

COVID-19 Correlates of Risk Analysis Report

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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 = 163) | Total (N = 1077) |
|-------------------------------------------|----------------------|----------------------|---------------------|
| Age | | | |
| Age < 65 | 432 (47.3%) | 80 (49.1%) | 512 (47.5%) |
| Age ≥ 65 | 482 (52.7%) | 83 (50.9%) | 565 (52.5%) |
| Mean (Range) | 58.6 (18.0, 85.0) | 59.0 (18.0, 85.0) | 58.7 (18.0, 85.0) |
| BMI | | | |
| Mean ± SD | 30.1 ± 7.0 | 29.6 ± 7.2 | 30.0 ± 7.0 |
| Sex | | | |
| Female | 519 (56.8%) | 87 (53.4%) | 606 (56.3%) |
| Male | 395 (43.2%) | 76 (46.6%) | 471 (43.7%) |
| Race | | | |
| White Non-Hispanic | 362 (43.8%) | 67 (44.7%) | 429 (43.9%) |
| Black or African American | 195 (23.6%) | 39 (26.0%) | 234 (24.0%) |
| Asian | 67 (8.1%) | 12 (8.0%) | 79 (8.1%) |
| American Indian or Alaska Native | 13 (1.6%) | 5 (3.3%) | 18 (1.8%) |
| Native Hawaiian or Other Pacific Islander | 17 (2.1%) | 1 (0.7%) | 18 (1.8%) |
| Multiracial | 52 (6.3%) | 8 (5.3%) | 60 (6.1%) |
| Other | 34 (4.1%) | 4 (2.7%) | 38 (3.9%) |
| Not reported and unknown | 87 (10.5%) | 14 (9.3%) | 101 (10.3%) |
| Communities of Color | 420 (53.7%) | 73 (52.1%) | 493 (53.5%) |
| Hispanic or Latino ethnicity | | | |
| Hispanic or Latino | 136 (14.9%) | 20 (12.3%) | 156 (14.5%) |
| Not Hispanic or Latino | 690 (75.5%) | 130 (79.8%) | 820 (76.1%) |
| Not reported and unknown | 88 (9.6%) | 13 (8.0%) | 101 (9.4%) |

(continued)

| Characteristics | Vaccine (N = 914) | Placebo (N = 163) | Total (N = 1077) |
|-------------------------------|----------------------|----------------------|---------------------|
| Risk for Severe Covid-19 | | | |
| At-risk | 469 (51.3%) | 84 (51.5%) | 553 (51.3%) |
| Not at-risk | 445 (48.7%) | 79 (48.5%) | 524 (48.7%) |
| Age, Risk for Severe Covid-19 | | | |
| Age < 65 At-risk | 214 (23.4%) | 40 (24.5%) | 254 (23.6%) |
| Age < 65 Not at-risk | 218 (23.9%) | 40 (24.5%) | 258 (24.0%) |
| Age ≥ 65 | 482 (52.7%) | 83 (50.9%) | 565 (52.5%) |

This table summarises the random subcohort, which was randomly sampled from the per-protocol individuals without a COVID failure event < 7 days post Day 57. The sampling was stratified by the key baseline covariates: assigned treatment arm, baseline SARS-CoV-2 status (defined by serostatus and possibly also NAAT and/or RNA PCR testing), any additional important demographic factors such as the randomization strata (e.g., defined by age and/or co-morbidities).

Table 2. Demographic and Clinical Characteristics at Baseline in the baseline SARS-CoV-2 positive per-protocol cohort

| Characteristics | Vaccine (N = 274) | Placebo (N = 270) | Total (N = 544) |
|-------------------------------------------|----------------------|----------------------|--------------------|
| Age | | | |
| Age < 65 | 146 (53.3%) | 147 (54.4%) | 293 (53.9%) |
| Age ≥ 65 | 128 (46.7%) | 123 (45.6%) | 251 (46.1%) |
| Mean (Range) | 56.0 (18.0, 85.0) | 55.8 (18.0, 85.0) | 55.9 (18.0, 85.0) |
| BMI | | | |
| Mean ± SD | 30.7 ± 6.8 | 30.1 ± 7.2 | 30.4 ± 7.0 |
| Sex | | | |
| Female | 153 (55.8%) | 155 (57.4%) | 308 (56.6%) |
| Male | 121 (44.2%) | 115 (42.6%) | 236 (43.4%) |
| Race | | | |
| White Non-Hispanic | 125 (49.8%) | 121 (49.0%) | 246 (49.4%) |
| Black or African American | 52 (20.7%) | 60 (24.3%) | 112 (22.5%) |
| Asian | 24 (9.6%) | 13 (5.3%) | 37 (7.4%) |
| American Indian or Alaska Native | 6 (2.4%) | 4 (1.6%) | 10 (2.0%) |
| Native Hawaiian or Other Pacific Islander | 5 (2.0%) | 1 (0.4%) | 6 (1.2%) |
| Multiracial | 12 (4.8%) | 19 (7.7%) | 31 (6.2%) |
| Other | 7 (2.8%) | 5 (2.0%) | 12 (2.4%) |
| Not reported and unknown | 20 (8.0%) | 24 (9.7%) | 44 (8.8%) |
| Communities of Color | 120 (49.0%) | 111 (47.8%) | 231 (48.4%) |
| Hispanic or Latino ethnicity | | | |
| Hispanic or Latino | 35 (12.8%) | 38 (14.1%) | 73 (13.4%) |
| Not Hispanic or Latino | 217 (79.2%) | 214 (79.3%) | 431 (79.2%) |
| Not reported and unknown | 22 (8.0%) | 18 (6.7%) | 40 (7.4%) |
| Risk for Severe Covid-19 | | | |
| At-risk | 125 (45.6%) | 123 (45.6%) | 248 (45.6%) |
| Not at-risk | 149 (54.4%) | 147 (54.4%) | 296 (54.4%) |
| Age, Risk for Severe Covid-19 | | | |
| Age < 65 At-risk | 73 (26.6%) | 75 (27.8%) | 148 (27.2%) |
| Age < 65 Not at-risk | 73 (26.6%) | 72 (26.7%) | 145 (26.7%) |
| Age ≥ 65 | 128 (46.7%) | 123 (45.6%) | 251 (46.1%) |

This table summarises the random subcohort, which was randomly sampled from the per-protocol individuals without a COVID failure event < 7 days post Day 57. The sampling was stratified by the key baseline covariates: assigned treatment arm, baseline SARS-CoV-2 status (defined by serostatus and possibly also NAAT and/or RNA PCR testing), any additional important demographic factors such as the randomization strata (e.g., defined by age and/or co-morbidities).

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 | | | | | | | |
|--------|------------------------|-------------------------------------------------|----------------------------------------|----------------------------|-----|----------------------------------------------|-------------------------------|--------------------------|----------------------|
| | | Cases* | | | | Non-Cases/Control | | | |
| | | N | Resp rate | GMT/GMC | N | Resp rate | GMT/GMC | Resp Rate Difference | GMTR/GMCR |
| Day 29 | Anti N IgG (IU/ml) | 11 | 64.1/64.1 = 100.0% (100.0%, 100.0%) | 9163 (3359, 24998) | 903 | 13230.9/13230.9 = 100.0% (100.0%, 100.0%) | 23718 (20083, 28010) | 0% (0%, 0%) | 0.39 (0.14, 1.07) |
| Day 29 | Anti RBD IgG (IU/ml) | 11 | 64.1/64.1 = 100.0% (100.0%, 100.0%) | 9820 (4734, 20366) | 903 | 13230.9/13230.9 = 100.0% (100.0%, 100.0%) | 23105 (20011, 26677) | 0% (0%, 0%) | 0.43 (0.20, 0.89) |
| Day 29 | Anti Spike IgG (IU/ml) | 11 | 64.1/64.1 = 100.0% (100.0%, 100.0%) | 12852 (7097, 23271) | 903 | 13230.9/13230.9 = 100.0% (100.0%, 100.0%) | 41328 (37060, 46086) | 0% (0%, 0%) | 0.31 (0.17, 0.57) |
| Day 29 | Pseudovirus-nAb ID50 | 11 | 56.7/64.1 = 90.9% (46.3%, 99.1%) | 37 (16, 86) | 903 | 11676.4/13230.9 = 88.3% (84.8%, 91.1%) | 107 (91, 126) | 2.6% (-42.1%, 11.6%) | 0.35 (0.15, 0.82) |
| Day 29 | Pseudovirus-nAb ID80 | 11 | 56.1/64.1 = 81.8% (42.0%, 96.5%) | 103 (30, 351) | 903 | 12465.5/13230.9 = 94.2% (91.6%, 96.1%) | 190 (161, 223) | -12.4% (-52.3%, 2.6%) | 0.54 (0.16, 1.87) |
| Day 57 | Anti N IgG (IU/ml) | 11 | 64.1/64.1 = 100.0% (100.0%, 100.0%) | 110124 (35353, 343038) | 903 | 13230.9/13230.9 = 100.0% (100.0%, 100.0%) | 327744 (269226, 398981) | 0% (0%, 0%) | 0.34 (0.11, 1.06) |
| Day 57 | Anti RBD IgG (IU/ml) | 11 | 64.1/64.1 = 100.0% (100.0%, 100.0%) | 334195 (161041, 693528) | 903 | 13230.9/13230.9 = 100.0% (100.0%, 100.0%) | 974227 (829937, 1143602) | 0% (0%, 0%) | 0.34 (0.16, 0.72) |
| Day 57 | Anti Spike IgG (IU/ml) | 11 | 64.1/64.1 = 100.0% (100.0%, 100.0%) | 240794 (105801, 548023) | 903 | 13230.9/13230.9 = 100.0% (100.0%, 100.0%) | 2116905 (1856215, 2414208) | 0% (0%, 0%) | 0.11 (0.05, 0.26) |
| Day 57 | Pseudovirus-nAb ID50 | 11 | 64.1/64.1 = 100.0% (100.0%, 100.0%) | 188 (73, 487) | 903 | 13095.3/13230.9 = 99.0% (98.0%, 99.5%) | 1517 (1244, 1850) | 1% (0.5%, 2%) | 0.12 (0.05, 0.33) |
| Day 57 | Pseudovirus-nAb ID80 | 11 | 64.1/64.1 = 100.0% (100.0%, 100.0%) | 350 (165, 740) | 903 | 13110.7/13230.9 = 99.1% (97.1%, 99.7%) | 2249 (1829, 2766) | 0.9% (0.3%, 2.9%) | 0.16 (0.07, 0.34) |

*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 | | | | | | | |
|--------|------------------------|-------------------------------------------------|--------------------|-------------------------------|-------------------|--------------------------------------------|-------------------------------|----------------------|------------------------|
| | | Cases* | | | Non-Cases/Control | | | Comparison | |
| | | N | Resp rate | GMT/GMC | N | Resp rate | GMT/GMC | Resp Rate Difference | GMTR/GMCR |
| Day 29 | Anti N IgG (IU/ml) | 2 | 17.2/17.2 = 100.0% | 130813 (3444, 4969160) | 272 | 1414.8/1414.8 = 100.0% (100.0%, 100.0%) | 43029 (32995, 56114) | 0% | 3.04 (0.08, 116.61) |
| Day 29 | Anti RBD IgG (IU/ml) | 2 | 17.2/17.2 = 100.0% | 153444 (6865, 3429945) | 272 | 1414.8/1414.8 = 100.0% (100.0%, 100.0%) | 35885 (27859, 46223) | 0% | 4.28 (0.19, 96.57) |
| Day 29 | Anti Spike IgG (IU/ml) | 2 | 17.2/17.2 = 100.0% | 104737 (14230, 770889) | 272 | 1414.8/1414.8 = 100.0% (100.0%, 100.0%) | 80297 (65042, 99128) | 0% | 1.30 (0.18, 9.71) |
| Day 29 | Pseudovirus-nAb ID50 | 2 | 17.2/17.2 = 100.0% | 323 (71, 1472) | 272 | 1365.9/1414.8 = 96.5% (91.4%, 98.6%) | 185 (141, 244) | 3.5% | 1.74 (0.37, 8.13) |
| Day 29 | Pseudovirus-nAb ID80 | 2 | 17.2/17.2 = 100.0% | 481 (4, 60966) | 272 | 1390.1/1414.8 = 98.2% (93.6%, 99.5%) | 428 (320, 573) | 1.8% | 1.12 (0.01, 143.66) |
| Day 57 | Anti N IgG (IU/ml) | 2 | 17.2/17.2 = 100.0% | 2440779 (43120, 138159231) | 272 | 1414.8/1414.8 = 100.0% (100.0%, 100.0%) | 985914 (697182, 1394221) | 0% | 2.48 (0.04, 142.23) |
| Day 57 | Anti RBD IgG (IU/ml) | 2 | 17.2/17.2 = 100.0% | 2749023 (61314, 123253076) | 272 | 1414.8/1414.8 = 100.0% (100.0%, 100.0%) | 2328268 (1802226, 3007855) | 0% | 1.18 (0.03, 53.40) |
| Day 57 | Anti Spike IgG (IU/ml) | 2 | 17.2/17.2 = 100.0% | 3627856 (538606, 24435925) | 272 | 1414.8/1414.8 = 100.0% (100.0%, 100.0%) | 5409865 (4378235, 6684574) | 0% | 0.67 (0.10, 4.57) |
| Day 57 | Pseudovirus-nAb ID50 | 2 | 17.2/17.2 = 100.0% | 1829 (160, 20945) | 272 | 1414.8/1414.8 = 100.0% (100.0%, 100.0%) | 5816 (3934, 8599) | 0% | 0.31 (0.03, 3.72) |
| Day 57 | Pseudovirus-nAb ID80 | 2 | 17.2/17.2 = 100.0% | 5772 (290, 114704) | 272 | 1414.8/1414.8 = 100.0% (100.0%, 100.0%) | 7960 (5601, 11311) | 0% | 0.73 (0.04, 14.71) |

*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 | Anti N IgG (IU/ml) | 2 | 4/4 = 100.0% | 44658 (376, 5310188) | 268 | 1353/1353 = 100.0% (100.0%, 100.0%) | 12485 (9430, 16531) | 0% | 3.58 (0.03, 428.83) |
| Day 29 | Anti RBD IgG (IU/ml) | 2 | 4/4 = 100.0% | 42959 (6946, 265696) | 268 | 1353/1353 = 100.0% (100.0%, 100.0%) | 12824 (10117, 16255) | 0% | 3.35 (0.53, 21.04) |
| Day 29 | Anti Spike IgG (IU/ml) | 2 | 4/4 = 100.0% | 37021 (6048, 226609) | 268 | 1353/1353 = 100.0% (100.0%, 100.0%) | 18162 (15129, 21803) | 0% | 2.04 (0.33, 12.59) |
| Day 29 | Pseudovirus-nAb ID50 | 2 | 1.6/4 = 50.0% | 93 (0, 28176) | 268 | 1138.2/1353 = 84.1% (76.9%, 89.4%) | 51 (40, 66) | -34.1% | 1.80 (0.01, 550.47) |
| Day 29 | Pseudovirus-nAb ID80 | 2 | 4/4 = 100.0% | 372 (107, 1290) | 268 | 1254.5/1353 = 92.7% (86.8%, 96.1%) | 129 (98, 169) | 7.3% | 2.89 (0.81, 10.32) |
| Day 57 | Anti N IgG (IU/ml) | 2 | 4/4 = 100.0% | 652604 (78974, 5392810) | 268 | 1353/1353 = 100.0% (100.0%, 100.0%) | 129537 (92255, 181885) | 0% | 5.04 (0.59, 42.78) |
| Day 57 | Anti RBD IgG (IU/ml) | 2 | 4/4 = 100.0% | 2348281 (194513, 28349939) | 268 | 1353/1353 = 100.0% (100.0%, 100.0%) | 380897 (298347, 486288) | 0% | 6.17 (0.50, 75.32) |
| Day 57 | Anti Spike IgG (IU/ml) | 2 | 4/4 = 100.0% | 767715 (603034, 977368) | 268 | 1353/1353 = 100.0% (100.0%, 100.0%) | 676673 (530979, 862343) | 0% | 1.13 (0.81, 1.60) |
| Day 57 | Pseudovirus-nAb ID50 | 2 | 4/4 = 100.0% | 1515 (18, 129242) | 268 | 1297.7/1353 = 95.9% (90.6%, 98.3%) | 565 (408, 782) | 4.1% | 2.68 (0.03, 231.59) |
| Day 57 | Pseudovirus-nAb ID80 | 2 | 4/4 = 100.0% | 6066 (474, 77675) | 268 | 1326.1/1353 = 98.0% (93.2%, 99.4%) | 1319 (934, 1864) | 2% | 4.60 (0.35, 60.26) |

*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

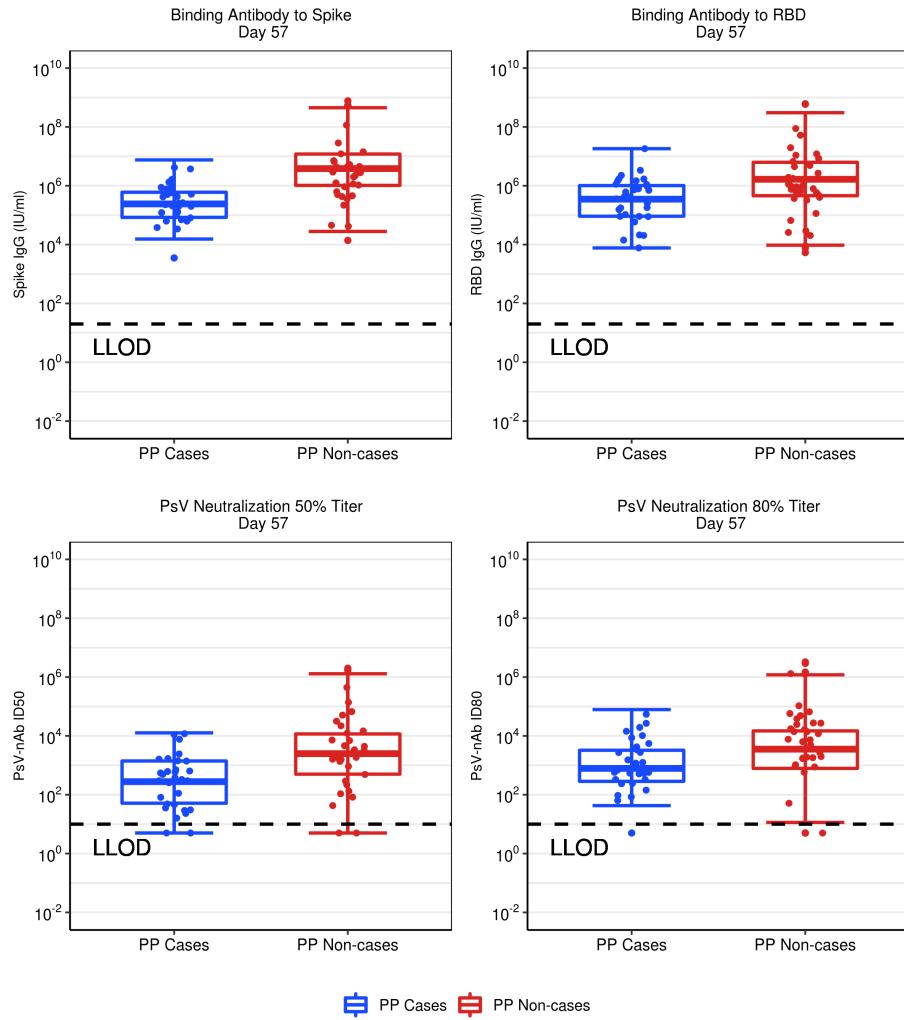


Figure 2.1: Boxplots of D57 Ab markers: baseline negative vaccine arm.

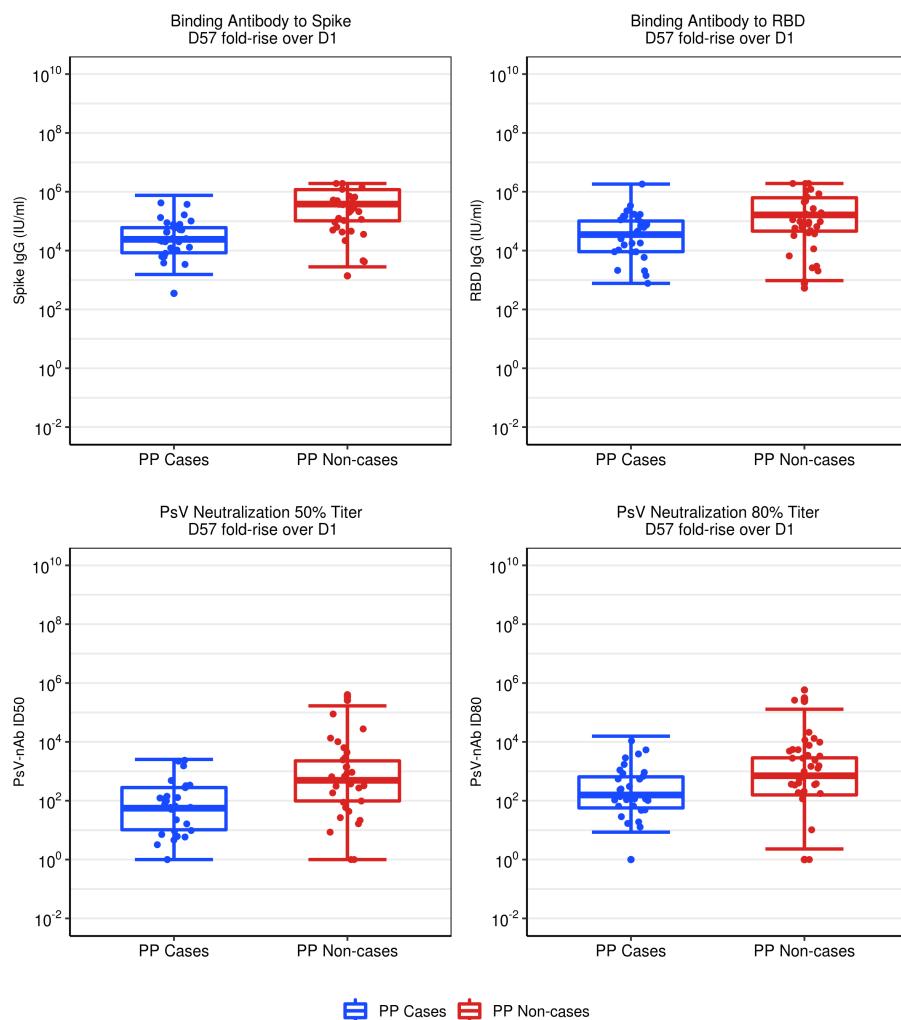


Figure 2.2: Boxplots of D57 fold-rise over D1 Ab markers: baseline negative vaccine arm.

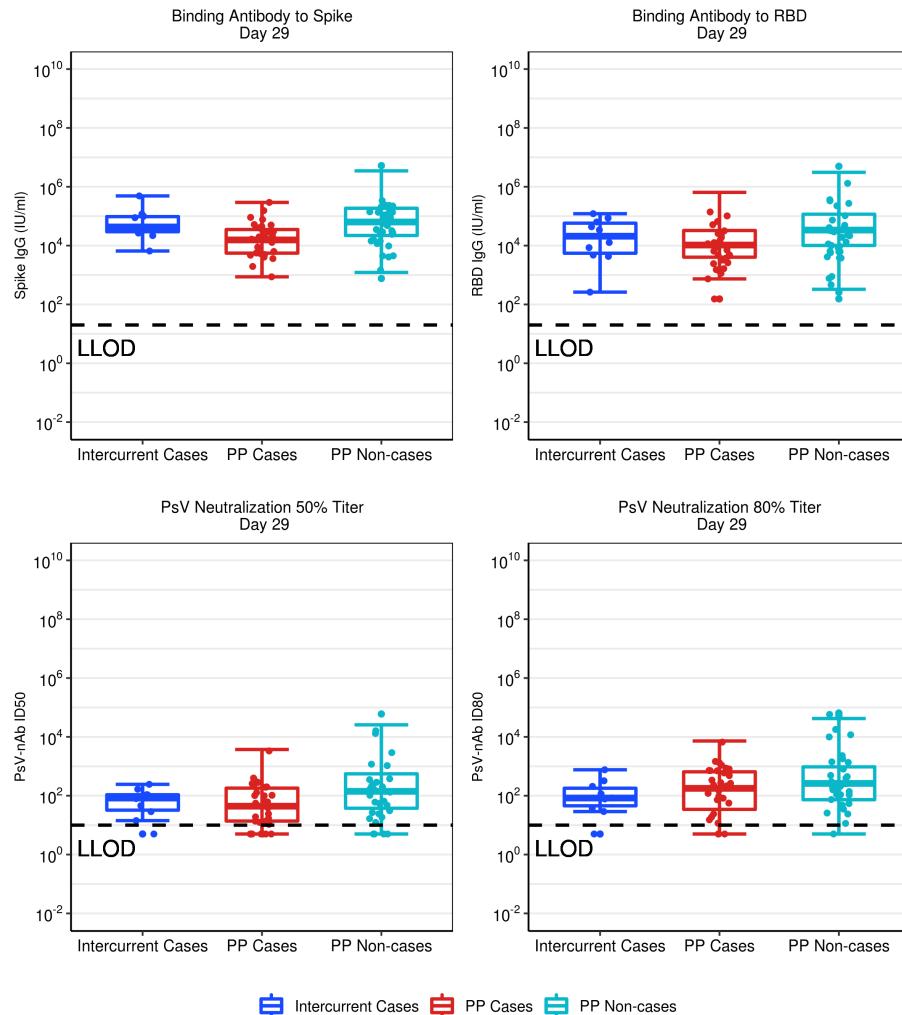


Figure 2.3: Boxplots of D29 Ab markers: baseline negative vaccine arm.

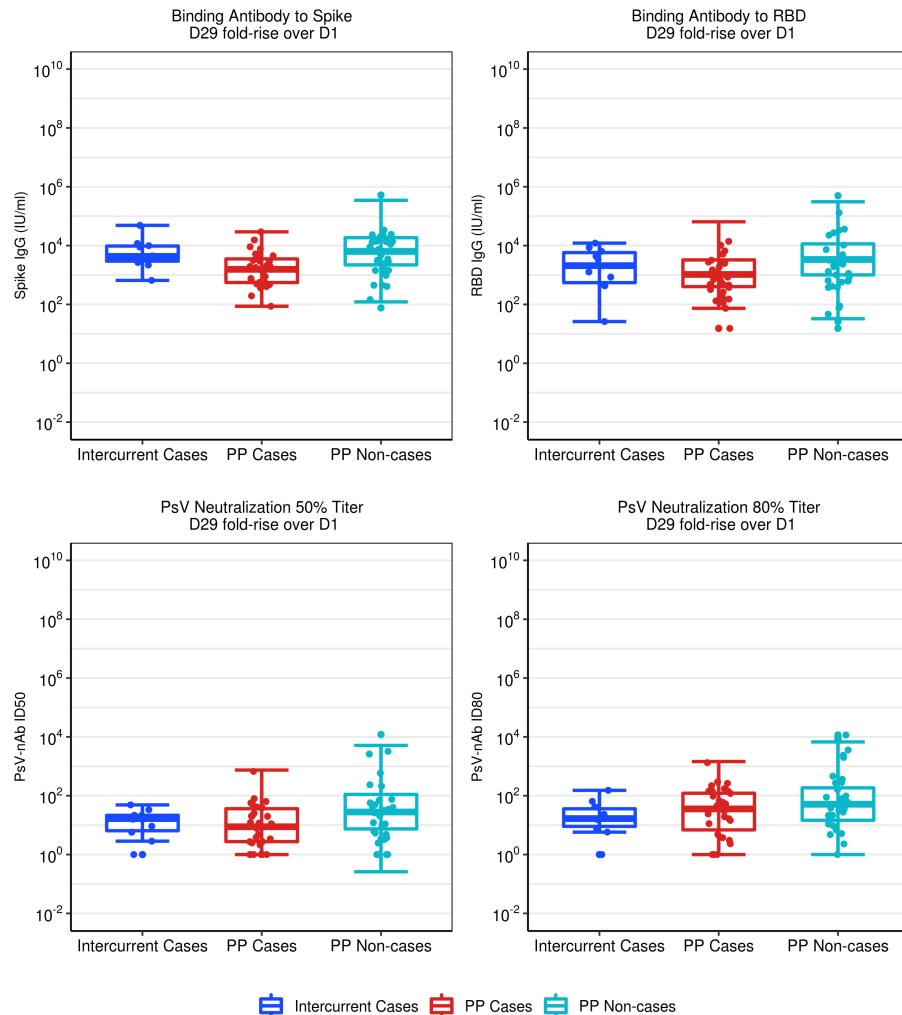


Figure 2.4: Boxplots of D29 fold-rise over D1 Ab markers: baseline negative vaccine arm.

2.1.2 Baseline seropositive

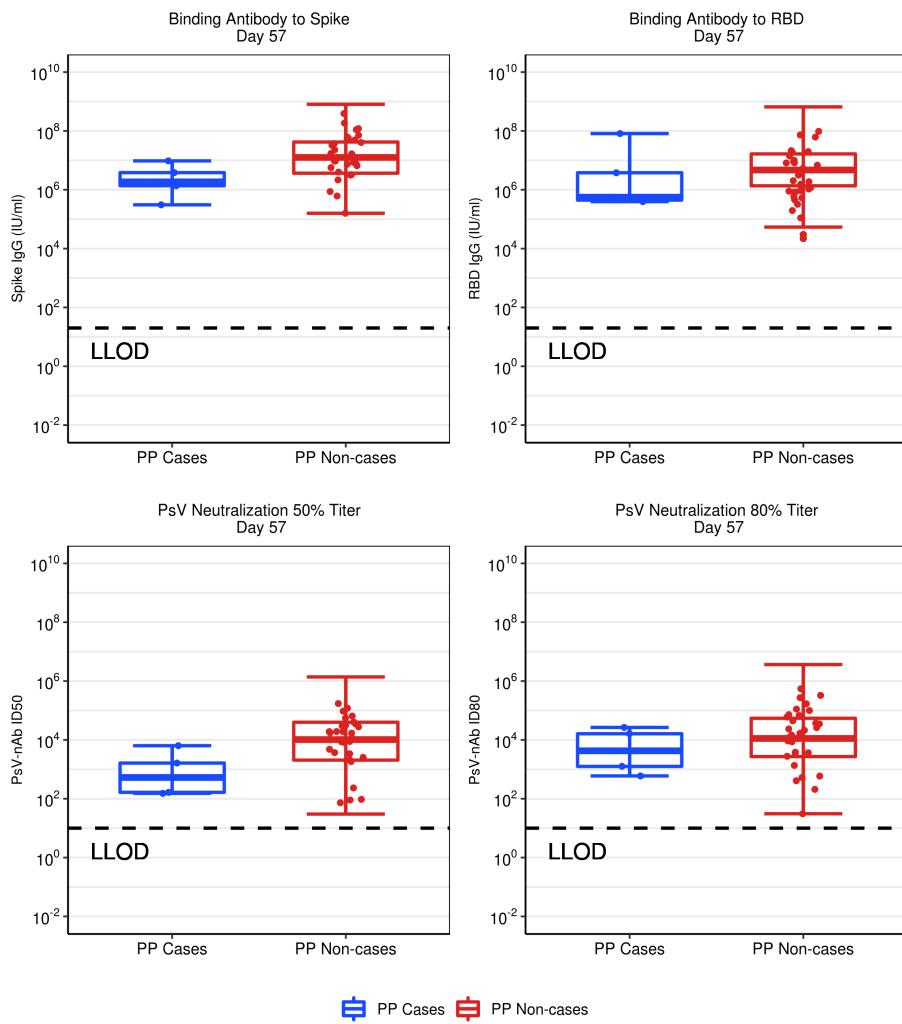


Figure 2.5: Boxplots of D57 Ab markers: baseline positive vaccine arm.

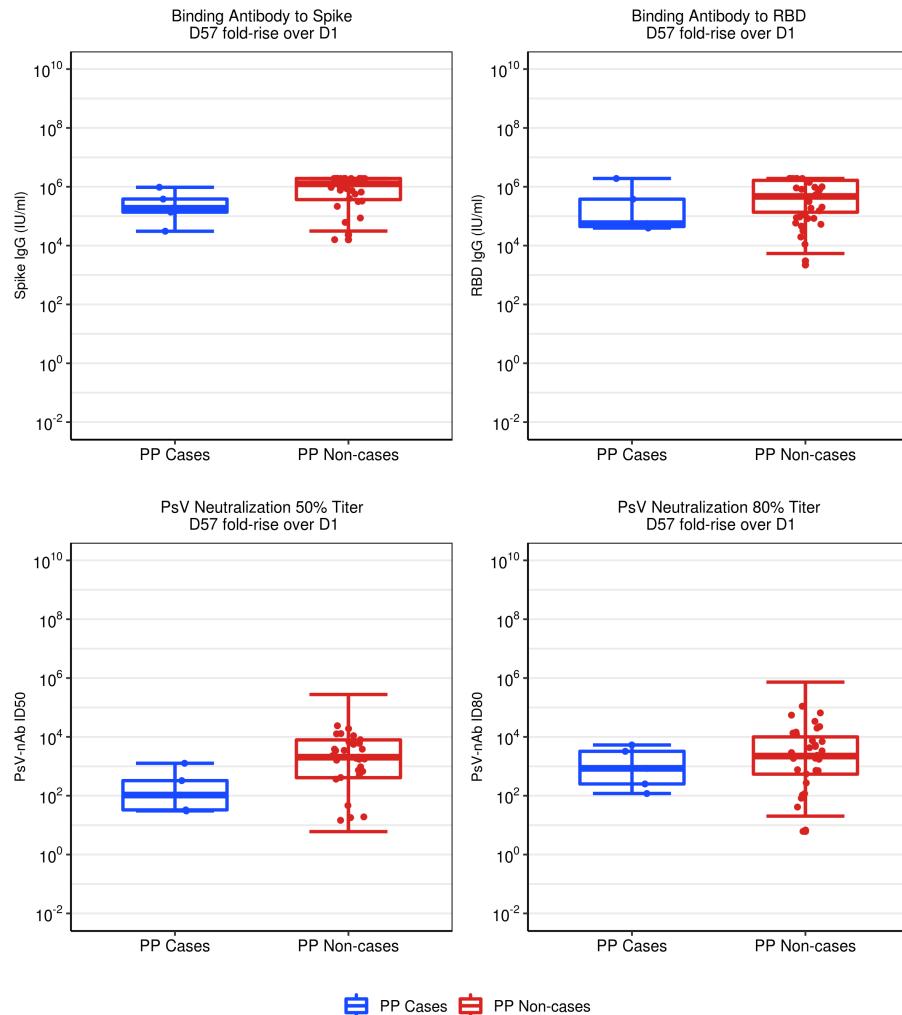


Figure 2.6: Boxplots of D57 fold-rise over D1 Ab markers: baseline positive vaccine arm.

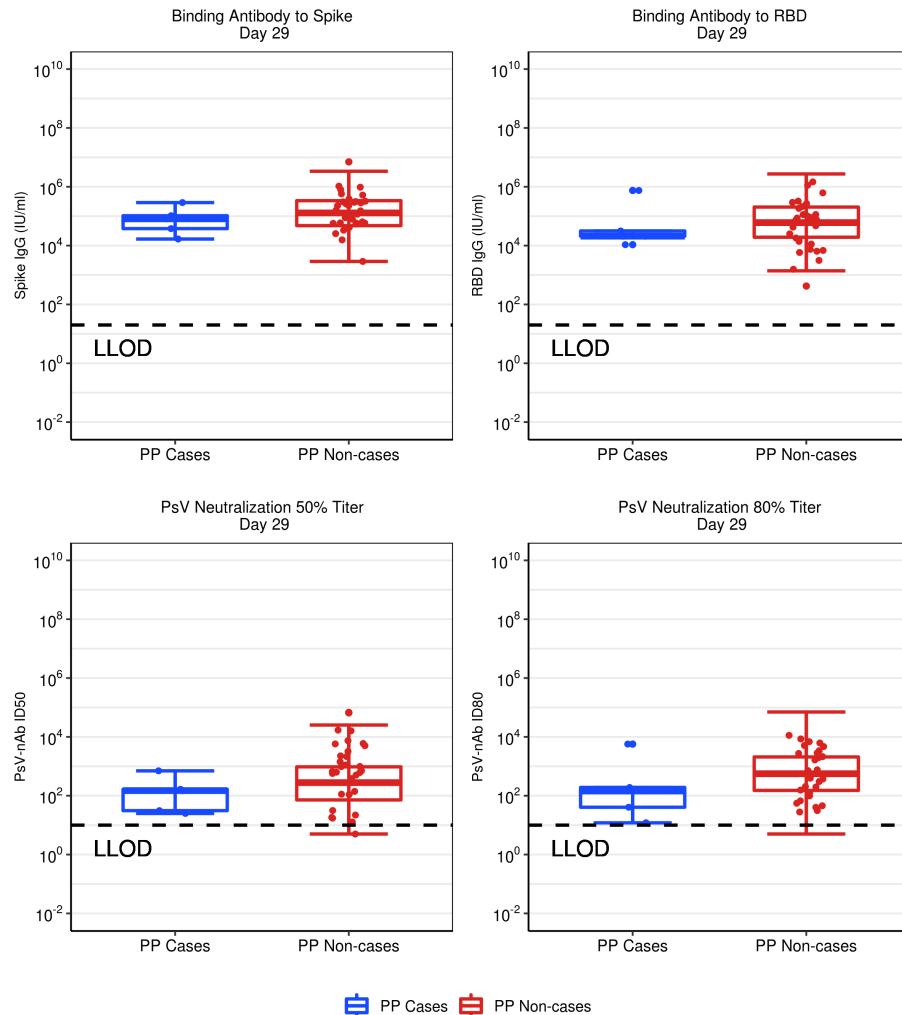


Figure 2.7: Boxplots of D29 Ab markers: baseline positive vaccine arm.

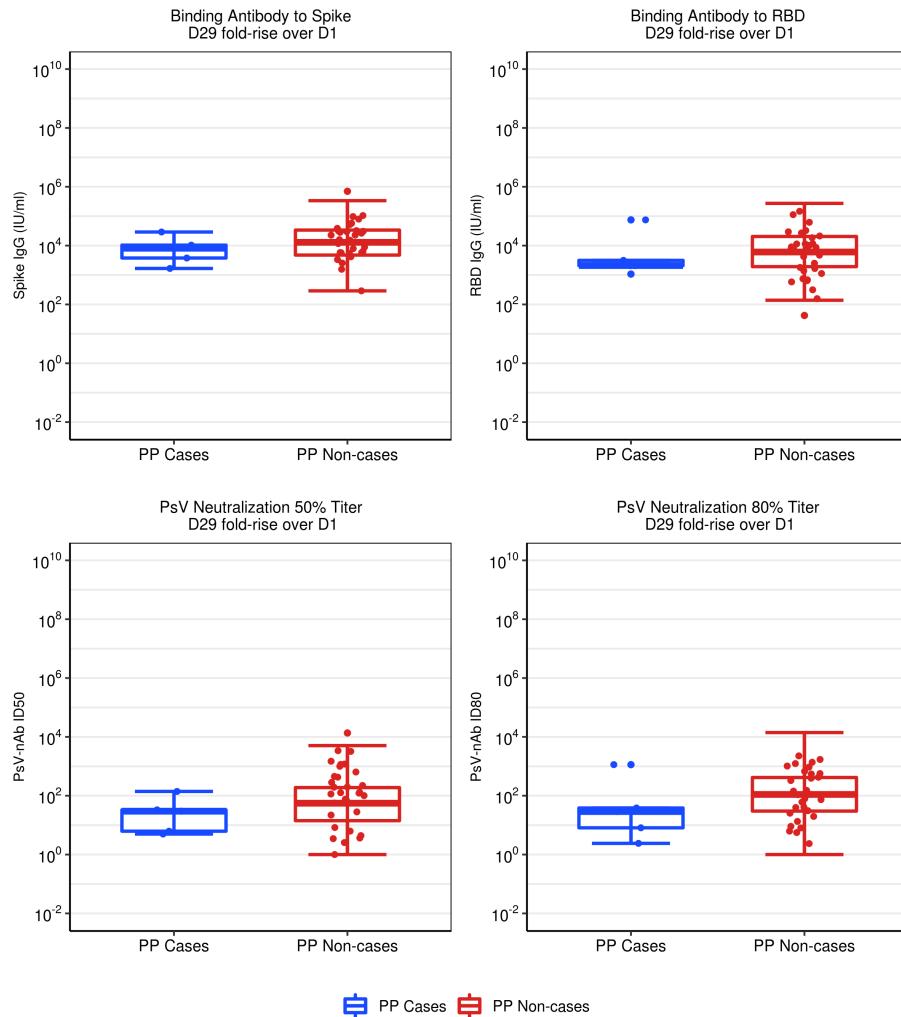


Figure 2.8: Boxplots of D29 fold-rise over D1 Ab markers: baseline positive vaccine arm.

2.2 Weighted RCDF plots

2.2.1 Baseline seronegative

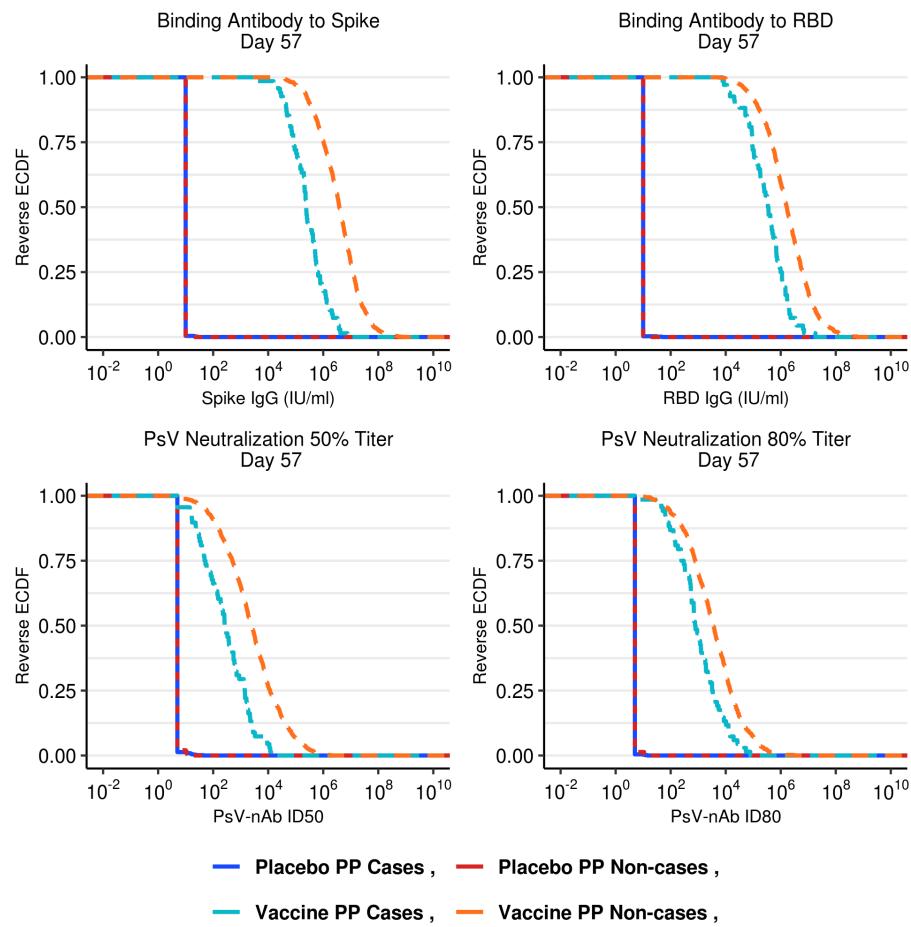


Figure 2.9: RCDF plots for D57 Ab markers: baseline negative by treatment arm.

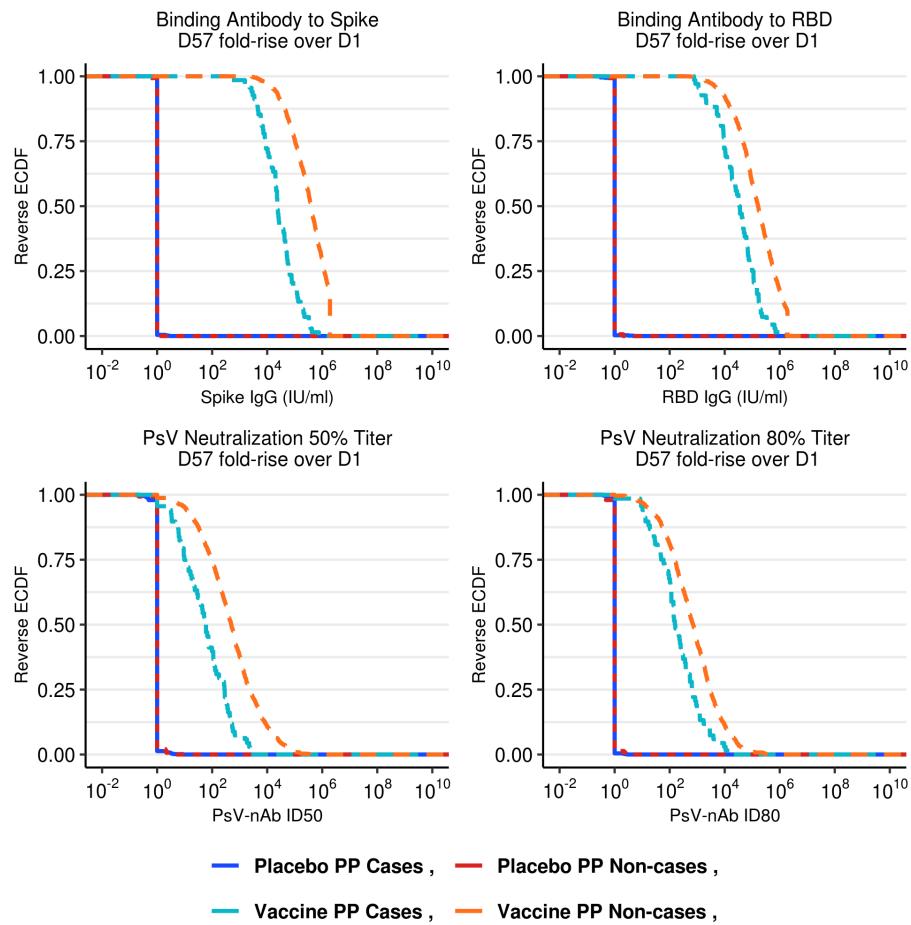


Figure 2.10: RCDF plots for D57 fold-rise over D1 Ab markers: baseline negative by treatment arm.

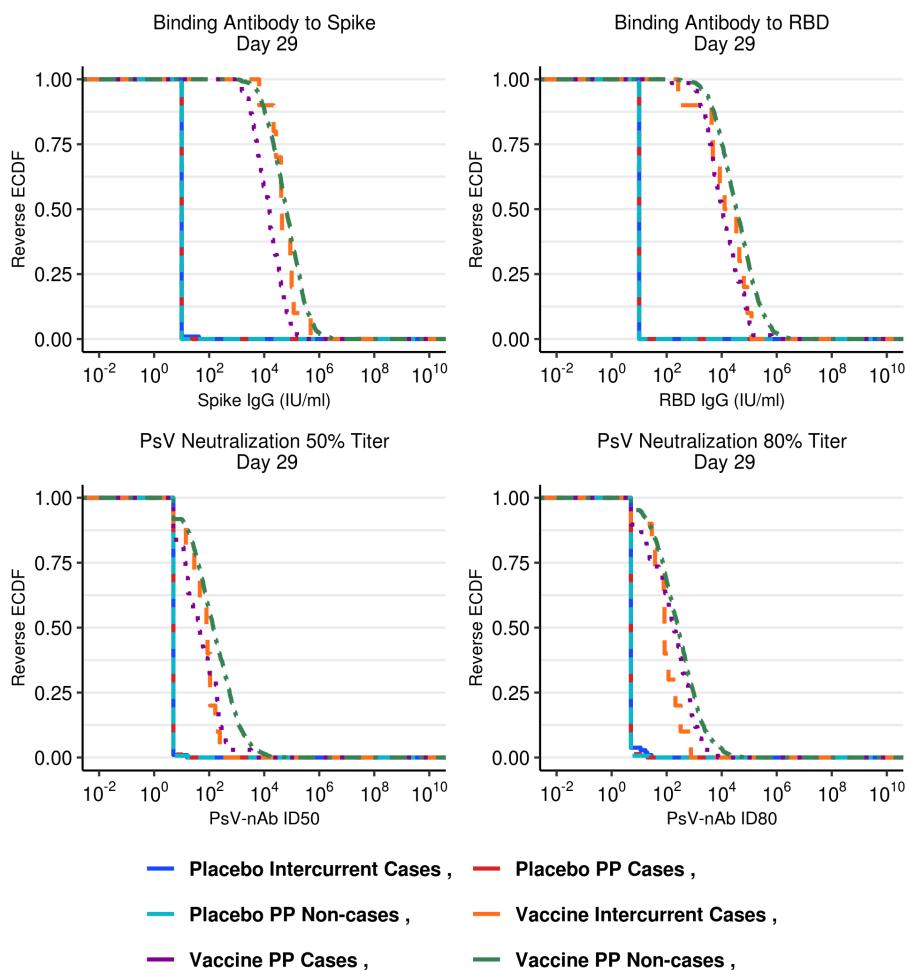


Figure 2.11: RCDF plots for D29 Ab markers: baseline negative by treatment arm.

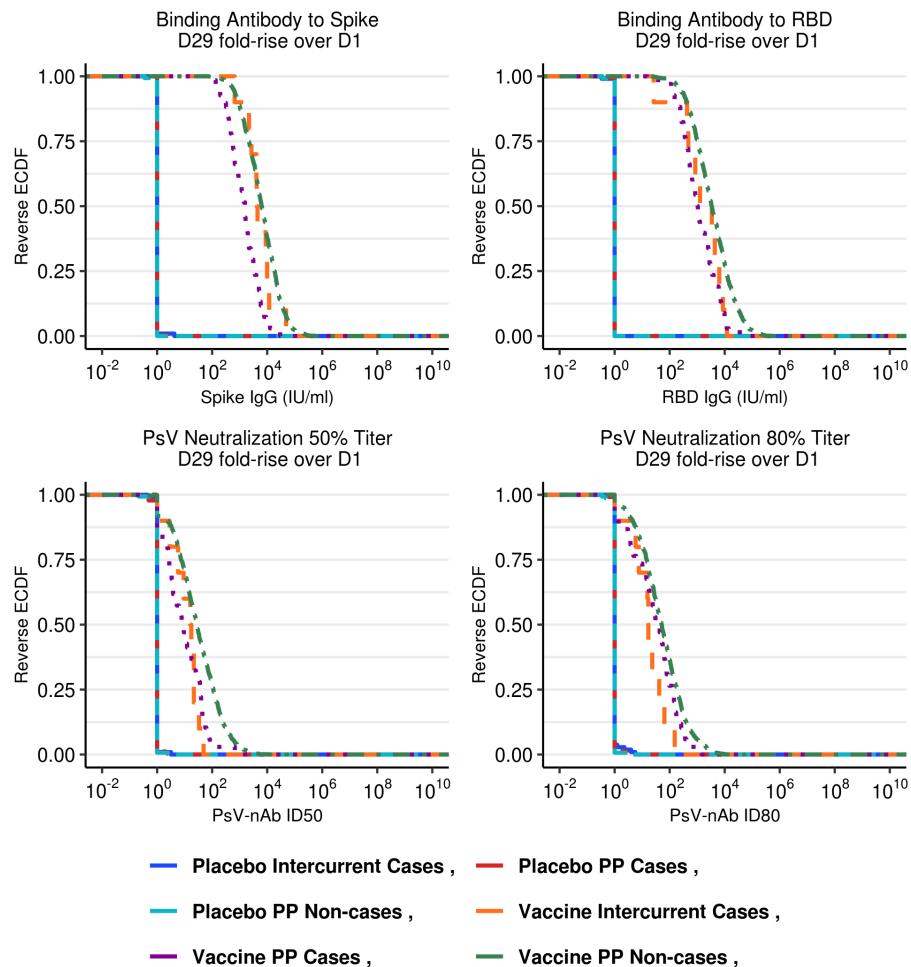


Figure 2.12: RCDF plots for D29 fold-rise over D1 Ab markers: baseline negative by treatment arm.

2.2.2 Baseline seropositive

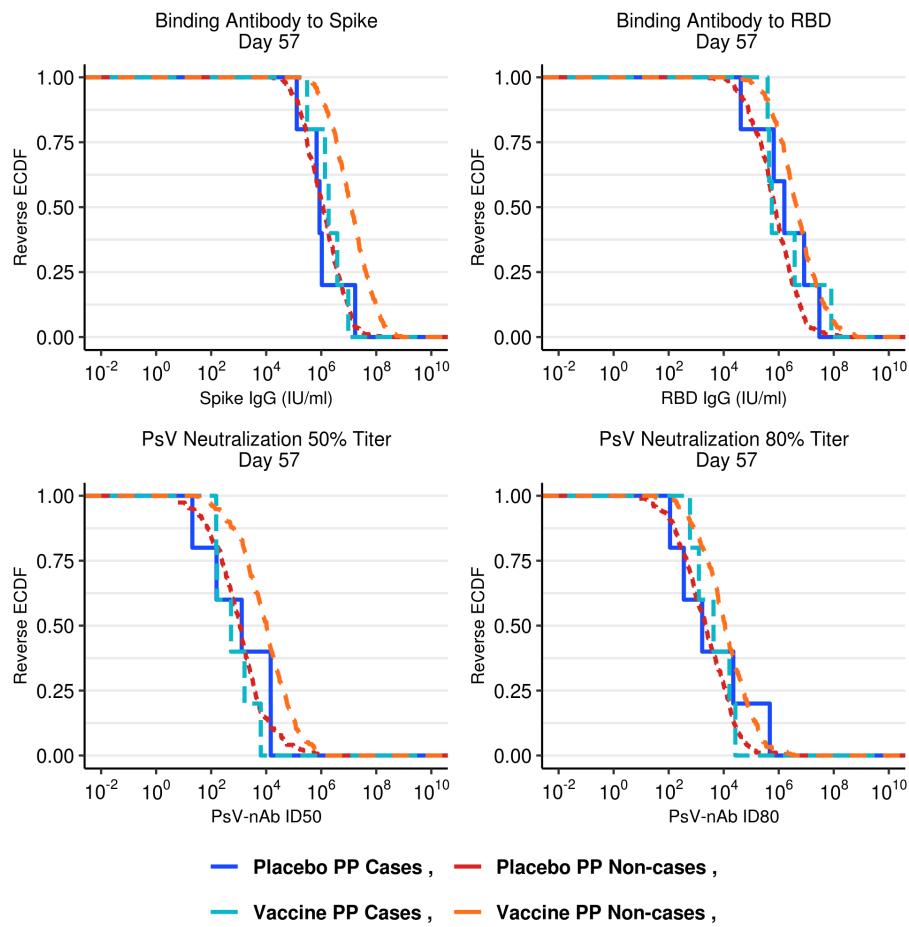


Figure 2.13: RCDF plots for D57 Ab markers: baseline positive by treatment arm.

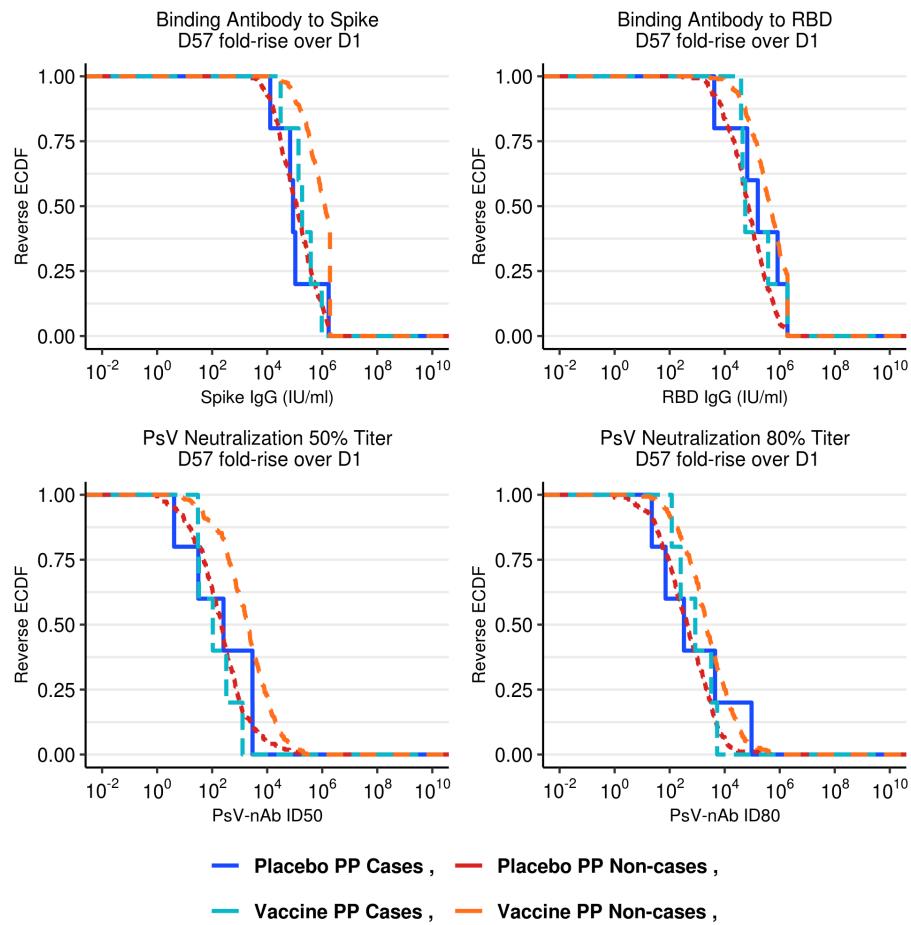


Figure 2.14: RCDF plots for D57 fold-rise over D1 Ab markers: baseline positive by treatment arm.

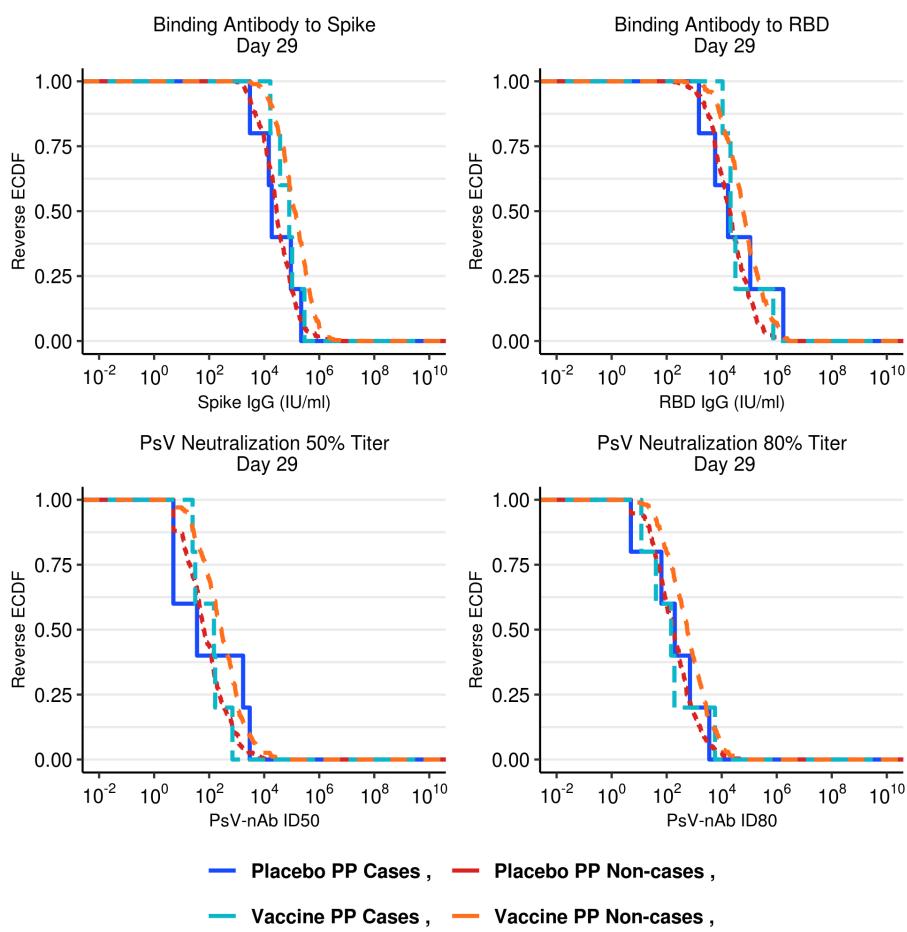


Figure 2.15: RCDF plots for D29 Ab markers: baseline positive by treatment arm.

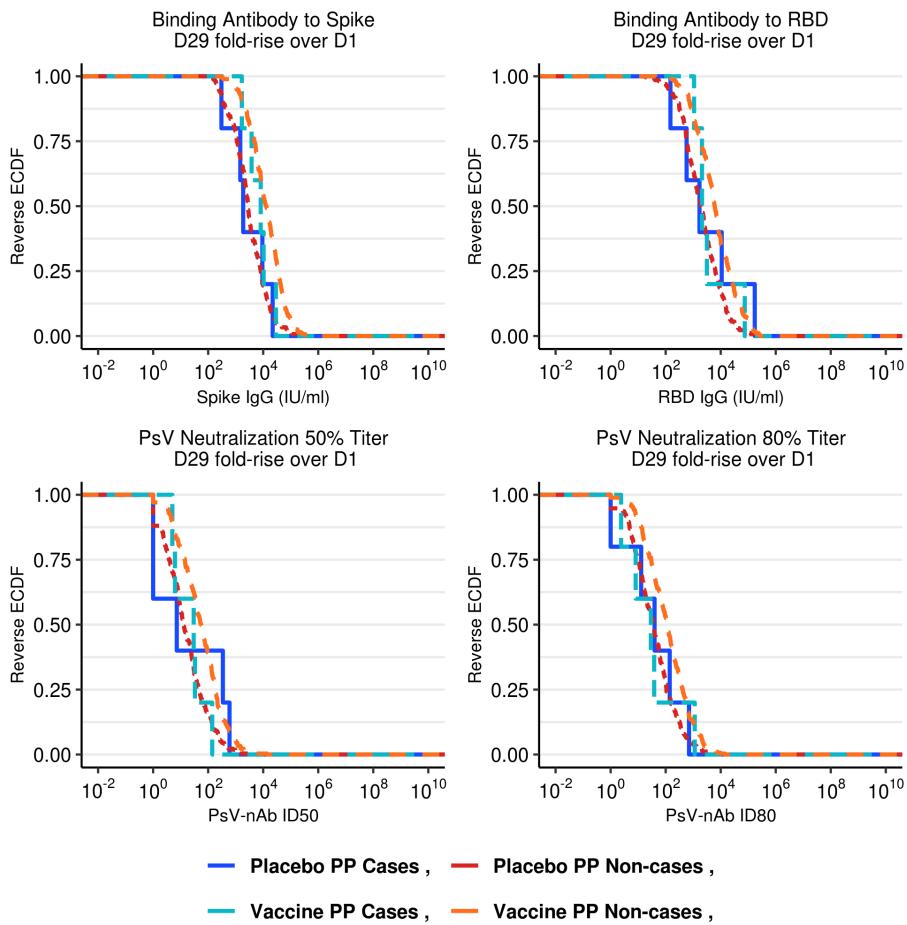


Figure 2.16: RCDF plots for D29 fold-rise over D1 Ab markers: baseline positive by treatment arm.

2.3 Weighted RCDF plots of threshold correlate concentration for overall vaccine efficacy

2.3.1 Baseline seronegative

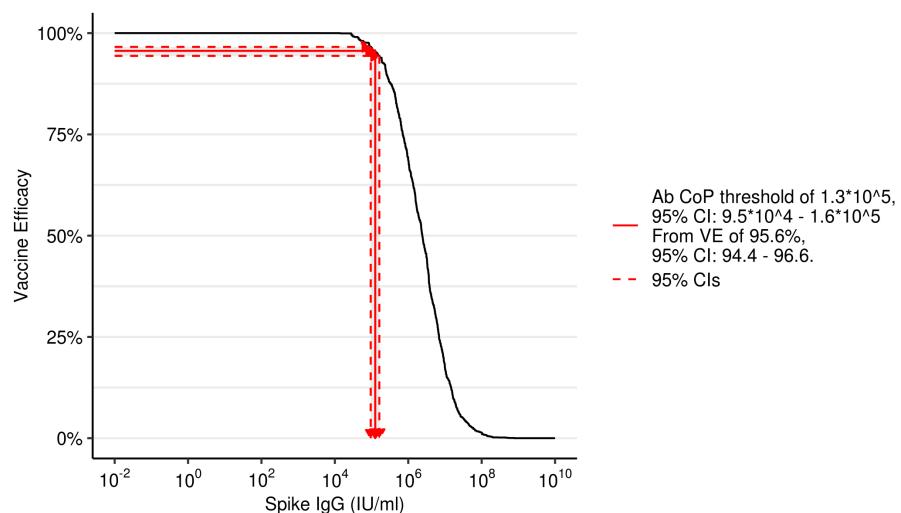


Figure 2.17: Marker RCDF of D57 anti-Spike binding Ab: baseline negative vaccine arm

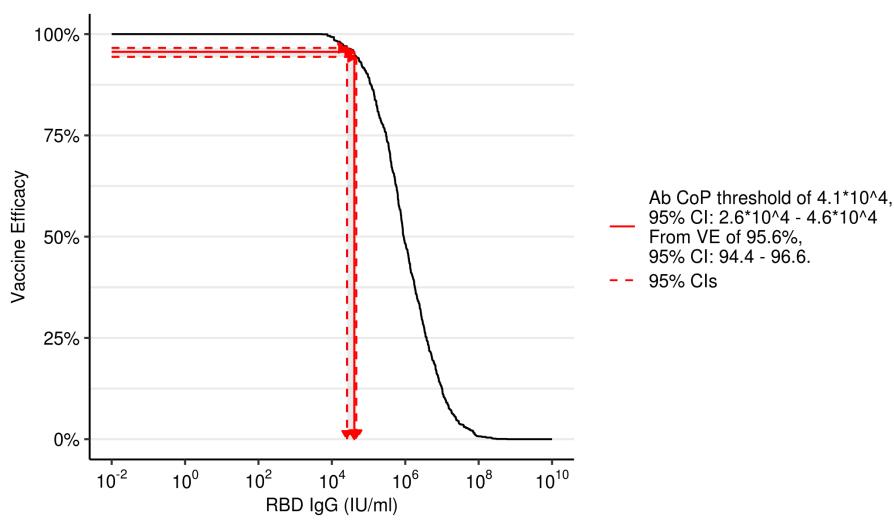


Figure 2.18: Marker RCDF of D57 anti-RBD binding Ab: baseline negative vaccine arm

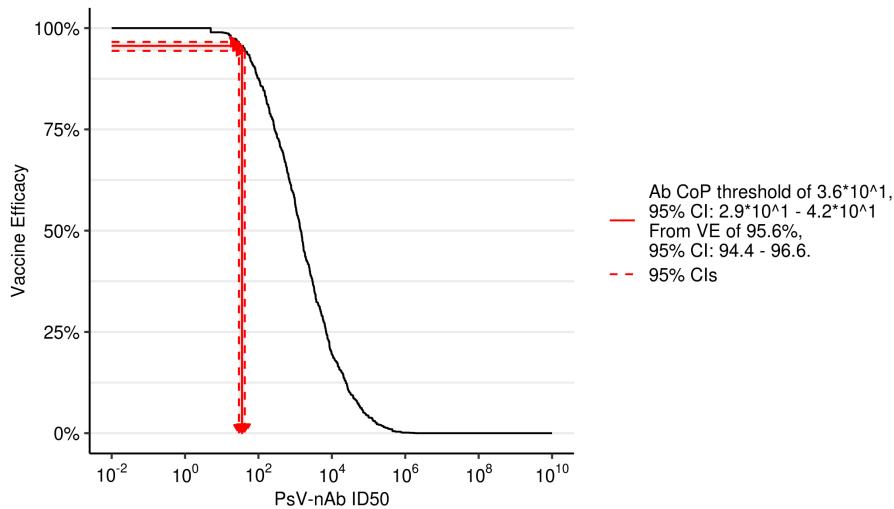


Figure 2.19: Marker RCDF of D57 PsV-nAb ID50: baseline negative vaccine arm

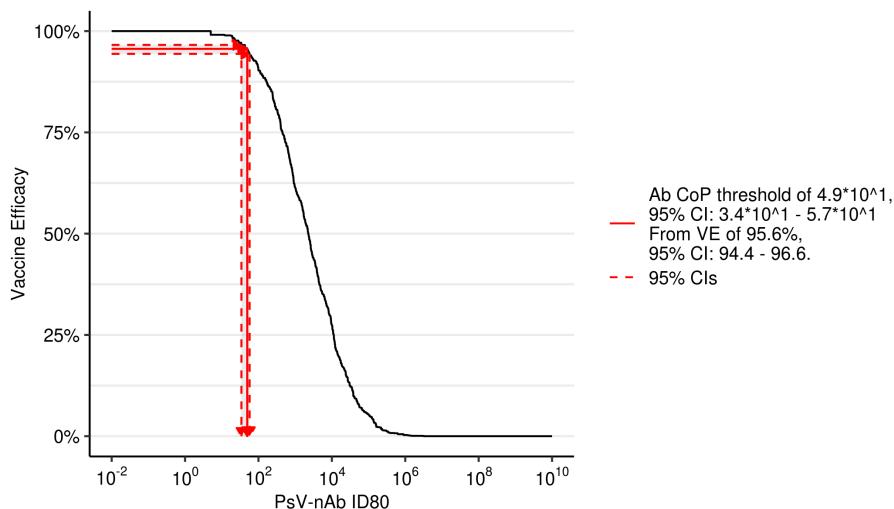


Figure 2.20: Marker RCDF of D57 PsV-nAb ID80: baseline negative vaccine arm

2.4 Spaghetti plots

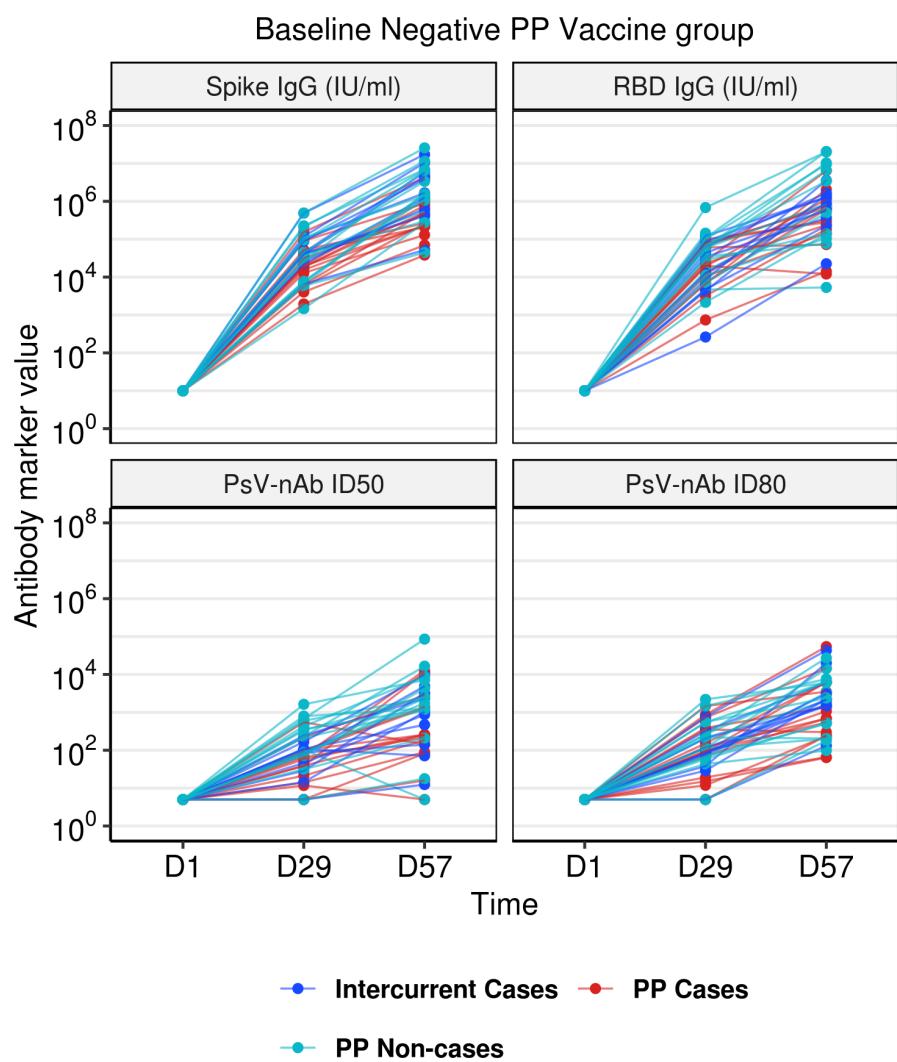


Figure 2.21: Spaghetti Plots of Marker Trajectory: baseline negative vaccine arm

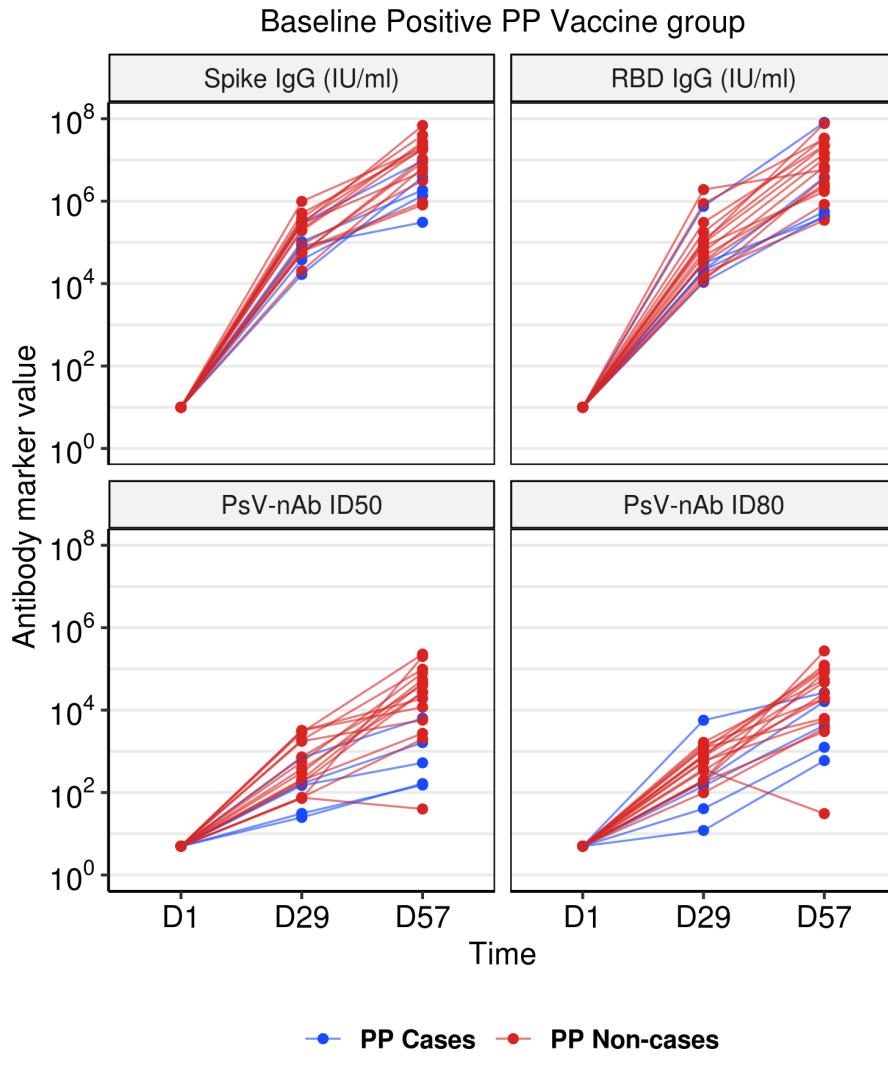


Figure 2.22: Spaghetti Plots of Marker Trajectory: baseline positive vaccine arm

2.5 Violin and line plots

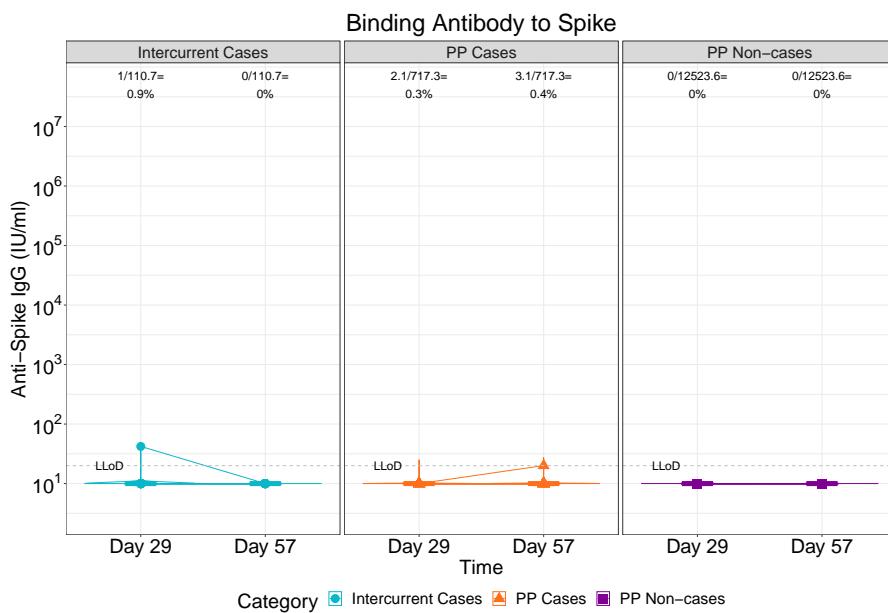


Figure 2.23: lineplots of Binding Antibody to Spike: baseline negative placebo arm (2 timepoints)

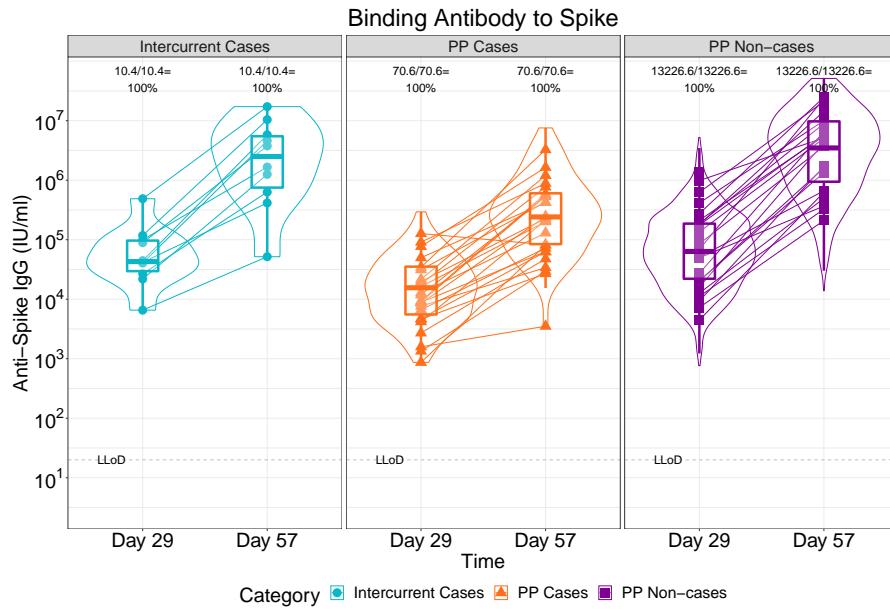


Figure 2.24: lineplots of Binding Antibody to Spike: baseline negative vaccine arm (2 timepoints)

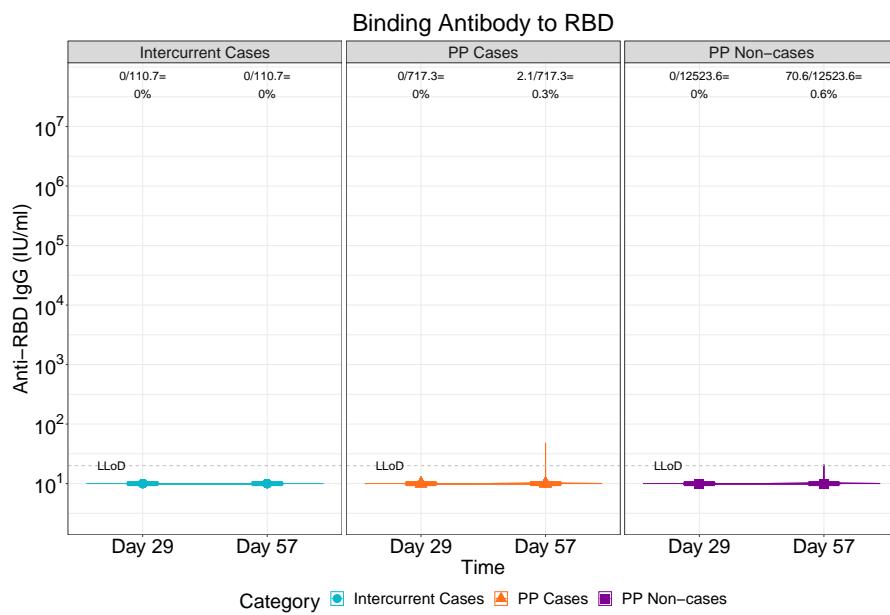


Figure 2.25: lineplots of Binding Antibody to RBD: baseline negative placebo arm (2 timepoints)

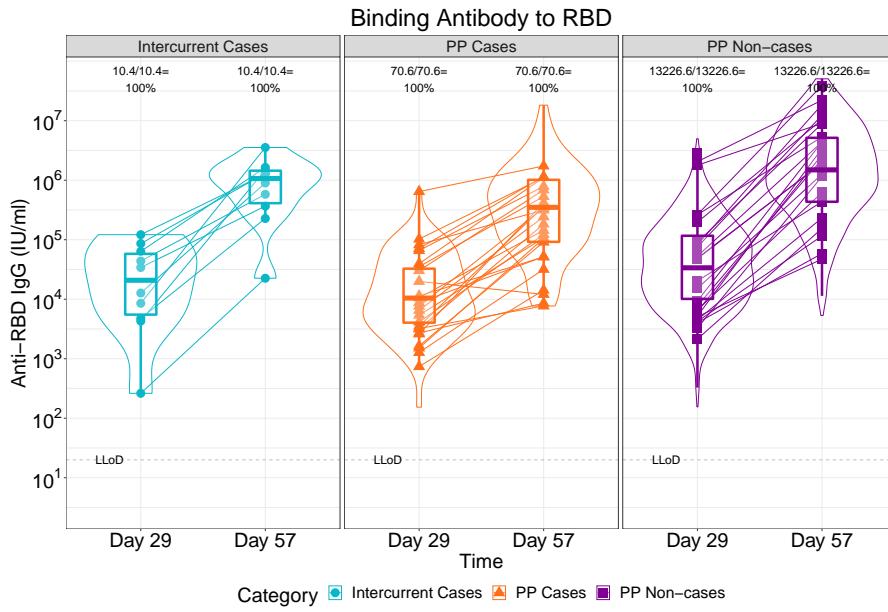


Figure 2.26: lineplots of Binding Antibody to RBD: baseline negative vaccine arm (2 timepoints)

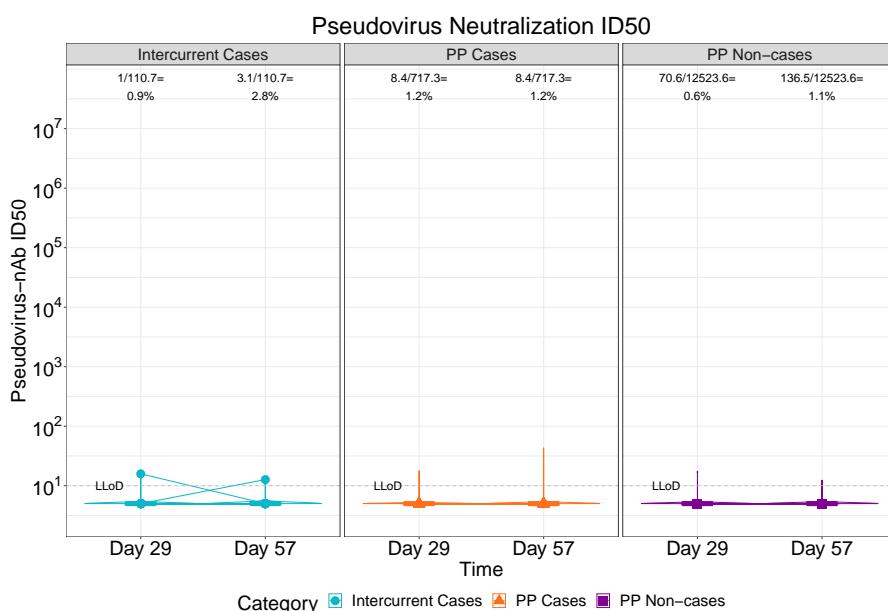


Figure 2.27: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm (2 timepoints)

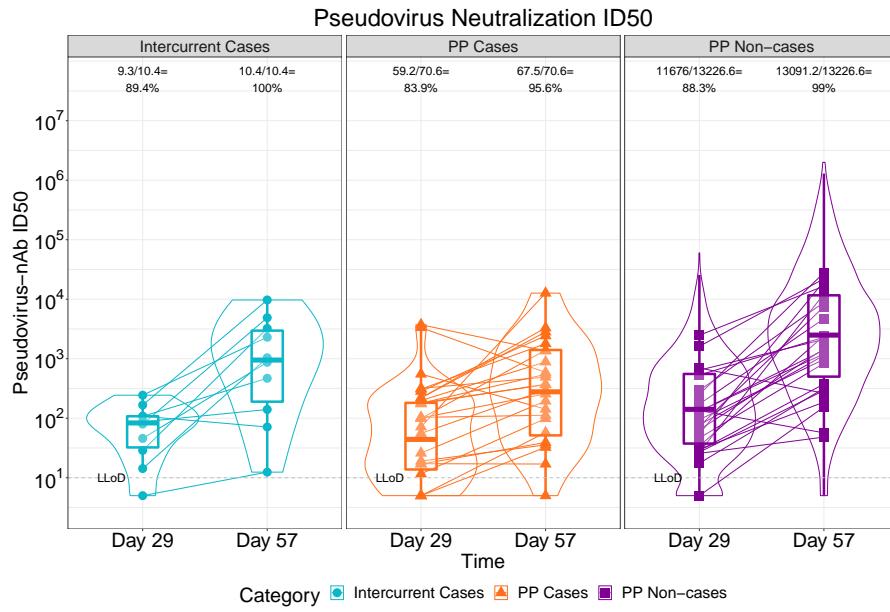


Figure 2.28: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm (2 timepoints)

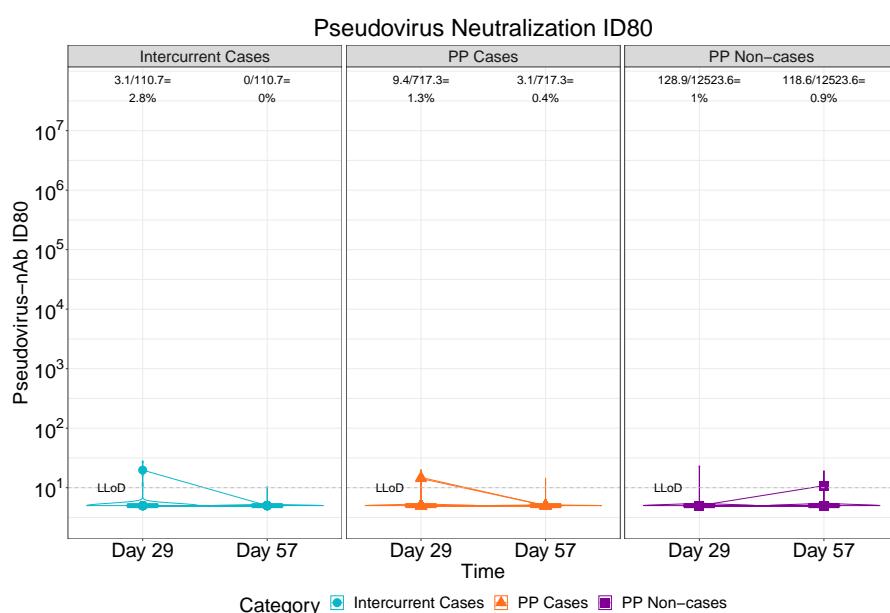


Figure 2.29: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm (2 timepoints)

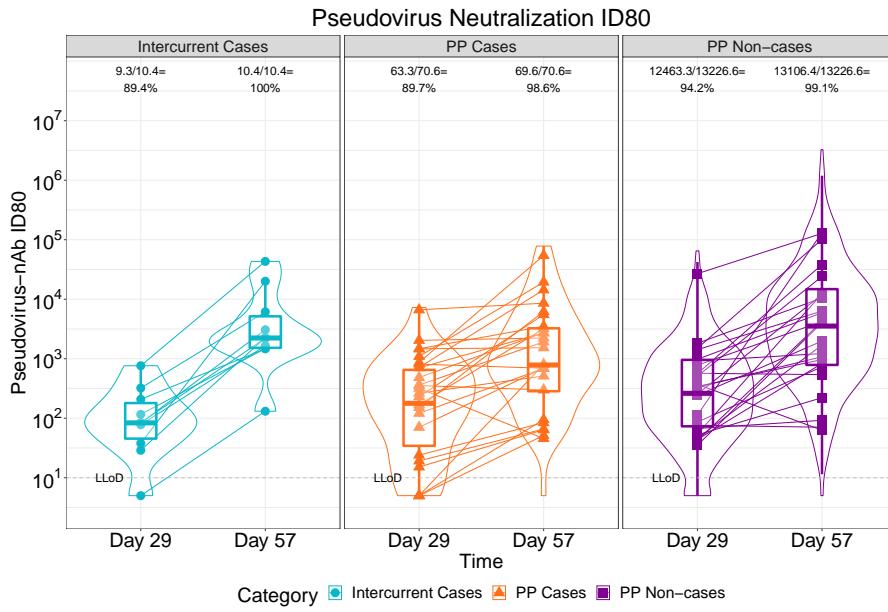


Figure 2.30: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm (2 timepoints)

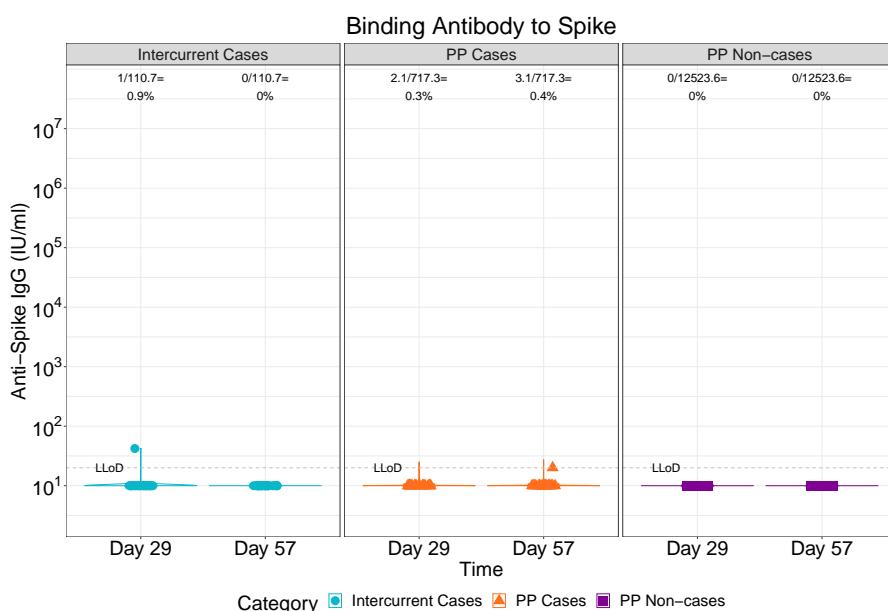


Figure 2.31: violinplots of Binding Antibody to Spike: baseline negative placebo arm (2 timepoints)

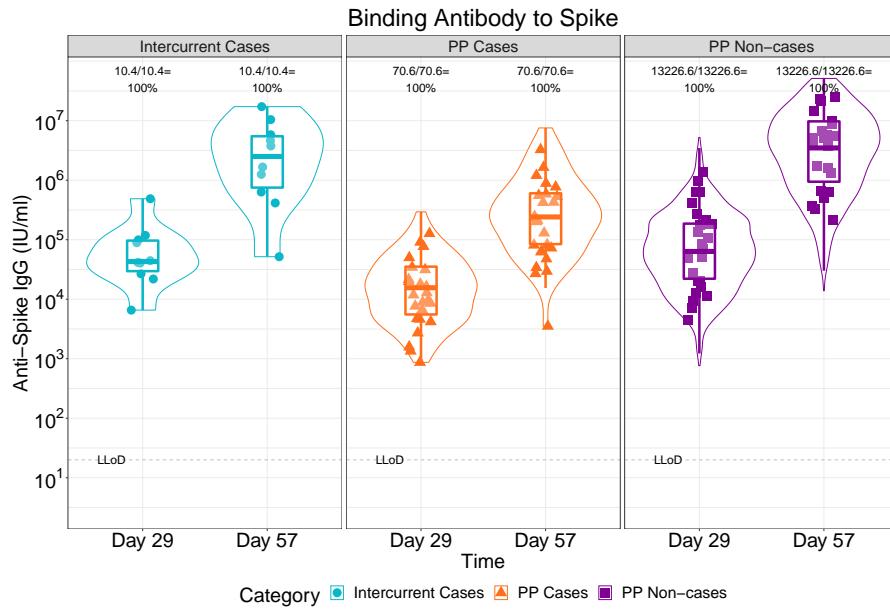


Figure 2.32: violinplots of Binding Antibody to Spike: baseline negative vaccine arm (2 timepoints)

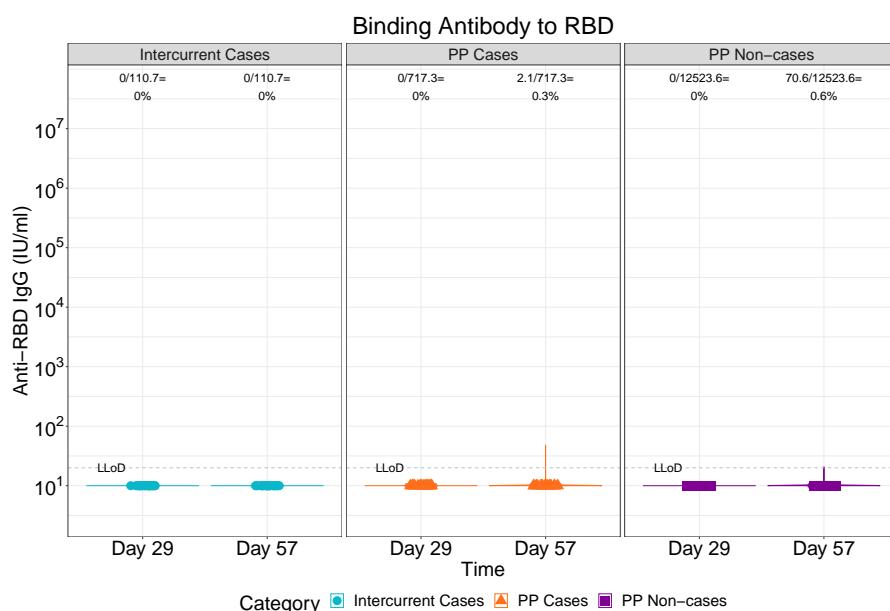


Figure 2.33: violinplots of Binding Antibody to RBD: baseline negative placebo arm (2 timepoints)

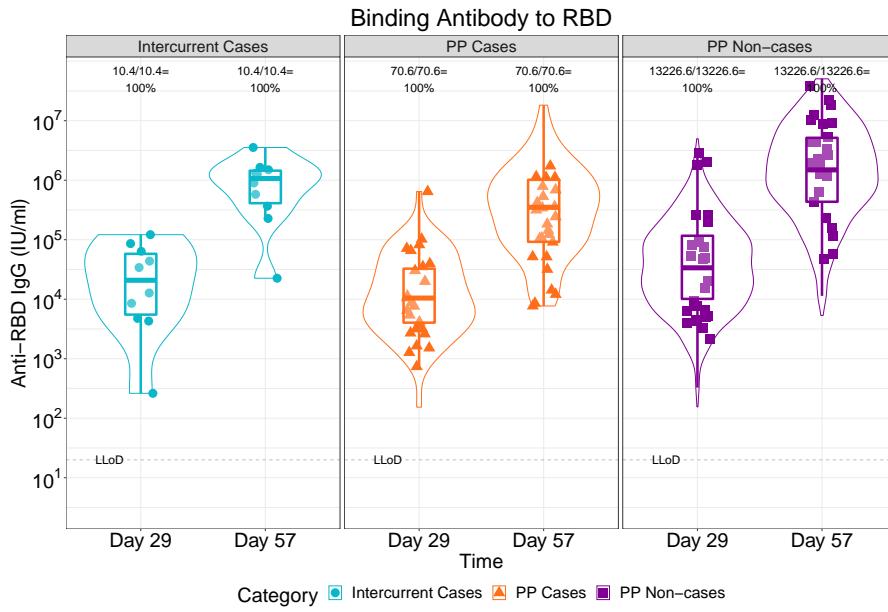


Figure 2.34: violinplots of Binding Antibody to RBD: baseline negative vaccine arm (2 timepoints)

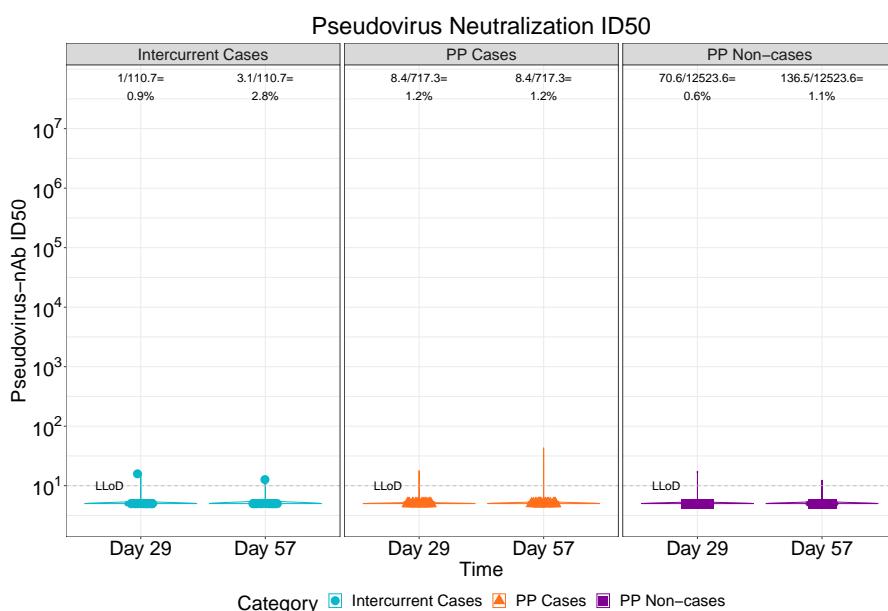


Figure 2.35: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm (2 timepoints)

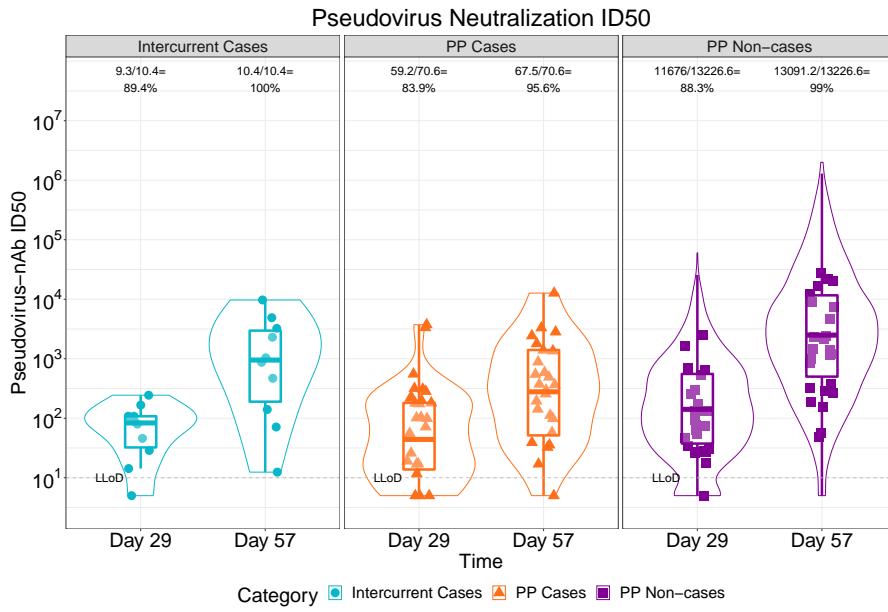


Figure 2.36: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm (2 timepoints)

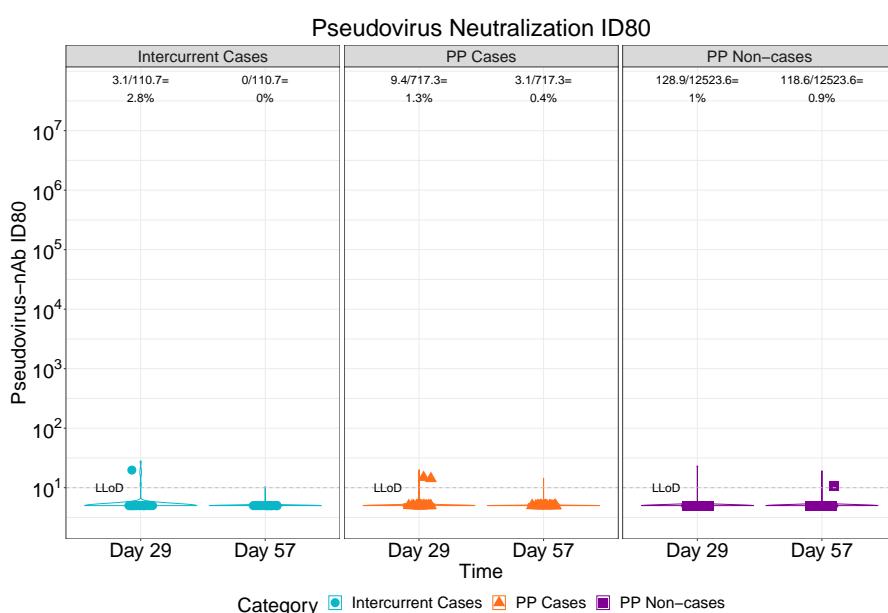


Figure 2.37: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm (2 timepoints)

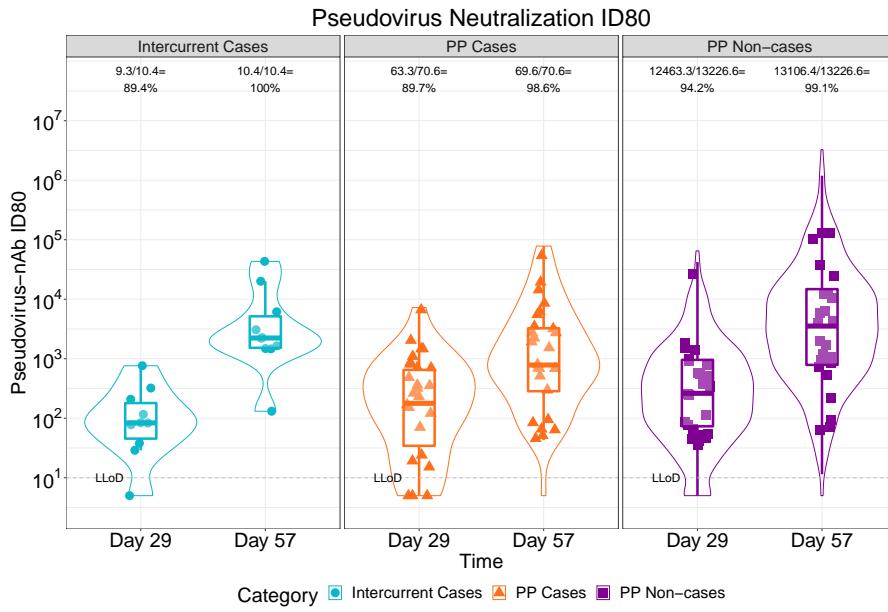


Figure 2.38: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm (2 timepoints)

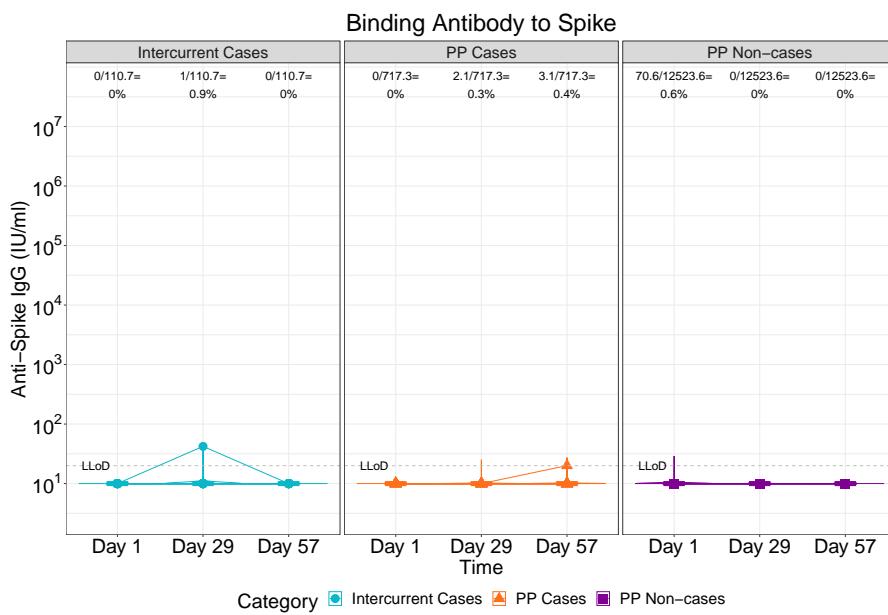


Figure 2.39: lineplots of Binding Antibody to Spike: baseline negative placebo arm (3 timepoints)

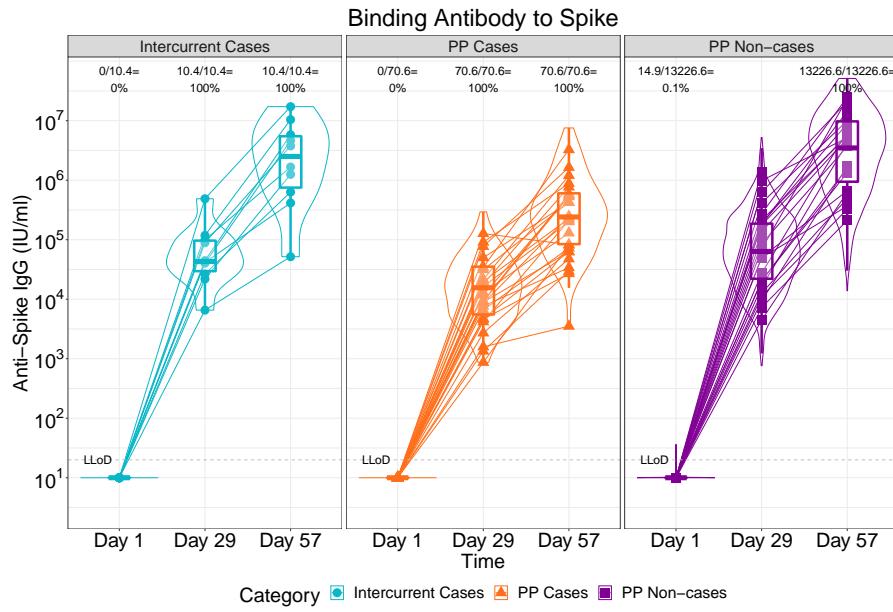


Figure 2.40: lineplots of Binding Antibody to Spike: baseline negative vaccine arm (3 timepoints)

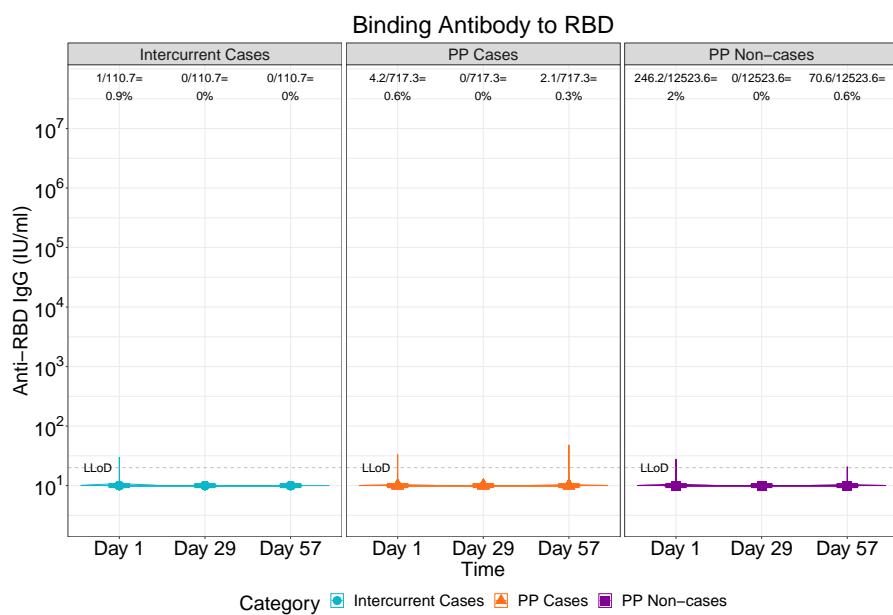


Figure 2.41: lineplots of Binding Antibody to RBD: baseline negative placebo arm (3 timepoints)

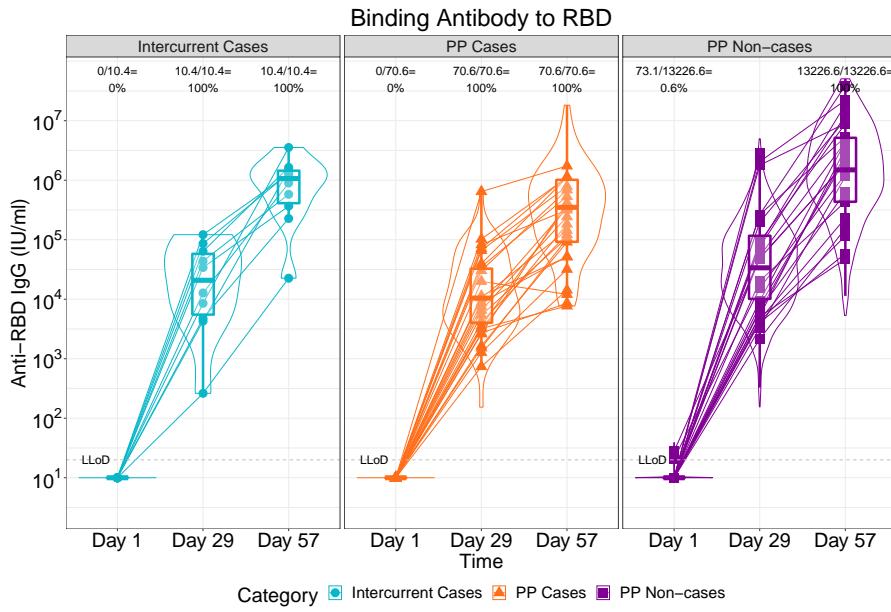


Figure 2.42: lineplots of Binding Antibody to RBD: baseline negative vaccine arm (3 timepoints)

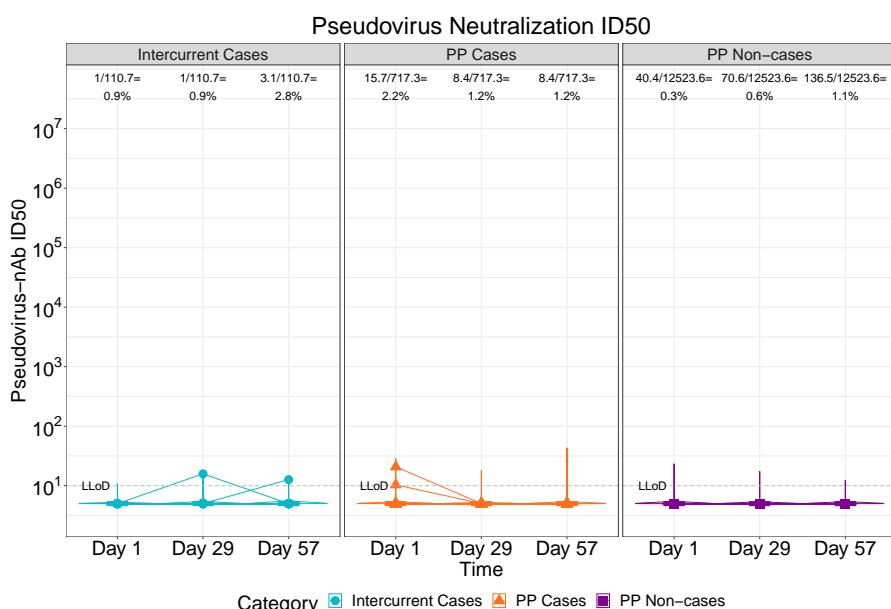


Figure 2.43: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm (3 timepoints)

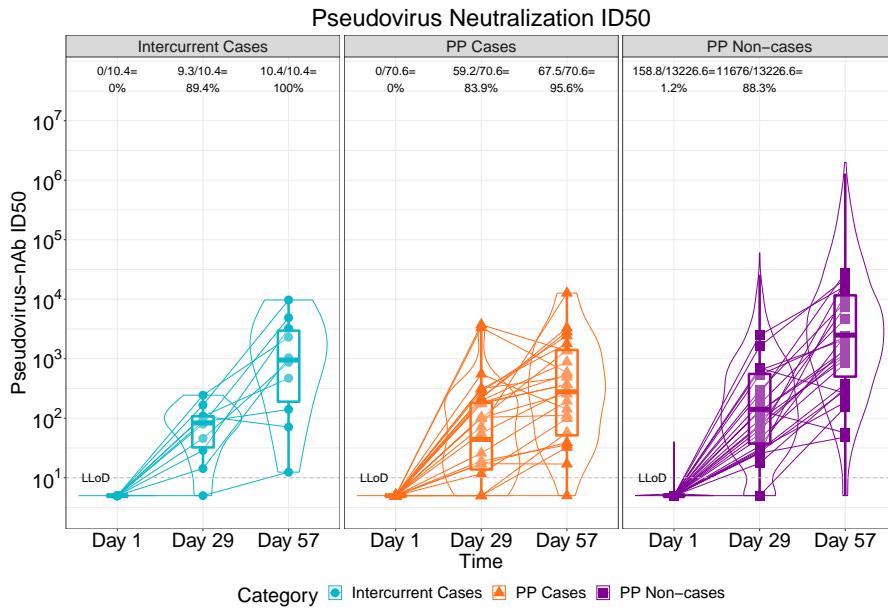


Figure 2.44: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm (3 timepoints)

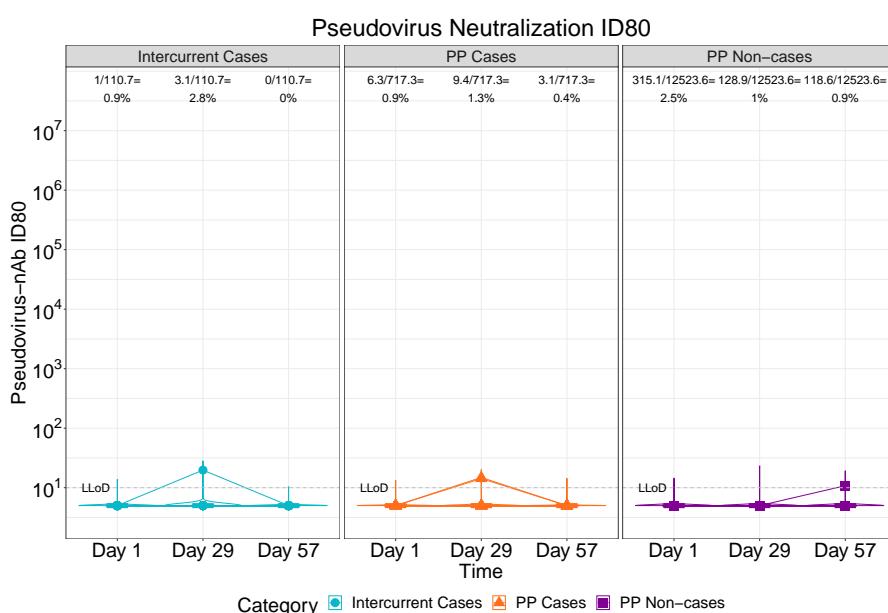


Figure 2.45: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm (3 timepoints)

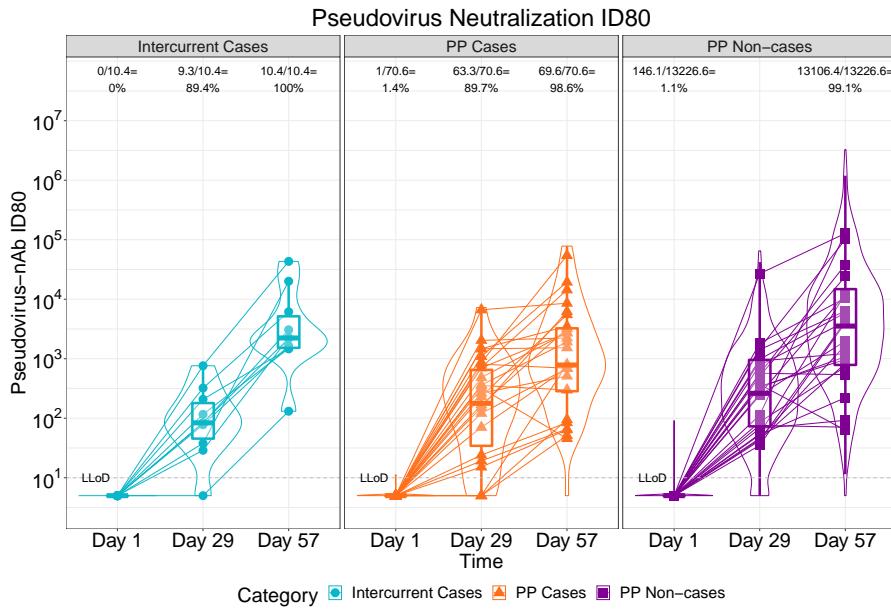


Figure 2.46: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm (3 timepoints)

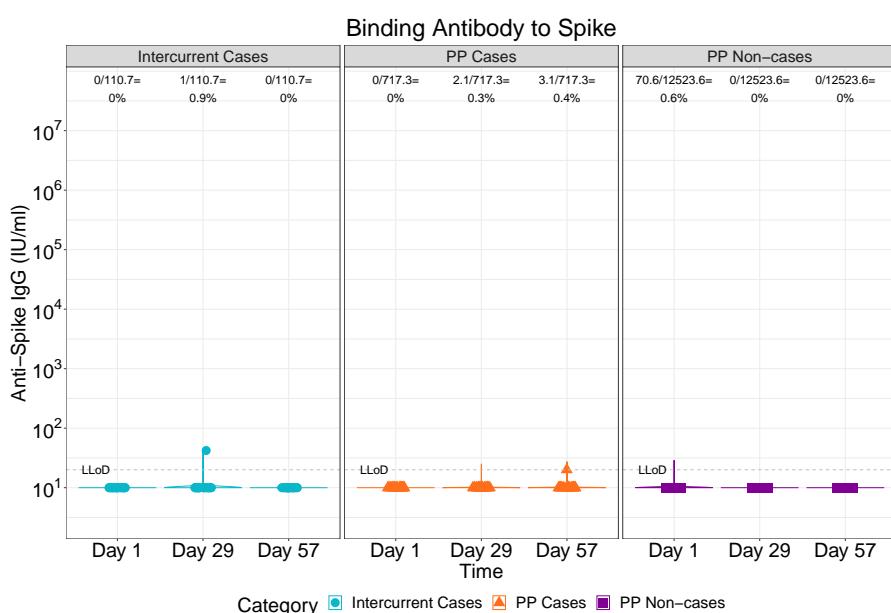


Figure 2.47: violinplots of Binding Antibody to Spike: baseline negative placebo arm (3 timepoints)

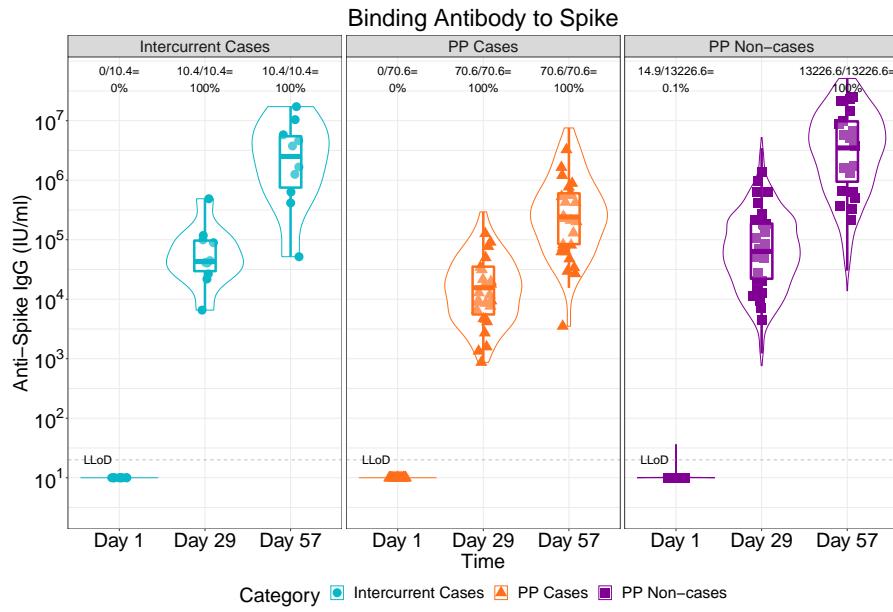


Figure 2.48: violinplots of Binding Antibody to Spike: baseline negative vaccine arm (3 timepoints)

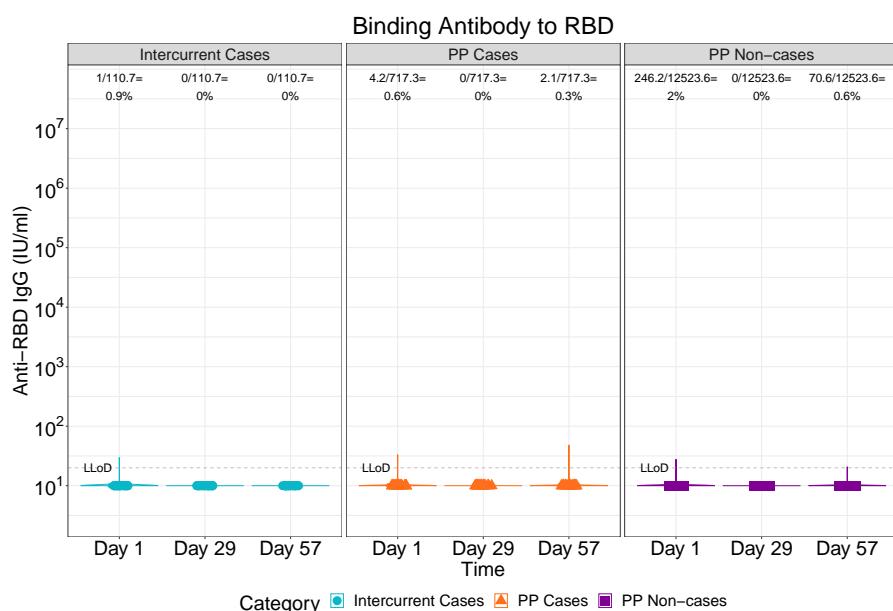


Figure 2.49: violinplots of Binding Antibody to RBD: baseline negative placebo arm (3 timepoints)

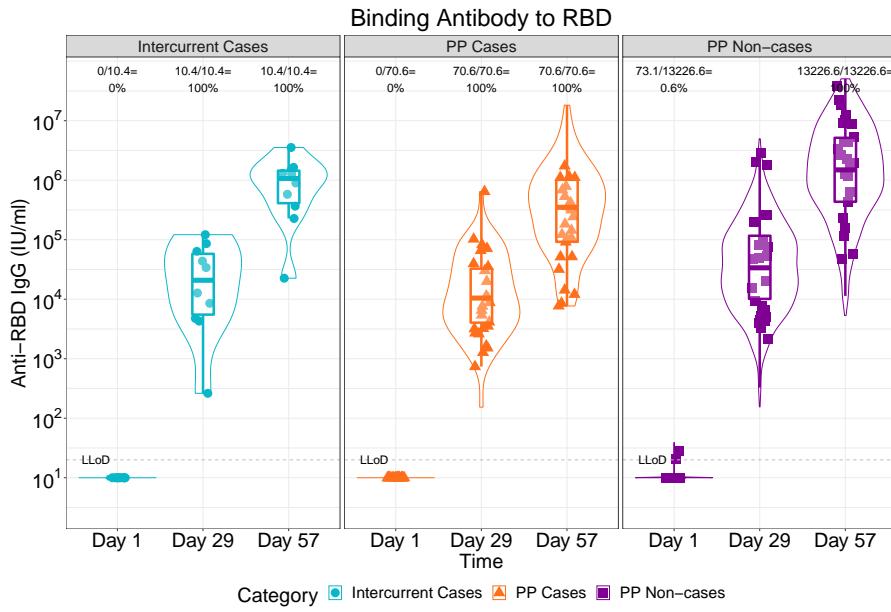


Figure 2.50: violinplots of Binding Antibody to RBD: baseline negative vaccine arm (3 timepoints)

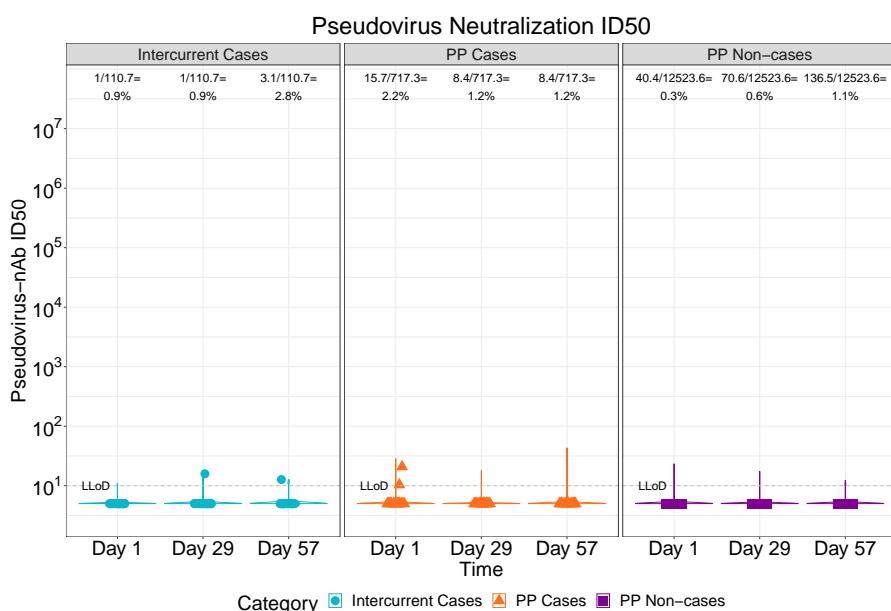


Figure 2.51: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm (3 timepoints)

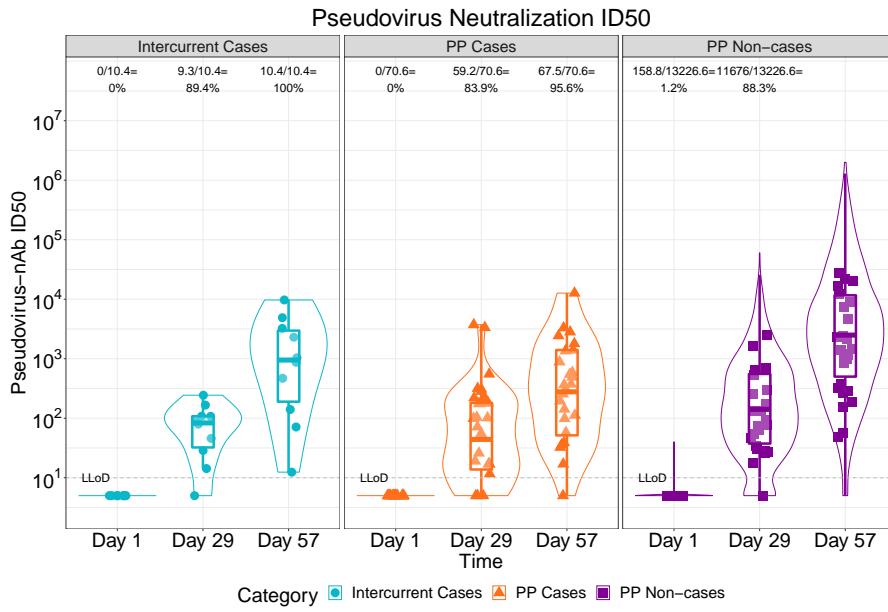


Figure 2.52: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm (3 timepoints)

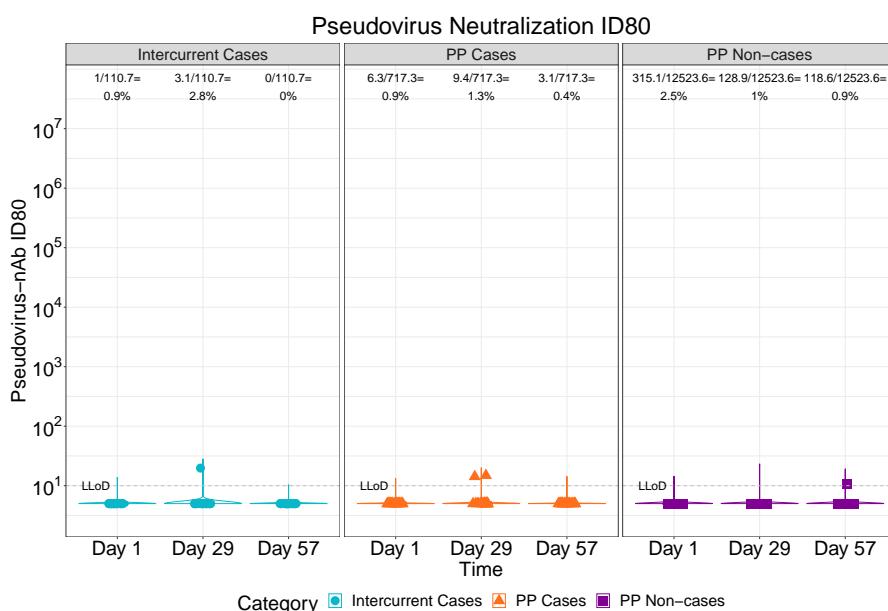


Figure 2.53: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm (3 timepoints)

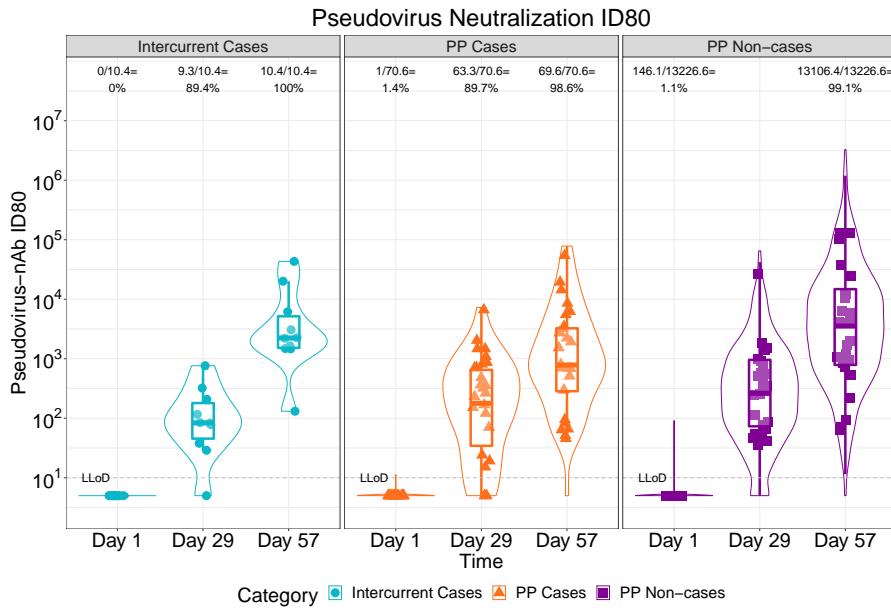


Figure 2.54: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm (3 timepoints)

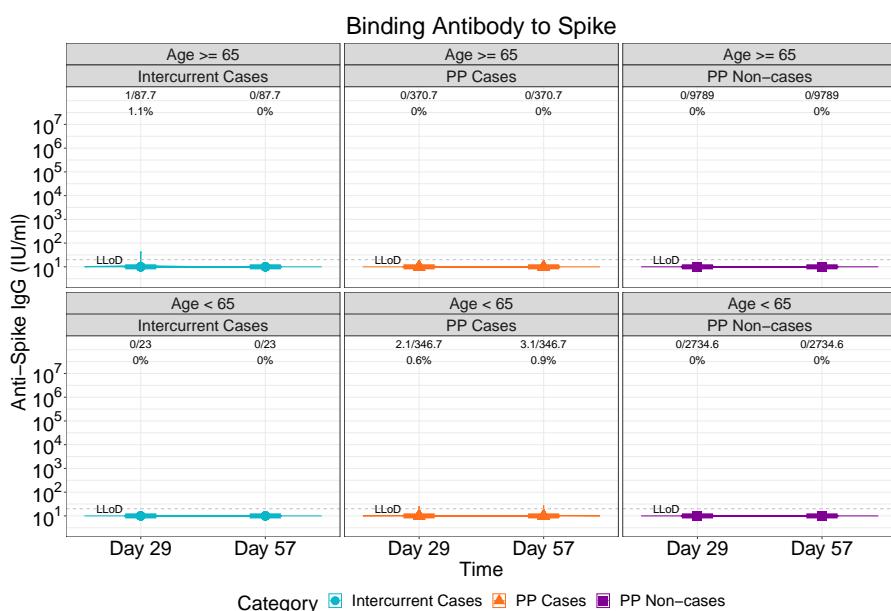


Figure 2.55: lineplots of Binding Antibody to Spike: baseline negative placebo arm by age (2 timepoints)

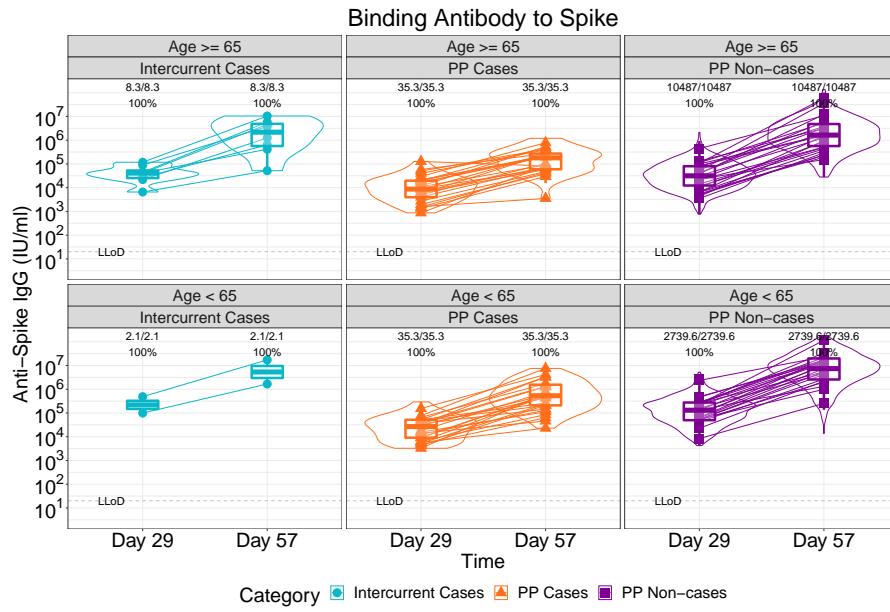


Figure 2.56: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by age (2 timepoints)

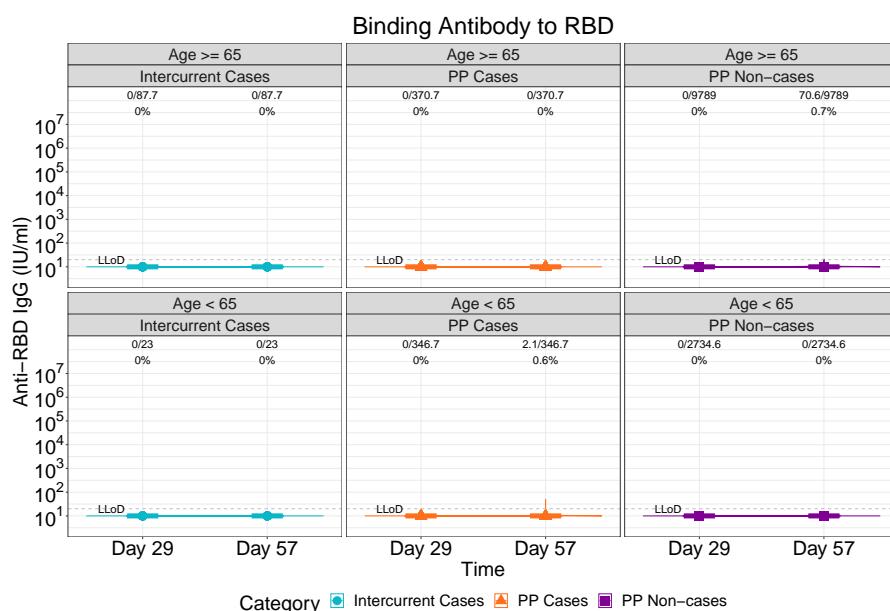


Figure 2.57: lineplots of Binding Antibody to RBD: baseline negative placebo arm by age (2 timepoints)

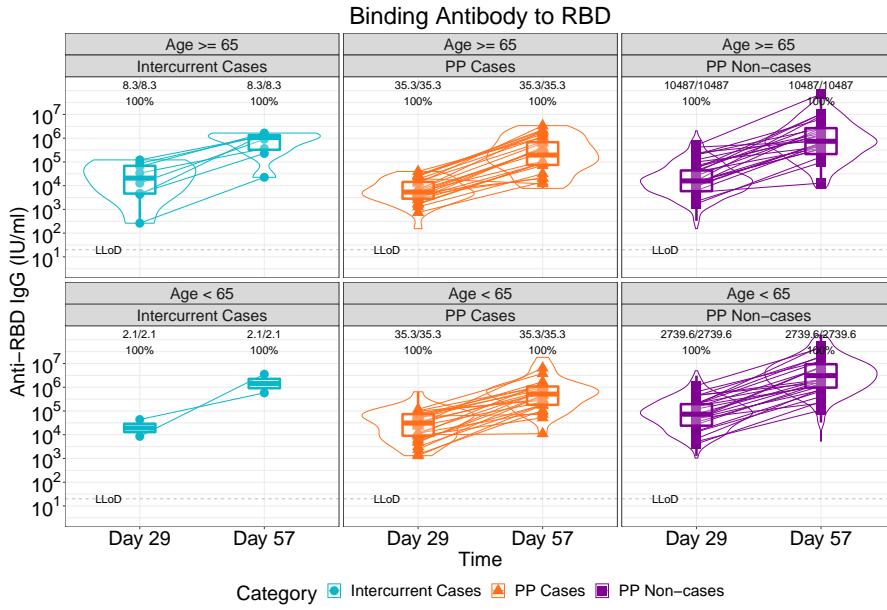


Figure 2.58: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by age (2 timepoints)

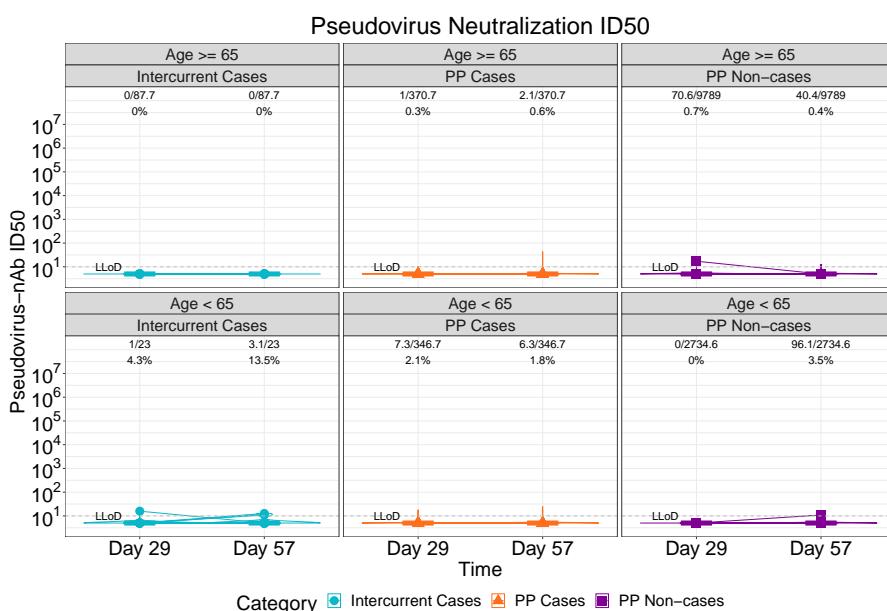


Figure 2.59: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age (2 timepoints)

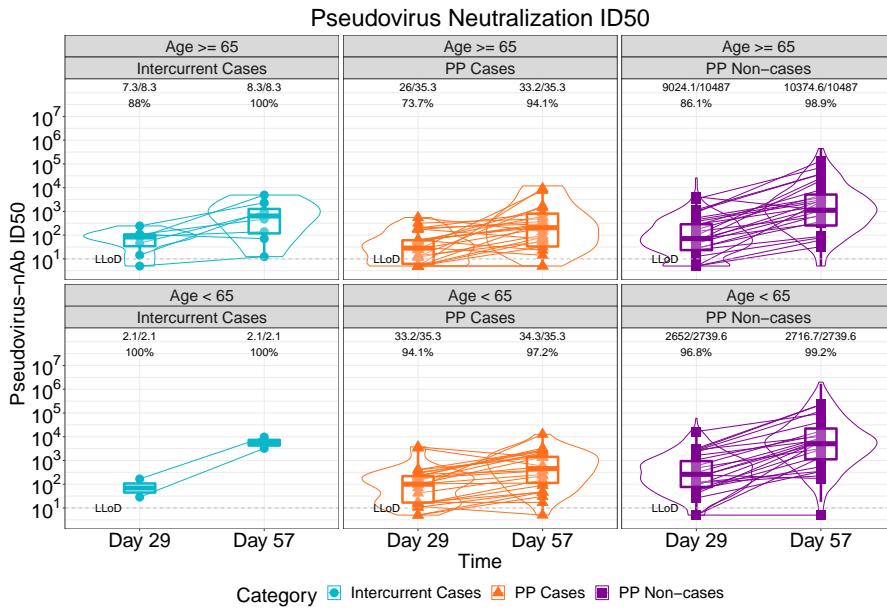


Figure 2.60: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age (2 timepoints)

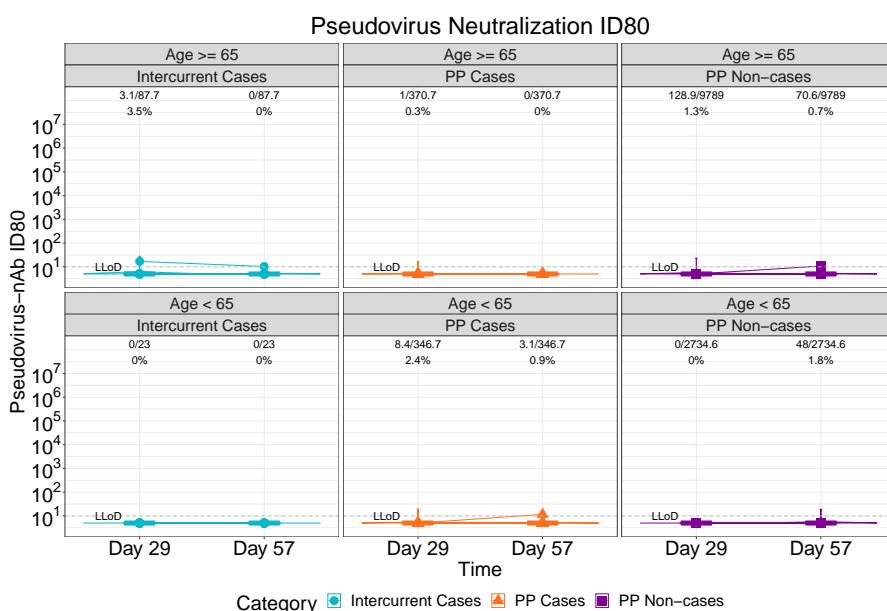


Figure 2.61: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age (2 timepoints)

Pseudovirus Neutralization ID80

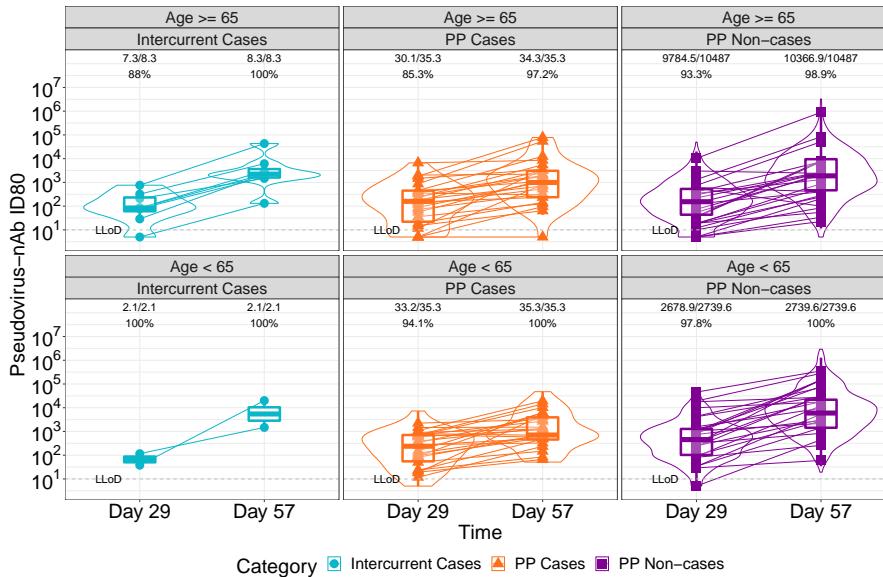


Figure 2.62: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age (2 timepoints)

Binding Antibody to Spike

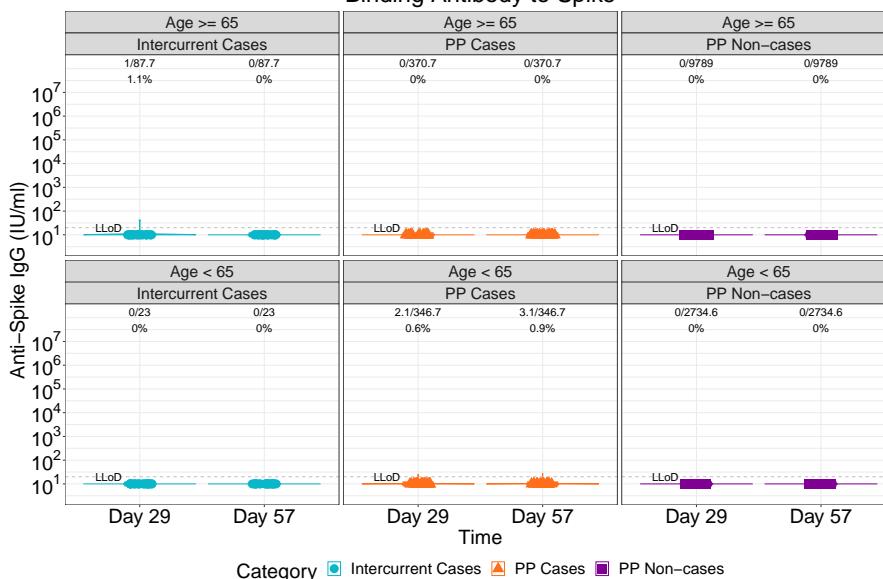


Figure 2.63: violinplots of Binding Antibody to Spike: baseline negative placebo arm by age (2 timepoints)

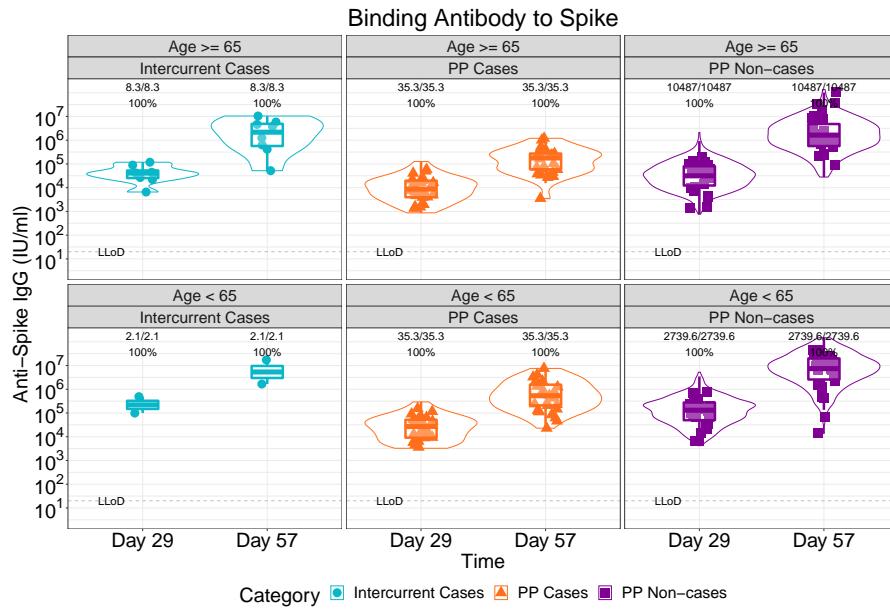


Figure 2.64: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by age (2 timepoints)

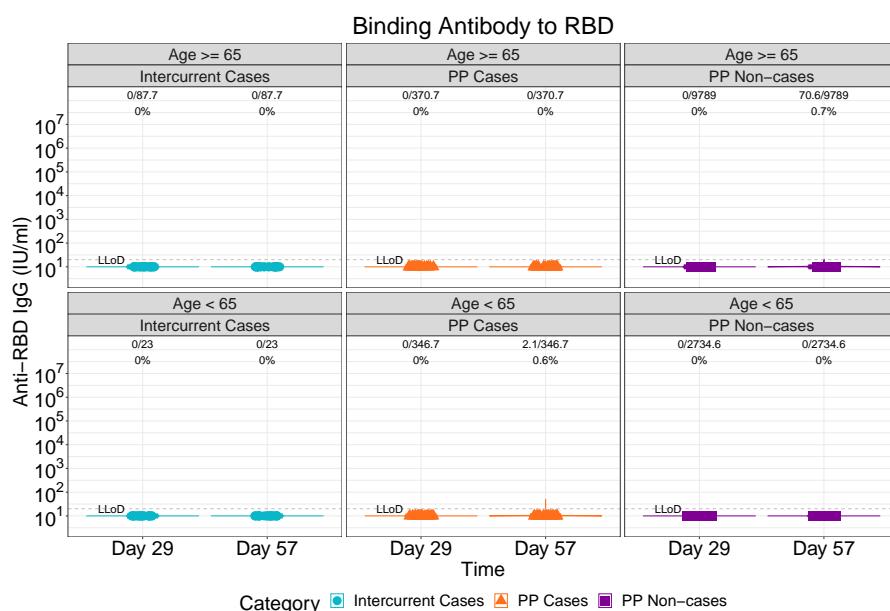


Figure 2.65: violinplots of Binding Antibody to RBD: baseline negative placebo arm by age (2 timepoints)

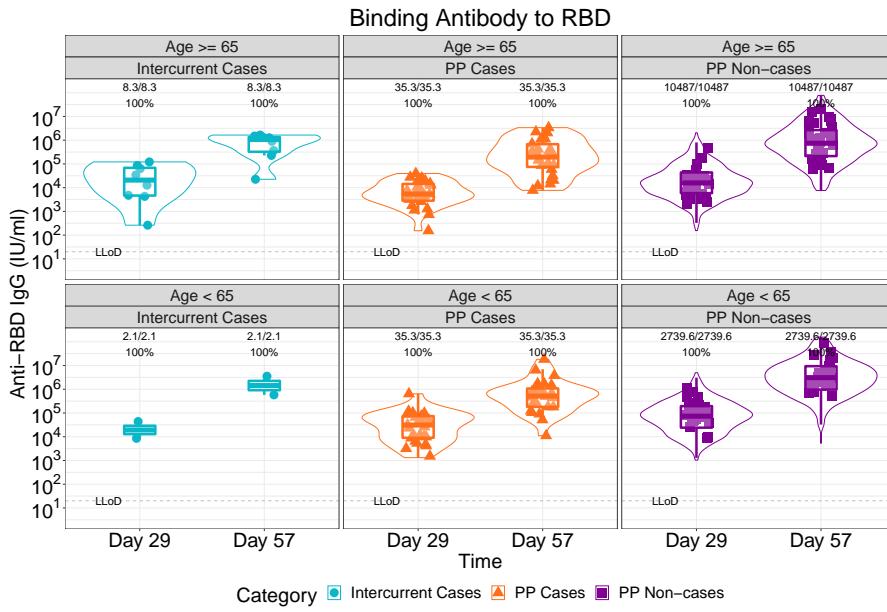


Figure 2.66: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by age (2 timepoints)

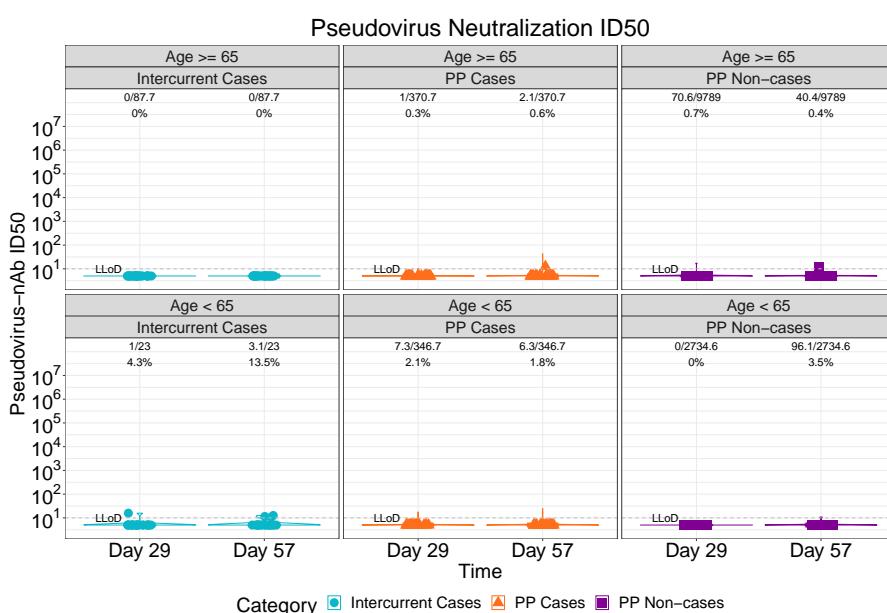


Figure 2.67: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age (2 timepoints)

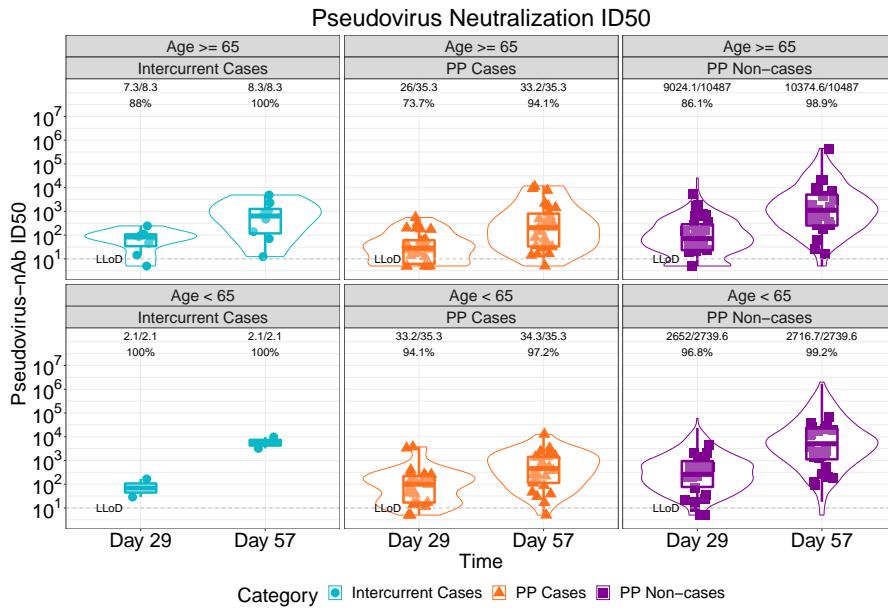


Figure 2.68: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age (2 timepoints)

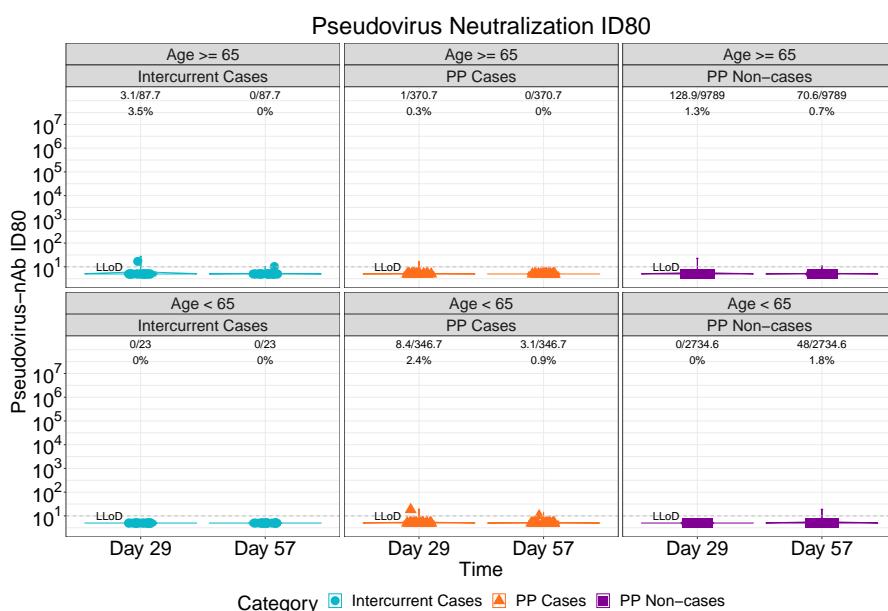


Figure 2.69: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age (2 timepoints)

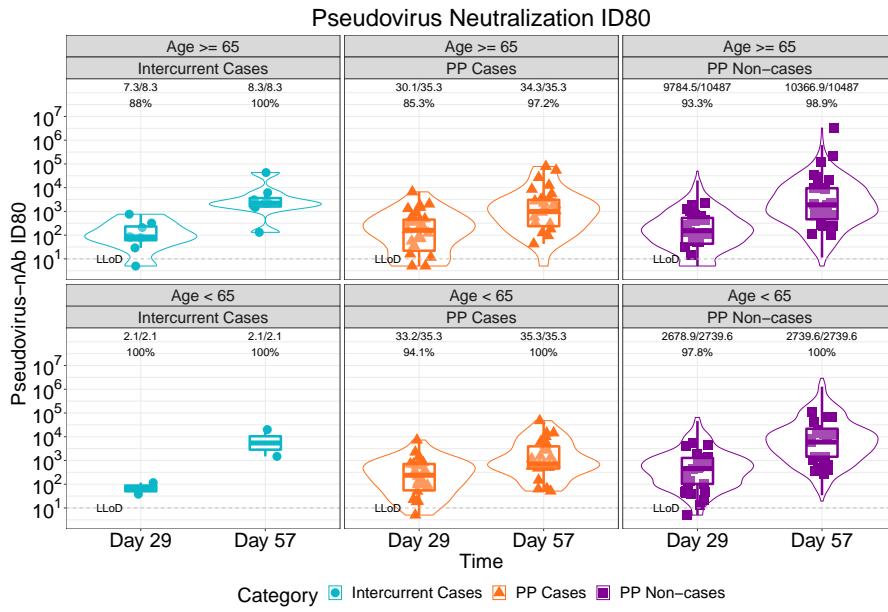


Figure 2.70: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age (2 timepoints)

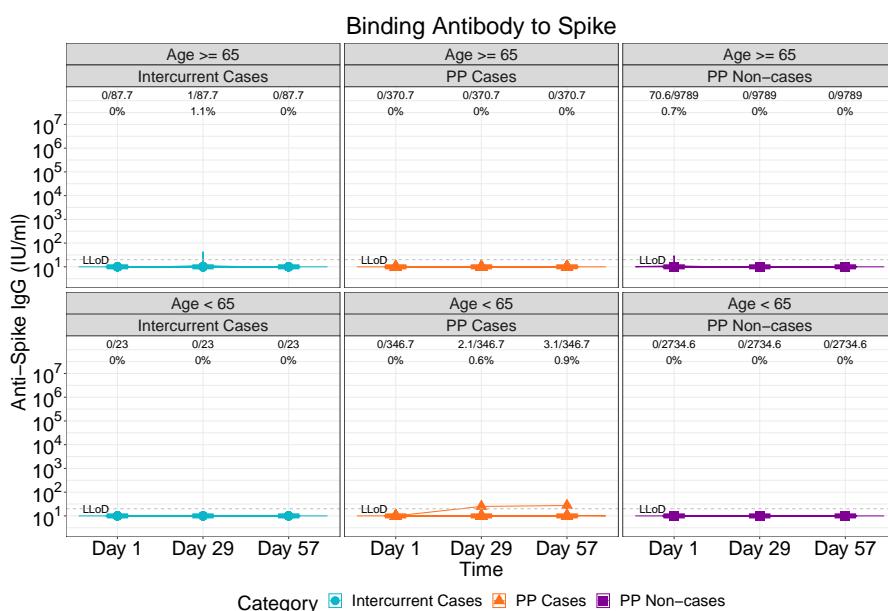


Figure 2.71: lineplots of Binding Antibody to Spike: baseline negative placebo arm by age (3 timepoints)

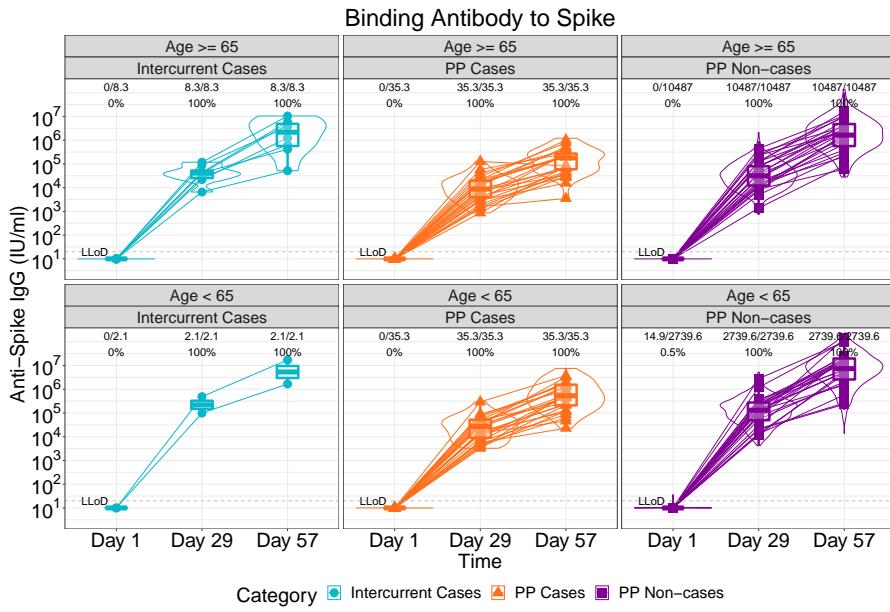


Figure 2.72: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by age (3 timepoints)

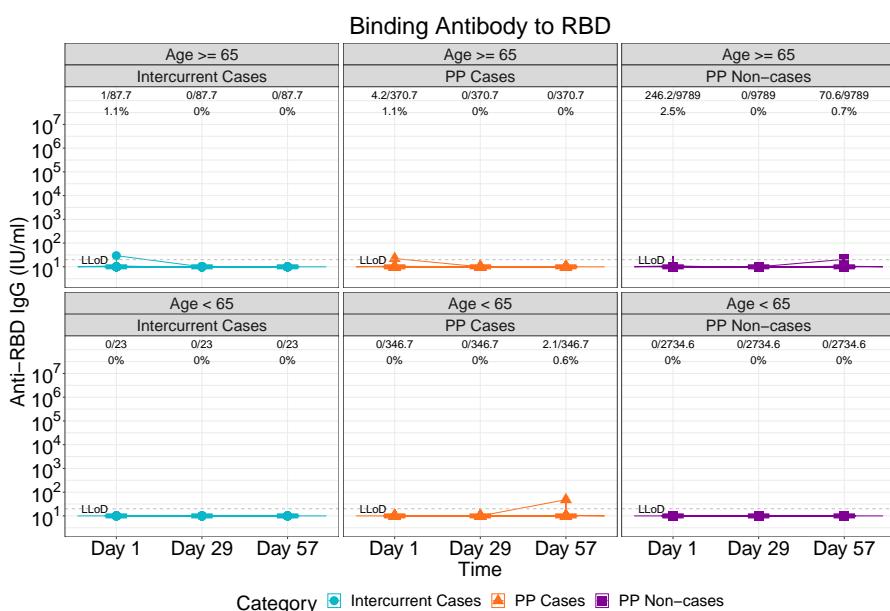


Figure 2.73: lineplots of Binding Antibody to RBD: baseline negative placebo arm by age (3 timepoints)

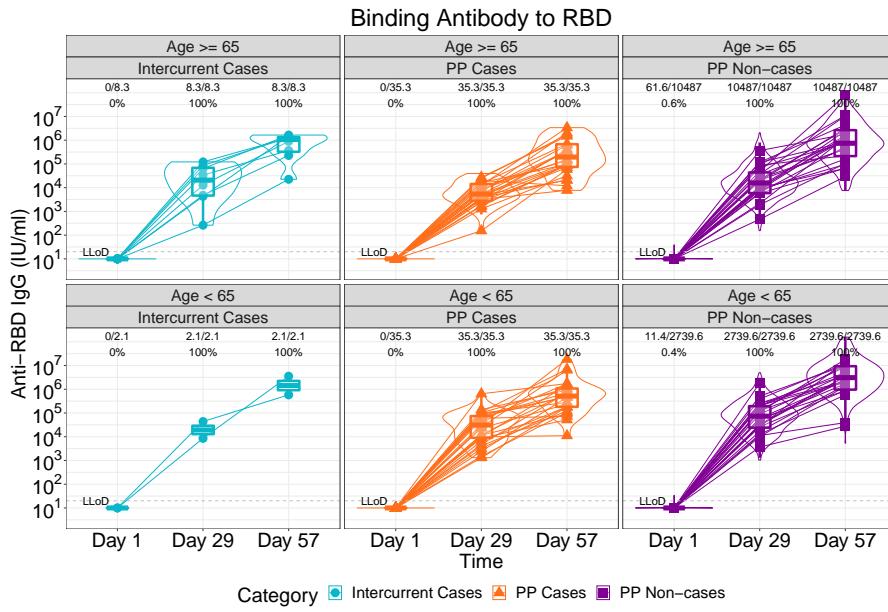


Figure 2.74: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by age (3 timepoints)

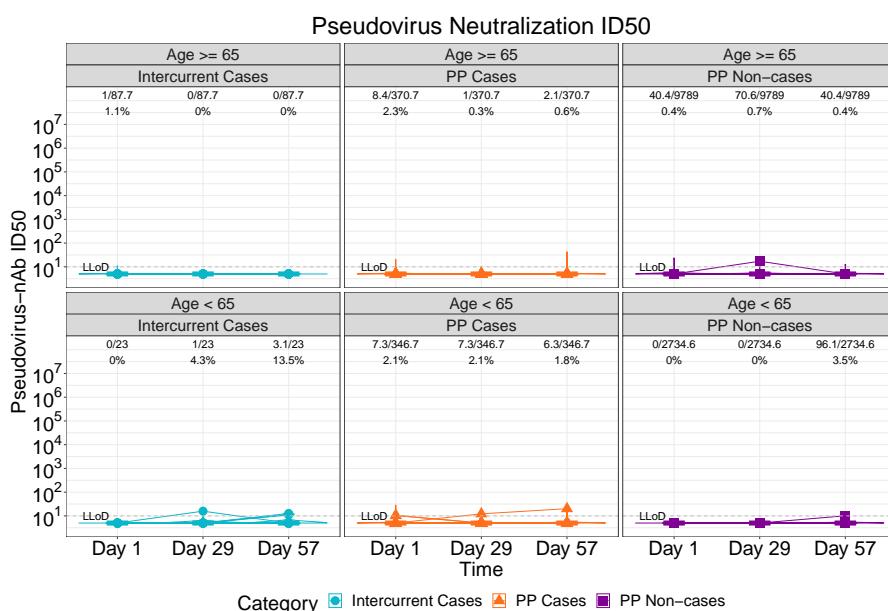


Figure 2.75: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age (3 timepoints)

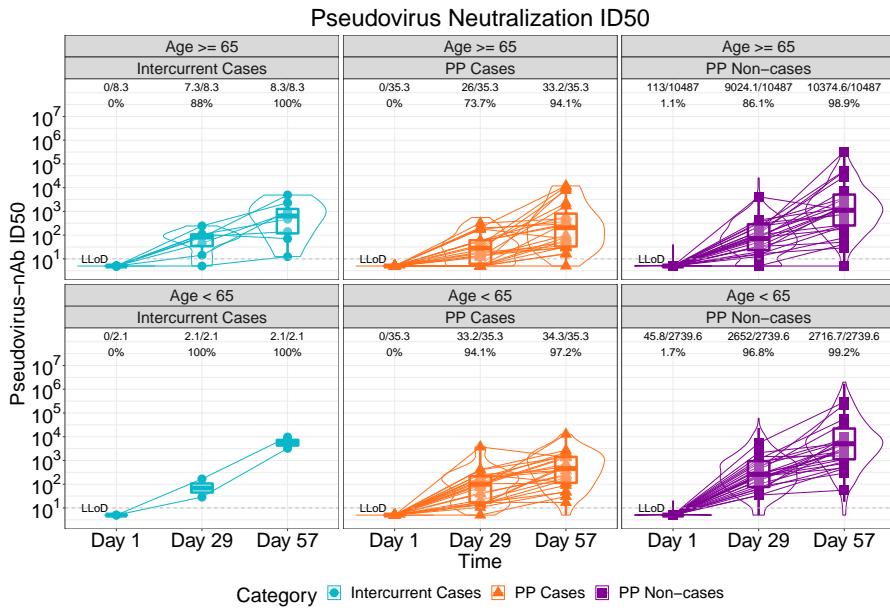


Figure 2.76: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age (3 timepoints)

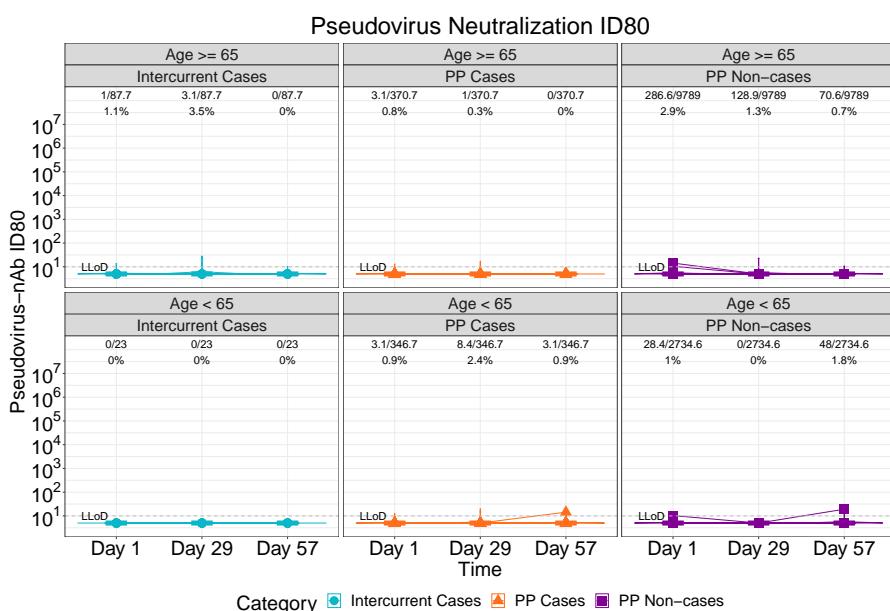


Figure 2.77: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age (3 timepoints)

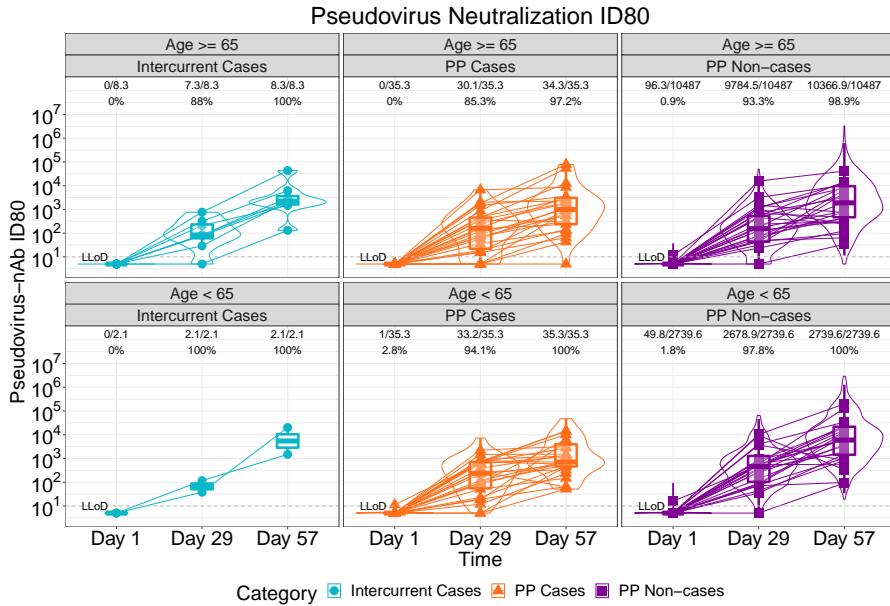


Figure 2.78: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age (3 timepoints)

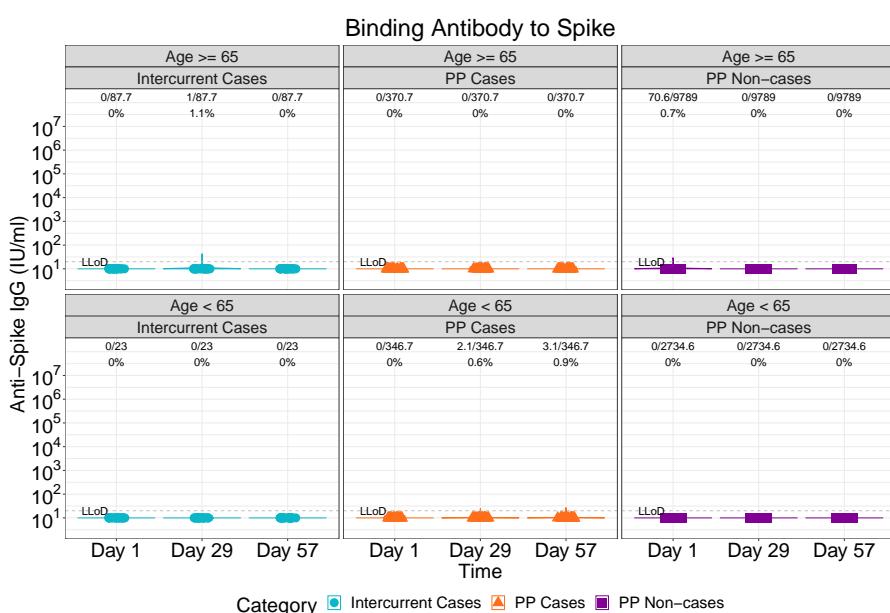


Figure 2.79: violinplots of Binding Antibody to Spike: baseline negative placebo arm by age (3 timepoints)

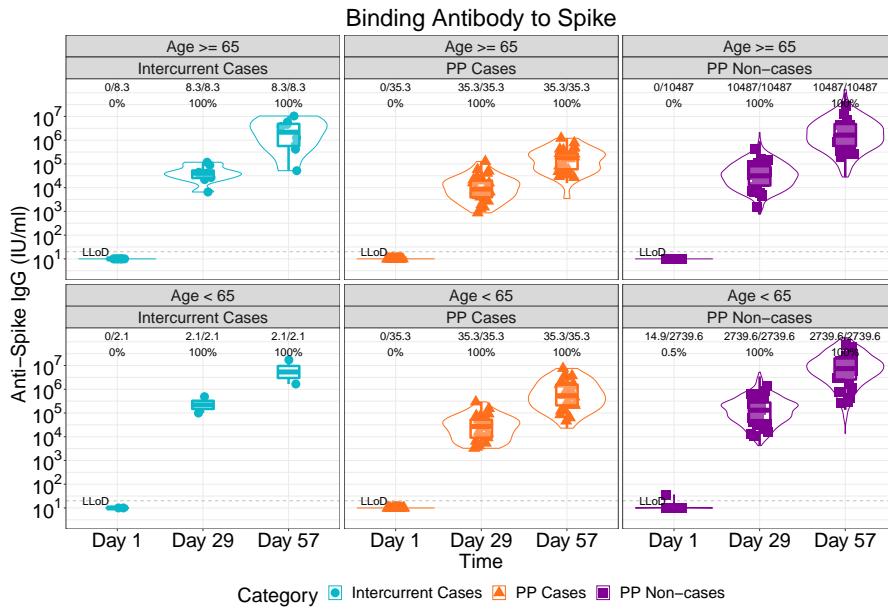


Figure 2.80: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by age (3 timepoints)

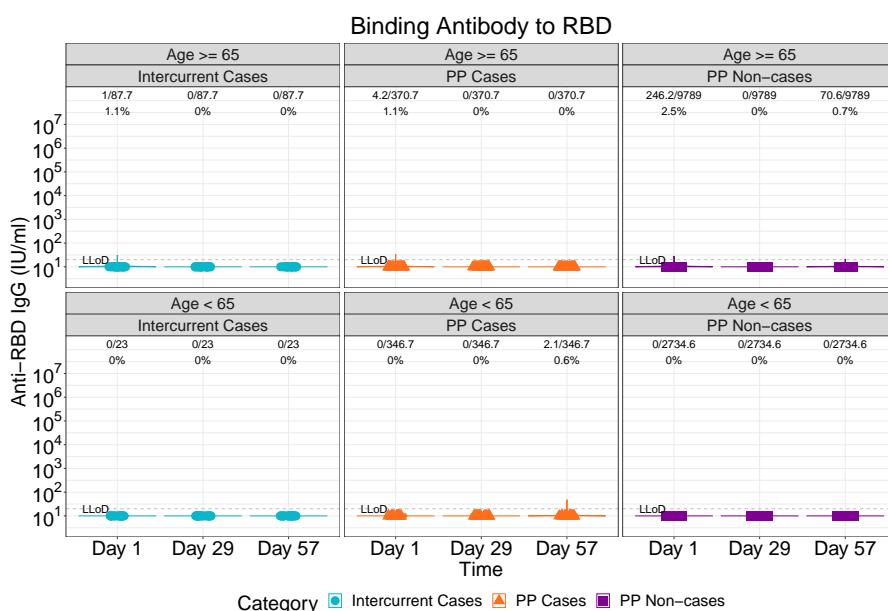


Figure 2.81: violinplots of Binding Antibody to RBD: baseline negative placebo arm by age (3 timepoints)

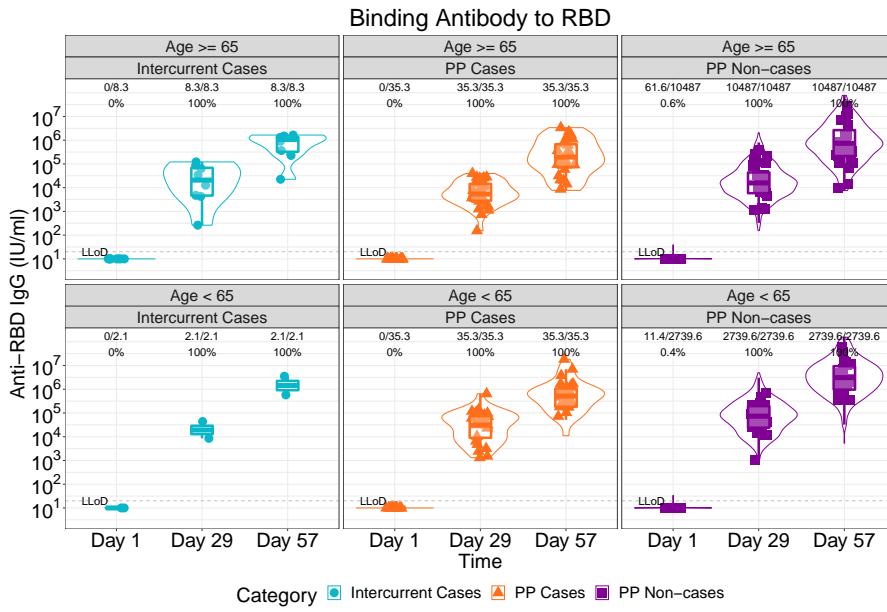


Figure 2.82: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by age (3 timepoints)

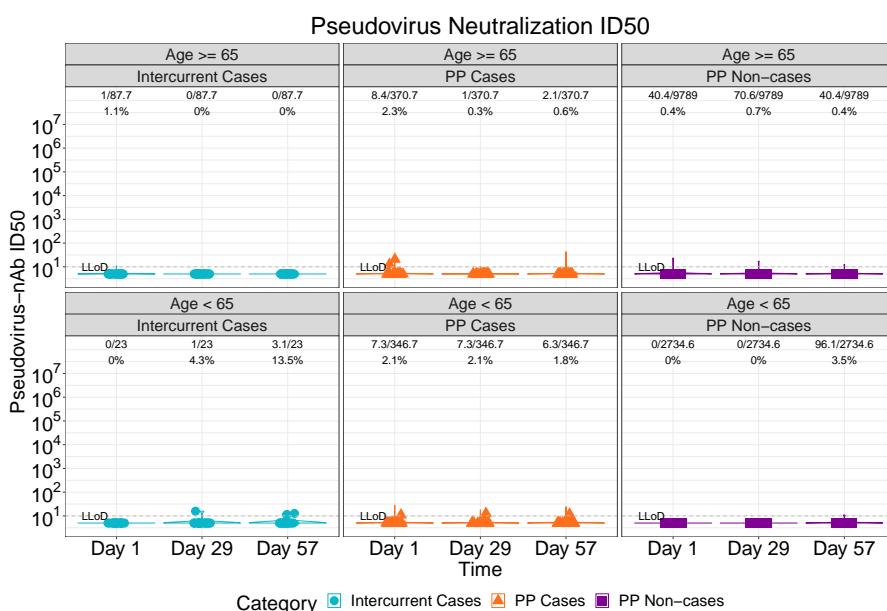


Figure 2.83: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age (3 timepoints)

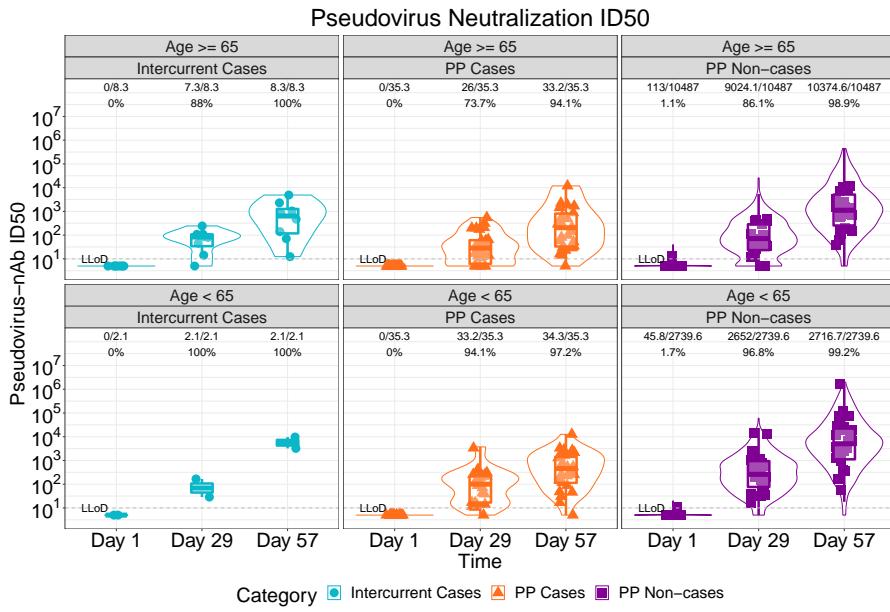


Figure 2.84: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age (3 timepoints)

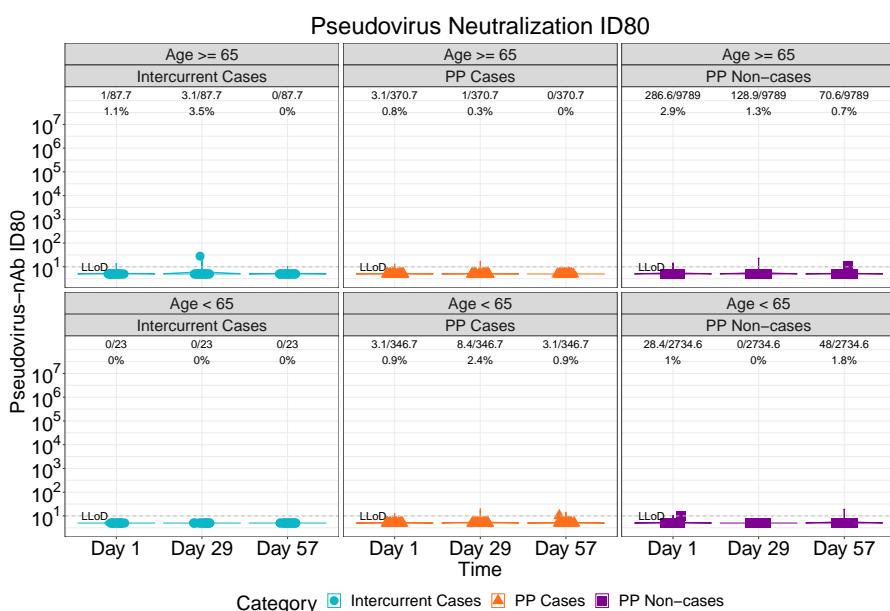


Figure 2.85: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age (3 timepoints)

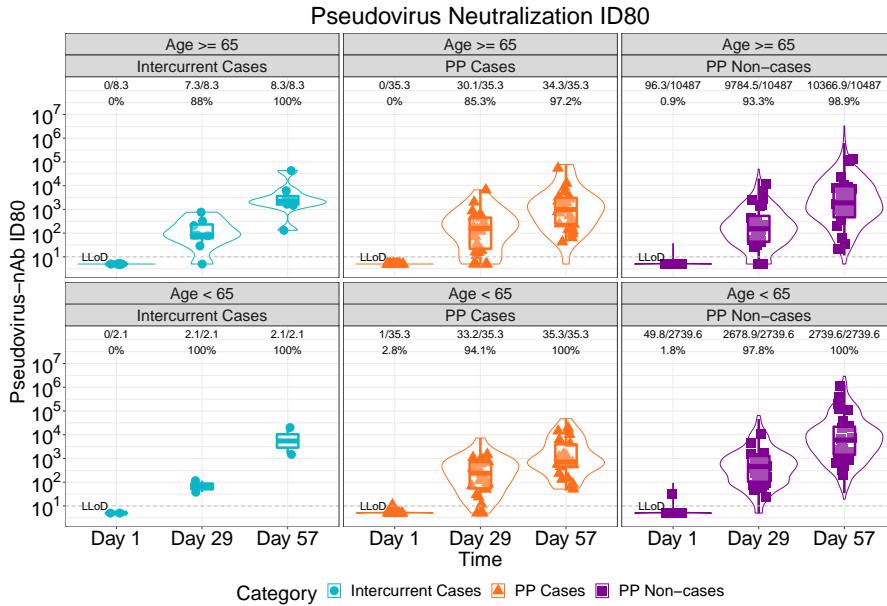


Figure 2.86: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age (3 timepoints)

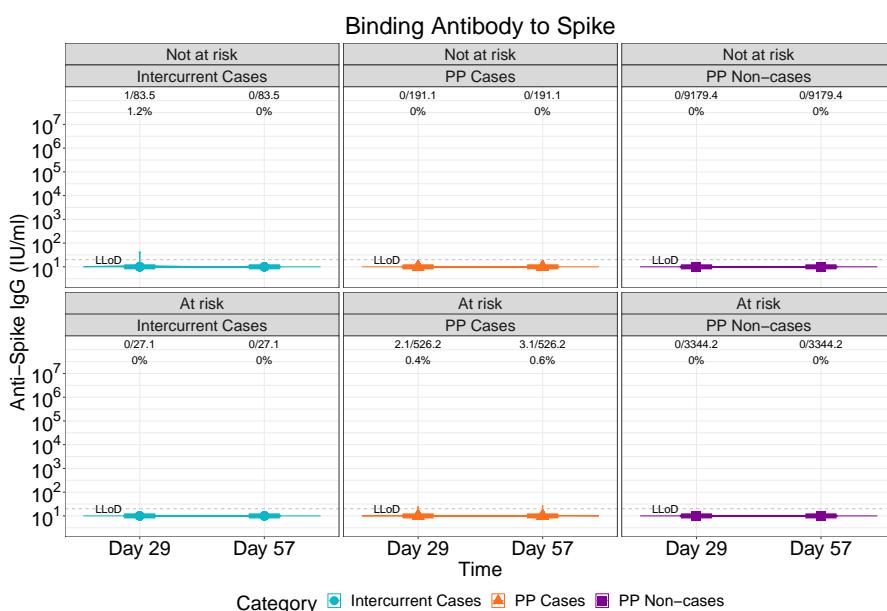


Figure 2.87: lineplots of Binding Antibody to Spike: baseline negative placebo arm by risk condition (2 timepoints)

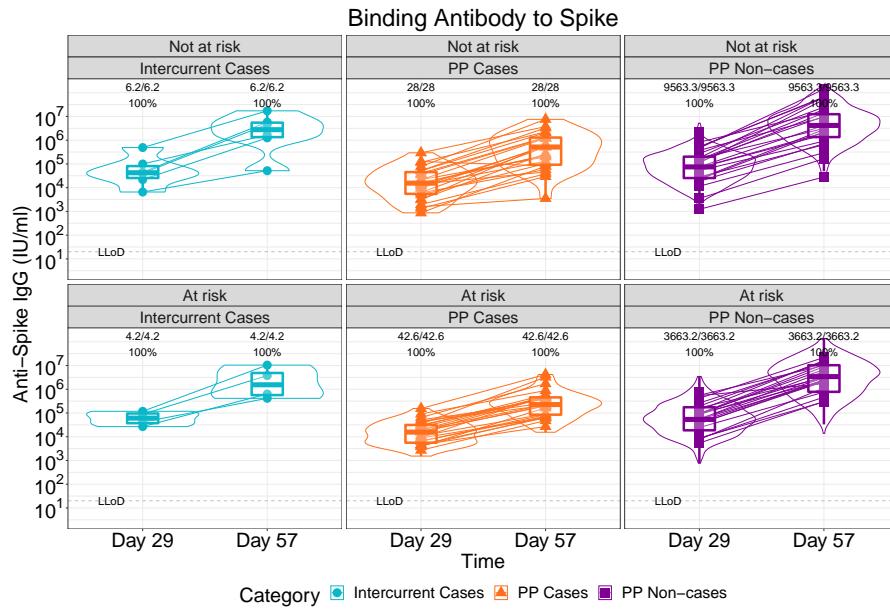


Figure 2.88: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by risk condition (2 timepoints)

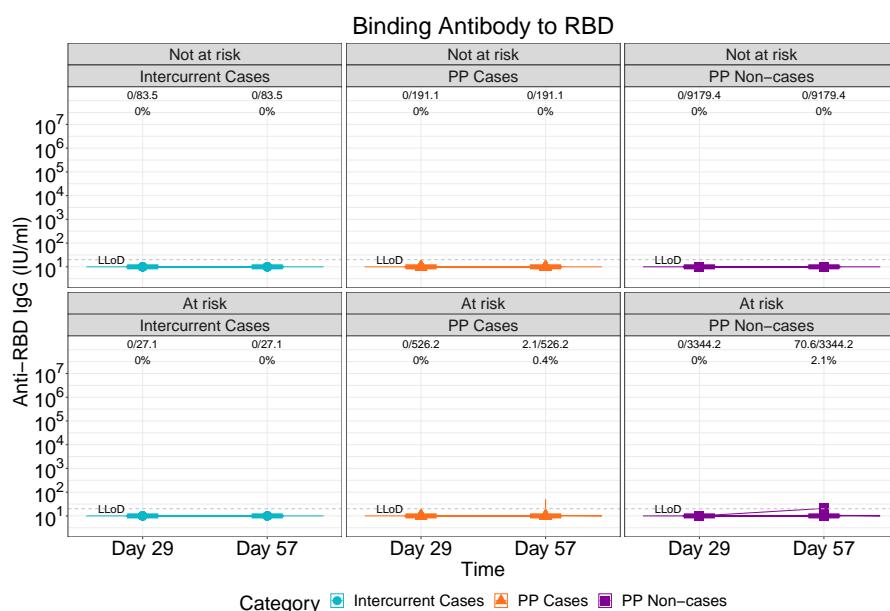


Figure 2.89: lineplots of Binding Antibody to RBD: baseline negative placebo arm by risk condition (2 timepoints)

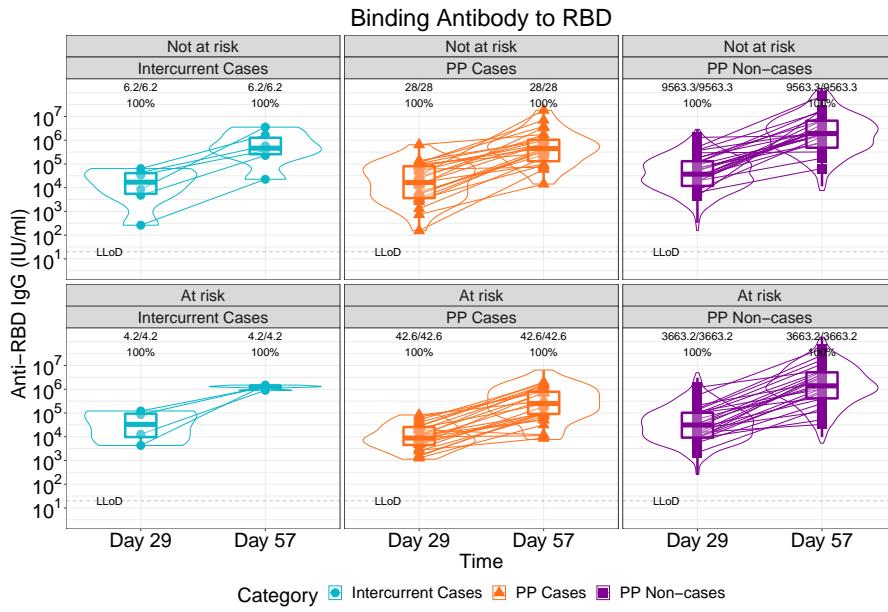


Figure 2.90: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by risk condition (2 timepoints)

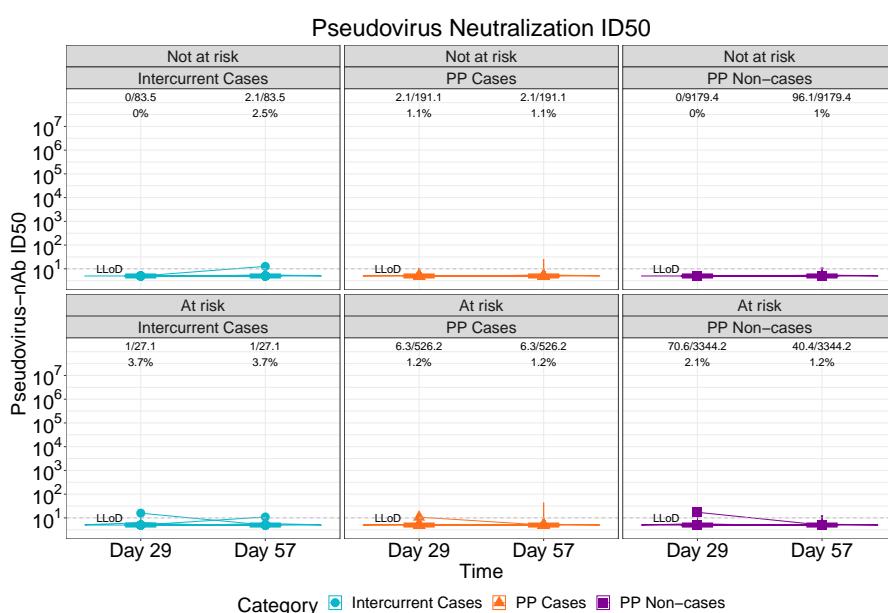


Figure 2.91: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by risk condition (2 timepoints)

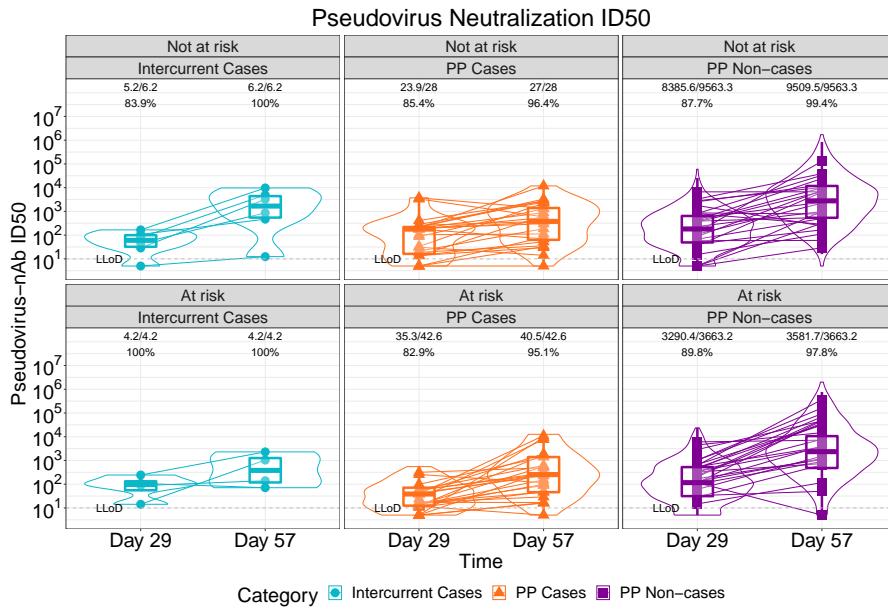


Figure 2.92: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by risk condition (2 timepoints)

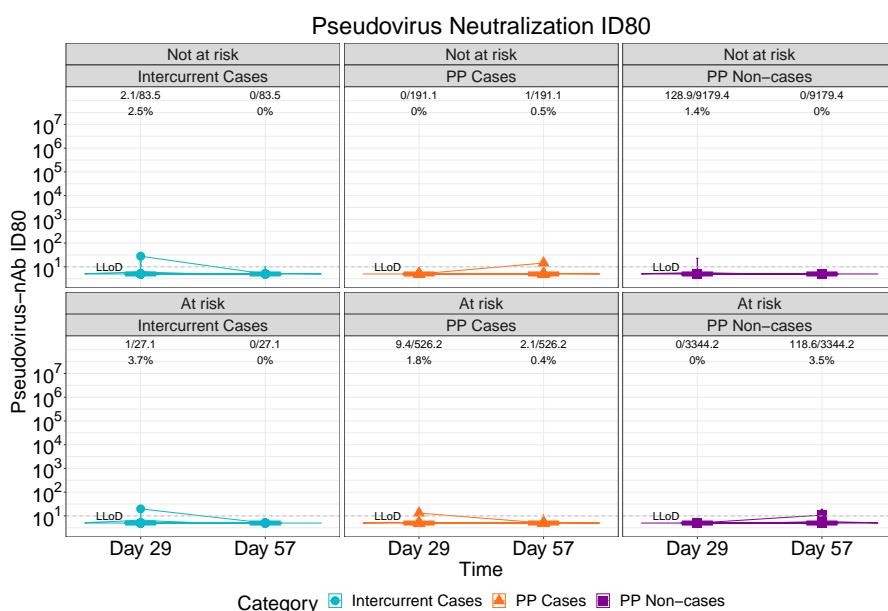


Figure 2.93: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by risk condition (2 timepoints)

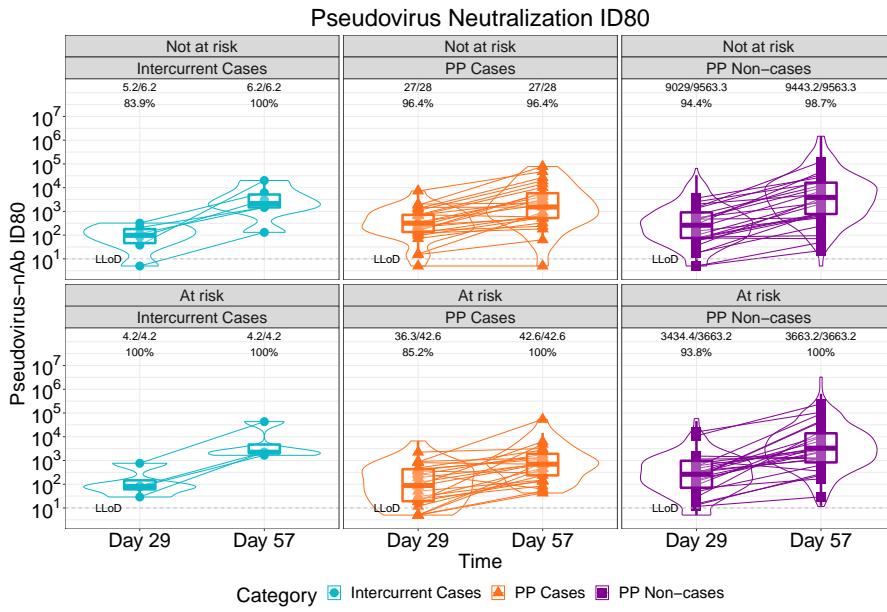


Figure 2.94: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by risk condition (2 timepoints)

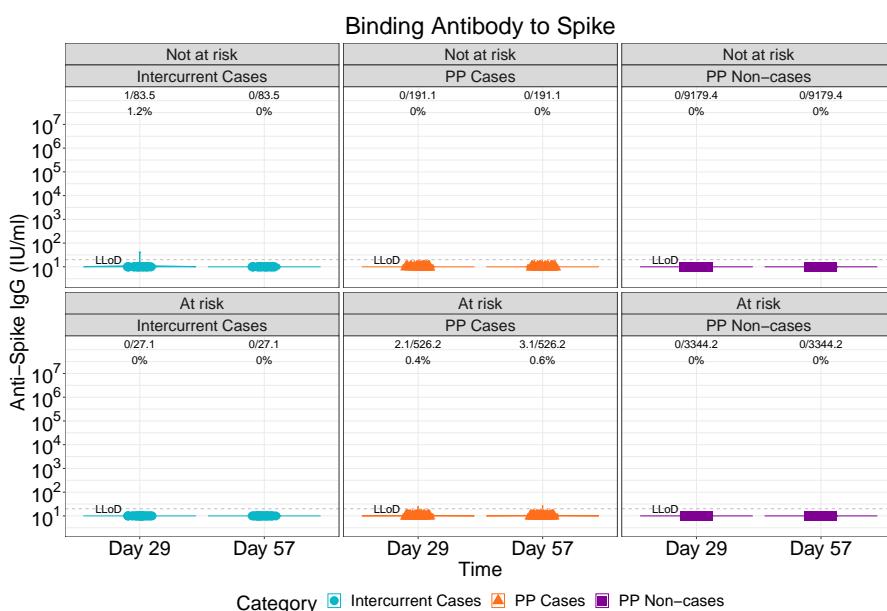


Figure 2.95: violinplots of Binding Antibody to Spike: baseline negative placebo arm by risk condition (2 timepoints)

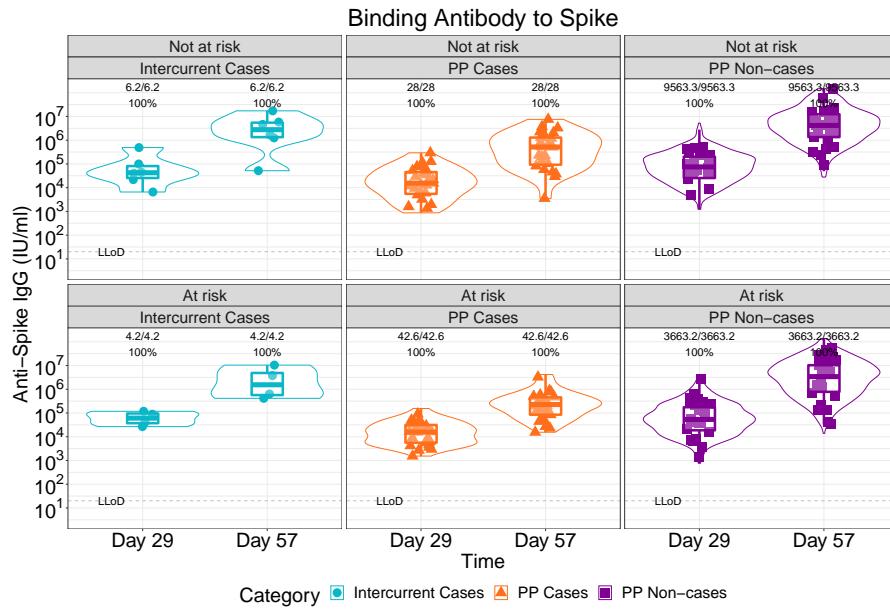


Figure 2.96: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by risk condition (2 timepoints)

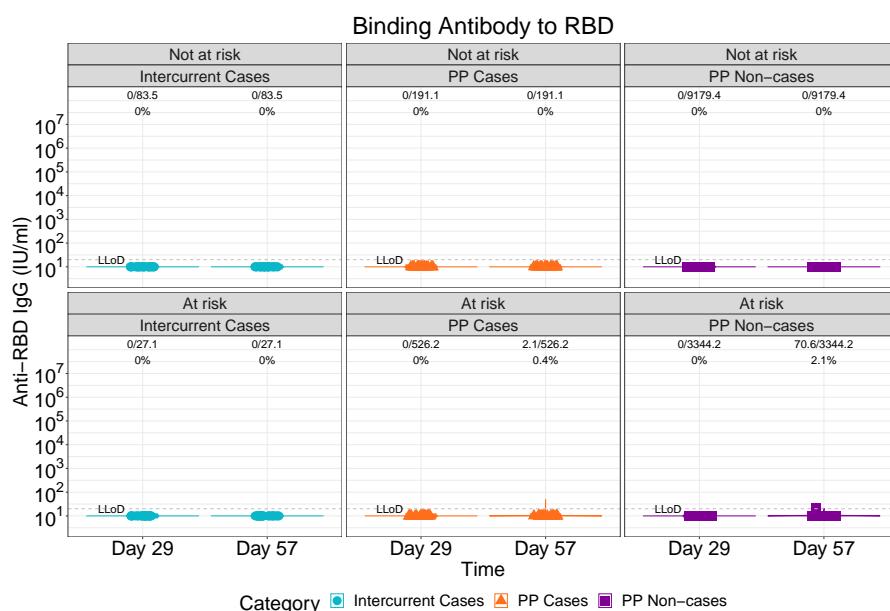


Figure 2.97: violinplots of Binding Antibody to RBD: baseline negative placebo arm by risk condition (2 timepoints)

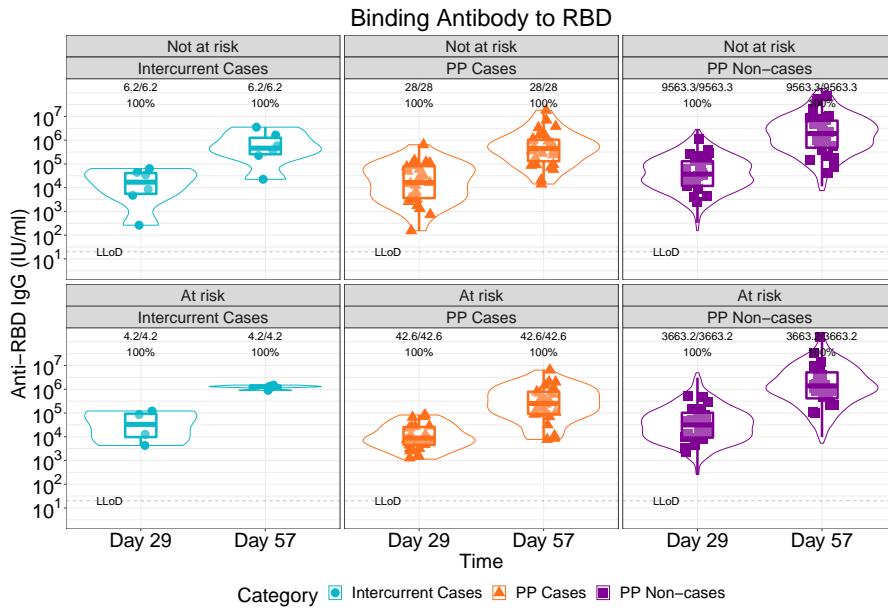


Figure 2.98: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by risk condition (2 timepoints)

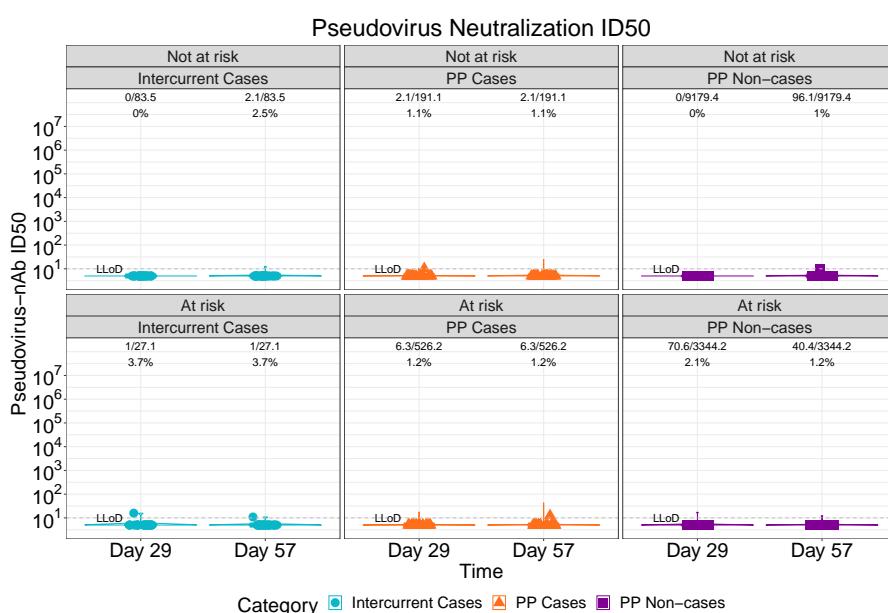


Figure 2.99: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by risk condition (2 timepoints)

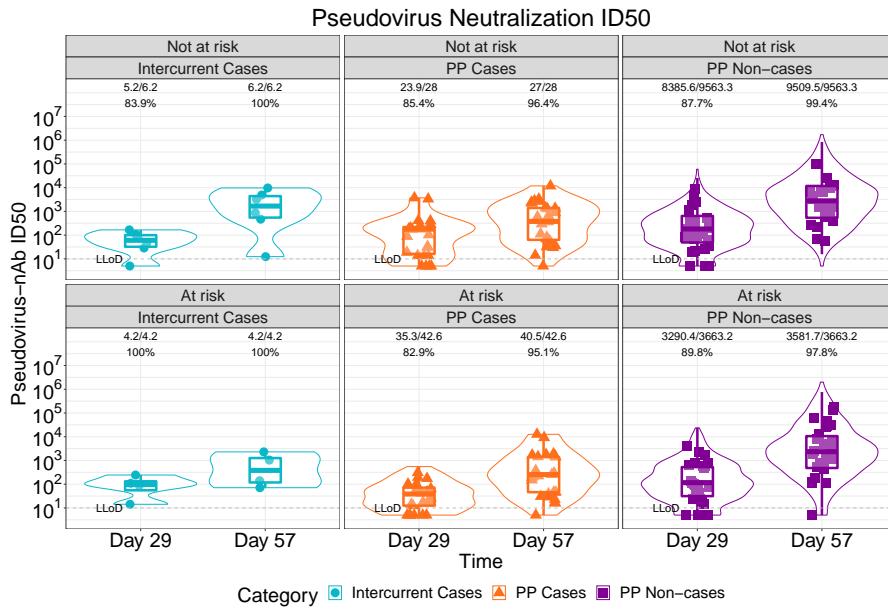


Figure 2.100: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by risk condition (2 timepoints)

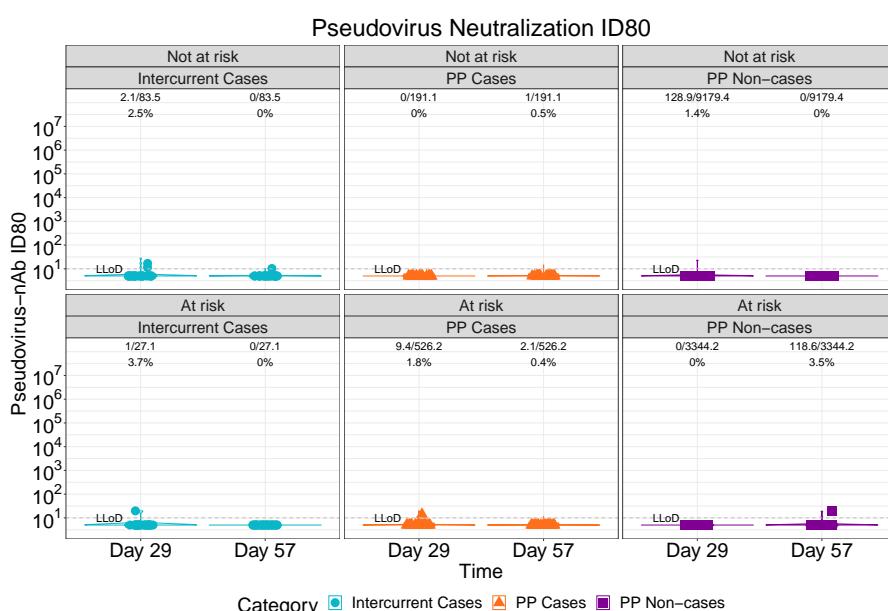


Figure 2.101: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by risk condition (2 timepoints)

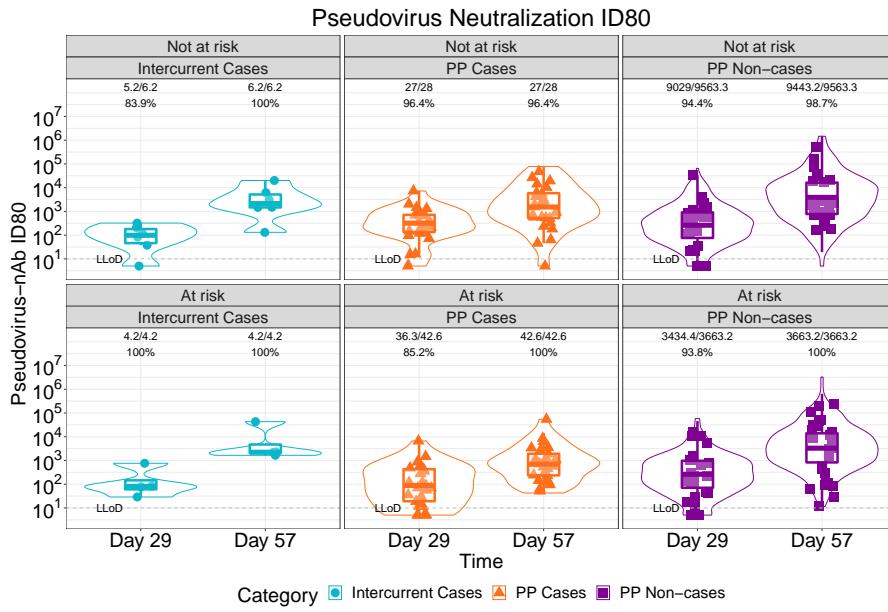


Figure 2.102: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by risk condition (2 timepoints)

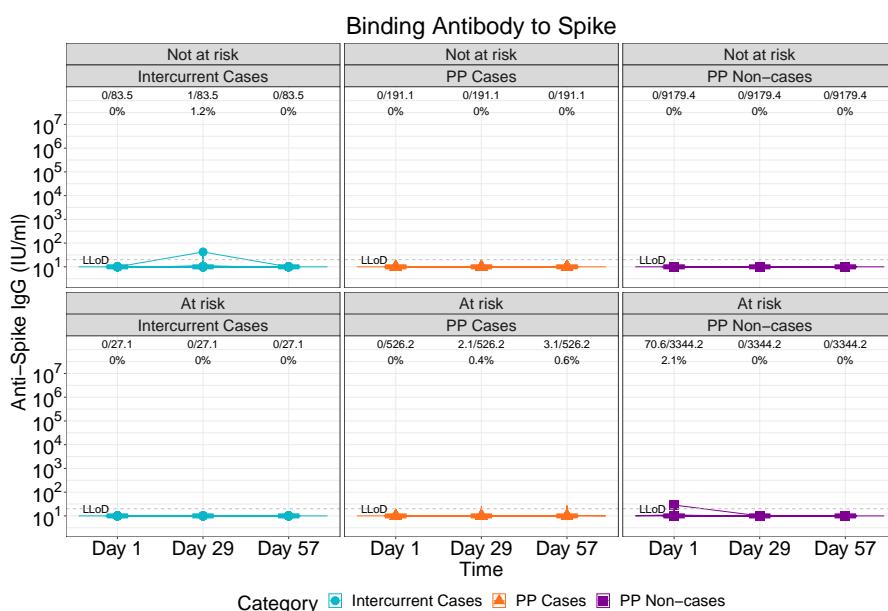


Figure 2.103: lineplots of Binding Antibody to Spike: baseline negative placebo arm by risk condition (3 timepoints)

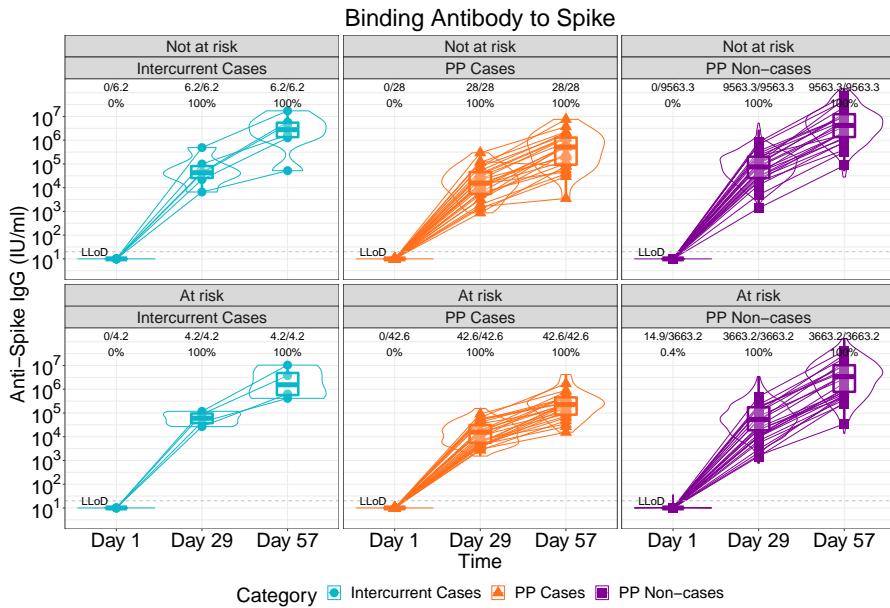


Figure 2.104: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by risk condition (3 timepoints)

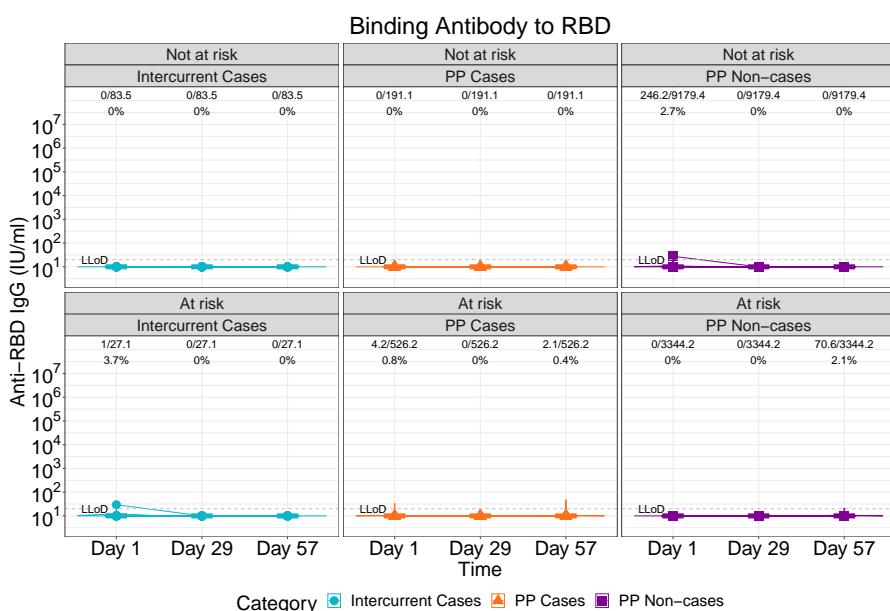


Figure 2.105: lineplots of Binding Antibody to RBD: baseline negative placebo arm by risk condition (3 timepoints)

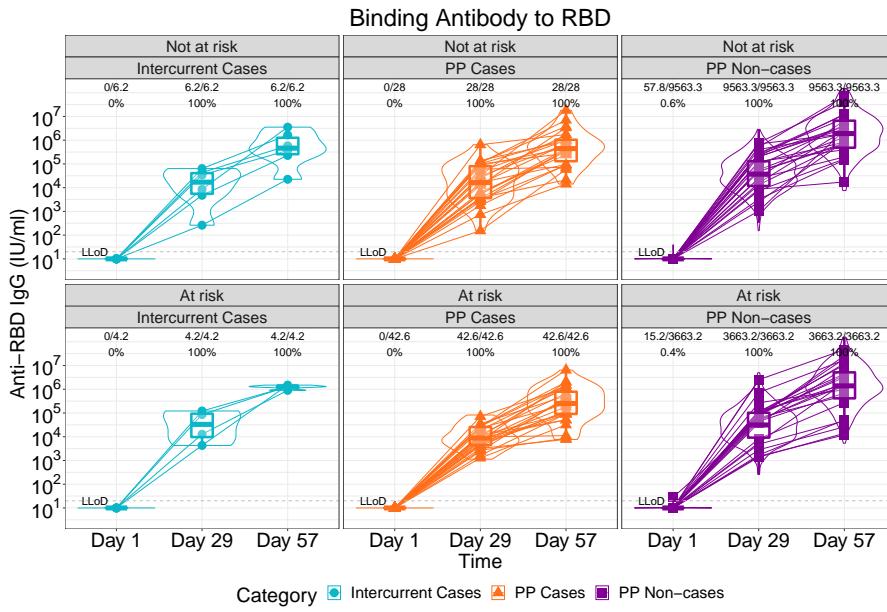


Figure 2.106: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by risk condition (3 timepoints)

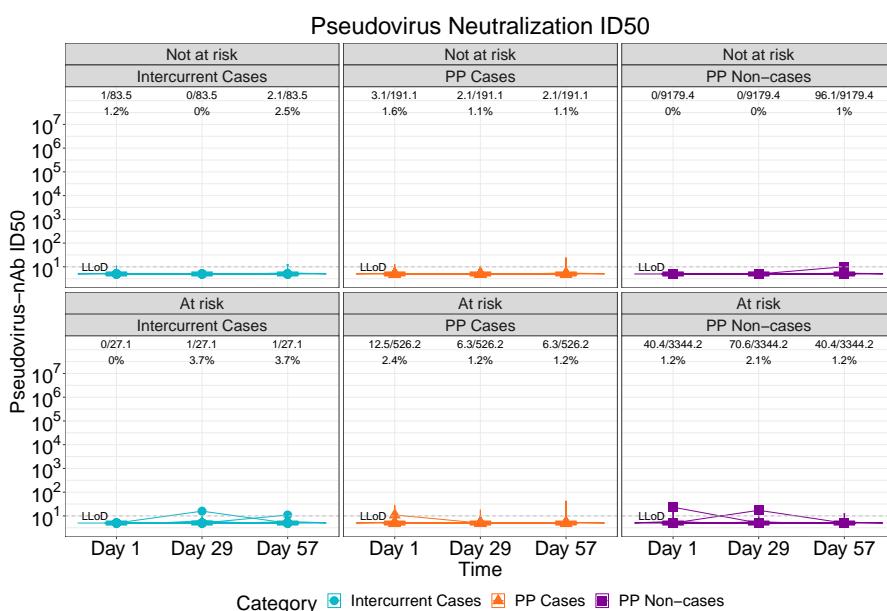


Figure 2.107: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by risk condition (3 timepoints)

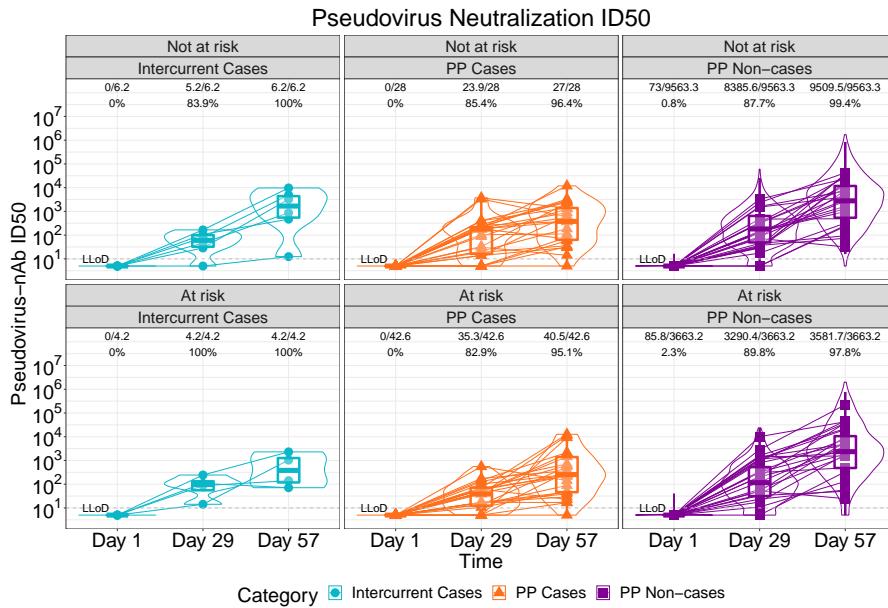


Figure 2.108: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by risk condition (3 timepoints)

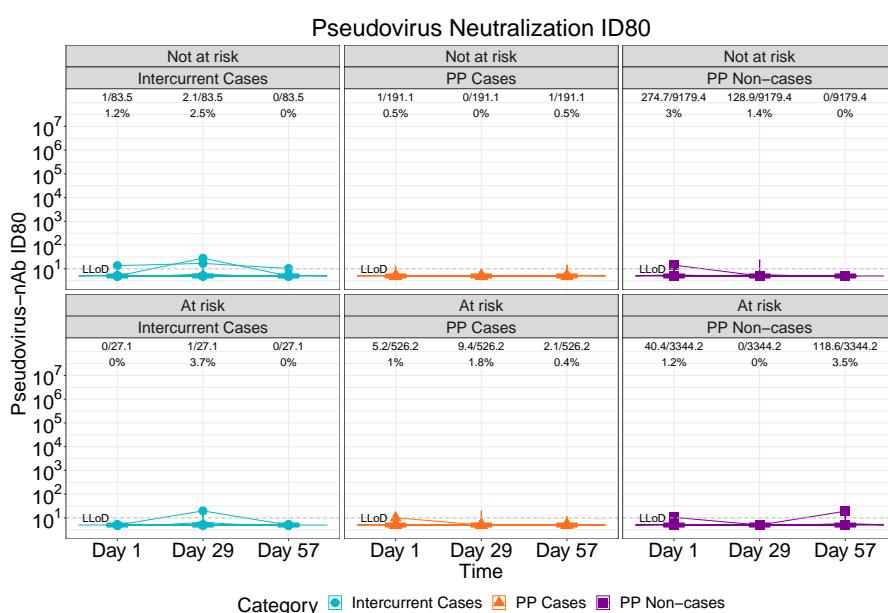


Figure 2.109: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by risk condition (3 timepoints)

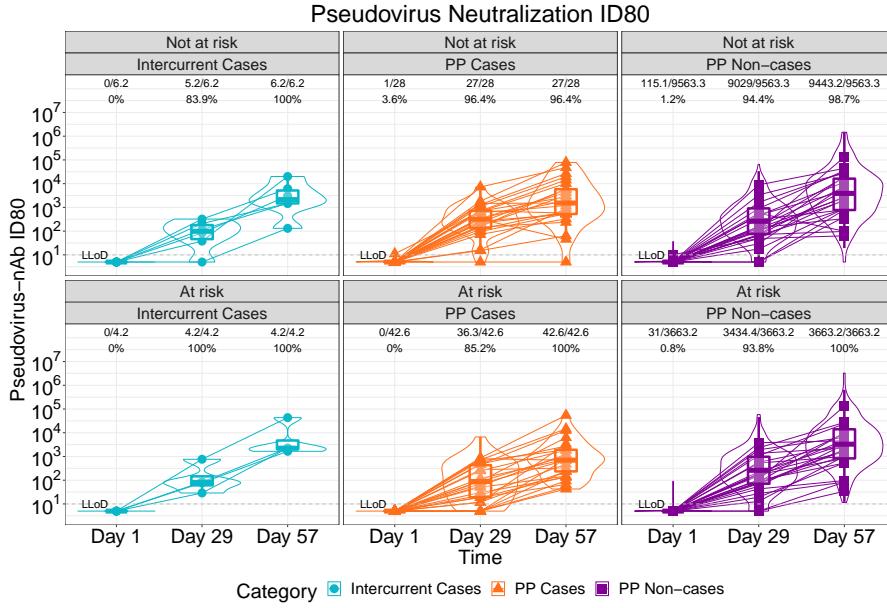


Figure 2.110: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by risk condition (3 timepoints)

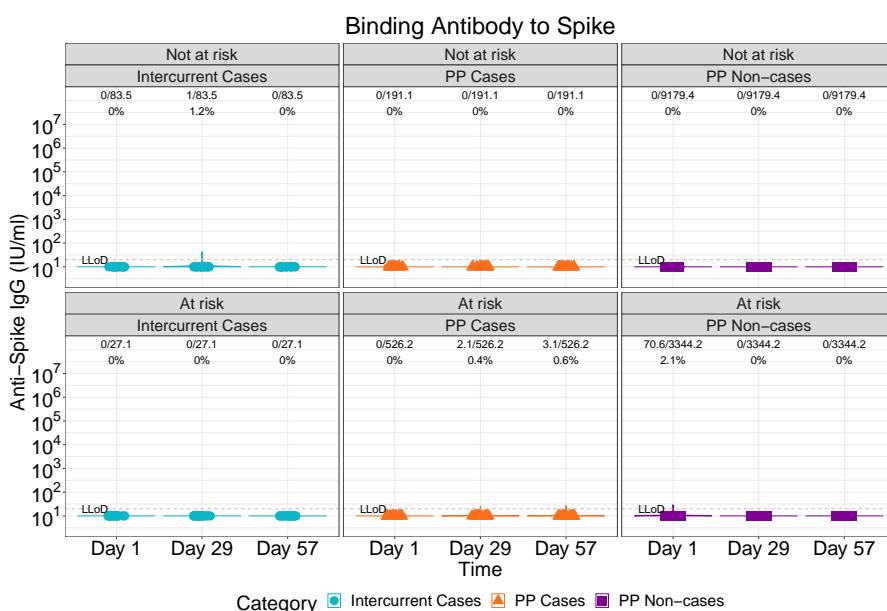


Figure 2.111: violinplots of Binding Antibody to Spike: baseline negative placebo arm by risk condition (3 timepoints)

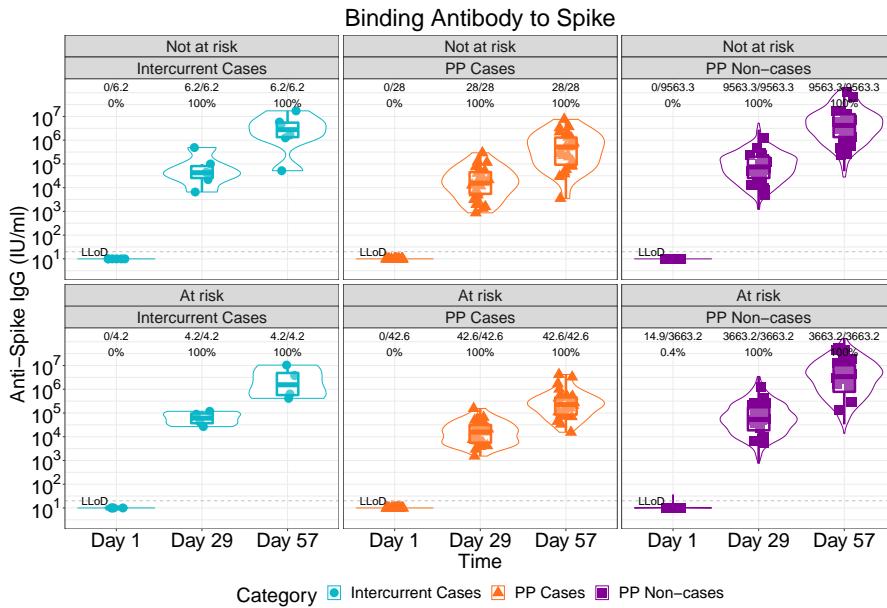


Figure 2.112: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by risk condition (3 timepoints)

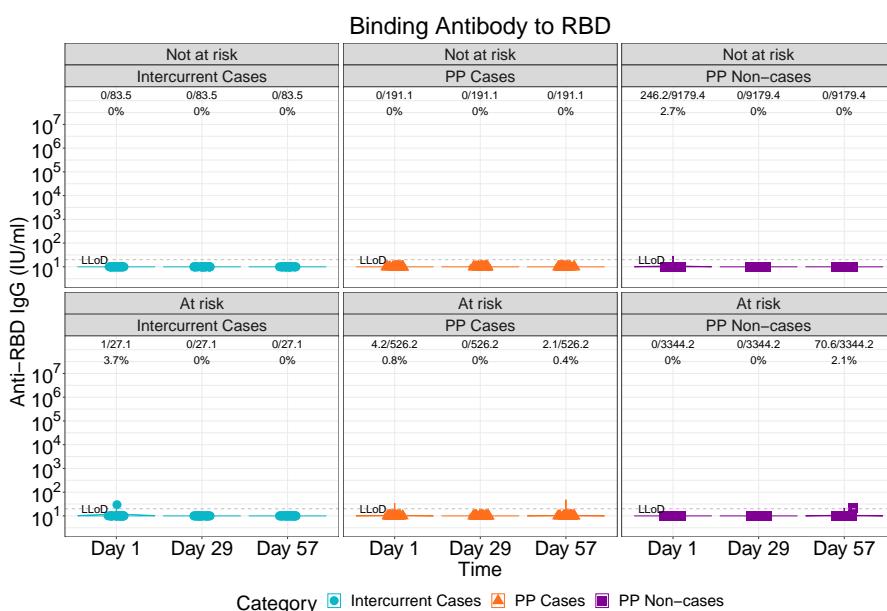


Figure 2.113: violinplots of Binding Antibody to RBD: baseline negative placebo arm by risk condition (3 timepoints)

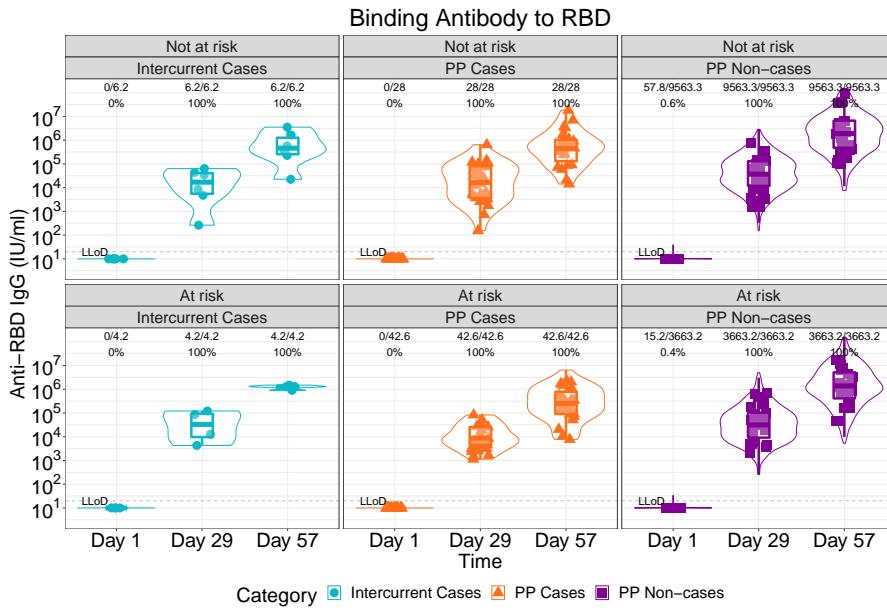


Figure 2.114: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by risk condition (3 timepoints)

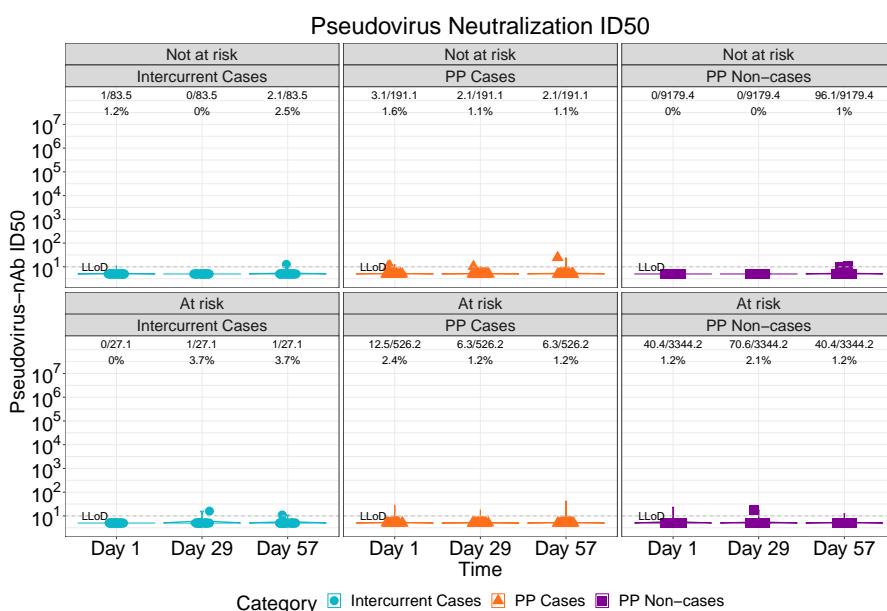


Figure 2.115: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by risk condition (3 timepoints)

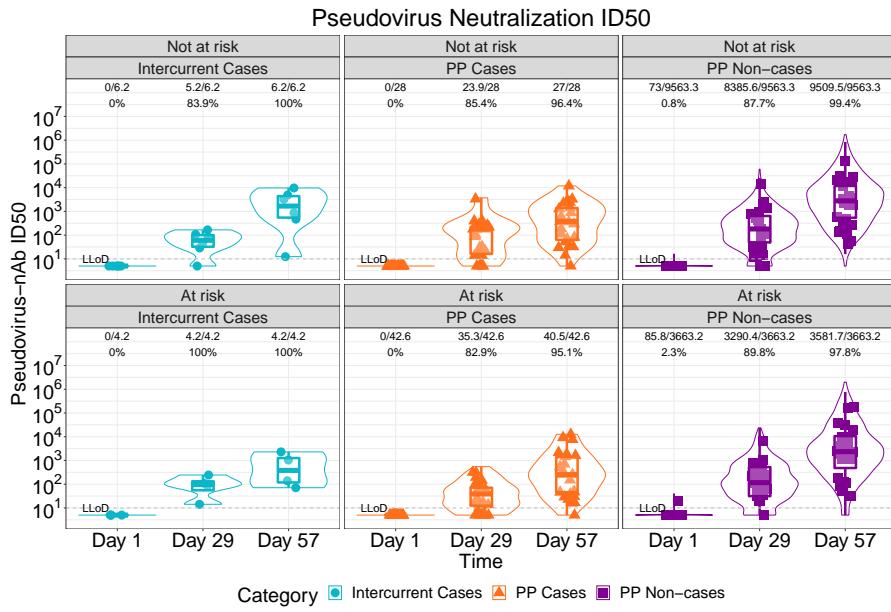


Figure 2.116: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by risk condition (3 timepoints)

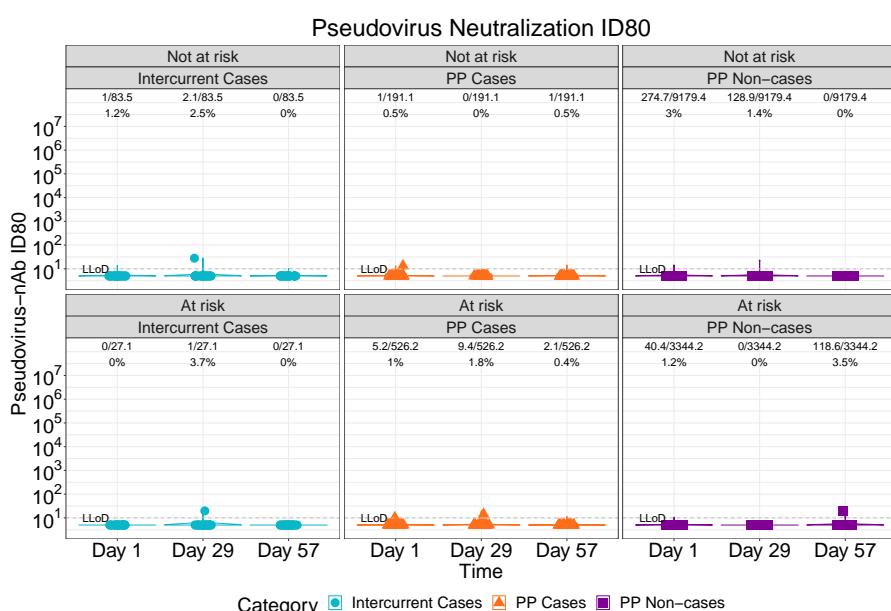


Figure 2.117: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by risk condition (3 timepoints)

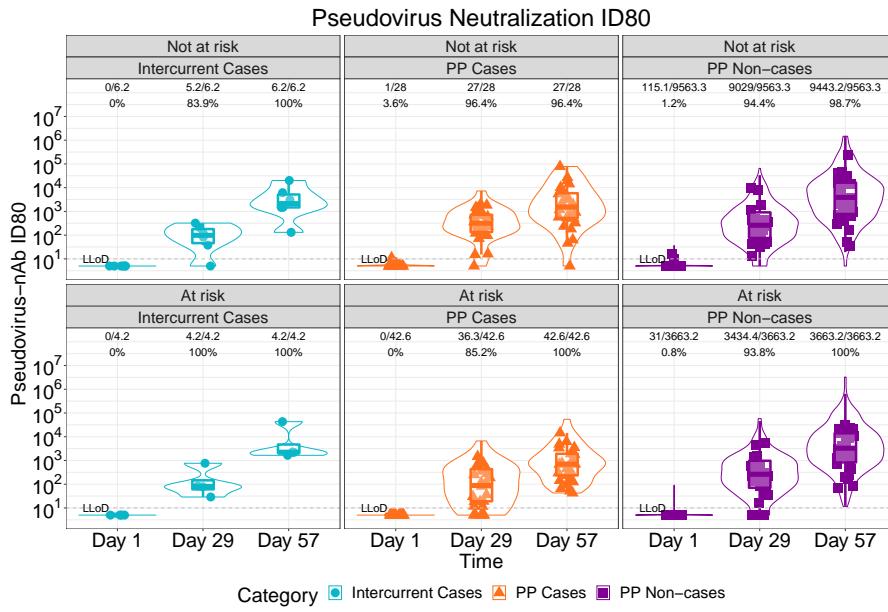


Figure 2.118: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by risk condition (3 timepoints)

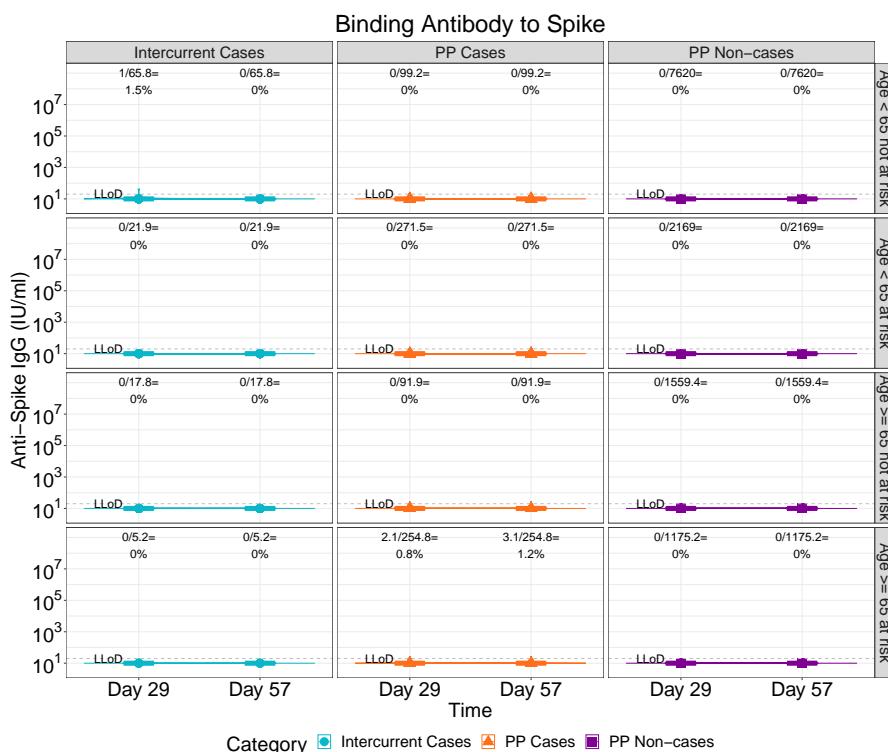


Figure 2.119: lineplots of Binding Antibody to Spike: baseline negative placebo arm by age and risk condition (2 timepoints)

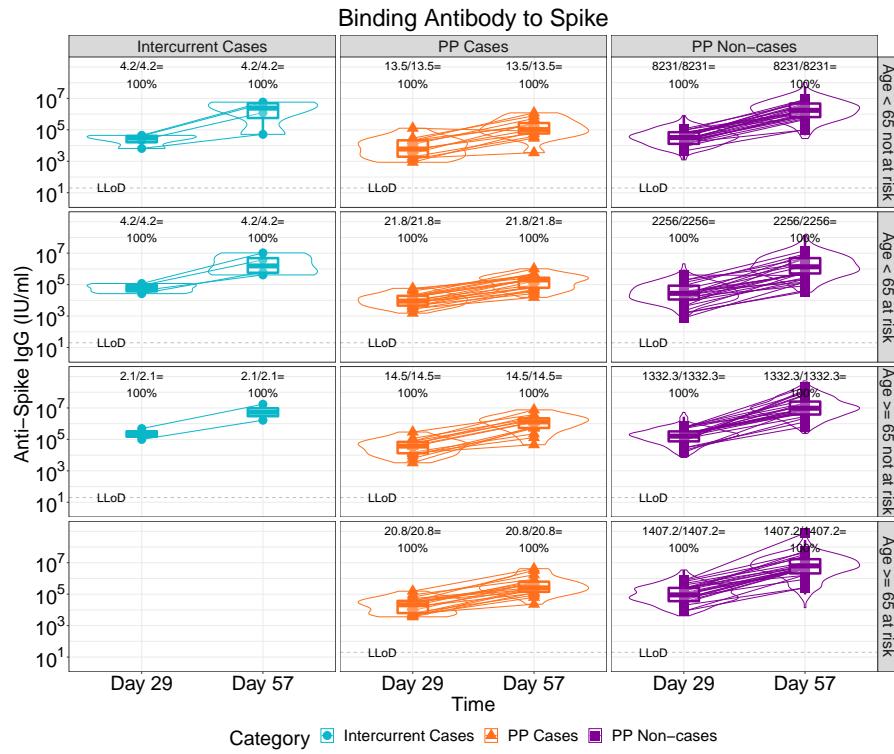


Figure 2.120: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by age and risk condition (2 timepoints)

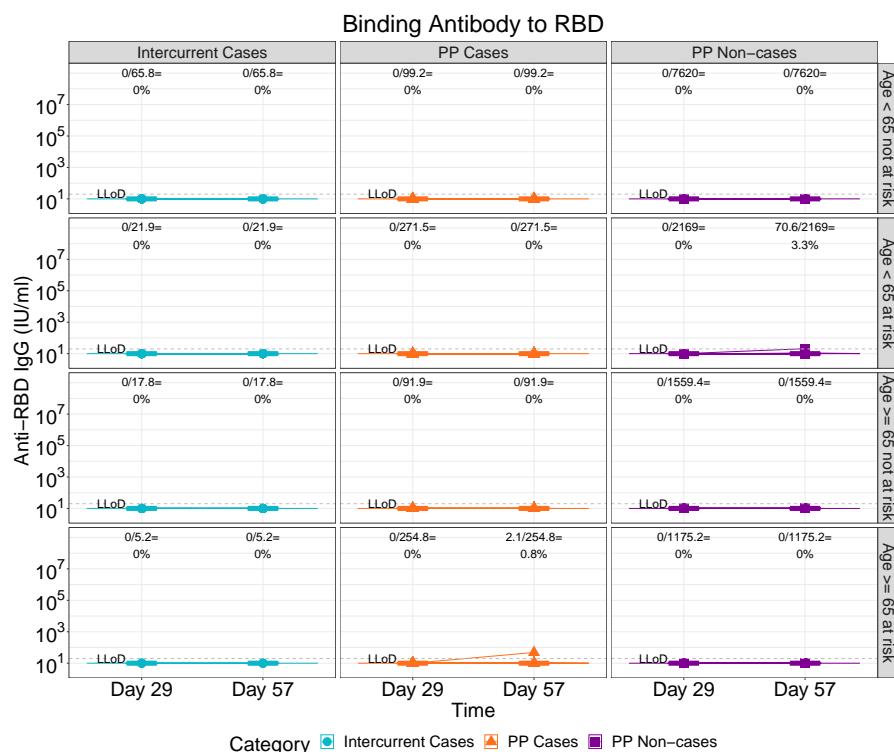


Figure 2.121: lineplots of Binding Antibody to RBD: baseline negative placebo arm by age and risk condition (2 timepoints)

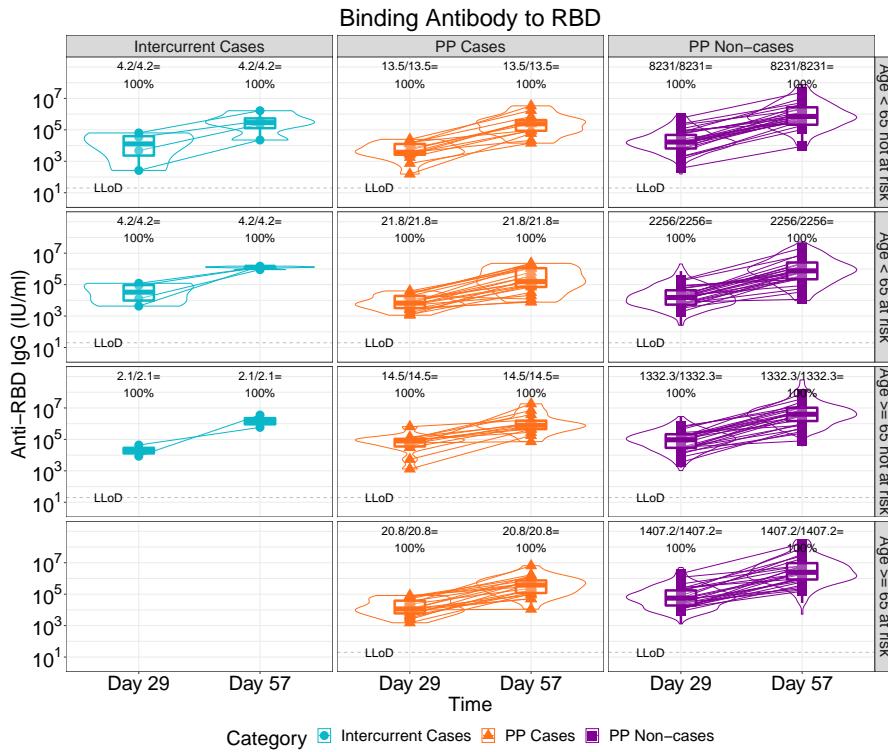


Figure 2.122: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by age and risk condition (2 timepoints)

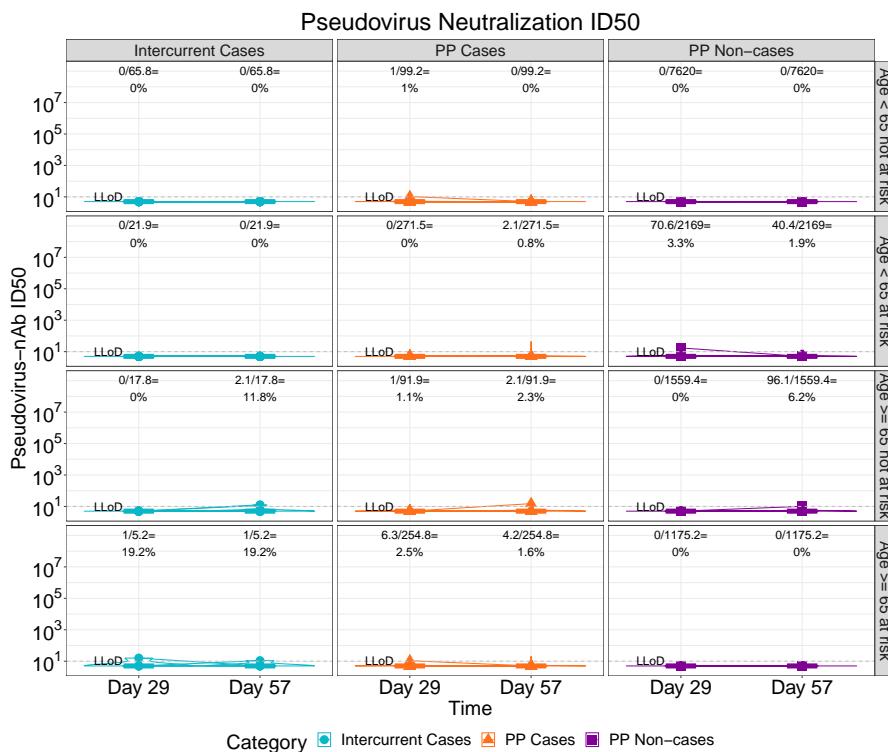


Figure 2.123: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age and risk condition (2 timepoints)

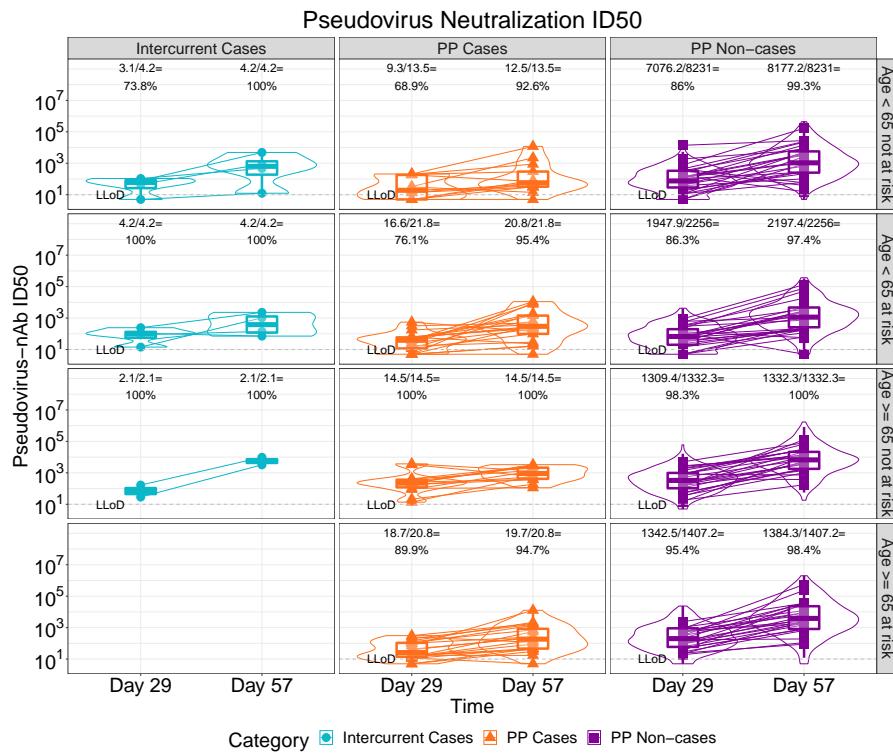


Figure 2.124: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age and risk condition (2 timepoints)

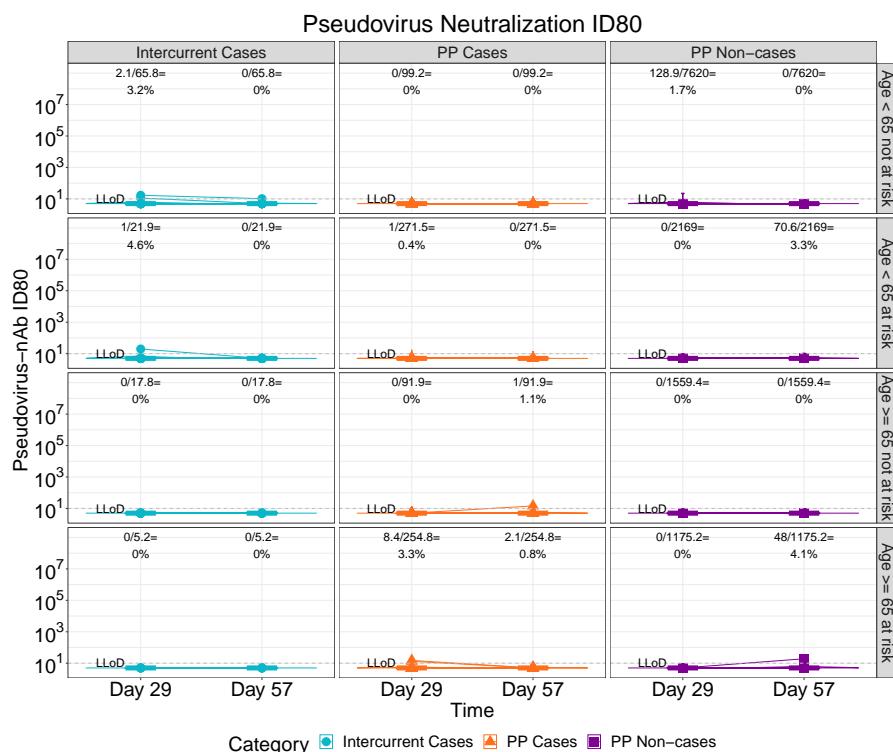


Figure 2.125: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age and risk condition (2 timepoints)

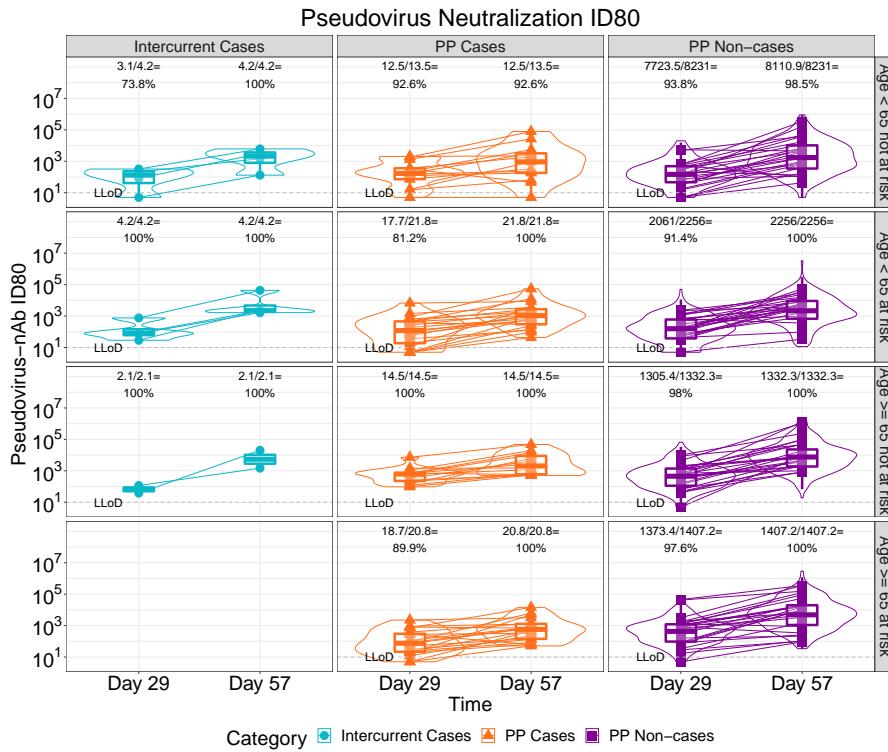


Figure 2.126: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age and risk condition (2 timepoints)

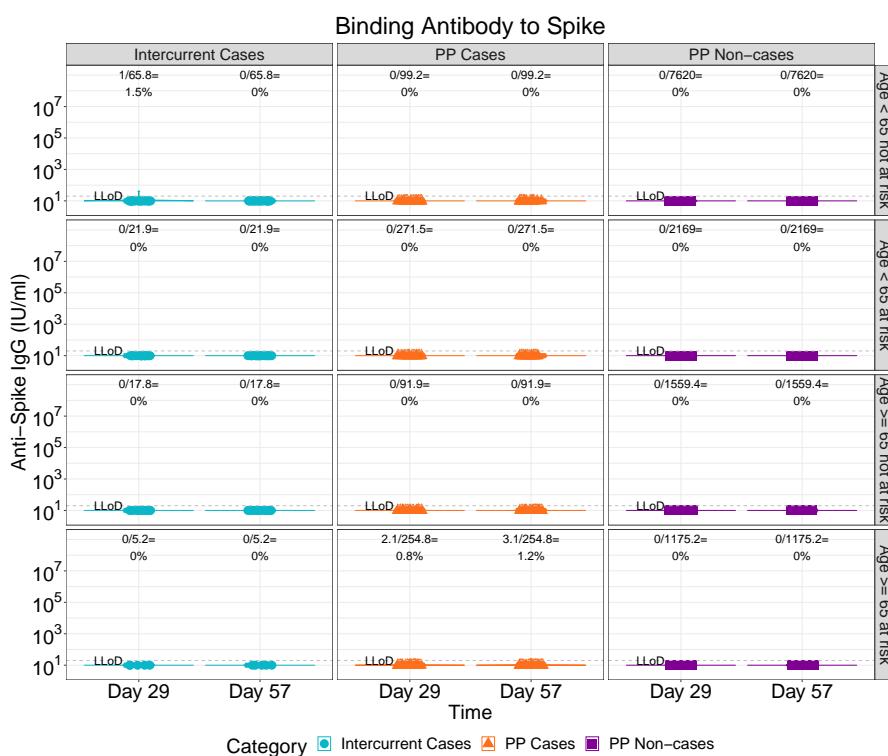


Figure 2.127: violinplots of Binding Antibody to Spike: baseline negative placebo arm by age and risk condition (2 timepoints)

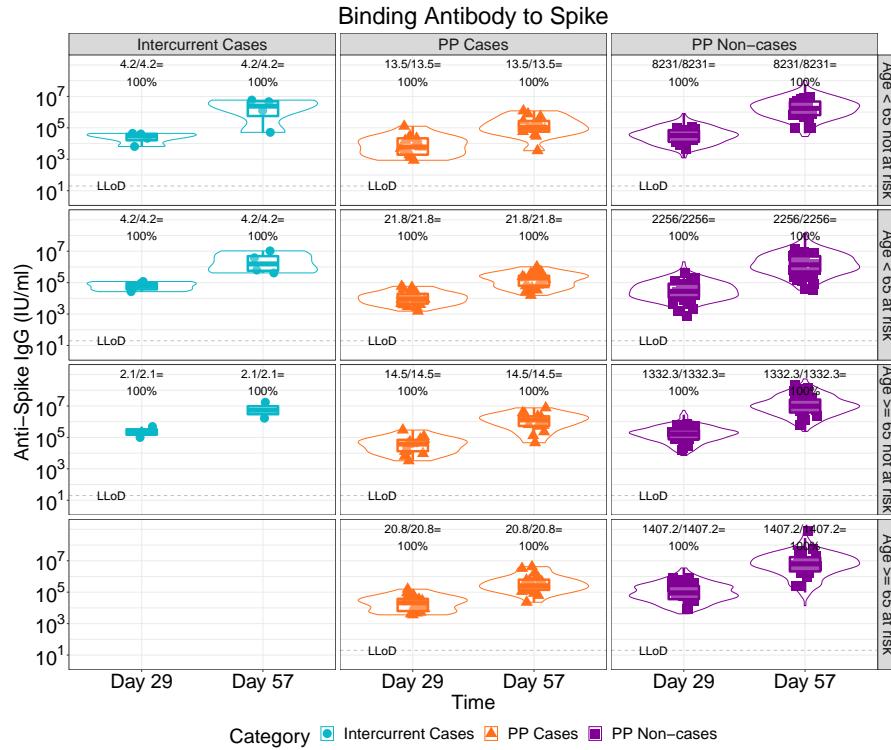


Figure 2.128: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by age and risk condition (2 timepoints)

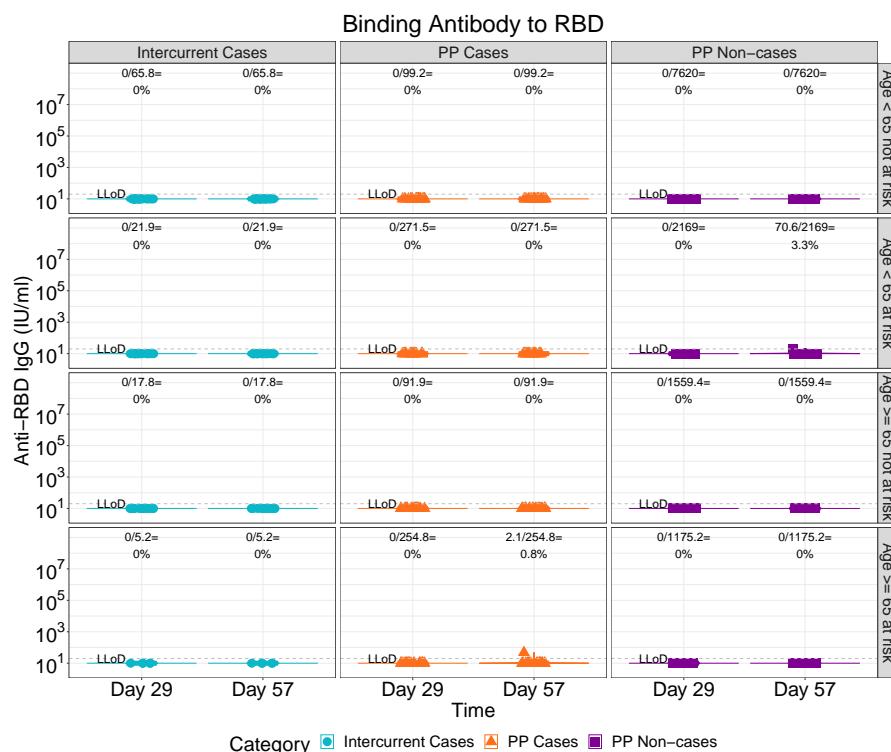


Figure 2.129: violinplots of Binding Antibody to RBD: baseline negative placebo arm by age and risk condition (2 timepoints)

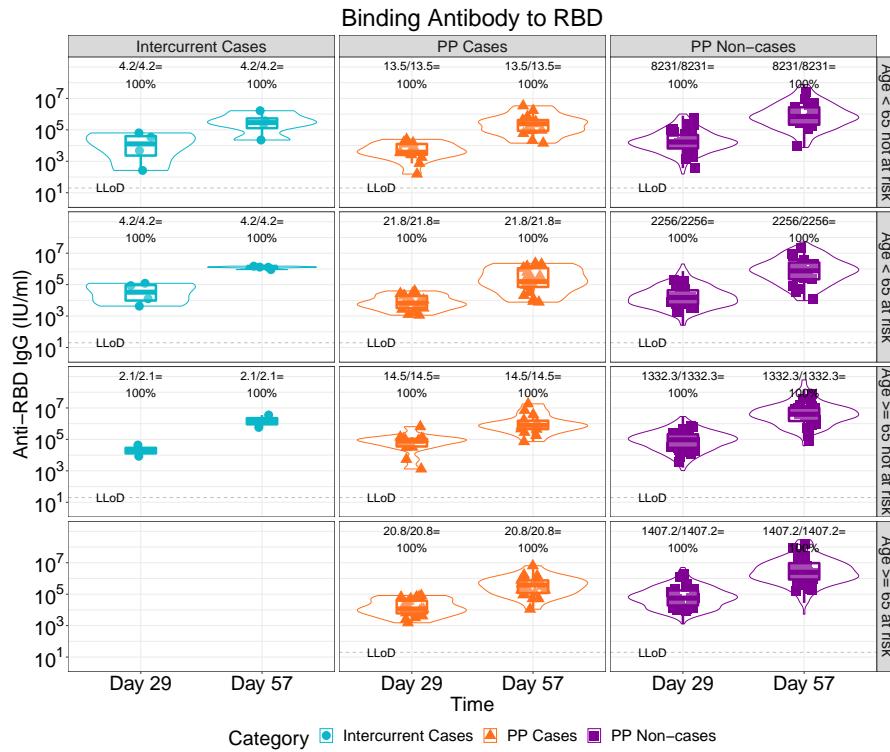


Figure 2.130: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by age and risk condition (2 timepoints)

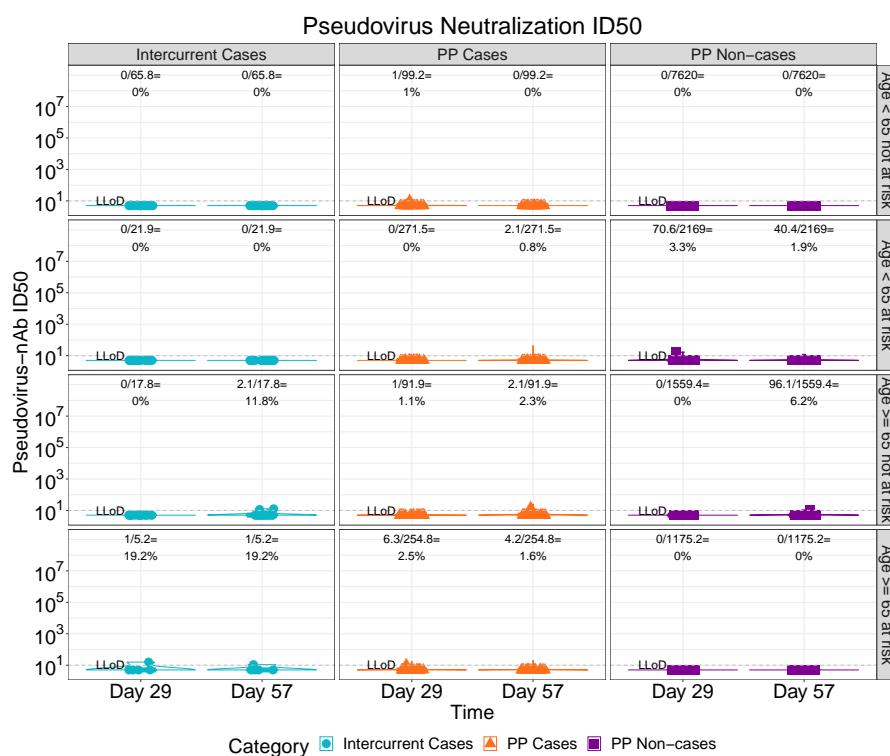


Figure 2.131: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age and risk condition (2 timepoints)

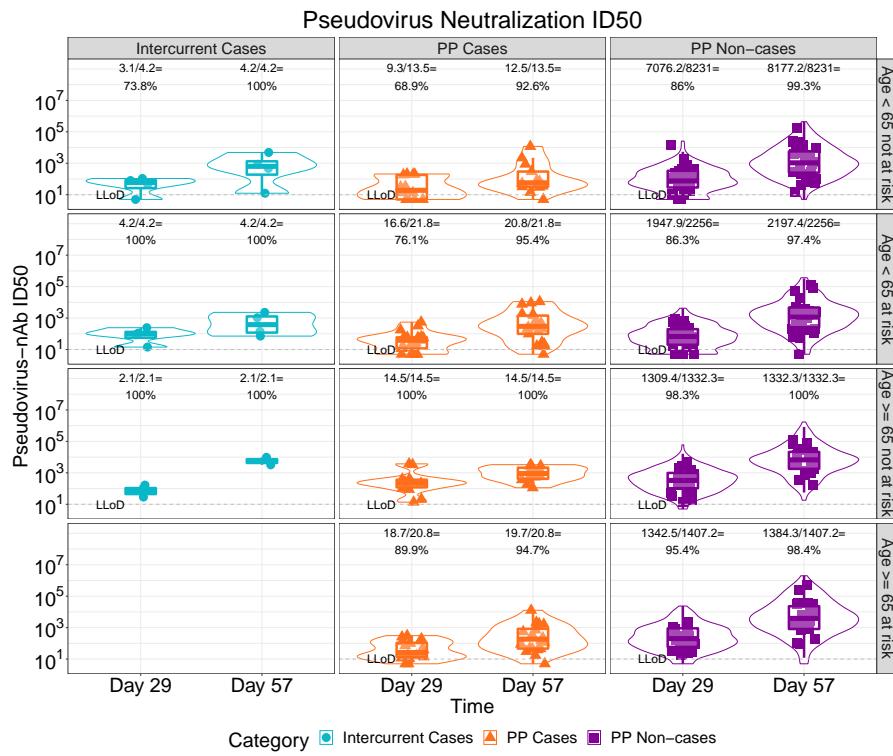


Figure 2.132: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age and risk condition (2 timepoints)

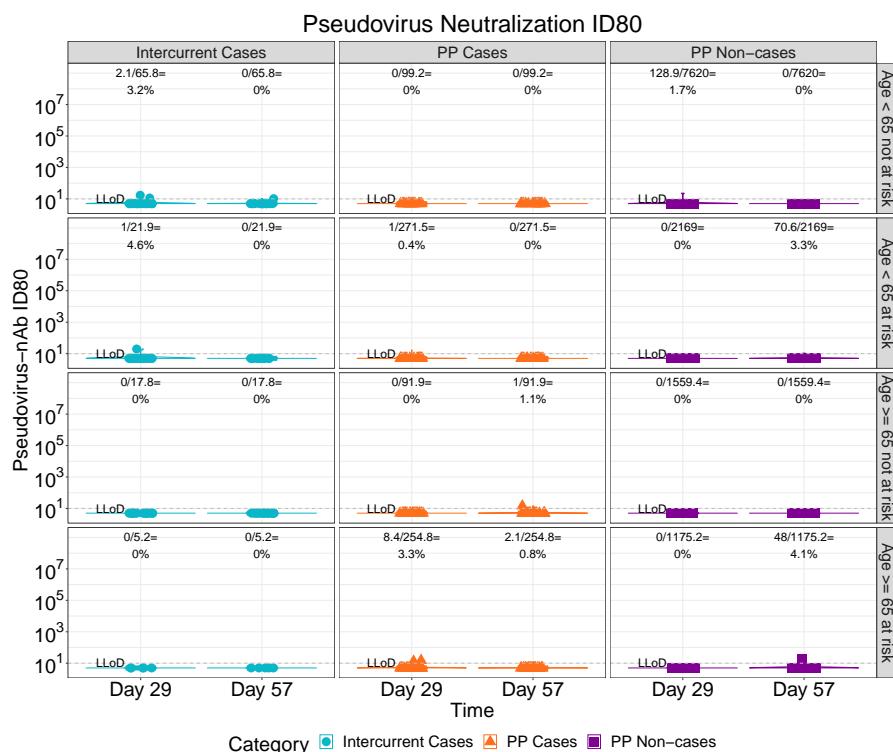


Figure 2.133: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age and risk condition (2 timepoints)

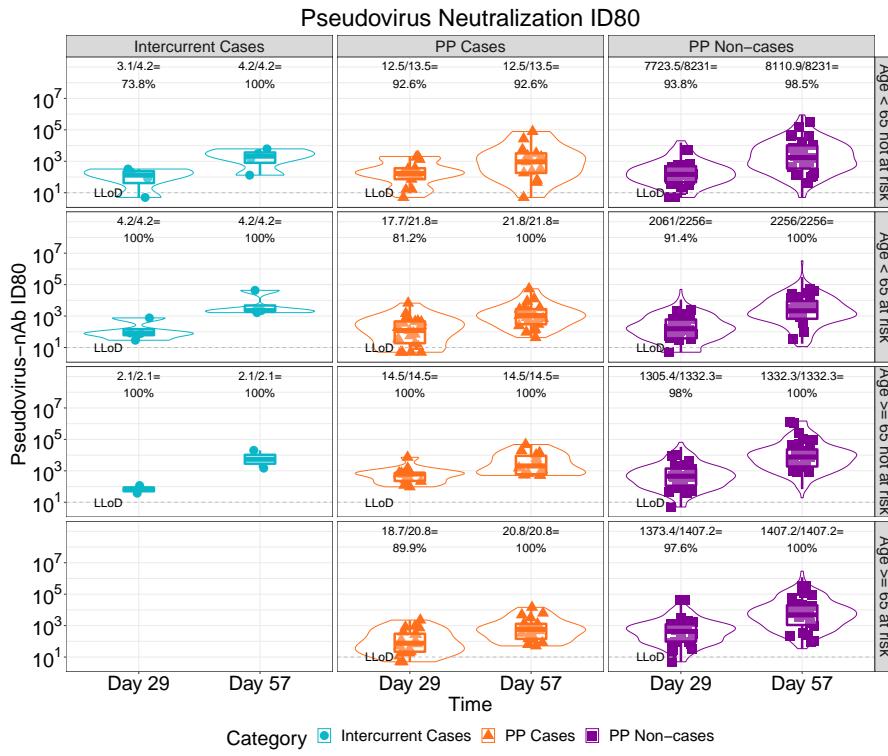


Figure 2.134: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age and risk condition (2 timepoints)

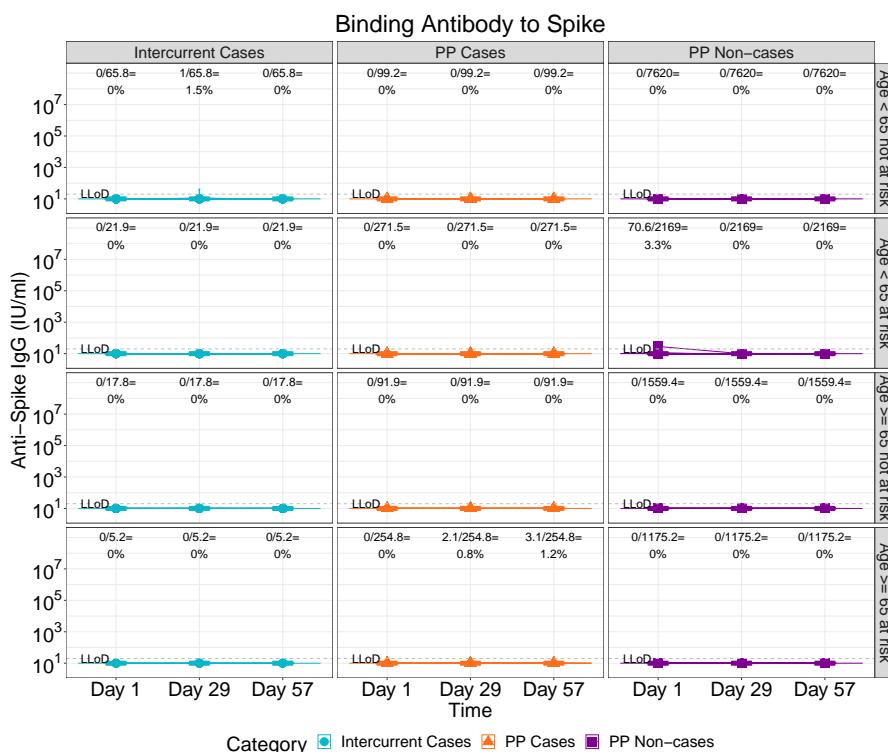


Figure 2.135: lineplots of Binding Antibody to Spike: baseline negative placebo arm by age and risk condition (3 timepoints)

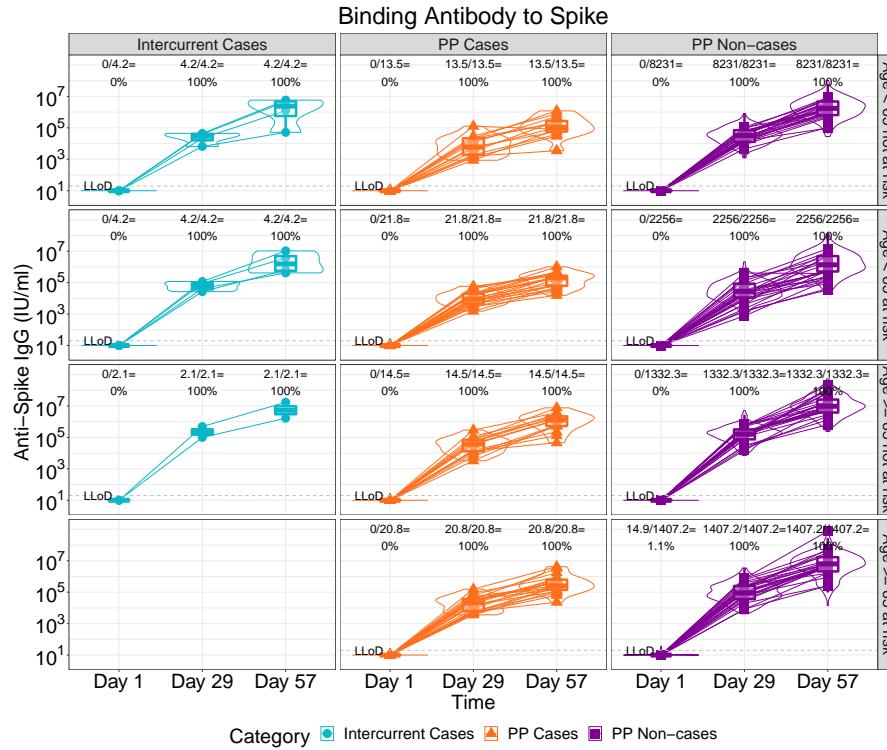


Figure 2.136: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by age and risk condition (3 timepoints)

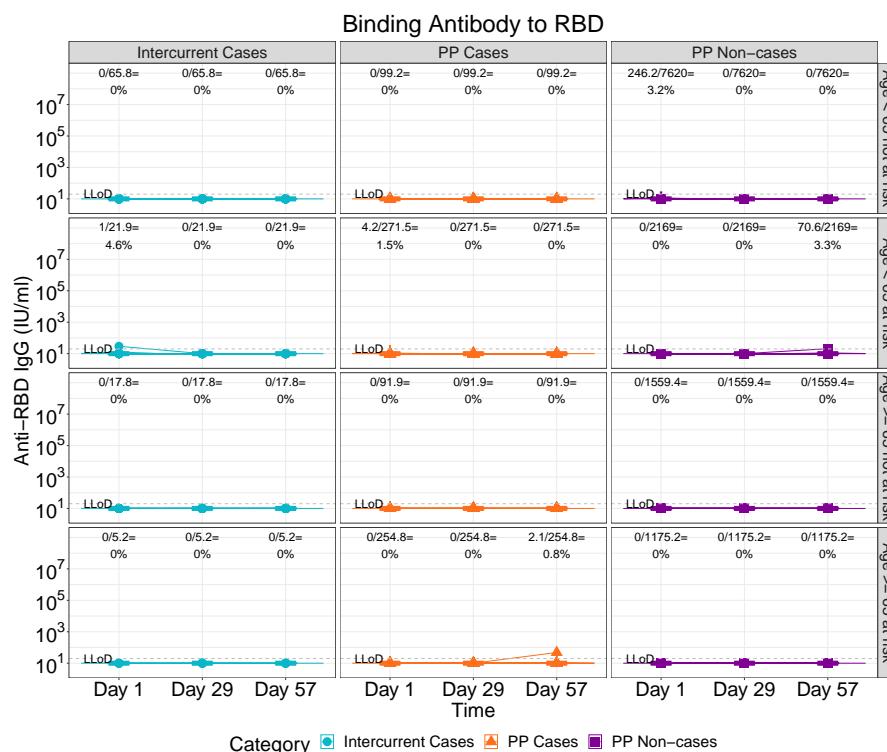


Figure 2.137: lineplots of Binding Antibody to RBD: baseline negative placebo arm by age and risk condition (3 timepoints)

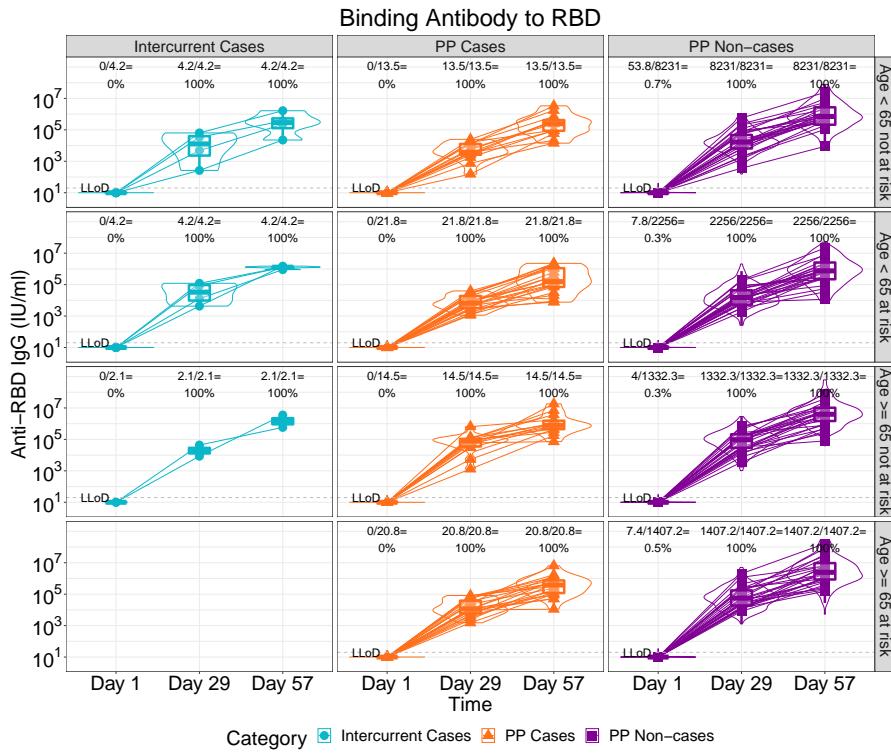


Figure 2.138: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by age and risk condition (3 timepoints)

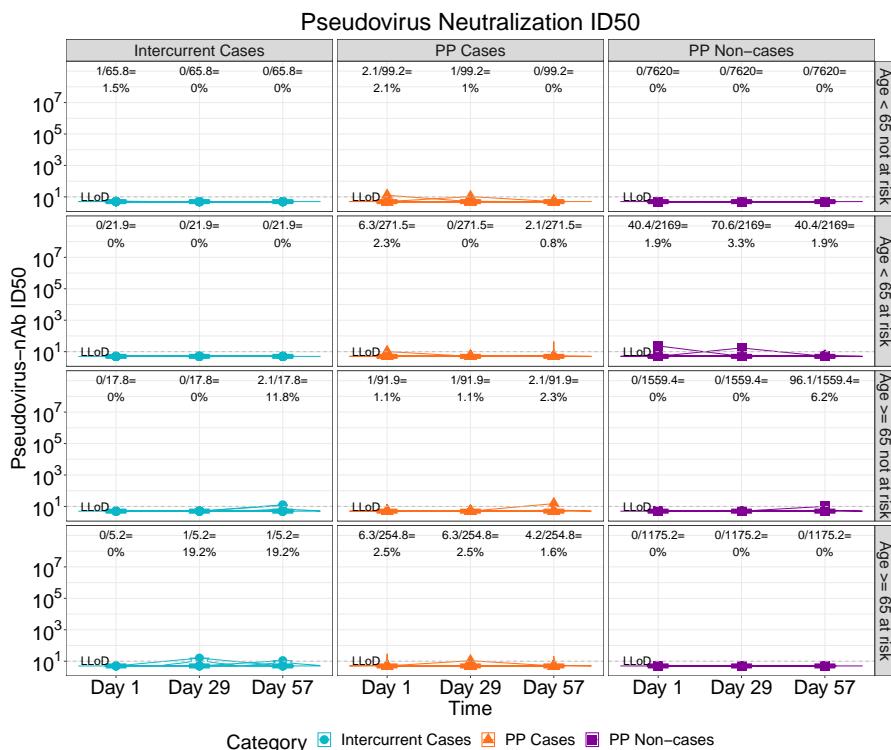


Figure 2.139: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age and risk condition (3 timepoints)

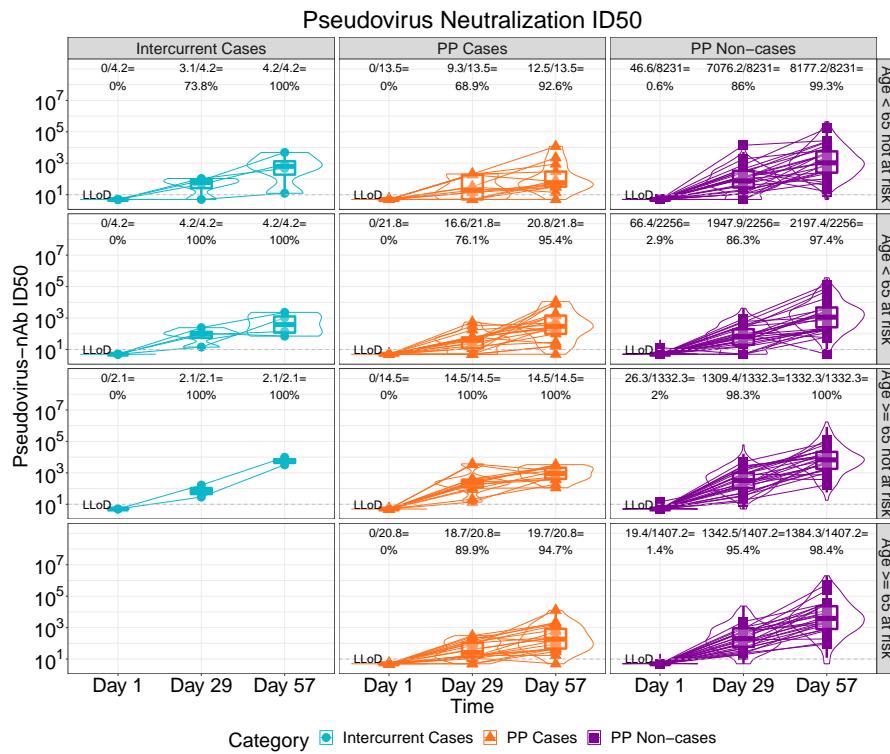


Figure 2.140: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age and risk condition (3 timepoints)

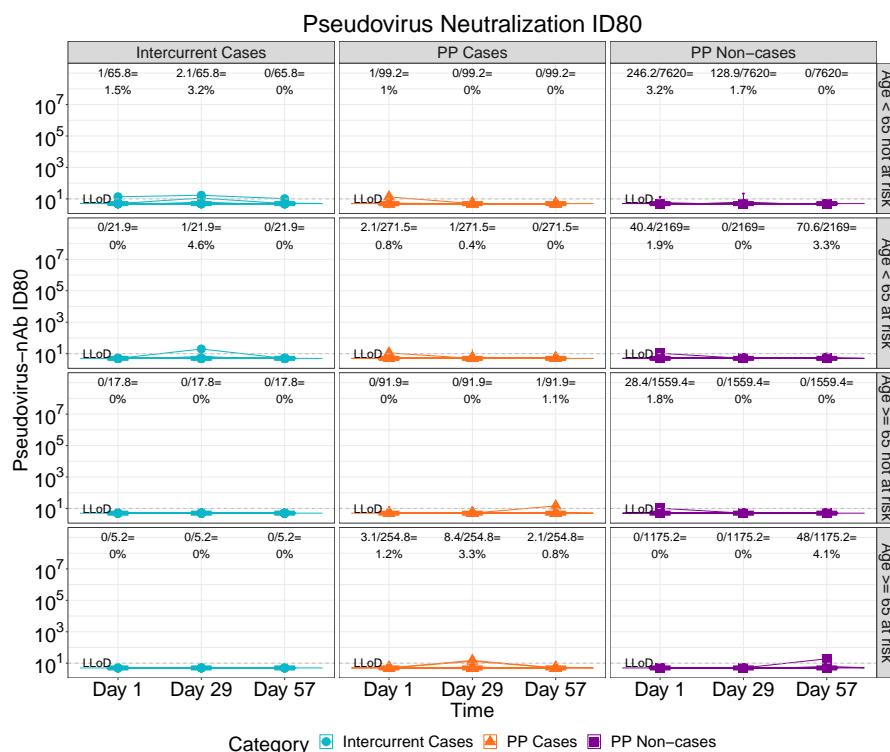


Figure 2.141: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age and risk condition (3 timepoints)

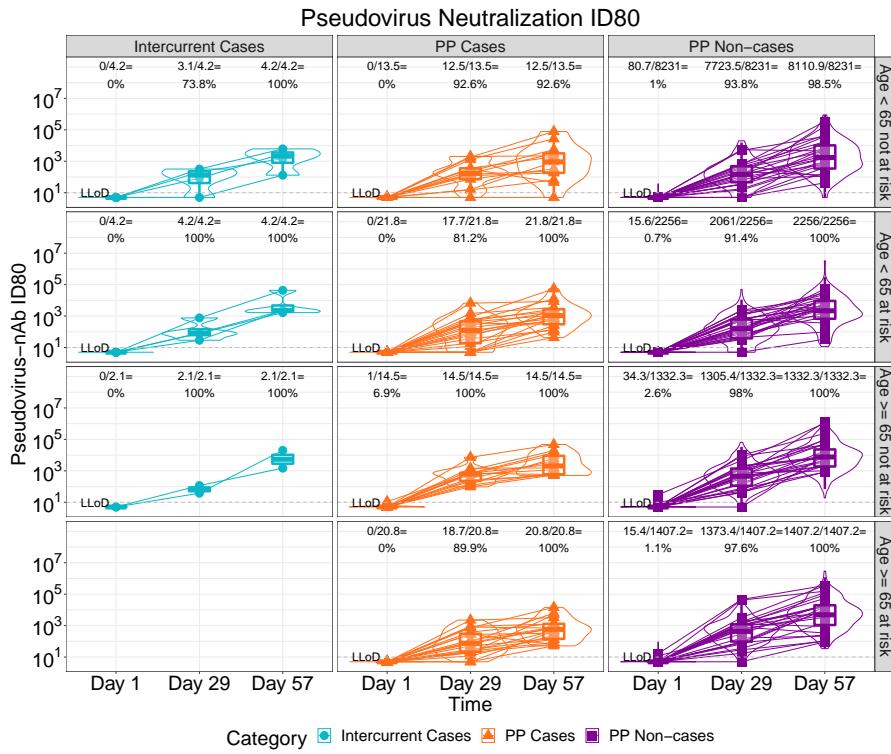


Figure 2.142: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age and risk condition (3 timepoints)

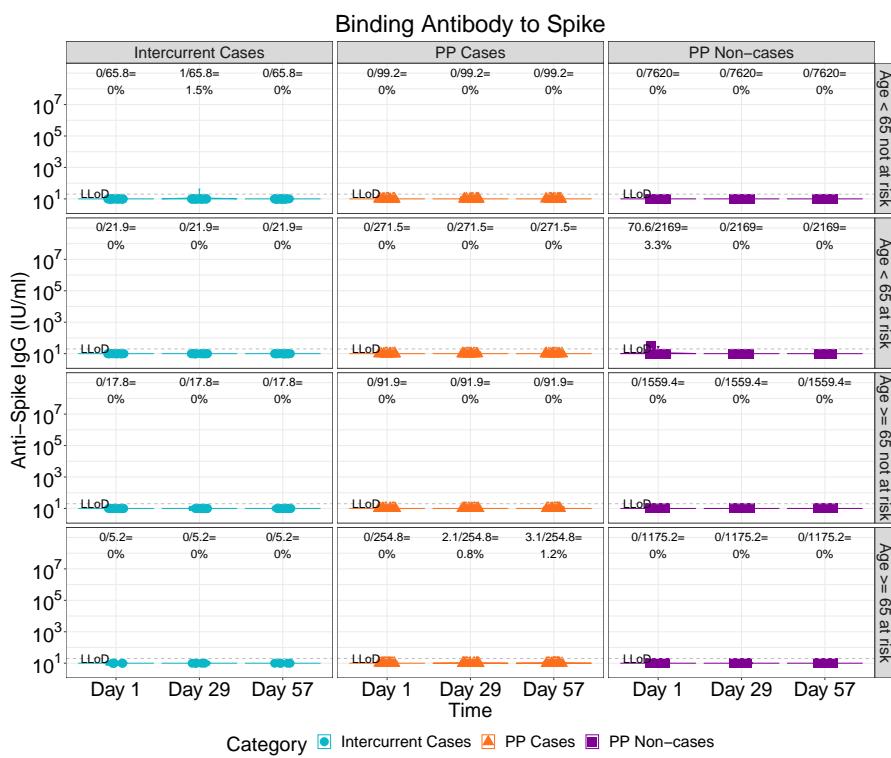


Figure 2.143: violinplots of Binding Antibody to Spike: baseline negative placebo arm by age and risk condition (3 timepoints)

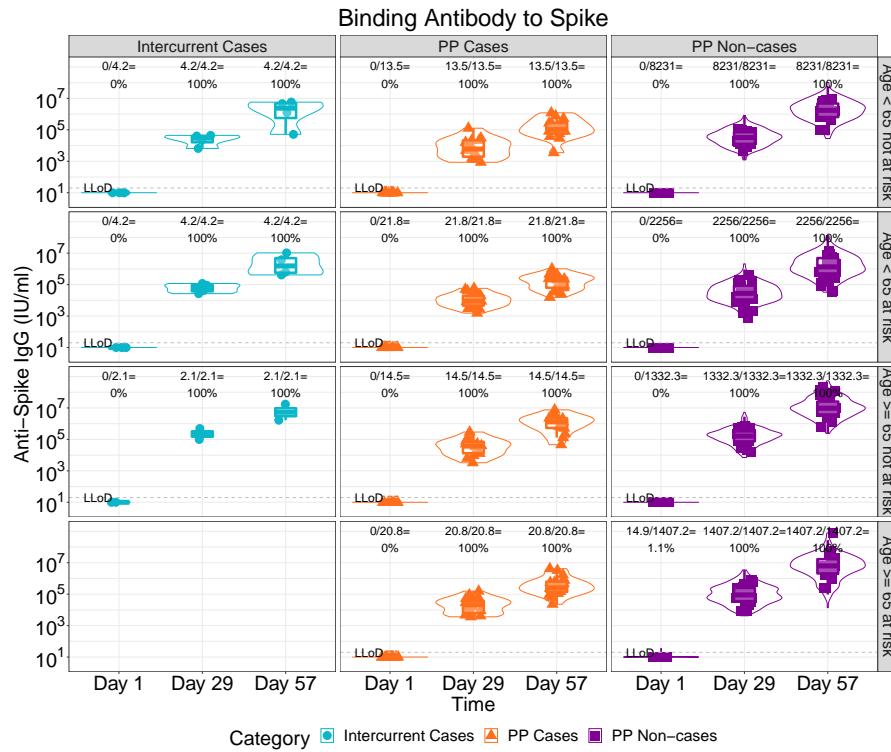


Figure 2.144: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by age and risk condition (3 timepoints)

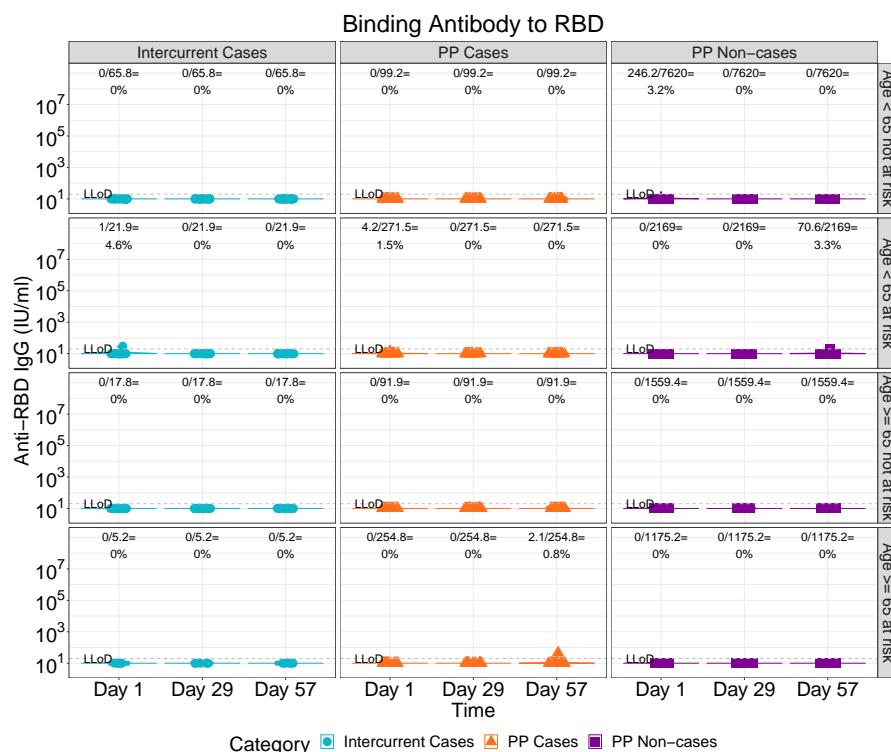


Figure 2.145: violinplots of Binding Antibody to RBD: baseline negative placebo arm by age and risk condition (3 timepoints)

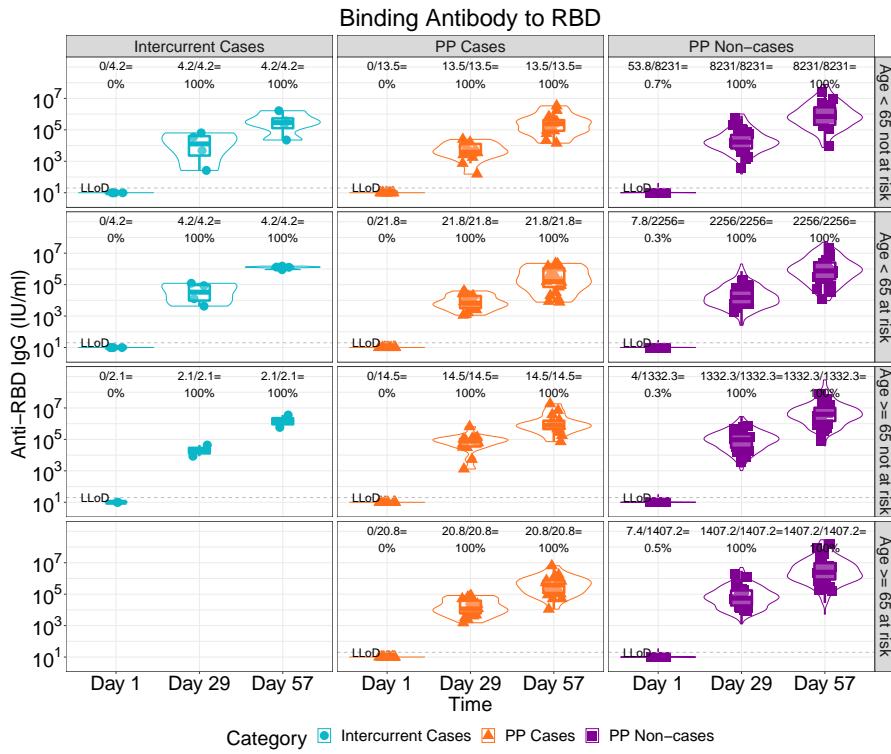


Figure 2.146: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by age and risk condition (3 timepoints)

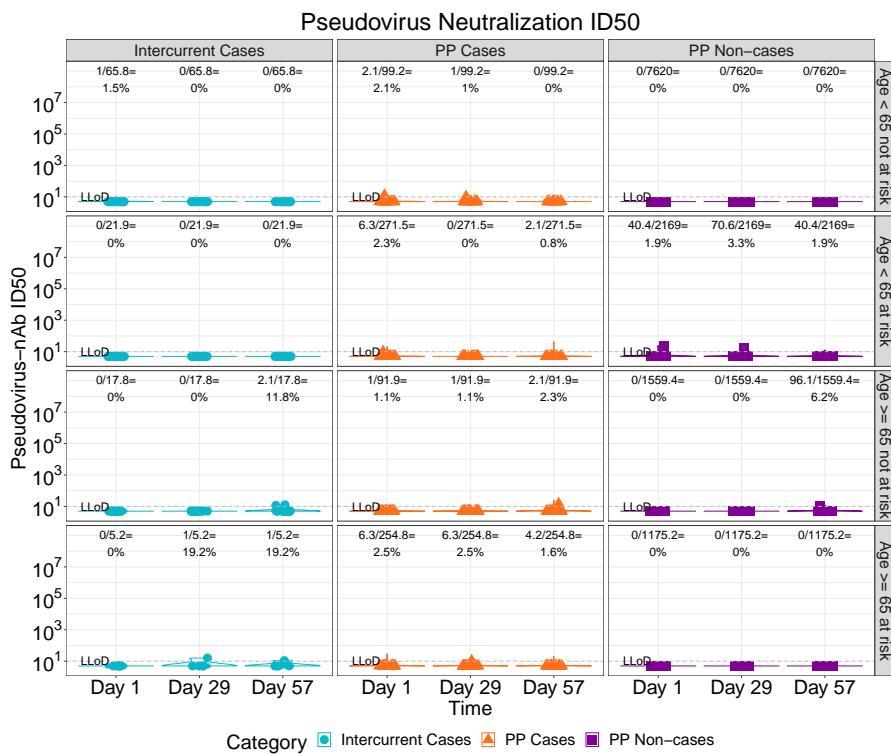


Figure 2.147: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age and risk condition (3 timepoints)

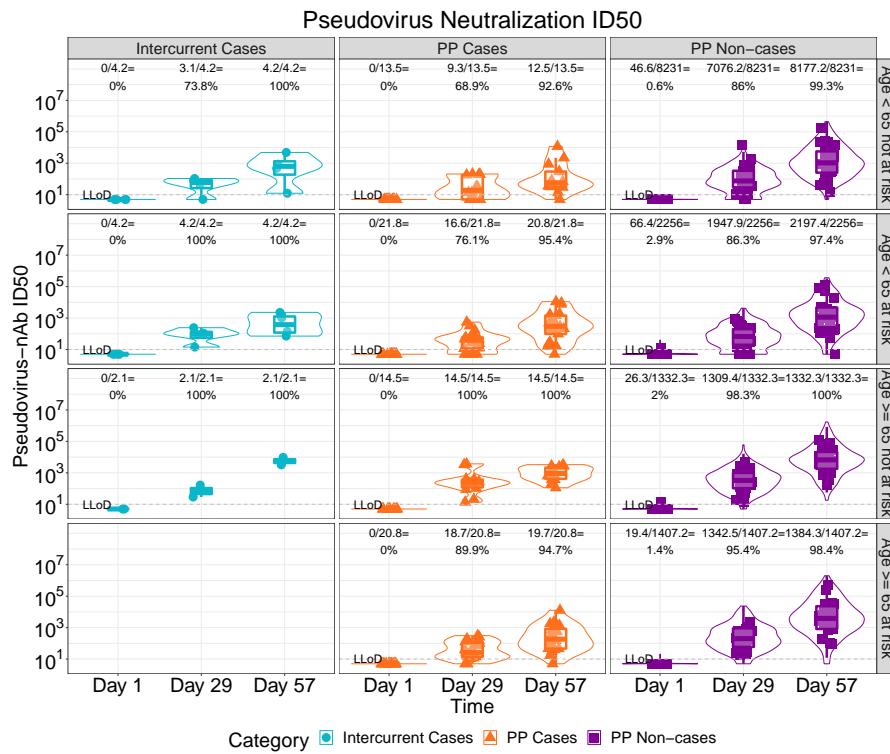


Figure 2.148: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age and risk condition (3 timepoints)

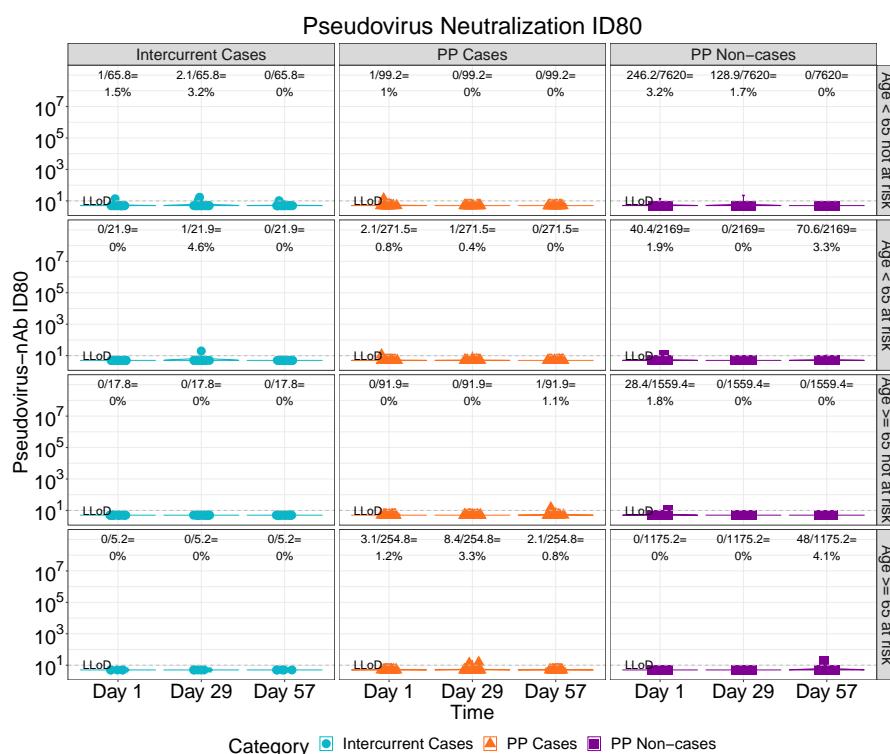


Figure 2.149: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age and risk condition (3 timepoints)

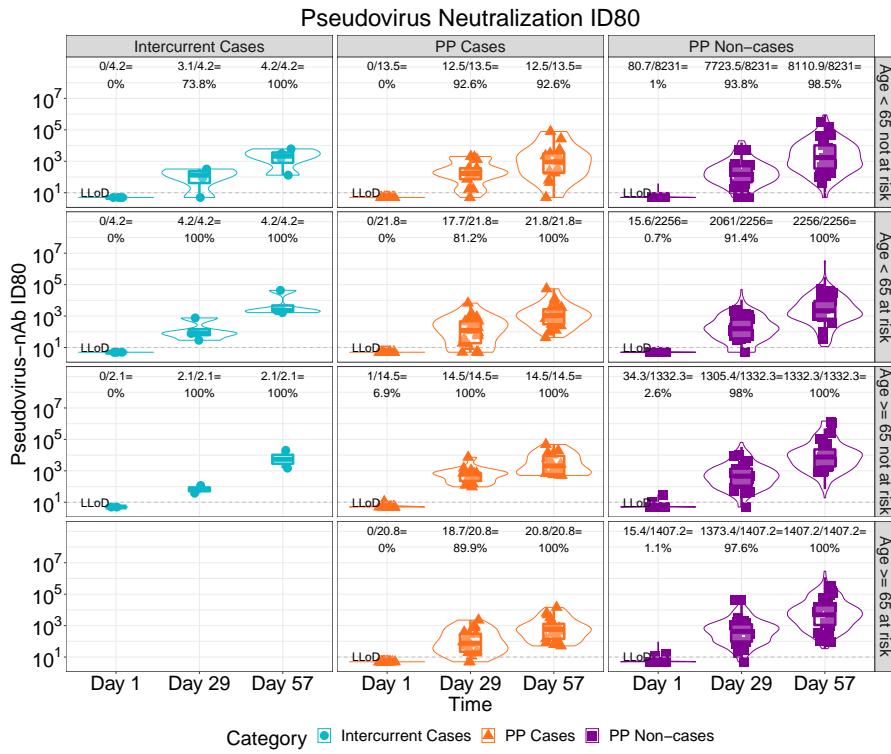


Figure 2.150: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age and risk condition (3 timepoints)

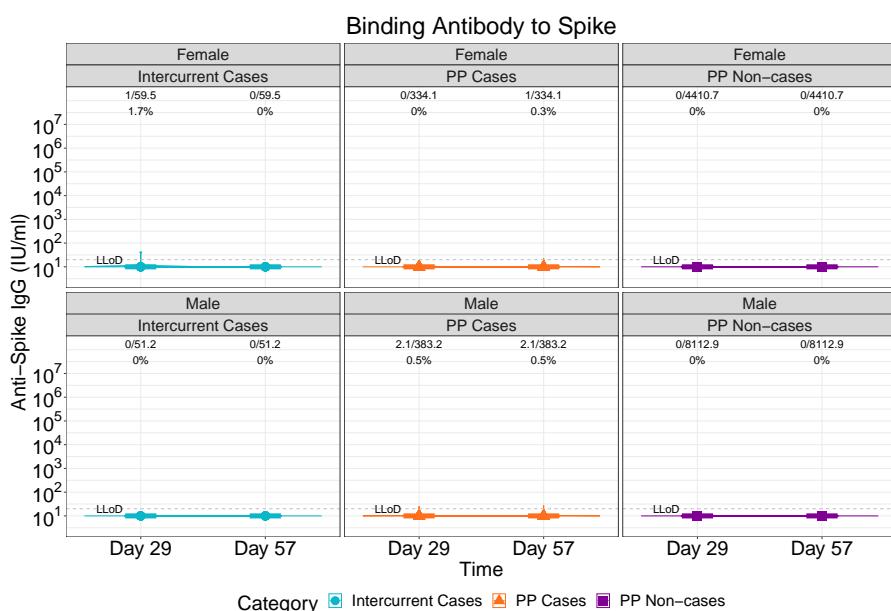


Figure 2.151: lineplots of Binding Antibody to Spike: baseline negative placebo arm by sex assigned at birth (2 timepoints)

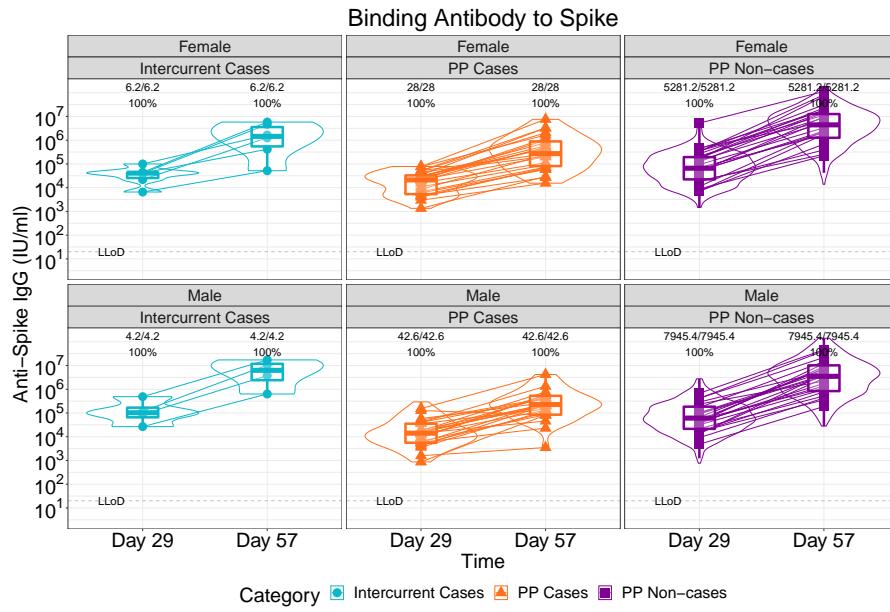


Figure 2.152: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by sex assigned at birth (2 timepoints)

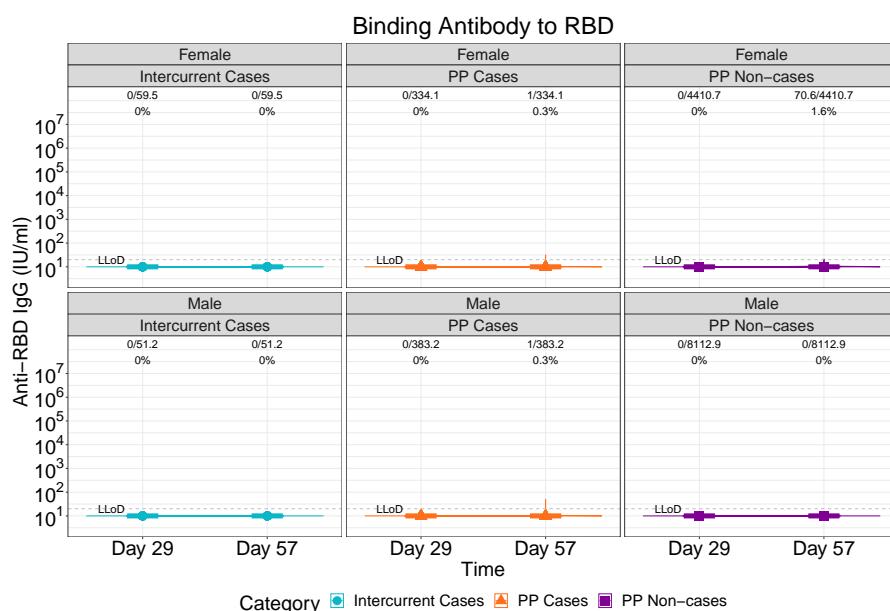


Figure 2.153: lineplots of Binding Antibody to RBD: baseline negative placebo arm by sex assigned at birth (2 timepoints)

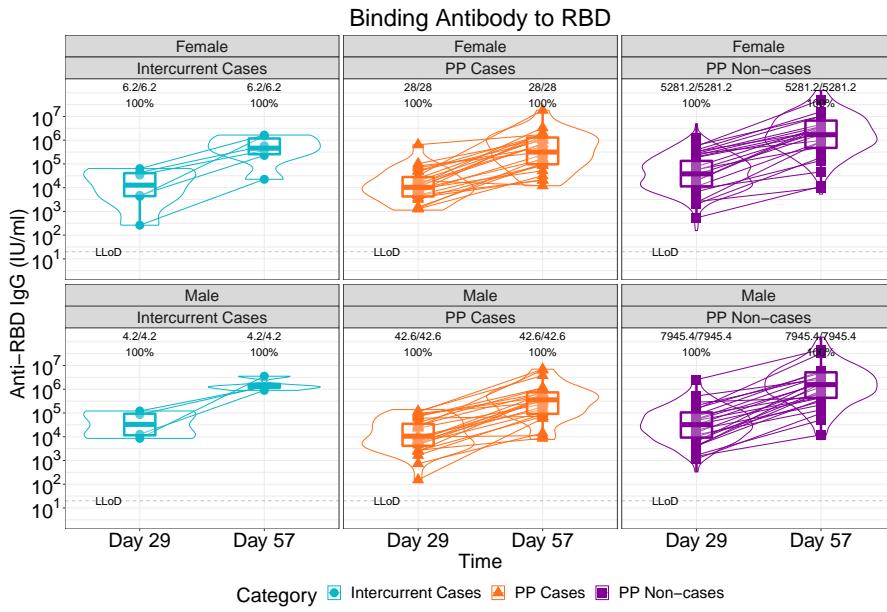


Figure 2.154: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by sex assigned at birth (2 timepoints)

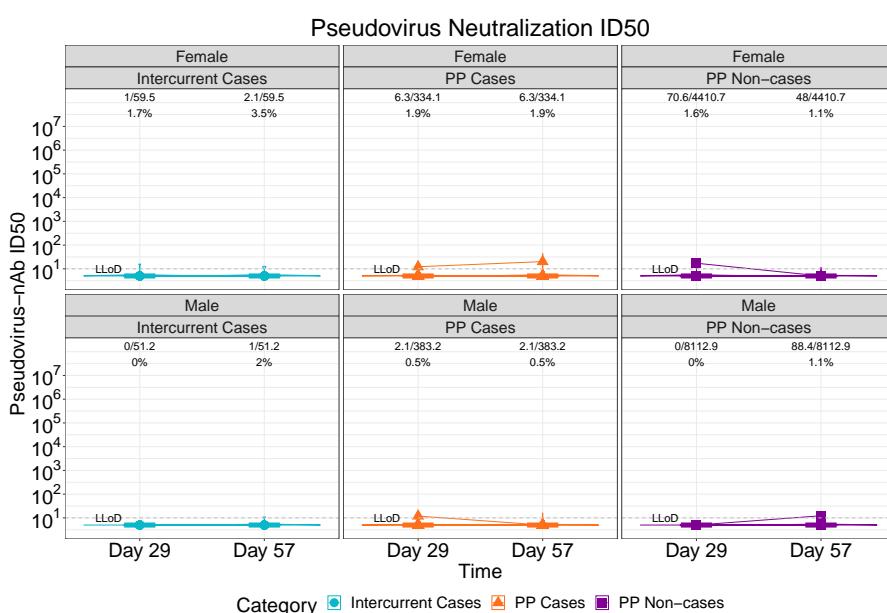


Figure 2.155: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by sex assigned at birth (2 timepoints)

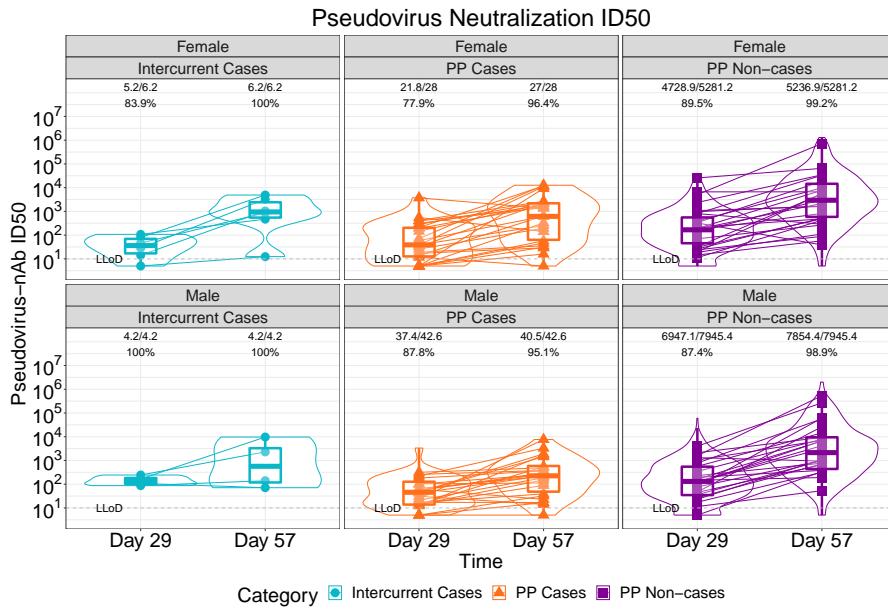


Figure 2.156: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by sex assigned at birth (2 timepoints)

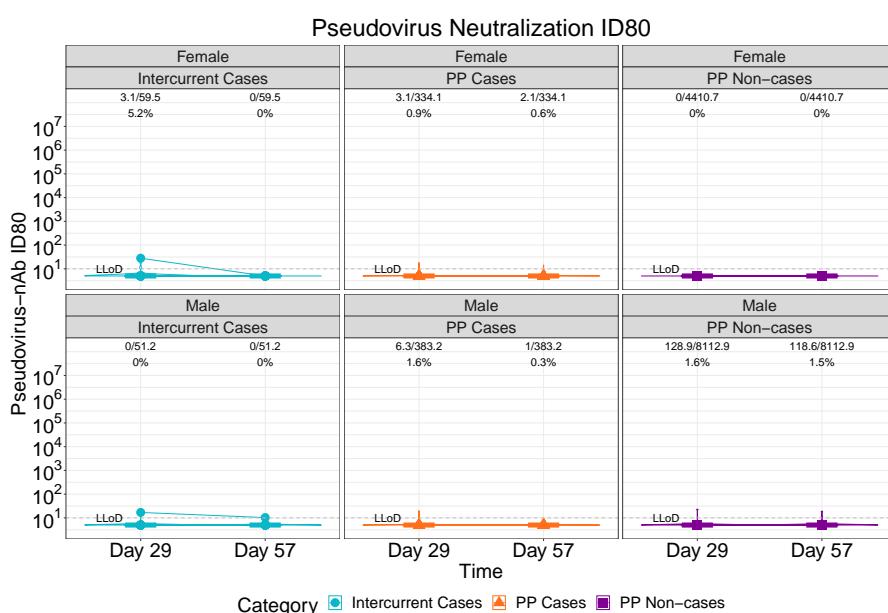


Figure 2.157: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by sex assigned at birth (2 timepoints)

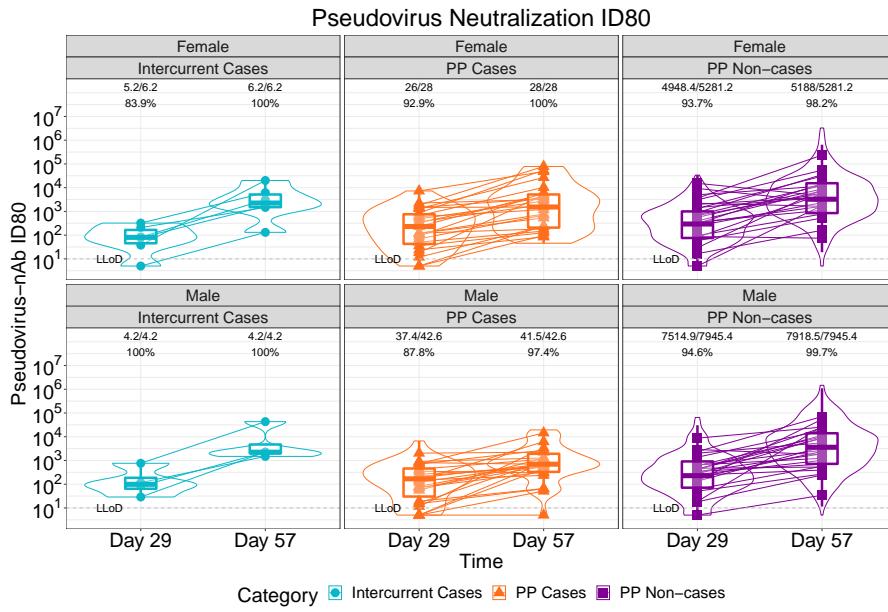


Figure 2.158: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by sex assigned at birth (2 timepoints)

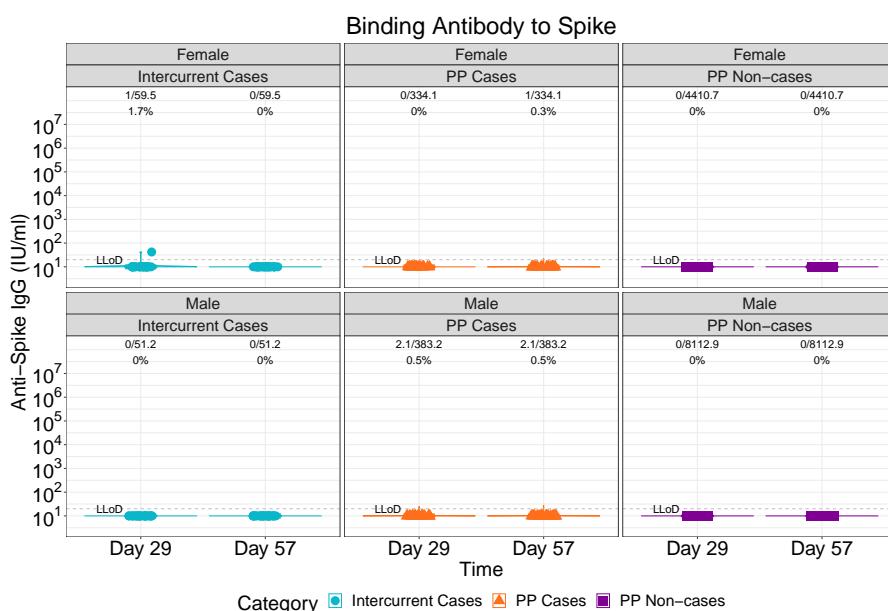


Figure 2.159: violinplots of Binding Antibody to Spike: baseline negative placebo arm by sex assigned at birth (2 timepoints)

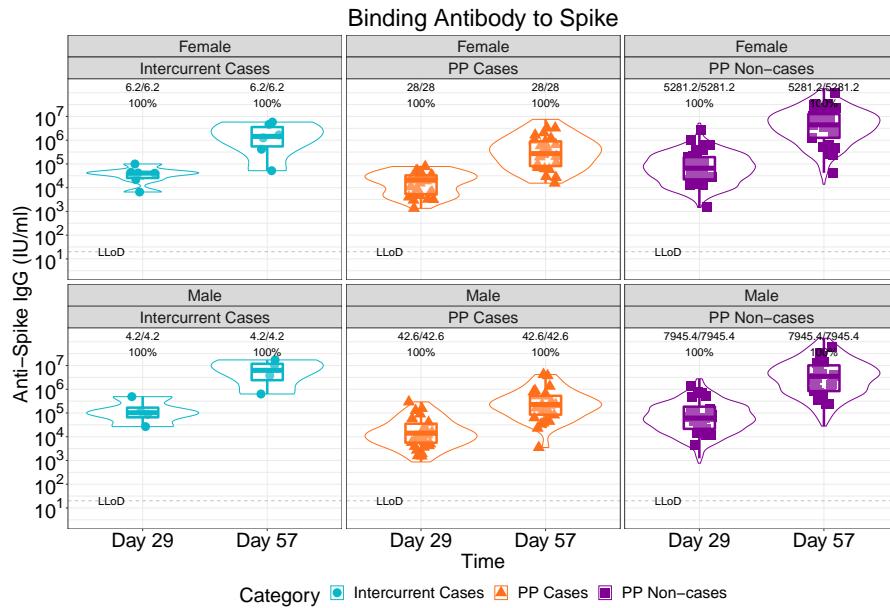


Figure 2.160: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by sex assigned at birth (2 timepoints)

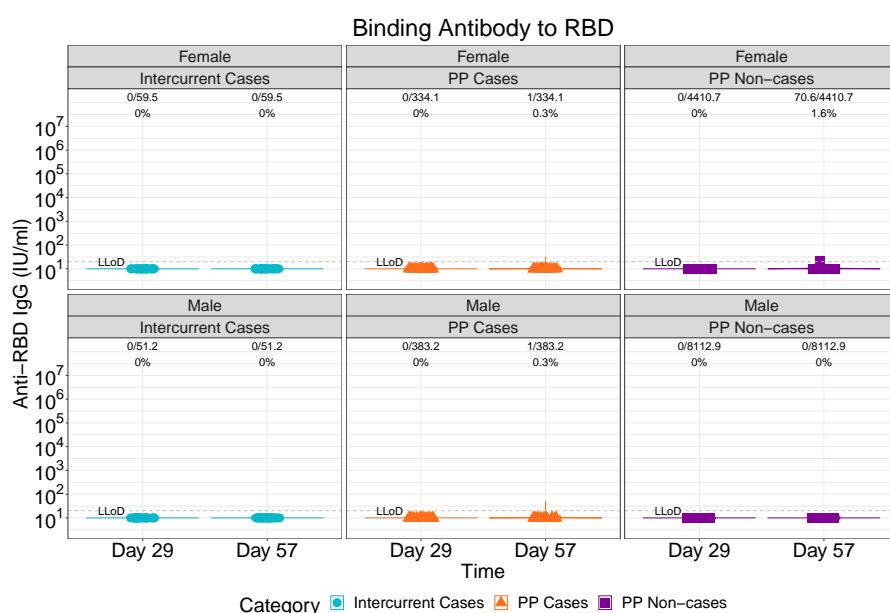


Figure 2.161: violinplots of Binding Antibody to RBD: baseline negative placebo arm by sex assigned at birth (2 timepoints)

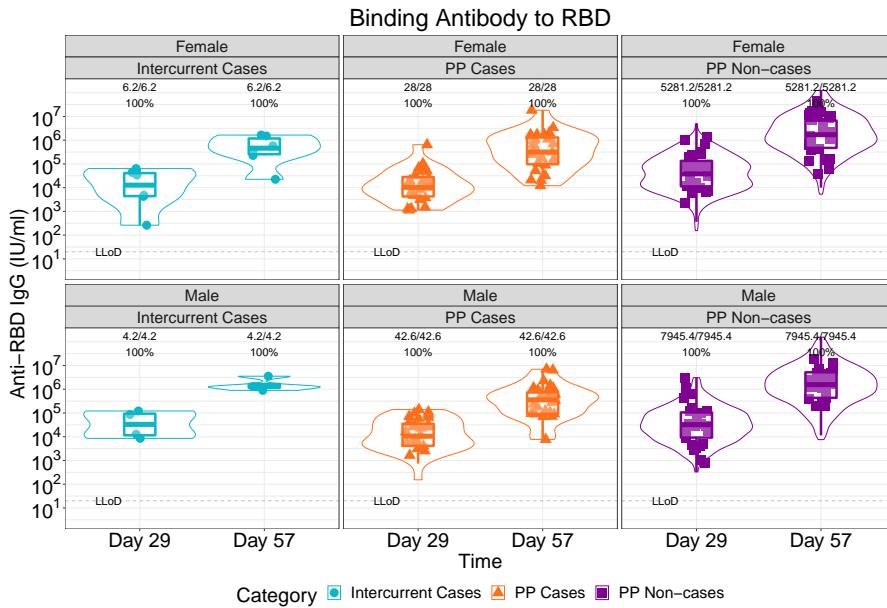


Figure 2.162: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by sex assigned at birth (2 timepoints)

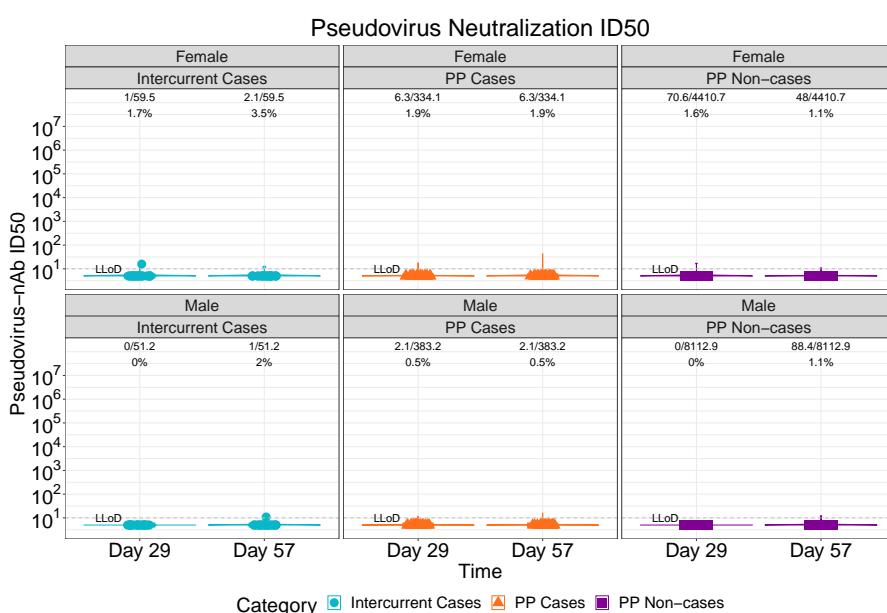


Figure 2.163: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by sex assigned at birth (2 timepoints)

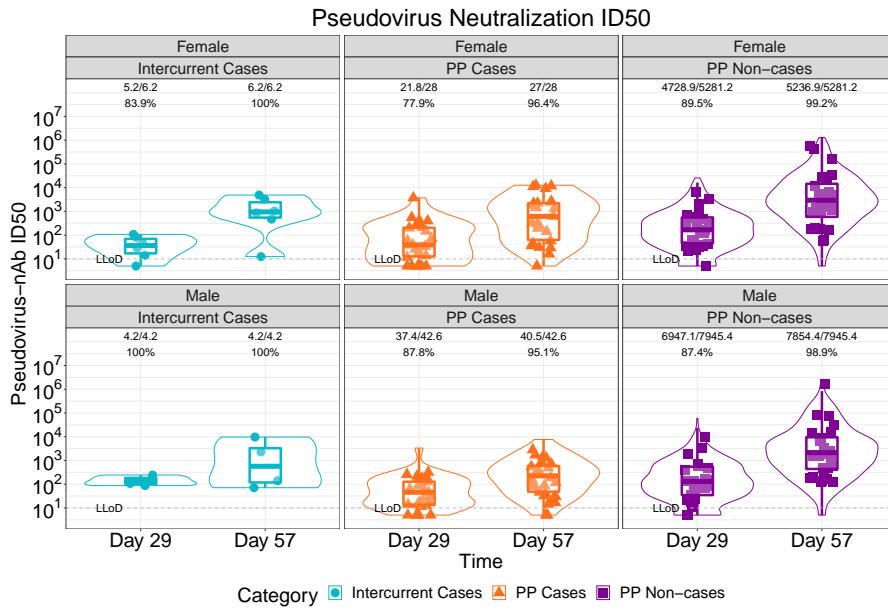


Figure 2.164: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by sex assigned at birth (2 timepoints)

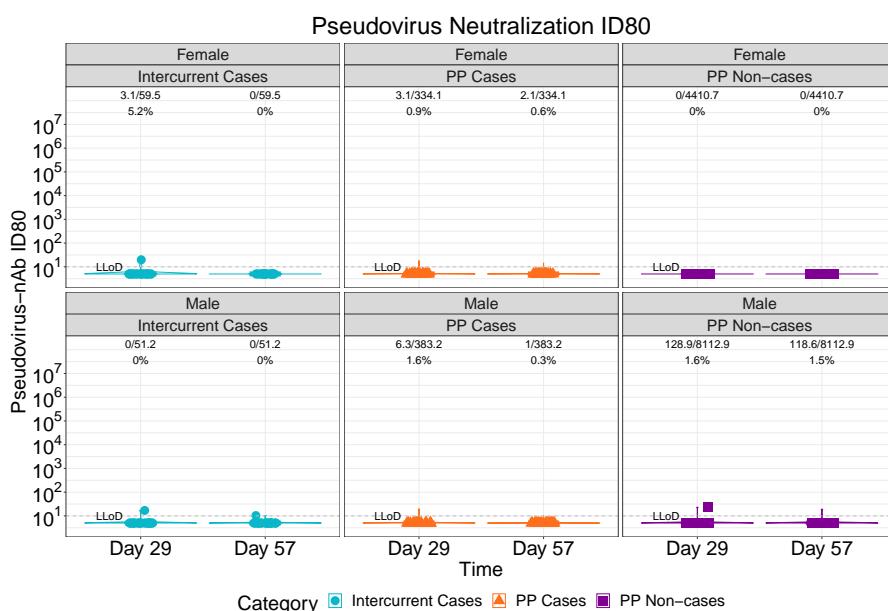


Figure 2.165: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by sex assigned at birth (2 timepoints)

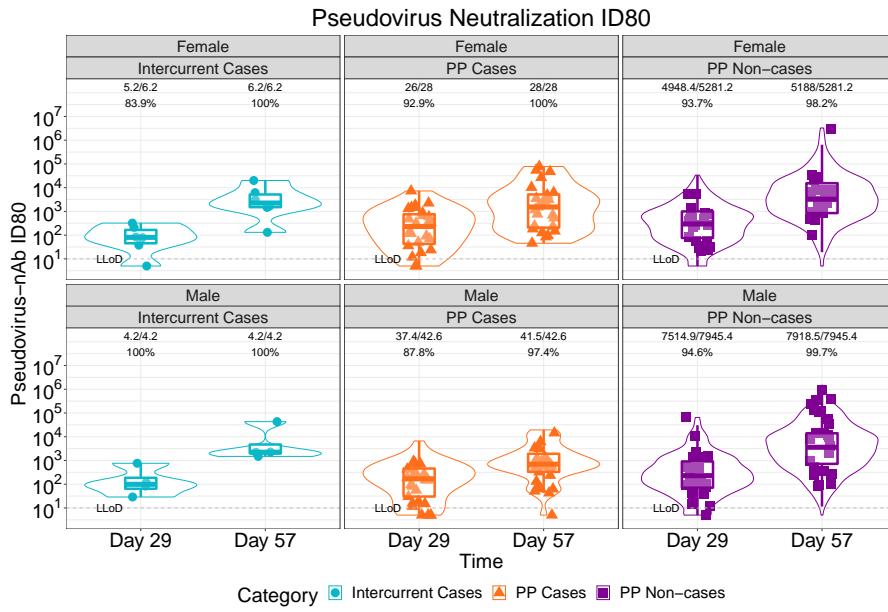


Figure 2.166: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by sex assigned at birth (2 timepoints)

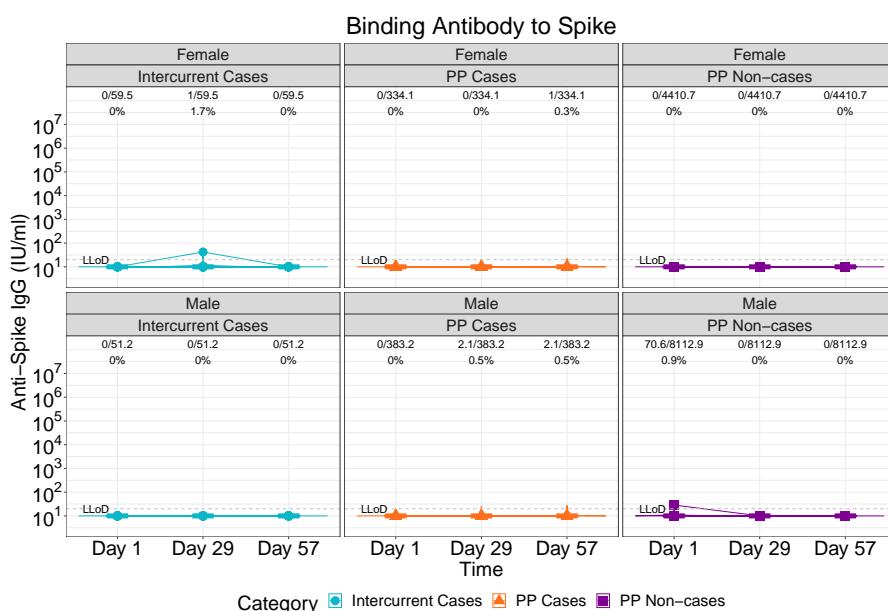


Figure 2.167: lineplots of Binding Antibody to Spike: baseline negative placebo arm by sex assigned at birth (3 timepoints)

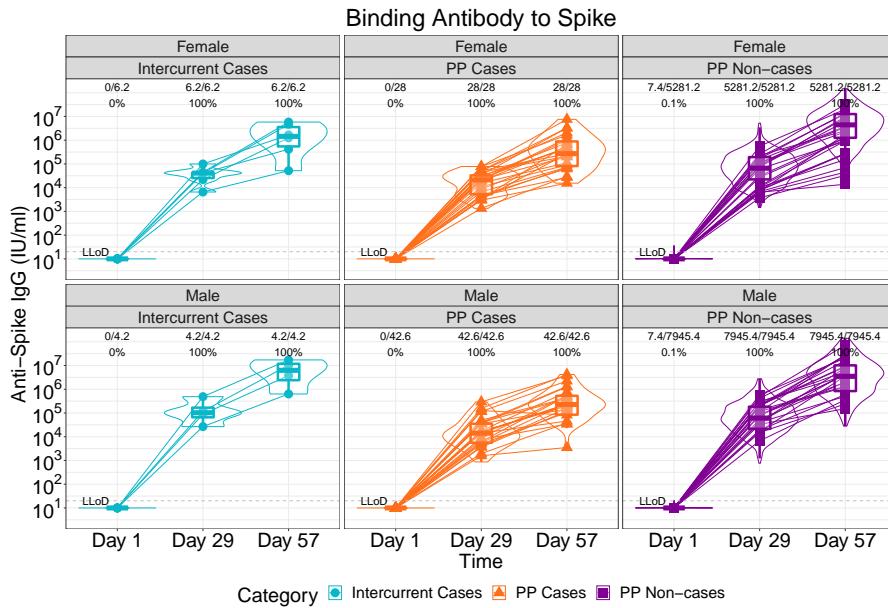


Figure 2.168: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by sex assigned at birth (3 timepoints)

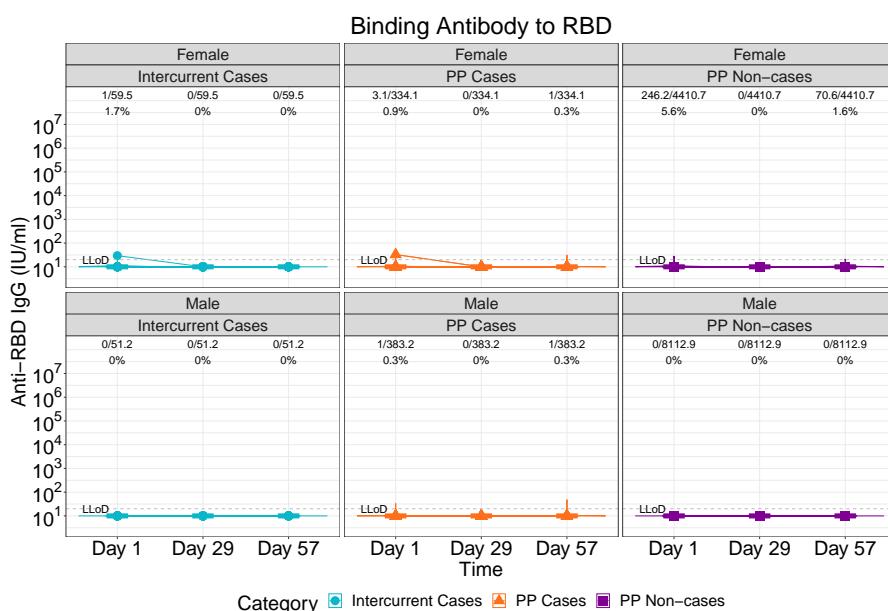


Figure 2.169: lineplots of Binding Antibody to RBD: baseline negative placebo arm by sex assigned at birth (3 timepoints)

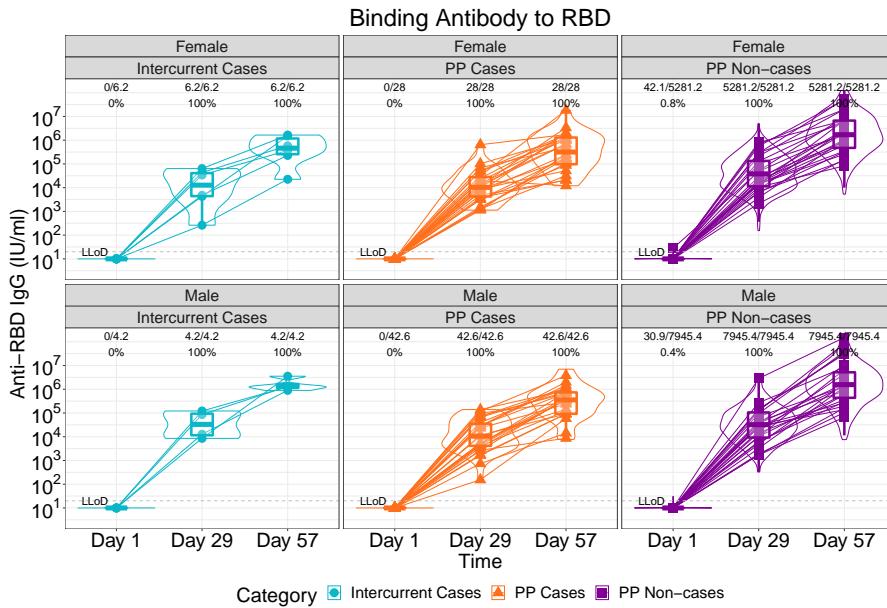


Figure 2.170: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by sex assigned at birth (3 timepoints)

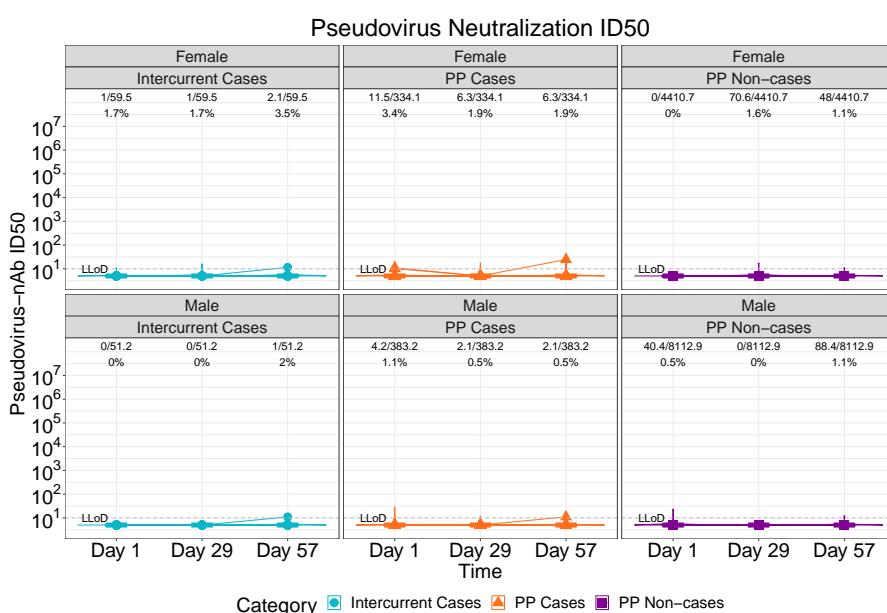


Figure 2.171: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by sex assigned at birth (3 timepoints)

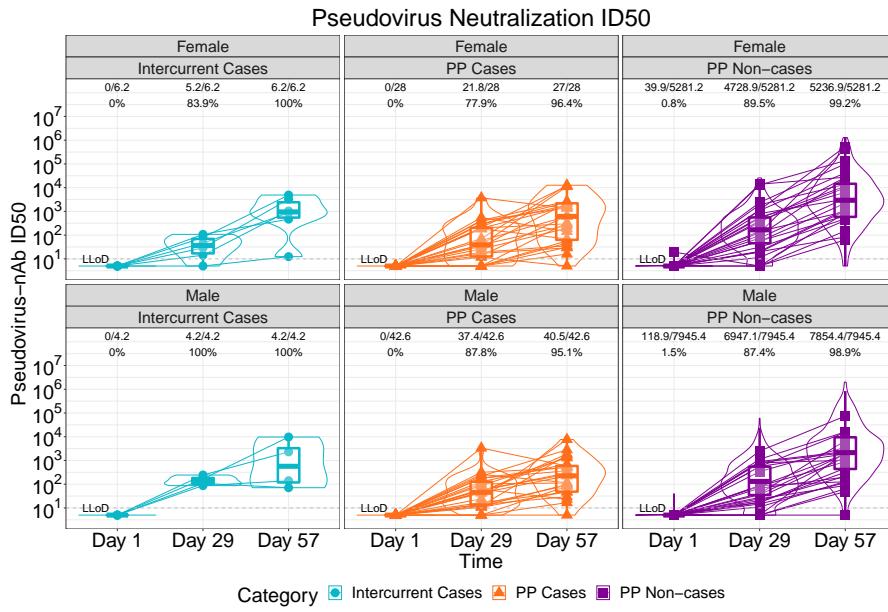


Figure 2.172: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by sex assigned at birth (3 timepoints)

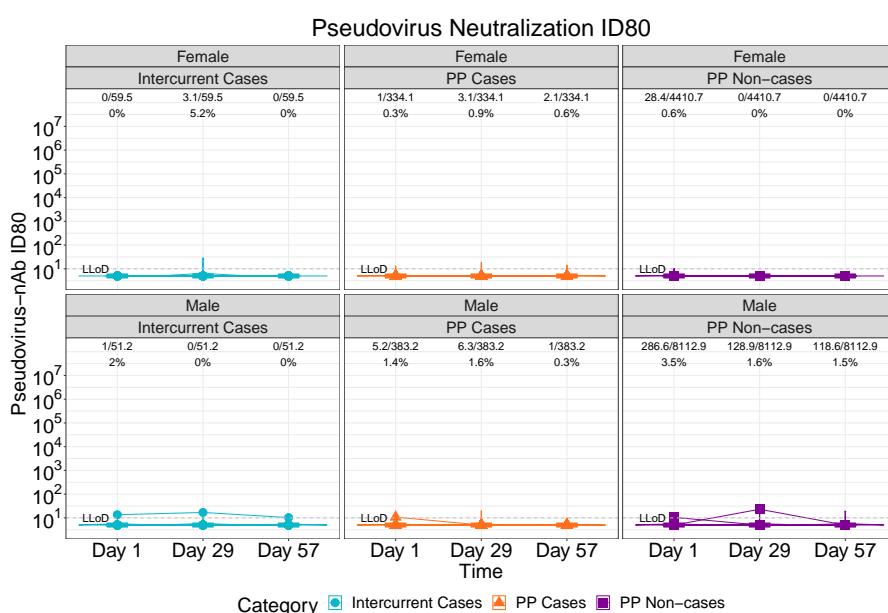


Figure 2.173: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by sex assigned at birth (3 timepoints)

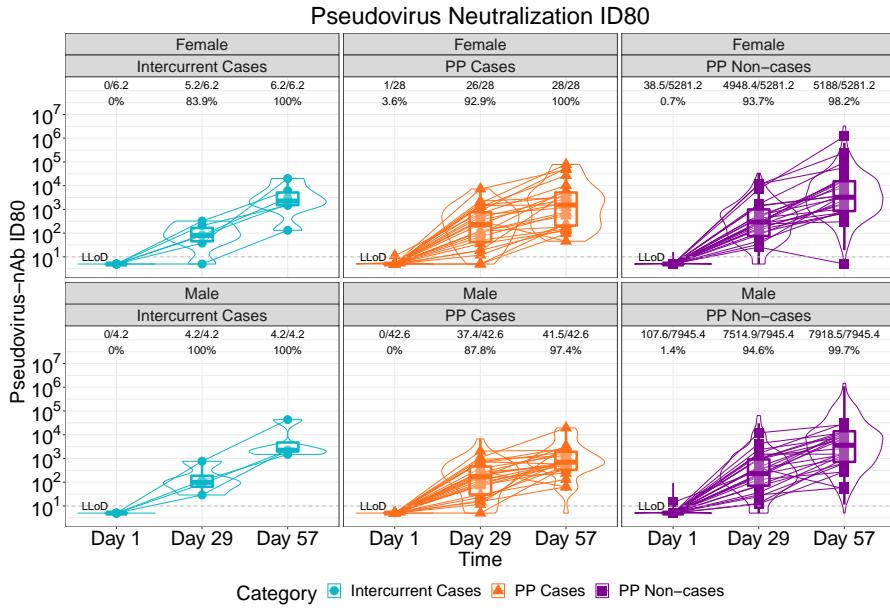


Figure 2.174: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by sex assigned at birth (3 timepoints)

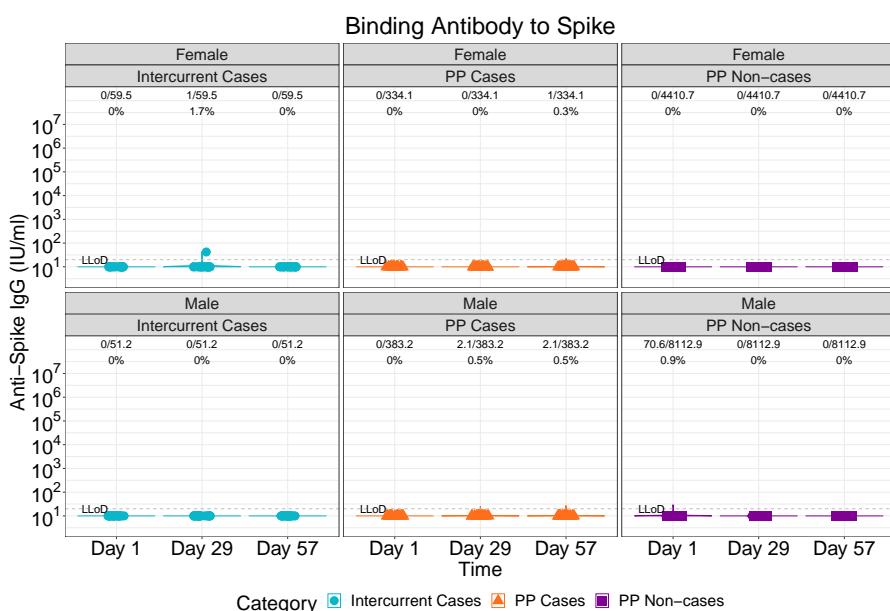


Figure 2.175: violinplots of Binding Antibody to Spike: baseline negative placebo arm by sex assigned at birth (3 timepoints)

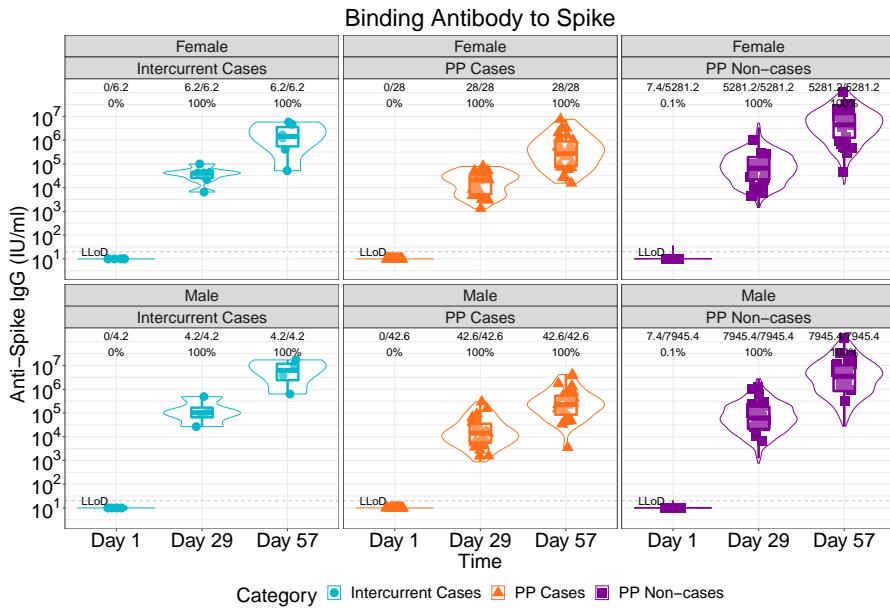


Figure 2.176: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by sex assigned at birth (3 timepoints)

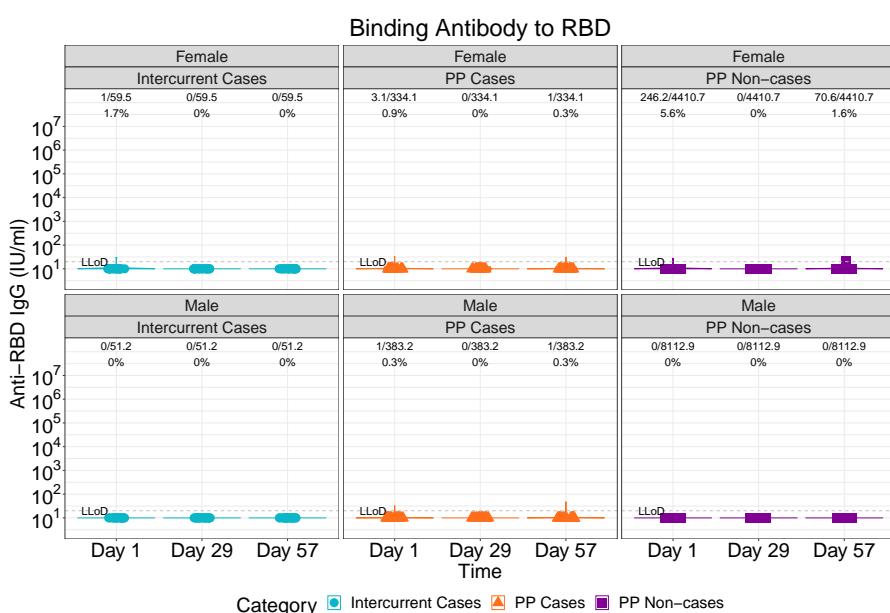


Figure 2.177: violinplots of Binding Antibody to RBD: baseline negative placebo arm by sex assigned at birth (3 timepoints)

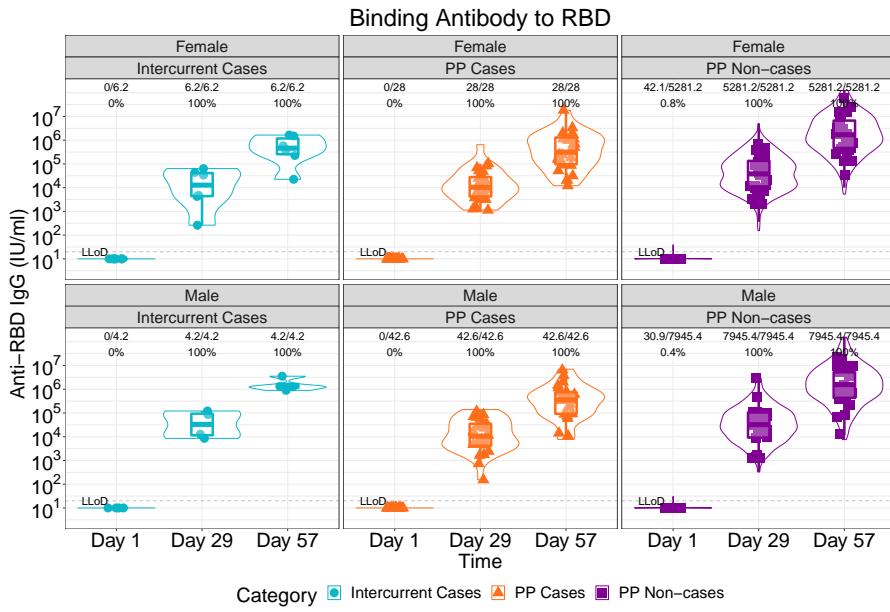


Figure 2.178: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by sex assigned at birth (3 timepoints)

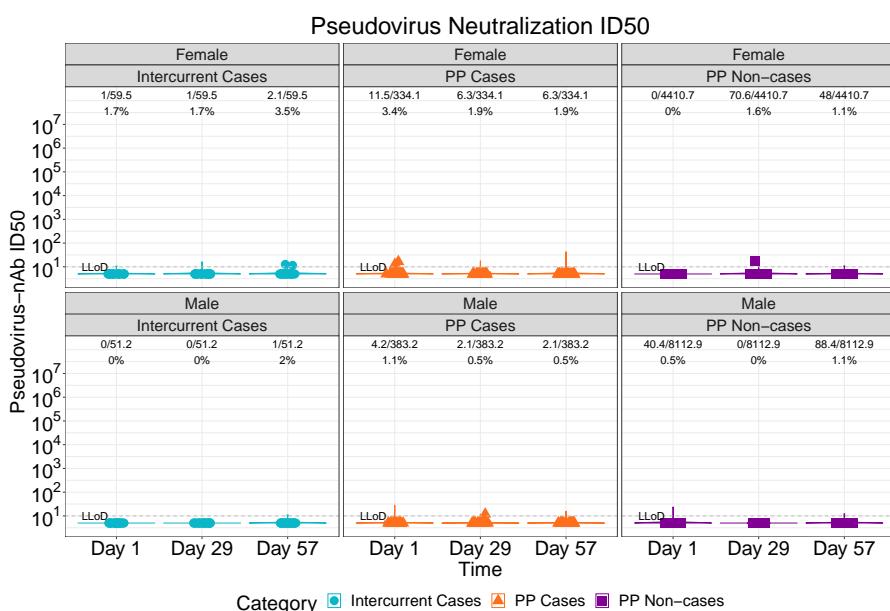


Figure 2.179: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by sex assigned at birth (3 timepoints)

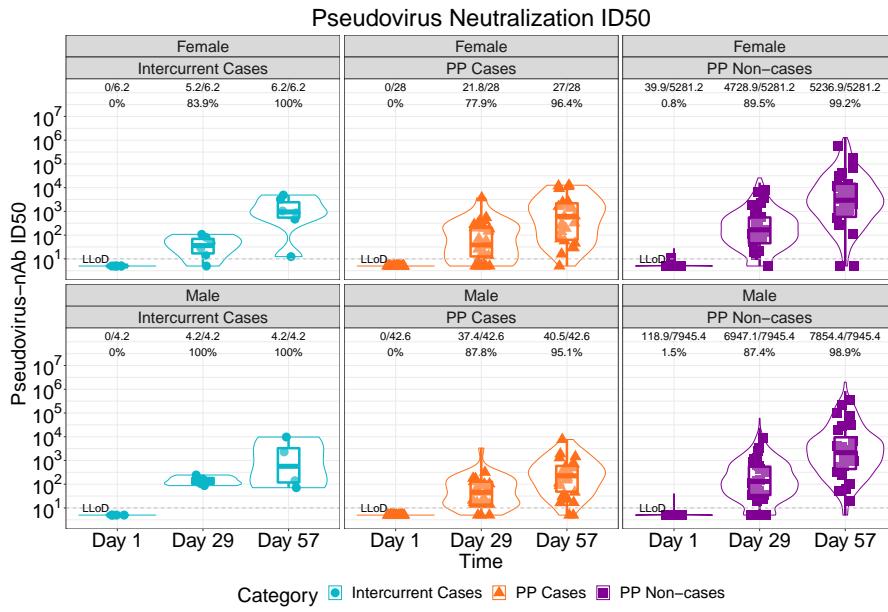


Figure 2.180: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by sex assigned at birth (3 timepoints)

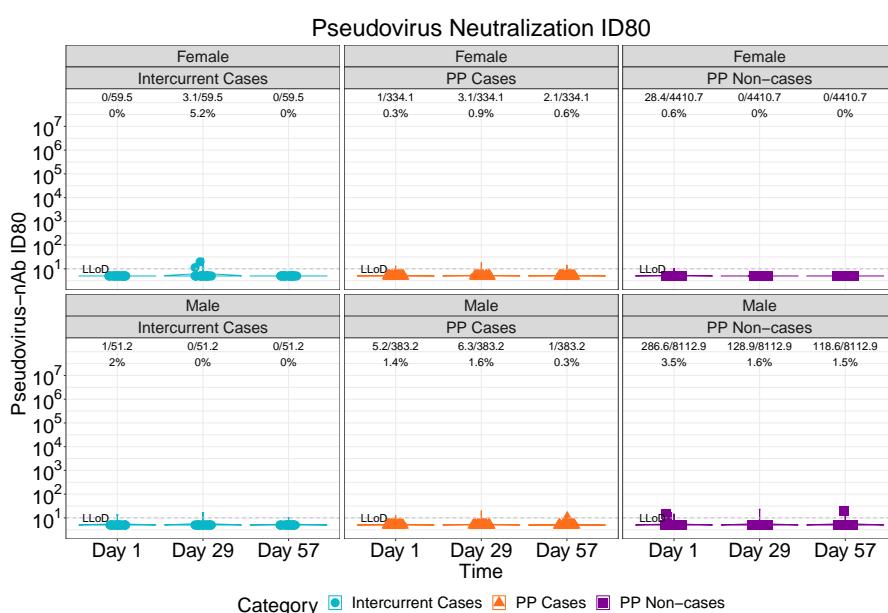


Figure 2.181: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by sex assigned at birth (3 timepoints)

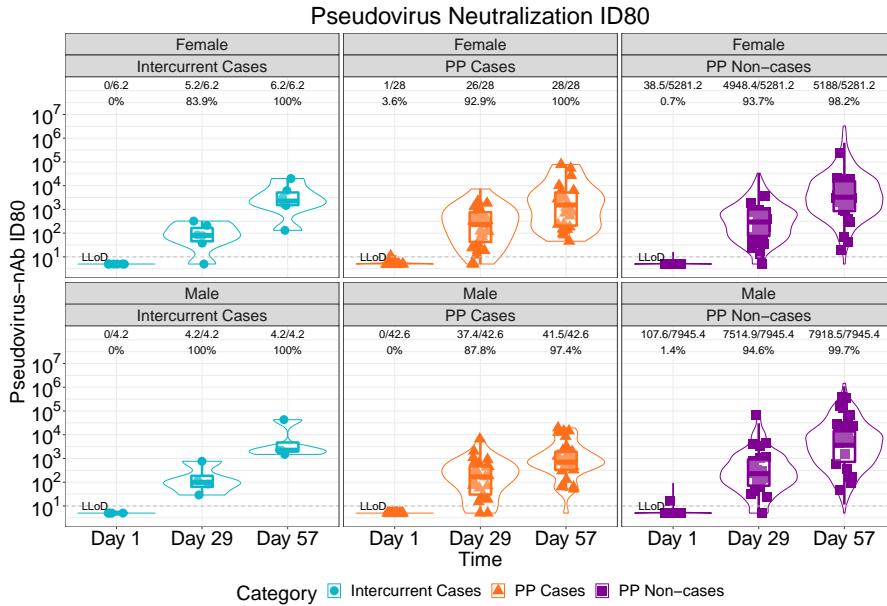


Figure 2.182: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by sex assigned at birth (3 timepoints)

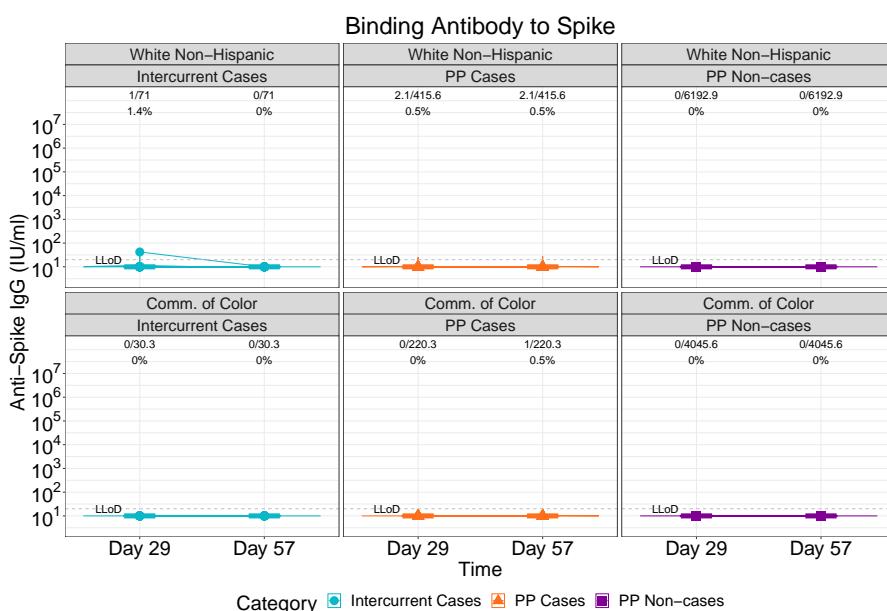


Figure 2.183: lineplots of Binding Antibody to Spike: baseline negative placebo arm by race and ethnic group (2 timepoints)

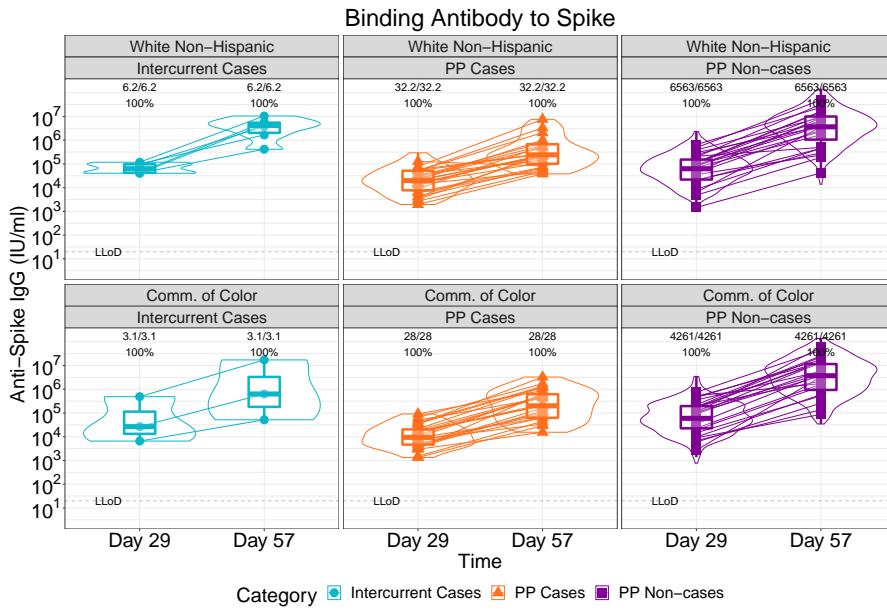


Figure 2.184: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by race and ethnic group (2 timepoints)

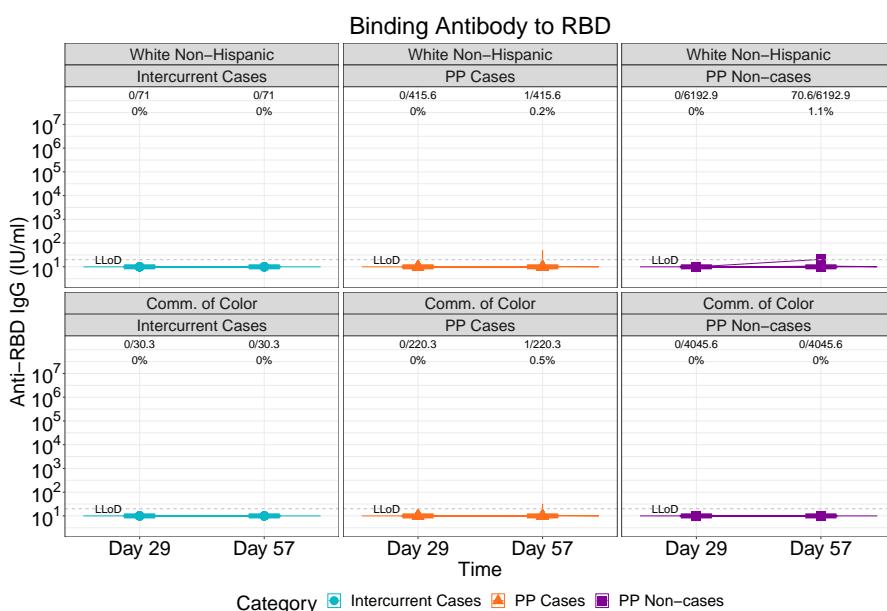


Figure 2.185: lineplots of Binding Antibody to RBD: baseline negative placebo arm by race and ethnic group (2 timepoints)

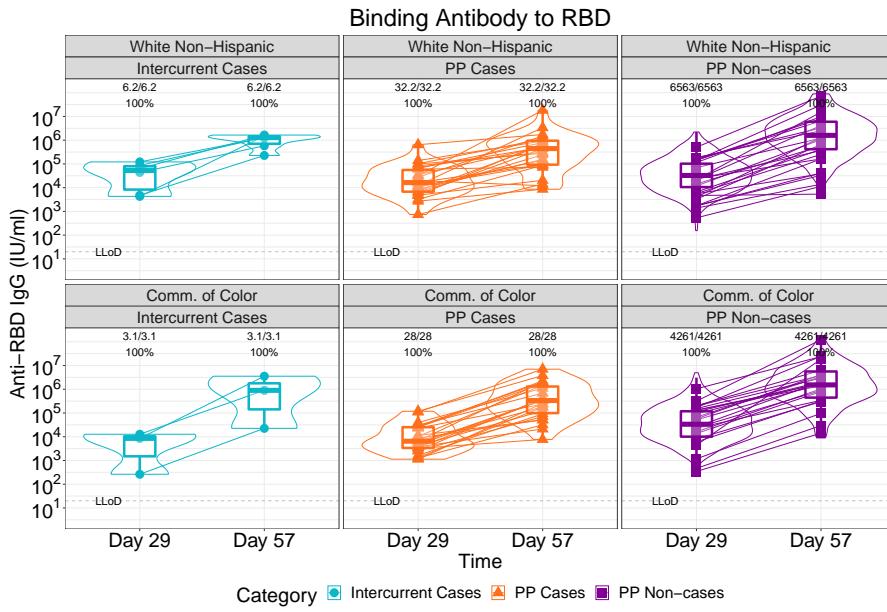


Figure 2.186: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by race and ethnic group (2 timepoints)

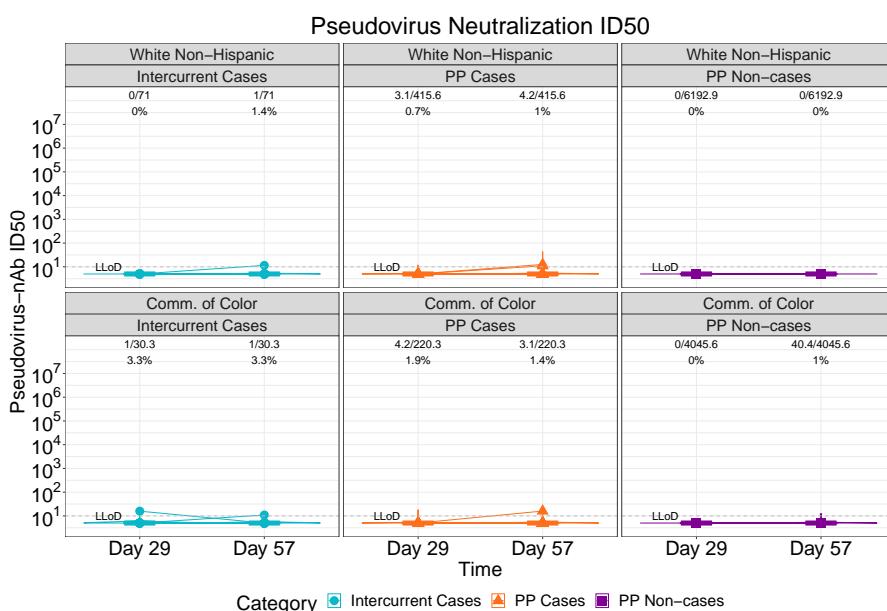


Figure 2.187: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by race and ethnic group (2 timepoints)

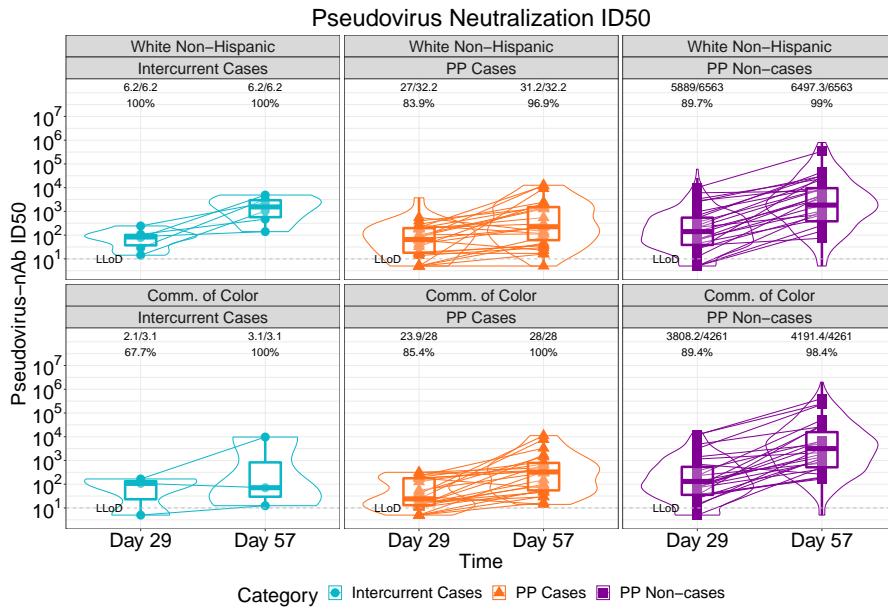


Figure 2.188: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by race and ethnic group (2 timepoints)

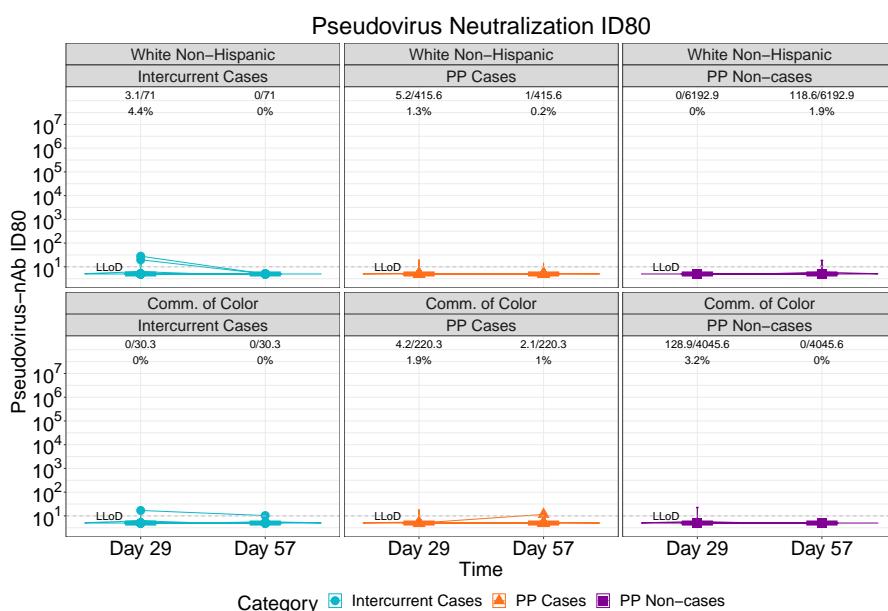


Figure 2.189: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by race and ethnic group (2 timepoints)

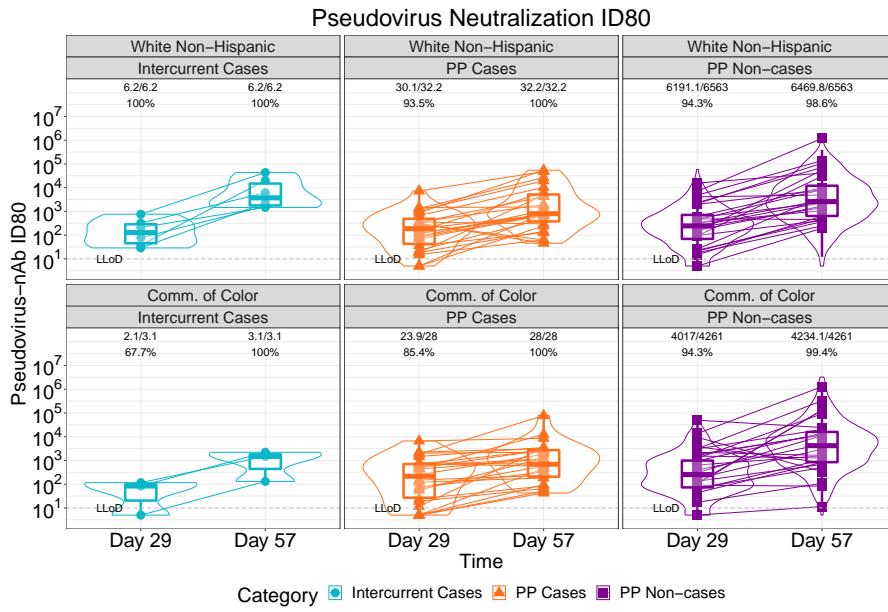


Figure 2.190: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by race and ethnic group (2 timepoints)

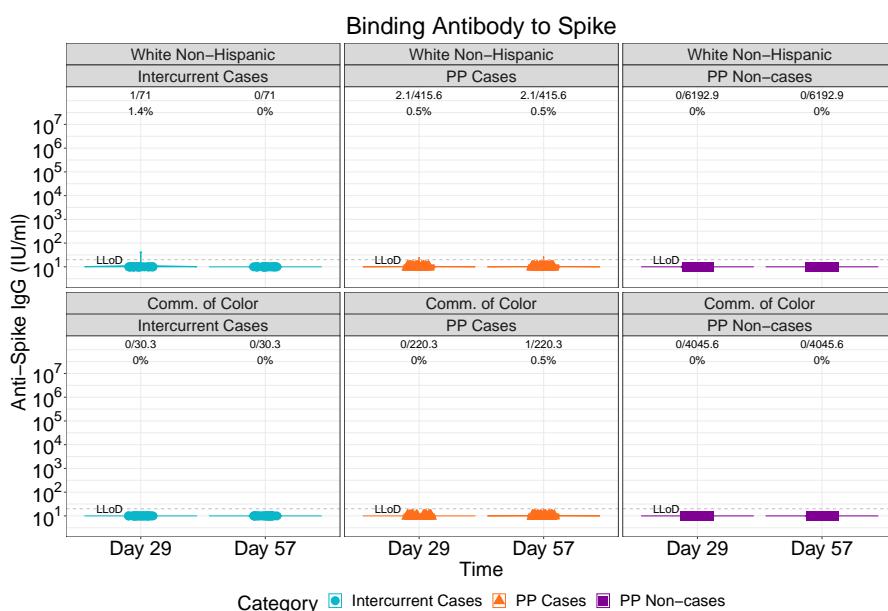


Figure 2.191: violinplots of Binding Antibody to Spike: baseline negative placebo arm by race and ethnic group (2 timepoints)

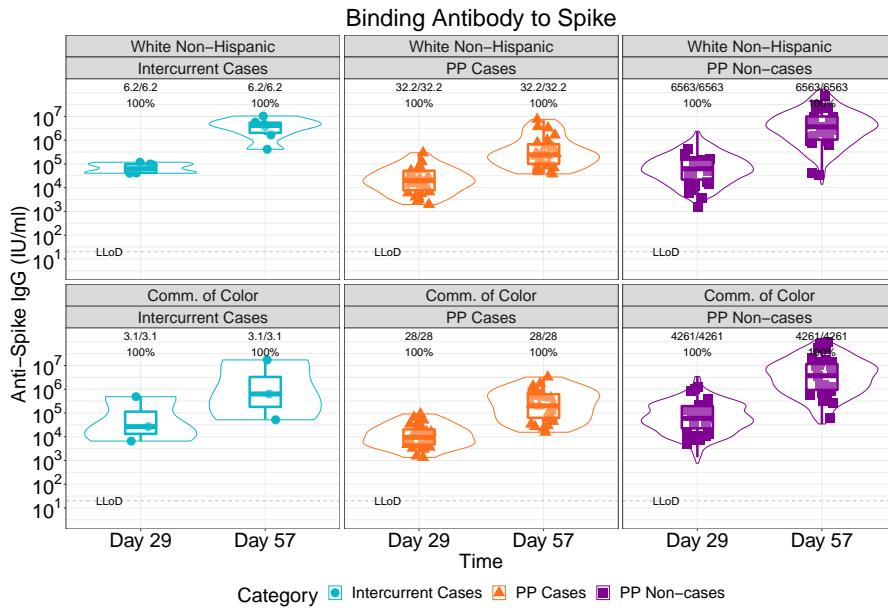


Figure 2.192: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by race and ethnic group (2 timepoints)

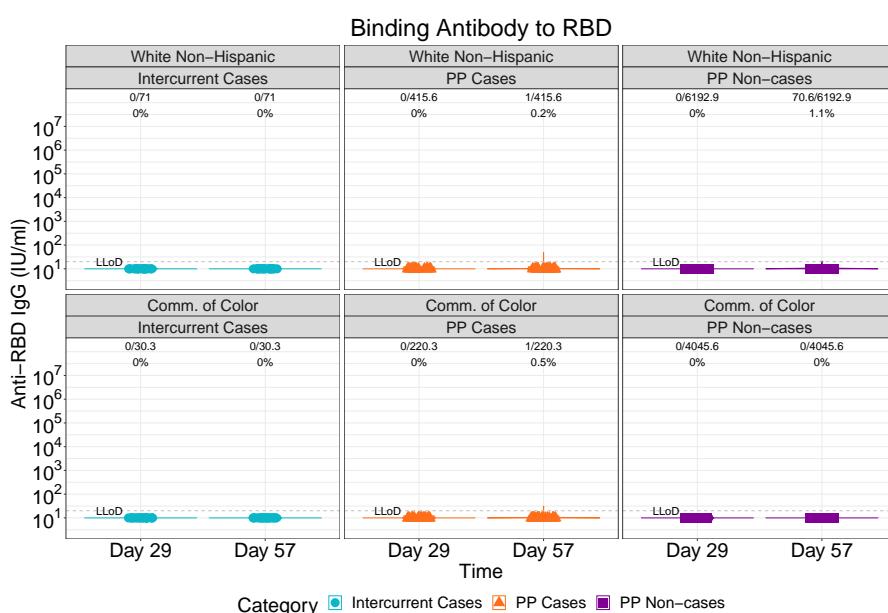


Figure 2.193: violinplots of Binding Antibody to RBD: baseline negative placebo arm by race and ethnic group (2 timepoints)

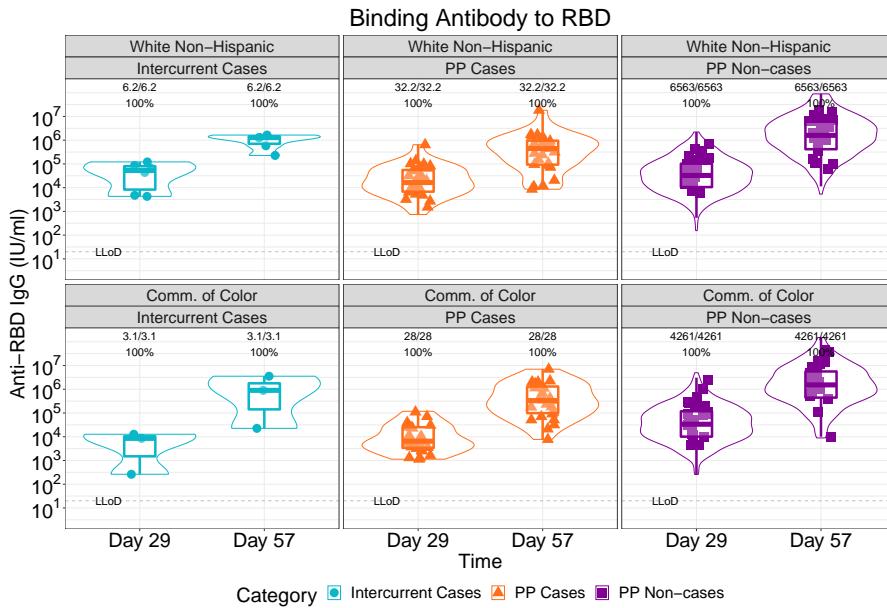


Figure 2.194: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by race and ethnic group (2 timepoints)

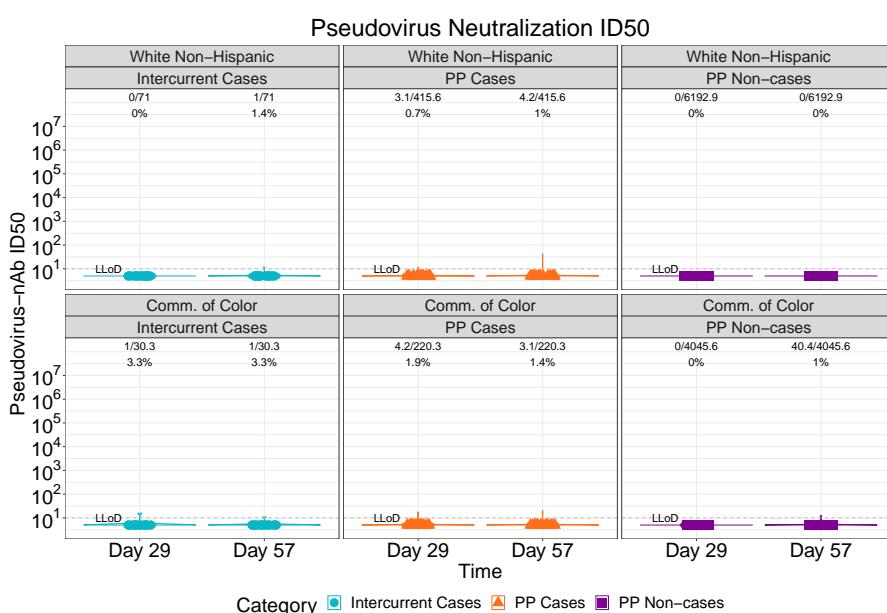


Figure 2.195: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by race and ethnic group (2 timepoints)

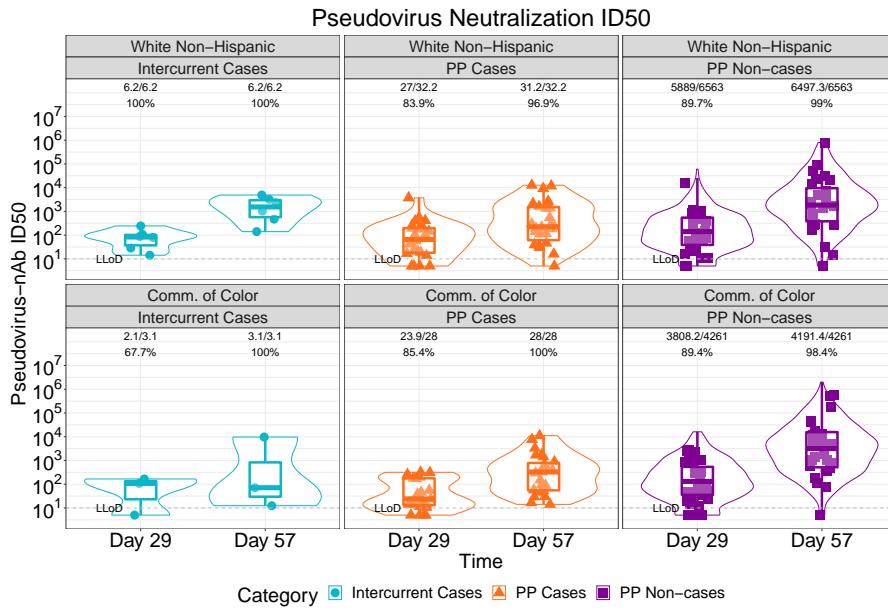


Figure 2.196: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by race and ethnic group (2 timepoints)

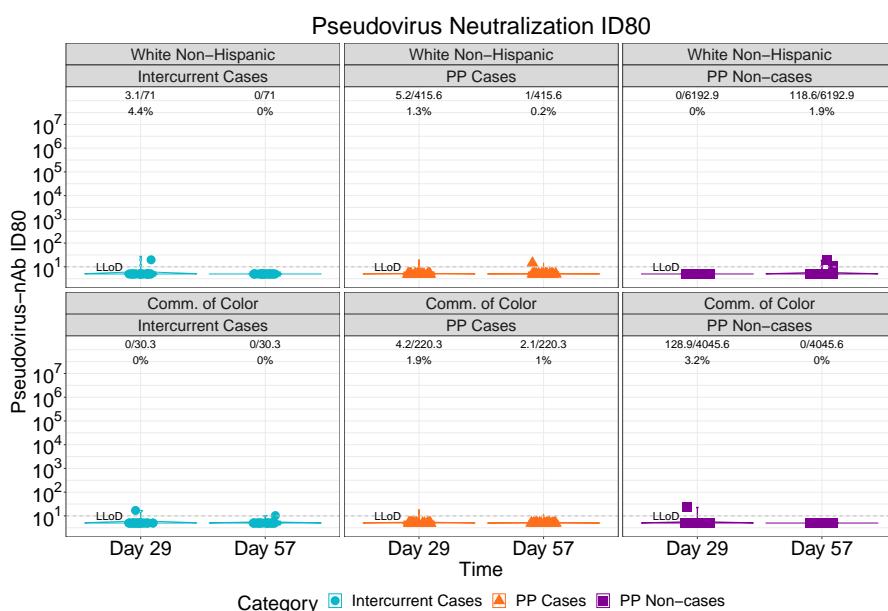


Figure 2.197: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by race and ethnic group (2 timepoints)

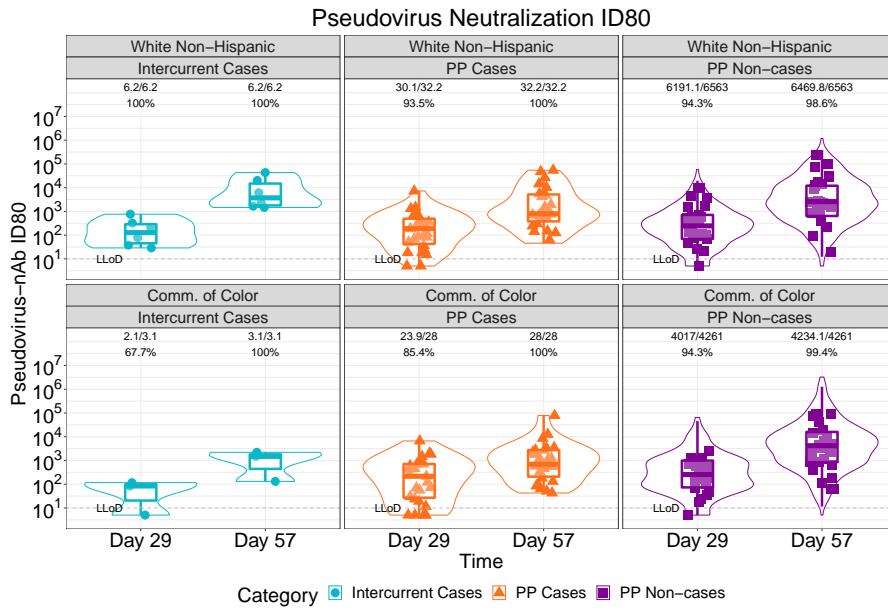


Figure 2.198: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by race and ethnic group (2 timepoints)

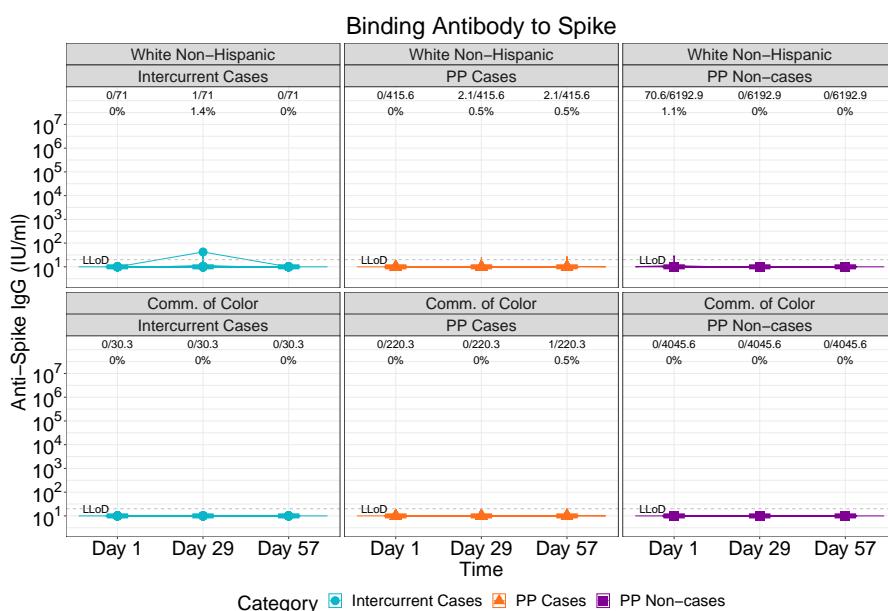


Figure 2.199: lineplots of Binding Antibody to Spike: baseline negative placebo arm by race and ethnic group (3 timepoints)

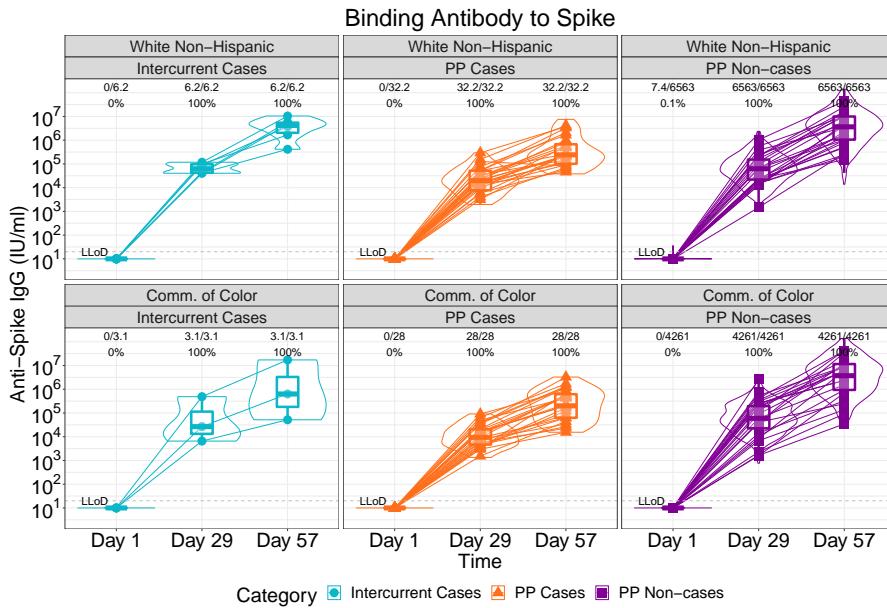


Figure 2.200: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by race and ethnic group (3 timepoints)

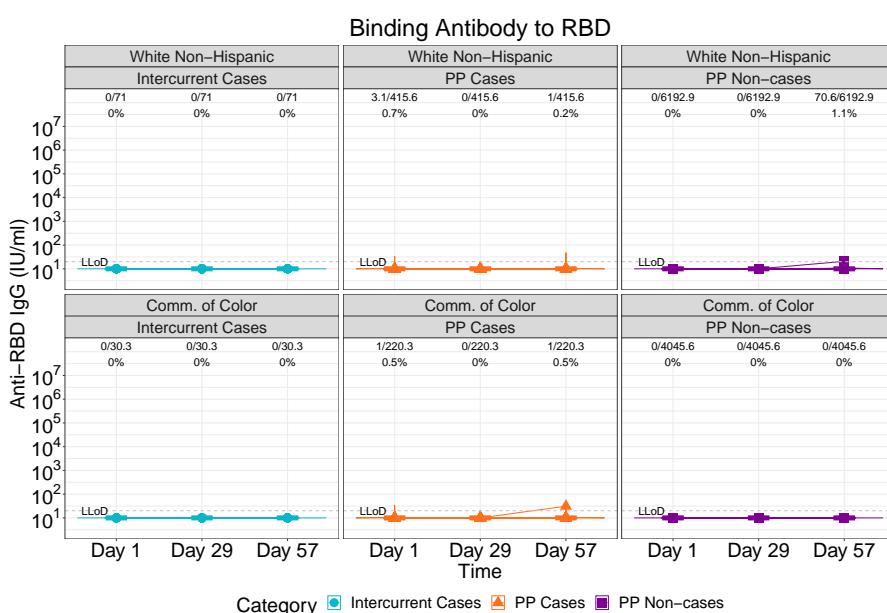


Figure 2.201: lineplots of Binding Antibody to RBD: baseline negative placebo arm by race and ethnic group (3 timepoints)

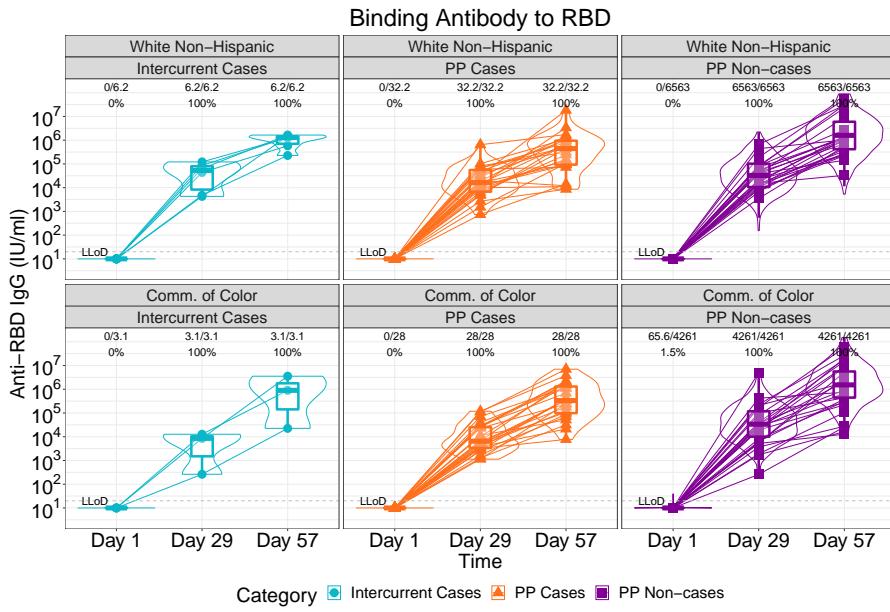


Figure 2.202: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by race and ethnic group (3 timepoints)

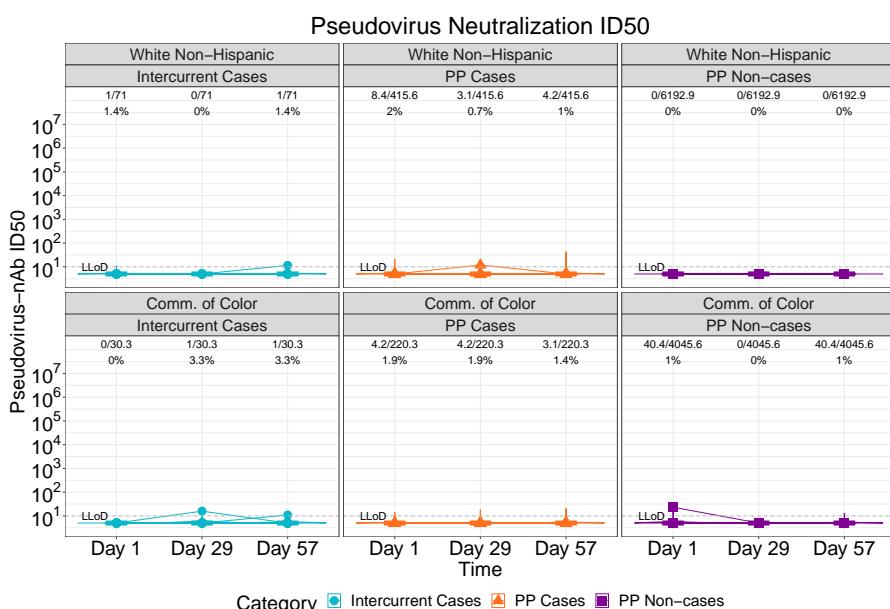


Figure 2.203: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by race and ethnic group (3 timepoints)

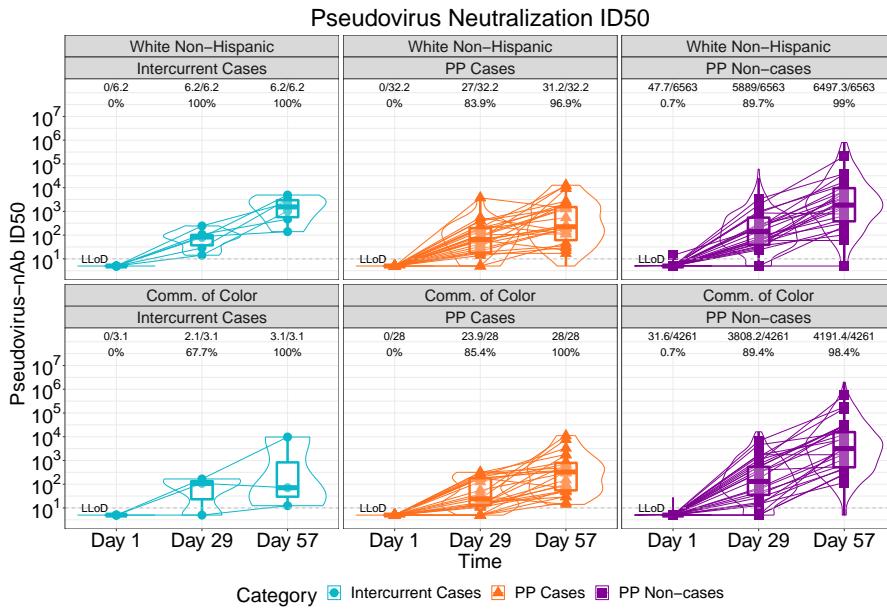


Figure 2.204: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by race and ethnic group (3 timepoints)

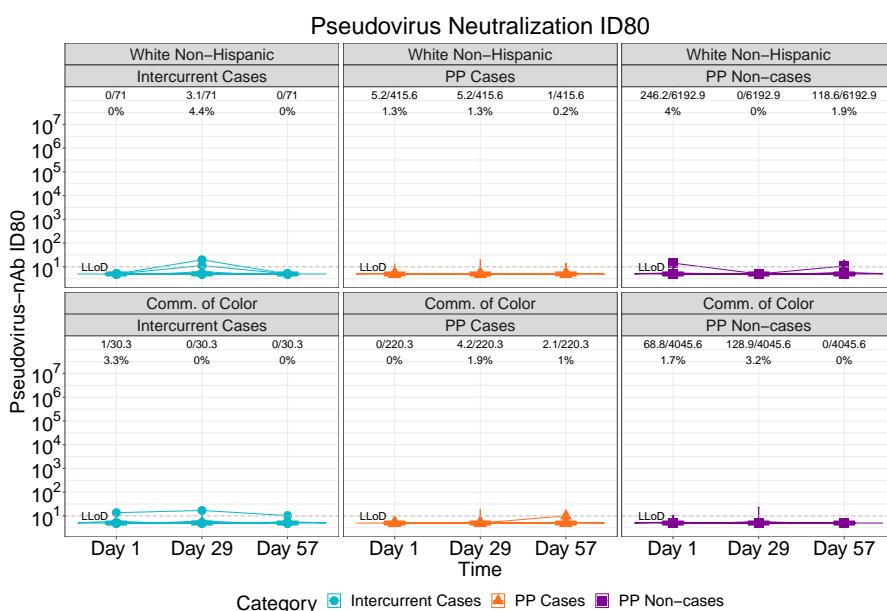


Figure 2.205: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by race and ethnic group (3 timepoints)

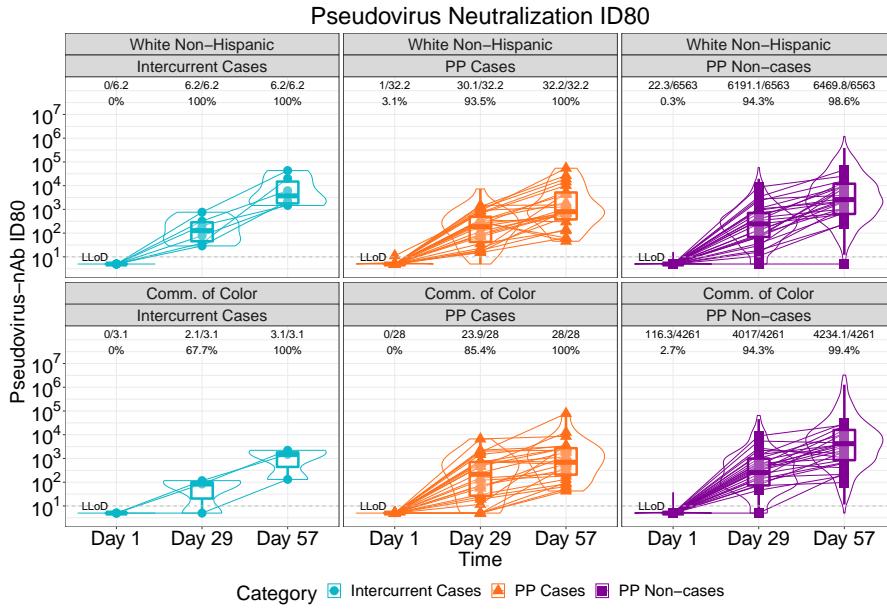


Figure 2.206: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by race and ethnic group (3 timepoints)

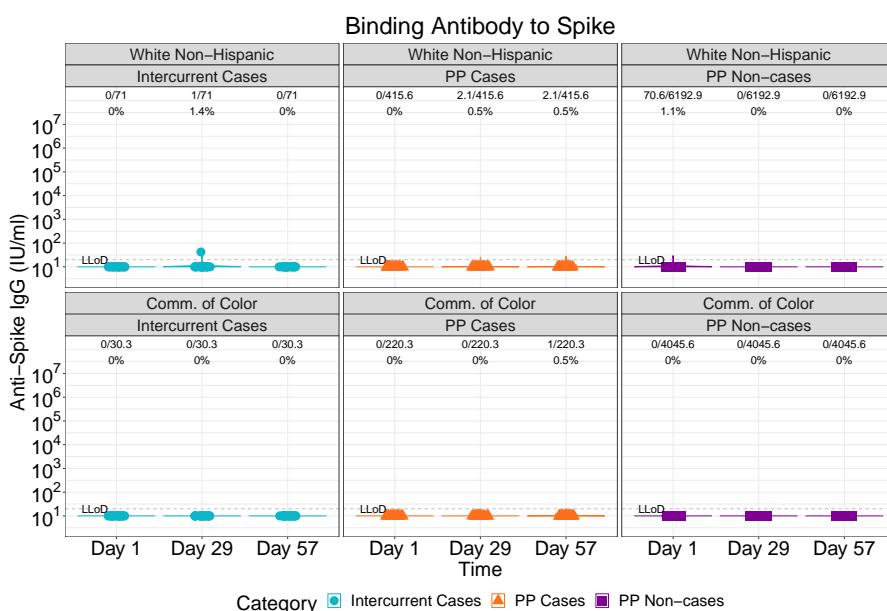


Figure 2.207: violinplots of Binding Antibody to Spike: baseline negative placebo arm by race and ethnic group (3 timepoints)

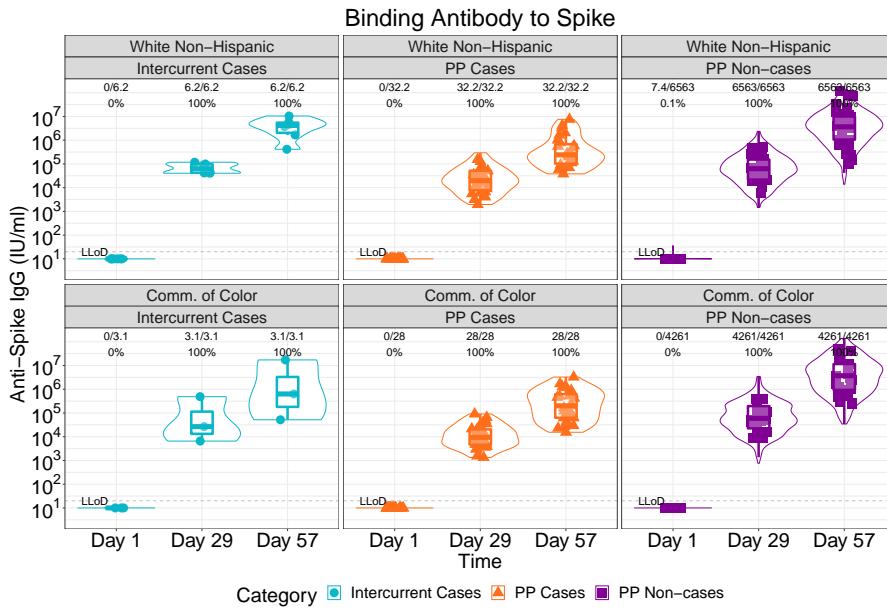


Figure 2.208: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by race and ethnic group (3 timepoints)

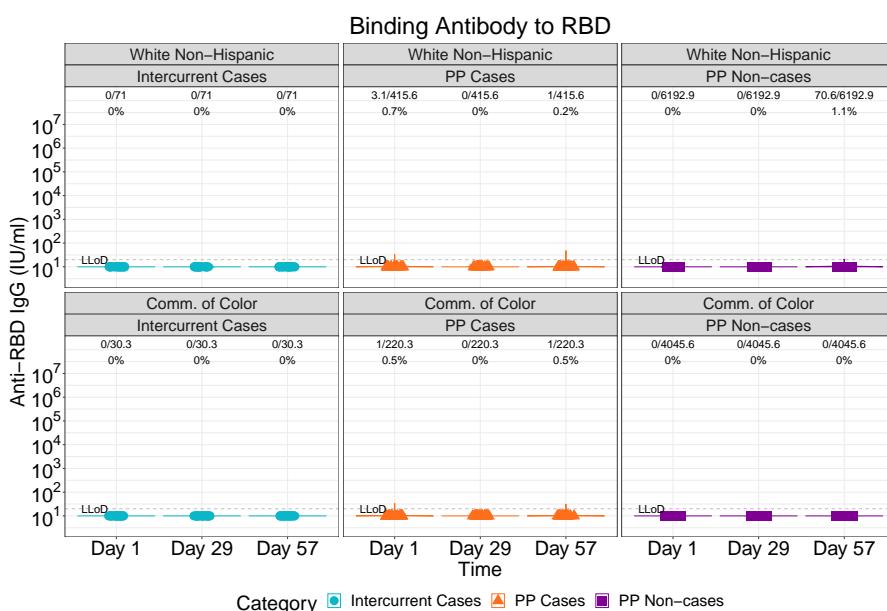


Figure 2.209: violinplots of Binding Antibody to RBD: baseline negative placebo arm by race and ethnic group (3 timepoints)

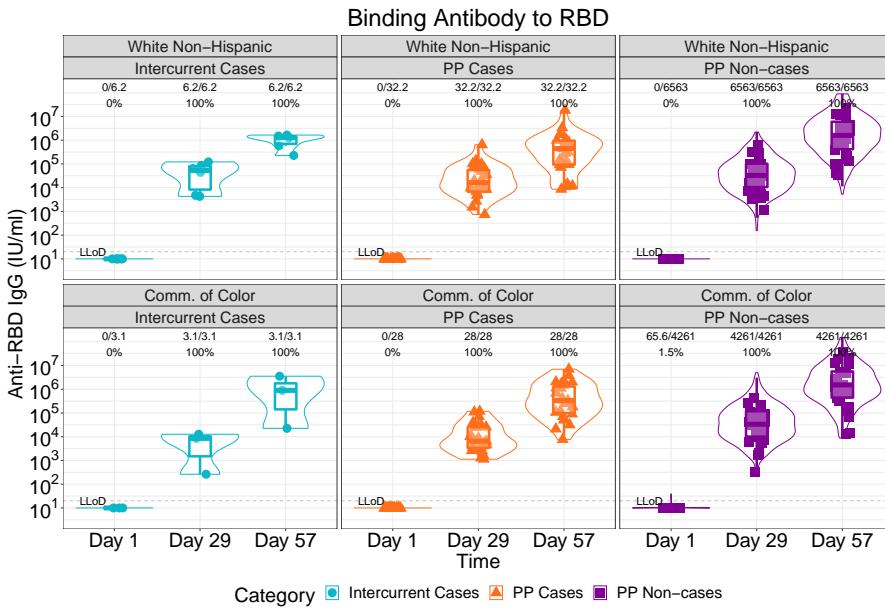


Figure 2.210: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by race and ethnic group (3 timepoints)

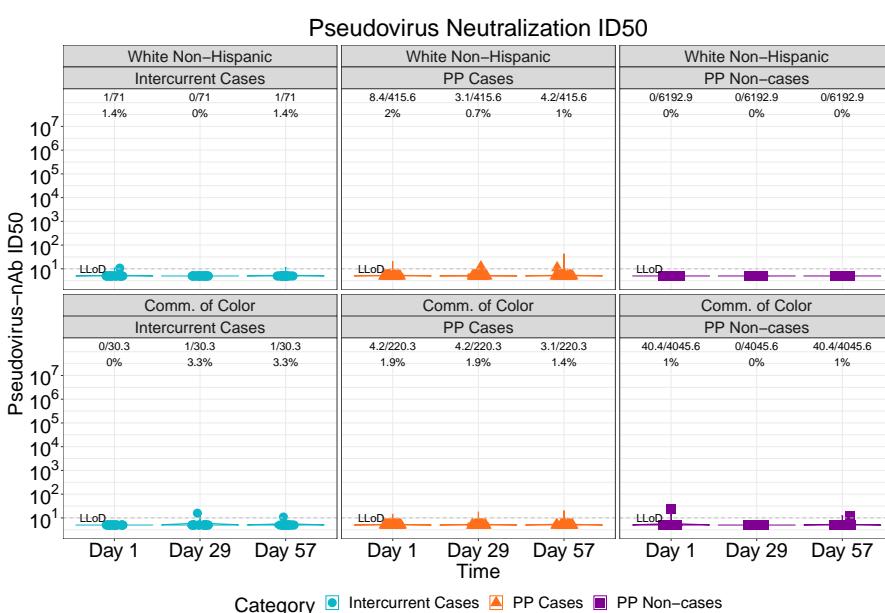


Figure 2.211: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by race and ethnic group (3 timepoints)

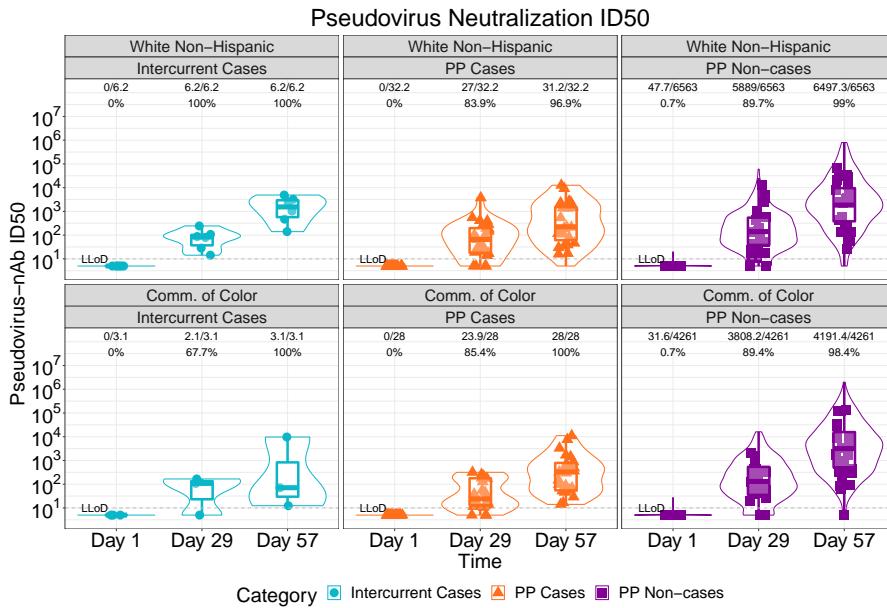


Figure 2.212: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by race and ethnic group (3 timepoints)

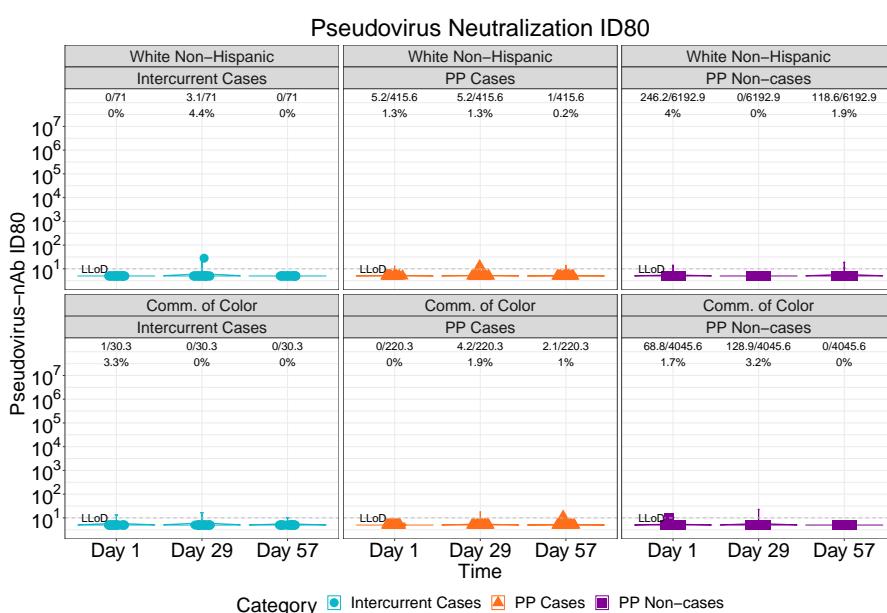


Figure 2.213: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by race and ethnic group (3 timepoints)

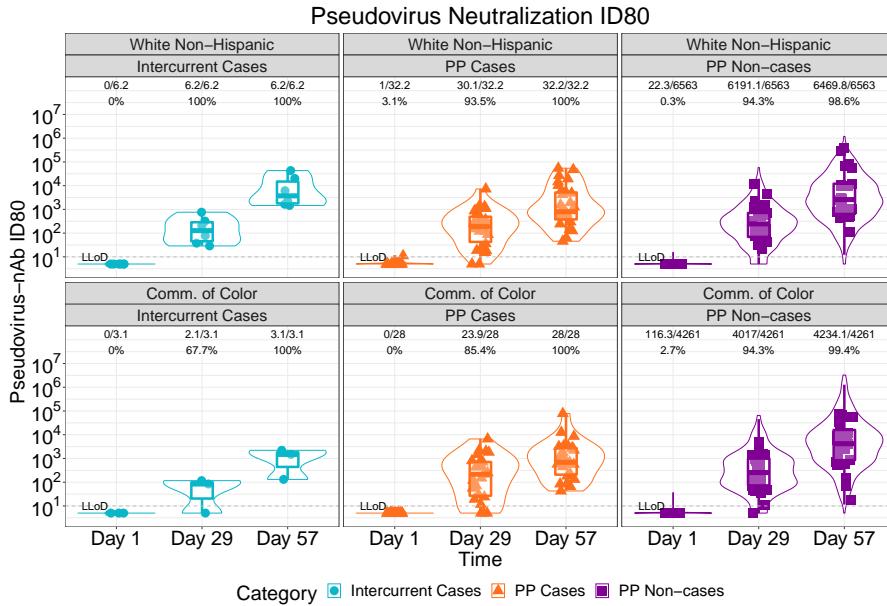


Figure 2.214: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by race and ethnic group (3 timepoints)

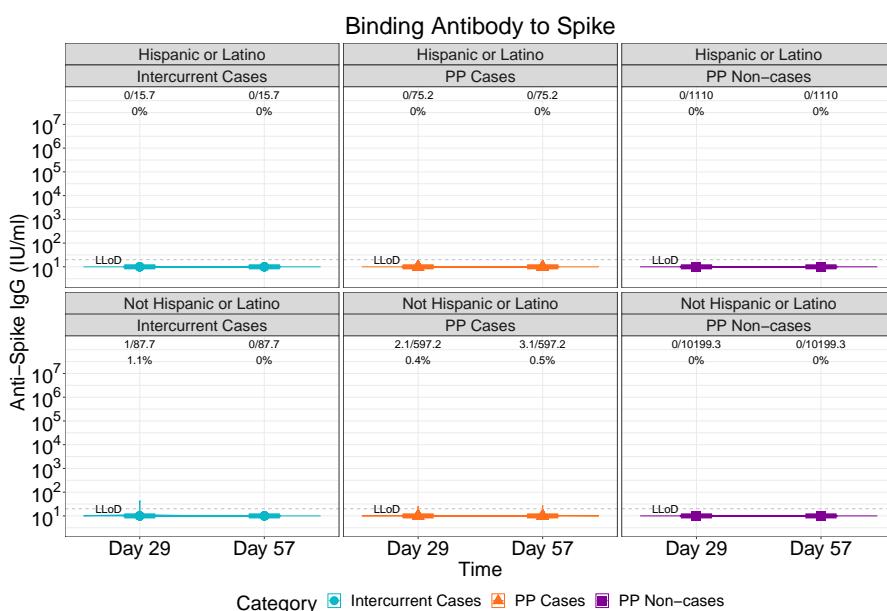


Figure 2.215: lineplots of Binding Antibody to Spike: baseline negative placebo arm by dichotomous classification of race and ethnic group (2 timepoints)

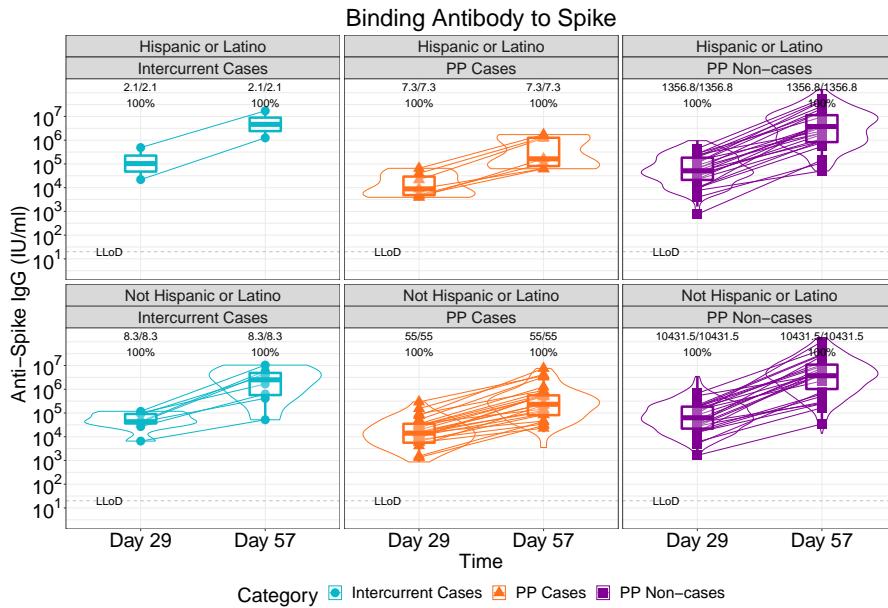


Figure 2.216: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by dichotomous classification of race and ethnic group (2 timepoints)

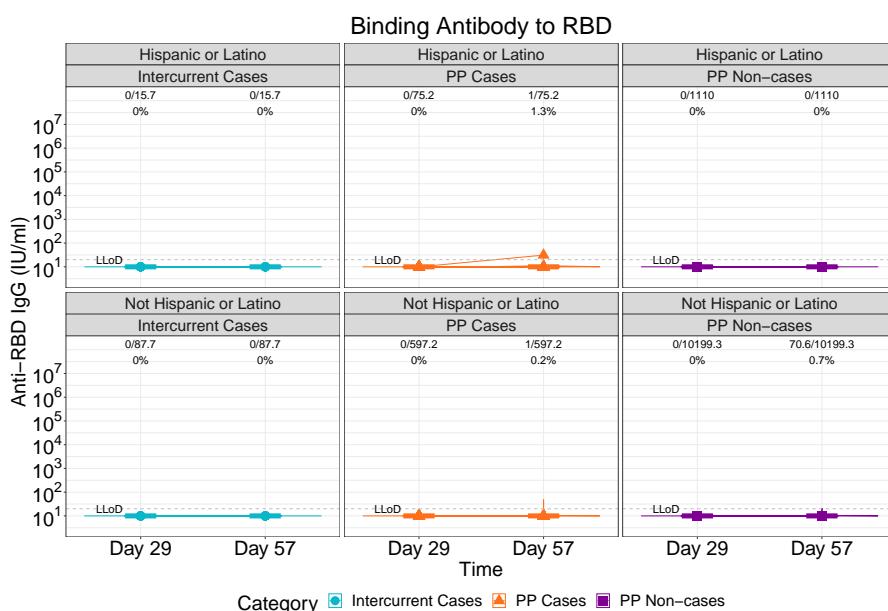


Figure 2.217: lineplots of Binding Antibody to RBD: baseline negative placebo arm by dichotomous classification of race and ethnic group (2 timepoints)

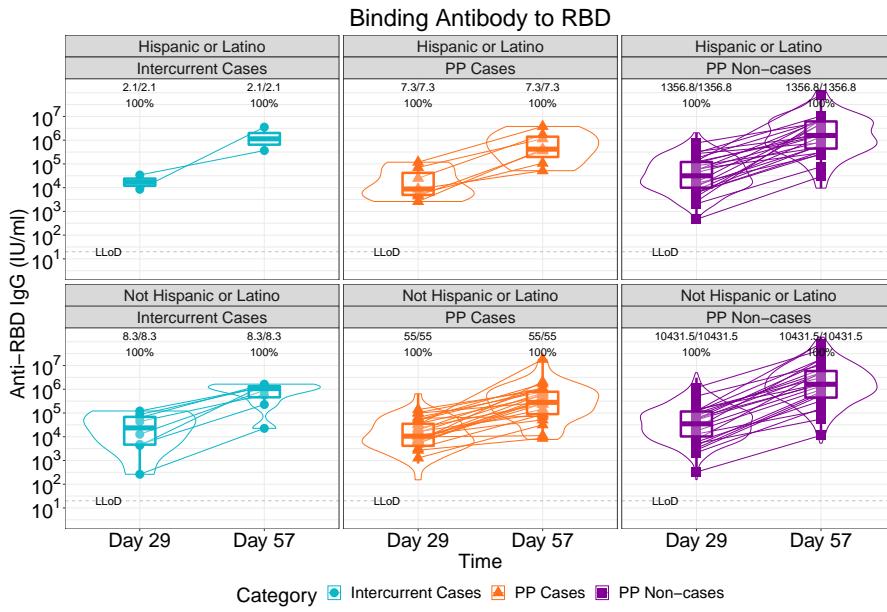


Figure 2.218: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by dichotomous classification of race and ethnic group (2 timepoints)

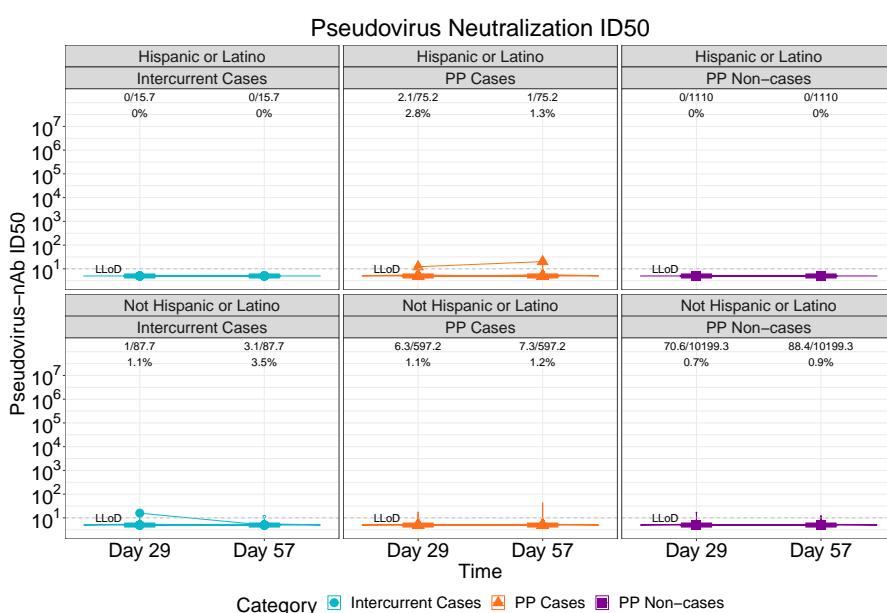


Figure 2.219: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by dichotomous classification of race and ethnic group (2 timepoints)

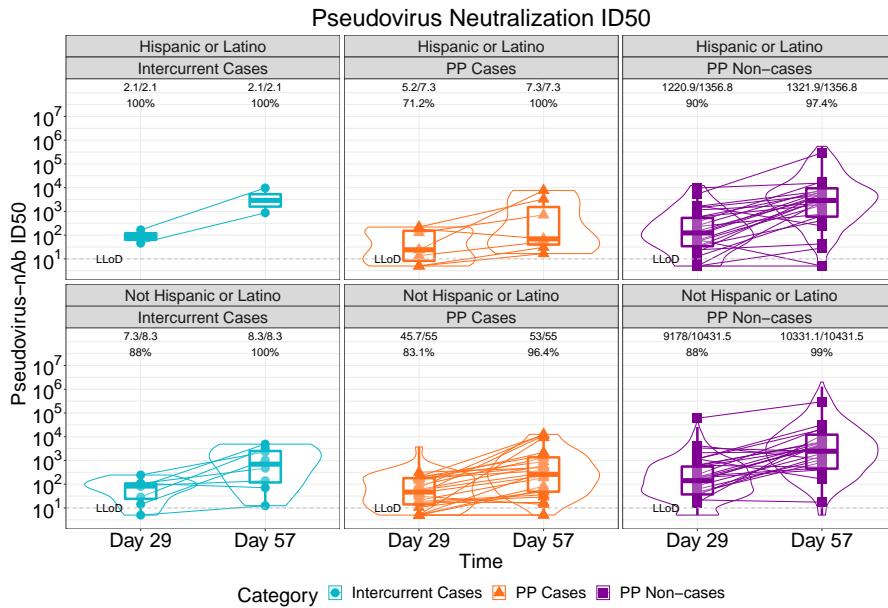


Figure 2.220: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by dichotomous classification of race and ethnic group (2 timepoints)

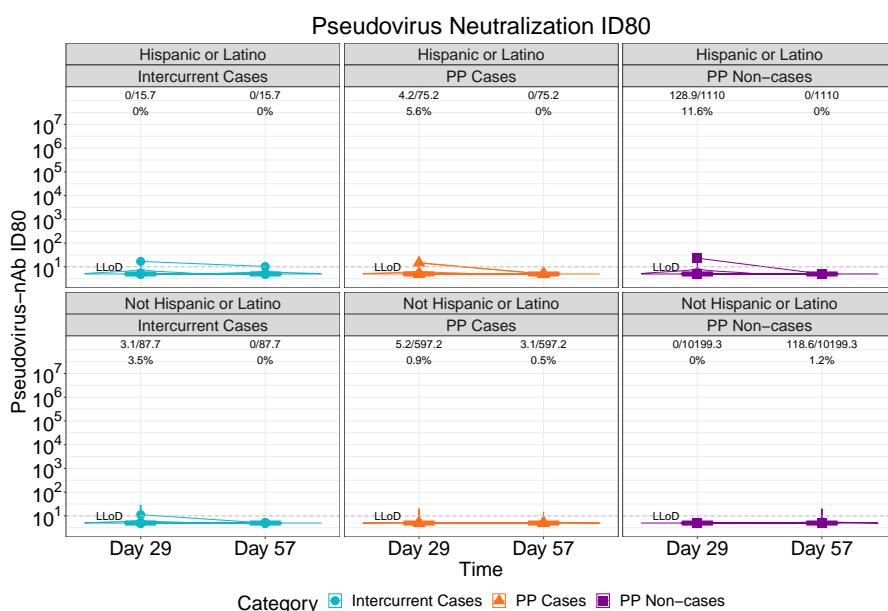


Figure 2.221: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by dichotomous classification of race and ethnic group (2 timepoints)

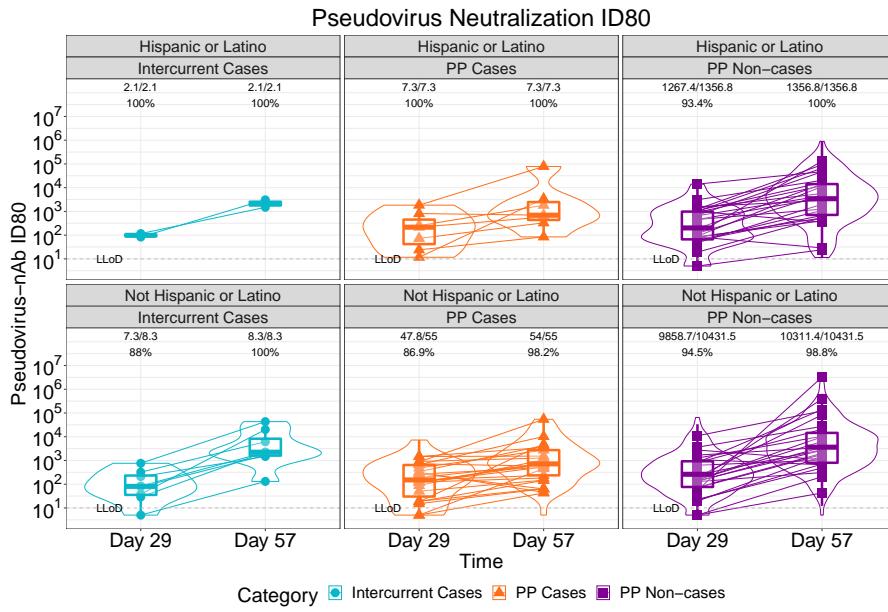


Figure 2.222: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by dichotomous classification of race and ethnic group (2 timepoints)

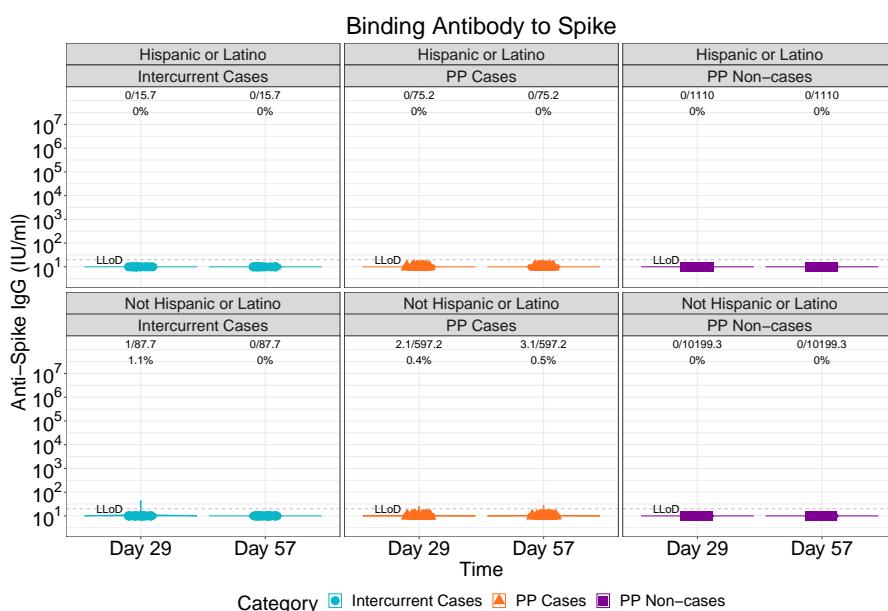


Figure 2.223: violinplots of Binding Antibody to Spike: baseline negative placebo arm by dichotomous classification of race and ethnic group (2 timepoints)

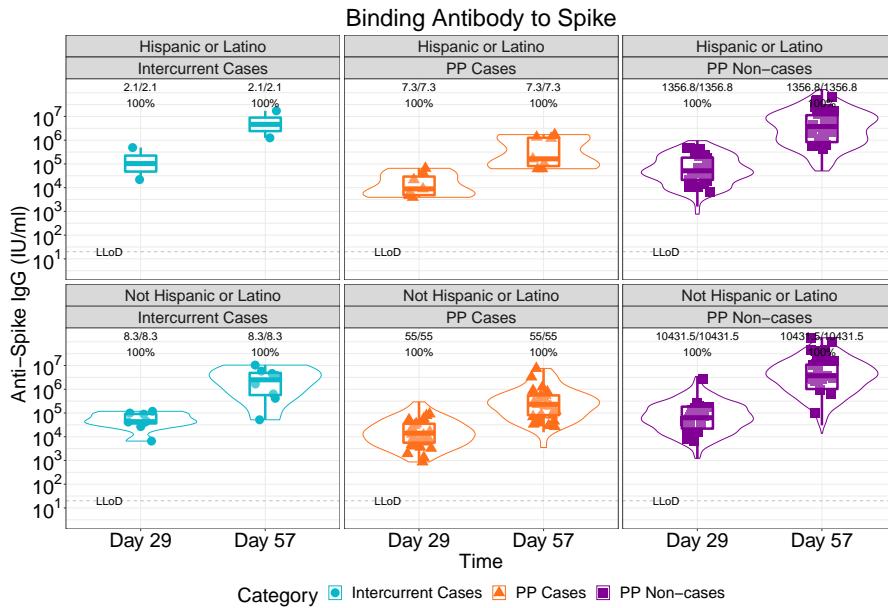


Figure 2.224: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by dichotomous classification of race and ethnic group (2 timepoints)

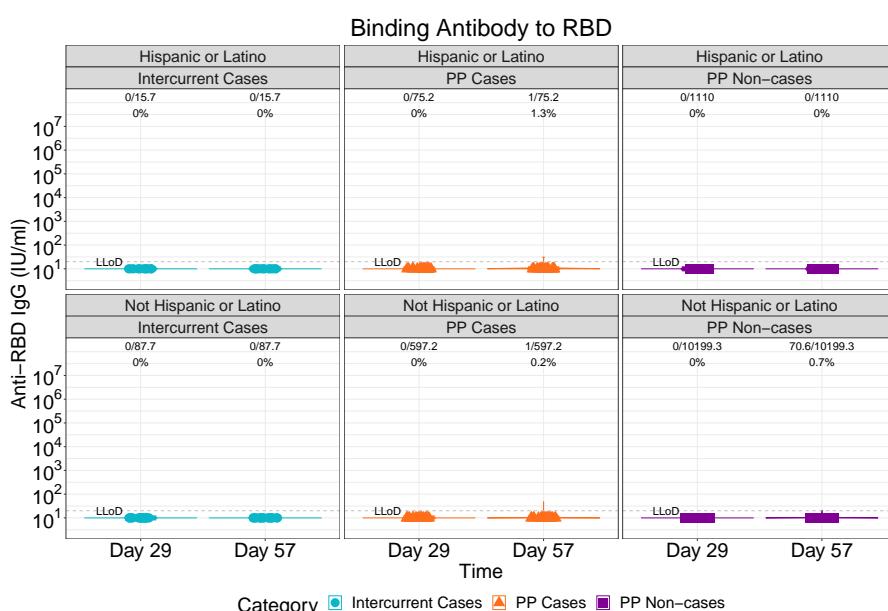


Figure 2.225: violinplots of Binding Antibody to RBD: baseline negative placebo arm by dichotomous classification of race and ethnic group (2 timepoints)

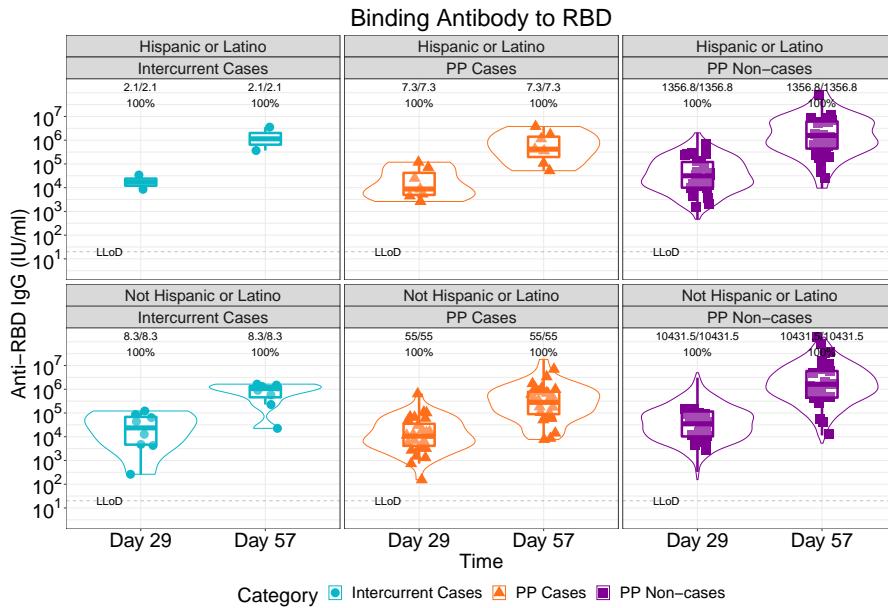


Figure 2.226: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by dichotomous classification of race and ethnic group (2 timepoints)

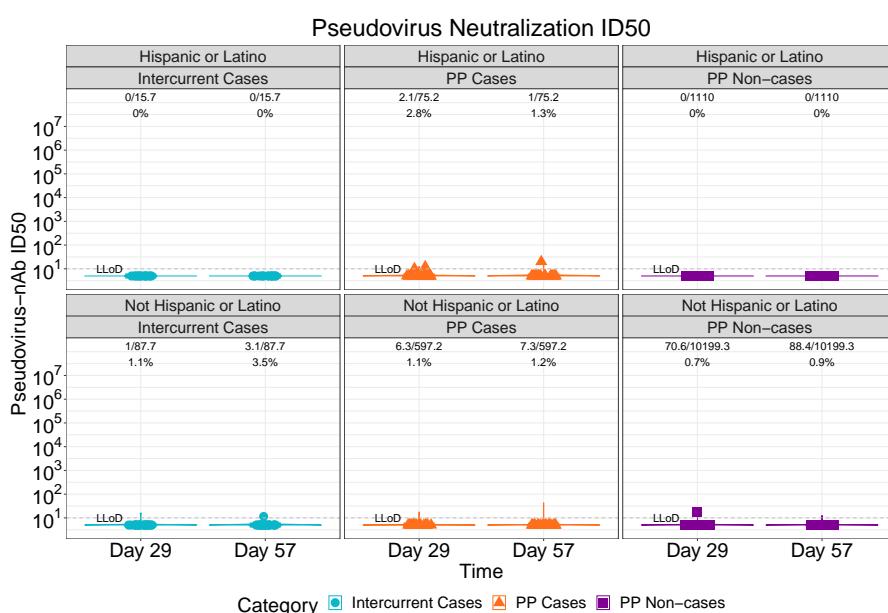


Figure 2.227: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by dichotomous classification of race and ethnic group (2 timepoints)

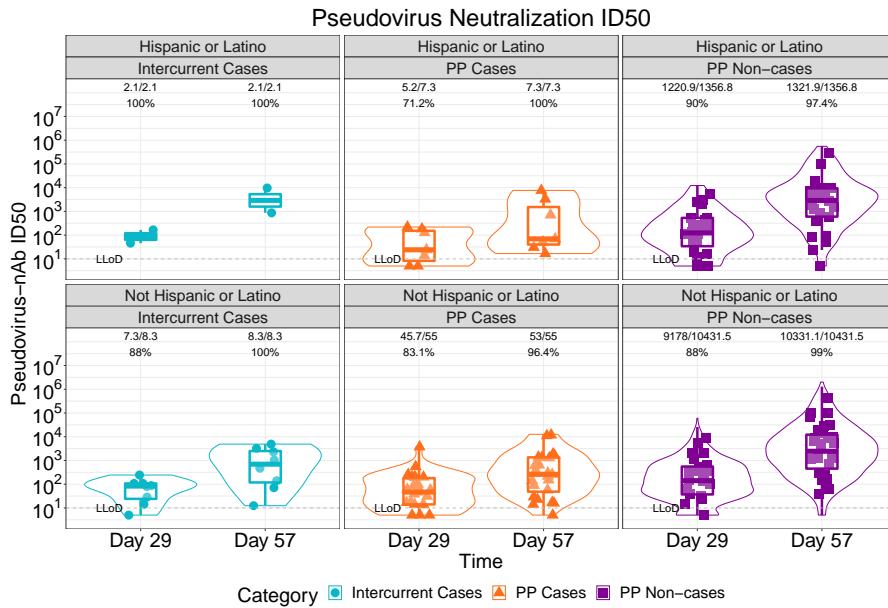


Figure 2.228: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by dichotomous classification of race and ethnic group (2 timepoints)

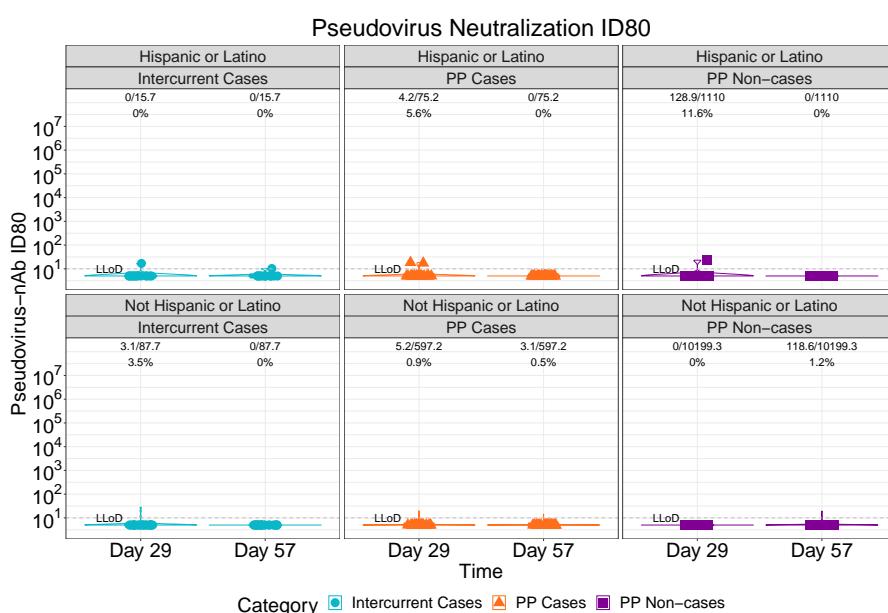


Figure 2.229: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by dichotomous classification of race and ethnic group (2 timepoints)

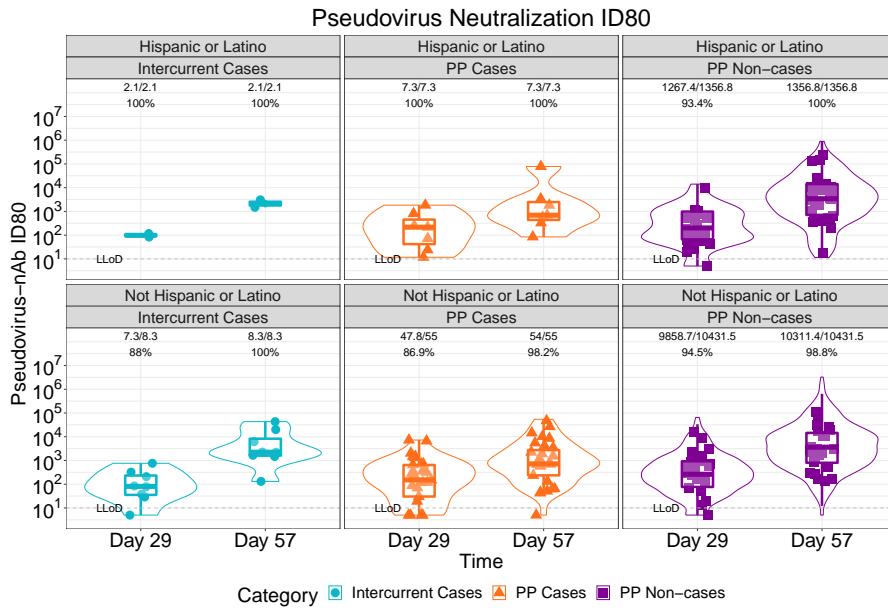


Figure 2.230: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by dichotomous classification of race and ethnic group (2 timepoints)



Figure 2.231: lineplots of Binding Antibody to Spike: baseline negative placebo arm by dichotomous classification of race and ethnic group (3 timepoints)

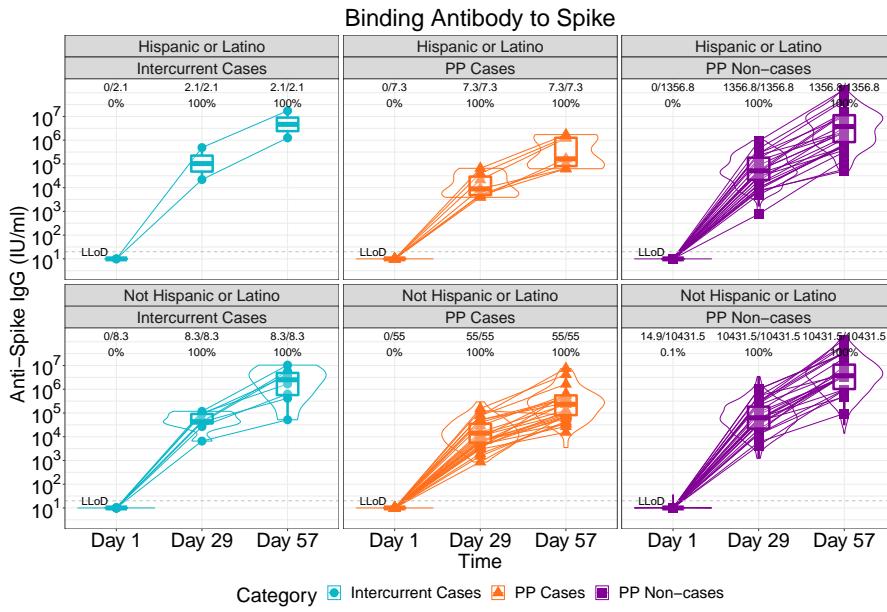


Figure 2.232: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by dichotomous classification of race and ethnic group (3 timepoints)

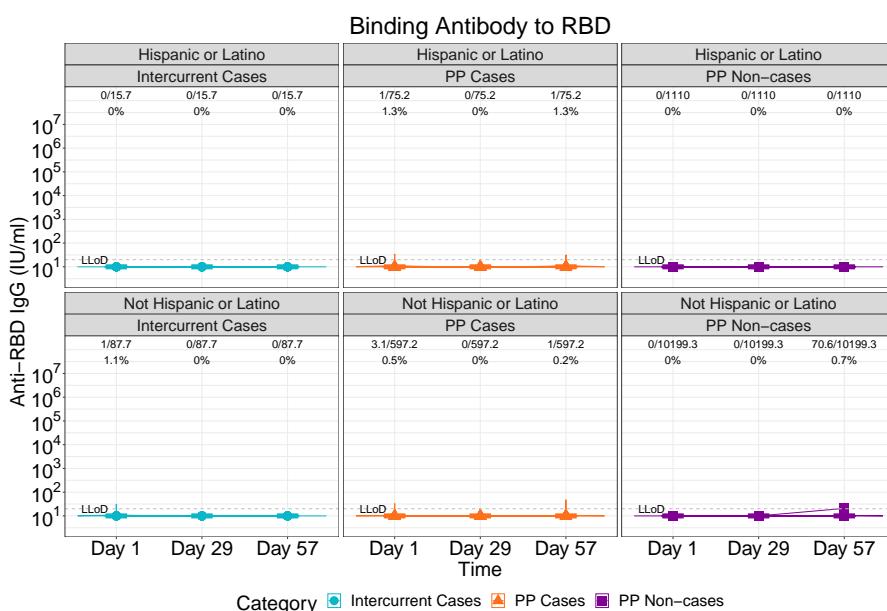


Figure 2.233: lineplots of Binding Antibody to RBD: baseline negative placebo arm by dichotomous classification of race and ethnic group (3 timepoints)

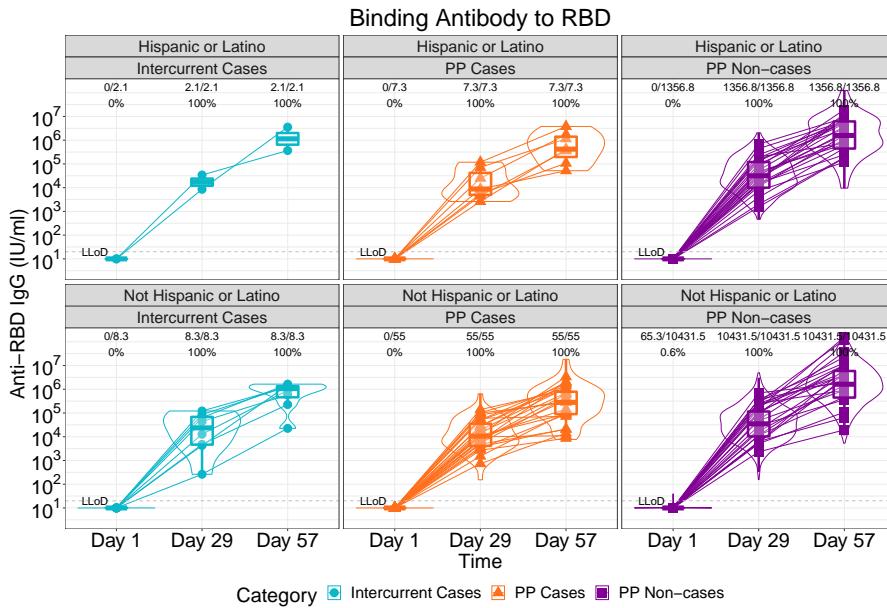


Figure 2.234: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by dichotomous classification of race and ethnic group (3 timepoints)

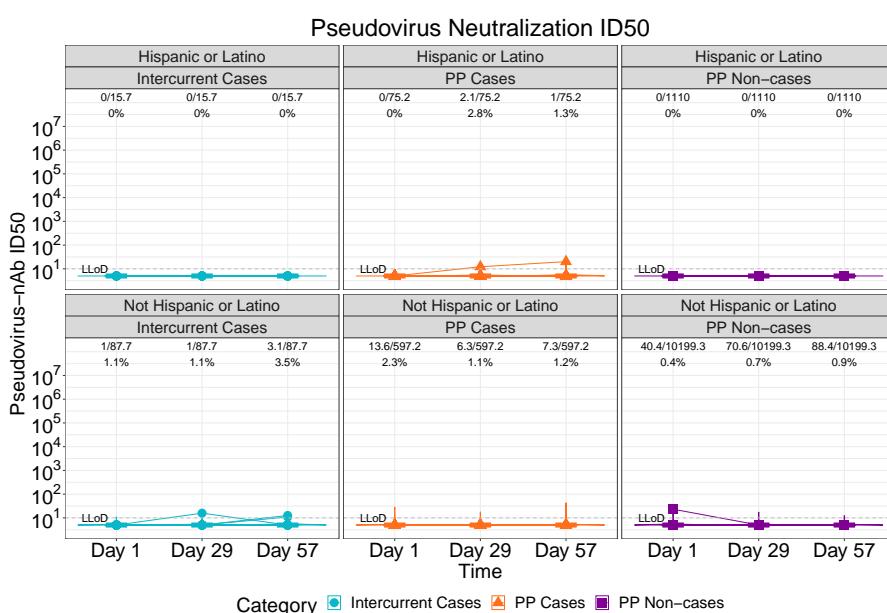


Figure 2.235: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by dichotomous classification of race and ethnic group (3 timepoints)

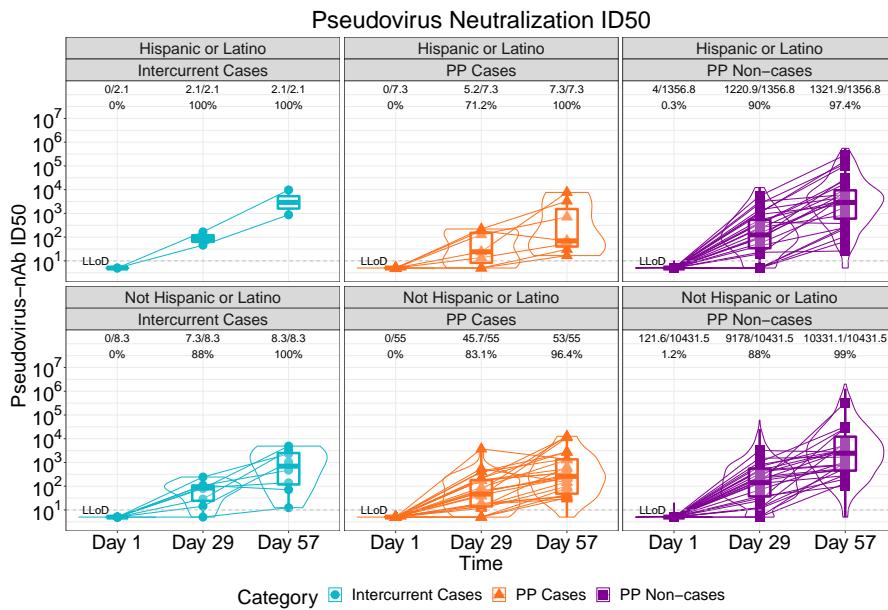


Figure 2.236: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by dichotomous classification of race and ethnic group (3 timepoints)

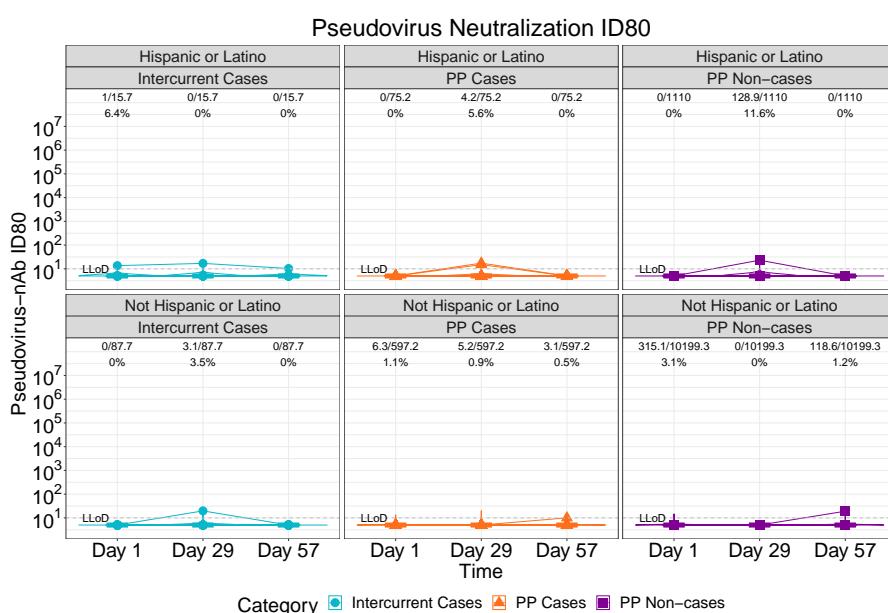


Figure 2.237: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by dichotomous classification of race and ethnic group (3 timepoints)

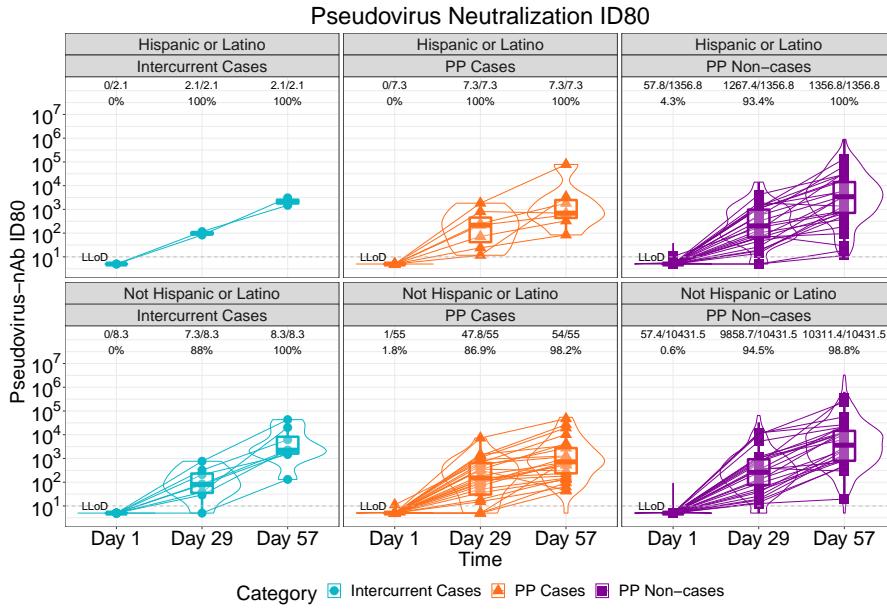


Figure 2.238: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by dichotomous classification of race and ethnic group (3 timepoints)

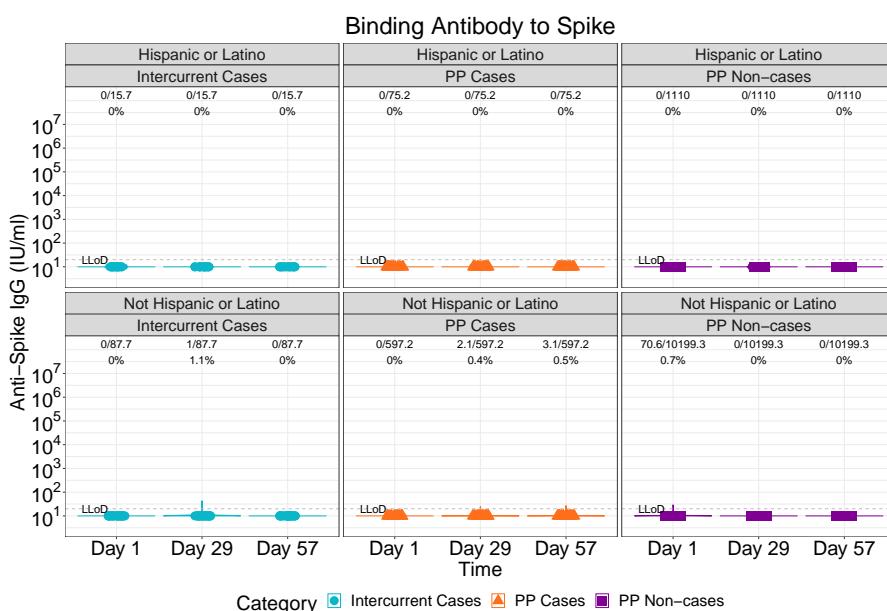


Figure 2.239: violinplots of Binding Antibody to Spike: baseline negative placebo arm by dichotomous classification of race and ethnic group (3 timepoints)

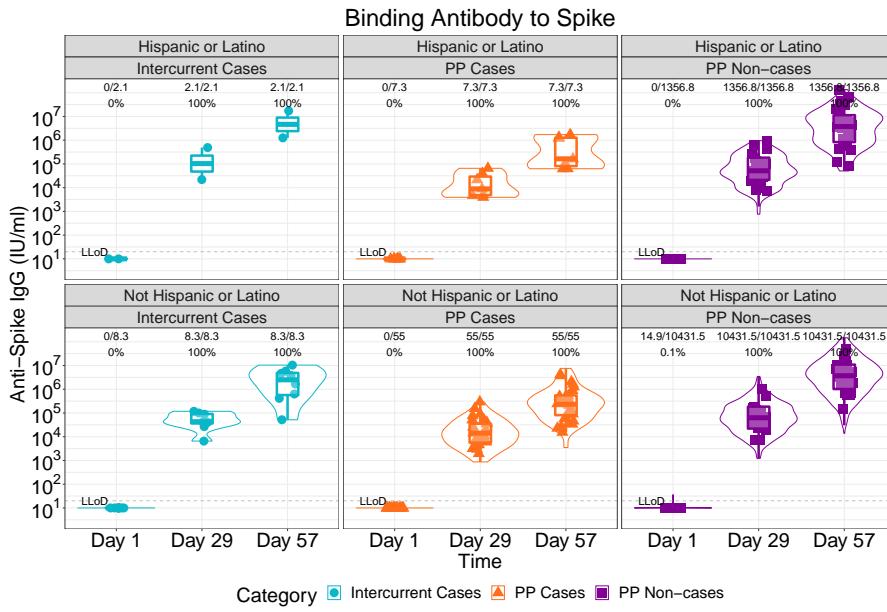


Figure 2.240: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by dichotomous classification of race and ethnic group (3 timepoints)

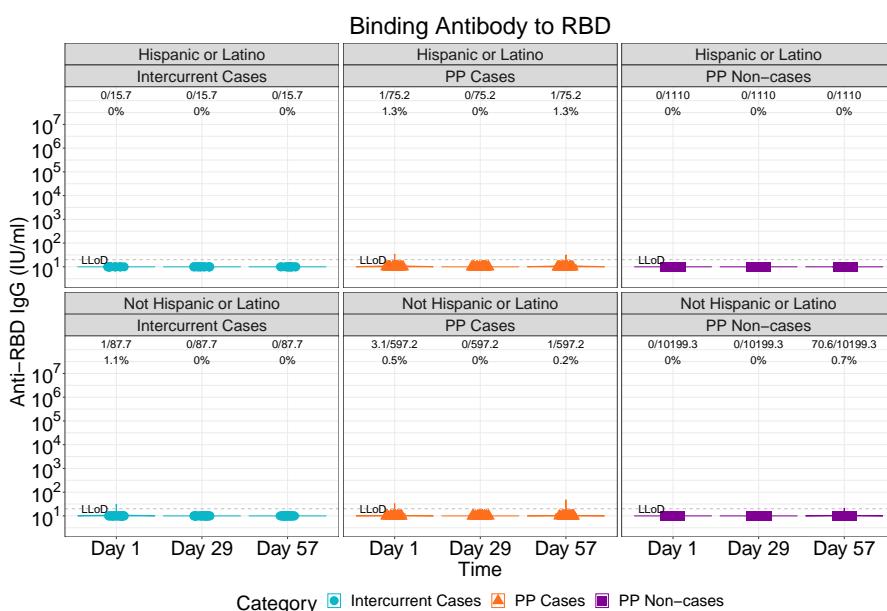


Figure 2.241: violinplots of Binding Antibody to RBD: baseline negative placebo arm by dichotomous classification of race and ethnic group (3 timepoints)

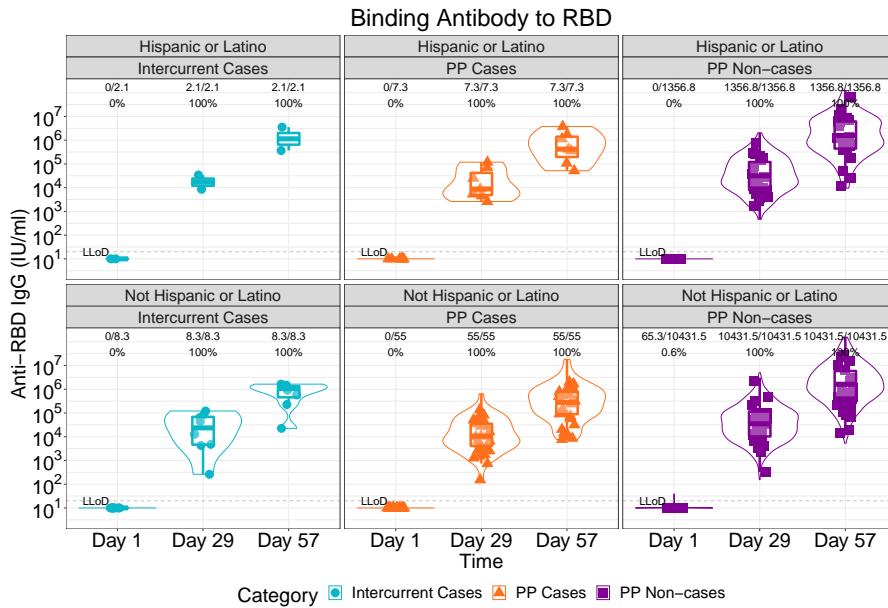


Figure 2.242: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by dichotomous classification of race and ethnic group (3 timepoints)

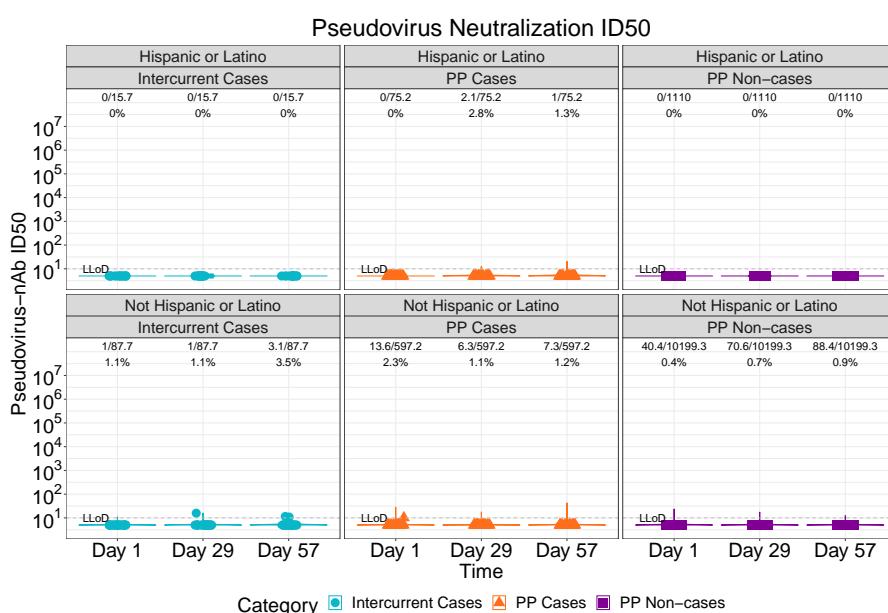


Figure 2.243: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by dichotomous classification of race and ethnic group (3 timepoints)

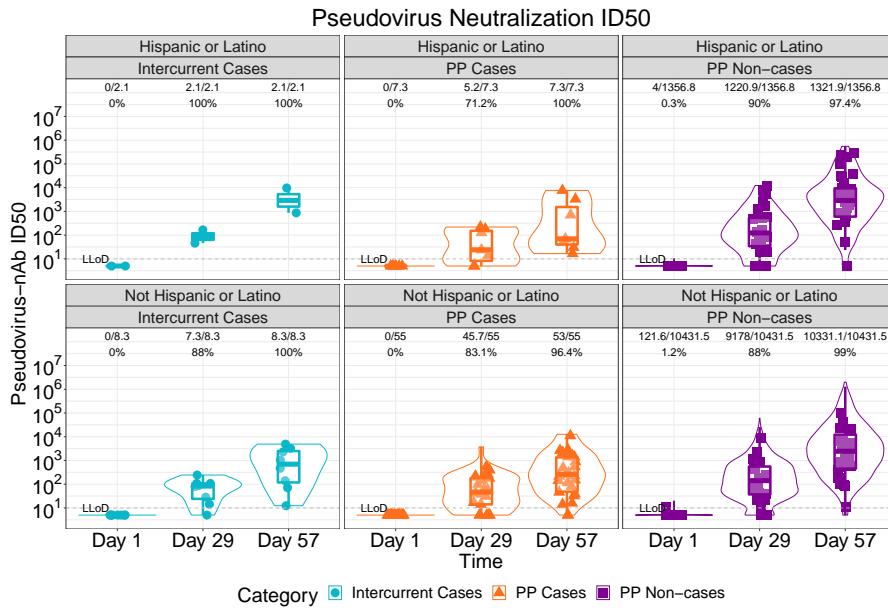


Figure 2.244: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by dichotomous classification of race and ethnic group (3 timepoints)

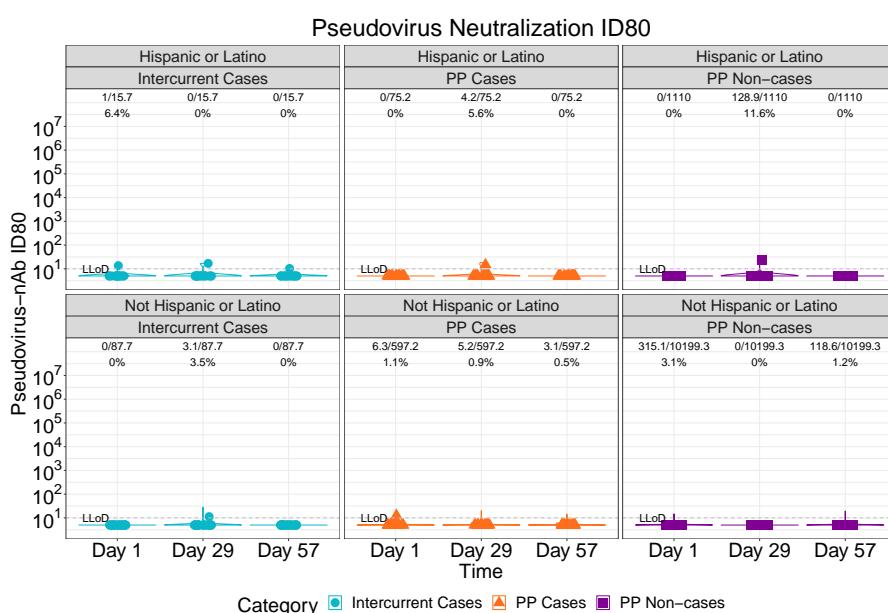


Figure 2.245: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by dichotomous classification of race and ethnic group (3 timepoints)

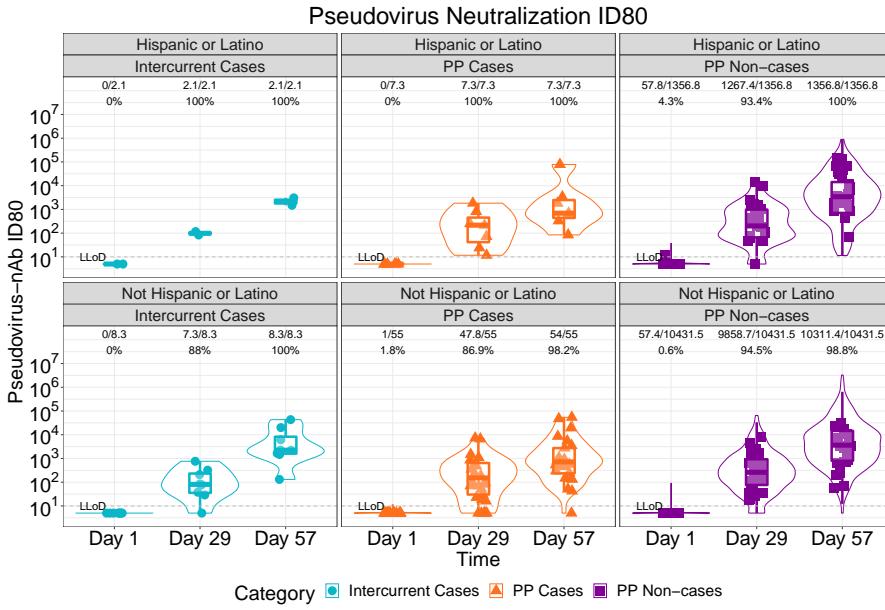


Figure 2.246: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by dichotomous classification of race and ethnic group (3 timepoints)

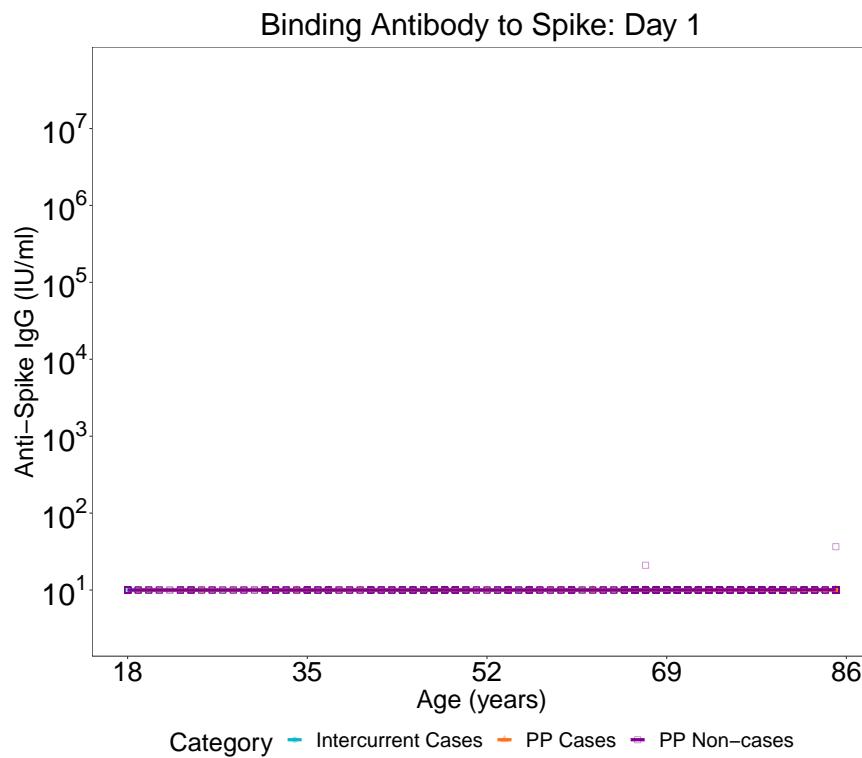


Figure 2.247: scatterplots of Binding Antibody to Spike: baseline negative vaccine arm at day 1

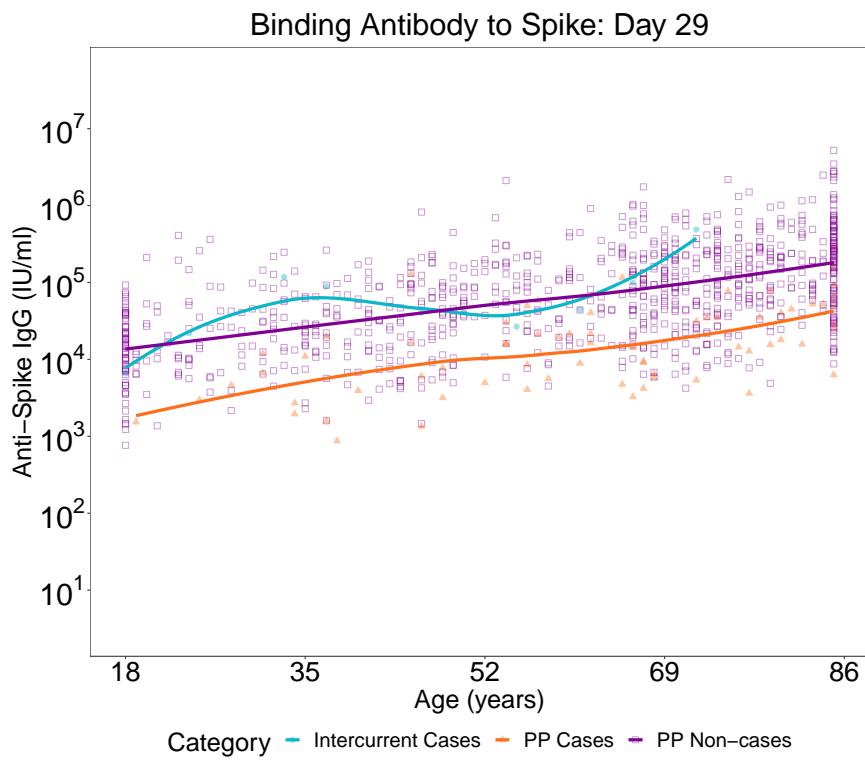


Figure 2.248: scatterplots of Binding Antibody to Spike: baseline negative vaccine arm at day 29

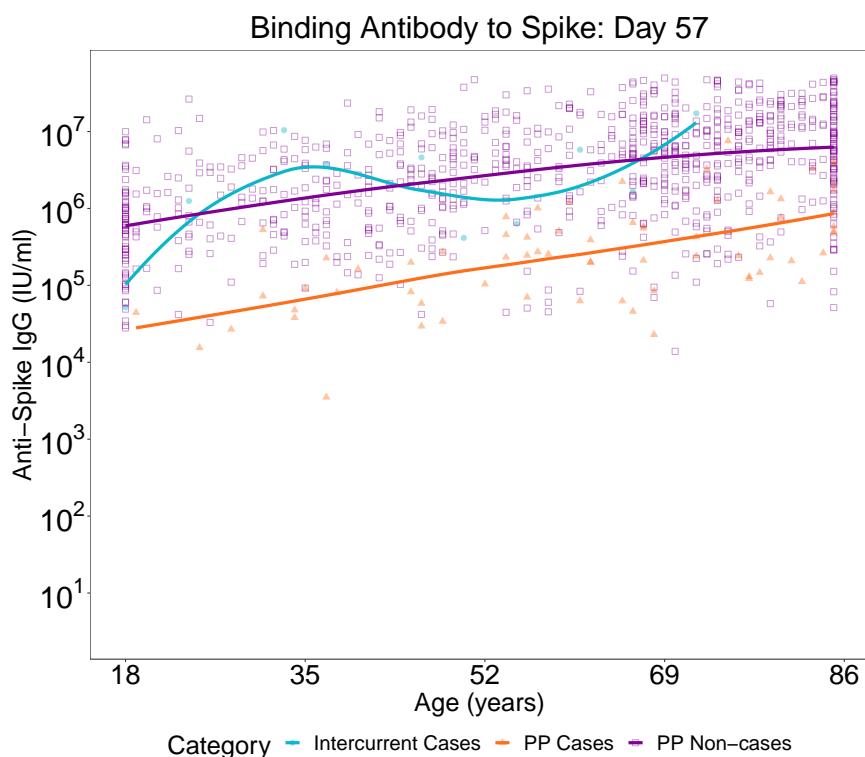


Figure 2.249: scatterplots of Binding Antibody to Spike: baseline negative vaccine arm at day 57

Binding Antibody to RBD: Day 1

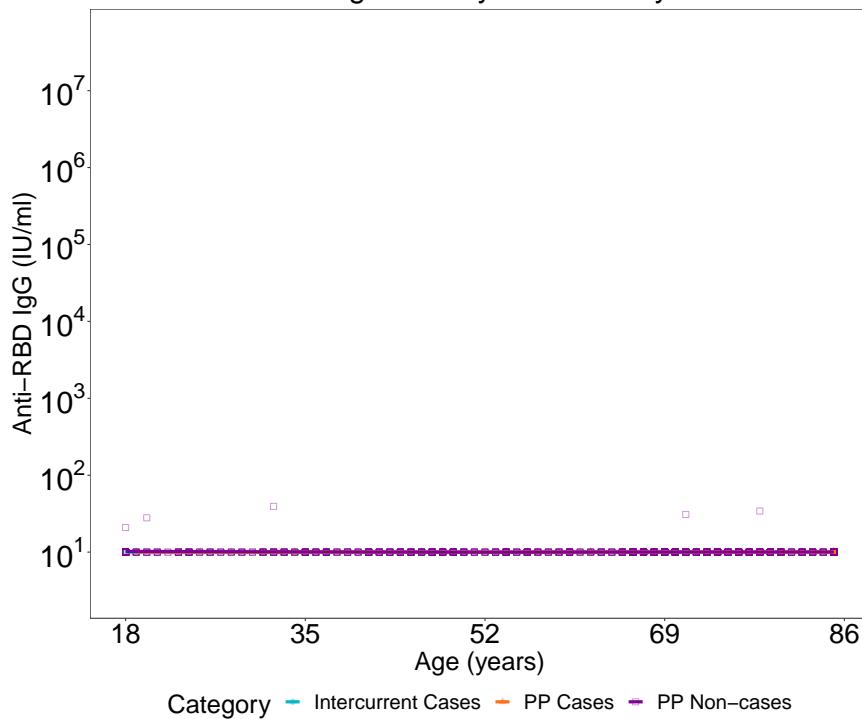


Figure 2.250: scatterplots of Binding Antibody to RBD: baseline negative vaccine arm at day 1

Binding Antibody to RBD: Day 29

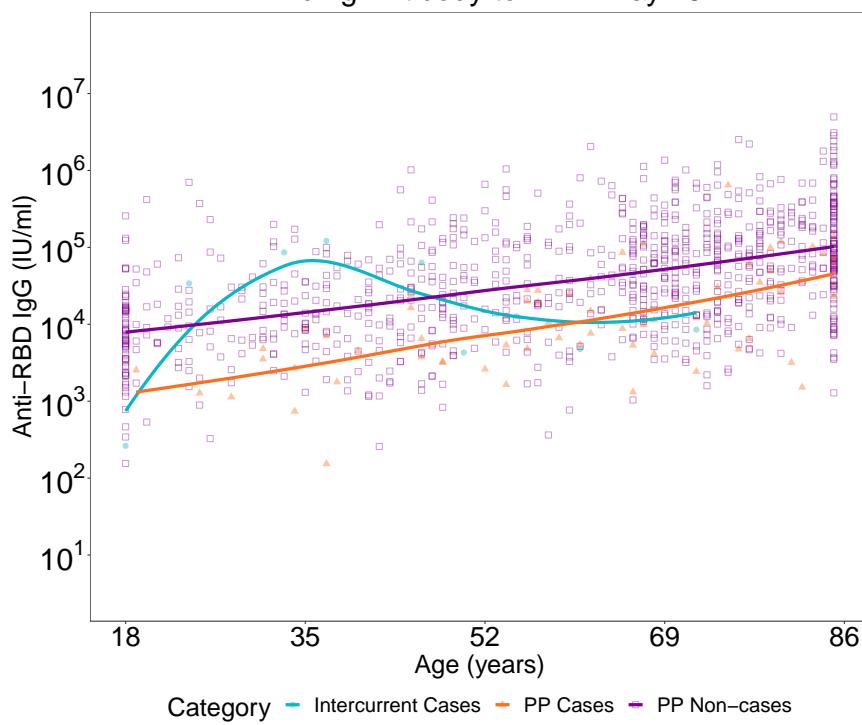


Figure 2.251: scatterplots of Binding Antibody to RBD: baseline negative vaccine arm at day 29

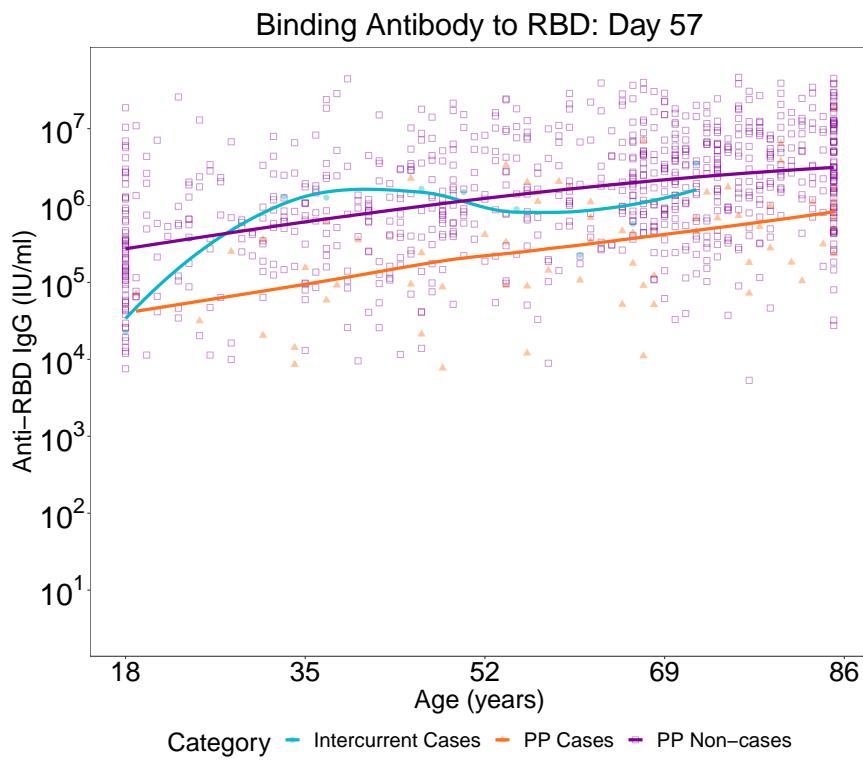


Figure 2.252: scatterplots of Binding Antibody to RBD: baseline negative vaccine arm at day 57

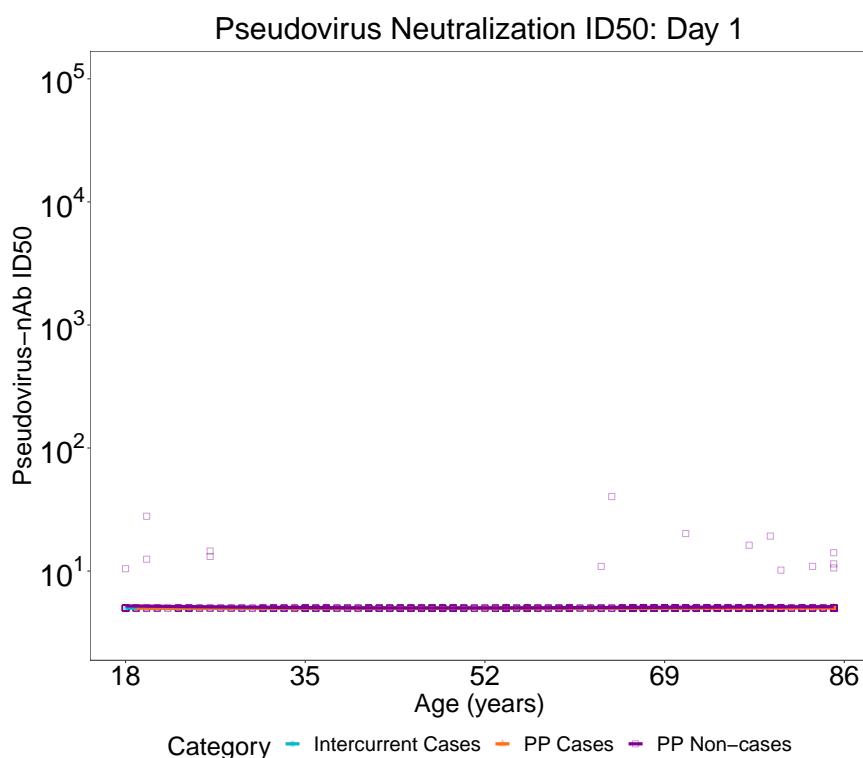


Figure 2.253: scatterplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm at day 1

Pseudovirus Neutralization ID50: Day 29

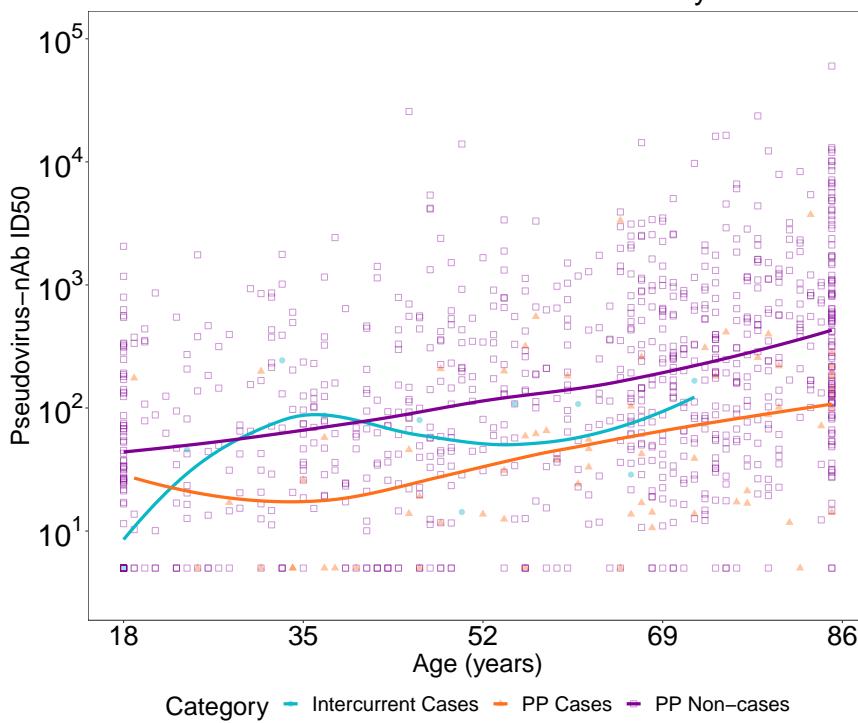


Figure 2.254: scatterplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm at day 29

Pseudovirus Neutralization ID50: Day 57

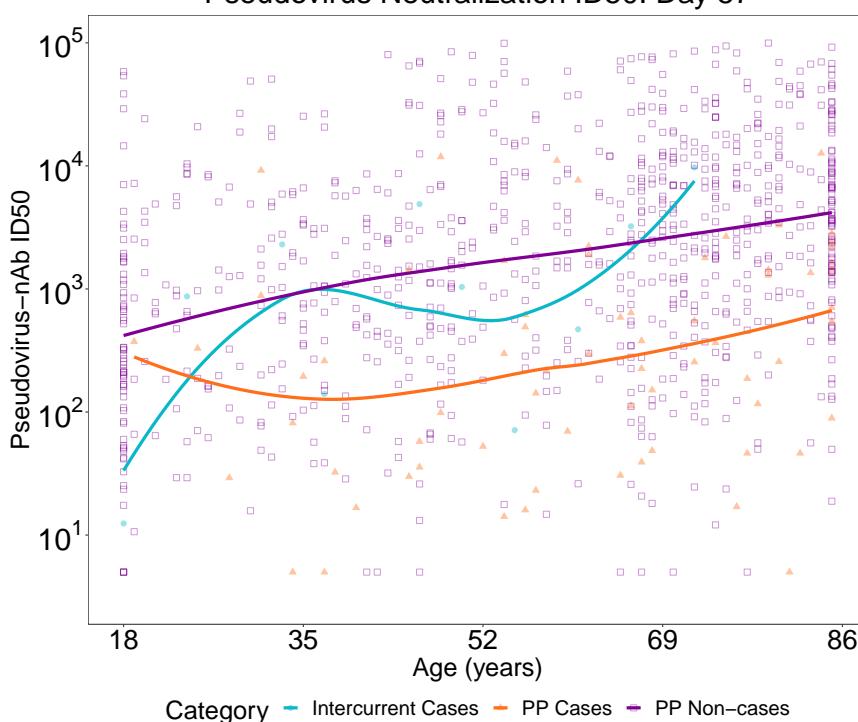


Figure 2.255: scatterplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm at day 57

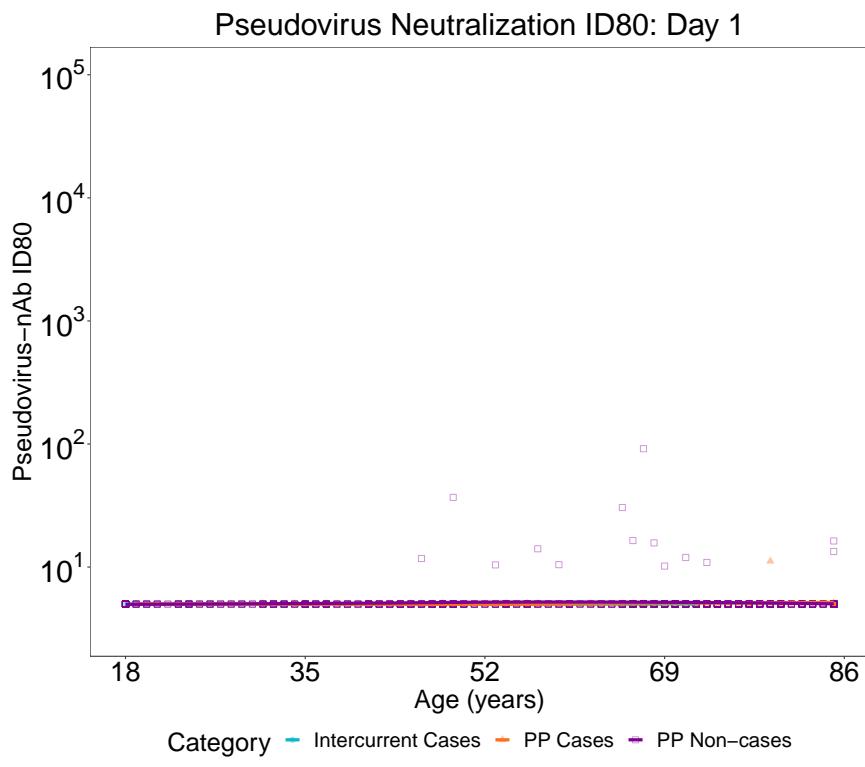


Figure 2.256: scatterplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm at day 1

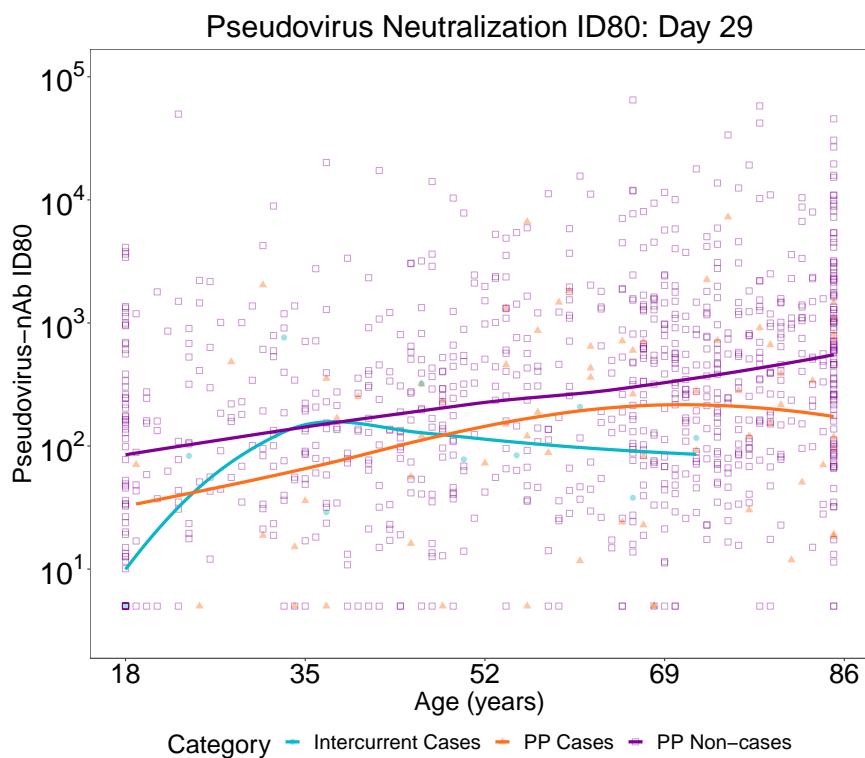


Figure 2.257: scatterplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm at day 29

Pseudovirus Neutralization ID80: Day 57

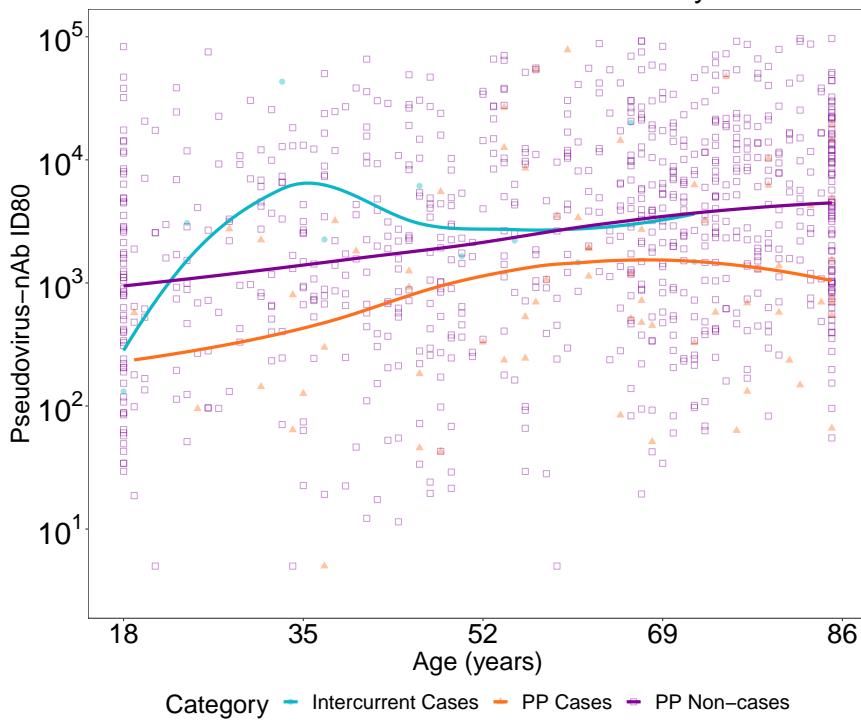


Figure 2.258: scatterplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm at day 57

Binding Antibody to Spike: Day 1

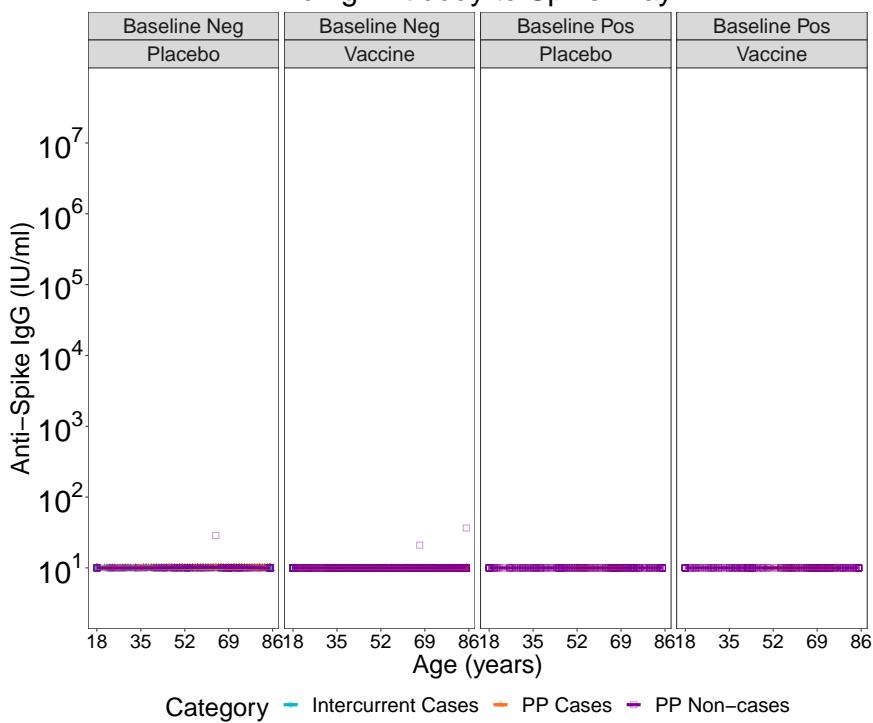


Figure 2.259: scatterplots of Binding Antibody to Spike: by arm at day 1

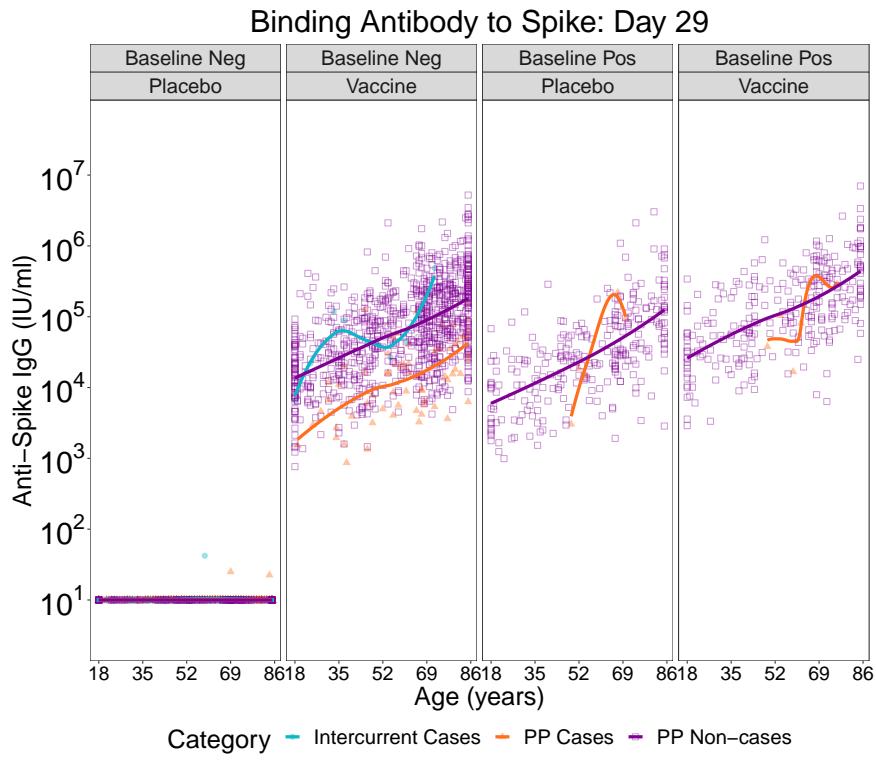


Figure 2.260: scatterplots of Binding Antibody to Spike: by arm at day 29

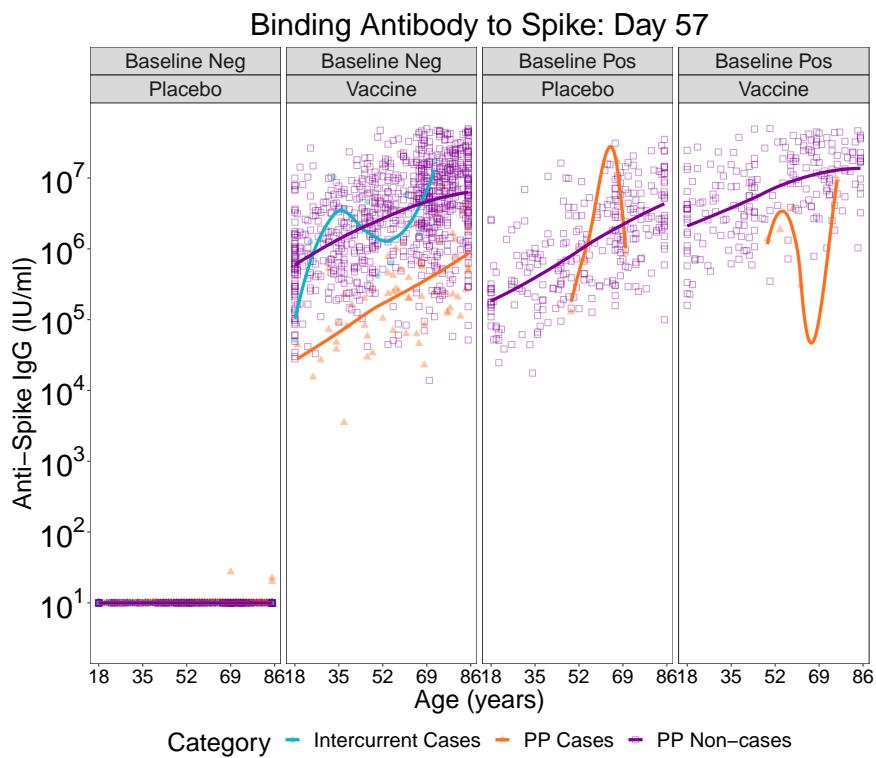


Figure 2.261: scatterplots of Binding Antibody to Spike: by arm at day 57

Binding Antibody to RBD: Day 1

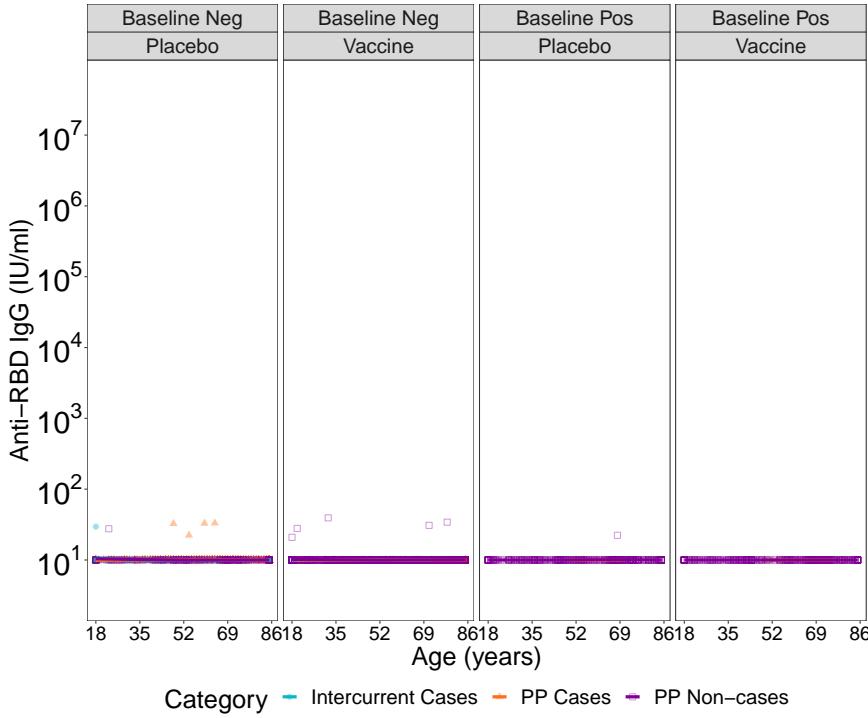


Figure 2.262: scatterplots of Binding Antibody to RBD: by arm at day 1

Binding Antibody to RBD: Day 29

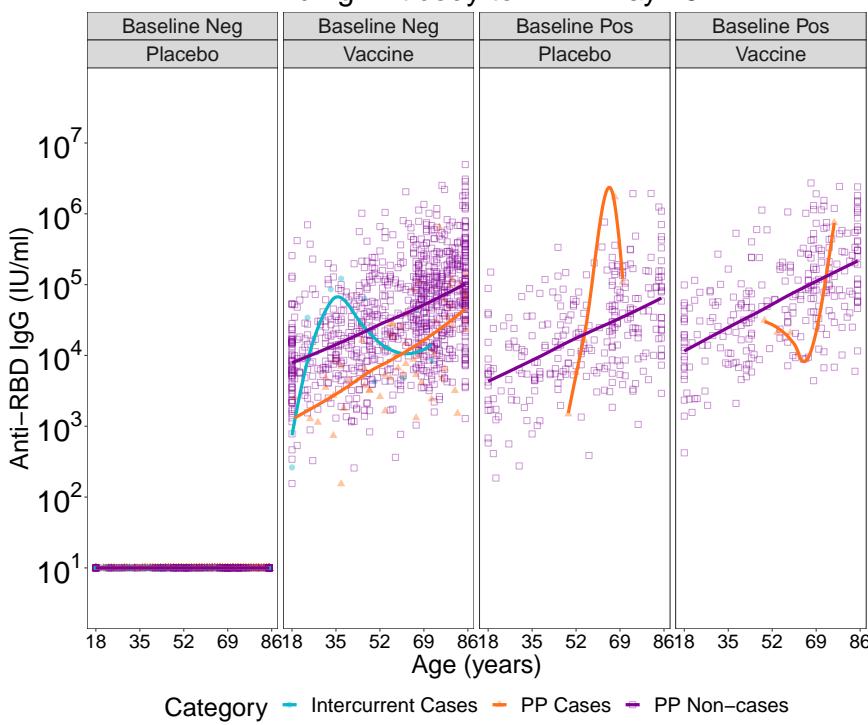


Figure 2.263: scatterplots of Binding Antibody to RBD: by arm at day 29

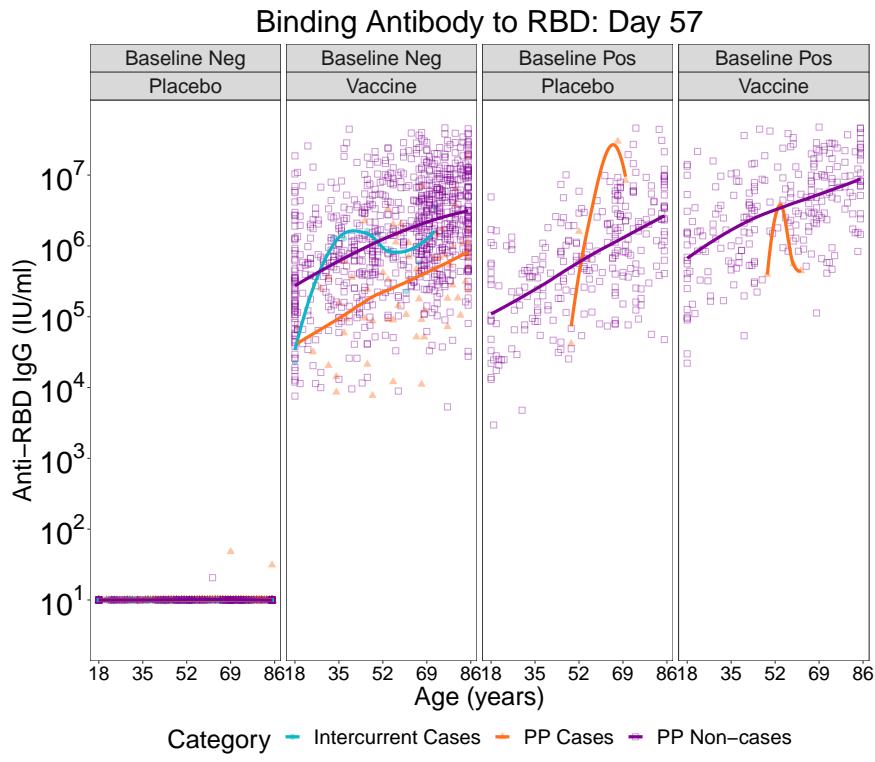


Figure 2.264: scatterplots of Binding Antibody to RBD: by arm at day 57

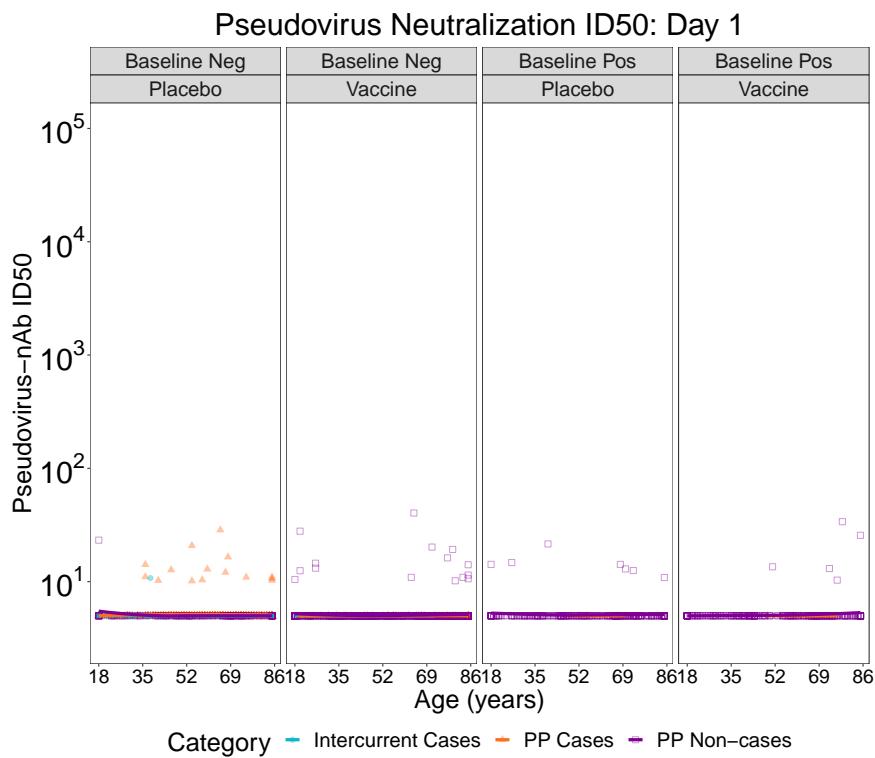


Figure 2.265: scatterplots of Pseudovirus Neutralization ID50: by arm at day 1

Pseudovirus Neutralization ID50: Day 29

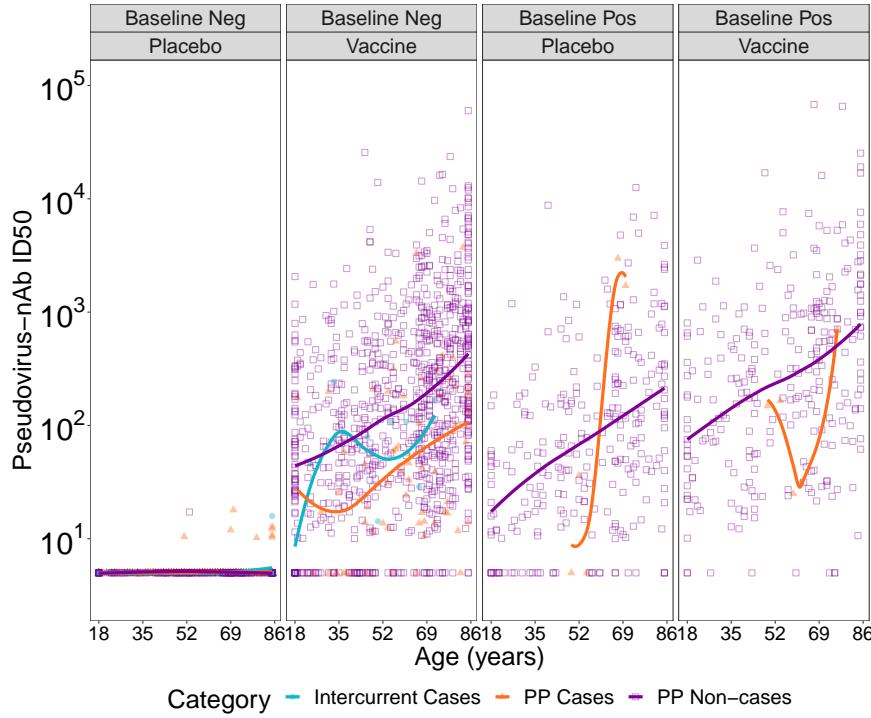


Figure 2.266: scatterplots of Pseudovirus Neutralization ID50: by arm at day 29

Pseudovirus Neutralization ID50: Day 57

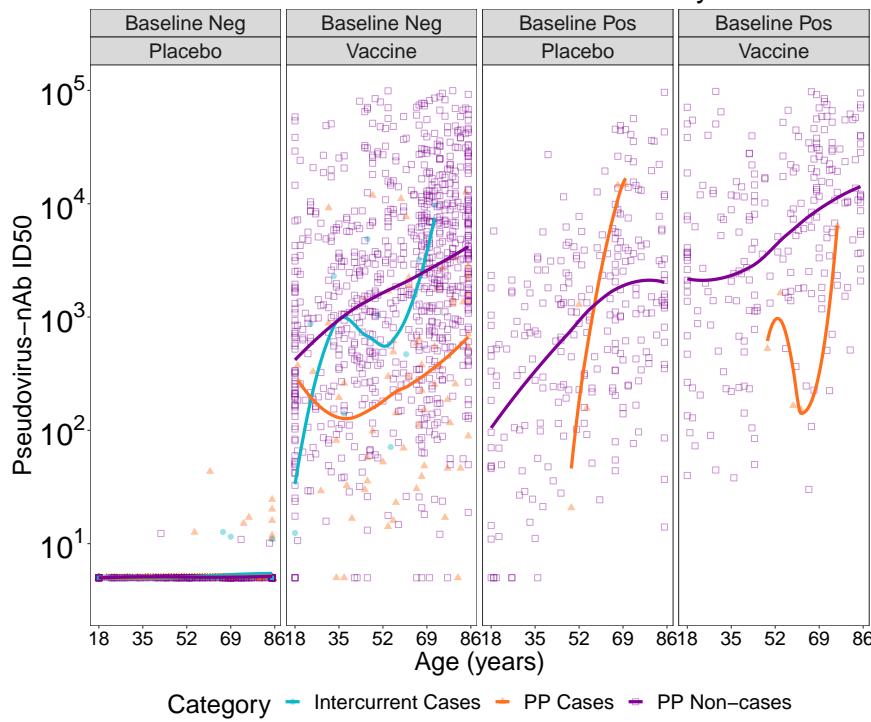


Figure 2.267: scatterplots of Pseudovirus Neutralization ID50: by arm at day 57

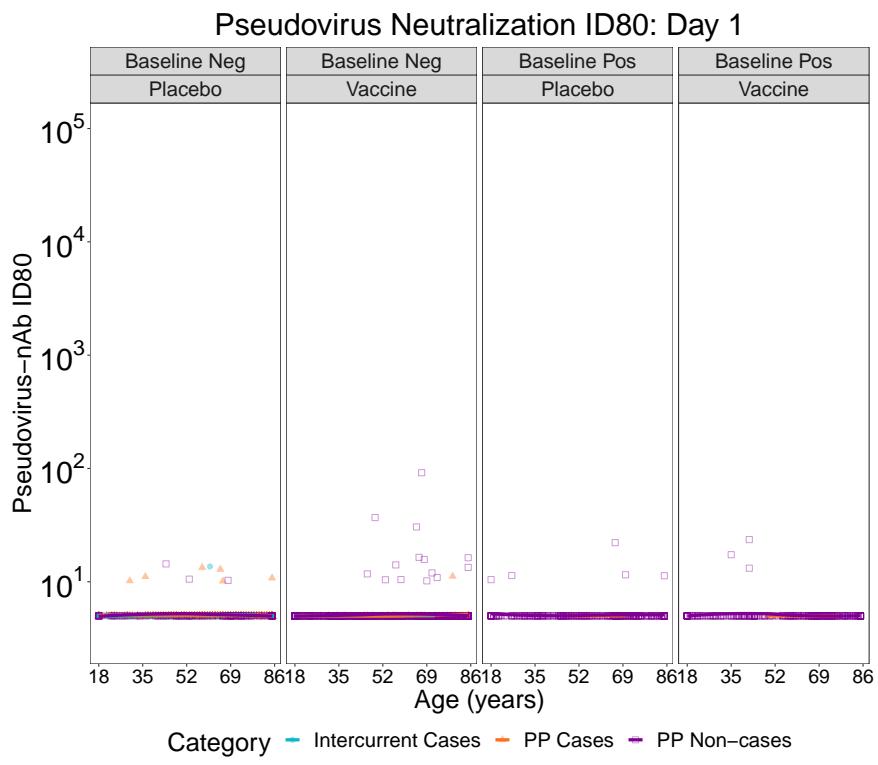


Figure 2.268: scatterplots of Pseudovirus Neutralization ID80: by arm at day 1

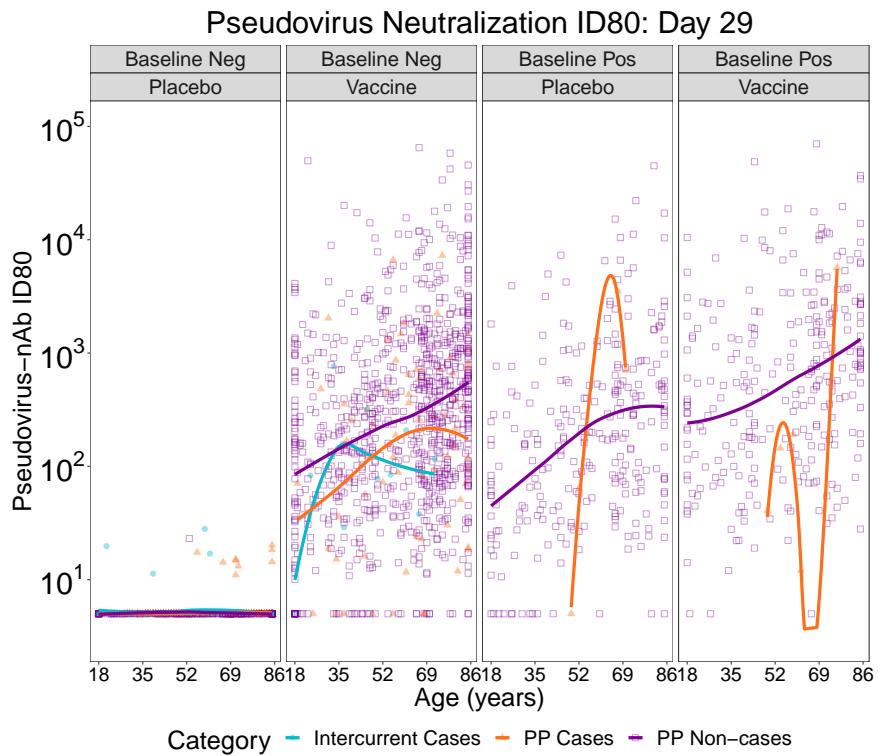


Figure 2.269: scatterplots of Pseudovirus Neutralization ID80: by arm at day 29

Pseudovirus Neutralization ID80: Day 57

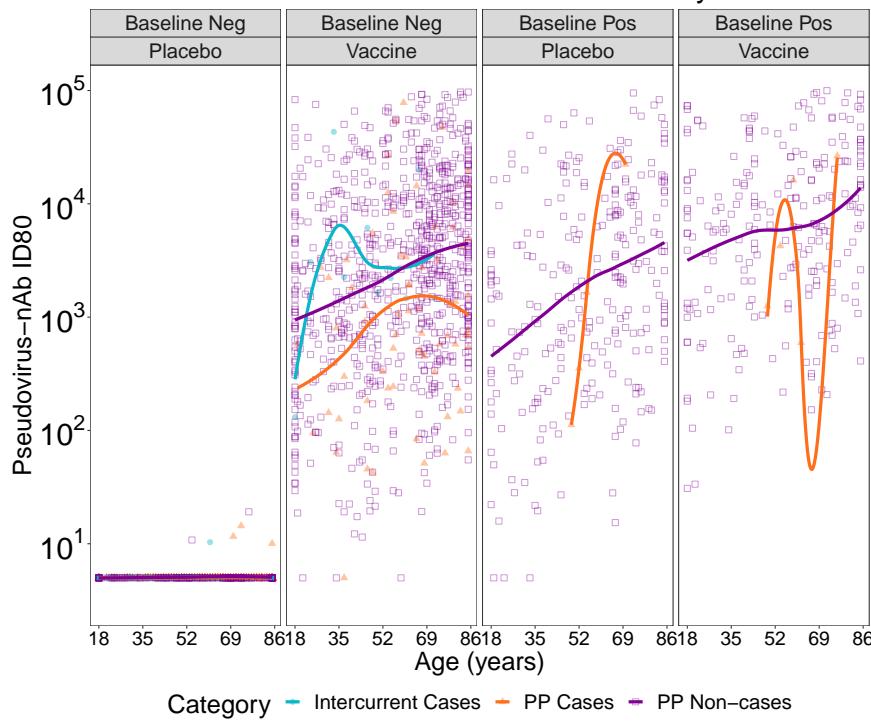


Figure 2.270: scatterplots of Pseudovirus Neutralization ID80: by arm at day 57

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 |
|----------------------------|------------------------------|----------------------------------|-------------|----------------------|---------|--------|
| Spike IgG (IU/ml) | 70/13,295 | 0.10 | (0.06-0.15) | <0.001 | <0.001 | <0.001 |
| RBD IgG (IU/ml) | 70/13,295 | 0.27 | (0.20-0.37) | <0.001 | <0.001 | <0.001 |
| PsV-nAb ID50 | 70/13,295 | 0.30 | (0.23-0.40) | <0.001 | <0.001 | <0.001 |
| PsV-nAb ID80 | 70/13,295 | 0.49 | (0.37-0.63) | <0.001 | <0.001 | <0.001 |

*Baseline covariates adjusted for: age in years, at risk or not, community of color or not . Average follow-up time 172 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*

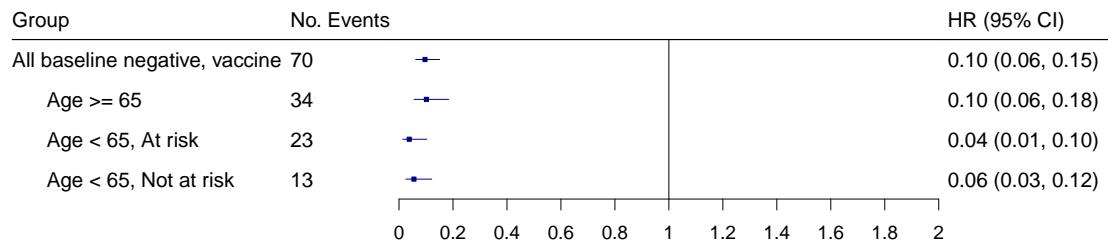
| Mock Immunologic Marker | Tertile | No. cases / No. at-risk** | Attack rate | Pt. Est. | Haz. Ratio 95% CI | P-value (2-sided) | Overall P- value*** | Overall q- value | Overall FWER |
|----------------------------|---------|------------------------------|----------------|----------|----------------------|----------------------|------------------------|---------------------|--------------|
| Spike IgG (IU/ml) | Lower | 58/4,434 | 0.0131 | 1 | N/A | N/A | <0.001 | <0.001 | <0.001 |
| | Middle | 11/4,436 | 0.0025 | 0.10 | (0.05-0.19) | <0.001 | | | |
| | Upper | 1/4,424 | 0.0002 | 0.00 | (0.00-0.03) | <0.001 | | | |
| RBD IgG (IU/ml) | Lower | 38/4,459 | 0.0085 | 1 | N/A | N/A | <0.001 | <0.001 | <0.001 |
| | Middle | 27/4,397 | 0.0061 | 0.40 | (0.23-0.69) | 0.001 | | | |
| | Upper | 5/4,439 | 0.0011 | 0.05 | (0.02-0.12) | <0.001 | | | |
| PsV-nAb ID50 | Lower | 45/4,457 | 0.0101 | 1 | N/A | N/A | <0.001 | <0.001 | <0.001 |
| | Middle | 21/4,364 | 0.0048 | 0.31 | (0.17-0.56) | <0.001 | | | |
| | Upper | 5/4,475 | 0.0011 | 0.05 | (0.02-0.12) | <0.001 | | | |
| PsV-nAb ID80 | Lower | 35/4,443 | 0.0079 | 1 | N/A | N/A | <0.001 | <0.001 | <0.001 |
| | Middle | 25/4,419 | 0.0057 | 0.46 | (0.26-0.83) | 0.010 | | | |
| | Upper | 10/4,433 | 0.0023 | 0.15 | (0.07-0.33) | <0.001 | | | |
| Placebo | | 719/13,359 | 0.0538 | | | | | | |

*Baseline covariates adjusted for: age in years, at risk or not, community of color or not . Average follow-up time 172 days, maximum follow-up time 185 days. Cutpoints: Spike IgG (IU/ml) [6.03, 6.67], RBD IgG (IU/ml) [5.65, 6.39], PsV-nAb ID50 [2.74, 3.56], PsV-nAb ID80 [2.9, 3.83].

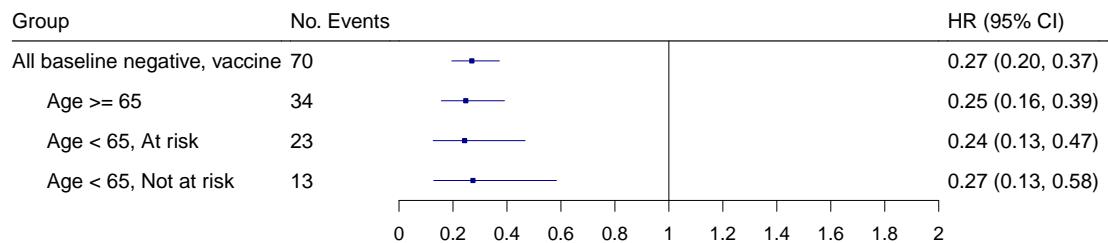
**No. at-risk = number of per-protocol baseline negative vaccine recipients at-risk for COVID at 7 days post Day 57 visit; no. cases = number of this cohort with an observed COVID endpoints.

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

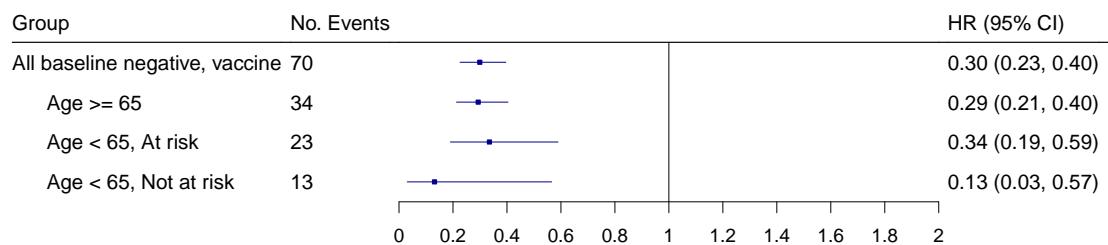
Binding Antibody to Spike: Day 57



Binding Antibody to RBD: Day 57



PsV Neutralization 50% Titer: Day 57



PsV Neutralization 80% Titer: Day 57

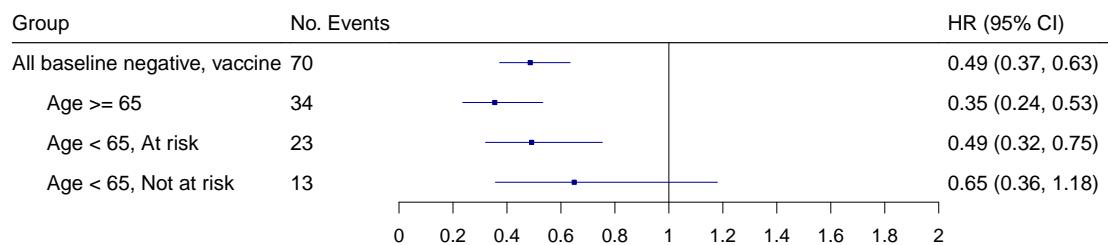


Figure 3.1: Forest plots of hazard ratios per 10-fold increase in the marker among baseline seronegative vaccine recipients and subgroups with 95% point-wise confidence intervals.

Binding Antibody to Spike: Day 57

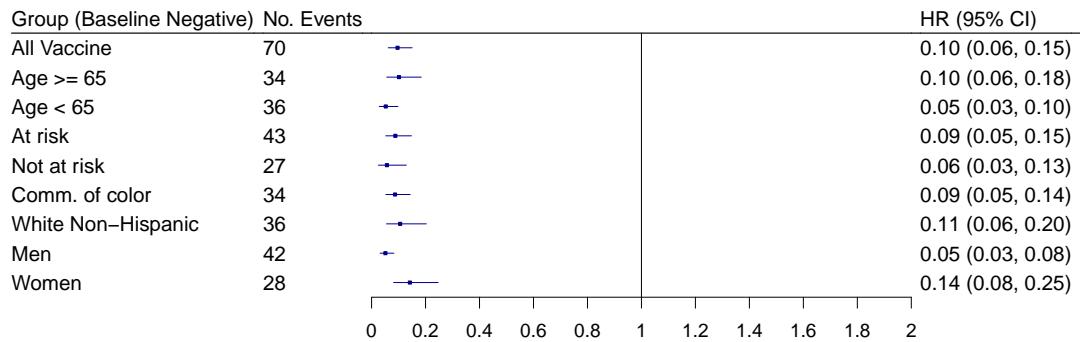


Figure 3.2: Forest plots of hazard ratios per 10-fold increase in the Day 57 binding Ab to spike markers among baseline seronegative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

Binding Antibody to RBD: Day 57

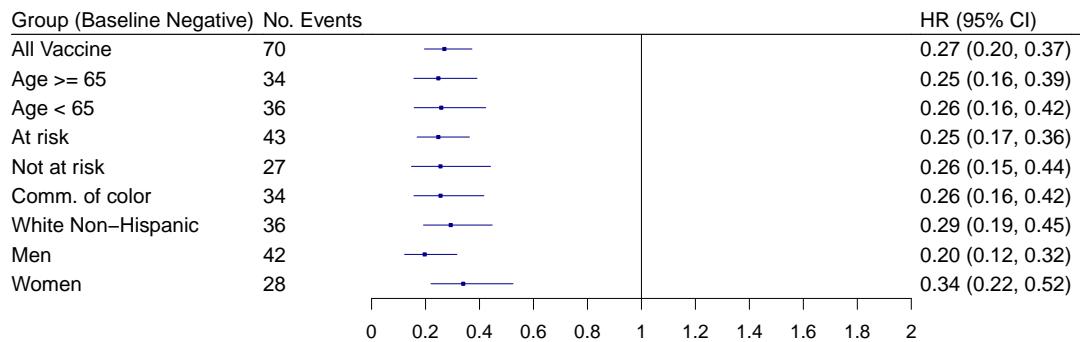


Figure 3.3: Forest plots of hazard ratios per 10-fold increase in the Day 57 binding Ab to RBD markers among baseline seronegative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

PsV Neutralization 50% Titer: Day 57

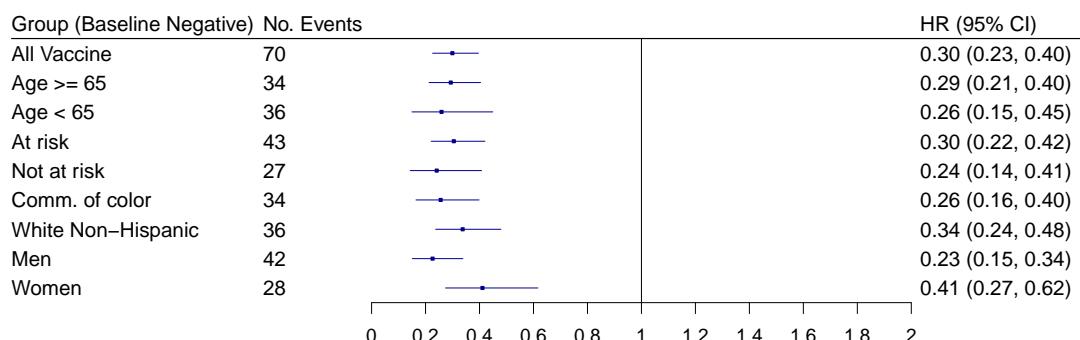


Figure 3.4: Forest plots of hazard ratios per 10-fold increase in the Day 57 pseudo neut ID50 markers among baseline seronegative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

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

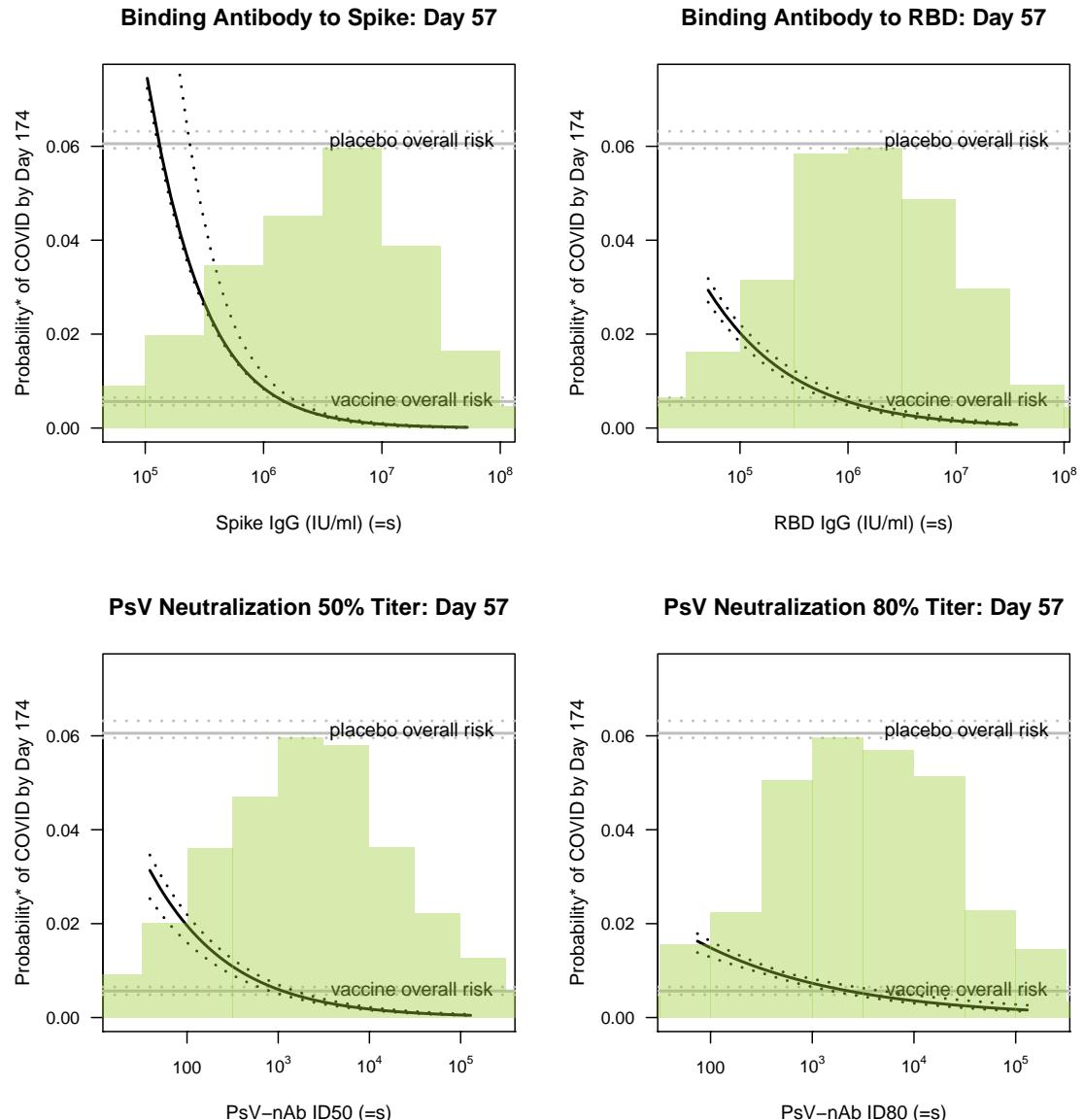
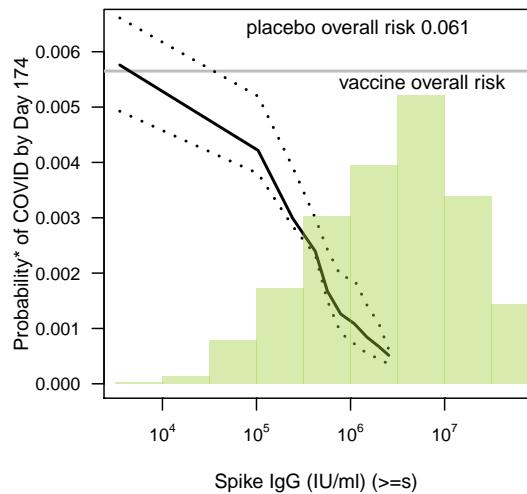
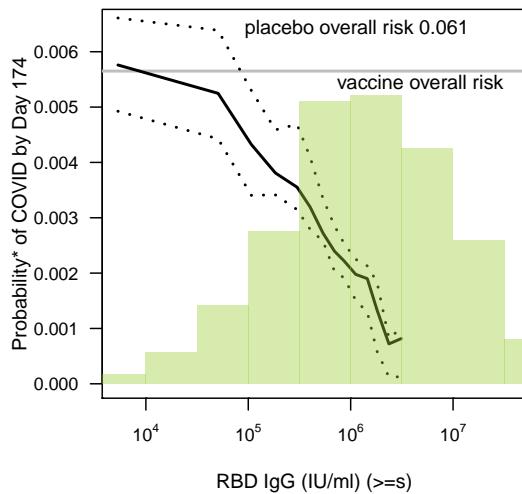


Figure 3.6: Marginalized cumulative risk by Day 174 as functions of Day 57 markers ($=s$) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands. The horizontal lines indicate the overall cumulative risk of the placebo and vaccine arms by Day 174 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod: lower limit of detection.

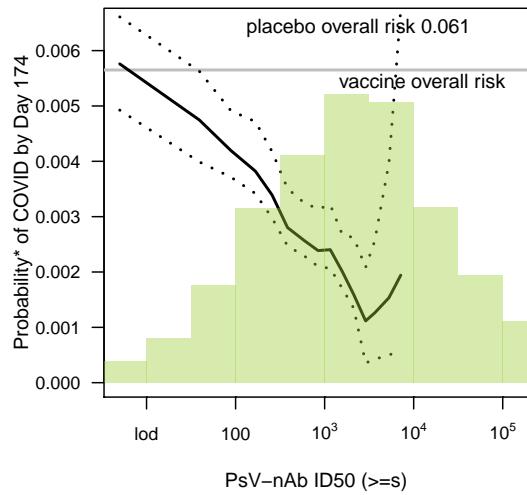
Binding Antibody to Spike: Day 57



Binding Antibody to RBD: Day 57



PsV Neutralization 50% Titer: Day 57



PsV Neutralization 80% Titer: Day 57

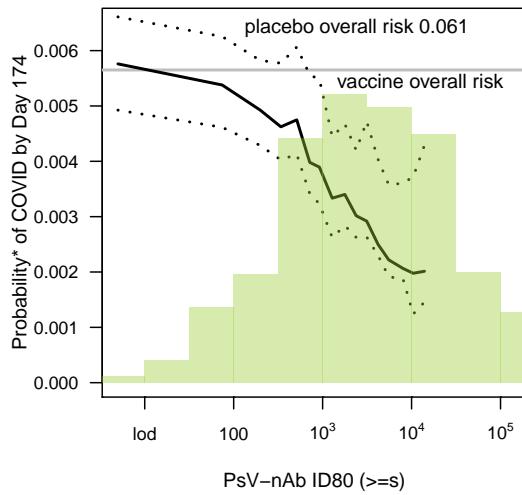


Figure 3.7: Marginalized cumulative risk by Day 174 as functions of Day 57 markers above a threshold ($\geq s$) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands (at least 5 cases are required). The horizontal lines indicate the overall cumulative risk of the vaccine arm by Day 174 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod: lower limit of detection.

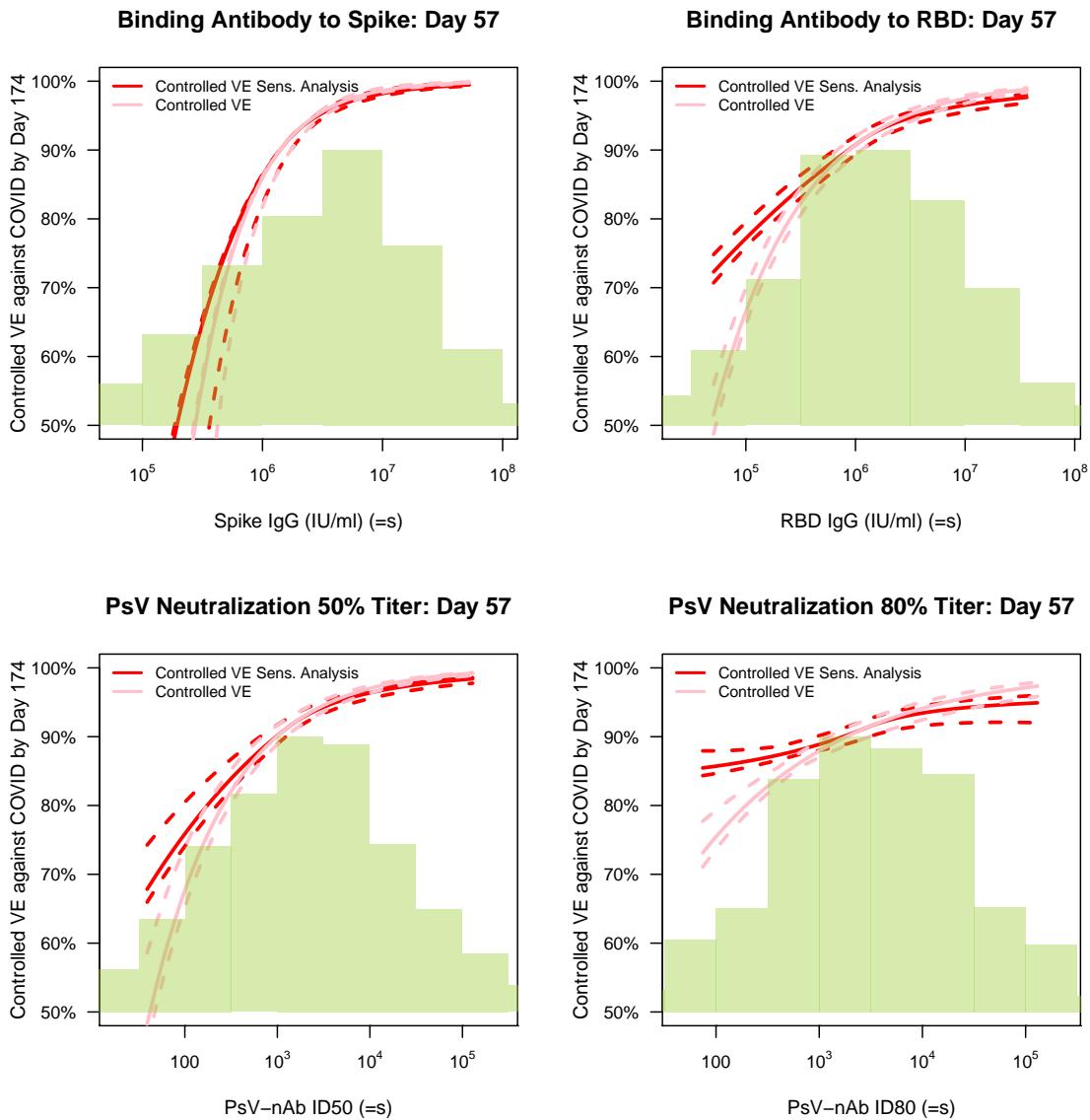


Figure 3.8: Controlled VE with sensitivity analysis as functions of Day 57 markers (=s) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands. Histograms of the immunological markers in the vaccine arm are overlaid. lod: lower limit of detection.

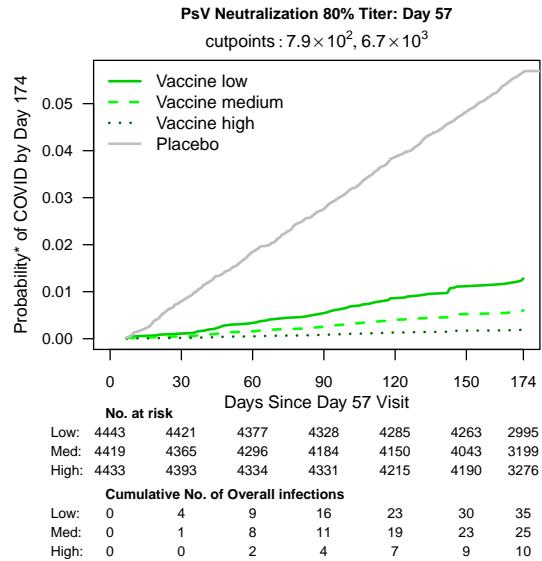
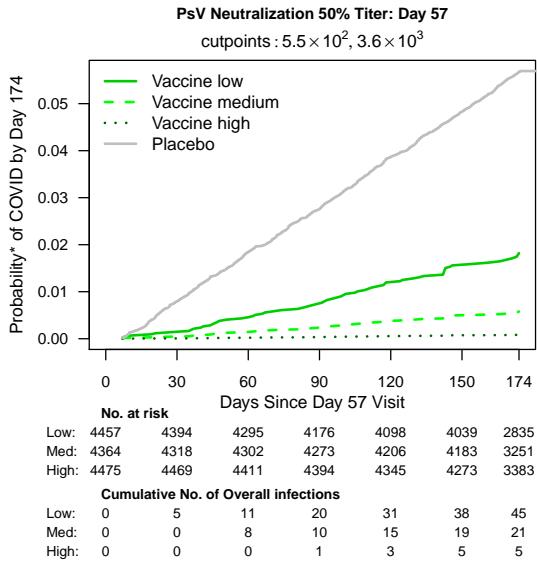
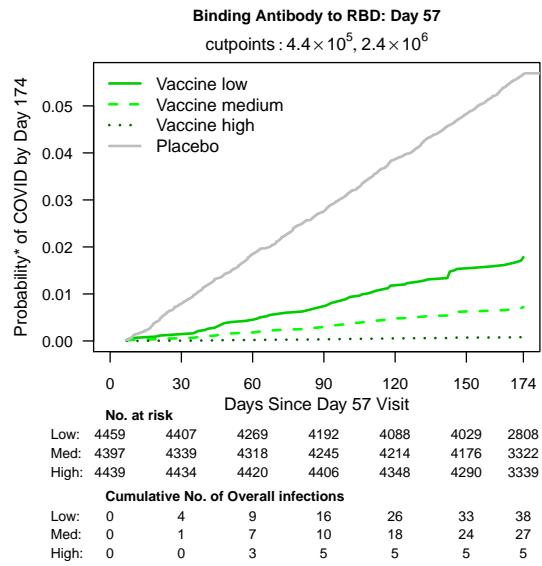
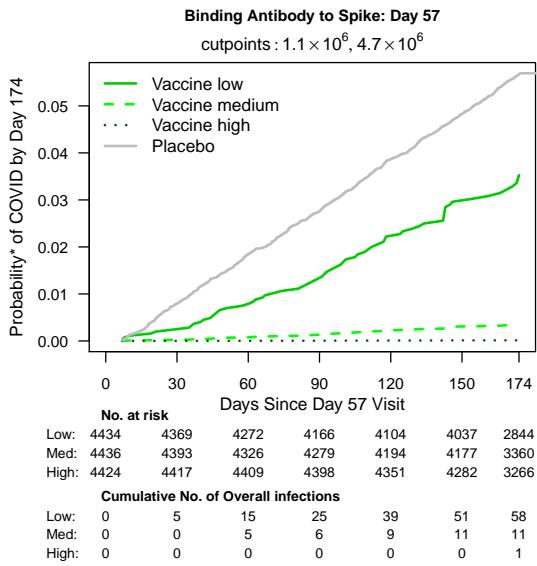


Figure 3.9: Marginalized cumulative incidence rate curves for trichotomized Day 57 markers among baseline seronegative vaccine recipients. The gray line is the overall cumulative incidence rate curve in the placebo arm.

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 |
|----------------------------|------------------------------|----------------------------------|-------------|----------------------|---------|--------|
| Spike IgG (IU/ml) | 81/13,315 | 0.09 | (0.05-0.16) | <0.001 | <0.001 | <0.001 |
| RBD IgG (IU/ml) | 81/13,315 | 0.29 | (0.20-0.42) | <0.001 | <0.001 | <0.001 |
| PsV-nAb ID50 | 81/13,315 | 0.38 | (0.28-0.51) | <0.001 | <0.001 | <0.001 |
| PsV-nAb ID80 | 81/13,315 | 0.59 | (0.43-0.81) | 0.001 | <0.001 | <0.001 |

*Baseline covariates adjusted for: age in years, at risk or not, community of color or not . Average follow-up time 200 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*

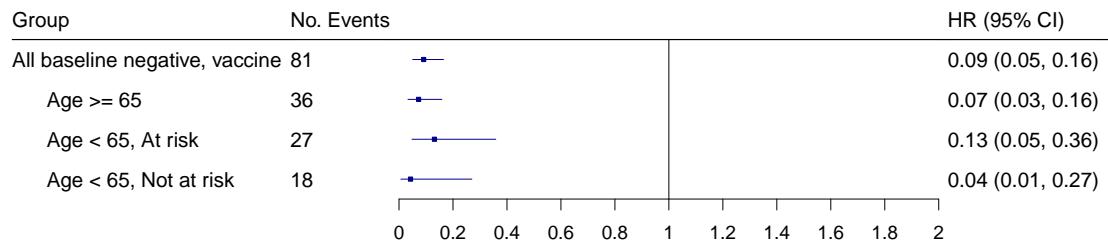
| Mock Immunologic Marker | Tertile | No. cases / No. at-risk** | Attack rate | Pt. Est. | Haz. Ratio 95% CI | P-value (2-sided) | Overall P- value*** | Overall q- value | Overall FWER |
|----------------------------|---------|------------------------------|----------------|----------|----------------------|----------------------|------------------------|---------------------|--------------|
| Spike IgG (IU/ml) | Lower | 49/4,460 | 0.0110 | 1 | N/A | N/A | <0.001 | <0.001 | <0.001 |
| | Middle | 21/4,406 | 0.0048 | 0.24 | (0.13-0.43) | <0.001 | | | |
| | Upper | 11/4,449 | 0.0025 | 0.06 | (0.03-0.14) | <0.001 | | | |
| RBD IgG (IU/ml) | Lower | 40/4,461 | 0.0090 | 1 | N/A | N/A | <0.001 | <0.001 | <0.001 |
| | Middle | 21/4,412 | 0.0048 | 0.38 | (0.22-0.68) | 0.001 | | | |
| | Upper | 20/4,442 | 0.0045 | 0.19 | (0.10-0.35) | <0.001 | | | |
| PsV-nAb ID50 | Lower | 40/4,441 | 0.0090 | 1 | N/A | N/A | <0.001 | <0.001 | <0.001 |
| | Middle | 30/4,429 | 0.0068 | 0.54 | (0.32-0.92) | 0.022 | | | |
| | Upper | 10/4,445 | 0.0022 | 0.14 | (0.07-0.29) | <0.001 | | | |
| PsV-nAb ID80 | Lower | 29/4,440 | 0.0065 | 1 | N/A | N/A | 0.075 | | |
| | Middle | 28/4,434 | 0.0063 | 0.76 | (0.43-1.35) | 0.349 | | | |
| | Upper | 24/4,441 | 0.0054 | 0.50 | (0.27-0.91) | 0.023 | | | |
| Placebo | | 828/13,380 | 0.0619 | | | | | | |

*Baseline covariates adjusted for: age in years, at risk or not, community of color or not . Average follow-up time 200 days, maximum follow-up time 213 days. Cutpoints: Spike IgG (IU/ml) [4.35, 4.87], RBD IgG (IU/ml) [4.05, 4.64], PsV-nAb ID50 [1.67, 2.39], PsV-nAb ID80 [1.92, 2.61].

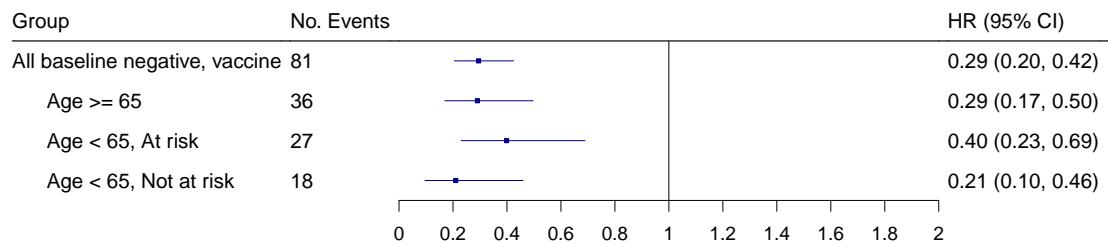
**No. at-risk = number of per-protocol baseline negative vaccine recipients at-risk for COVID at 7 days post Day 29 visit; no. cases = number of this cohort with an observed COVID endpoints.

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

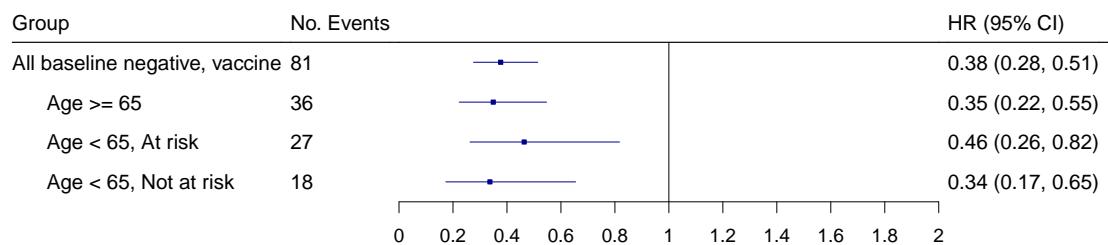
Binding Antibody to Spike: Day 29



Binding Antibody to RBD: Day 29



PsV Neutralization 50% Titer: Day 29



PsV Neutralization 80% Titer: Day 29

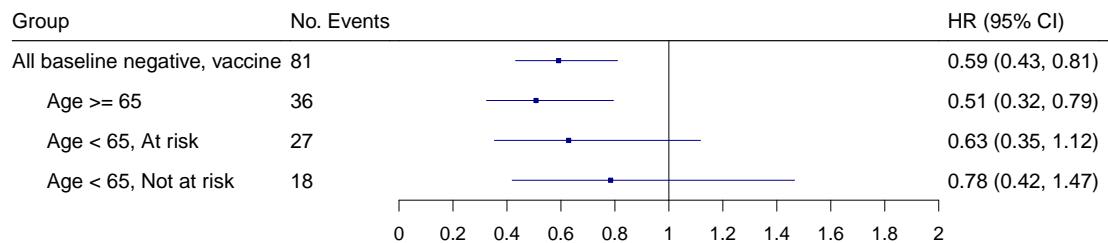


Figure 4.1: Forest plots of hazard ratios per 10-fold increase in the marker among baseline seronegative vaccine recipients and subgroups with 95% point-wise confidence intervals.

Binding Antibody to Spike: Day 29

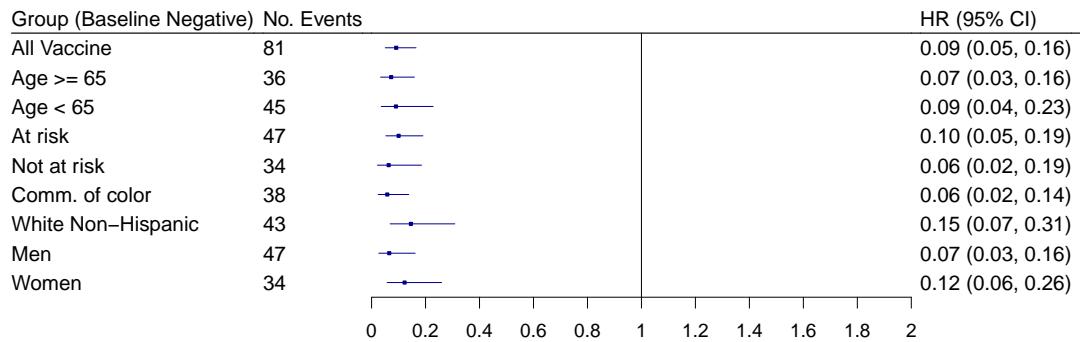


Figure 4.2: Forest plots of hazard ratios per 10-fold increase in the Day 29 binding Ab to spike markers among baseline seronegative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

Binding Antibody to RBD: Day 29

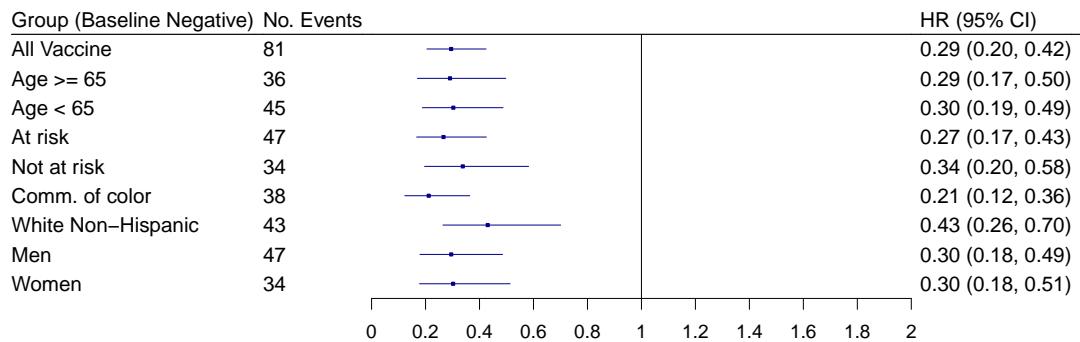


Figure 4.3: Forest plots of hazard ratios per 10-fold increase in the Day 29 binding Ab to RBD markers among baseline seronegative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

PsV Neutralization 50% Titer: Day 29

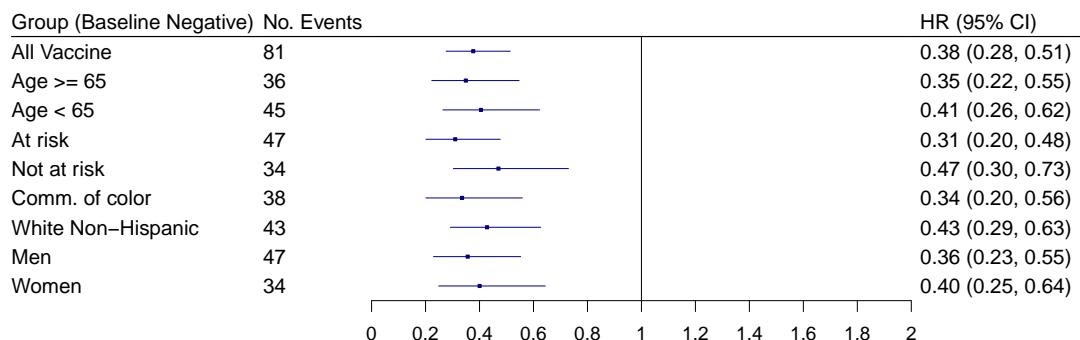


Figure 4.4: Forest plots of hazard ratios per 10-fold increase in the Day 29 pseudo neut ID50 markers among baseline seronegative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

PsV Neutralization 80% Titer: Day 29

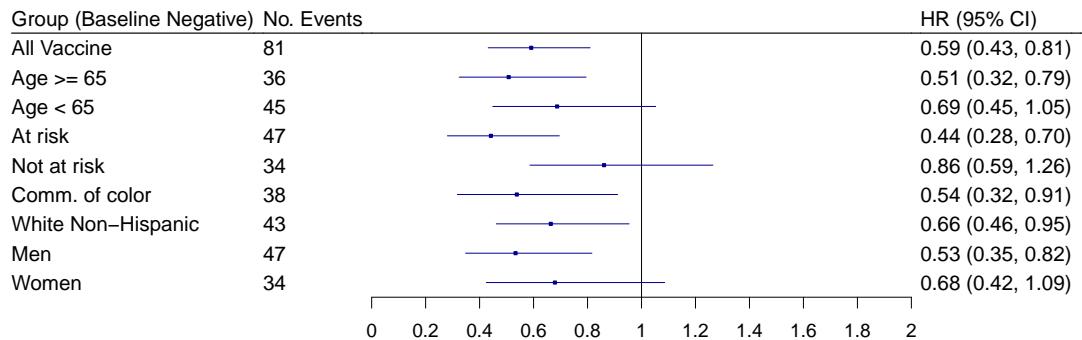


Figure 4.5: Forest plots of hazard ratios per 10-fold increase in the Day 29 pseudo neut ID80 markers among baseline seronegative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

4.2 Marginalized risk and controlled vaccine efficacy plots

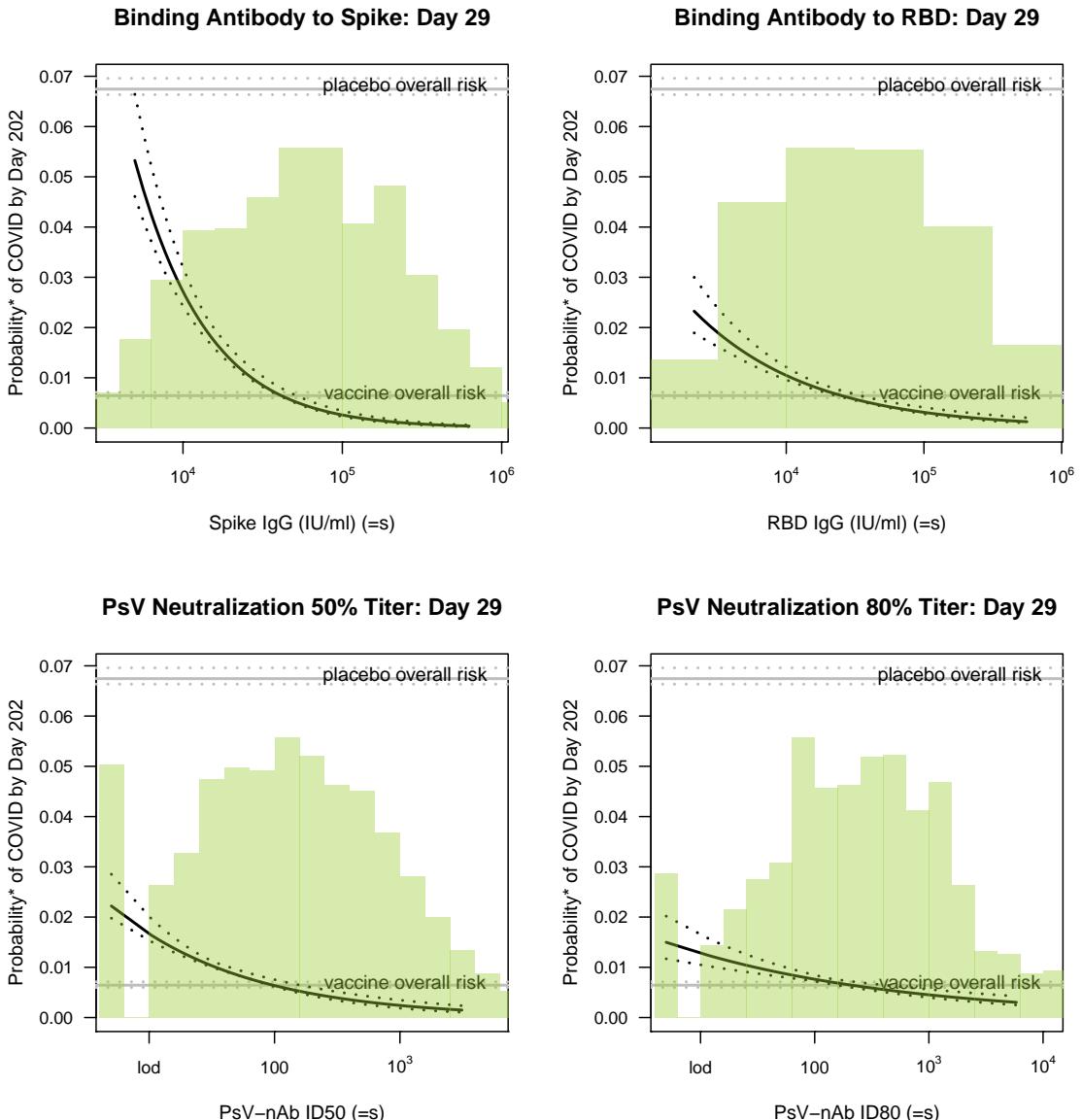
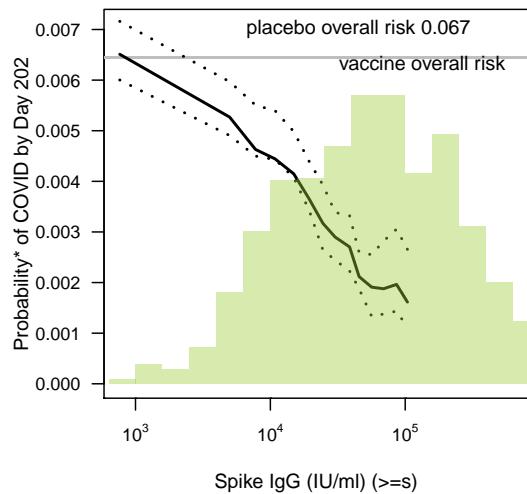
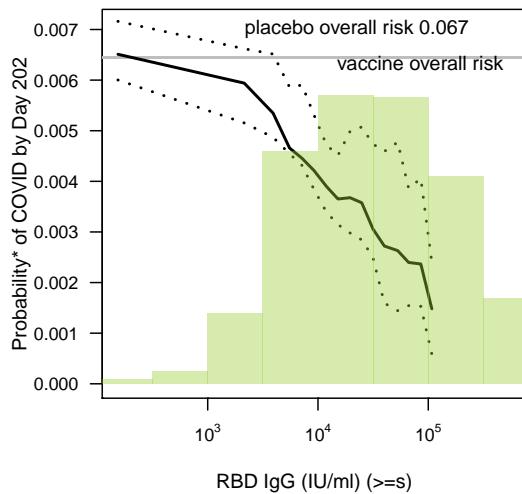


Figure 4.6: Marginalized cumulative risk by Day 202 as functions of Day 29 markers (=s) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands. The horizontal lines indicate the overall cumulative risk of the placebo and vaccine arms by Day 202 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod: lower limit of detection.

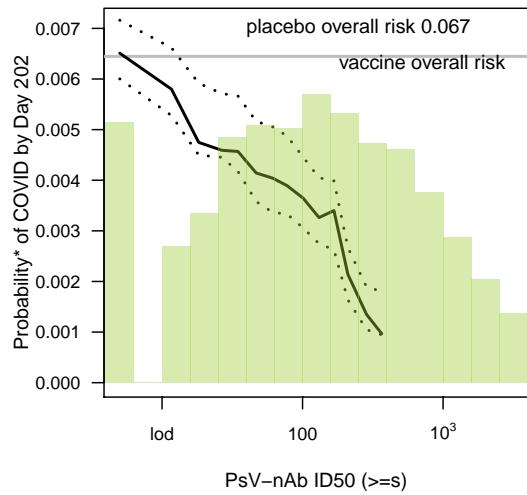
Binding Antibody to Spike: Day 29



Binding Antibody to RBD: Day 29



PsV Neutralization 50% Titer: Day 29



PsV Neutralization 80% Titer: Day 29

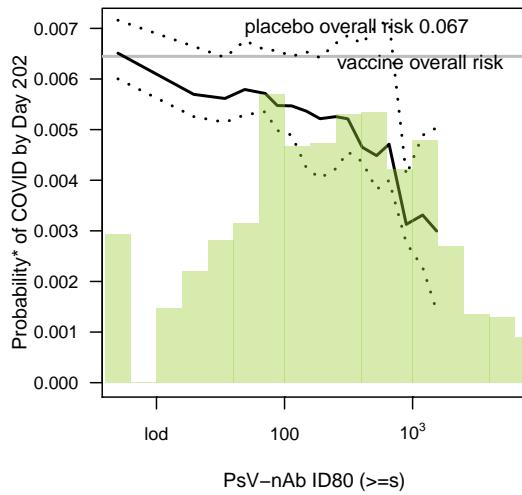


Figure 4.7: Marginalized cumulative risk by Day 202 as functions of Day 29 markers above a threshold ($\geq s$) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands (at least 5 cases are required). The horizontal lines indicate the overall cumulative risk of the vaccine arm by Day 202 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod: lower limit of detection.

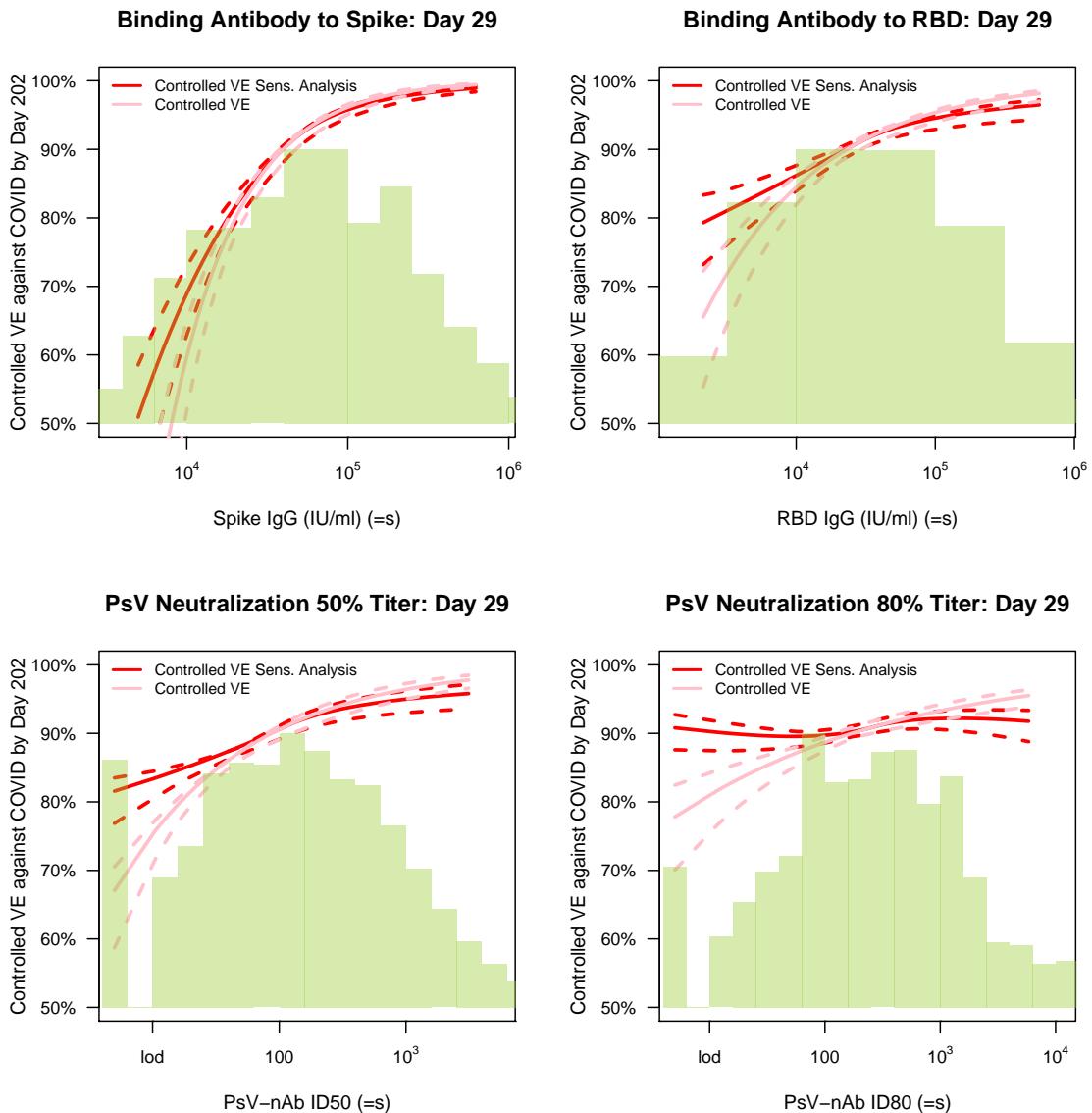


Figure 4.8: Controlled VE with sensitivity analysis as functions of Day 29 markers (=s) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands. Histograms of the immunological markers in the vaccine arm are overlaid. lod: lower limit of detection.

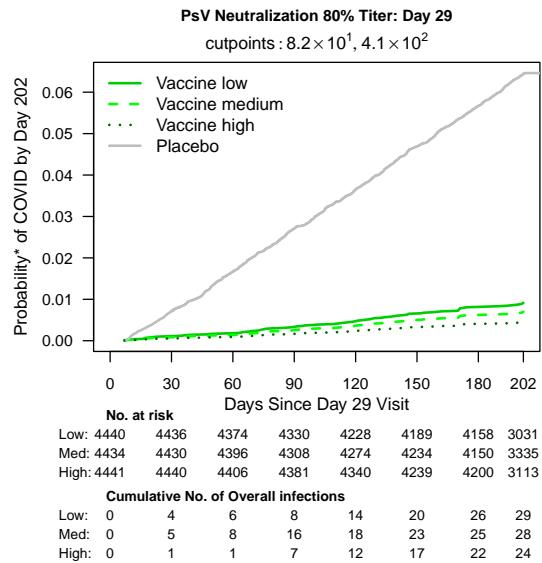
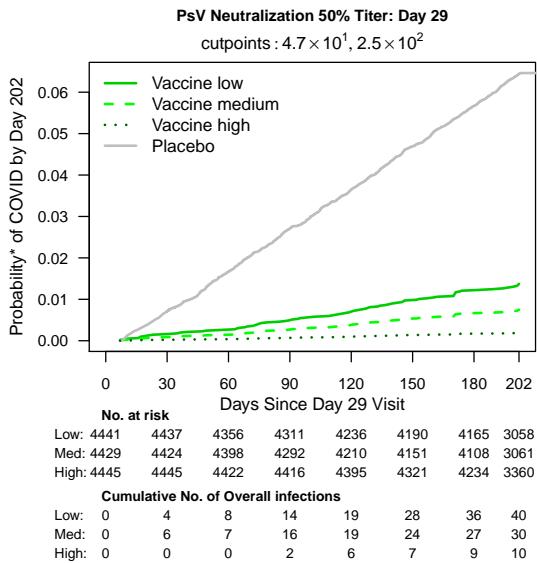
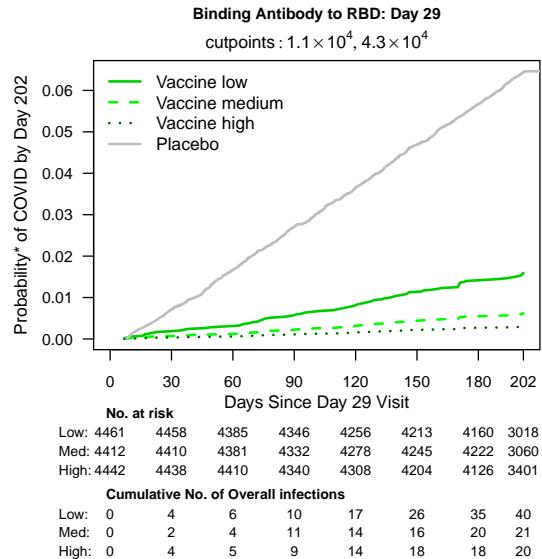


Figure 4.9: Marginalized cumulative incidence rate curves for trichotomized Day 29 markers among baseline seronegative vaccine recipients. The gray line is the overall cumulative incidence rate curve in the placebo arm.

Chapter 5

Univariate CoR: Nonparametric Threshold Modeling

An extension of the unadjusted nonparametric threshold-searching approach developed in [Donovan et al. \(2019\)](#), 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

5.1.1 Day 57 Spike protein binding antibody

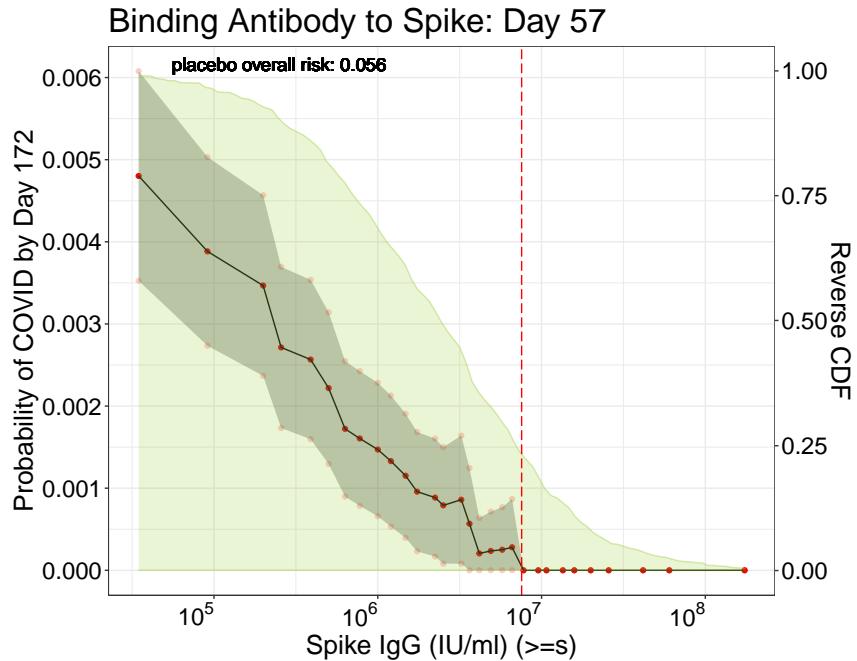


Figure 5.1: Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

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 |
|------------------------|---------------|---------------|---------|----------|
| 4.536 | $3.44 * 10^4$ | 0.00480 | 0.00353 | 0.00608 |
| 5.413 | $2.59 * 10^5$ | 0.00271 | 0.00173 | 0.00369 |
| 5.797 | $6.27 * 10^5$ | 0.00172 | 0.00090 | 0.00255 |
| 6.165 | $1.46 * 10^6$ | 0.00115 | 0.00040 | 0.00191 |
| 6.405 | $2.54 * 10^6$ | 0.00079 | 0.00008 | 0.00150 |
| 6.622 | $4.19 * 10^6$ | 0.00021 | 0.00000 | 0.00064 |
| 6.820 | $6.61 * 10^6$ | 0.00028 | 0.00000 | 0.00087 |
| 7.127 | $1.34 * 10^7$ | 0.00000 | 0.00000 | NA |
| 7.409 | $2.56 * 10^7$ | 0.00000 | 0.00000 | NA |
| 8.244 | $1.75 * 10^8$ | 0.00000 | 0.00000 | NA |

5.1.2 Day 57 RBD binding antibody

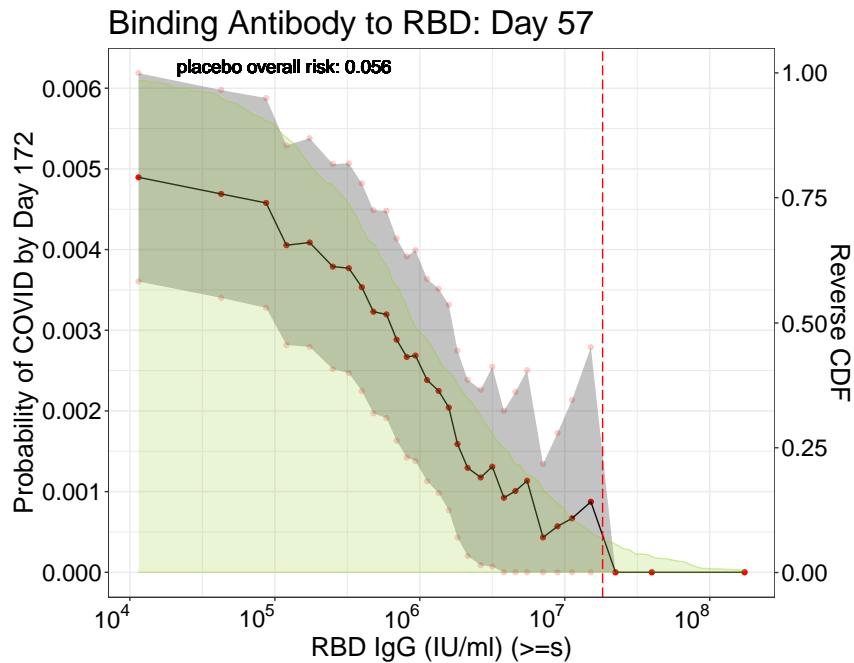


Figure 5.2: Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

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 |
|------------------------|--------------------|---------------|---------|----------|
| 4.062 | 1.15×10^4 | 0.00490 | 0.00360 | 0.00619 |
| 5.085 | 1.22×10^5 | 0.00405 | 0.00282 | 0.00529 |
| 5.507 | 3.21×10^5 | 0.00377 | 0.00247 | 0.00507 |
| 5.839 | 6.90×10^5 | 0.00288 | 0.00163 | 0.00414 |
| 6.048 | 1.12×10^6 | 0.00238 | 0.00113 | 0.00364 |
| 6.257 | 1.81×10^6 | 0.00159 | 0.00043 | 0.00275 |
| 6.499 | 3.16×10^6 | 0.00131 | 0.00007 | 0.00255 |
| 6.847 | 7.03×10^6 | 0.00043 | 0.00000 | 0.00134 |
| 7.181 | 1.52×10^7 | 0.00087 | 0.00000 | 0.00279 |
| 8.239 | 1.73×10^8 | 0.00000 | 0.00000 | NA |

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

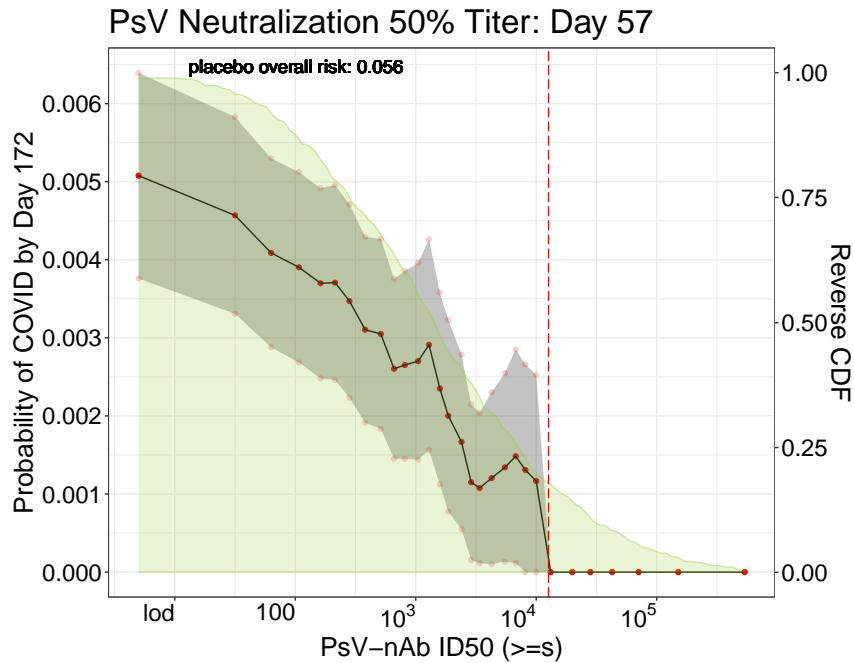


Figure 5.3: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

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 |
|------------------------|---------------|---------------|---------|----------|
| 0.699 | $5.00 * 10^0$ | 0.00508 | 0.00376 | 0.00639 |
| 2.033 | $1.08 * 10^2$ | 0.00390 | 0.00268 | 0.00512 |
| 2.447 | $2.80 * 10^2$ | 0.00347 | 0.00223 | 0.00471 |
| 2.913 | $8.18 * 10^2$ | 0.00265 | 0.00145 | 0.00385 |
| 3.196 | $1.57 * 10^3$ | 0.00235 | 0.00112 | 0.00358 |
| 3.464 | $2.91 * 10^3$ | 0.00115 | 0.00016 | 0.00215 |
| 3.736 | $5.45 * 10^3$ | 0.00134 | 0.00013 | 0.00255 |
| 4.123 | $1.33 * 10^4$ | 0.00000 | 0.00000 | NA |
| 4.629 | $4.26 * 10^4$ | 0.00000 | 0.00000 | NA |
| 5.730 | $5.37 * 10^5$ | 0.00000 | 0.00000 | NA |

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

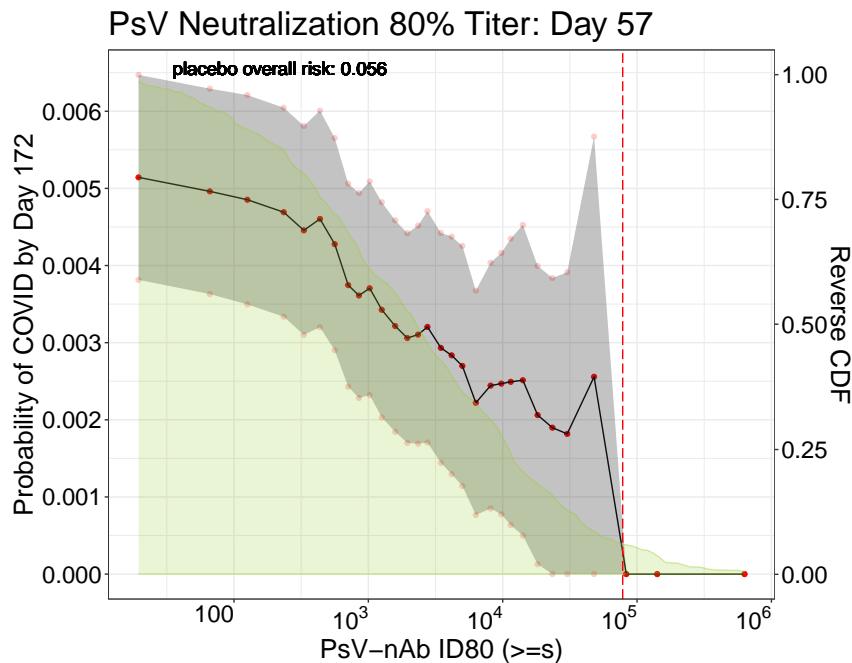


Figure 5.4: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

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 |
|------------------------|---------------|---------------|---------|----------|
| 1.289 | $1.95 * 10^1$ | 0.00514 | 0.00381 | 0.00647 |
| 2.368 | $2.33 * 10^2$ | 0.00469 | 0.00334 | 0.00605 |
| 2.755 | $5.69 * 10^2$ | 0.00428 | 0.00290 | 0.00565 |
| 3.104 | $1.27 * 10^3$ | 0.00343 | 0.00203 | 0.00482 |
| 3.373 | $2.36 * 10^3$ | 0.00310 | 0.00169 | 0.00452 |
| 3.624 | $4.21 * 10^3$ | 0.00284 | 0.00130 | 0.00438 |
| 3.909 | $8.11 * 10^3$ | 0.00244 | 0.00085 | 0.00404 |
| 4.259 | $1.82 * 10^4$ | 0.00206 | 0.00013 | 0.00400 |
| 4.676 | $4.74 * 10^4$ | 0.00256 | 0.00000 | 0.00567 |
| 5.796 | $6.25 * 10^5$ | 0.00000 | 0.00000 | NA |

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

5.2.1 Day 29 Spike protein antibody

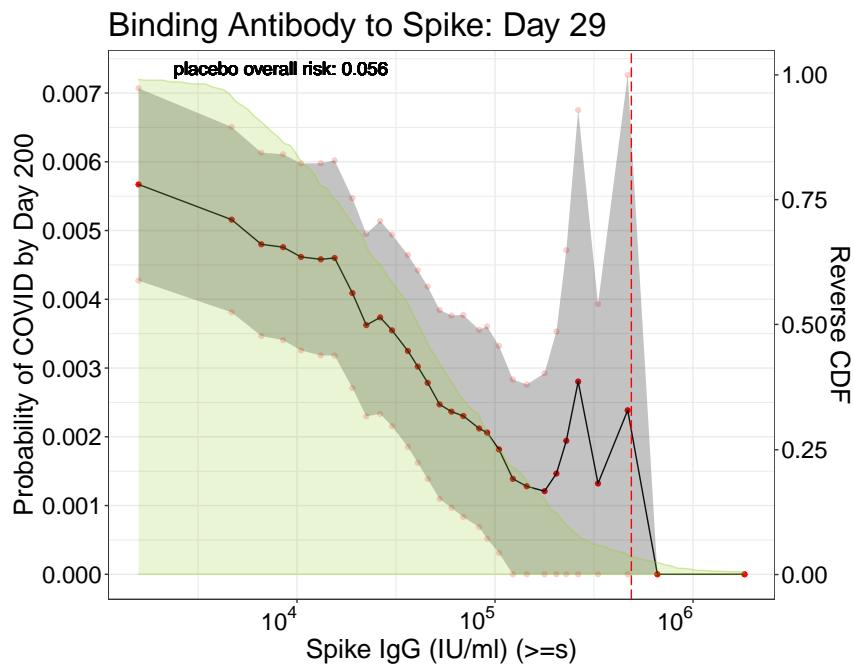


Figure 5.5: Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

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 |
|------------------------|---------------|---------------|---------|----------|
| 3.202 | $1.59 * 10^3$ | 0.00567 | 0.00427 | 0.00707 |
| 3.926 | $8.43 * 10^3$ | 0.00476 | 0.00341 | 0.00611 |
| 4.187 | $1.54 * 10^4$ | 0.00460 | 0.00318 | 0.00602 |
| 4.478 | $3.01 * 10^4$ | 0.00355 | 0.00215 | 0.00494 |
| 4.658 | $4.55 * 10^4$ | 0.00278 | 0.00138 | 0.00419 |
| 4.841 | $6.93 * 10^4$ | 0.00230 | 0.00083 | 0.00377 |
| 5.022 | $1.05 * 10^5$ | 0.00182 | 0.00031 | 0.00332 |
| 5.310 | $2.04 * 10^5$ | 0.00147 | 0.00000 | 0.00353 |
| 5.523 | $3.33 * 10^5$ | 0.00132 | 0.00000 | 0.00393 |
| 6.259 | $1.82 * 10^6$ | 0.00000 | 0.00000 | NA |

5.2.2 Day 29 RBD binding antibody

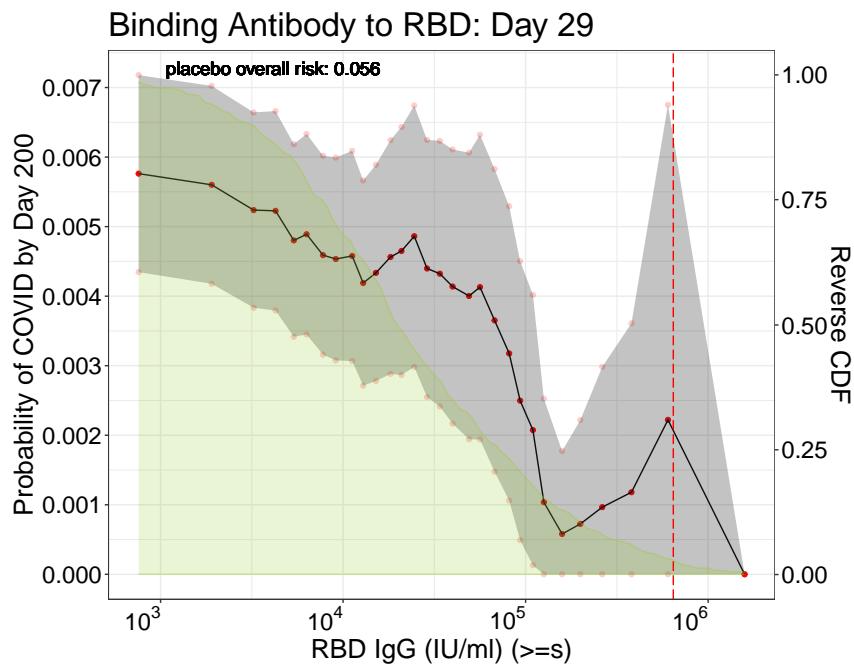


Figure 5.6: Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

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 |
|------------------------|---------------|---------------|---------|----------|
| 2.882 | $7.62 * 10^2$ | 0.00576 | 0.00435 | 0.00718 |
| 3.628 | $4.25 * 10^3$ | 0.00523 | 0.00379 | 0.00666 |
| 3.889 | $7.74 * 10^3$ | 0.00459 | 0.00316 | 0.00602 |
| 4.180 | $1.51 * 10^4$ | 0.00434 | 0.00278 | 0.00589 |
| 4.395 | $2.48 * 10^4$ | 0.00486 | 0.00298 | 0.00674 |
| 4.603 | $4.01 * 10^4$ | 0.00414 | 0.00217 | 0.00611 |
| 4.826 | $6.70 * 10^4$ | 0.00365 | 0.00148 | 0.00583 |
| 5.105 | $1.27 * 10^5$ | 0.00104 | 0.00000 | 0.00253 |
| 5.422 | $2.64 * 10^5$ | 0.00097 | 0.00000 | 0.00298 |
| 6.197 | $1.57 * 10^6$ | 0.00000 | 0.00000 | NA |

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

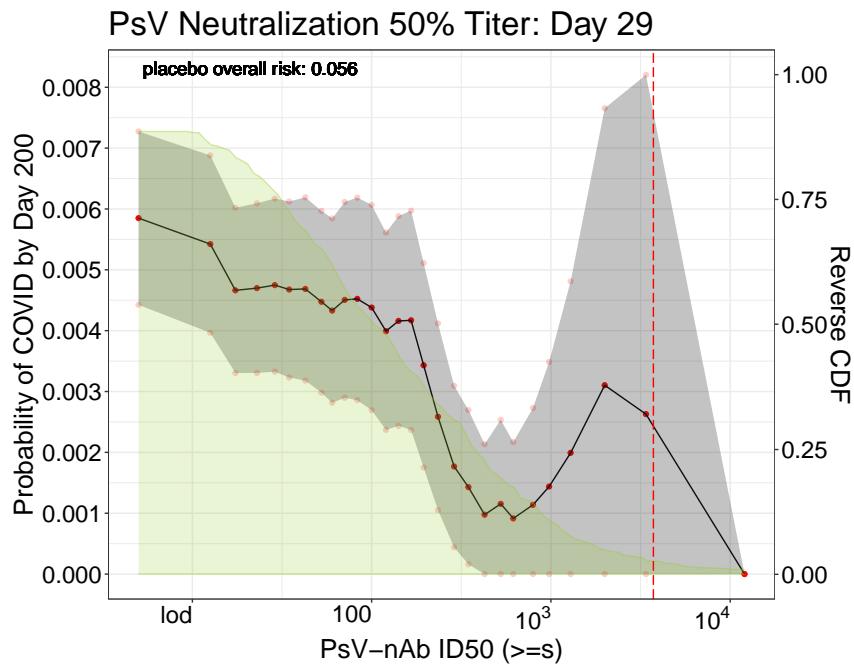


Figure 5.7: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

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 |
|------------------------|---------------|---------------|---------|----------|
| 0.699 | $5.00 * 10^0$ | 0.00585 | 0.00442 | 0.00727 |
| 1.363 | $2.31 * 10^1$ | 0.00470 | 0.00331 | 0.00609 |
| 1.628 | $4.25 * 10^1$ | 0.00469 | 0.00318 | 0.00619 |
| 1.848 | $7.05 * 10^1$ | 0.00451 | 0.00290 | 0.00611 |
| 2.078 | $1.20 * 10^2$ | 0.00399 | 0.00237 | 0.00561 |
| 2.293 | $1.96 * 10^2$ | 0.00343 | 0.00175 | 0.00511 |
| 2.537 | $3.44 * 10^2$ | 0.00143 | 0.00016 | 0.00270 |
| 2.791 | $6.18 * 10^2$ | 0.00091 | 0.00000 | 0.00217 |
| 3.109 | $1.29 * 10^3$ | 0.00199 | 0.00000 | 0.00481 |
| 4.080 | $1.20 * 10^4$ | 0.00000 | 0.00000 | NA |

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

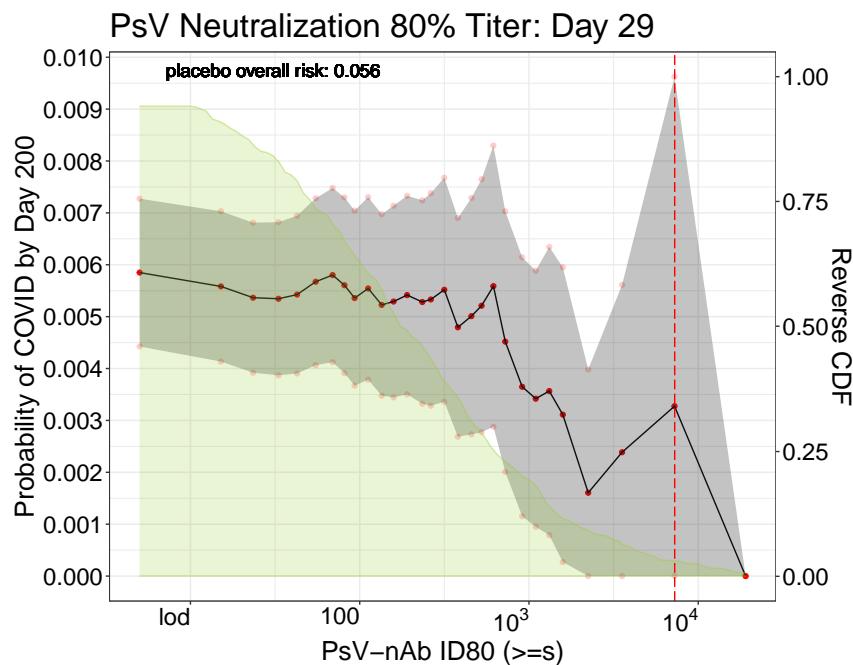


Figure 5.8: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

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 | 0.00585 | 0.00442 | 0.00727 |
| 1.525 | 3.35 * 10 ¹ | 0.00535 | 0.00387 | 0.00682 |
| 1.840 | 6.92 * 10 ¹ | 0.00580 | 0.00412 | 0.00748 |
| 2.049 | 1.12 * 10 ² | 0.00554 | 0.00379 | 0.00730 |
| 2.276 | 1.89 * 10 ² | 0.00542 | 0.00350 | 0.00733 |
| 2.583 | 3.83 * 10 ² | 0.00479 | 0.00269 | 0.00690 |
| 2.785 | 6.10 * 10 ² | 0.00559 | 0.00288 | 0.00830 |
| 3.039 | 1.09 * 10 ³ | 0.00342 | 0.00095 | 0.00589 |
| 3.351 | 2.24 * 10 ³ | 0.00161 | 0.00000 | 0.00398 |
| 4.285 | 1.93 * 10 ⁴ | 0.00000 | 0.00000 | NA |

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

5.3.1 Day 57 Spike protein binding antibody

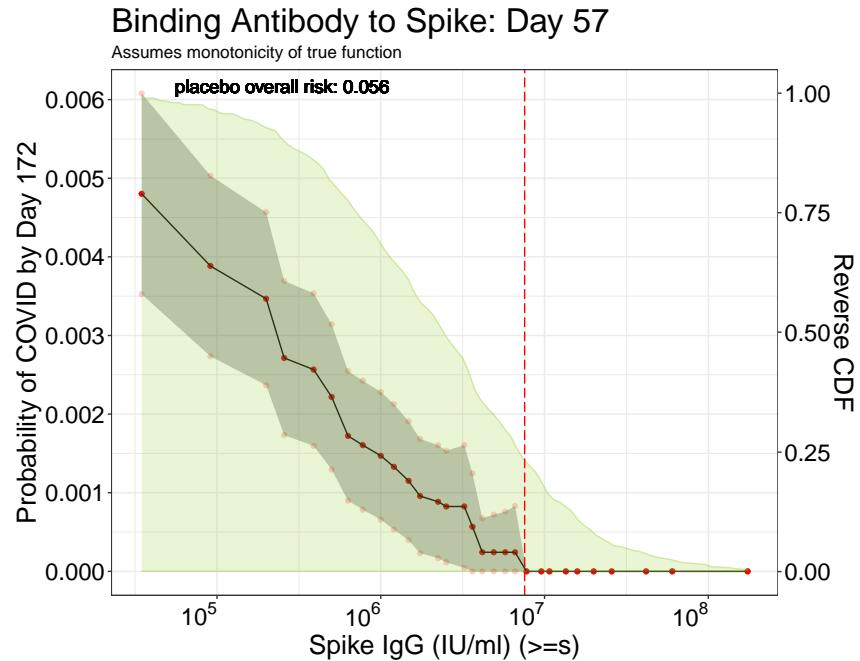


Figure 5.9: Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted 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 |
|------------------------|--------------------|---------------|---------|----------|
| 4.536 | 3.44×10^4 | 0.00480 | 0.00353 | 0.00608 |
| 5.413 | 2.59×10^5 | 0.00271 | 0.00173 | 0.00369 |
| 5.797 | 6.27×10^5 | 0.00172 | 0.00090 | 0.00255 |
| 6.165 | 1.46×10^6 | 0.00115 | 0.00040 | 0.00191 |
| 6.405 | 2.54×10^6 | 0.00083 | 0.00012 | 0.00153 |
| 6.622 | 4.19×10^6 | 0.00024 | 0.00000 | 0.00067 |
| 6.820 | 6.61×10^6 | 0.00024 | 0.00000 | 0.00083 |
| 7.127 | 1.34×10^7 | 0.00000 | 0.00000 | NA |
| 7.409 | 2.56×10^7 | 0.00000 | 0.00000 | NA |
| 8.244 | 1.75×10^8 | 0.00000 | 0.00000 | NA |

5.3.2 Day 57 RBD binding antibody

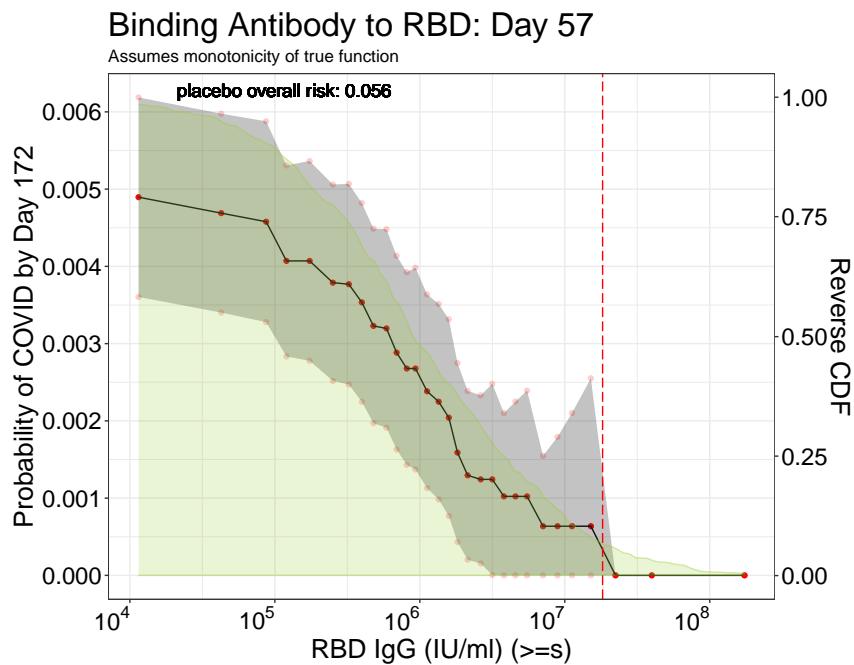


Figure 5.10: Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using 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 |
|------------------------------|--------------------|---------------|---------|----------|
| 4.062 | 1.15×10^4 | 0.00490 | 0.00360 | 0.00619 |
| 5.085 | 1.22×10^5 | 0.00407 | 0.00283 | 0.00531 |
| 5.507 | 3.21×10^5 | 0.00377 | 0.00247 | 0.00507 |
| 5.839 | 6.90×10^5 | 0.00288 | 0.00163 | 0.00414 |
| 6.048 | 1.12×10^6 | 0.00238 | 0.00113 | 0.00364 |
| 6.257 | 1.81×10^6 | 0.00159 | 0.00043 | 0.00275 |
| 6.499 | 3.16×10^6 | 0.00124 | 0.00001 | 0.00248 |
| 6.847 | 7.03×10^6 | 0.00064 | 0.00000 | 0.00155 |
| 7.181 | 1.52×10^7 | 0.00064 | 0.00000 | 0.00255 |
| 8.239 | 1.73×10^8 | 0.00000 | 0.00000 | NA |

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

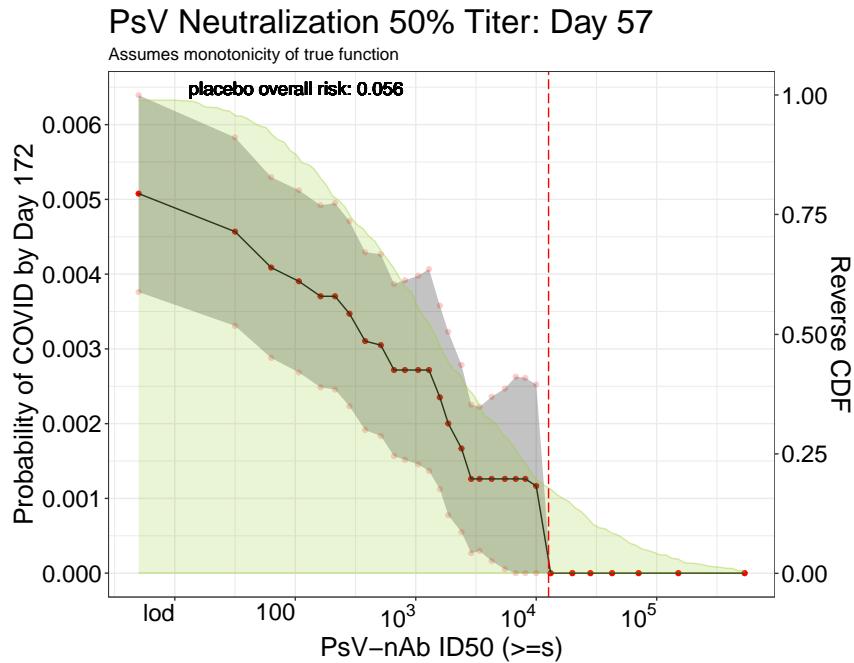


Figure 5.11: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence 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 |
|------------------------|---------------|---------------|---------|----------|
| 0.699 | $5.00 * 10^0$ | 0.00508 | 0.00376 | 0.00639 |
| 2.033 | $1.08 * 10^2$ | 0.00390 | 0.00268 | 0.00512 |
| 2.447 | $2.80 * 10^2$ | 0.00347 | 0.00223 | 0.00471 |
| 2.913 | $8.18 * 10^2$ | 0.00272 | 0.00152 | 0.00392 |
| 3.196 | $1.57 * 10^3$ | 0.00235 | 0.00112 | 0.00358 |
| 3.464 | $2.91 * 10^3$ | 0.00126 | 0.00027 | 0.00225 |
| 3.736 | $5.45 * 10^3$ | 0.00126 | 0.00005 | 0.00247 |
| 4.123 | $1.33 * 10^4$ | 0.00000 | 0.00000 | NA |
| 4.629 | $4.26 * 10^4$ | 0.00000 | 0.00000 | NA |
| 5.730 | $5.37 * 10^5$ | 0.00000 | 0.00000 | NA |

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

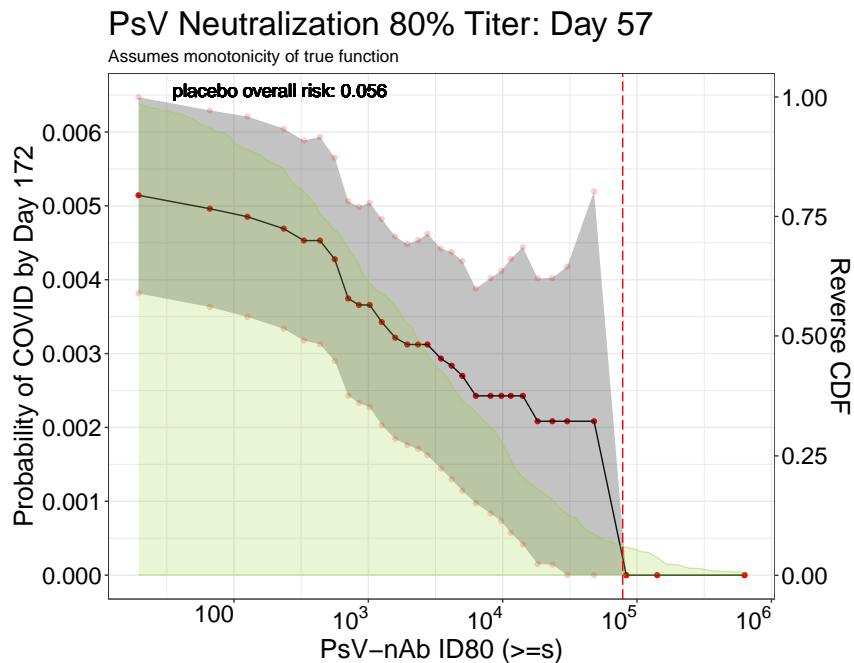


Figure 5.12: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence 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 |
|------------------------|--------------------|---------------|---------|----------|
| 1.289 | 1.95×10^1 | 0.00514 | 0.00381 | 0.00647 |
| 2.368 | 2.33×10^2 | 0.00469 | 0.00334 | 0.00605 |
| 2.755 | 5.69×10^2 | 0.00428 | 0.00290 | 0.00565 |
| 3.104 | 1.27×10^3 | 0.00343 | 0.00203 | 0.00482 |
| 3.373 | 2.36×10^3 | 0.00312 | 0.00171 | 0.00454 |
| 3.624 | 4.21×10^3 | 0.00284 | 0.00130 | 0.00438 |
| 3.909 | 8.11×10^3 | 0.00243 | 0.00083 | 0.00402 |
| 4.259 | 1.82×10^4 | 0.00208 | 0.00015 | 0.00402 |
| 4.676 | 4.74×10^4 | 0.00208 | 0.00000 | 0.00520 |
| 5.796 | 6.25×10^5 | 0.00000 | 0.00000 | NA |

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

5.4.1 Day 29 Spike protein antibody

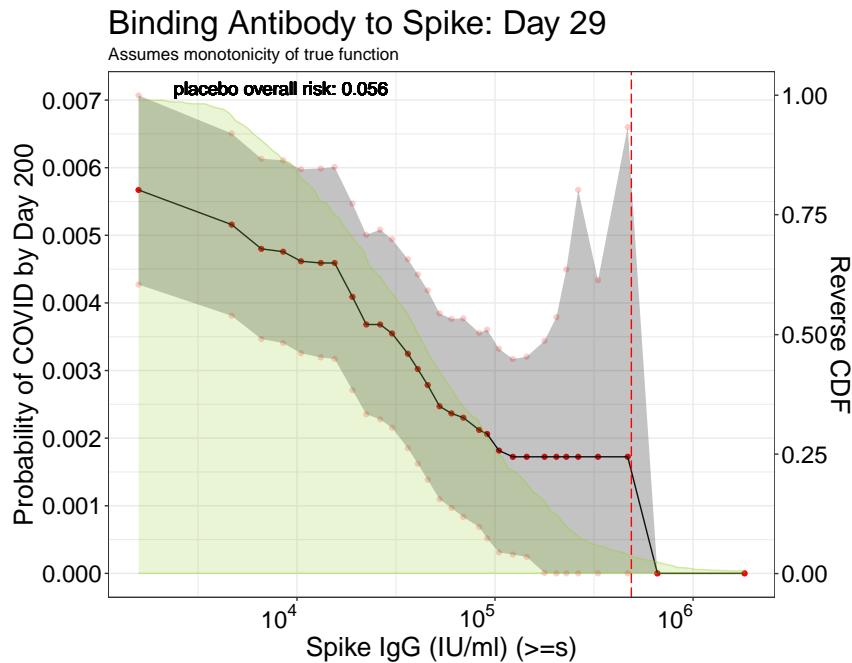


Figure 5.13: Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using 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 |
|------------------------------|--------------------|---------------|---------|----------|
| 3.202 | 1.59×10^3 | 0.00567 | 0.00427 | 0.00707 |
| 3.926 | 8.43×10^3 | 0.00476 | 0.00341 | 0.00611 |
| 4.187 | 1.54×10^4 | 0.00459 | 0.00317 | 0.00601 |
| 4.478 | 3.01×10^4 | 0.00355 | 0.00215 | 0.00494 |
| 4.658 | 4.55×10^4 | 0.00278 | 0.00138 | 0.00419 |
| 4.841 | 6.93×10^4 | 0.00230 | 0.00083 | 0.00377 |
| 5.022 | 1.05×10^5 | 0.00182 | 0.00031 | 0.00332 |
| 5.310 | 2.04×10^5 | 0.00172 | 0.00000 | 0.00379 |
| 5.523 | 3.33×10^5 | 0.00172 | 0.00000 | 0.00434 |
| 6.259 | 1.82×10^6 | 0.00000 | 0.00000 | NA |

5.4.2 Day 29 RBD binding antibody

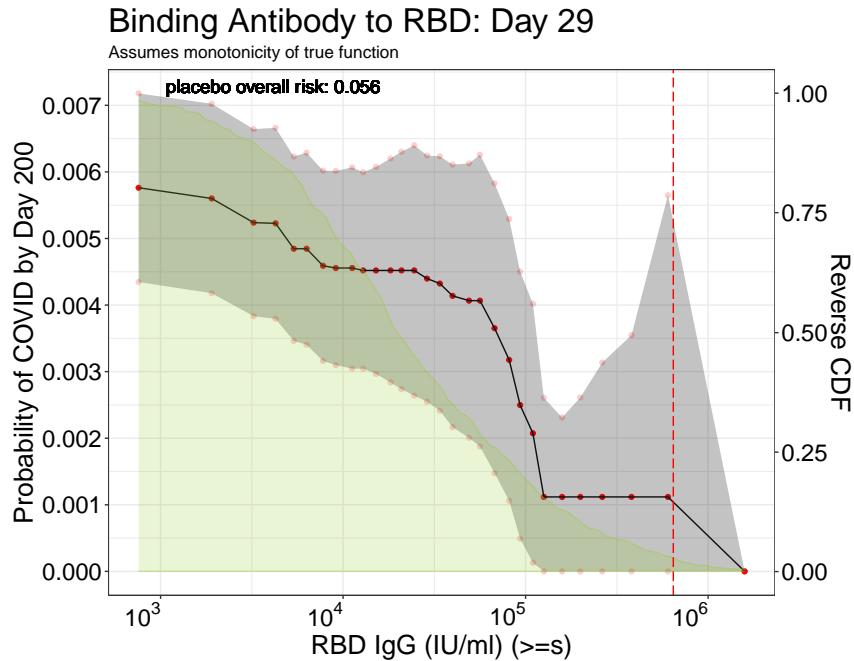


Figure 5.14: Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using 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 |
|------------------------------|--------------------|---------------|---------|----------|
| 2.882 | 7.62×10^2 | 0.00576 | 0.00435 | 0.00718 |
| 3.628 | 4.25×10^3 | 0.00523 | 0.00379 | 0.00666 |
| 3.889 | 7.74×10^3 | 0.00459 | 0.00316 | 0.00602 |
| 4.180 | 1.51×10^4 | 0.00452 | 0.00297 | 0.00607 |
| 4.395 | 2.48×10^4 | 0.00452 | 0.00264 | 0.00640 |
| 4.603 | 4.01×10^4 | 0.00414 | 0.00217 | 0.00611 |
| 4.826 | 6.70×10^4 | 0.00365 | 0.00148 | 0.00583 |
| 5.105 | 1.27×10^5 | 0.00112 | 0.00000 | 0.00261 |
| 5.422 | 2.64×10^5 | 0.00112 | 0.00000 | 0.00314 |
| 6.197 | 1.57×10^6 | 0.00000 | 0.00000 | NA |

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

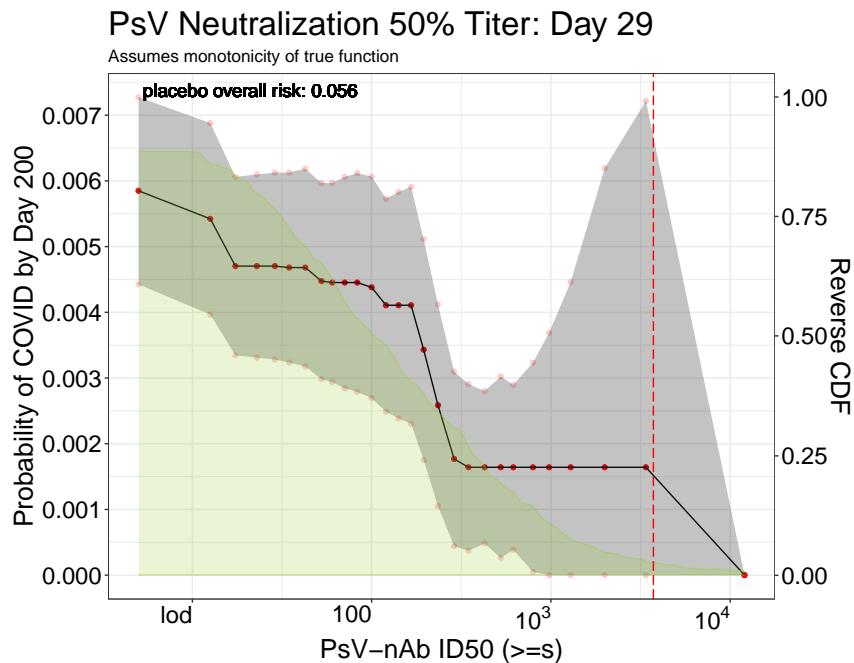


Figure 5.15: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence 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 |
|------------------------|---------------|---------------|---------|----------|
| 0.699 | $5.00 * 10^0$ | 0.00585 | 0.00442 | 0.00727 |
| 1.363 | $2.31 * 10^1$ | 0.00470 | 0.00331 | 0.00610 |
| 1.628 | $4.25 * 10^1$ | 0.00468 | 0.00318 | 0.00619 |
| 1.848 | $7.05 * 10^1$ | 0.00445 | 0.00284 | 0.00606 |
| 2.078 | $1.20 * 10^2$ | 0.00411 | 0.00249 | 0.00573 |
| 2.293 | $1.96 * 10^2$ | 0.00343 | 0.00175 | 0.00511 |
| 2.537 | $3.44 * 10^2$ | 0.00164 | 0.00037 | 0.00291 |
| 2.791 | $6.18 * 10^2$ | 0.00164 | 0.00039 | 0.00290 |
| 3.109 | $1.29 * 10^3$ | 0.00164 | 0.00000 | 0.00446 |
| 4.080 | $1.20 * 10^4$ | 0.00000 | 0.00000 | NA |

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

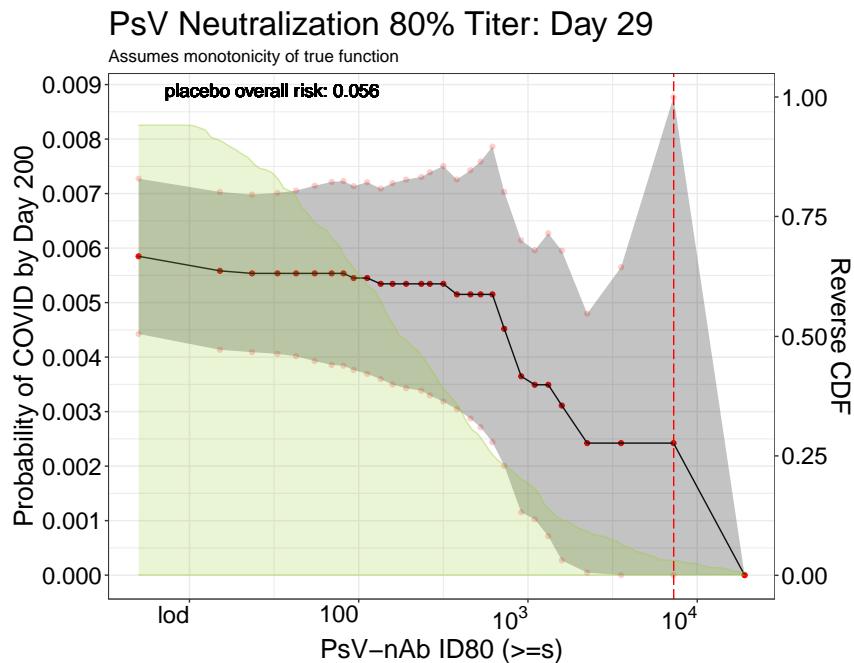


Figure 5.16: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence 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 | $5.00 * 10^0$ | 0.00585 | 0.00442 | 0.00727 |
| 1.525 | $3.35 * 10^1$ | 0.00554 | 0.00406 | 0.00701 |
| 1.840 | $6.92 * 10^1$ | 0.00554 | 0.00386 | 0.00721 |
| 2.049 | $1.12 * 10^2$ | 0.00545 | 0.00369 | 0.00721 |
| 2.276 | $1.89 * 10^2$ | 0.00534 | 0.00343 | 0.00726 |
| 2.583 | $3.83 * 10^2$ | 0.00515 | 0.00304 | 0.00726 |
| 2.785 | $6.10 * 10^2$ | 0.00515 | 0.00244 | 0.00786 |
| 3.039 | $1.09 * 10^3$ | 0.00349 | 0.00102 | 0.00596 |
| 3.351 | $2.24 * 10^3$ | 0.00242 | 0.00005 | 0.00480 |
| 4.285 | $1.93 * 10^4$ | 0.00000 | 0.00000 | NA |

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

5.5.1 Day 57 Spike protein binding antibody

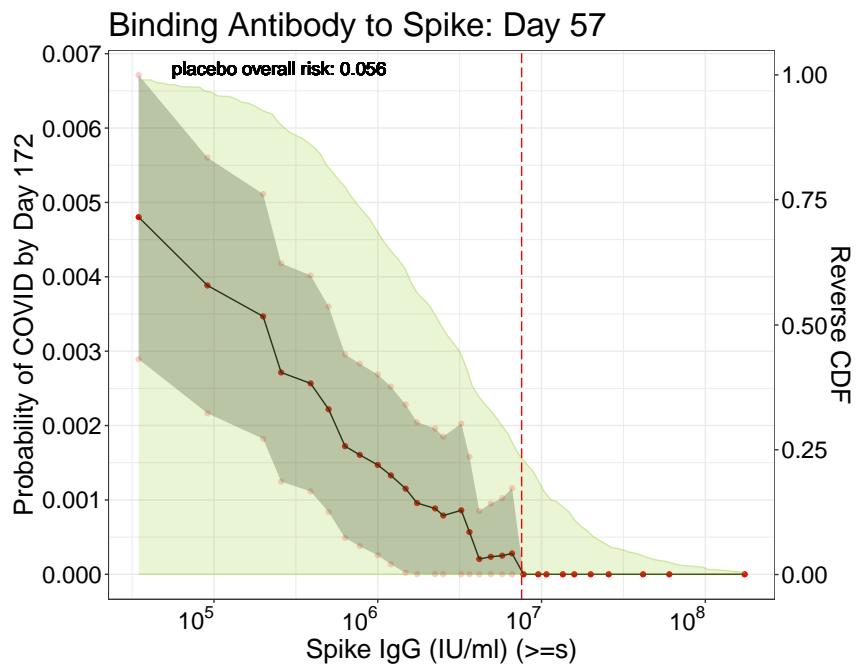


Figure 5.17: Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

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 |
|------------------------|---------------|---------------|---------|----------|
| 4.536 | $3.44 * 10^4$ | 0.00480 | 0.00289 | 0.00671 |
| 5.413 | $2.59 * 10^5$ | 0.00271 | 0.00125 | 0.00418 |
| 5.797 | $6.27 * 10^5$ | 0.00172 | 0.00049 | 0.00296 |
| 6.165 | $1.46 * 10^6$ | 0.00115 | 0.00002 | 0.00228 |
| 6.405 | $2.54 * 10^6$ | 0.00079 | 0.00000 | 0.00185 |
| 6.622 | $4.19 * 10^6$ | 0.00021 | 0.00000 | 0.00085 |
| 6.820 | $6.61 * 10^6$ | 0.00028 | 0.00000 | 0.00116 |
| 7.127 | $1.34 * 10^7$ | 0.00000 | 0.00000 | NA |
| 7.409 | $2.56 * 10^7$ | 0.00000 | 0.00000 | NA |
| 8.244 | $1.75 * 10^8$ | 0.00000 | 0.00000 | NA |

5.5.2 Day 57 RBD binding antibody

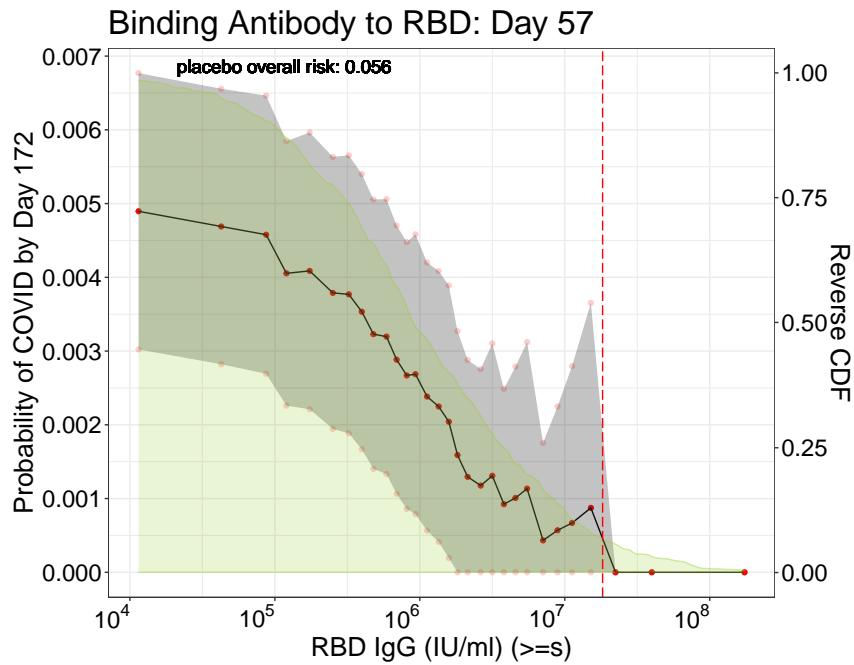


Figure 5.18: Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

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 |
|------------------------|--------------------|---------------|---------|----------|
| 4.062 | 1.15×10^4 | 0.00490 | 0.00302 | 0.00677 |
| 5.085 | 1.22×10^5 | 0.00405 | 0.00226 | 0.00585 |
| 5.507 | 3.21×10^5 | 0.00377 | 0.00188 | 0.00565 |
| 5.839 | 6.90×10^5 | 0.00288 | 0.00106 | 0.00470 |
| 6.048 | 1.12×10^6 | 0.00238 | 0.00056 | 0.00420 |
| 6.257 | 1.81×10^6 | 0.00159 | 0.00000 | 0.00327 |
| 6.499 | 3.16×10^6 | 0.00131 | 0.00000 | 0.00310 |
| 6.847 | 7.03×10^6 | 0.00043 | 0.00000 | 0.00176 |
| 7.181 | 1.52×10^7 | 0.00087 | 0.00000 | 0.00365 |
| 8.239 | 1.73×10^8 | 0.00000 | 0.00000 | NA |

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

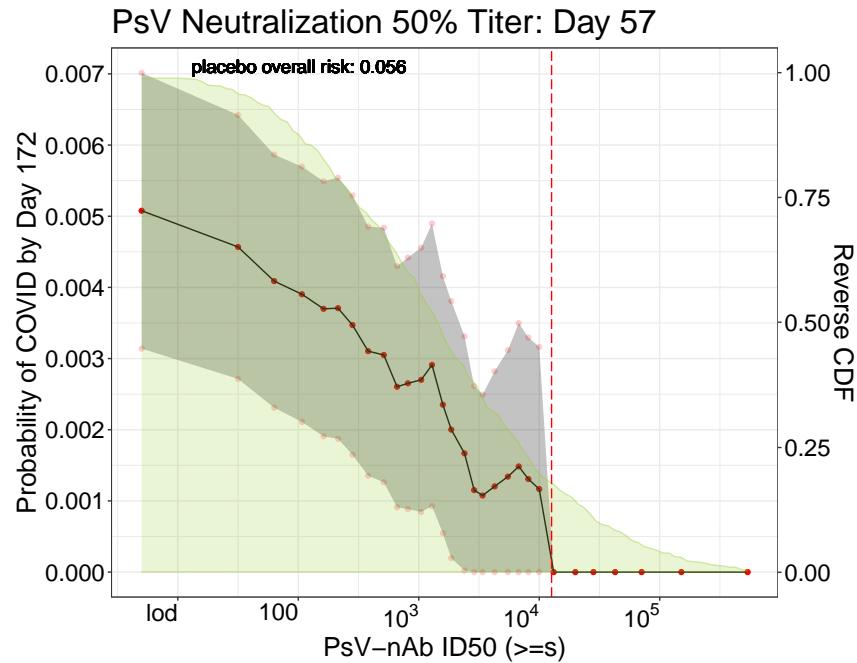


Figure 5.19: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

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 |
|------------------------------|------------------------|---------------|---------|----------|
| 0.699 | 5.00 * 10 ⁰ | 0.00508 | 0.00314 | 0.00701 |
| 2.033 | 1.08 * 10 ² | 0.00390 | 0.00211 | 0.00570 |
| 2.447 | 2.80 * 10 ² | 0.00347 | 0.00165 | 0.00529 |
| 2.913 | 8.18 * 10 ² | 0.00265 | 0.00089 | 0.00442 |
| 3.196 | 1.57 * 10 ³ | 0.00235 | 0.00055 | 0.00416 |
| 3.464 | 2.91 * 10 ³ | 0.00115 | 0.00000 | 0.00261 |
| 3.736 | 5.45 * 10 ³ | 0.00134 | 0.00000 | 0.00312 |
| 4.123 | 1.33 * 10 ⁴ | 0.00000 | 0.00000 | NA |
| 4.629 | 4.26 * 10 ⁴ | 0.00000 | 0.00000 | NA |
| 5.730 | 5.37 * 10 ⁵ | 0.00000 | 0.00000 | NA |

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

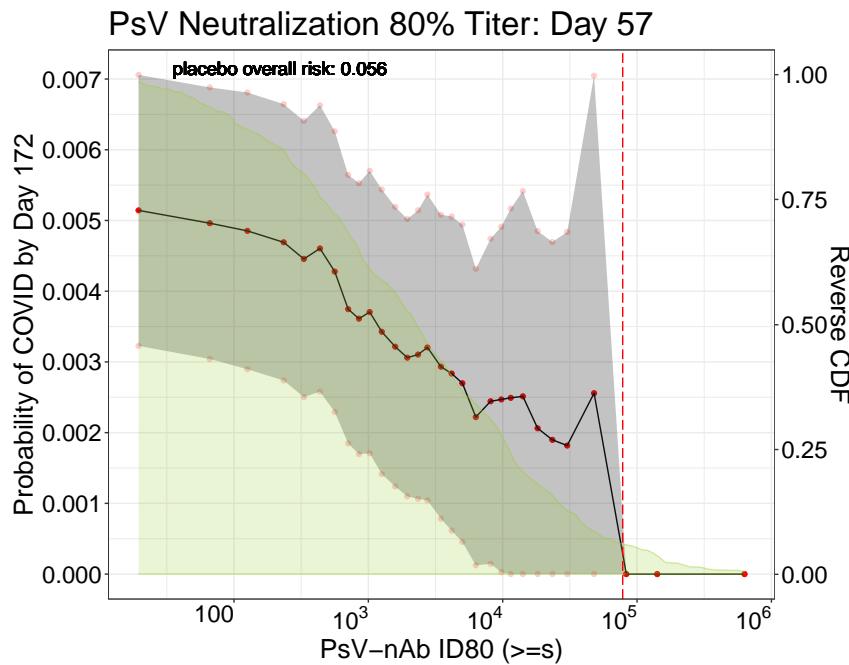


Figure 5.20: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

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 |
|------------------------|--------------------|---------------|---------|----------|
| 1.289 | 1.95×10^1 | 0.00514 | 0.00323 | 0.00706 |
| 2.368 | 2.33×10^2 | 0.00469 | 0.00274 | 0.00665 |
| 2.755 | 5.69×10^2 | 0.00428 | 0.00229 | 0.00626 |
| 3.104 | 1.27×10^3 | 0.00343 | 0.00141 | 0.00544 |
| 3.373 | 2.36×10^3 | 0.00310 | 0.00107 | 0.00514 |
| 3.624 | 4.21×10^3 | 0.00284 | 0.00061 | 0.00506 |
| 3.909 | 8.11×10^3 | 0.00244 | 0.00015 | 0.00474 |
| 4.259 | 1.82×10^4 | 0.00206 | 0.00000 | 0.00485 |
| 4.676 | 4.74×10^4 | 0.00256 | 0.00000 | 0.00705 |
| 5.796 | 6.25×10^5 | 0.00000 | 0.00000 | NA |

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

5.6.1 Day 29 Spike protein antibody

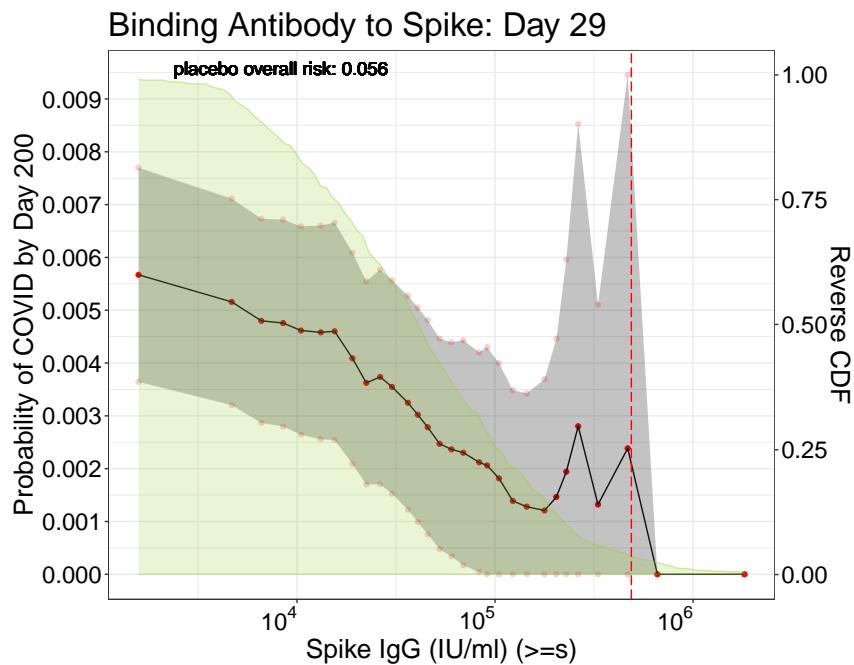


Figure 5.21: Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

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 |
|------------------------|---------------|---------------|---------|----------|
| 3.202 | $1.59 * 10^3$ | 0.00567 | 0.00364 | 0.00770 |
| 3.926 | $8.43 * 10^3$ | 0.00476 | 0.00280 | 0.00672 |
| 4.187 | $1.54 * 10^4$ | 0.00460 | 0.00254 | 0.00666 |
| 4.478 | $3.01 * 10^4$ | 0.00355 | 0.00153 | 0.00557 |
| 4.658 | $4.55 * 10^4$ | 0.00278 | 0.00076 | 0.00481 |
| 4.841 | $6.93 * 10^4$ | 0.00230 | 0.00017 | 0.00443 |
| 5.022 | $1.05 * 10^5$ | 0.00182 | 0.00000 | 0.00400 |
| 5.310 | $2.04 * 10^5$ | 0.00147 | 0.00000 | 0.00446 |
| 5.523 | $3.33 * 10^5$ | 0.00132 | 0.00000 | 0.00511 |
| 6.259 | $1.82 * 10^6$ | 0.00000 | 0.00000 | NA |

5.6.2 Day 29 RBD binding antibody

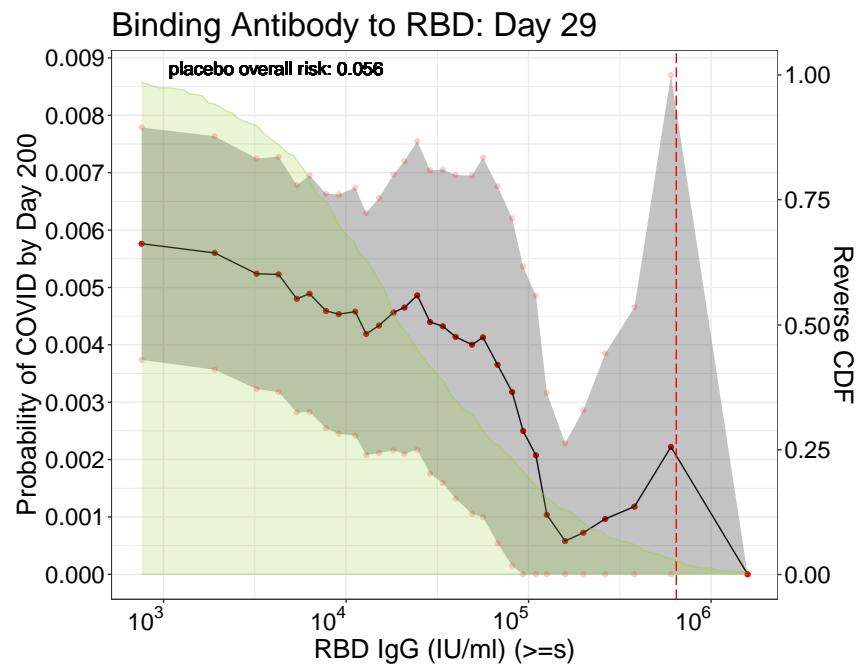


Figure 5.22: Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

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 |
|------------------------|---------------|---------------|---------|----------|
| 2.882 | $7.62 * 10^2$ | 0.00576 | 0.00374 | 0.00779 |
| 3.628 | $4.25 * 10^3$ | 0.00523 | 0.00318 | 0.00728 |
| 3.889 | $7.74 * 10^3$ | 0.00459 | 0.00255 | 0.00663 |
| 4.180 | $1.51 * 10^4$ | 0.00434 | 0.00211 | 0.00656 |
| 4.395 | $2.48 * 10^4$ | 0.00486 | 0.00217 | 0.00755 |
| 4.603 | $4.01 * 10^4$ | 0.00414 | 0.00132 | 0.00696 |
| 4.826 | $6.70 * 10^4$ | 0.00365 | 0.00054 | 0.00676 |
| 5.105 | $1.27 * 10^5$ | 0.00104 | 0.00000 | 0.00317 |
| 5.422 | $2.64 * 10^5$ | 0.00097 | 0.00000 | 0.00385 |
| 6.197 | $1.57 * 10^6$ | 0.00000 | 0.00000 | NA |

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

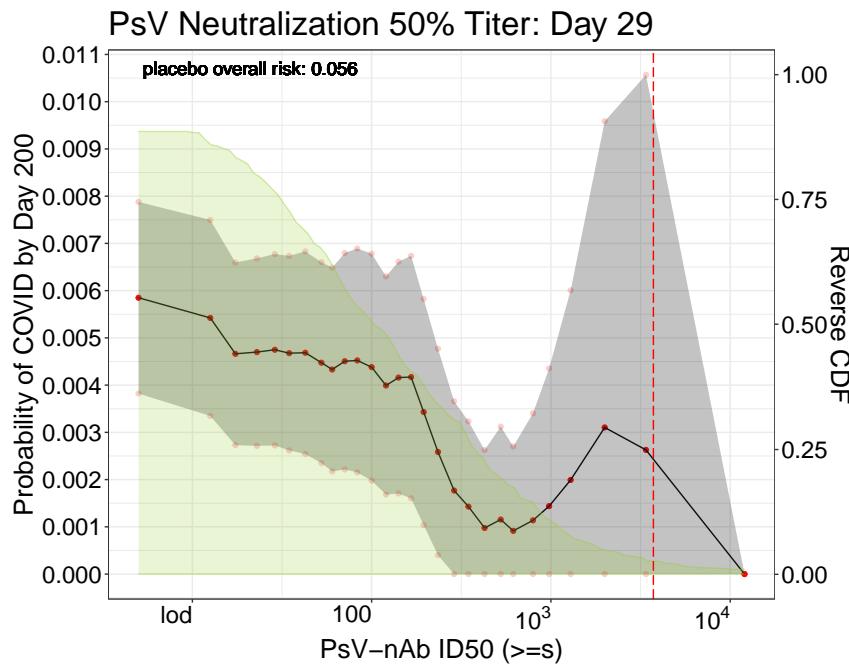


Figure 5.23: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

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 |
|------------------------------|------------------------|---------------|---------|----------|
| 0.699 | 5.00 * 10 ⁰ | 0.00585 | 0.00382 | 0.00788 |
| 1.363 | 2.31 * 10 ¹ | 0.00470 | 0.00271 | 0.00668 |
| 1.628 | 4.25 * 10 ¹ | 0.00469 | 0.00254 | 0.00683 |
| 1.848 | 7.05 * 10 ¹ | 0.00451 | 0.00222 | 0.00680 |
| 2.078 | 1.20 * 10 ² | 0.00399 | 0.00168 | 0.00630 |
| 2.293 | 1.96 * 10 ² | 0.00343 | 0.00104 | 0.00582 |
| 2.537 | 3.44 * 10 ² | 0.00143 | 0.00000 | 0.00323 |
| 2.791 | 6.18 * 10 ² | 0.00091 | 0.00000 | 0.00270 |
| 3.109 | 1.29 * 10 ³ | 0.00199 | 0.00000 | 0.00601 |
| 4.080 | 1.20 * 10 ⁴ | 0.00000 | 0.00000 | NA |

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

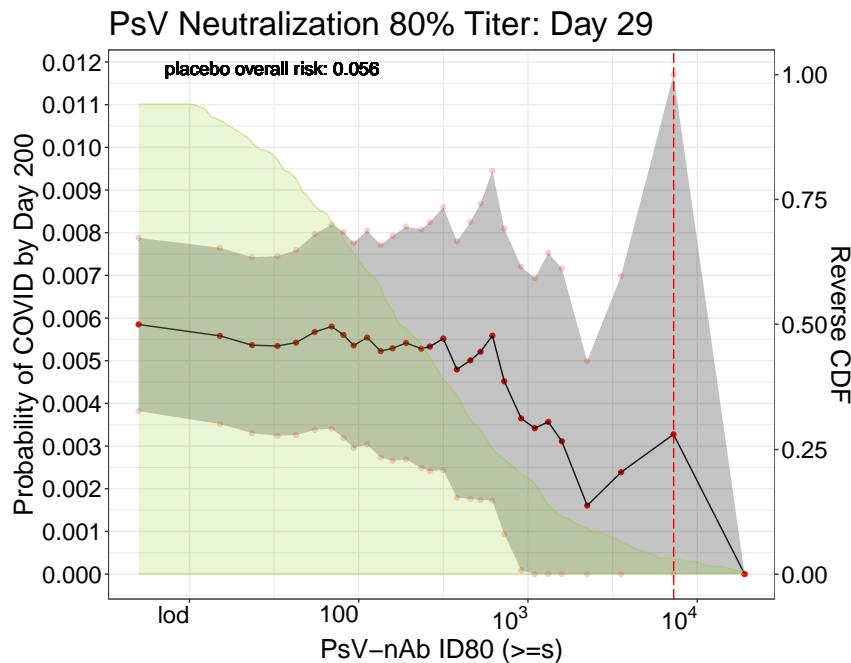


Figure 5.24: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

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 | 0.00585 | 0.00382 | 0.00788 |
| 1.525 | 3.35 * 10 ¹ | 0.00535 | 0.00324 | 0.00745 |
| 1.840 | 6.92 * 10 ¹ | 0.00580 | 0.00341 | 0.00819 |
| 2.049 | 1.12 * 10 ² | 0.00554 | 0.00304 | 0.00805 |
| 2.276 | 1.89 * 10 ² | 0.00542 | 0.00269 | 0.00814 |
| 2.583 | 3.83 * 10 ² | 0.00479 | 0.00179 | 0.00780 |
| 2.785 | 6.10 * 10 ² | 0.00559 | 0.00172 | 0.00945 |
| 3.039 | 1.09 * 10 ³ | 0.00342 | 0.00000 | 0.00694 |
| 3.351 | 2.24 * 10 ³ | 0.00161 | 0.00000 | 0.00499 |
| 4.285 | 1.93 * 10 ⁴ | 0.00000 | 0.00000 | NA |

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

5.7.1 Day 57 Spike protein binding antibody

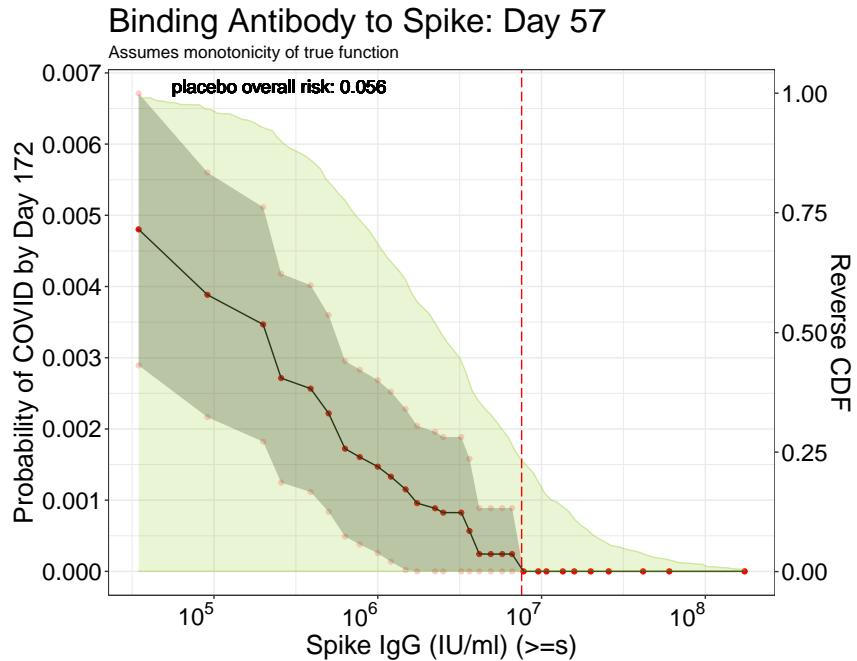


Figure 5.25: Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are 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 |
|------------------------|--------------------|---------------|---------|----------|
| 4.536 | 3.44×10^4 | 0.00480 | 0.00289 | 0.00671 |
| 5.413 | 2.59×10^5 | 0.00271 | 0.00125 | 0.00418 |
| 5.797 | 6.27×10^5 | 0.00172 | 0.00049 | 0.00296 |
| 6.165 | 1.46×10^6 | 0.00115 | 0.00002 | 0.00228 |
| 6.405 | 2.54×10^6 | 0.00083 | 0.00000 | 0.00189 |
| 6.622 | 4.19×10^6 | 0.00024 | 0.00000 | 0.00089 |
| 6.820 | 6.61×10^6 | 0.00024 | 0.00000 | 0.00112 |
| 7.127 | 1.34×10^7 | 0.00000 | 0.00000 | NA |
| 7.409 | 2.56×10^7 | 0.00000 | 0.00000 | NA |
| 8.244 | 1.75×10^8 | 0.00000 | 0.00000 | NA |

5.7.2 Day 57 RBD binding antibody

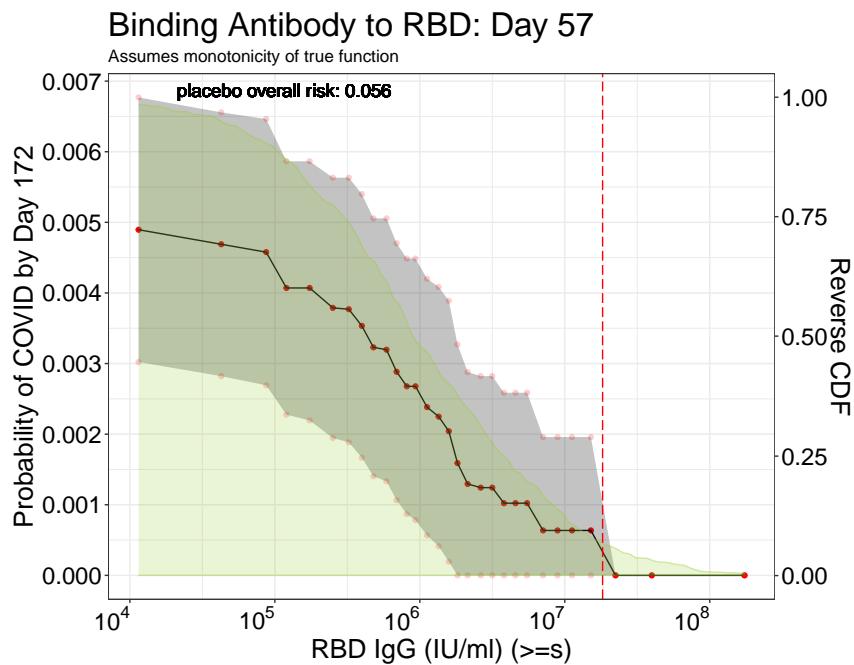


Figure 5.26: Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted 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 |
|------------------------------|--------------------|---------------|---------|----------|
| 4.062 | 1.15×10^4 | 0.00490 | 0.00302 | 0.00677 |
| 5.085 | 1.22×10^5 | 0.00407 | 0.00228 | 0.00586 |
| 5.507 | 3.21×10^5 | 0.00377 | 0.00188 | 0.00565 |
| 5.839 | 6.90×10^5 | 0.00288 | 0.00106 | 0.00470 |
| 6.048 | 1.12×10^6 | 0.00238 | 0.00056 | 0.00420 |
| 6.257 | 1.81×10^6 | 0.00159 | 0.00000 | 0.00327 |
| 6.499 | 3.16×10^6 | 0.00124 | 0.00000 | 0.00304 |
| 6.847 | 7.03×10^6 | 0.00064 | 0.00000 | 0.00196 |
| 7.181 | 1.52×10^7 | 0.00064 | 0.00000 | 0.00341 |
| 8.239 | 1.73×10^8 | 0.00000 | 0.00000 | NA |

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

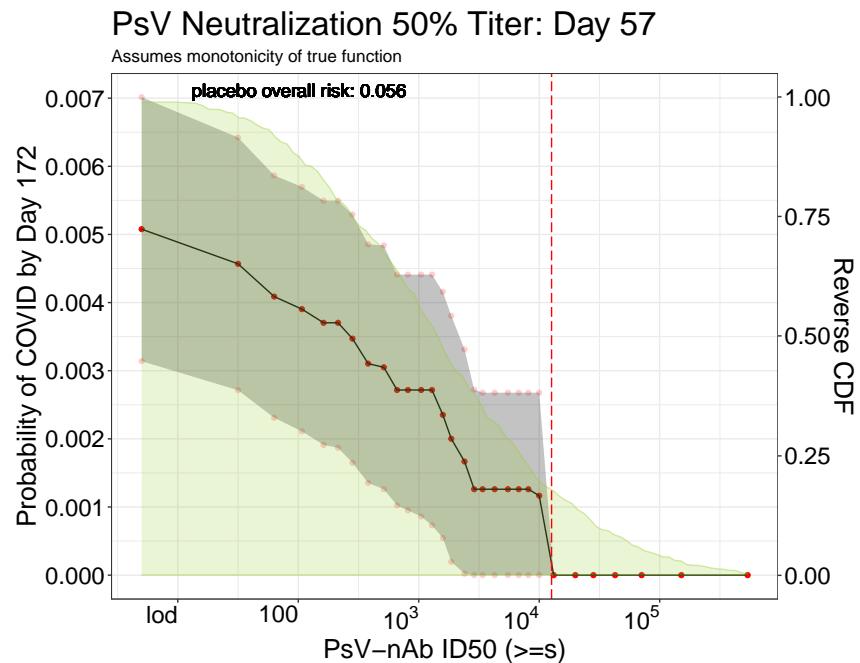


Figure 5.27: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence 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 |
|------------------------|---------------|---------------|---------|----------|
| 0.699 | $5.00 * 10^0$ | 0.00508 | 0.00314 | 0.00701 |
| 2.033 | $1.08 * 10^2$ | 0.00390 | 0.00211 | 0.00570 |
| 2.447 | $2.80 * 10^2$ | 0.00347 | 0.00165 | 0.00529 |
| 2.913 | $8.18 * 10^2$ | 0.00272 | 0.00095 | 0.00448 |
| 3.196 | $1.57 * 10^3$ | 0.00235 | 0.00055 | 0.00416 |
| 3.464 | $2.91 * 10^3$ | 0.00126 | 0.00000 | 0.00272 |
| 3.736 | $5.45 * 10^3$ | 0.00126 | 0.00000 | 0.00304 |
| 4.123 | $1.33 * 10^4$ | 0.00000 | 0.00000 | NA |
| 4.629 | $4.26 * 10^4$ | 0.00000 | 0.00000 | NA |
| 5.730 | $5.37 * 10^5$ | 0.00000 | 0.00000 | NA |

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

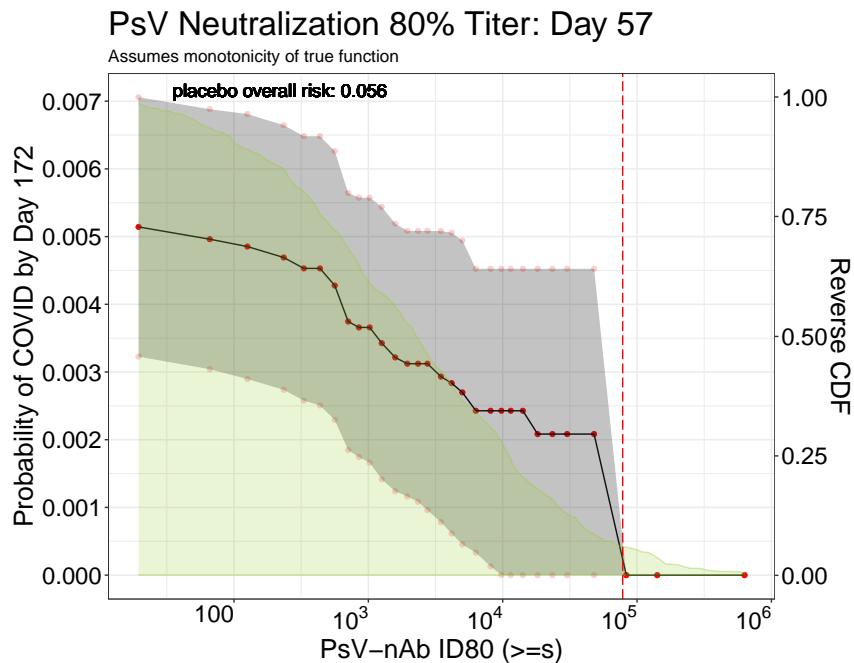


Figure 5.28: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence 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 |
|------------------------|---------------|---------------|---------|----------|
| 1.289 | $1.95 * 10^1$ | 0.00514 | 0.00323 | 0.00706 |
| 2.368 | $2.33 * 10^2$ | 0.00469 | 0.00274 | 0.00665 |
| 2.755 | $5.69 * 10^2$ | 0.00428 | 0.00229 | 0.00626 |
| 3.104 | $1.27 * 10^3$ | 0.00343 | 0.00141 | 0.00544 |
| 3.373 | $2.36 * 10^3$ | 0.00312 | 0.00108 | 0.00516 |
| 3.624 | $4.21 * 10^3$ | 0.00284 | 0.00061 | 0.00506 |
| 3.909 | $8.11 * 10^3$ | 0.00243 | 0.00013 | 0.00473 |
| 4.259 | $1.82 * 10^4$ | 0.00208 | 0.00000 | 0.00487 |
| 4.676 | $4.74 * 10^4$ | 0.00208 | 0.00000 | 0.00657 |
| 5.796 | $6.25 * 10^5$ | 0.00000 | 0.00000 | NA |

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

5.8.1 Day 29 Spike protein antibody

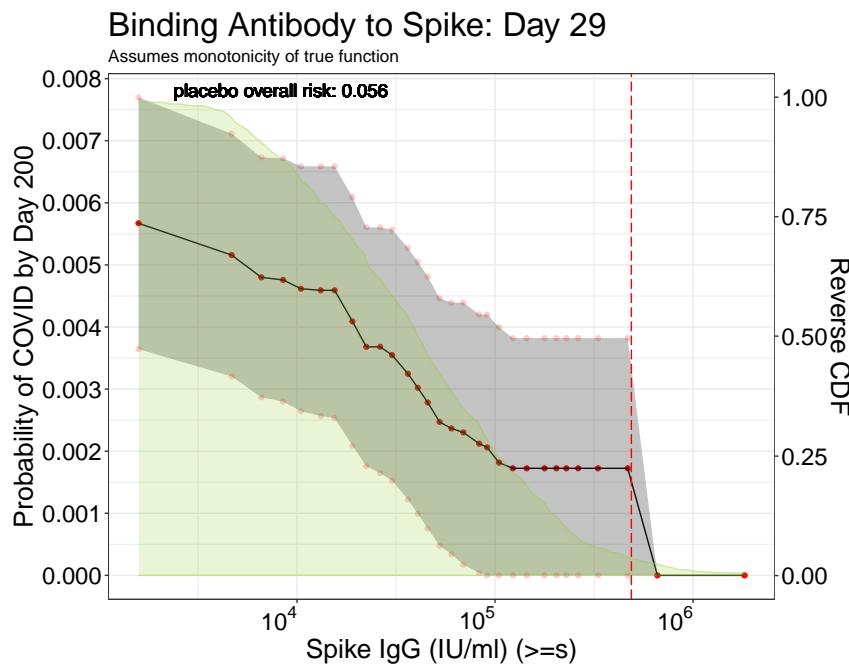


Figure 5.29: Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted 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 |
|------------------------------|------------------------|---------------|---------|----------|
| 3.202 | 1.59 * 10 ³ | 0.00567 | 0.00364 | 0.00770 |
| 3.926 | 8.43 * 10 ³ | 0.00476 | 0.00280 | 0.00672 |
| 4.187 | 1.54 * 10 ⁴ | 0.00459 | 0.00253 | 0.00665 |
| 4.478 | 3.01 * 10 ⁴ | 0.00355 | 0.00153 | 0.00557 |
| 4.658 | 4.55 * 10 ⁴ | 0.00278 | 0.00076 | 0.00481 |
| 4.841 | 6.93 * 10 ⁴ | 0.00230 | 0.00017 | 0.00443 |
| 5.022 | 1.05 * 10 ⁵ | 0.00182 | 0.00000 | 0.00400 |
| 5.310 | 2.04 * 10 ⁵ | 0.00172 | 0.00000 | 0.00472 |
| 5.523 | 3.33 * 10 ⁵ | 0.00172 | 0.00000 | 0.00551 |
| 6.259 | 1.82 * 10 ⁶ | 0.00000 | 0.00000 | NA |

5.8.2 Day 29 RBD binding antibody

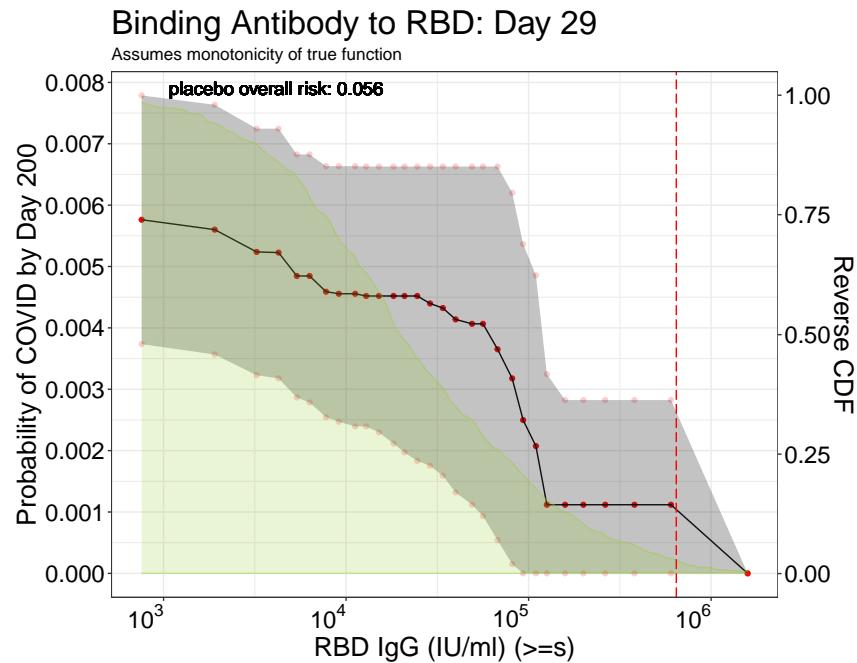


Figure 5.30: Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted 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 |
|------------------------------|--------------------|---------------|---------|----------|
| 2.882 | 7.62×10^2 | 0.00576 | 0.00374 | 0.00779 |
| 3.628 | 4.25×10^3 | 0.00523 | 0.00318 | 0.00728 |
| 3.889 | 7.74×10^3 | 0.00459 | 0.00255 | 0.00663 |
| 4.180 | 1.51×10^4 | 0.00452 | 0.00230 | 0.00674 |
| 4.395 | 2.48×10^4 | 0.00452 | 0.00183 | 0.00721 |
| 4.603 | 4.01×10^4 | 0.00414 | 0.00132 | 0.00696 |
| 4.826 | 6.70×10^4 | 0.00365 | 0.00054 | 0.00676 |
| 5.105 | 1.27×10^5 | 0.00112 | 0.00000 | 0.00325 |
| 5.422 | 2.64×10^5 | 0.00112 | 0.00000 | 0.00400 |
| 6.197 | 1.57×10^6 | 0.00000 | 0.00000 | NA |

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

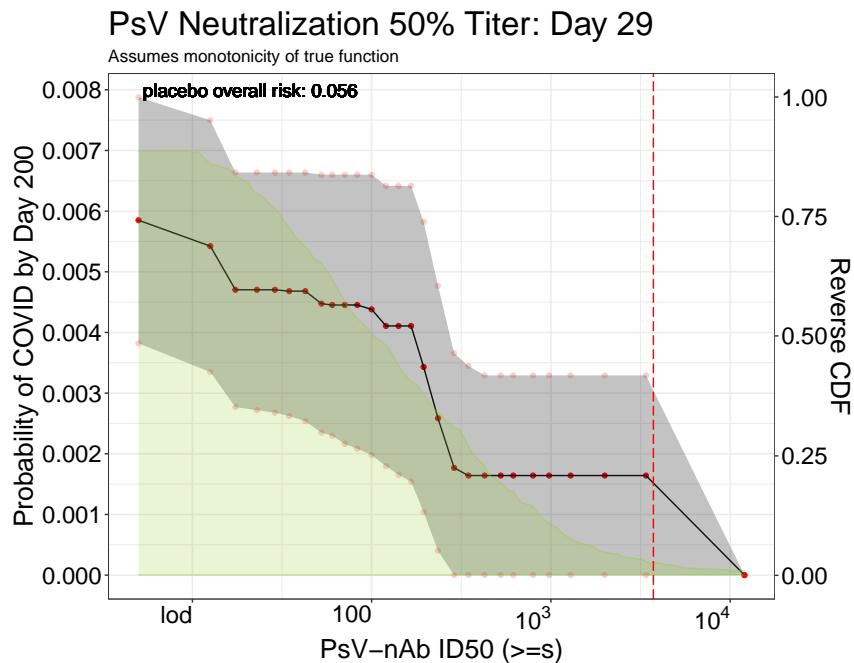


Figure 5.31: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence 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 |
|------------------------|---------------|---------------|---------|----------|
| 0.699 | $5.00 * 10^0$ | 0.00585 | 0.00382 | 0.00788 |
| 1.363 | $2.31 * 10^1$ | 0.00470 | 0.00272 | 0.00669 |
| 1.628 | $4.25 * 10^1$ | 0.00468 | 0.00254 | 0.00683 |
| 1.848 | $7.05 * 10^1$ | 0.00445 | 0.00216 | 0.00674 |
| 2.078 | $1.20 * 10^2$ | 0.00411 | 0.00180 | 0.00642 |
| 2.293 | $1.96 * 10^2$ | 0.00343 | 0.00104 | 0.00582 |
| 2.537 | $3.44 * 10^2$ | 0.00164 | 0.00000 | 0.00345 |
| 2.791 | $6.18 * 10^2$ | 0.00164 | 0.00000 | 0.00343 |
| 3.109 | $1.29 * 10^3$ | 0.00164 | 0.00000 | 0.00565 |
| 4.080 | $1.20 * 10^4$ | 0.00000 | 0.00000 | NA |

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

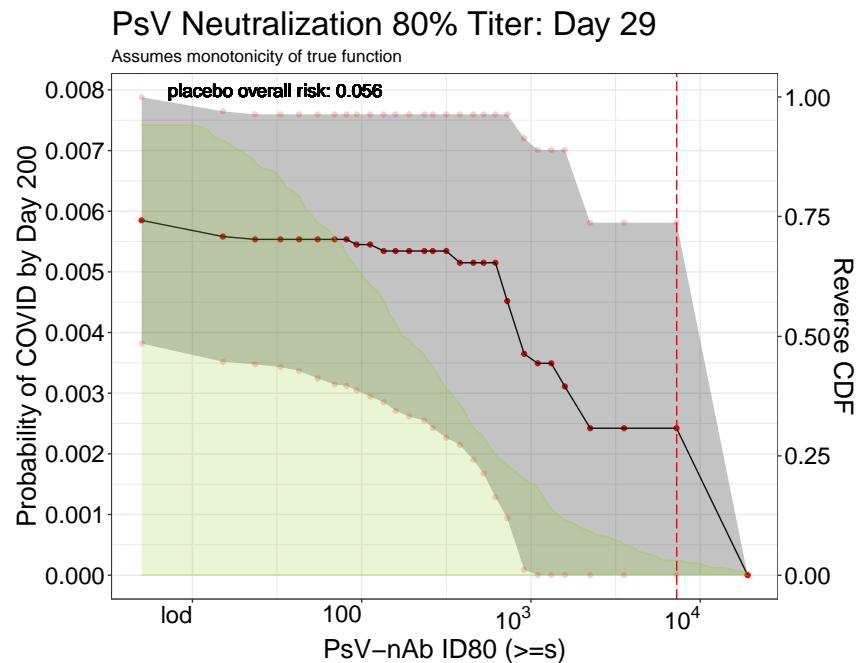


Figure 5.32: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence 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 | 0.00585 | 0.00382 | 0.00788 |
| 1.525 | 3.35×10^1 | 0.00554 | 0.00343 | 0.00764 |
| 1.840 | 6.92×10^1 | 0.00554 | 0.00314 | 0.00793 |
| 2.049 | 1.12×10^2 | 0.00545 | 0.00294 | 0.00796 |
| 2.276 | 1.89×10^2 | 0.00534 | 0.00262 | 0.00807 |
| 2.583 | 3.83×10^2 | 0.00515 | 0.00215 | 0.00816 |
| 2.785 | 6.10×10^2 | 0.00515 | 0.00129 | 0.00902 |
| 3.039 | 1.09×10^3 | 0.00349 | 0.00000 | 0.00701 |
| 3.351 | 2.24×10^3 | 0.00242 | 0.00000 | 0.00581 |
| 4.285 | 1.93×10^4 | 0.00000 | 0.00000 | NA |

Bibliography

Donovan, K., Hudgens, M., and Gilbert, P. B. (2019). Nonparametric inference for immune response thresholds of risk in vaccine studies. *Annals of Applied Statistics*, 13(2):1147–1165. PMCID: PMC6613658 [Delayed release (embargo): Available on 2020-06-01].