NA

5.2 Plots and Tables with estimates and pointwise confidence intervals for Day 29

MOCK

5.2.1 Day 29 Spike protein antibody

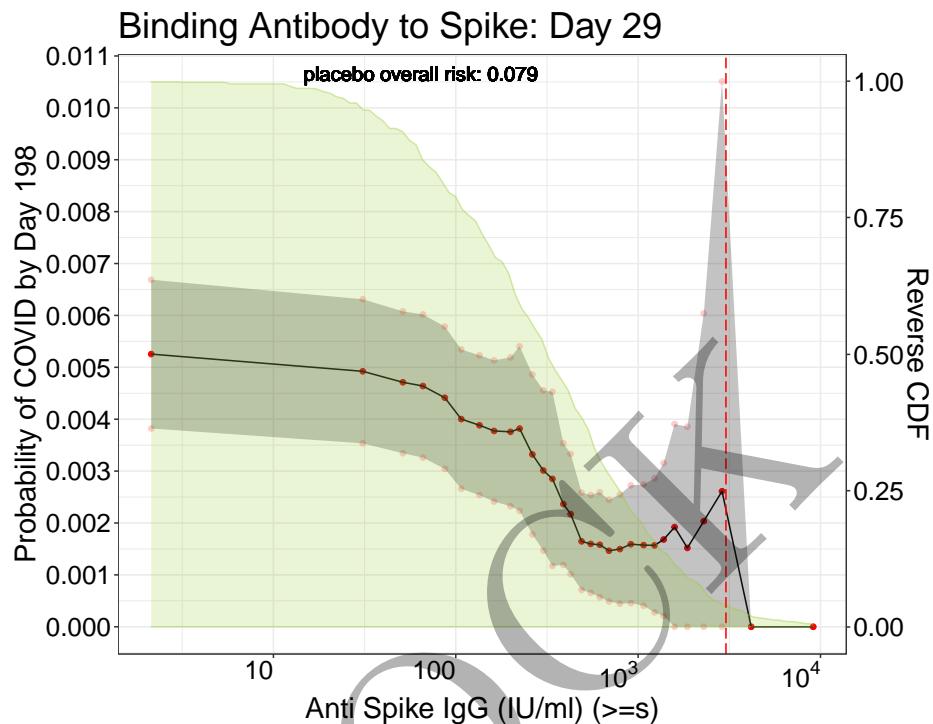


Figure 5.5: Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table of risk estimates for a range of thresholds of Day 29 Spike protein antibody levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.326	$2.12 * 10^0$	0.00525	0.00382	0.00669
1.821	$6.62 * 10^1$	0.00464	0.00326	0.00602
2.129	$1.35 * 10^2$	0.00388	0.00254	0.00523
2.422	$2.64 * 10^2$	0.00332	0.00178	0.00486
2.590	$3.89 * 10^2$	0.00236	0.00119	0.00354
2.740	$5.50 * 10^2$	0.00160	0.00066	0.00254
2.901	$7.96 * 10^2$	0.00150	0.00044	0.00255
3.145	$1.40 * 10^3$	0.00168	0.00021	0.00316
3.364	$2.31 * 10^3$	0.00204	0.00000	0.00604
3.965	$9.23 * 10^3$	0.00000	0.00000	NA

5.2.2 Day 29 RBD binding antibody

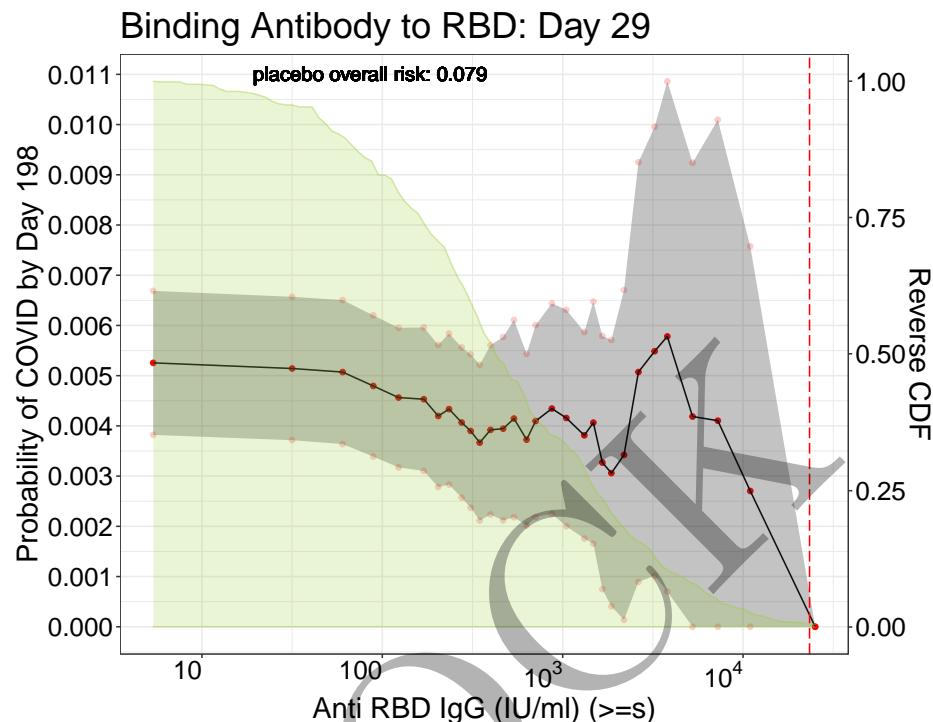


Figure 5.6: Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table of risk estimates for a range of thresholds of Day 29 RBD binding antibody levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.731	$5.38 * 10^0$	0.00525	0.00382	0.00669
1.948	$8.87 * 10^1$	0.00480	0.00339	0.00620
2.306	$2.02 * 10^2$	0.00420	0.00278	0.00561
2.542	$3.48 * 10^2$	0.00367	0.00212	0.00522
2.726	$5.32 * 10^2$	0.00415	0.00218	0.00611
2.943	$8.77 * 10^2$	0.00434	0.00225	0.00644
3.167	$1.47 * 10^3$	0.00406	0.00165	0.00647
3.423	$2.65 * 10^3$	0.00507	0.00089	0.00925
3.717	$5.21 * 10^3$	0.00419	0.00000	0.00924
4.401	$2.52 * 10^4$	0.00000	0.00000	NA

5.2.3 Day 29 Pseudo virus-neutralizing antibody (50% titer)

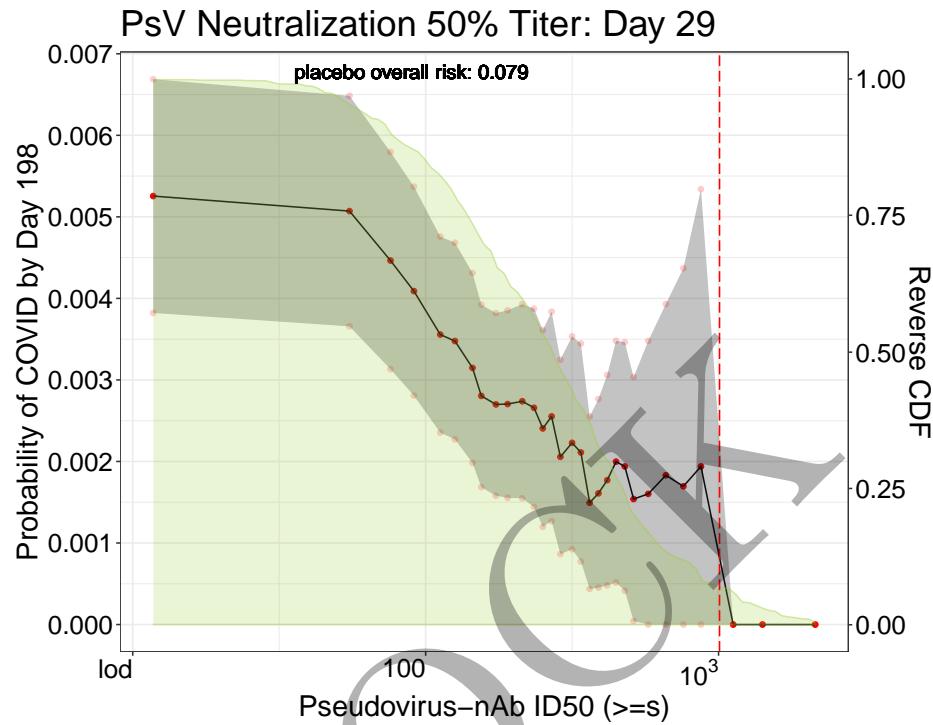


Figure 5.7: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table of risk estimates for a range of thresholds of Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.068	$1.17 * 10^1$	0.00525	0.00382	0.00669
1.960	$9.12 * 10^1$	0.00409	0.00281	0.00537
2.158	$1.44 * 10^2$	0.00315	0.00198	0.00431
2.325	$2.11 * 10^2$	0.00274	0.00155	0.00393
2.434	$2.72 * 10^2$	0.00255	0.00127	0.00384
2.534	$3.42 * 10^2$	0.00211	0.00077	0.00345
2.623	$4.20 * 10^2$	0.00177	0.00048	0.00306
2.759	$5.74 * 10^2$	0.00160	0.00000	0.00348
2.940	$8.71 * 10^2$	0.00194	0.00000	0.00534
3.333	$2.15 * 10^3$	0.00000	0.00000	NA

5.2.4 Day 29 Pseudo virus-neutralizing antibody (80% titer)

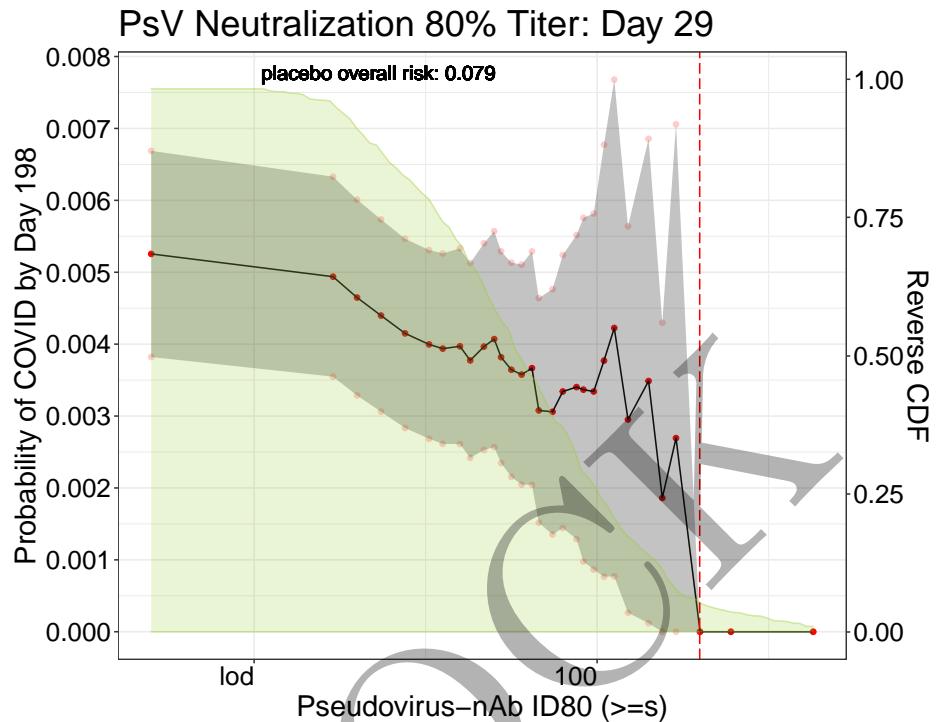


Figure 5.8: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table of risk estimates for a range of thresholds of Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.699	$5.00 * 10^0$	0.00525	0.00382	0.00669
1.374	$2.37 * 10^1$	0.00440	0.00306	0.00573
1.551	$3.56 * 10^1$	0.00394	0.00261	0.00526
1.698	$4.99 * 10^1$	0.00407	0.00257	0.00557
1.777	$5.98 * 10^1$	0.00358	0.00205	0.00511
1.869	$7.40 * 10^1$	0.00306	0.00135	0.00477
1.957	$9.06 * 10^1$	0.00337	0.00098	0.00576
2.090	$1.23 * 10^2$	0.00295	0.00026	0.00564
2.233	$1.71 * 10^2$	0.00269	0.00000	0.00706
2.633	$4.30 * 10^2$	0.00000	0.00000	NA

5.3 Plots and Tables with estimates and pointwise confidence interval for Day 57 (monotone-corrected)

MOCK

5.3.1 Day 57 Spike protein binding antibody

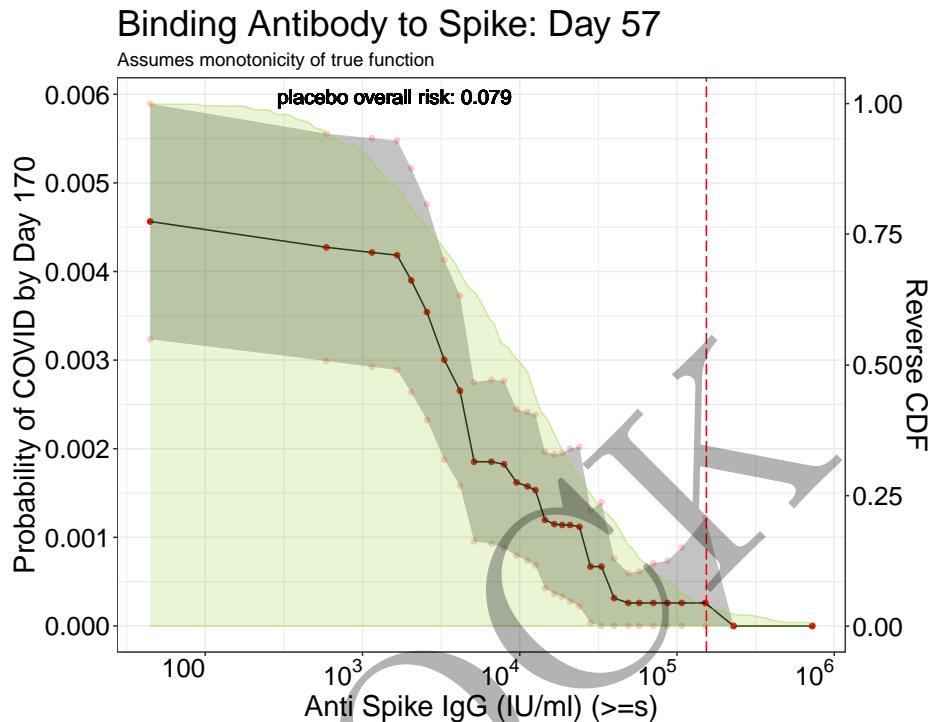


Figure 5.9: Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table of monotone-corrected risk estimates for a range of thresholds of Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals.

log ₁₀ -Threshold	Threshold	Risk estimate	CI left	CI right
1.650	4.47 * 10 ¹	0.00456	0.00324	0.00589
3.218	1.65 * 10 ³	0.00418	0.00289	0.00548
3.521	3.32 * 10 ³	0.00300	0.00188	0.00413
3.899	7.93 * 10 ³	0.00182	0.00088	0.00277
4.104	1.27 * 10 ⁴	0.00153	0.00068	0.00238
4.270	1.86 * 10 ⁴	0.00114	0.00033	0.00195
4.454	2.84 * 10 ⁴	0.00067	0.00003	0.00131
4.760	5.75 * 10 ⁴	0.00026	0.00000	0.00061
5.028	1.07 * 10 ⁵	0.00026	0.00000	0.00088
5.864	7.31 * 10 ⁵	0.00000	0.00000	NA

5.3.2 Day 57 RBD binding antibody

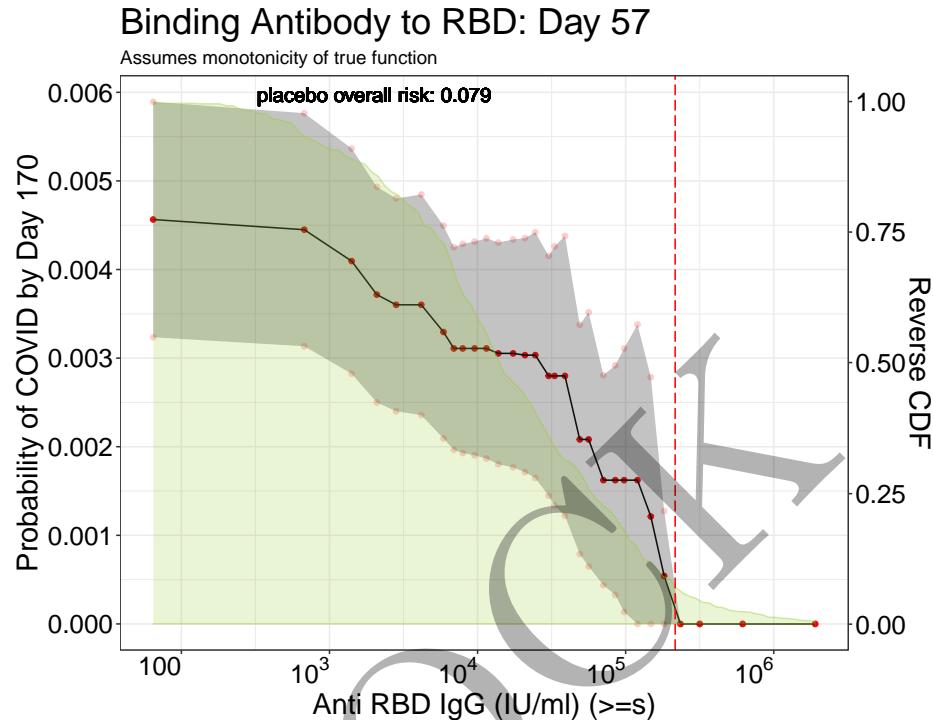


Figure 5.10: Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table of monotone-corrected risk estimates for a range of thresholds of Day 57 RBD binding antibody levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.814	6.52×10^1	0.00456	0.00324	0.00589
3.316	2.07×10^3	0.00372	0.00250	0.00493
3.771	5.90×10^3	0.00329	0.00209	0.00450
4.064	1.16×10^4	0.00311	0.00187	0.00435
4.320	2.09×10^4	0.00303	0.00171	0.00435
4.523	3.33×10^4	0.00280	0.00134	0.00426
4.752	5.65×10^4	0.00208	0.00065	0.00352
5.080	1.20×10^5	0.00162	0.00000	0.00338
5.368	2.33×10^5	0.00000	0.00000	NA
6.276	1.89×10^6	0.00000	0.00000	NA

5.3.3 Day 57 Pseudo virus-neutralizing antibody (50% titer)

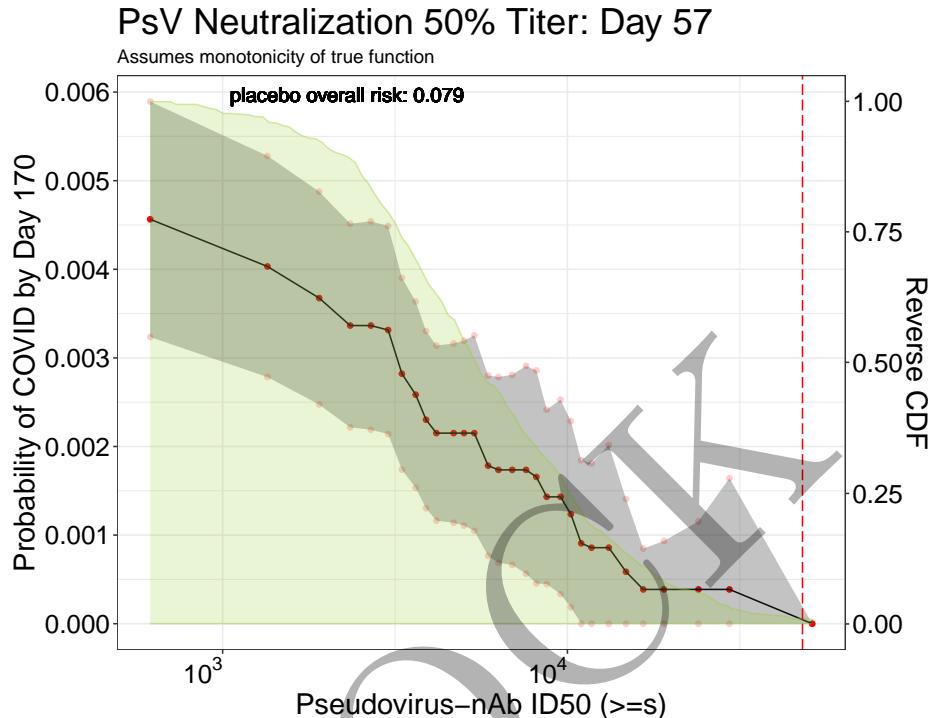


Figure 5.11: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table of monotone-corrected risk estimates for a range of thresholds of Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
2.792	6.19×10^2	0.00456	0.00324	0.00589
3.375	2.37×10^3	0.00337	0.00222	0.00451
3.519	3.30×10^3	0.00282	0.00174	0.00390
3.669	4.67×10^3	0.00215	0.00114	0.00316
3.768	5.86×10^3	0.00178	0.00077	0.00280
3.878	7.55×10^3	0.00174	0.00056	0.00291
3.979	9.53×10^3	0.00143	0.00033	0.00253
4.122	1.32×10^4	0.00086	0.00000	0.00202
4.281	1.91×10^4	0.00039	0.00000	0.00093
4.713	5.16×10^4	0.00000	0.00000	NA

5.3.4 Day 57 Pseudo virus-neutralizing antibody (80% titer)

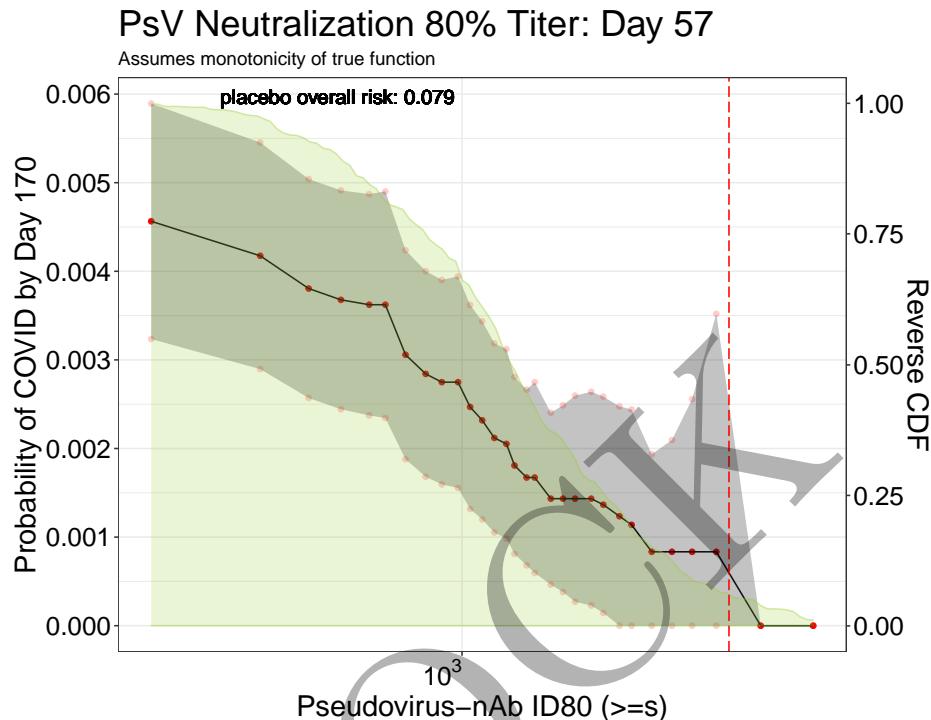


Figure 5.12: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table of monotone-corrected risk estimates for a range of thresholds of Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
2.229	$1.69 * 10^2$	0.00456	0.00324	0.00589
2.697	$4.98 * 10^2$	0.00368	0.00244	0.00491
2.859	$7.23 * 10^2$	0.00306	0.00188	0.00424
3.020	$1.05 * 10^3$	0.00247	0.00132	0.00362
3.107	$1.28 * 10^3$	0.00205	0.00098	0.00312
3.184	$1.53 * 10^3$	0.00167	0.00060	0.00275
3.284	$1.92 * 10^3$	0.00143	0.00027	0.00260
3.421	$2.64 * 10^3$	0.00114	0.00000	0.00244
3.565	$3.67 * 10^3$	0.00083	0.00000	0.00256
3.871	$7.43 * 10^3$	0.00000	0.00000	NA

5.4 Plots and Tables with estimates and pointwise confidence intervals for Day 29 (monotone-corrected)

MOCK

5.4.1 Day 29 Spike protein antibody

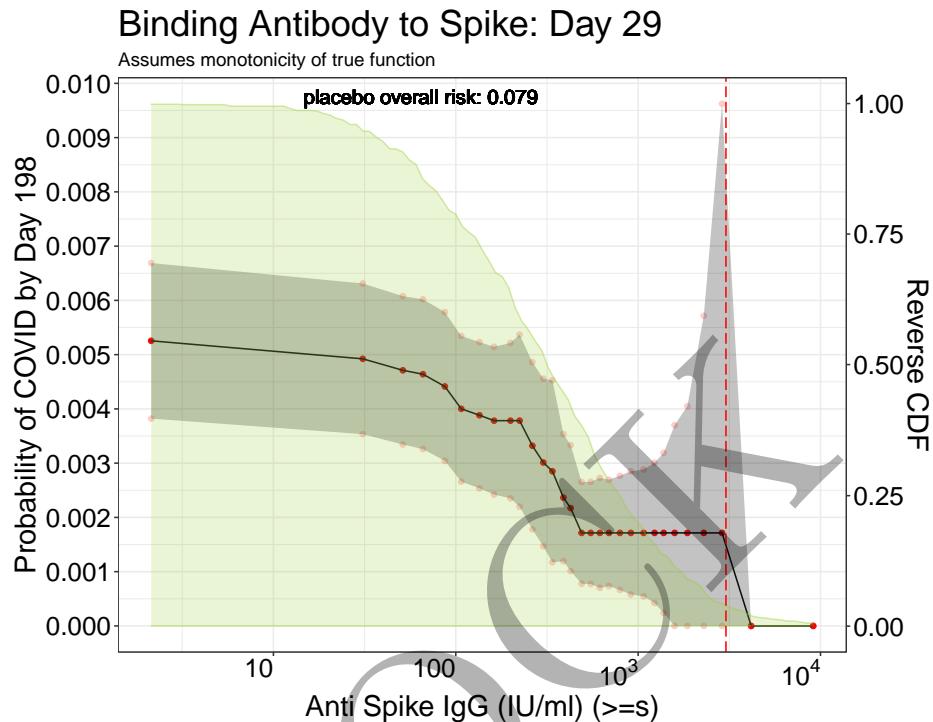


Figure 5.13: Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table of monotone-corrected risk estimates for a range of thresholds of Day 29 Spike protein antibody levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.326	$2.12 * 10^0$	0.00525	0.00382	0.00669
1.821	$6.62 * 10^1$	0.00464	0.00326	0.00602
2.129	$1.35 * 10^2$	0.00388	0.00254	0.00523
2.422	$2.64 * 10^2$	0.00332	0.00178	0.00486
2.590	$3.89 * 10^2$	0.00236	0.00119	0.00354
2.740	$5.50 * 10^2$	0.00171	0.00077	0.00266
2.901	$7.96 * 10^2$	0.00171	0.00066	0.00277
3.145	$1.40 * 10^3$	0.00171	0.00024	0.00319
3.364	$2.31 * 10^3$	0.00171	0.00000	0.00572
3.965	$9.23 * 10^3$	0.00000	0.00000	NA

5.4.2 Day 29 RBD binding antibody

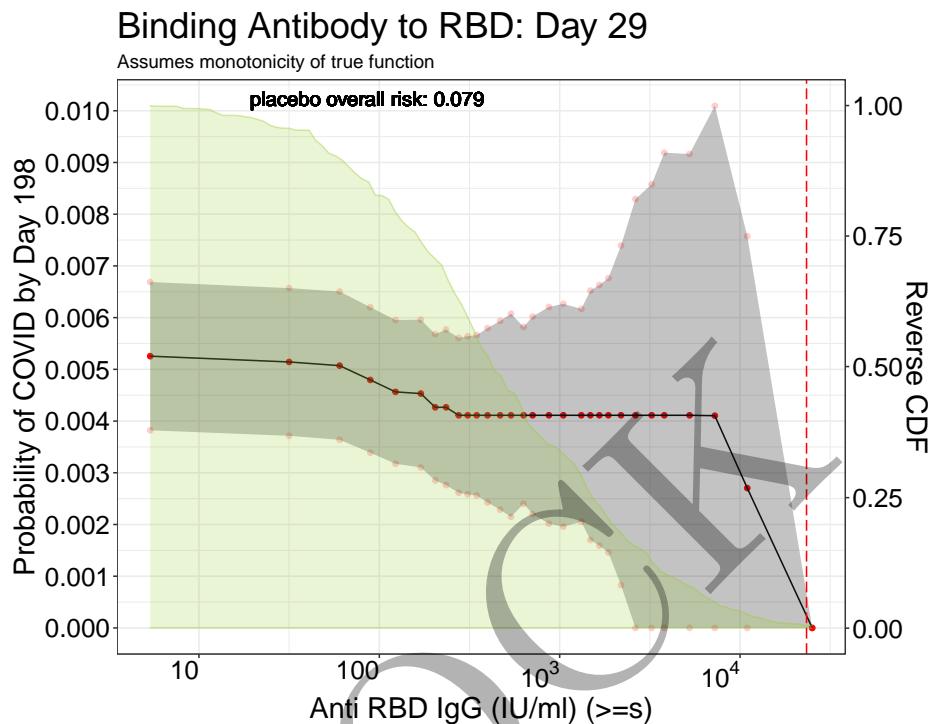


Figure 5.14: Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table of monotone-corrected risk estimates for a range of thresholds of Day 29 RBD binding antibody levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.731	5.38×10^0	0.00525	0.00382	0.00669
1.948	8.87×10^1	0.00480	0.00339	0.00620
2.306	2.02×10^2	0.00427	0.00285	0.00568
2.542	3.48×10^2	0.00411	0.00256	0.00566
2.726	5.32×10^2	0.00411	0.00215	0.00608
2.943	8.77×10^2	0.00411	0.00202	0.00621
3.167	1.47×10^3	0.00411	0.00170	0.00652
3.423	2.65×10^3	0.00411	0.00000	0.00829
3.717	5.21×10^3	0.00411	0.00000	0.00916
4.401	2.52×10^4	0.00000	0.00000	NA

5.4.3 Day 29 Pseudo virus-neutralizing antibody (50% titer)

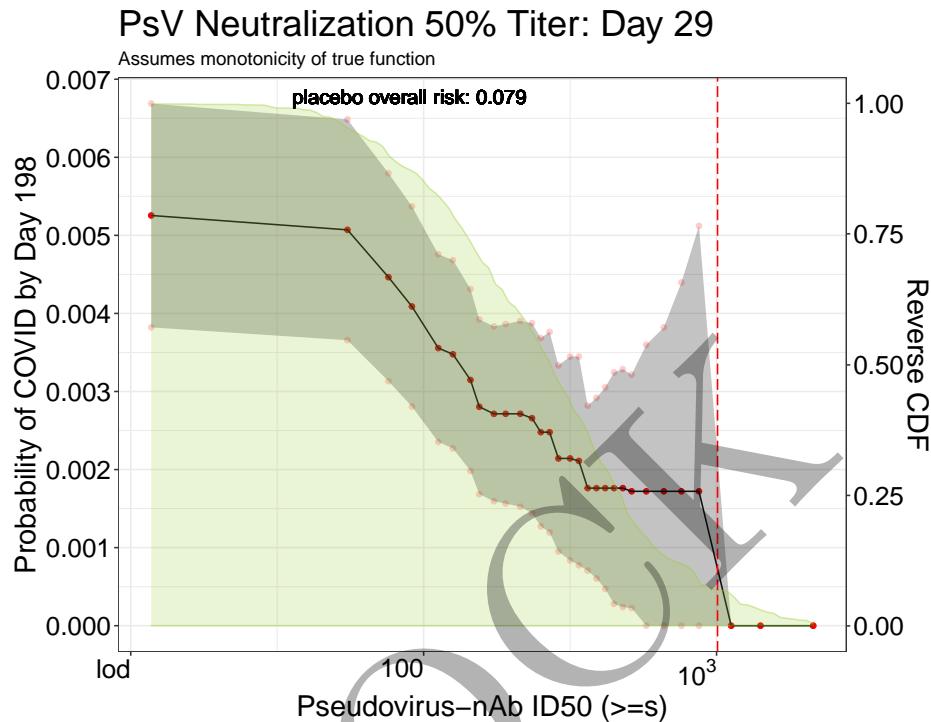


Figure 5.15: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table of monotone-corrected risk estimates for a range of thresholds of Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.068	1.17×10^1	0.00525	0.00382	0.00669
1.960	9.12×10^1	0.00409	0.00281	0.00537
2.158	1.44×10^2	0.00315	0.00198	0.00431
2.325	2.11×10^2	0.00271	0.00152	0.00390
2.434	2.72×10^2	0.00248	0.00119	0.00376
2.534	3.42×10^2	0.00211	0.00077	0.00345
2.623	4.20×10^2	0.00176	0.00047	0.00305
2.759	5.74×10^2	0.00172	0.00000	0.00360
2.940	8.71×10^2	0.00172	0.00000	0.00512
3.333	2.15×10^3	0.00000	0.00000	NA

5.4.4 Day 29 Pseudo virus-neutralizing antibody (80% titer)

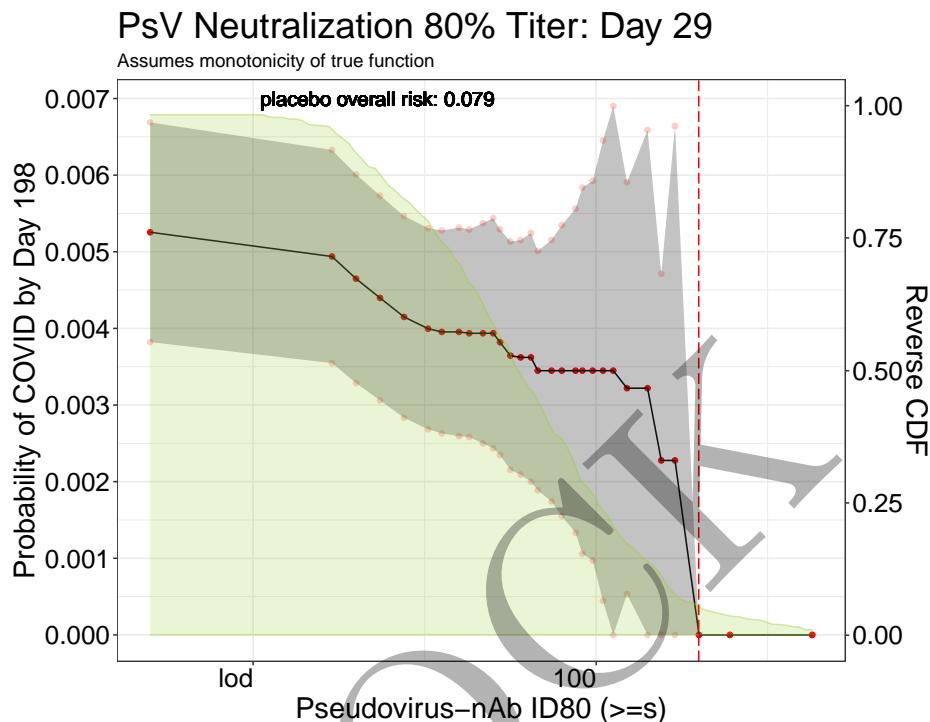


Figure 5.16: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table of monotone-corrected risk estimates for a range of thresholds of Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.699	$5.00 * 10^0$	0.00525	0.00382	0.00669
1.374	$2.37 * 10^1$	0.00440	0.00306	0.00573
1.551	$3.56 * 10^1$	0.00395	0.00263	0.00528
1.698	$4.99 * 10^1$	0.00394	0.00243	0.00544
1.777	$5.98 * 10^1$	0.00362	0.00209	0.00515
1.869	$7.40 * 10^1$	0.00345	0.00174	0.00515
1.957	$9.06 * 10^1$	0.00345	0.00106	0.00584
2.090	$1.23 * 10^2$	0.00322	0.00053	0.00591
2.233	$1.71 * 10^2$	0.00228	0.00000	0.00664
2.633	$4.30 * 10^2$	0.00000	0.00000	NA

5.5 Plots and Tables with estimates and simultaneous confidence bands for Day 57

MOCK

5.5.1 Day 57 Spike protein binding antibody

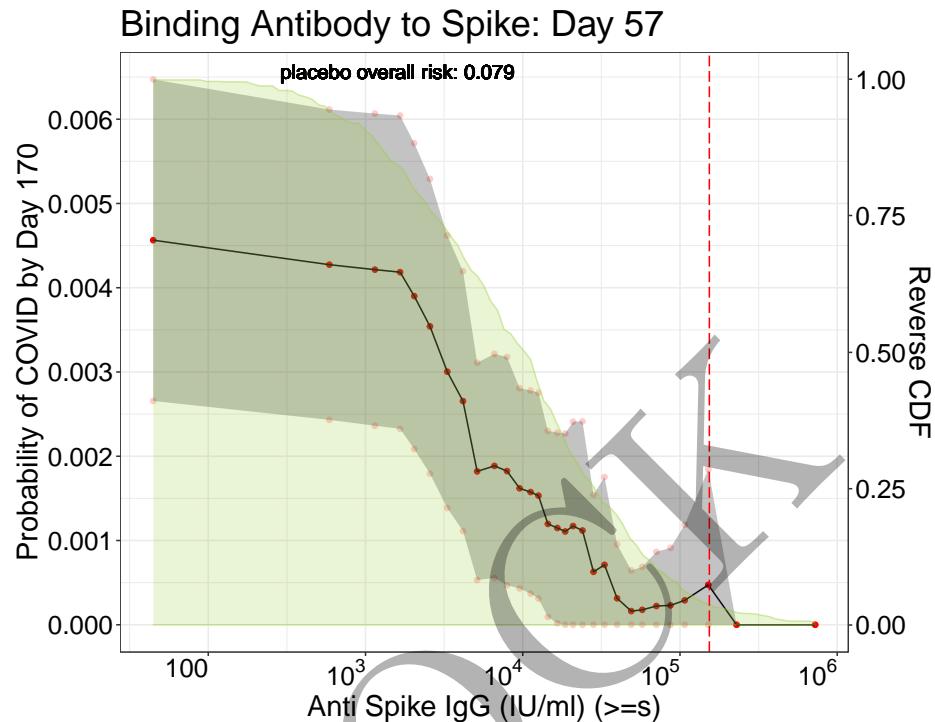


Figure 5.17: Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table of risk estimates for a range of thresholds of Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.650	4.47×10^1	0.00456	0.00266	0.00647
3.218	1.65×10^3	0.00418	0.00233	0.00604
3.521	3.32×10^3	0.00300	0.00139	0.00462
3.899	7.93×10^3	0.00182	0.00047	0.00318
4.104	1.27×10^4	0.00153	0.00031	0.00275
4.270	1.86×10^4	0.00111	0.00000	0.00227
4.454	2.84×10^4	0.00063	0.00000	0.00154
4.760	5.75×10^4	0.00018	0.00000	0.00069
5.028	1.07×10^5	0.00029	0.00000	0.00119
5.864	7.31×10^5	0.00000	0.00000	NA

5.5.2 Day 57 RBD binding antibody

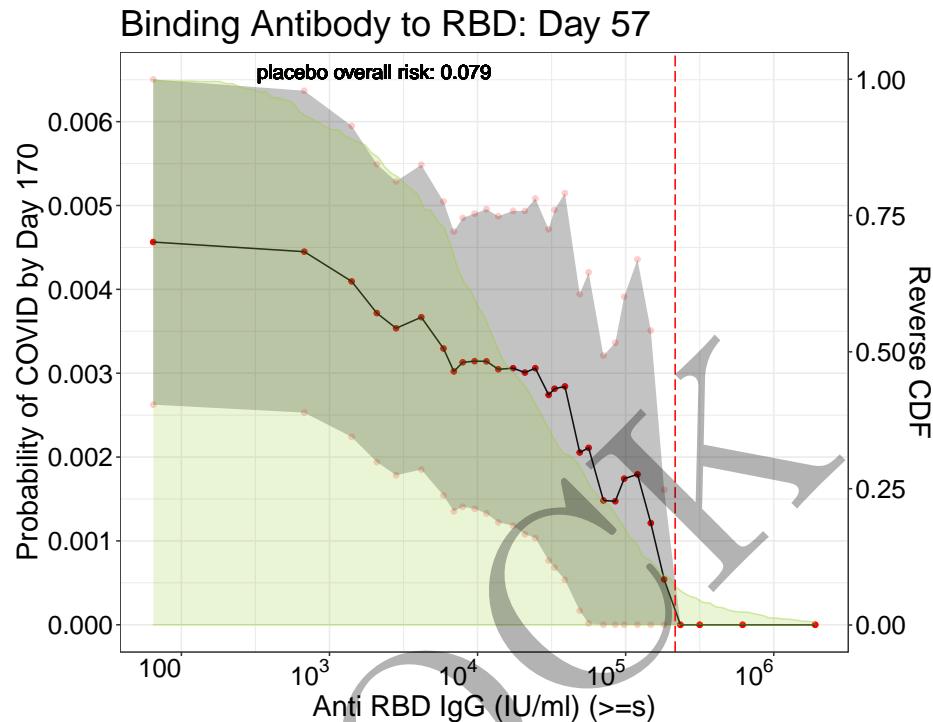


Figure 5.18: Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table of risk estimates for a range of thresholds of Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.814	$6.52 * 10^1$	0.00456	0.00262	0.00650
3.316	$2.07 * 10^3$	0.00372	0.00194	0.00549
3.771	$5.90 * 10^3$	0.00329	0.00154	0.00505
4.064	$1.16 * 10^4$	0.00314	0.00133	0.00496
4.320	$2.09 * 10^4$	0.00301	0.00108	0.00494
4.523	$3.33 * 10^4$	0.00281	0.00068	0.00495
4.752	$5.65 * 10^4$	0.00211	0.00002	0.00420
5.080	$1.20 * 10^5$	0.00179	0.00000	0.00436
5.368	$2.33 * 10^5$	0.00000	0.00000	NA
6.276	$1.89 * 10^6$	0.00000	0.00000	NA

5.5.3 Day 57 Pseudo virus-neutralizing antibody (50% titer)

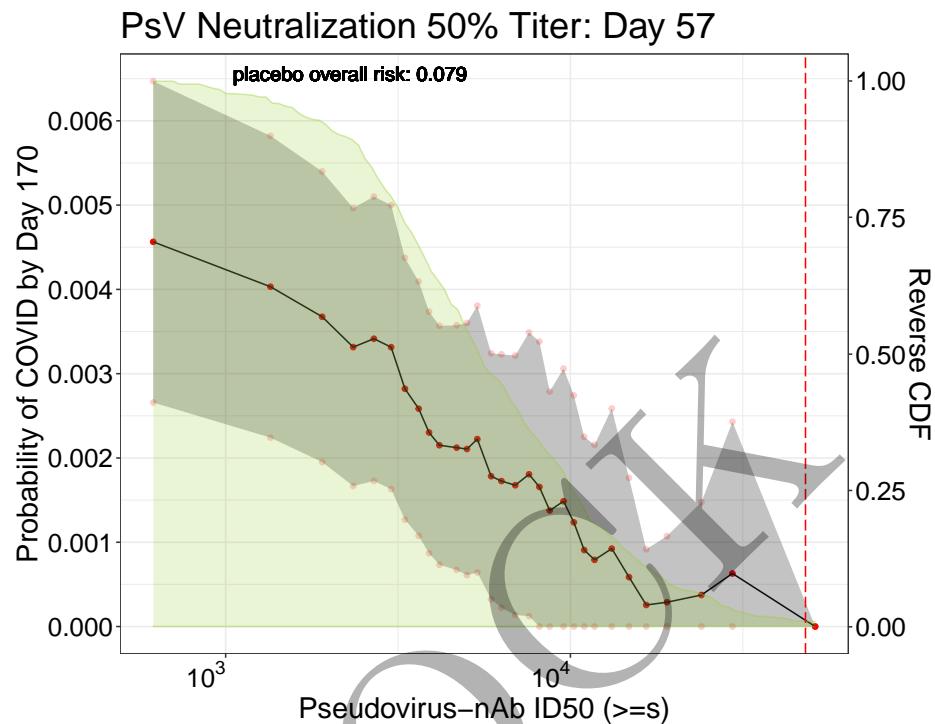


Figure 5.19: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table of risk estimates for a range of thresholds of Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
2.792	6.19×10^2	0.00456	0.00266	0.00647
3.375	2.37×10^3	0.00332	0.00167	0.00496
3.519	3.30×10^3	0.00282	0.00127	0.00437
3.669	4.67×10^3	0.00212	0.00067	0.00357
3.768	5.86×10^3	0.00178	0.00032	0.00324
3.878	7.55×10^3	0.00181	0.00012	0.00349
3.979	9.53×10^3	0.00149	0.00000	0.00306
4.122	1.32×10^4	0.00092	0.00000	0.00259
4.281	1.91×10^4	0.00029	0.00000	0.00107
4.713	5.16×10^4	0.00000	0.00000	NA

5.5.4 Day 57 Pseudo virus-neutralizing antibody (80% titer)

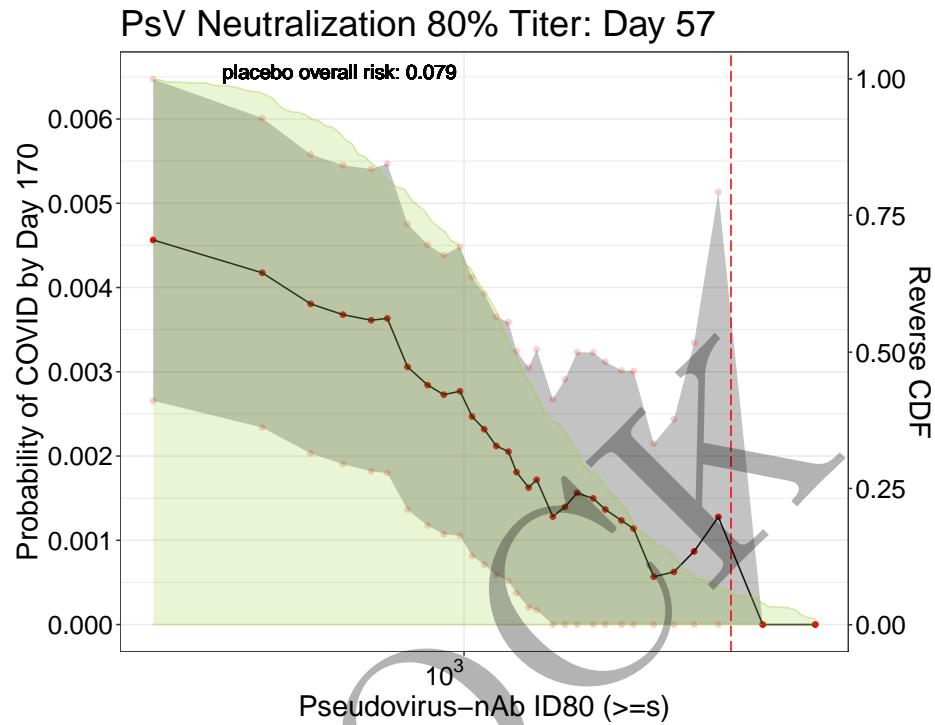


Figure 5.20: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table of risk estimates for a range of thresholds of Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
2.229	$1.69 * 10^2$	0.00456	0.00266	0.00647
2.697	$4.98 * 10^2$	0.00368	0.00190	0.00545
2.859	$7.23 * 10^2$	0.00306	0.00136	0.00475
3.020	$1.05 * 10^3$	0.00247	0.00081	0.00412
3.107	$1.28 * 10^3$	0.00205	0.00052	0.00359
3.184	$1.53 * 10^3$	0.00172	0.00017	0.00327
3.284	$1.92 * 10^3$	0.00156	0.00000	0.00323
3.421	$2.64 * 10^3$	0.00114	0.00000	0.00301
3.565	$3.67 * 10^3$	0.00087	0.00000	0.00334
3.871	$7.43 * 10^3$	0.00000	0.00000	NA

5.6 Plots and Tables with estimates and simultaneous confidence bands for Day 29

MOCK

5.6.1 Day 29 Spike protein antibody

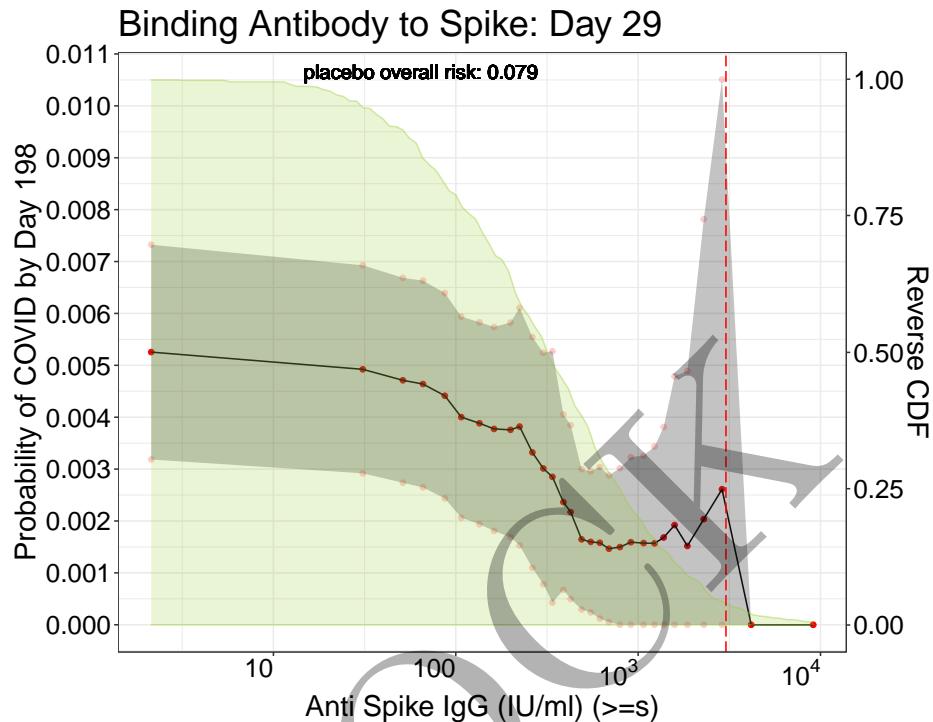


Figure 5.21: Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table of risk estimates for a range of thresholds of Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.326	$2.12 * 10^0$	0.00525	0.00319	0.00732
1.821	$6.62 * 10^1$	0.00464	0.00265	0.00663
2.129	$1.35 * 10^2$	0.00388	0.00194	0.00583
2.422	$2.64 * 10^2$	0.00332	0.00110	0.00554
2.590	$3.89 * 10^2$	0.00236	0.00067	0.00406
2.740	$5.50 * 10^2$	0.00160	0.00024	0.00296
2.901	$7.96 * 10^2$	0.00150	0.00000	0.00302
3.145	$1.40 * 10^3$	0.00168	0.00000	0.00381
3.364	$2.31 * 10^3$	0.00204	0.00000	0.00782
3.965	$9.23 * 10^3$	0.00000	0.00000	NA

5.6.2 Day 29 RBD binding antibody

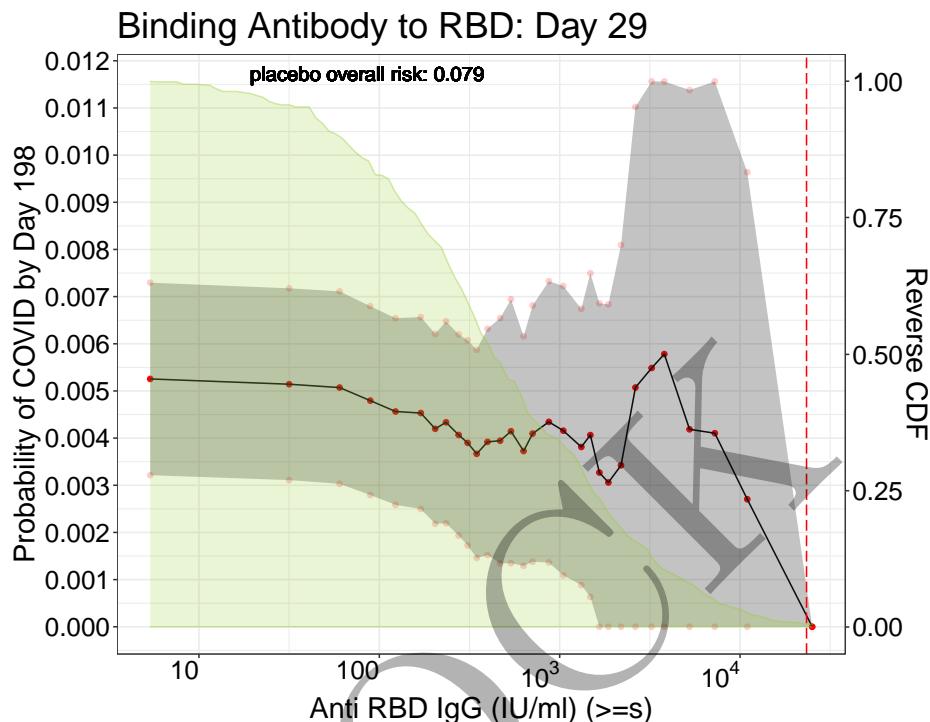


Figure 5.22: Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table of risk estimates for a range of thresholds of Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.731	$5.38 * 10^0$	0.00525	0.00321	0.00730
1.948	$8.87 * 10^1$	0.00480	0.00279	0.00680
2.306	$2.02 * 10^2$	0.00420	0.00218	0.00621
2.542	$3.48 * 10^2$	0.00367	0.00146	0.00587
2.726	$5.32 * 10^2$	0.00415	0.00135	0.00694
2.943	$8.77 * 10^2$	0.00434	0.00136	0.00733
3.167	$1.47 * 10^3$	0.00406	0.00063	0.00750
3.423	$2.65 * 10^3$	0.00507	0.00000	0.01102
3.717	$5.21 * 10^3$	0.00419	0.00000	0.01138
4.401	$2.52 * 10^4$	0.00000	0.00000	NA

5.6.3 Day 29 Pseudo virus-neutralizing antibody (50% titer)

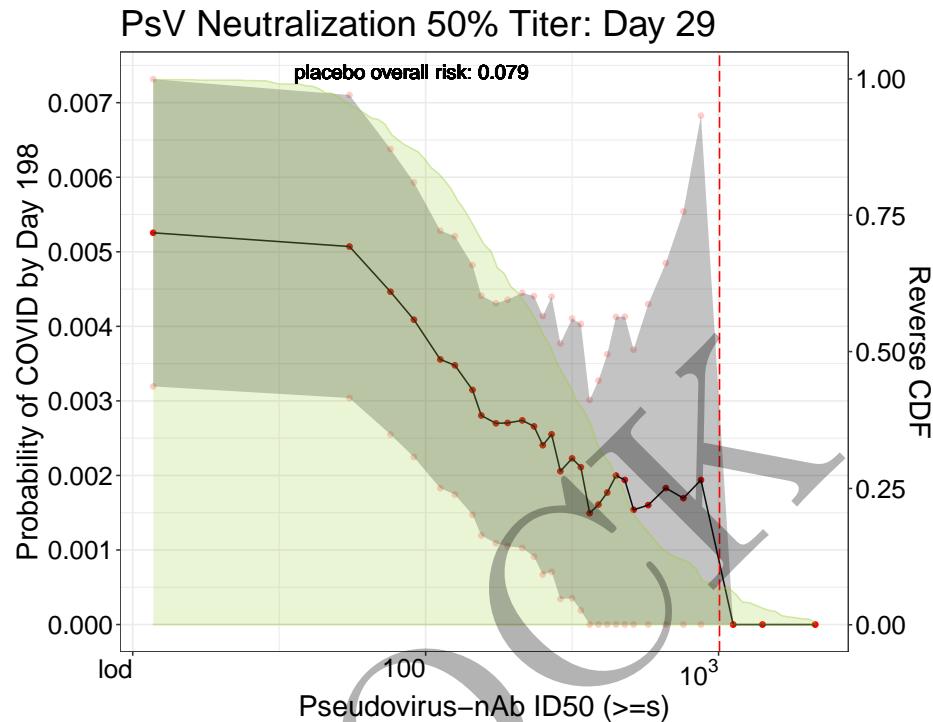


Figure 5.23: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table of risk estimates for a range of thresholds of Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.068	$1.17 * 10^1$	0.00525	0.00319	0.00732
1.960	$9.12 * 10^1$	0.00409	0.00225	0.00593
2.158	$1.44 * 10^2$	0.00315	0.00147	0.00482
2.325	$2.11 * 10^2$	0.00274	0.00103	0.00445
2.434	$2.72 * 10^2$	0.00255	0.00071	0.00440
2.534	$3.42 * 10^2$	0.00211	0.00019	0.00403
2.623	$4.20 * 10^2$	0.00177	0.00000	0.00363
2.759	$5.74 * 10^2$	0.00160	0.00000	0.00430
2.940	$8.71 * 10^2$	0.00194	0.00000	0.00683
3.333	$2.15 * 10^3$	0.00000	0.00000	NA

5.6.4 Day 29 Pseudo virus-neutralizing antibody (80% titer)

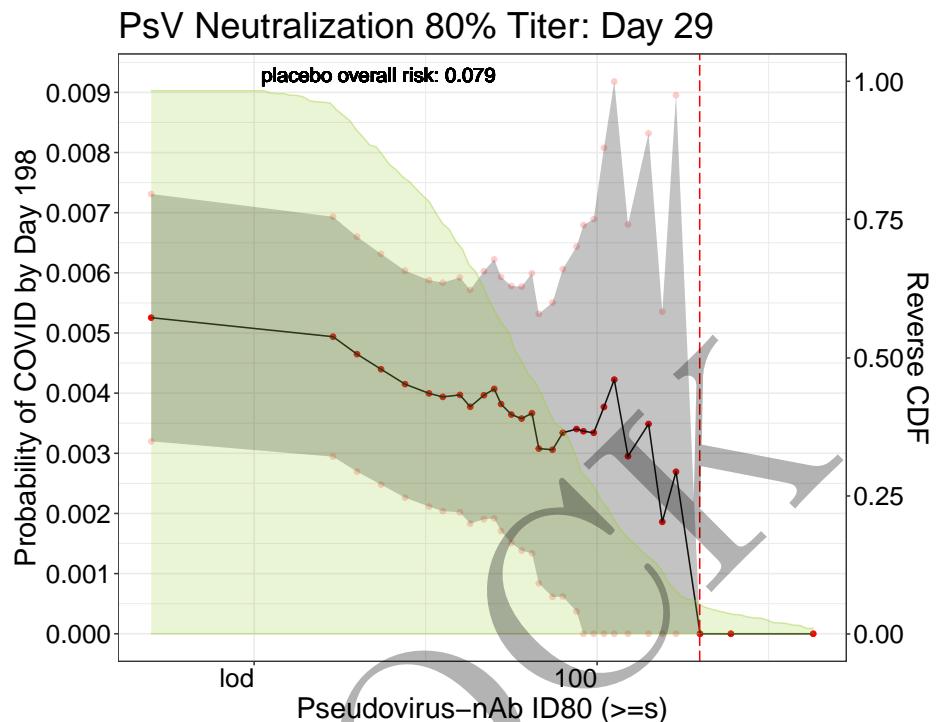


Figure 5.24: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table of risk estimates for a range of thresholds of Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.699	$5.00 * 10^0$	0.00525	0.00320	0.00731
1.374	$2.37 * 10^1$	0.00440	0.00248	0.00631
1.551	$3.56 * 10^1$	0.00394	0.00204	0.00584
1.698	$4.99 * 10^1$	0.00407	0.00192	0.00622
1.777	$5.98 * 10^1$	0.00358	0.00138	0.00577
1.869	$7.40 * 10^1$	0.00306	0.00061	0.00551
1.957	$9.06 * 10^1$	0.00337	0.00000	0.00679
2.090	$1.23 * 10^2$	0.00295	0.00000	0.00681
2.233	$1.71 * 10^2$	0.00269	0.00000	0.00895
2.633	$4.30 * 10^2$	0.00000	0.00000	NA

5.7 Plots and Tables with estimates and pointwise confidence interval for Day 57 (monotone-corrected)

MOCK

5.7.1 Day 57 Spike protein binding antibody

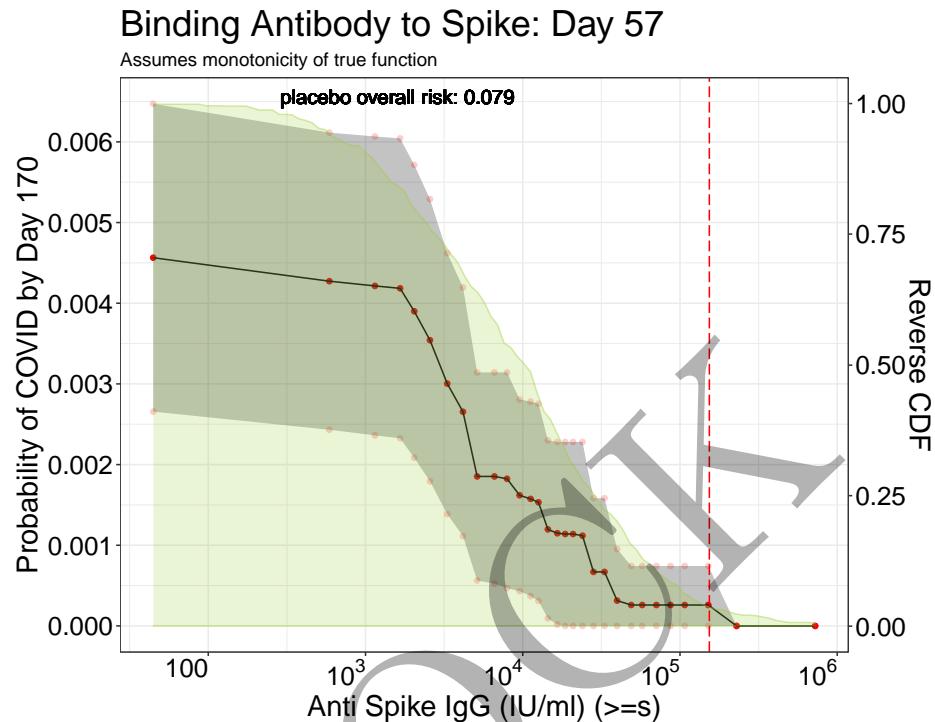


Figure 5.25: Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table of monotone-corrected risk estimates for a range of thresholds of Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.650	4.47×10^1	0.00456	0.00266	0.00647
3.218	1.65×10^3	0.00418	0.00233	0.00604
3.521	3.32×10^3	0.00300	0.00139	0.00462
3.899	7.93×10^3	0.00182	0.00047	0.00318
4.104	1.27×10^4	0.00153	0.00031	0.00275
4.270	1.86×10^4	0.00114	0.00000	0.00230
4.454	2.84×10^4	0.00067	0.00000	0.00158
4.760	5.75×10^4	0.00026	0.00000	0.00077
5.028	1.07×10^5	0.00026	0.00000	0.00116
5.864	7.31×10^5	0.00000	0.00000	NA

5.7.2 Day 57 RBD binding antibody

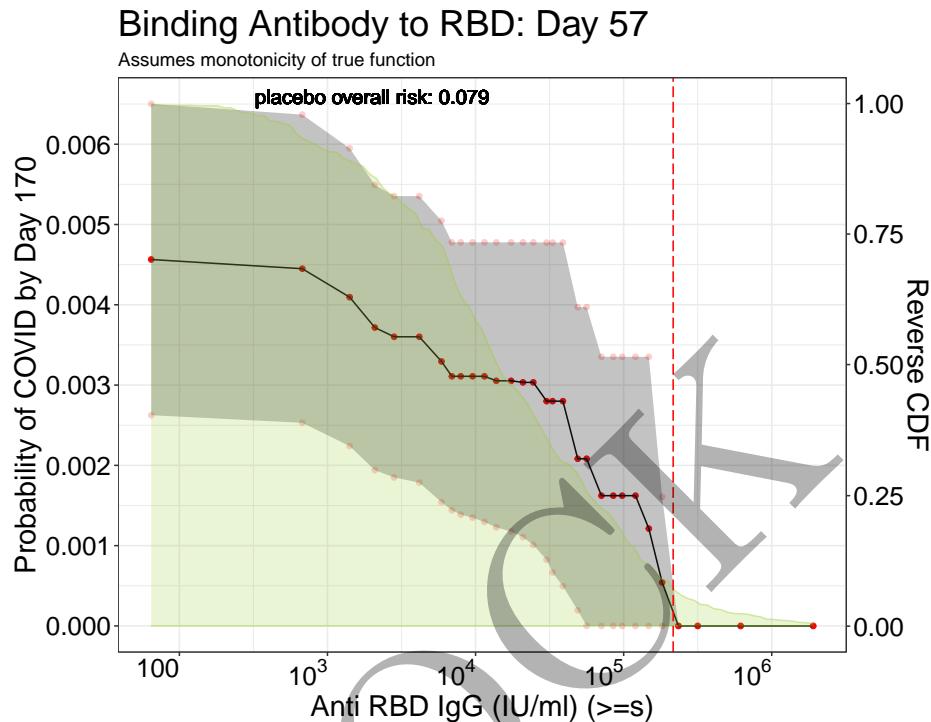


Figure 5.26: Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table of monotone-corrected risk estimates for a range of thresholds of Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.814	6.52×10^1	0.00456	0.00262	0.00650
3.316	2.07×10^3	0.00372	0.00194	0.00549
3.771	5.90×10^3	0.00329	0.00154	0.00505
4.064	1.16×10^4	0.00311	0.00130	0.00492
4.320	2.09×10^4	0.00303	0.00111	0.00496
4.523	3.33×10^4	0.00280	0.00067	0.00493
4.752	5.65×10^4	0.00208	0.00000	0.00418
5.080	1.20×10^5	0.00162	0.00000	0.00419
5.368	2.33×10^5	0.00000	0.00000	NA
6.276	1.89×10^6	0.00000	0.00000	NA

5.7.3 Day 57 Pseudo virus-neutralizing antibody (50% titer)

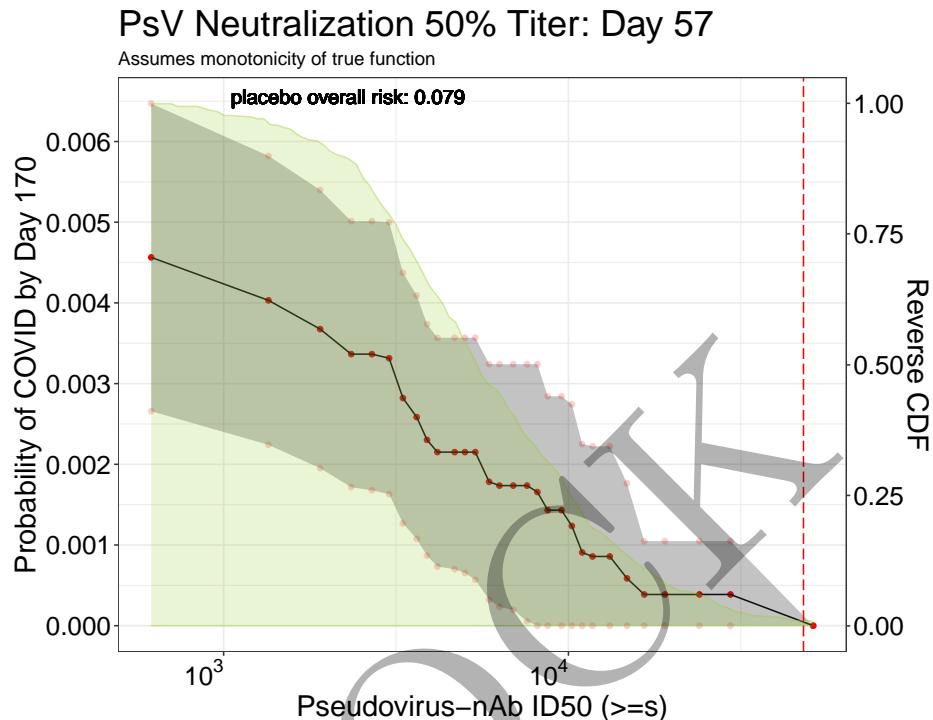


Figure 5.27: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table of monotone-corrected risk estimates for a range of thresholds of Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
2.792	6.19×10^2	0.00456	0.00266	0.00647
3.375	2.37×10^3	0.00337	0.00172	0.00501
3.519	3.30×10^3	0.00282	0.00127	0.00437
3.669	4.67×10^3	0.00215	0.00070	0.00360
3.768	5.86×10^3	0.00178	0.00032	0.00324
3.878	7.55×10^3	0.00174	0.00005	0.00342
3.979	9.53×10^3	0.00143	0.00000	0.00301
4.122	1.32×10^4	0.00086	0.00000	0.00252
4.281	1.91×10^4	0.00039	0.00000	0.00117
4.713	5.16×10^4	0.00000	0.00000	NA

5.7.4 Day 57 Pseudo virus-neutralizing antibody (80% titer)

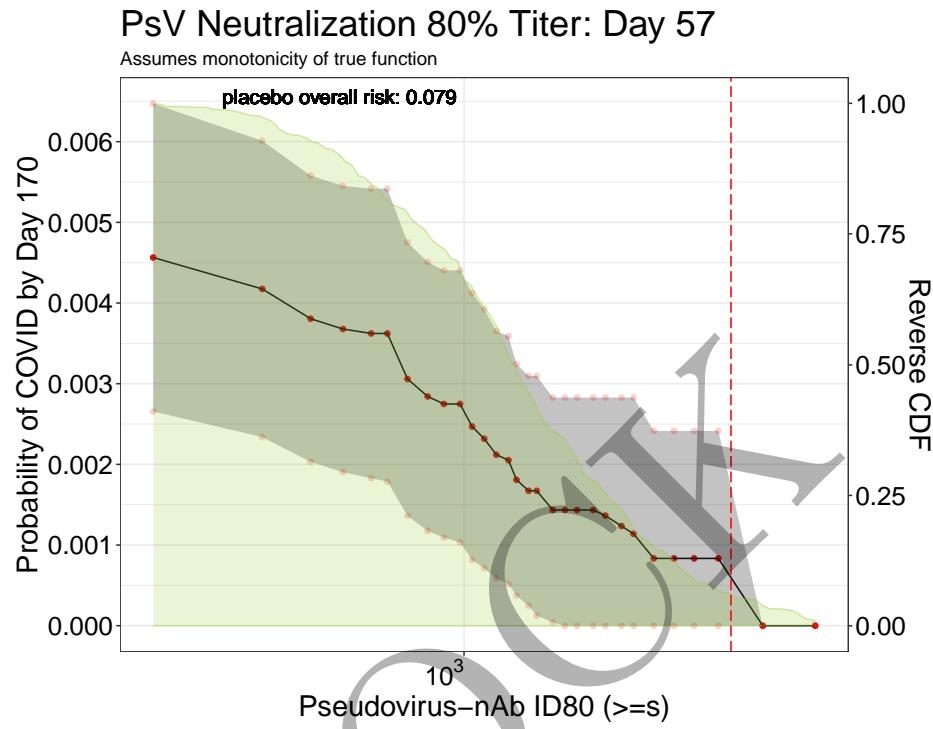


Figure 5.28: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table of monotone-corrected risk estimates for a range of thresholds of Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
2.229	$1.69 * 10^2$	0.00456	0.00266	0.00647
2.697	$4.98 * 10^2$	0.00368	0.00190	0.00545
2.859	$7.23 * 10^2$	0.00306	0.00136	0.00475
3.020	$1.05 * 10^3$	0.00247	0.00081	0.00412
3.107	$1.28 * 10^3$	0.00205	0.00052	0.00359
3.184	$1.53 * 10^3$	0.00167	0.00013	0.00322
3.284	$1.92 * 10^3$	0.00143	0.00000	0.00310
3.421	$2.64 * 10^3$	0.00114	0.00000	0.00301
3.565	$3.67 * 10^3$	0.00083	0.00000	0.00331
3.871	$7.43 * 10^3$	0.00000	0.00000	NA

5.8 Plots and Tables with estimates and pointwise confidence intervals for Day 29 (monotone-corrected)

MOCK

5.8.1 Day 29 Spike protein antibody

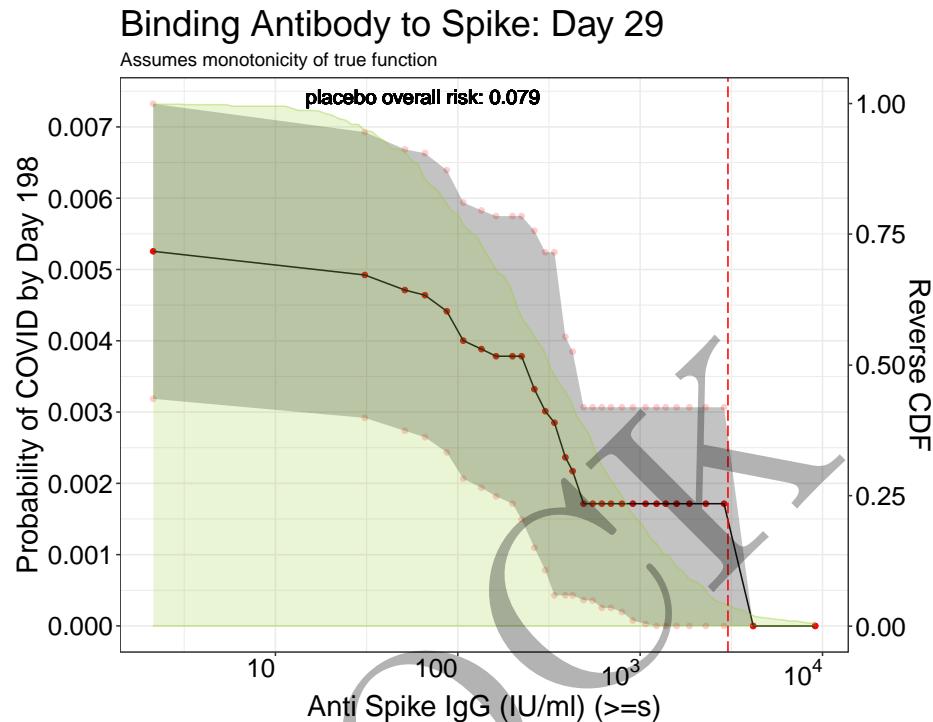


Figure 5.29: Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table of monotone-corrected risk estimates for a range of thresholds of Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.326	$2.12 * 10^0$	0.00525	0.00319	0.00732
1.821	$6.62 * 10^1$	0.00464	0.00265	0.00663
2.129	$1.35 * 10^2$	0.00388	0.00194	0.00583
2.422	$2.64 * 10^2$	0.00332	0.00110	0.00554
2.590	$3.89 * 10^2$	0.00236	0.00067	0.00406
2.740	$5.50 * 10^2$	0.00171	0.00036	0.00307
2.901	$7.96 * 10^2$	0.00171	0.00019	0.00323
3.145	$1.40 * 10^3$	0.00171	0.00000	0.00384
3.364	$2.31 * 10^3$	0.00171	0.00000	0.00749
3.965	$9.23 * 10^3$	0.00000	0.00000	NA

5.8.2 Day 29 RBD binding antibody

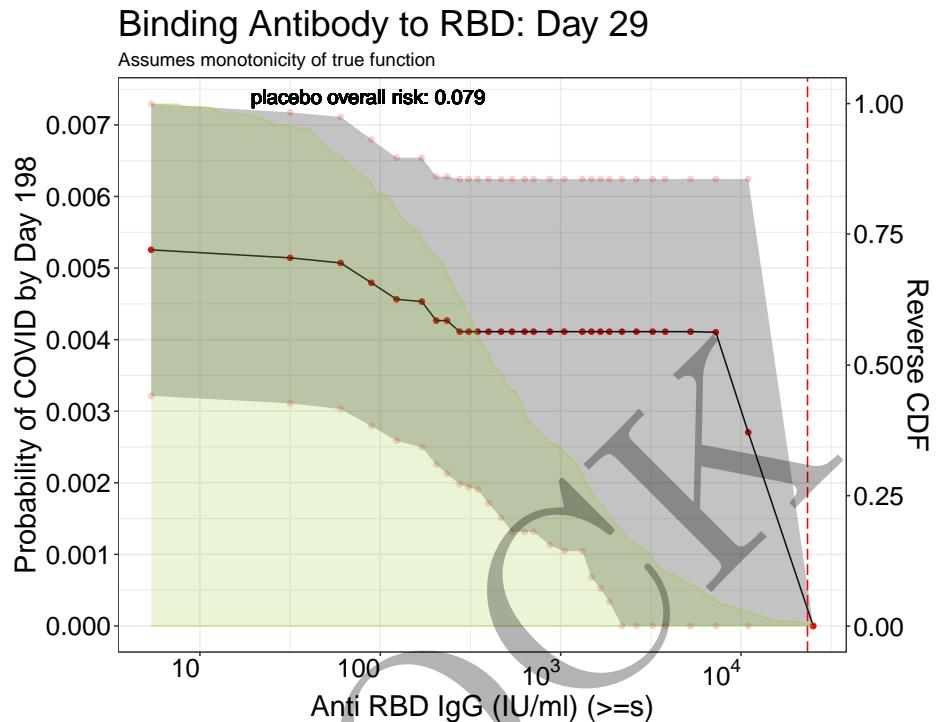


Figure 5.30: Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table of monotone-corrected risk estimates for a range of thresholds of Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.731	5.38×10^0	0.00525	0.00321	0.00730
1.948	8.87×10^1	0.00480	0.00279	0.00680
2.306	2.02×10^2	0.00427	0.00225	0.00628
2.542	3.48×10^2	0.00411	0.00190	0.00632
2.726	5.32×10^2	0.00411	0.00131	0.00691
2.943	8.77×10^2	0.00411	0.00113	0.00709
3.167	1.47×10^3	0.00411	0.00068	0.00754
3.423	2.65×10^3	0.00411	0.00000	0.01006
3.717	5.21×10^3	0.00411	0.00000	0.01131
4.401	2.52×10^4	0.00000	0.00000	NA

5.8.3 Day 29 Pseudo virus-neutralizing antibody (50% titer)

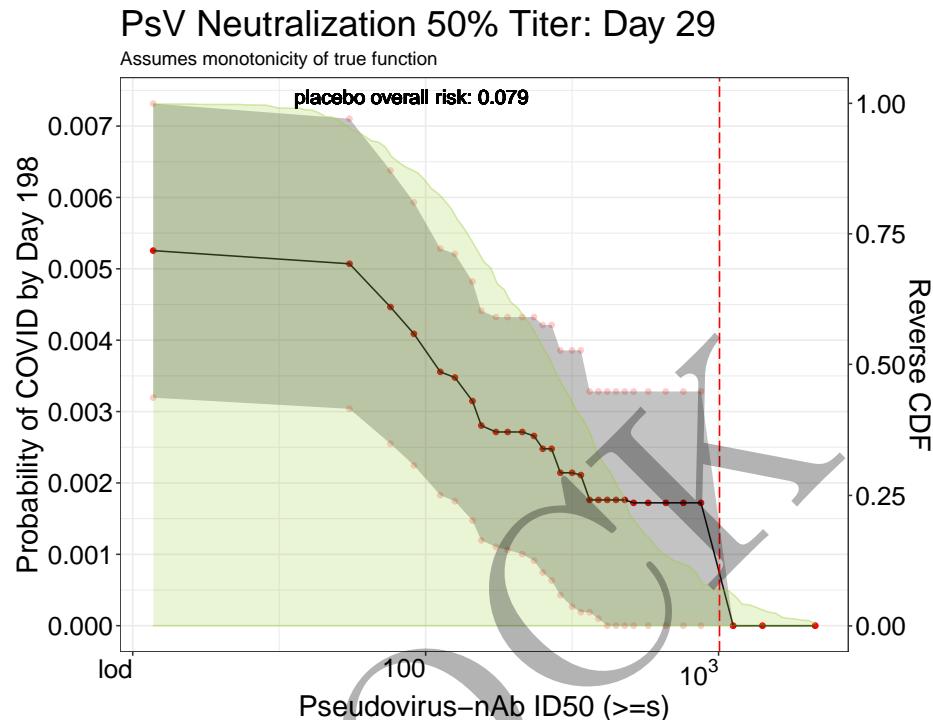


Figure 5.31: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table of monotone-corrected risk estimates for a range of thresholds of Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.068	1.17×10^1	0.00525	0.00319	0.00732
1.960	9.12×10^1	0.00409	0.00225	0.00593
2.158	1.44×10^2	0.00315	0.00147	0.00482
2.325	2.11×10^2	0.00271	0.00100	0.00442
2.434	2.72×10^2	0.00248	0.00063	0.00432
2.534	3.42×10^2	0.00211	0.00019	0.00403
2.623	4.20×10^2	0.00176	0.00000	0.00362
2.759	5.74×10^2	0.00172	0.00000	0.00442
2.940	8.71×10^2	0.00172	0.00000	0.00661
3.333	2.15×10^3	0.00000	0.00000	NA

5.8.4 Day 29 Pseudo virus-neutralizing antibody (80% titer)

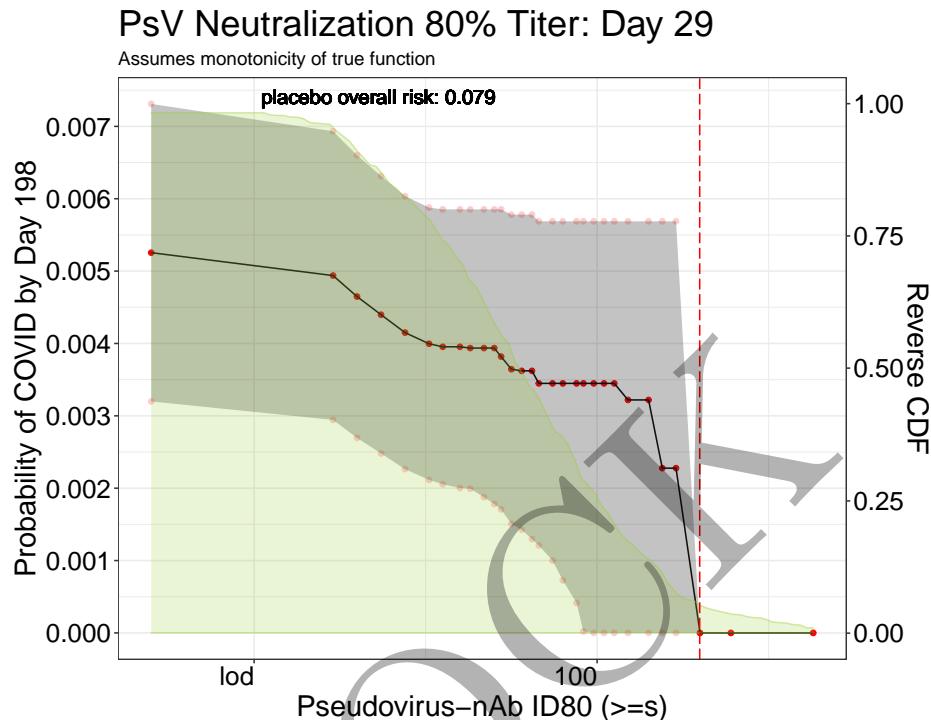


Figure 5.32: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table of monotone-corrected risk estimates for a range of thresholds of Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.699	$5.00 * 10^0$	0.00525	0.00320	0.00731
1.374	$2.37 * 10^1$	0.00440	0.00248	0.00631
1.551	$3.56 * 10^1$	0.00395	0.00205	0.00585
1.698	$4.99 * 10^1$	0.00394	0.00178	0.00609
1.777	$5.98 * 10^1$	0.00362	0.00143	0.00582
1.869	$7.40 * 10^1$	0.00345	0.00100	0.00590
1.957	$9.06 * 10^1$	0.00345	0.00002	0.00688
2.090	$1.23 * 10^2$	0.00322	0.00000	0.00707
2.233	$1.71 * 10^2$	0.00228	0.00000	0.00854
2.633	$4.30 * 10^2$	0.00000	0.00000	NA

MOCK

Chapter 6

Appendix

- This report was built from the [CoVPN/correlates_reporting](#) repository with commit hash 5a117fe0efe61c487f4e14490d3753f565e8928c. A diff of the changes introduced by that commit may be viewed at https://github.com/CoVPN/correlates_reporting/commit/5a117fe0efe61c487f4e14490d3753f565e8928c
- The sha256 hash sum of the raw input file, “COVID_VEtiral_practicedata_primarystage1.csv”: 45ff85033ffbc717462d678b41bc4060a12c7bc60952e2cb72297bb5500b97b9
- The sha256 hash sum of the processed file, “practice_data.csv”: b0200c809e38148017579ee8697fc0ff5682aac2c67ced04748