

COVID-19 Correlates of Risk Analysis Report
MockCOVE Study

USG COVID-19 Response Biostatistics Team

June 23, 2021

Contents

1	Disclaimers	31
2	Summary Tables	33
2.1	Demographic and Clinical Characteristics at Baseline in the Baseline SARS-CoV-2 Negative Per-Protocol Cohort	33
2.2	Demographic and Clinical Characteristics at Baseline in the Baseline SARS-CoV-2 Positive Per-Protocol Cohort	35
2.3	Sample Sizes of Baseline Strata for Correlates of Risk Analysis	36
2.4	Antibody levels in the baseline SARS-CoV-2 negative per-protocol cohort (vaccine recipients)	37
2.5	Antibody levels in the baseline SARS-CoV-2 positive per-protocol cohort (vaccine recipients)	39
2.6	Antibody levels in the baseline SARS-CoV-2 positive per-protocol cohort (placebo recipients)	41
3	Graphical Descriptions of Antibody Marker Data	43
3.1	Boxplots	44
3.2	Weighted RCDF plots	48
3.3	Weighted RCDF plots of threshold correlate concentration for vaccine efficacy	52
3.4	Spaghetti plots	56
3.5	Violin and line plots	57
4	Day 57 Univariate CoR: Cox Models of Risk	329
4.1	Hazard ratios	329
4.2	Marginalized risk and controlled vaccine efficacy plots	334
5	Day 29 Univariate CoR: Cox Models of Risk	343
5.1	Hazard ratios	343
5.2	Marginalized risk and controlled vaccine efficacy plots	348
6	Univariate CoR: Nonparametric Threshold Modeling (>=s)	357
6.1	Plots and Tables with estimates and pointwise confidence interval for Day 57	358
6.2	Plots and Tables with estimates and pointwise confidence intervals for Day 29	363

6.3	Plots and Tables with estimates and pointwise confidence interval for Day 57 (monotone-corrected)	368
6.4	Plots and Tables with estimates and pointwise confidence intervals for Day 29 (monotone-corrected)	373
6.5	Plots and Tables with estimates and simultaneous confidence bands for Day 57	378
6.6	Plots and Tables with estimates and simultaneous confidence bands for Day 29	383
6.7	Plots and Tables with estimates and pointwise confidence interval for Day 57 (monotone-corrected)	388
6.8	Plots and Tables with estimates and pointwise confidence intervals for Day 29 (monotone-corrected)	393
7	Univariate CoR: Nonparametric Threshold Modeling (<=s)	399
7.1	Plots and Tables with estimates and pointwise confidence interval for Day 57	399
7.2	Plots and Tables with estimates and pointwise confidence intervals for Day 29	404
7.3	Plots and Tables with estimates and pointwise confidence interval for Day 57 (monotone-corrected)	409
7.4	Plots and Tables with estimates and pointwise confidence intervals for Day 29 (monotone-corrected)	414
7.5	Plots and Tables with estimates and simultaneous confidence bands for Day 57	419
7.6	Plots and Tables with estimates and simultaneous confidence bands for Day 29	424
7.7	Plots and Tables with estimates and pointwise confidence interval for Day 57 (monotone-corrected)	429
7.8	Plots and Tables with estimates and pointwise confidence intervals for Day 29 (monotone-corrected)	434
8	Day 57 Univariate CoR: Nonlinear modeling	439
9	Day 29 Univariate CoR: Nonlinear modeling	443
10	Appendix	447

List of Tables

2.1	Table 1. Demographic and Clinical Characteristics at Baseline in the Baseline SARS-CoV-2 Negative Per-Protocol Cohort	33
2.2	Table 2. Demographic and Clinical Characteristics at Baseline in the Baseline SARS-CoV-2 Positive Per-Protocol Cohort	35
2.3	Table 3. Sample Sizes of Baseline Strata for Correlates of Risk Analysis	36
2.4	Table 4. Antibody levels in the baseline SARS-CoV-2 negative per-protocol cohort (vaccine recipients)	37
2.5	Table 5. Antibody levels in the baseline SARS-CoV-2 positive per-protocol cohort (vaccine recipients)	39
2.6	Table 6. Antibody levels in the baseline SARS-CoV-2 positive per-protocol cohort (placebo recipients)	41
4.1	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*	329
4.2	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*	330
4.3	Analysis of Day 57 markers (upper vs. lower tertile) as a CoR and a controlled risk CoP.	334
4.4	Marginalized cumulative risk by Day 164 as functions of Day 57 markers (=s) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence intervals (5 replicates).	337
4.5	Controlled VE as functions of Day 57 markers (=s) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence intervals (5 replicates).	339
4.6	Controlled VE with sensitivity analysis as functions of Day 57 markers (=s) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence intervals (5 replicates).	340
5.1	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*	343
5.2	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*	344
5.3	Analysis of Day 29 markers (upper vs. lower tertile) as a CoR and a controlled risk CoP.	348
5.4	Marginalized cumulative risk by Day 192 as functions of Day 29 markers (=s) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence intervals (5 replicates).	351
5.5	Controlled VE as functions of Day 29 markers (=s) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence intervals (5 replicates).	353

5.6	Controlled VE with sensitivity analysis as functions of Day 29 markers ($=s$) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence intervals (5 replicates).	354
6.1	Table of risk estimates for a range of thresholds of Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals.	359
6.2	Table of risk estimates for a range of thresholds of Day 57 RBD binding antibody levels with pointwise 95% confidence intervals.	360
6.3	Table of risk estimates for a range of thresholds of Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals.	361
6.4	Table of risk estimates for a range of thresholds of Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals.	362
6.5	Table of risk estimates for a range of thresholds of Day 29 Spike protein antibody levels with pointwise 95% confidence intervals.	364
6.6	Table of risk estimates for a range of thresholds of Day 29 RBD binding antibody levels with pointwise 95% confidence intervals.	365
6.7	Table of risk estimates for a range of thresholds of Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals.	366
6.8	Table of risk estimates for a range of thresholds of Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals.	367
6.9	Table of monotone-corrected risk estimates for a range of thresholds of Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals.	369
6.10	Table of monotone-corrected risk estimates for a range of thresholds of Day 57 RBD binding antibody levels with pointwise 95% confidence intervals.	370
6.11	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.	371
6.12	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.	372
6.13	Table of monotone-corrected risk estimates for a range of thresholds of Day 29 Spike protein antibody levels with pointwise 95% confidence intervals.	374
6.14	Table of monotone-corrected risk estimates for a range of thresholds of Day 29 RBD binding antibody levels with pointwise 95% confidence intervals.	375
6.15	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.	376
6.16	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.	377
6.17	Table of risk estimates for a range of thresholds of Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals.	379
6.18	Table of risk estimates for a range of thresholds of Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals.	380
6.19	Table of risk estimates for a range of thresholds of Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals.	381
6.20	Table of risk estimates for a range of thresholds of Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals.	382

6.21	Table of risk estimates for a range of thresholds of Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals.	384
6.22	Table of risk estimates for a range of thresholds of Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals.	385
6.23	Table of risk estimates for a range of thresholds of Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals.	386
6.24	Table of risk estimates for a range of thresholds of Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals.	387
6.25	Table of monotone-corrected risk estimates for a range of thresholds of Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals.	389
6.26	Table of monotone-corrected risk estimates for a range of thresholds of Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals.	390
6.27	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.	391
6.28	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.	392
6.29	Table of monotone-corrected risk estimates for a range of thresholds of Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals.	394
6.30	Table of monotone-corrected risk estimates for a range of thresholds of Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals.	395
6.31	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.	396
6.32	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.	397
7.1	Table of risk estimates for a range of thresholds of Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals.	400
7.2	Table of risk estimates for a range of thresholds of Day 57 RBD binding antibody levels with pointwise 95% confidence intervals.	401
7.3	Table of risk estimates for a range of thresholds of Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals.	402
7.4	Table of risk estimates for a range of thresholds of Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals.	403
7.5	Table of risk estimates for a range of thresholds of Day 29 Spike protein antibody levels with pointwise 95% confidence intervals.	405
7.6	Table of risk estimates for a range of thresholds of Day 29 RBD binding antibody levels with pointwise 95% confidence intervals.	406
7.7	Table of risk estimates for a range of thresholds of Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals.	407
7.8	Table of risk estimates for a range of thresholds of Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals.	408
7.9	Table of monotone-corrected risk estimates for a range of thresholds of Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals.	410

7.10 Table of monotone-corrected risk estimates for a range of thresholds of Day 57 RBD binding antibody levels with pointwise 95% confidence intervals.	411
7.11 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.	412
7.12 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.	413
7.13 Table of monotone-corrected risk estimates for a range of thresholds of Day 29 Spike protein antibody levels with pointwise 95% confidence intervals.	415
7.14 Table of monotone-corrected risk estimates for a range of thresholds of Day 29 RBD binding antibody levels with pointwise 95% confidence intervals.	416
7.15 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.	417
7.16 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.	418
7.17 Table of risk estimates for a range of thresholds of Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals.	420
7.18 Table of risk estimates for a range of thresholds of Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals.	421
7.19 Table of risk estimates for a range of thresholds of Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals.	422
7.20 Table of risk estimates for a range of thresholds of Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals.	423
7.21 Table of risk estimates for a range of thresholds of Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals.	425
7.22 Table of risk estimates for a range of thresholds of Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals.	426
7.23 Table of risk estimates for a range of thresholds of Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals.	427
7.24 Table of risk estimates for a range of thresholds of Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals.	428
7.25 Table of monotone-corrected risk estimates for a range of thresholds of Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals.	430
7.26 Table of monotone-corrected risk estimates for a range of thresholds of Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals.	431
7.27 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.	432
7.28 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.	433
7.29 Table of monotone-corrected risk estimates for a range of thresholds of Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals.	435
7.30 Table of monotone-corrected risk estimates for a range of thresholds of Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals.	436
7.31 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.	437

7.32 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.	438
---	-----

List of Figures

3.1	Boxplots of D57 Ab markers: vaccine arm. The three dashed lines in each figure are ULOQ, LLOQ, and LLOD, from top to bottom respectively.	44
3.2	Boxplots of D57 fold-rise over D1 Ab markers: vaccine arm.	45
3.3	Boxplots of D29 Ab markers: vaccine arm. The three dashed lines in each figure are ULOQ, LLOQ, and LLOD, from top to bottom respectively.	46
3.4	Boxplots of D29 fold-rise over D1 Ab markers: vaccine arm.	47
3.5	RCDF plots for D57 Ab markers by treatment arm.	48
3.6	RCDF plots for D57 fold-rise over D1 Ab markers by treatment arm.	49
3.7	RCDF plots for D29 Ab markers by treatment arm.	50
3.8	RCDF plots for D29 fold-rise over D1 Ab markers by treatment arm.	51
3.9	Marker RCDF of D57 anti-Spike binding Ab: vaccine arm	52
3.10	Marker RCDF of D57 anti-RBD binding Ab: vaccine arm	53
3.11	Marker RCDF of D57 PsV-nAb ID50: vaccine arm	54
3.12	Marker RCDF of D57 PsV-nAb ID80: vaccine arm	55
3.13	Spaghetti Plots of Marker Trajectory: vaccine arm	56
3.14	lineplots of Binding Antibody to Spike: baseline negative placebo arm (version 1)	57
3.15	lineplots of Binding Antibody to Spike: baseline negative vaccine arm (version 1)	58
3.16	lineplots of Binding Antibody to RBD: baseline negative placebo arm (version 1)	59
3.17	lineplots of Binding Antibody to RBD: baseline negative vaccine arm (version 1)	60
3.18	lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm (version 1)	61
3.19	lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm (version 1)	62
3.20	lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm (version 1)	63
3.21	lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm (version 1)	64
3.22	violinplots of Binding Antibody to Spike: baseline negative placebo arm (version 1)	65
3.23	violinplots of Binding Antibody to Spike: baseline negative vaccine arm (version 1)	66
3.24	violinplots of Binding Antibody to RBD: baseline negative placebo arm (version 1)	67
3.25	violinplots of Binding Antibody to RBD: baseline negative vaccine arm (version 1)	68
3.26	violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm (version 1)	69
3.27	violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm (version 1)	70

3.28 violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm (version 1)	71
3.29 violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm (version 1)	72
3.30 lineplots of Binding Antibody to Spike: baseline negative placebo arm (version 2)	73
3.31 lineplots of Binding Antibody to Spike: baseline negative vaccine arm (version 2)	74
3.32 lineplots of Binding Antibody to RBD: baseline negative placebo arm (version 2)	75
3.33 lineplots of Binding Antibody to RBD: baseline negative vaccine arm (version 2)	76
3.34 lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm (version 2)	77
3.35 lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm (version 2)	78
3.36 lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm (version 2)	79
3.37 lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm (version 2)	80
3.38 violinplots of Binding Antibody to Spike: baseline negative placebo arm (version 2)	81
3.39 violinplots of Binding Antibody to Spike: baseline negative vaccine arm (version 2)	82
3.40 violinplots of Binding Antibody to RBD: baseline negative placebo arm (version 2)	83
3.41 violinplots of Binding Antibody to RBD: baseline negative vaccine arm (version 2)	84
3.42 violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm (version 2)	85
3.43 violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm (version 2)	86
3.44 violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm (version 2)	87
3.45 violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm (version 2)	88
3.46 lineplots of Binding Antibody to Spike: baseline negative placebo arm by age (version 1)	89
3.47 lineplots of Binding Antibody to Spike: baseline negative vaccine arm by age (version 1)	90
3.48 lineplots of Binding Antibody to RBD: baseline negative placebo arm by age (version 1)	91
3.49 lineplots of Binding Antibody to RBD: baseline negative vaccine arm by age (version 1)	92
3.50 lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age (version 1)	93
3.51 lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age (version 1)	94
3.52 lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age (version 1)	95
3.53 lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age (version 1)	96
3.54 violinplots of Binding Antibody to Spike: baseline negative placebo arm by age (version 1)	97
3.55 violinplots of Binding Antibody to Spike: baseline negative vaccine arm by age (version 1)	98
3.56 violinplots of Binding Antibody to RBD: baseline negative placebo arm by age (version 1)	99
3.57 violinplots of Binding Antibody to RBD: baseline negative vaccine arm by age (version 1)	100
3.58 violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age (version 1)	101
3.59 violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age (version 1)	102
3.60 violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age (version 1)	103
3.61 violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age (version 1)	104

3.62 lineplots of Binding Antibody to Spike: baseline negative placebo arm by age (version 2)	105
3.63 lineplots of Binding Antibody to Spike: baseline negative vaccine arm by age (version 2)	106
3.64 lineplots of Binding Antibody to RBD: baseline negative placebo arm by age (version 2)	107
3.65 lineplots of Binding Antibody to RBD: baseline negative vaccine arm by age (version 2)	108
3.66 lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age (version 2)	109
3.67 lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age (version 2)	110
3.68 lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age (version 2)	111
3.69 lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age (version 2)	112
3.70 violinplots of Binding Antibody to Spike: baseline negative placebo arm by age (version 2)	113
3.71 violinplots of Binding Antibody to Spike: baseline negative vaccine arm by age (version 2)	114
3.72 violinplots of Binding Antibody to RBD: baseline negative placebo arm by age (version 2)	115
3.73 violinplots of Binding Antibody to RBD: baseline negative vaccine arm by age (version 2)	116
3.74 violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age (version 2)	117
3.75 violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age (version 2)	118
3.76 violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age (version 2)	119
3.77 violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age (version 2)	120
3.78 lineplots of Binding Antibody to Spike: baseline negative placebo arm by risk condition (version 1)	121
3.79 lineplots of Binding Antibody to Spike: baseline negative vaccine arm by risk condition (version 1)	122
3.80 lineplots of Binding Antibody to RBD: baseline negative placebo arm by risk condition (version 1)	123
3.81 lineplots of Binding Antibody to RBD: baseline negative vaccine arm by risk condition (version 1)	124
3.82 lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by risk condition (version 1)	125
3.83 lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by risk condition (version 1)	126
3.84 lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by risk condition (version 1)	127
3.85 lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by risk condition (version 1)	128
3.86 violinplots of Binding Antibody to Spike: baseline negative placebo arm by risk condition (version 1)	129
3.87 violinplots of Binding Antibody to Spike: baseline negative vaccine arm by risk condition (version 1)	130
3.88 violinplots of Binding Antibody to RBD: baseline negative placebo arm by risk condition (version 1)	131

3.89 violinplots of Binding Antibody to RBD: baseline negative vaccine arm by risk condition (version 1)	132
3.90 violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by risk condition (version 1)	133
3.91 violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by risk condition (version 1)	134
3.92 violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by risk condition (version 1)	135
3.93 violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by risk condition (version 1)	136
3.94 lineplots of Binding Antibody to Spike: baseline negative placebo arm by risk condition (version 2)	137
3.95 lineplots of Binding Antibody to Spike: baseline negative vaccine arm by risk condition (version 2)	138
3.96 lineplots of Binding Antibody to RBD: baseline negative placebo arm by risk condition (version 2)	139
3.97 lineplots of Binding Antibody to RBD: baseline negative vaccine arm by risk condition (version 2)	140
3.98 lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by risk condition (version 2)	141
3.99 lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by risk condition (version 2)	142
3.100 lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by risk condition (version 2)	143
3.101 lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by risk condition (version 2)	144
3.102 violinplots of Binding Antibody to Spike: baseline negative placebo arm by risk condition (version 2)	145
3.103 violinplots of Binding Antibody to Spike: baseline negative vaccine arm by risk condition (version 2)	146
3.104 violinplots of Binding Antibody to RBD: baseline negative placebo arm by risk condition (version 2)	147
3.105 violinplots of Binding Antibody to RBD: baseline negative vaccine arm by risk condition (version 2)	148
3.106 violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by risk condition (version 2)	149
3.107 violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by risk condition (version 2)	150
3.108 violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by risk condition (version 2)	151
3.109 violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by risk condition (version 2)	152
3.110 lineplots of Binding Antibody to Spike: baseline negative placebo arm by age and risk condition (version 1)	153

3.111lineplots of Binding Antibody to Spike: baseline negative vaccine arm by age and risk condition (version 1)	154
3.112lineplots of Binding Antibody to RBD: baseline negative placebo arm by age and risk condition (version 1)	155
3.113lineplots of Binding Antibody to RBD: baseline negative vaccine arm by age and risk condition (version 1)	156
3.114lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age and risk condition (version 1)	157
3.115lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age and risk condition (version 1)	158
3.116lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age and risk condition (version 1)	159
3.117lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age and risk condition (version 1)	160
3.118violinplots of Binding Antibody to Spike: baseline negative placebo arm by age and risk condition (version 1)	161
3.119violinplots of Binding Antibody to Spike: baseline negative vaccine arm by age and risk condition (version 1)	162
3.120violinplots of Binding Antibody to RBD: baseline negative placebo arm by age and risk con- dition (version 1)	163
3.121violinplots of Binding Antibody to RBD: baseline negative vaccine arm by age and risk con- dition (version 1)	164
3.122violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age and risk condition (version 1)	165
3.123violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age and risk condition (version 1)	166
3.124violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age and risk condition (version 1)	167
3.125violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age and risk condition (version 1)	168
3.126lineplots of Binding Antibody to Spike: baseline negative placebo arm by age and risk condi- tion (version 2)	169
3.127lineplots of Binding Antibody to Spike: baseline negative vaccine arm by age and risk condition (version 2)	170
3.128lineplots of Binding Antibody to RBD: baseline negative placebo arm by age and risk condition (version 2)	171
3.129lineplots of Binding Antibody to RBD: baseline negative vaccine arm by age and risk condition (version 2)	172
3.130lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age and risk condition (version 2)	173
3.131lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age and risk condition (version 2)	174
3.132lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age and risk condition (version 2)	175

3.133lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age and risk condition (version 2)	176
3.134violinplots of Binding Antibody to Spike: baseline negative placebo arm by age and risk condition (version 2)	177
3.135violinplots of Binding Antibody to Spike: baseline negative vaccine arm by age and risk condition (version 2)	178
3.136violinplots of Binding Antibody to RBD: baseline negative placebo arm by age and risk condition (version 2)	179
3.137violinplots of Binding Antibody to RBD: baseline negative vaccine arm by age and risk condition (version 2)	180
3.138violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age and risk condition (version 2)	181
3.139violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age and risk condition (version 2)	182
3.140violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age and risk condition (version 2)	183
3.141violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age and risk condition (version 2)	184
3.142lineplots of Binding Antibody to Spike: baseline negative placebo arm by sex assigned at birth (version 1)	185
3.143lineplots of Binding Antibody to Spike: baseline negative vaccine arm by sex assigned at birth (version 1)	186
3.144lineplots of Binding Antibody to RBD: baseline negative placebo arm by sex assigned at birth (version 1)	187
3.145lineplots of Binding Antibody to RBD: baseline negative vaccine arm by sex assigned at birth (version 1)	188
3.146lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by sex assigned at birth (version 1)	189
3.147lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by sex assigned at birth (version 1)	190
3.148lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by sex assigned at birth (version 1)	191
3.149lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by sex assigned at birth (version 1)	192
3.150violinplots of Binding Antibody to Spike: baseline negative placebo arm by sex assigned at birth (version 1)	193
3.151violinplots of Binding Antibody to Spike: baseline negative vaccine arm by sex assigned at birth (version 1)	194
3.152violinplots of Binding Antibody to RBD: baseline negative placebo arm by sex assigned at birth (version 1)	195
3.153violinplots of Binding Antibody to RBD: baseline negative vaccine arm by sex assigned at birth (version 1)	196
3.154violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by sex assigned at birth (version 1)	197

3.155violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by sex assigned at birth (version 1)	198
3.156violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by sex assigned at birth (version 1)	199
3.157violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by sex assigned at birth (version 1)	200
3.158lineplots of Binding Antibody to Spike: baseline negative placebo arm by sex assigned at birth (version 2)	201
3.159lineplots of Binding Antibody to Spike: baseline negative vaccine arm by sex assigned at birth (version 2)	202
3.160lineplots of Binding Antibody to RBD: baseline negative placebo arm by sex assigned at birth (version 2)	203
3.161lineplots of Binding Antibody to RBD: baseline negative vaccine arm by sex assigned at birth (version 2)	204
3.162lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by sex assigned at birth (version 2)	205
3.163lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by sex assigned at birth (version 2)	206
3.164lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by sex assigned at birth (version 2)	207
3.165lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by sex assigned at birth (version 2)	208
3.166violinplots of Binding Antibody to Spike: baseline negative placebo arm by sex assigned at birth (version 2)	209
3.167violinplots of Binding Antibody to Spike: baseline negative vaccine arm by sex assigned at birth (version 2)	210
3.168violinplots of Binding Antibody to RBD: baseline negative placebo arm by sex assigned at birth (version 2)	211
3.169violinplots of Binding Antibody to RBD: baseline negative vaccine arm by sex assigned at birth (version 2)	212
3.170violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by sex assigned at birth (version 2)	213
3.171violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by sex assigned at birth (version 2)	214
3.172violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by sex assigned at birth (version 2)	215
3.173violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by sex assigned at birth (version 2)	216
3.174lineplots of Binding Antibody to Spike: baseline negative placebo arm by race and ethnic group (version 1)	217
3.175lineplots of Binding Antibody to Spike: baseline negative vaccine arm by race and ethnic group (version 1)	218
3.176lineplots of Binding Antibody to RBD: baseline negative placebo arm by race and ethnic group (version 1)	219

3.177lineplots of Binding Antibody to RBD: baseline negative vaccine arm by race and ethnic group (version 1)	220
3.178lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by race and ethnic group (version 1)	221
3.179lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by race and ethnic group (version 1)	222
3.180lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by race and ethnic group (version 1)	223
3.181lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by race and ethnic group (version 1)	224
3.182violinplots of Binding Antibody to Spike: baseline negative placebo arm by race and ethnic group (version 1)	225
3.183violinplots of Binding Antibody to Spike: baseline negative vaccine arm by race and ethnic group (version 1)	226
3.184violinplots of Binding Antibody to RBD: baseline negative placebo arm by race and ethnic group (version 1)	227
3.185violinplots of Binding Antibody to RBD: baseline negative vaccine arm by race and ethnic group (version 1)	228
3.186violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by race and ethnic group (version 1)	229
3.187violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by race and ethnic group (version 1)	230
3.188violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by race and ethnic group (version 1)	231
3.189violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by race and ethnic group (version 1)	232
3.190lineplots of Binding Antibody to Spike: baseline negative placebo arm by race and ethnic group (version 2)	233
3.191lineplots of Binding Antibody to Spike: baseline negative vaccine arm by race and ethnic group (version 2)	234
3.192lineplots of Binding Antibody to RBD: baseline negative placebo arm by race and ethnic group (version 2)	235
3.193lineplots of Binding Antibody to RBD: baseline negative vaccine arm by race and ethnic group (version 2)	236
3.194lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by race and ethnic group (version 2)	237
3.195lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by race and ethnic group (version 2)	238
3.196lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by race and ethnic group (version 2)	239
3.197lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by race and ethnic group (version 2)	240
3.198violinplots of Binding Antibody to Spike: baseline negative placebo arm by race and ethnic group (version 2)	241

3.199violinplots of Binding Antibody to Spike: baseline negative vaccine arm by race and ethnic group (version 2)	242
3.200violinplots of Binding Antibody to RBD: baseline negative placebo arm by race and ethnic group (version 2)	243
3.201violinplots of Binding Antibody to RBD: baseline negative vaccine arm by race and ethnic group (version 2)	244
3.202violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by race and ethnic group (version 2)	245
3.203violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by race and ethnic group (version 2)	246
3.204violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by race and ethnic group (version 2)	247
3.205violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by race and ethnic group (version 2)	248
3.206lineplots of Binding Antibody to Spike: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)	249
3.207lineplots of Binding Antibody to Spike: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)	250
3.208lineplots of Binding Antibody to RBD: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)	251
3.209lineplots of Binding Antibody to RBD: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)	252
3.210lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)	253
3.211lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)	254
3.212lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)	255
3.213lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)	256
3.214violinplots of Binding Antibody to Spike: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)	257
3.215violinplots of Binding Antibody to Spike: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)	258
3.216violinplots of Binding Antibody to RBD: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)	259
3.217violinplots of Binding Antibody to RBD: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)	260
3.218violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)	261
3.219violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)	262
3.220violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)	263

3.221violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)	264
3.222lineplots of Binding Antibody to Spike: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)	265
3.223lineplots of Binding Antibody to Spike: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)	266
3.224lineplots of Binding Antibody to RBD: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)	267
3.225lineplots of Binding Antibody to RBD: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)	268
3.226lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)	269
3.227lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)	270
3.228lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)	271
3.229lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)	272
3.230violinplots of Binding Antibody to Spike: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)	273
3.231violinplots of Binding Antibody to Spike: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)	274
3.232violinplots of Binding Antibody to RBD: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)	275
3.233violinplots of Binding Antibody to RBD: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)	276
3.234violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)	277
3.235violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)	278
3.236violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)	279
3.237violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)	280
3.238scatterplots of Binding Antibody to Spike vs Age: baseline negative vaccine arm at day 1 . .	281
3.239scatterplots of Binding Antibody to Spike vs Age: baseline negative vaccine arm at day 29 .	282
3.240scatterplots of Binding Antibody to Spike vs Age: baseline negative vaccine arm at day 57 .	283
3.241scatterplots of Binding Antibody to RBD vs Age: baseline negative vaccine arm at day 1 . .	284
3.242scatterplots of Binding Antibody to RBD vs Age: baseline negative vaccine arm at day 29 .	285
3.243scatterplots of Binding Antibody to RBD vs Age: baseline negative vaccine arm at day 57 .	286
3.244scatterplots of Pseudovirus Neutralization ID50 vs Age: baseline negative vaccine arm at day 1	287
3.245scatterplots of Pseudovirus Neutralization ID50 vs Age: baseline negative vaccine arm at day 29 .	288

3.246scatterplots of Pseudovirus Neutralization ID50 vs Age: baseline negative vaccine arm at day 57	289
3.247scatterplots of Pseudovirus Neutralization ID80 vs Age: baseline negative vaccine arm at day 1	290
3.248scatterplots of Pseudovirus Neutralization ID80 vs Age: baseline negative vaccine arm at day 29	291
3.249scatterplots of Pseudovirus Neutralization ID80 vs Age: baseline negative vaccine arm at day 57	292
3.250scatterplots of Binding Antibody to Spike vs Age: by arm at day 1	293
3.251scatterplots of Binding Antibody to Spike vs Age: by arm at day 29	294
3.252scatterplots of Binding Antibody to Spike vs Age: by arm at day 57	295
3.253scatterplots of Binding Antibody to RBD vs Age: by arm at day 1	296
3.254scatterplots of Binding Antibody to RBD vs Age: by arm at day 29	297
3.255scatterplots of Binding Antibody to RBD vs Age: by arm at day 57	298
3.256scatterplots of Pseudovirus Neutralization ID50 vs Age vs Age: by arm at day 1	299
3.257scatterplots of Pseudovirus Neutralization ID50 vs Age vs Age: by arm at day 29	300
3.258scatterplots of Pseudovirus Neutralization ID50 vs Age: by arm at day 57	301
3.259scatterplots of Pseudovirus Neutralization ID80 vs Age: by arm at day 1	302
3.260scatterplots of Pseudovirus Neutralization ID80 vs Age: by arm at day 29	303
3.261scatterplots of Pseudovirus Neutralization ID80 vs Age: by arm at day 57	304
3.262scatterplots of Binding Antibody to Spike vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 1	305
3.263scatterplots of Binding Antibody to Spike vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 29	306
3.264scatterplots of Binding Antibody to Spike vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 57	307
3.265scatterplots of Binding Antibody to RBD vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 1	308
3.266scatterplots of Binding Antibody to RBD vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 29	309
3.267scatterplots of Binding Antibody to RBD vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 57	310
3.268scatterplots of Pseudovirus Neutralization ID50 vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 1	311
3.269scatterplots of Pseudovirus Neutralization ID50 vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 29	312
3.270scatterplots of Pseudovirus Neutralization ID50 vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 57	313
3.271scatterplots of Pseudovirus Neutralization ID80 vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 1	314
3.272scatterplots of Pseudovirus Neutralization ID80 vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 29	315

3.273scatterplots of Pseudovirus Neutralization ID80 vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 57	316
3.274scatterplots of Binding Antibody to Spike vs Days Since the Day 29 Visit: by arm at day 1	317
3.275scatterplots of Binding Antibody to Spike vs Days Since the Day 29 Visit: by arm at day 29	318
3.276scatterplots of Binding Antibody to Spike vs Days Since the Day 29 Visit: by arm at day 57	319
3.277scatterplots of Binding Antibody to RBD vs Days Since the Day 29 Visit: by arm at day 1	320
3.278scatterplots of Binding Antibody to RBD vs Days Since the Day 29 Visit: by arm at day 29	321
3.279scatterplots of Binding Antibody to RBD vs Days Since the Day 29 Visit: by arm at day 57	322
3.280scatterplots of Pseudovirus Neutralization ID50 vs Days Since the Day 29 Visit vs Days Since the Day 29 Visit: by arm at day 1	323
3.281scatterplots of Pseudovirus Neutralization ID50 vs Days Since the Day 29 Visit vs Days Since the Day 29 Visit: by arm at day 29	324
3.282scatterplots of Pseudovirus Neutralization ID50 vs Days Since the Day 29 Visit: by arm at day 57	325
3.283scatterplots of Pseudovirus Neutralization ID80 vs Days Since the Day 29 Visit: by arm at day 1	326
3.284scatterplots of Pseudovirus Neutralization ID80 vs Days Since the Day 29 Visit: by arm at day 29	327
3.285scatterplots of Pseudovirus Neutralization ID80 vs Days Since the Day 29 Visit: by arm at day 57	328
4.1 Forest plots of hazard ratios per 10-fold increase in the marker among baseline negative vaccine recipients and subgroups with 95% point-wise confidence intervals.	331
4.2 Forest plots of hazard ratios per 10-fold increase in the Day 57 binding Ab to spike markers among baseline negative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.	332
4.3 Forest plots of hazard ratios per 10-fold increase in the Day 57 binding Ab to RBD markers among baseline negative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.	332
4.4 Forest plots of hazard ratios per 10-fold increase in the Day 57 pseudo neut ID50 markers among baseline negative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.	333
4.5 Forest plots of hazard ratios per 10-fold increase in the Day 57 pseudo neut ID80 markers among baseline negative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.	333
4.6 Marginalized cumulative incidence rate curves for trichotomized Day 57 markers among baseline negative vaccine recipients. The gray line is the overall cumulative incidence rate curve in the placebo arm.	335
4.7 Marginalized cumulative risk by Day 164 as functions of Day 57 markers (=s) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates). The horizontal lines indicate the overall cumulative risk of the placebo and vaccine arms by Day 164 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4, 15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.	336

4.8	Controlled VE with sensitivity analysis as functions of Day 57 markers ($=s$) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates). Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4, 15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.	338
4.9	Marginalized cumulative risk by Day 164 as functions of Day 57 markers above a threshold ($\geq s$) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence bands (at least 5 cases are required, 5 replicates). The horizontal lines indicate the overall cumulative risk of the vaccine arm by Day 164 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4, 15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.	341
4.10	Controlled VE as functions of Day 57 markers ($>=s$) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates). Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4, 15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.	342
5.1	Forest plots of hazard ratios per 10-fold increase in the marker among baseline negative vaccine recipients and subgroups with 95% point-wise confidence intervals.	345
5.2	Forest plots of hazard ratios per 10-fold increase in the Day 29 binding Ab to spike markers among baseline negative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.	346
5.3	Forest plots of hazard ratios per 10-fold increase in the Day 29 binding Ab to RBD markers among baseline negative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.	346
5.4	Forest plots of hazard ratios per 10-fold increase in the Day 29 pseudo neut ID50 markers among baseline negative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.	347
5.5	Forest plots of hazard ratios per 10-fold increase in the Day 29 pseudo neut ID80 markers among baseline negative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.	347
5.6	Marginalized cumulative incidence rate curves for trichotomized Day 29 markers among baseline negative vaccine recipients. The gray line is the overall cumulative incidence rate curve in the placebo arm.	349
5.7	Marginalized cumulative risk by Day 192 as functions of Day 29 markers ($=s$) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates). The horizontal lines indicate the overall cumulative risk of the placebo and vaccine arms by Day 192 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4, 15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.	350
5.8	Controlled VE with sensitivity analysis as functions of Day 29 markers ($=s$) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates). Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4, 15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.	352
5.9	Marginalized cumulative risk by Day 192 as functions of Day 29 markers above a threshold ($\geq s$) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence bands (at least 5 cases are required, 5 replicates). The horizontal lines indicate the overall cumulative risk of the vaccine arm by Day 192 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4, 15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.	355

5.10 Controlled VE as functions of Day 29 markers ($\geq s$) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates). Histograms of the immunological markers in the vaccine arm are overlaid. $l_0 = 0.3, 1.6, 2.4, 15$ for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.	356
6.1 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.	359
6.2 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.	360
6.3 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.	361
6.4 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.	362
6.5 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.	364
6.6 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.	365
6.7 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.	366
6.8 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.	367
6.9 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.	369
6.10 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.	370
6.11 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.	371
6.12 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.	372

6.13 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.	374
6.14 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.	375
6.15 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.	376
6.16 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.	377
6.17 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.	379
6.18 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.	380
6.19 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.	381
6.20 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.	382
6.21 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.	384
6.22 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.	385
6.23 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.	386
6.24 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.	387
6.25 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.	389

6.26 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.	390
6.27 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.	391
6.28 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.	392
6.29 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.	394
6.30 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.	395
6.31 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.	396
6.32 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.	397
7.1 Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals.	400
7.2 Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with pointwise 95% confidence intervals.	401
7.3 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.	402
7.4 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.	403
7.5 Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with pointwise 95% confidence intervals.	405
7.6 Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with pointwise 95% confidence intervals.	406
7.7 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.	407

7.8	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.	408
7.9	Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.	410
7.10	Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with pointwise 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.	411
7.11	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 estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.	412
7.12	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 estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.	413
7.13	Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with pointwise 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.	415
7.14	Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with pointwise 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.	416
7.15	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 estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.	417
7.16	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 estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.	418
7.17	Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals.	420
7.18	Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals.	421
7.19	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.	422
7.20	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.	423
7.21	Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals.	425
7.22	Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals.	426
7.23	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.	427
7.24	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.	428

7.25 Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.	430
7.26 Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.	431
7.27 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 estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.	432
7.28 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 estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.	433
7.29 Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.	435
7.30 Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.	436
7.31 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 estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.	437
7.32 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 estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.	438
8.1 Marginalized risk as functions of Day 57 markers (= s) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates) as modeled by GAM with automatic smoothness estimation. The horizontal lines indicate the overall cumulative risk of the vaccine and placebo arms by Day 164 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4, 15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.	440
8.2 Marginalized risk as functions of Day 57 markers (= s) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates) as modeled by GAM with automatic smoothness estimation. The horizontal lines indicate the overall cumulative risk of the vaccine arm by Day 164 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4, 15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.	441
9.1 Marginalized risk as functions of Day 29 markers (= s) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates) as modeled by GAM with automatic smoothness estimation. The horizontal lines indicate the overall cumulative risk of the vaccine and placebo arms by Day 192 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4, 15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.	444

9.2 Marginalized risk as functions of Day 29markers (=s) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates) as modeled by GAM with automatic smoothness estimation. The horizontal lines indicate the overall cumulative risk of the vaccine arm by Day 192 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4,15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.	445
---	-----

MOCH

MOCK

Chapter 1

Disclaimers

- The data presented in the analysis originated from the Moderna Sponsored mRNA-1273-P301 clinical study and are provided to NIAID in accordance with Clinical Trial Agreement between the parties. The study was funded in part by BARDA under Government Contract No. 75A50120C00034
- The preliminary immunogenicity data presented here do not reflect the Sponsors statistical analysis plan and therefore should not be interpreted as a protocol defined read-out of the clinical study.
- These data are not to be disclosed without written permission of Moderna.

MOCK

Chapter 2

Summary Tables

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

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

Characteristics	Vaccine (N = 747)	Placebo (N = 138)	Total (N = 885)
Age			
Age < 65	357 (47.8%)	72 (52.2%)	429 (48.5%)
Age ≥ 65	390 (52.2%)	66 (47.8%)	456 (51.5%)
Mean (Range)	58.5 (18.0, 85.0)	58.3 (18.0, 85.0)	58.5 (18.0, 85.0)
BMI			
Mean ± SD	29.7 ± 6.6	31.4 ± 6.3	30.0 ± 6.6
Risk for Severe Covid-19			
At-risk	381 (51.0%)	71 (51.4%)	452 (51.1%)
Not at-risk	366 (49.0%)	67 (48.6%)	433 (48.9%)
Age, Risk for Severe Covid-19			
Age < 65 At-risk	185 (24.8%)	36 (26.1%)	221 (25.0%)
Age < 65 Not at-risk	172 (23.0%)	36 (26.1%)	208 (23.5%)
Age ≥ 65	390 (52.2%)	66 (47.8%)	456 (51.5%)
Sex			
Female	427 (57.2%)	75 (54.3%)	502 (56.7%)
Male	320 (42.8%)	63 (45.7%)	383 (43.3%)
Hispanic or Latino ethnicity			
Hispanic or Latino	99 (13.3%)	20 (14.5%)	119 (13.4%)
Not Hispanic or Latino	623 (83.4%)	113 (81.9%)	736 (83.2%)
Not reported and unknown	25 (3.3%)	5 (3.6%)	30 (3.4%)
Race			
White	397 (53.1%)	74 (53.6%)	471 (53.2%)
Black or African American	184 (24.6%)	40 (29.0%)	224 (25.3%)
Asian	56 (7.5%)	10 (7.2%)	66 (7.5%)
American Indian or Alaska Native	16 (2.1%)	2 (1.4%)	18 (2.0%)
Native Hawaiian or Other Pacific Islander	17 (2.3%)	2 (1.4%)	19 (2.1%)

(continued)

Characteristics	Vaccine (N = 747)	Placebo (N = 138)	Total (N = 885)
Multiracial	57 (7.6%)	8 (5.8%)	65 (7.3%)
Other	16 (2.1%)	1 (0.7%)	17 (1.9%)
Not reported and unknown	4 (0.5%)	1 (0.7%)	5 (0.6%)
White Non-Hispanic	370 (49.5%)	63 (45.7%)	433 (48.9%)
Communities of Color	377 (50.5%)	75 (54.3%)	452 (51.1%)

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

MOCH

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

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

Characteristics	Vaccine (N = 234)	Placebo (N = 241)	Total (N = 475)
Age			
Age < 65	114 (48.7%)	120 (49.8%)	234 (49.3%)
Age ≥ 65	120 (51.3%)	121 (50.2%)	241 (50.7%)
Mean (Range)	58.3 (18.0, 85.0)	56.3 (18.0, 85.0)	57.3 (18.0, 85.0)
BMI			
Mean ± SD	29.7 ± 7.5	30.0 ± 6.6	29.9 ± 7.0
Risk for Severe Covid-19			
At-risk	111 (47.4%)	117 (48.5%)	228 (48.0%)
Not at-risk	123 (52.6%)	124 (51.5%)	247 (52.0%)
Age, Risk for Severe Covid-19			
Age < 65 At-risk	56 (23.9%)	59 (24.5%)	115 (24.2%)
Age < 65 Not at-risk	58 (24.8%)	61 (25.3%)	119 (25.1%)
Age ≥ 65	120 (51.3%)	121 (50.2%)	241 (50.7%)
Sex			
Female	139 (59.4%)	133 (55.2%)	272 (57.3%)
Male	95 (40.6%)	108 (44.8%)	203 (42.7%)
Hispanic or Latino ethnicity			
Hispanic or Latino	31 (13.2%)	34 (14.1%)	65 (13.7%)
Not Hispanic or Latino	194 (82.9%)	201 (83.4%)	395 (83.2%)
Not reported and unknown	9 (3.8%)	6 (2.5%)	15 (3.2%)
Race			
White	126 (53.8%)	129 (53.5%)	255 (53.7%)
Black or African American	58 (24.8%)	45 (18.7%)	103 (21.7%)
Asian	19 (8.1%)	27 (11.2%)	46 (9.7%)
American Indian or Alaska Native	10 (4.3%)	7 (2.9%)	17 (3.6%)
Native Hawaiian or Other Pacific Islander	4 (1.7%)	2 (0.8%)	6 (1.3%)
Multiracial	10 (4.3%)	16 (6.6%)	26 (5.5%)
Other	7 (3.0%)	13 (5.4%)	20 (4.2%)
Not reported and unknown		2 (0.8%)	2 (0.4%)
White Non-Hispanic	118 (50.4%)	121 (50.2%)	239 (50.3%)
Communities of Color	116 (49.6%)	120 (49.8%)	236 (49.7%)

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

2.3 Sample Sizes of Baseline Strata for Correlates of Risk Analysis

Table 3. Sample Sizes of Baseline Strata for Correlates of Risk Analysis

Per-protocol Cases and Non-Cases (Moderna Trial)																		
	Baseline SARS-CoV-2 Negative									Baseline SARS-CoV-2 Positive								
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
Vaccine																		
Day 29 Cases	8	18	6	2	7	0	3	12	3	0	0	0	0	0	1	2	0	0
Day 57 Cases	8	18	4	2	7	0	1	9	3	0	0	0	0	0	1	2	0	0
Non-Cases	153	235	69	78	106	35	67	105	39	48	72	26	24	32	12	23	35	11
Placebo																		
Day 29 Cases	141	329	77	48	109	31	87	243	55	0	1	1	0	1	0	1	1	0
Day 57 Cases	132	306	72	37	93	27	61	198	42	0	1	1	0	1	0	1	1	0
Non-Cases	21	34	9	16	16	2	16	18	3	43	77	32	19	39	16	22	38	9

Demographic covariate strata:

- | | |
|----------------------------------|--------------------------------------|
| 1. Age \geq 65 Minority | 6. Age < 65 At-risk Unknown |
| 2. Age \geq 65 Non-Minority | 7. Age < 65 Not At-risk Minority |
| 3. Age \geq 65 Unknown | 8. Age < 65 Not At-risk Non-Minority |
| 4. Age < 65 At-risk Minority | 9. Age < 65 Not At-risk Unknown |
| 5. Age < 65 At-risk Non-Minority | |

Minority includes Blacks or African Americans, Hispanics or Latinos, American Indians or Alaska Natives, Native Hawaiians, and other Pacific Islanders.

Non-Minority includes all other races with observed race (Asian, Multiracial, White, Other) and observed ethnicity Not Hispanic or Latino.

Unknown includes unknown, unreported race or ethnicity.

Cases for Day 29 marker correlates analyses are per-protocol vaccine recipients with the symptomatic infection COVID-19 primary endpoint diagnosed starting 7 days after the Day 29 study visit. Cases for Day 57 marker correlates analyses are per-protocol vaccine recipients with the symptomatic infection COVID-19 primary endpoint diagnosed starting 7 days after the Day 57 study visit. Non-cases are per-protocol participants sampled into the random subcohort with no COVID primary endpoint up to the time of data cut and no evidence of SARS-CoV-2 infection up to six days post Day 57 visit.

The table shows the numbers of cases sampled into the subcohort within baseline covariate strata.

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

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

Visit	Marker	Baseline SARS-CoV-2 Negative Vaccine Recipients						Comparison	
		Cases*		Non-Cases/Control		Resp Rate Difference	GMTR/GMCR		
N	Resp rate	N	Resp rate	GMT/GMC					
Day 29	Pseudovirus-nAb ID80	59	35.6/60 = 59.3% (46.2%, 71.3%)	21.18 (17.33, 25.87)	744	6530.6/11070 = 59.0% (54.4%, 63.4%)	25.97 (23.98, 28.13)	0 (-0.14, 0.13)	0.82 (0.66, 1.01)
Day 29	Pseudovirus-nAb ID50	59	53.9/60 = 89.8% (78.9%, 95.4%)	16.19 (12.51, 20.95)	744	9932/11070 = 89.7% (86.2%, 92.4%)	17.35 (15.85, 18.99)	0 (-0.11, 0.07)	0.93 (0.71, 1.23)
Day 29	Anti RBD IgG (IU/ml)	59	60/60 = 100.0% (100.0%, 100.0%)	456.66 (292.67, 712.53)	744	10896.8/11070 = 98.4% (96.6%, 99.3%)	473.53 (412.98, 542.96)	0.02 (0.01, 0.03)	0.96 (0.61, 1.54)
Day 29	Anti Spike IgG (IU/ml)	59	60/60 = 100.0% (100.0%, 100.0%)	236.57 (169.47, 330.25)	744	10981.5/11070 = 99.2% (97.7%, 99.7%)	266.03 (238.38, 296.89)	0.01 (0, 0.02)	0.89 (0.63, 1.26)
Day 29	Anti N IgG (IU/ml)	59	35.6/60 = 59.3% (46.2%, 71.3%)	39.18 (24.94, 61.55)	744	6848.9/11070 = 61.9% (57.3%, 66.2%)	36.77 (31.08, 43.49)	-0.03 (-0.16, 0.1)	1.07 (0.66, 1.73)
Day 57	Pseudovirus-nAb ID80	52	52/52 = 100.0% (100.0%, 100.0%)	408.70 (310.06, 538.71)	744	11065/11065 = 100.0% (100.0%, 100.0%)	564.67 (511.70, 623.12)	0 (0, 0)	0.72 (0.54, 0.97)
Day 57	Pseudovirus-nAb ID50	52	52/52 = 100.0% (100.0%, 100.0%)	320.14 (230.41, 444.83)	744	11065/11065 = 100.0% (100.0%, 100.0%)	427.25 (383.62, 475.84)	0 (0, 0)	0.75 (0.53, 1.06)
Day 57	Anti RBD IgG (IU/ml)	52	52/52 = 100.0% (100.0%, 100.0%)	3325.76 (2232.06, 4955.38)	744	11045.2/11065 = 99.8% (98.7%, 100.0%)	3599.25 (3171.86, 4084.22)	0 (0, 0.01)	0.92 (0.61, 1.40)
Day 57	Anti Spike IgG (IU/ml)	52	52/52 = 100.0% (100.0%, 100.0%)	1847.33 (1337.98, 2550.57)	744	11065/11065 = 100.0% (100.0%, 100.0%)	2668.40 (2364.64, 3011.17)	0 (0, 0)	0.69 (0.49, 0.98)

Day	Anti N IgG (IU/ml)	52	$37/52 = 71.2\%$ (57.2%, 82.0%)	71.78 (43.87, 117.44)	744	$8998.4/11065 = 81.3\%$ (77.3%, 84.8%)	110.30 (94.07, 129.33)	-0.1 (-0.25, 0.01)	0.65 (0.39, 1.09)
-----	--------------------	----	------------------------------------	--------------------------	-----	---	---------------------------	-----------------------	----------------------

Cases for Day 29 marker correlates analyses are baseline negative per-protocol vaccine recipients with the symptomatic infection COVID-19 primary endpoint diagnosed starting 7 days after the Day 29 study visit. Cases for Day 57 marker correlates analyses 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.

N is the number of cases sampled into the subcohort within baseline covariate strata.

The denominator in Resp Rate is the number of participants in the whole per-protocol cohort within baseline covariate strata, calculated using inverse probability weighting.



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

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

Visit	Marker	Baseline SARS-CoV-2 Positive Vaccine Recipients						Comparison	
		Cases*		Non-Cases/Control				Resp Rate Difference	GMTR/GMCR
		N	Resp rate	GMT/GMC	N	Resp rate	GMT/GMC		
Day 29	Pseudovirus-nAb ID80	3	3.3/5 = 66.7% (0.6%, 99.8%)	28.17 (20.25, 39.20)	234	904.7/1218.1 = 74.3% (66.3%, 80.9%)	51.20 (44.64, 58.73)	-0.08 (-0.74, 0.27)	0.55 (0.38, 0.79)
Day 29	Pseudovirus-nAb ID50	3	5/5 = 100.0% (100.0%, 100.0%)	37.31 (35.33, 39.40)	234	1159.7/1218.1 = 95.2% (89.2%, 97.9%)	32.70 (28.11, 38.04)	0.05 (0.02, 0.11)	1.14 (0.97, 1.34)
Day 29	Anti RBD IgG (IU/ml)	3	5/5 = 100.0% (100.0%, 100.0%)	622.59 (124.89, 3103.56)	234	1213.5/1218.1 = 99.6% (97.3%, 99.9%)	823.96 (640.00, 1060.79)	0 (0, 0.03)	0.76 (0.15, 3.84)
Day 29	Anti Spike IgG (IU/ml)	3	5/5 = 100.0% (100.0%, 100.0%)	180.93 (156.70, 208.91)	234	1209.6/1218.1 = 99.3% (95.1%, 99.9%)	474.27 (397.60, 565.71)	0.01 (0, 0.05)	0.38 (0.30, 0.48)
Day 29	Anti N IgG (IU/ml)	3	5/5 = 100.0% (100.0%, 100.0%)	220.52 (99.97, 486.42)	234	928.1/1218.1 = 76.2% (68.6%, 82.4%)	70.68 (55.09, 90.70)	0.24 (0.18, 0.31)	3.12 (1.36, 7.15)
Day 57	Pseudovirus-nAb ID80	3	5/5 = 100.0% (100.0%, 100.0%)	1156.48 (486.62, 2748.44)	233	1229/1229 = 100.0% (100.0%, 100.0%)	1559.92 (1333.89, 1824.26)	0 (0, 0)	0.74 (0.31, 1.79)
Day 57	Pseudovirus-nAb ID50	3	5/5 = 100.0% (100.0%, 100.0%)	493.08 (319.26, 761.53)	233	1229/1229 = 100.0% (100.0%, 100.0%)	1227.59 (1000.73, 1505.88)	0 (0, 0)	0.40 (0.25, 0.65)
Day 57	Anti RBD IgG (IU/ml)	3	5/5 = 100.0% (100.0%, 100.0%)	15558.50 (14386.64, 16825.81)	233	1229/1229 = 100.0% (100.0%, 100.0%)	8619.19 (7266.78, 10223.28)	0 (0, 0)	1.81 (1.50, 2.18)
Day 57	Anti Spike IgG (IU/ml)	3	5/5 = 100.0% (100.0%, 100.0%)	4871.27 (3719.87, 6379.06)	233	1229/1229 = 100.0% (100.0%, 100.0%)	5665.25 (4956.22, 6475.72)	0 (0, 0)	0.86 (0.64, 1.16)

Day 57	Anti N IgG (IU/ml)	3	$5/5 = 100.0\%$ (100.0%, 100.0%)	293.21 (150.76, 570.25)	233	$1182.5/1229 = 96.2\%$ (90.6%, 98.5%)	248.12 (202.53, 303.97)	0.04 (0.01, 0.09)	1.18 (0.59, 2.37)
-----------	--------------------	---	-------------------------------------	----------------------------	-----	--	----------------------------	----------------------	----------------------

The SAP does not specify correlates analyses in baseline positive vaccine recipients. This table summarizes descriptively the same information for baseline positive vaccine recipients that was summarized for baseline negative vaccine recipients. Cases for Day 29 markers are baseline positive per-protocol vaccine recipients with the symptomatic infection COVID-19 primary endpoint diagnosed starting 7 days after the Day 29 study visit. Cases for Day 57 markers 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 positive per-protocol vaccine recipients sampled into the random subcohort with no COVID-19 endpoint diagnosis by the time of data-cut.

N is the number of cases sampled into the subcohort within baseline covariate strata.

The denominator in Resp Rate is the number of participants in the whole per-protocol cohort within baseline covariate strata, calculated using inverse probability weighting.



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

Table 6. Antibody levels in the baseline SARS-CoV-2 positive per-protocol cohort (placebo recipients)

Visit	Marker	Baseline SARS-CoV-2 Positive Placebo Recipients						Comparison	
		Cases*			Non-Cases/Control			Resp Rate Difference	GMTR/GMCR
N	Resp rate	GMT/GMC	N	Resp rate	GMT/GMC				
Day 29	Pseudovirus-nAb ID80	5 3/5 = 60.0% (10.6%, 95.0%)	19.58 (9.63, 39.79)	238	442.9/1121 = 39.5% (32.4%, 47.1%)	20.38 (17.86, 23.27)	0.2 (-0.29, 0.56)	0.96 (0.47, 1.98)	
Day 29	Pseudovirus-nAb ID50	5 2/5 = 40.0% (5.0%, 89.4%)	4.46 (1.50, 13.28)	238	896.5/1121 = 80.0% (72.4%, 85.9%)	11.68 (9.90, 13.77)	-0.4 (-0.75, 0.1)	0.38 (0.13, 1.15)	
Day 29	Anti RBD IgG (IU/ml)	5 5/5 = 100.0% (100.0%, 100.0%)	498.48 (77.45, 3208.22)	238	1060/1121 = 94.6% (88.4%, 97.5%)	306.92 (232.82, 404.62)	0.05 (0.02, 0.12)	1.62 (0.25, 10.67)	
Day 29	Anti Spike IgG (IU/ml)	5 5/5 = 100.0% (100.0%, 100.0%)	266.06 (74.76, 946.84)	238	1085.9/1121 = 96.9% (91.9%, 98.8%)	170.13 (136.41, 212.19)	0.03 (0.01, 0.08)	1.56 (0.43, 5.67)	
Day 29	Anti N IgG (IU/ml)	5 3/5 = 60.0% (10.6%, 95.0%)	11.78 (2.03, 68.41)	238	603/1121 = 53.8% (45.9%, 61.5%)	26.96 (20.32, 35.77)	0.06 (-0.44, 0.42)	0.44 (0.07, 2.60)	
Day 57	Pseudovirus-nAb ID80	5 5/5 = 100.0% (100.0%, 100.0%)	288.29 (114.87, 723.51)	238	1119/1119 = 100.0% (100.0%, 100.0%)	462.73 (395.43, 541.48)	0 (0, 0)	0.62 (0.24, 1.58)	
Day 57	Pseudovirus-nAb ID50	5 5/5 = 100.0% (100.0%, 100.0%)	629.06 (128.64, 3076.16)	238	1119/1119 = 100.0% (100.0%, 100.0%)	313.97 (258.96, 380.65)	0 (0, 0)	2.00 (0.40, 9.91)	
Day 57	Anti RBD IgG (IU/ml)	5 5/5 = 100.0% (100.0%, 100.0%)	1704.47 (253.44, 11462.91)	238	1119/1119 = 100.0% (100.0%, 100.0%)	2656.74 (2066.29, 3415.92)	0 (0, 0)	0.64 (0.09, 4.39)	
Day 57	Anti Spike IgG (IU/ml)	5 5/5 = 100.0% (100.0%, 100.0%)	1648.06 (332.52, 8168.38)	238	1119/1119 = 100.0% (100.0%, 100.0%)	1953.05 (1538.23, 2479.73)	0 (0, 0)	0.84 (0.17, 4.26)	
Day 57	Anti N IgG (IU/ml)	5 3/5 = 60.0% (10.6%, 95.0%)	49.66 (3.50, 703.93)	238	865.3/1119 = 77.3% (69.5%, 83.6%)	94.81 (70.11, 128.23)	-0.17 (-0.67, 0.19)	0.52 (0.04, 7.55)	

(continued)

Visit	Marker	N	Resp rate	GMT/GMC	N	Resp rate	GMT/GMC	Resp Rate Difference	GMTR/GMCR
-------	--------	---	-----------	---------	---	-----------	---------	----------------------	-----------

The SAP does not specify correlates analyses in baseline positive placebo recipients. This table summarizes descriptively the same information for baseline positive placebo recipients that was summarized for baseline negative and positive vaccine recipients. Cases for Day 29 markers are baseline positive per-protocol placebo recipients with the symptomatic infection COVID-19 primary endpoint diagnosed starting 7 days after the Day 29 study visit. Cases for Day 57 markers are baseline positive per-protocol placebo recipients with the symptomatic infection COVID-19 primary endpoint diagnosed starting 7 days after the Day 57 study visit. Non-cases/Controls are baseline positive per-protocol placebo recipients sampled into the random subcohort with no COVID-19 endpoint diagnosis by the time of data-cut.

N is the number of cases sampled into the subcohort within baseline covariate strata.

The denominator in Resp Rate is the number of participants in the whole per-protocol cohort within baseline covariate strata, calculated using inverse probability weighting.

MOCK

Chapter 3

Graphical Descriptions of Antibody Marker Data

3.1 Boxplots

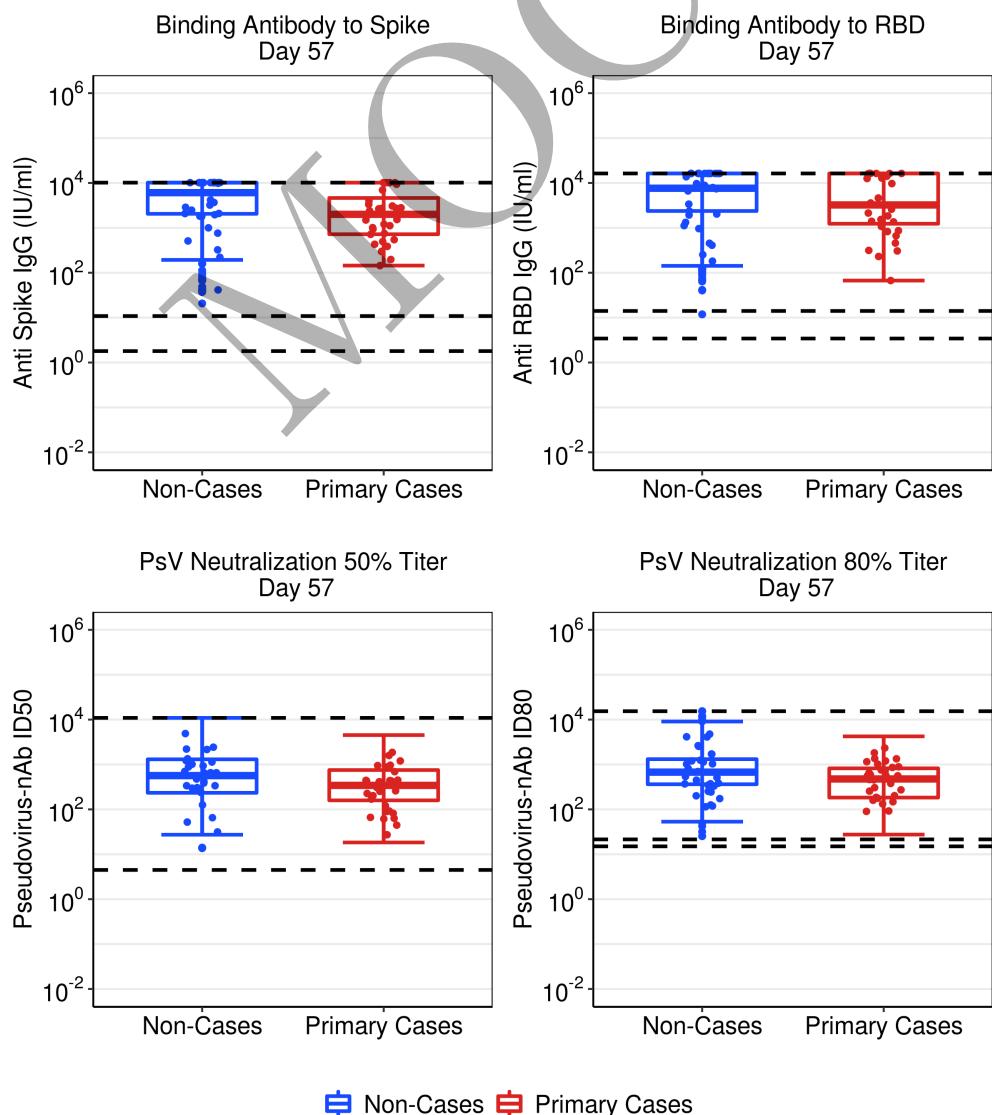


Figure 3.1: Boxplots of D57 Ab markers: vaccine arm. The three dashed lines in each figure are ULOQ, LLOQ, and LLOD, from top to bottom respectively.

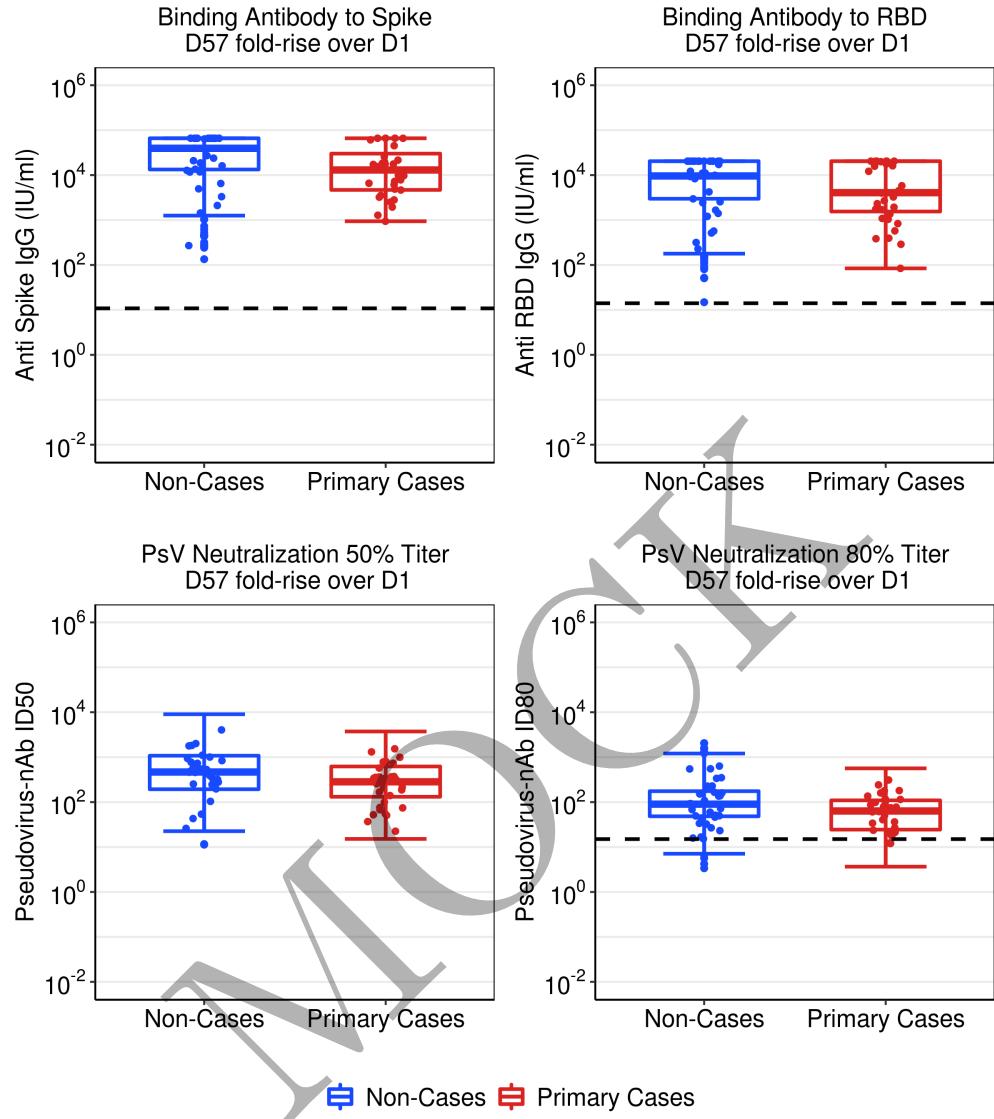


Figure 3.2: Boxplots of D57 fold-rise over D1 Ab markers: vaccine arm.

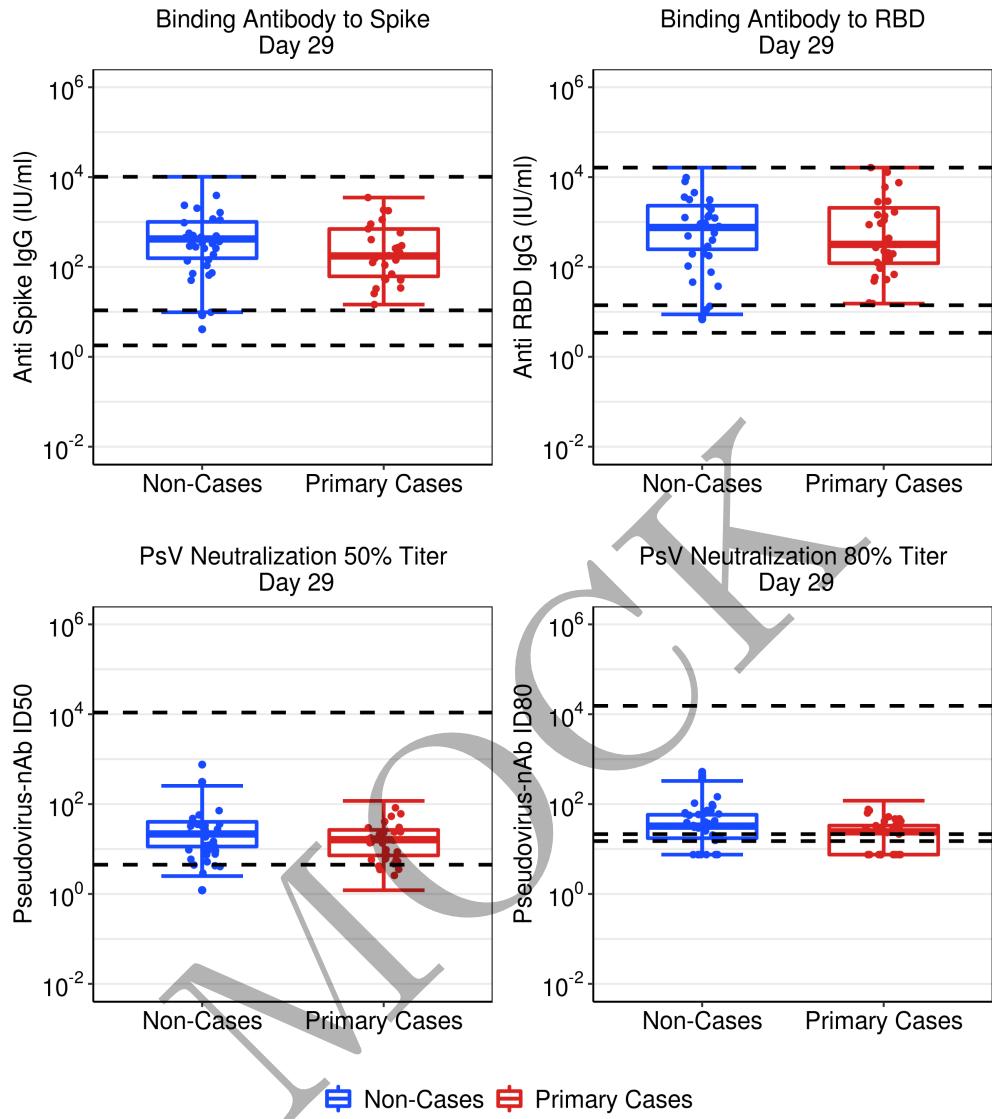


Figure 3.3: Boxplots of D29 Ab markers: vaccine arm. The three dashed lines in each figure are ULOQ, LLOQ, and LLOD, from top to bottom respectively.

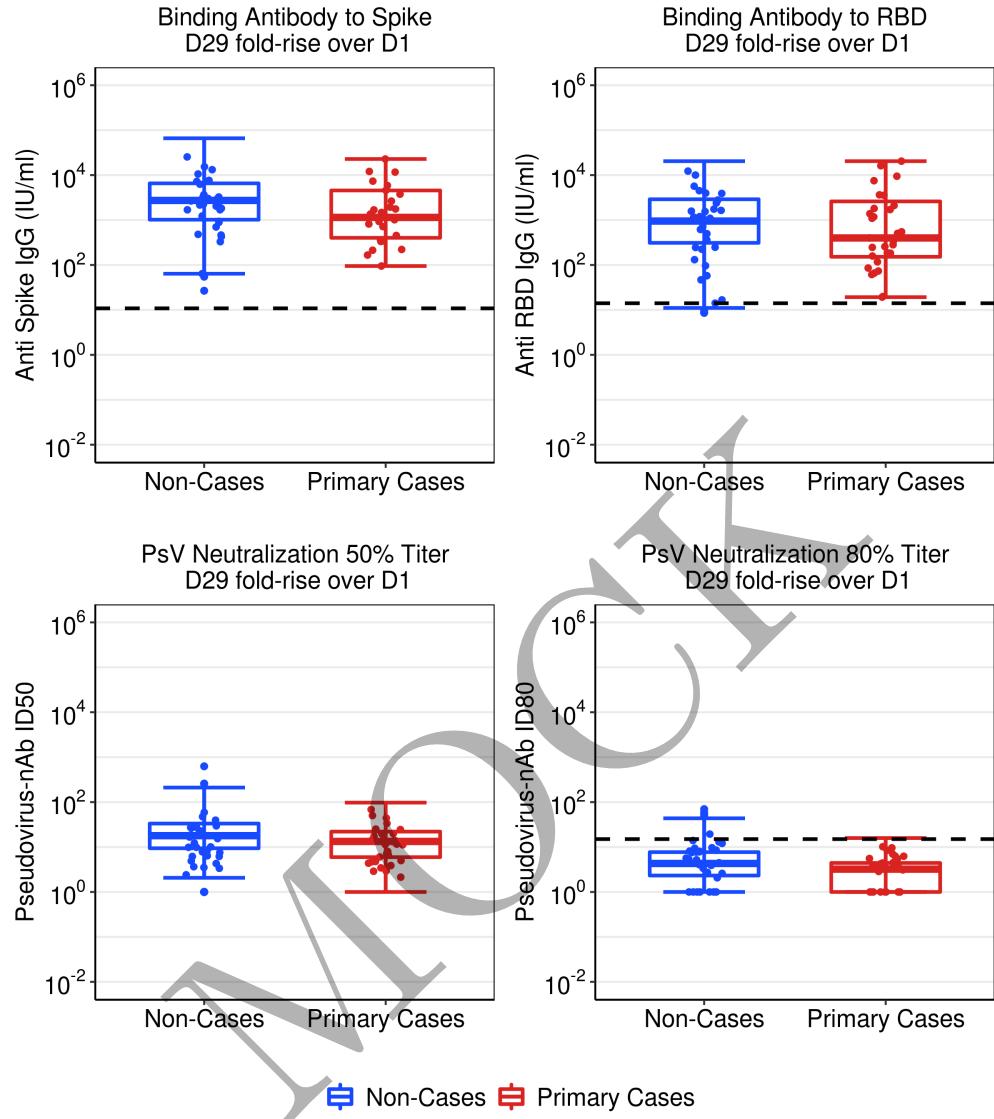


Figure 3.4: Boxplots of D29 fold-rise over D1 Ab markers: vaccine arm.

3.2 Weighted RCDF plots

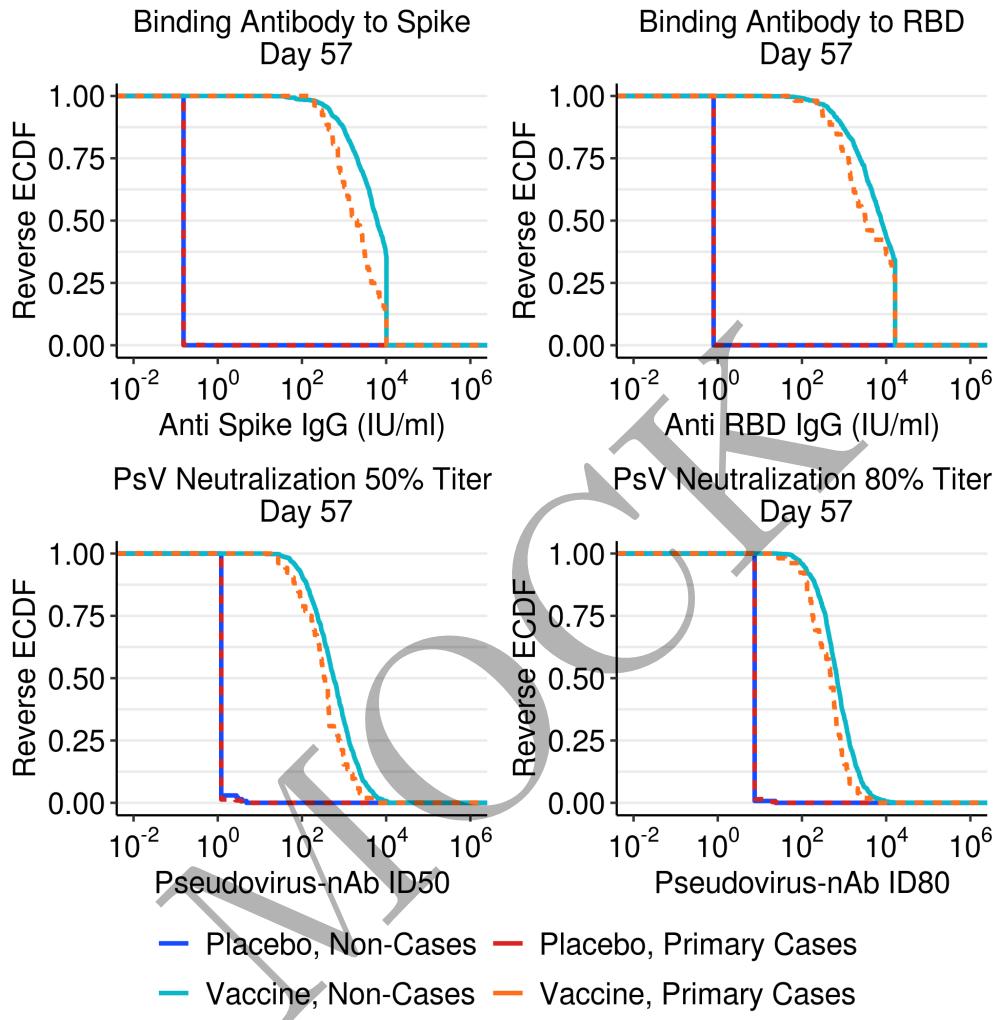


Figure 3.5: RCDF plots for D57 Ab markers by treatment arm.

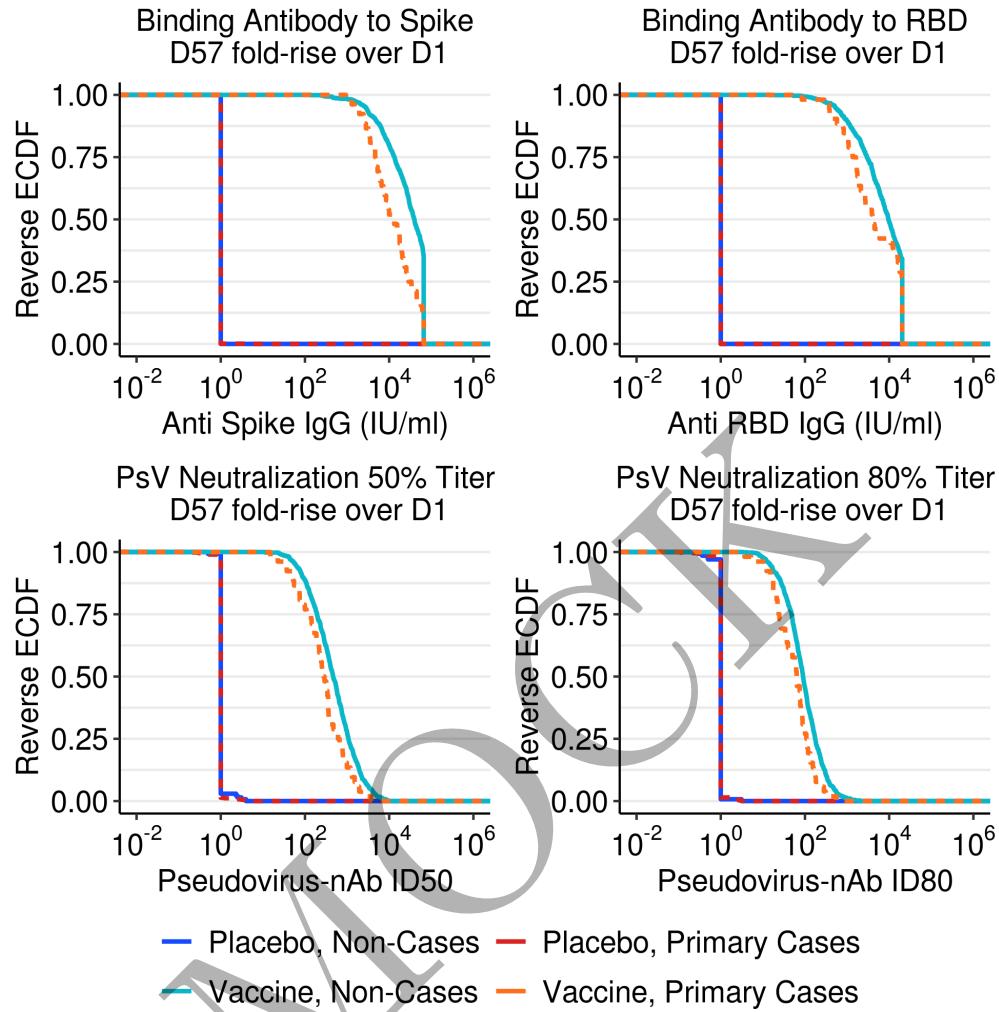


Figure 3.6: RCDF plots for D57 fold-rise over D1 Ab markers by treatment arm.

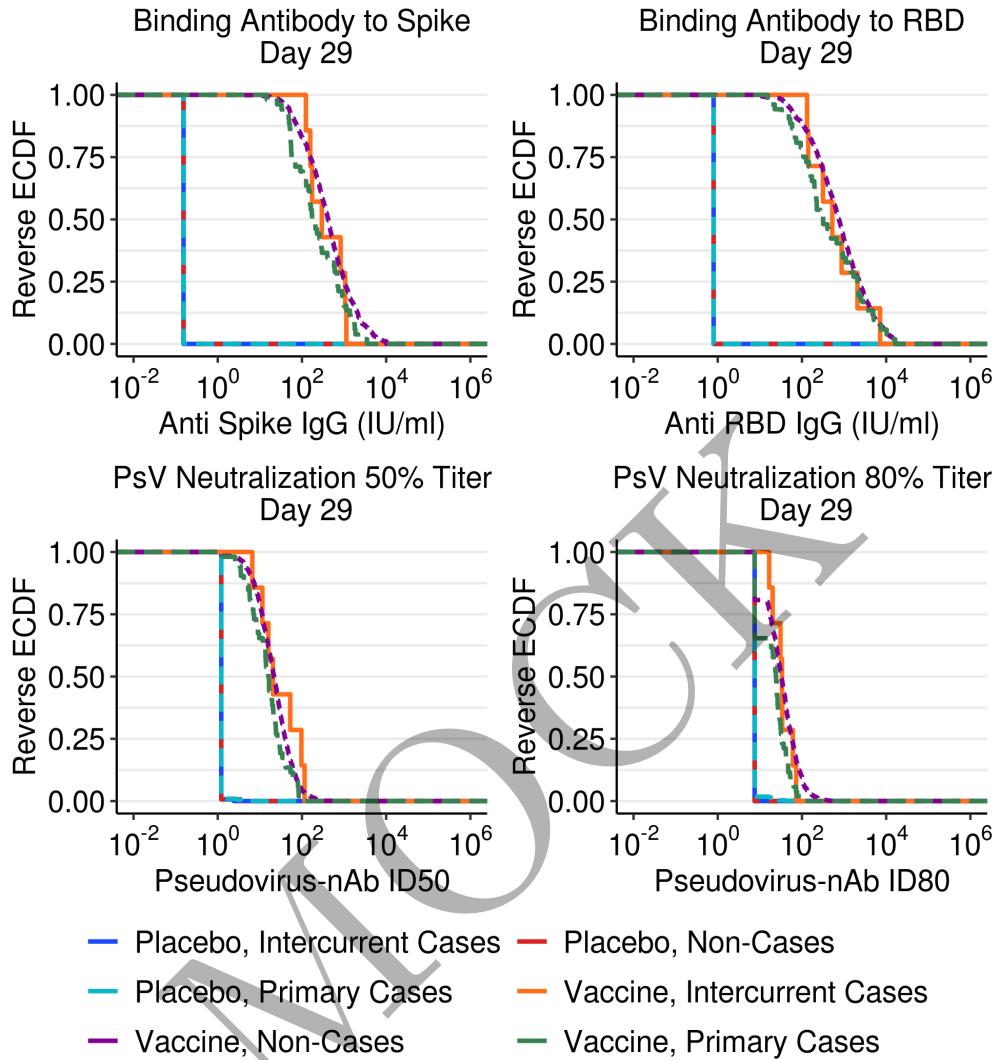


Figure 3.7: RCDF plots for D29 Ab markers by treatment arm.

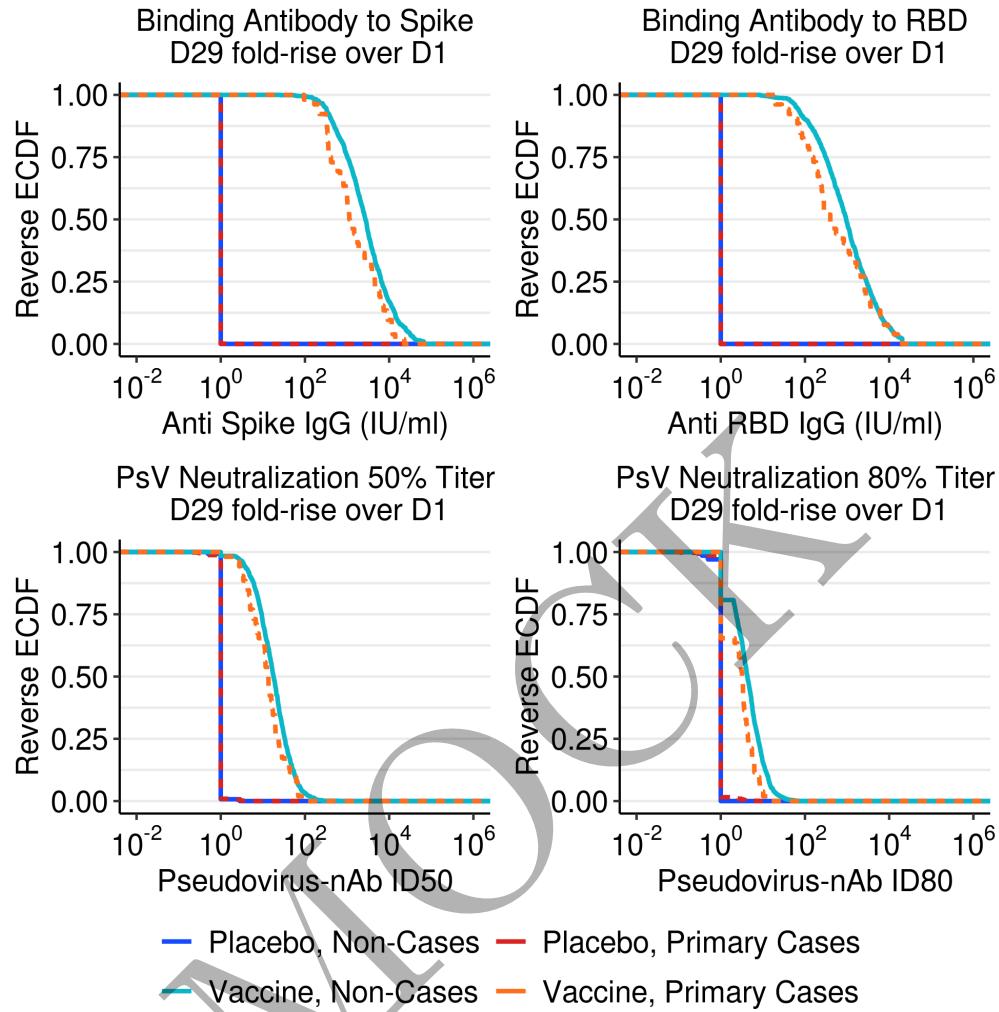


Figure 3.8: RCDF plots for D29 fold-rise over D1 Ab markers by treatment arm.

3.3 Weighted RCDF plots of threshold correlate concentration for vaccine efficacy

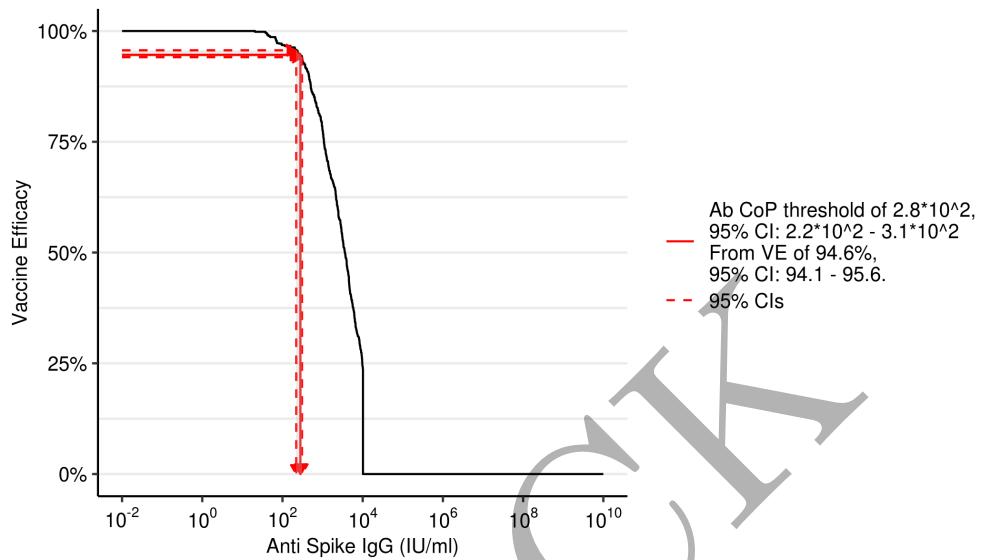


Figure 3.9: Marker RCDF of D57 anti-Spike binding Ab: vaccine arm

3.3. WEIGHTED RCDF PLOTS OF THRESHOLD CORRELATE CONCENTRATION FOR VACCINE EFFICACY53

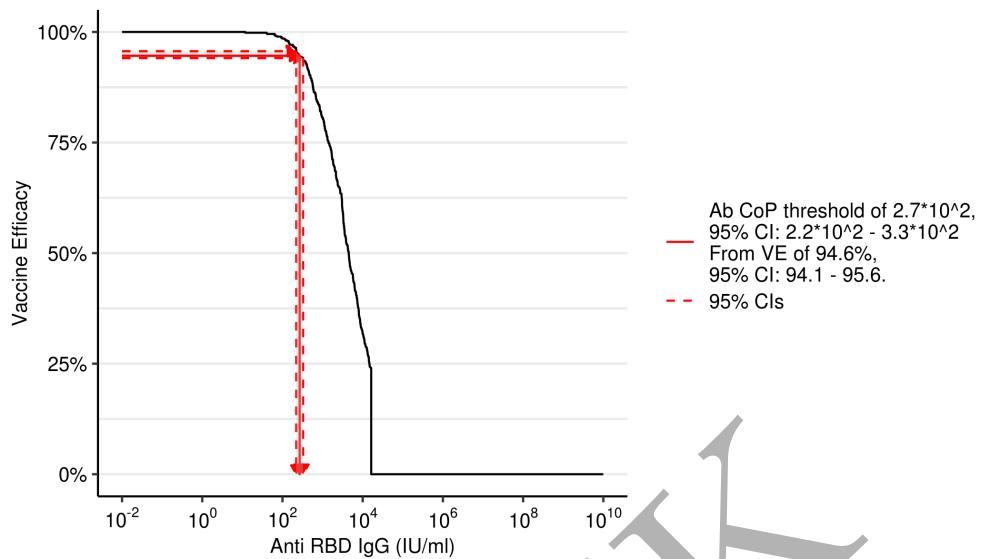


Figure 3.10: Marker RCDF of D57 anti-RBD binding Ab: vaccine arm

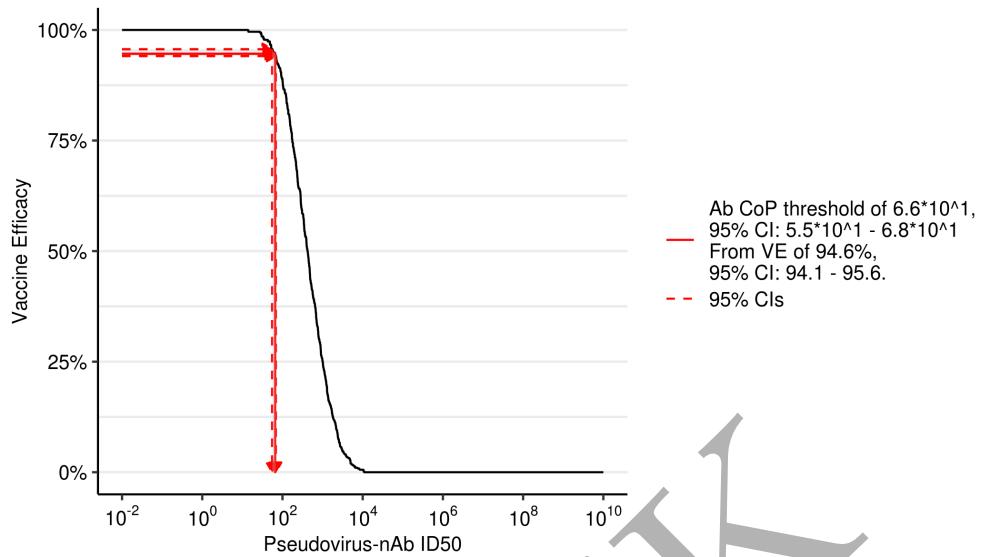


Figure 3.11: Marker RCDF of D57 PsV-nAb ID50: vaccine arm

3.3. WEIGHTED RCDF PLOTS OF THRESHOLD CORRELATE CONCENTRATION FOR VACCINE EFFICACY55

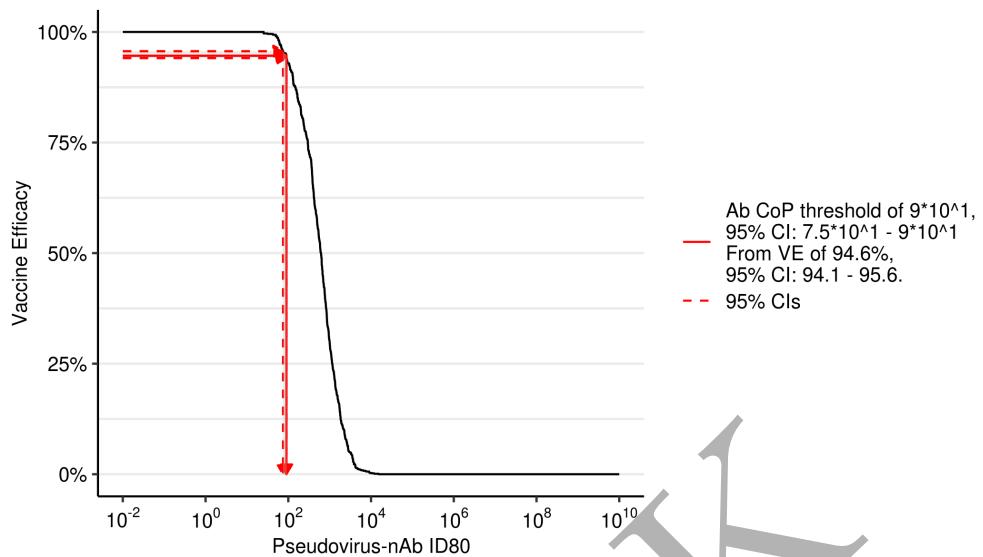


Figure 3.12: Marker RCDF of D57 PsV-nAb ID80: vaccine arm

3.4 Spaghetti plots

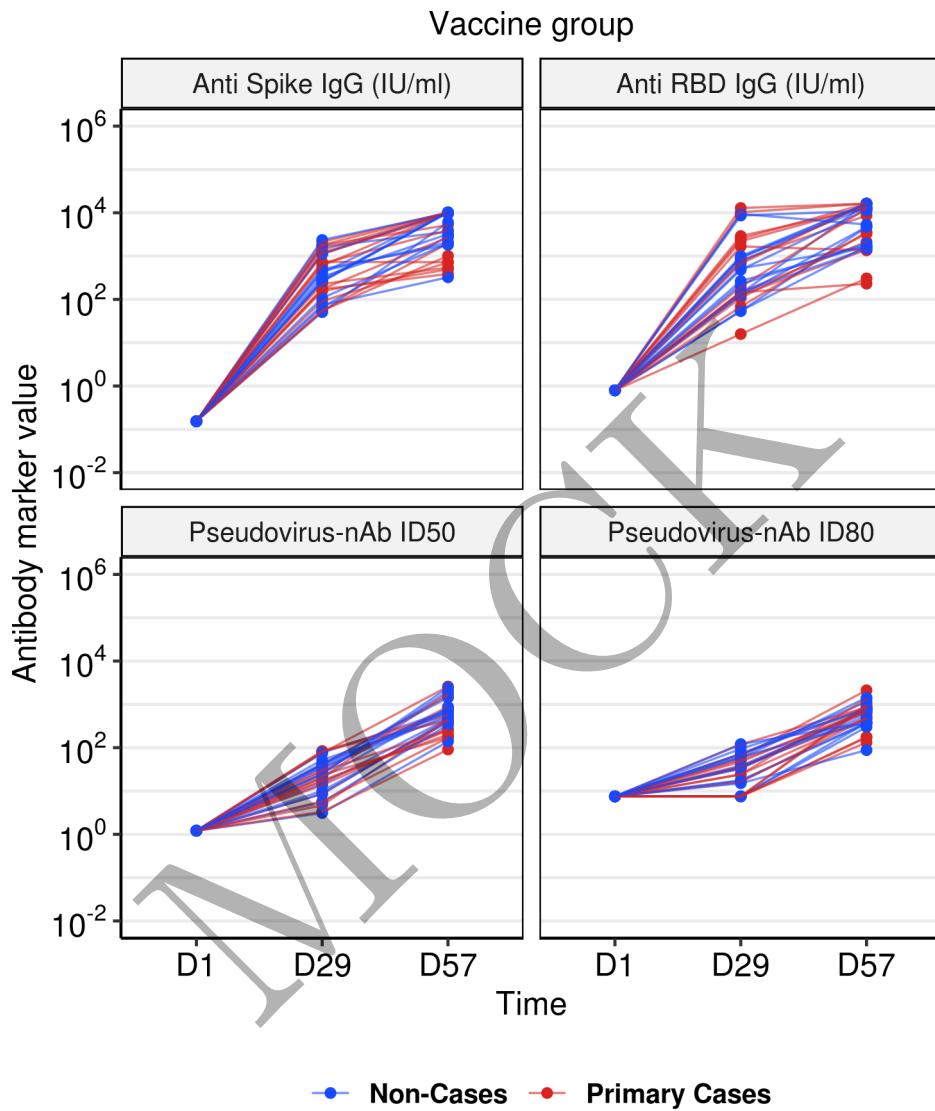


Figure 3.13: Spaghetti Plots of Marker Trajectory: vaccine arm

3.5 Violin and line plots

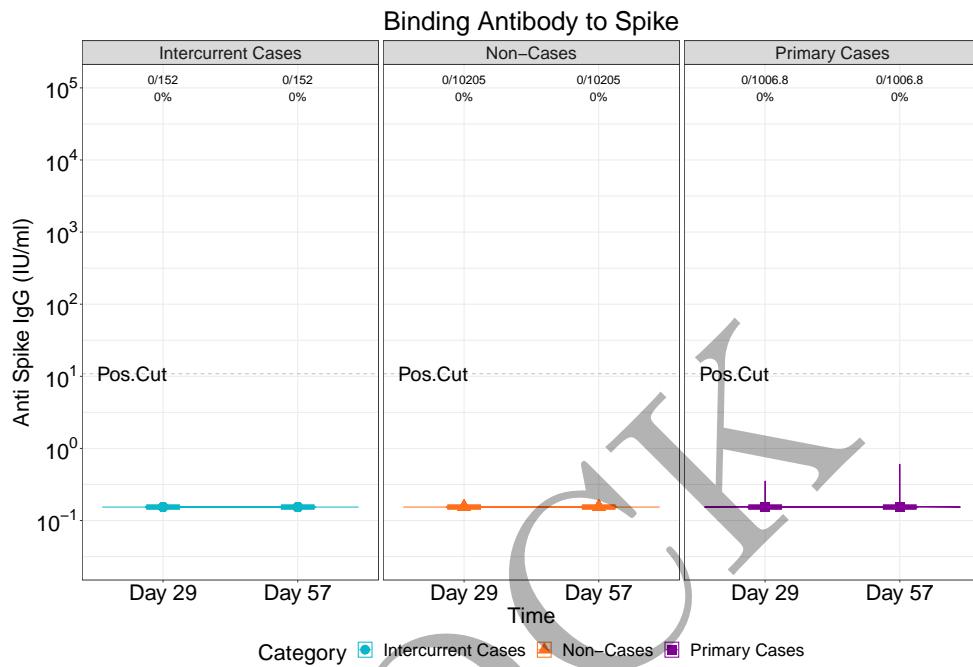


Figure 3.14: lineplots of Binding Antibody to Spike: baseline negative placebo arm (version 1)

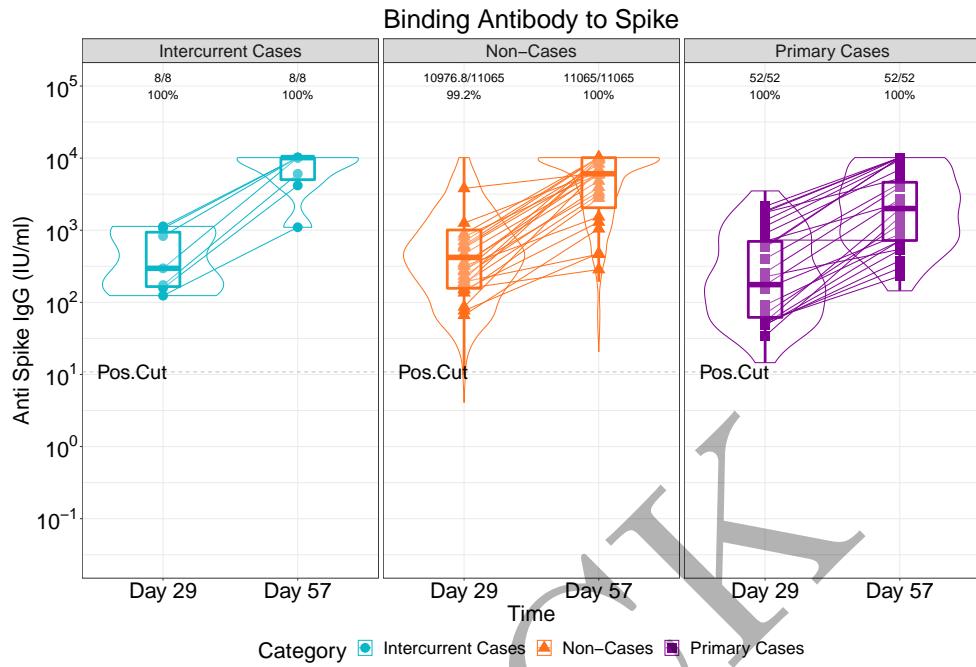


Figure 3.15: lineplots of Binding Antibody to Spike: baseline negative vaccine arm (version 1)

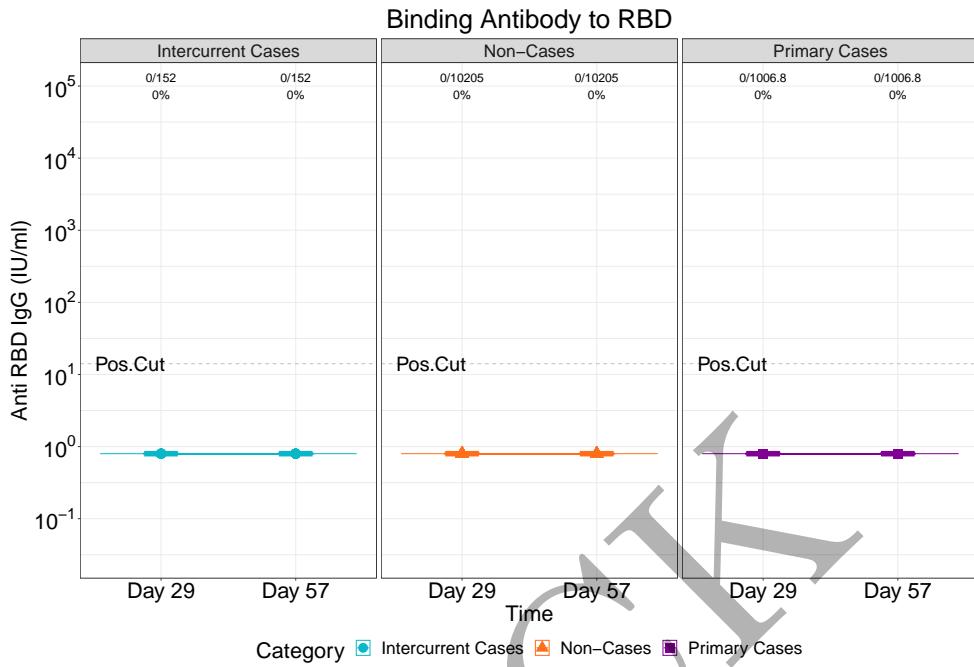


Figure 3.16: lineplots of Binding Antibody to RBD: baseline negative placebo arm (version 1)

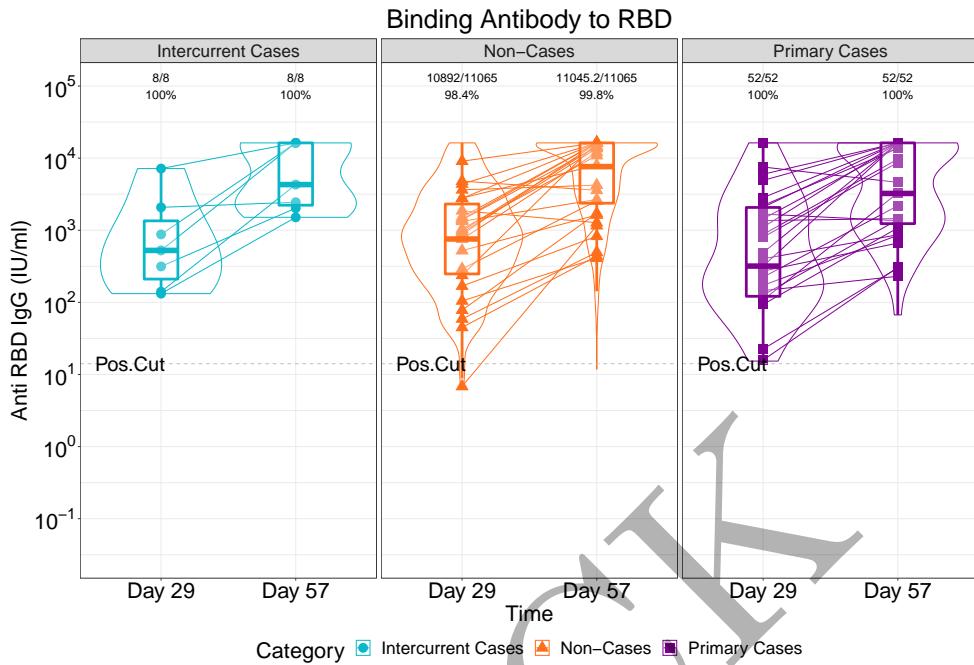


Figure 3.17: lineplots of Binding Antibody to RBD: baseline negative vaccine arm (version 1)

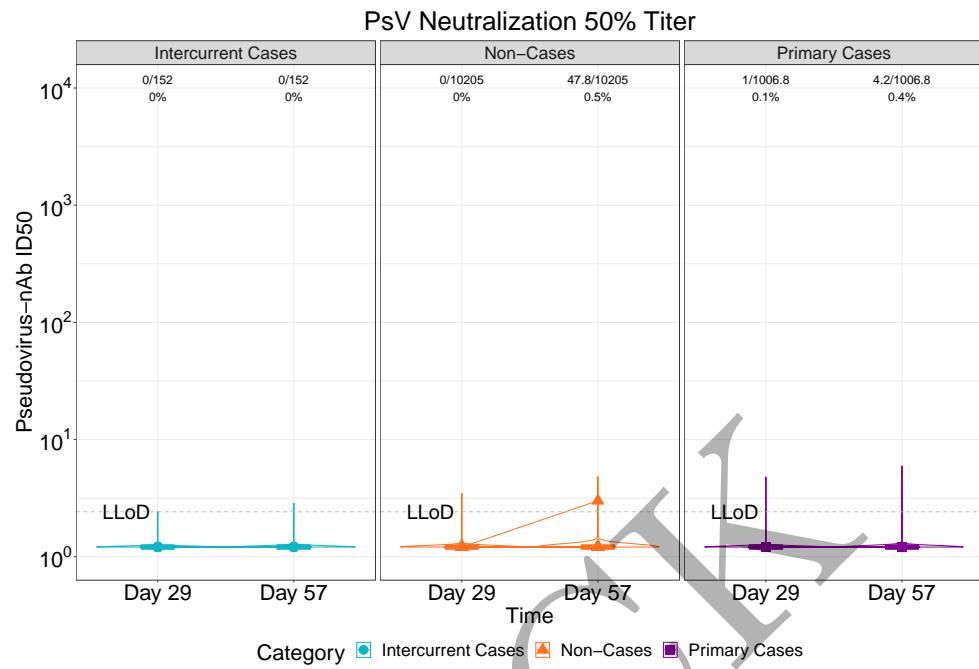


Figure 3.18: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm (version 1)

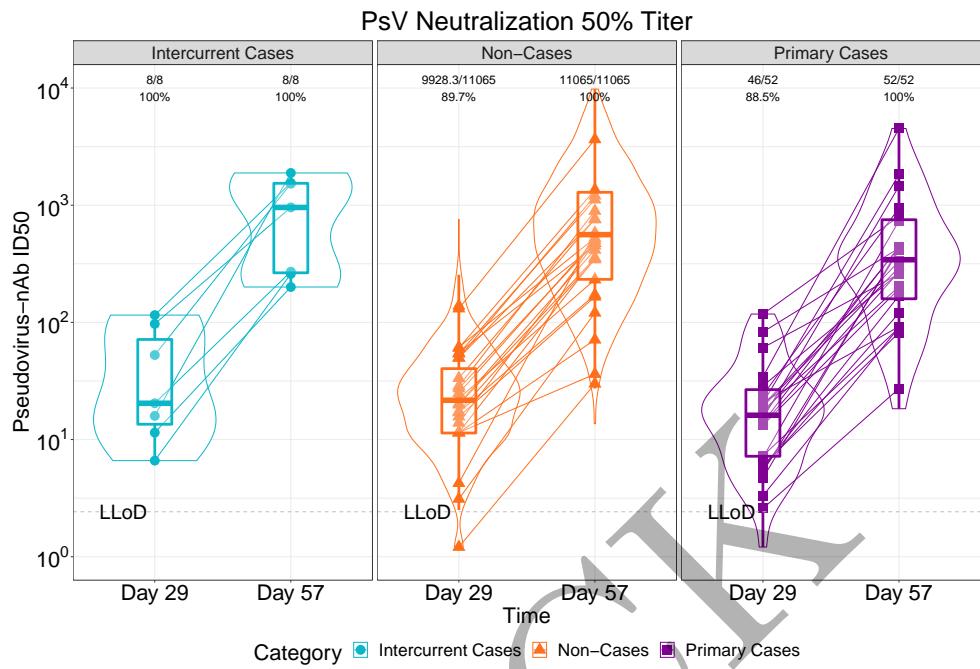


Figure 3.19: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm (version 1)

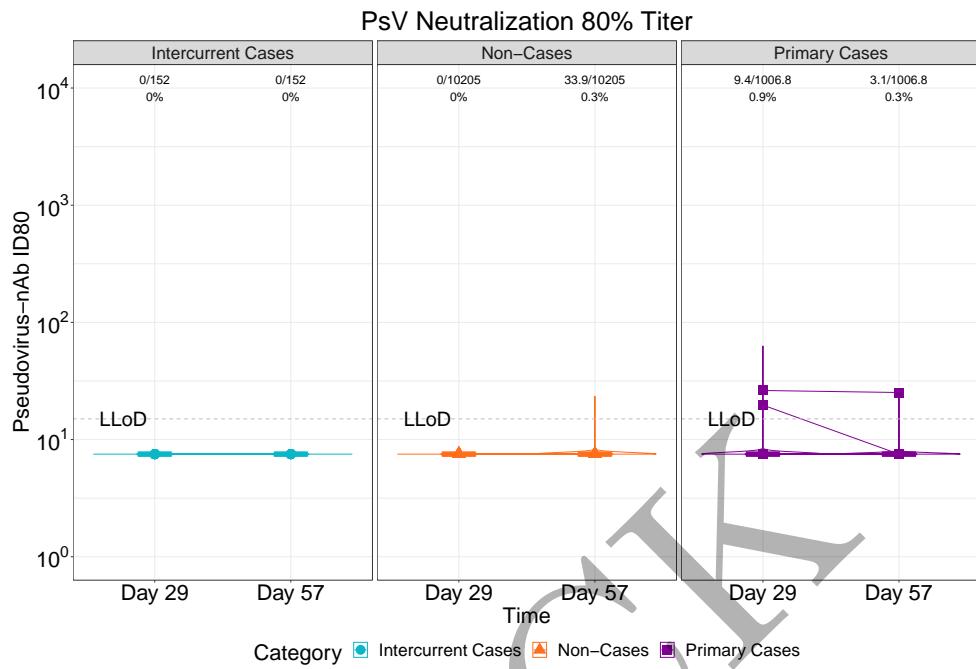


Figure 3.20: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm (version 1)

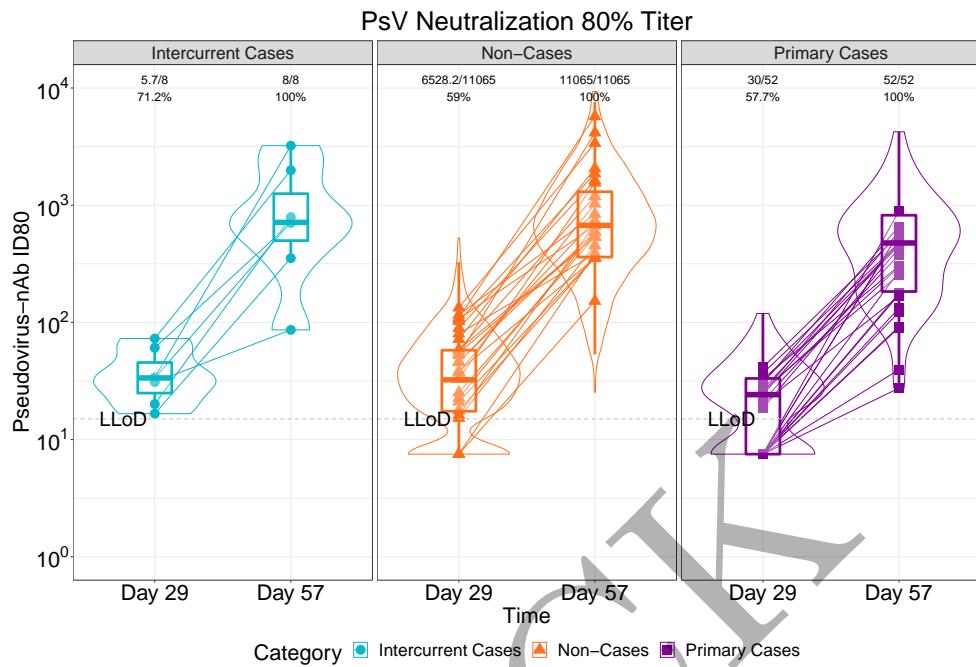


Figure 3.21: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm (version 1)

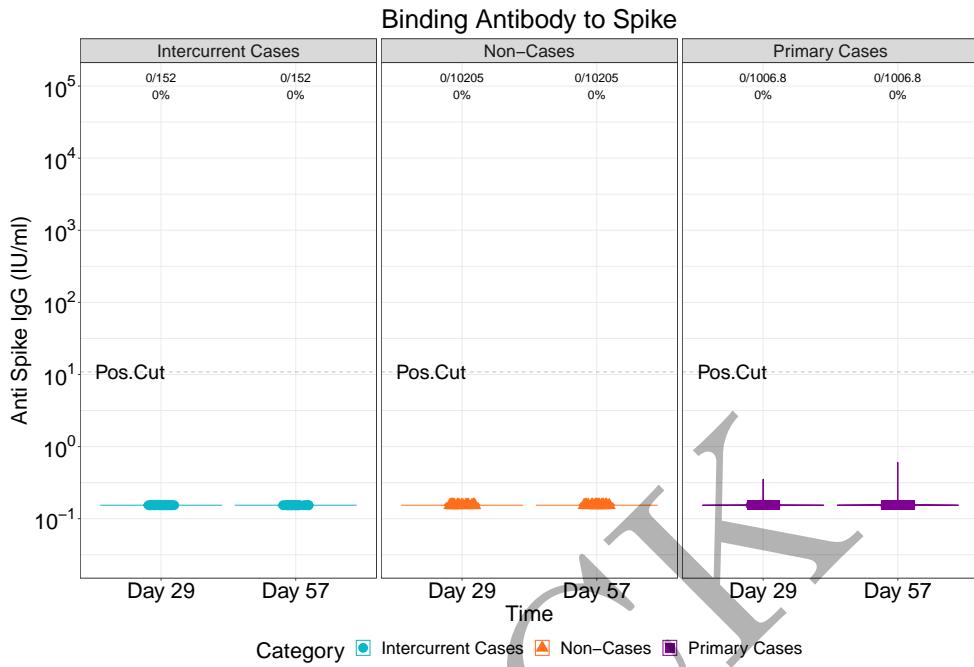


Figure 3.22: violinplots of Binding Antibody to Spike: baseline negative placebo arm (version 1)

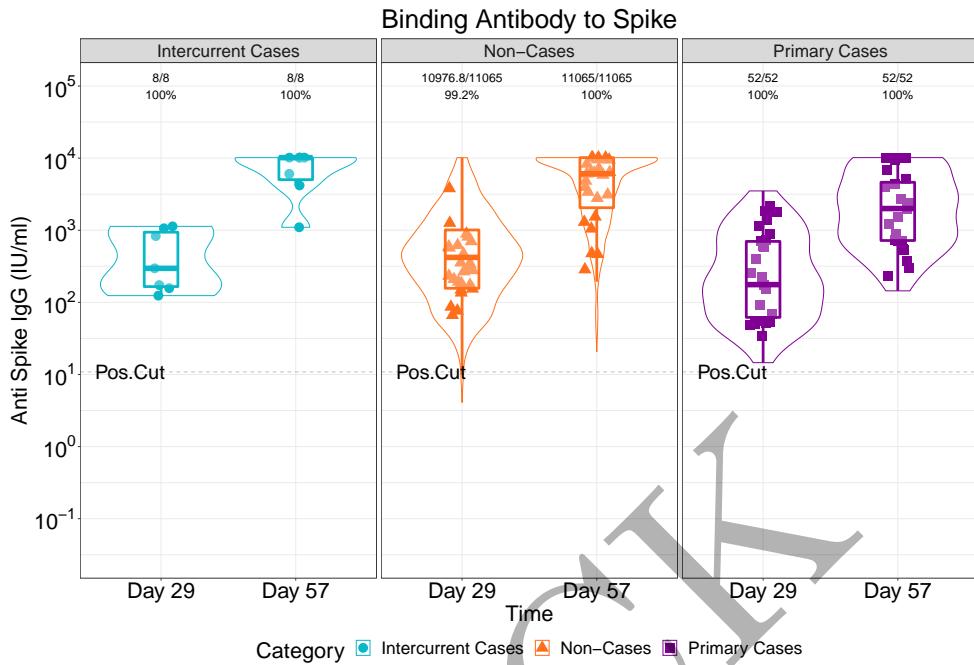


Figure 3.23: violinplots of Binding Antibody to Spike: baseline negative vaccine arm (version 1)

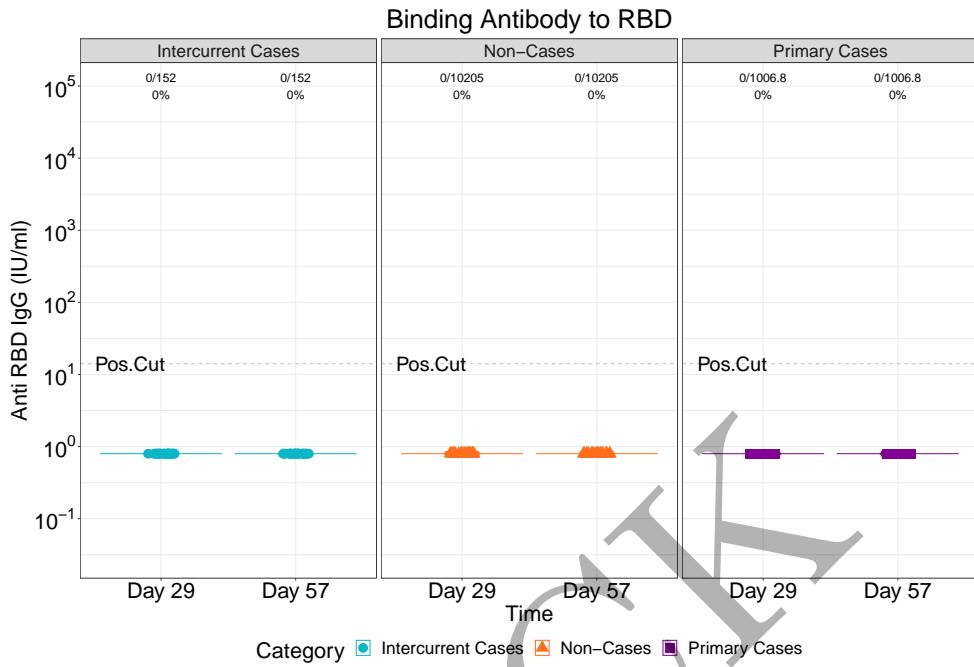


Figure 3.24: violinplots of Binding Antibody to RBD: baseline negative placebo arm (version 1)

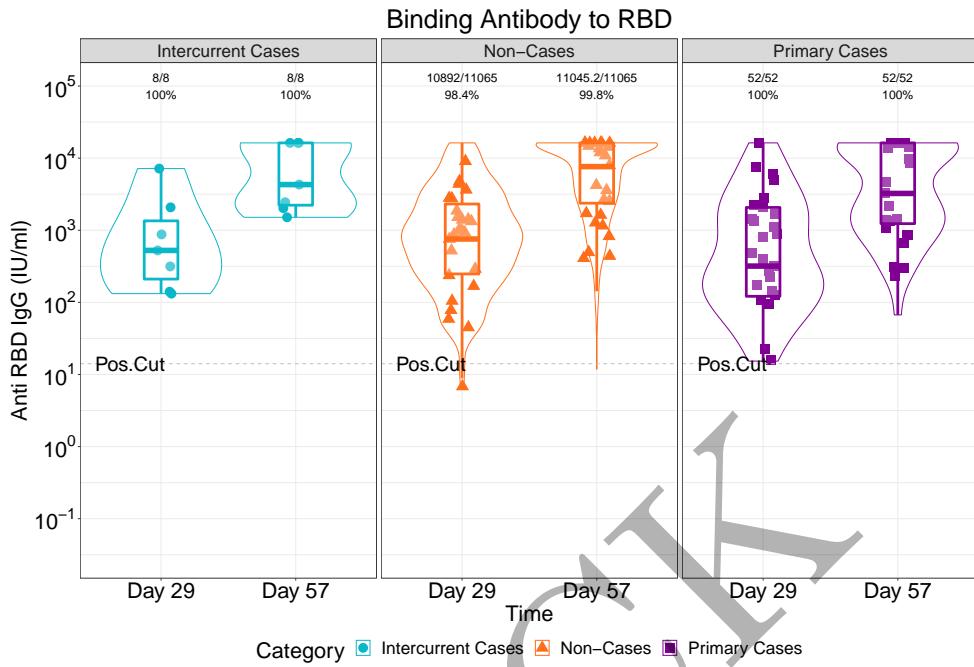


Figure 3.25: violinplots of Binding Antibody to RBD: baseline negative vaccine arm (version 1)

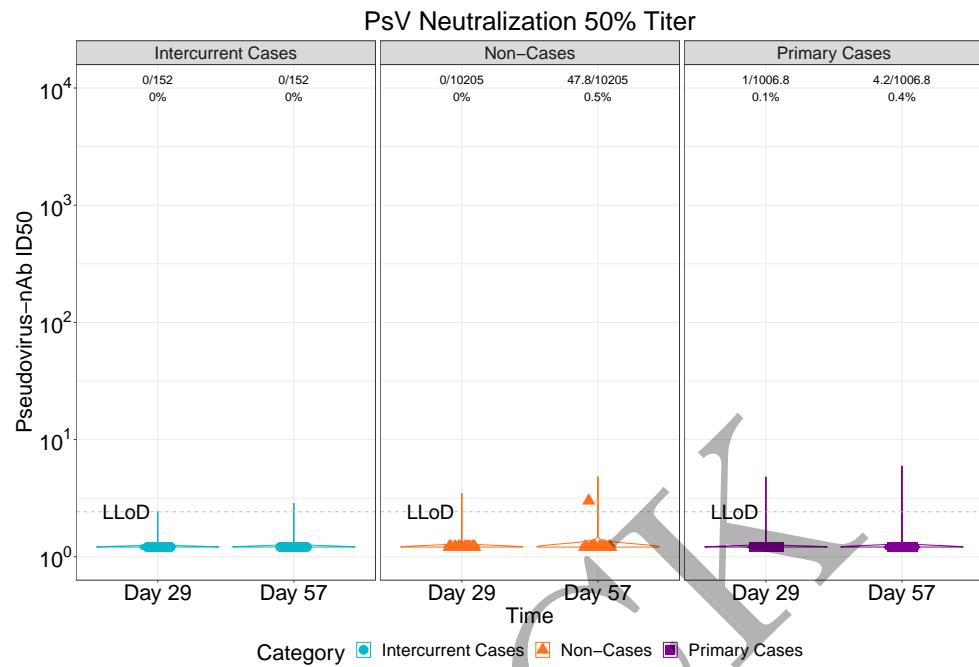


Figure 3.26: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm (version 1)

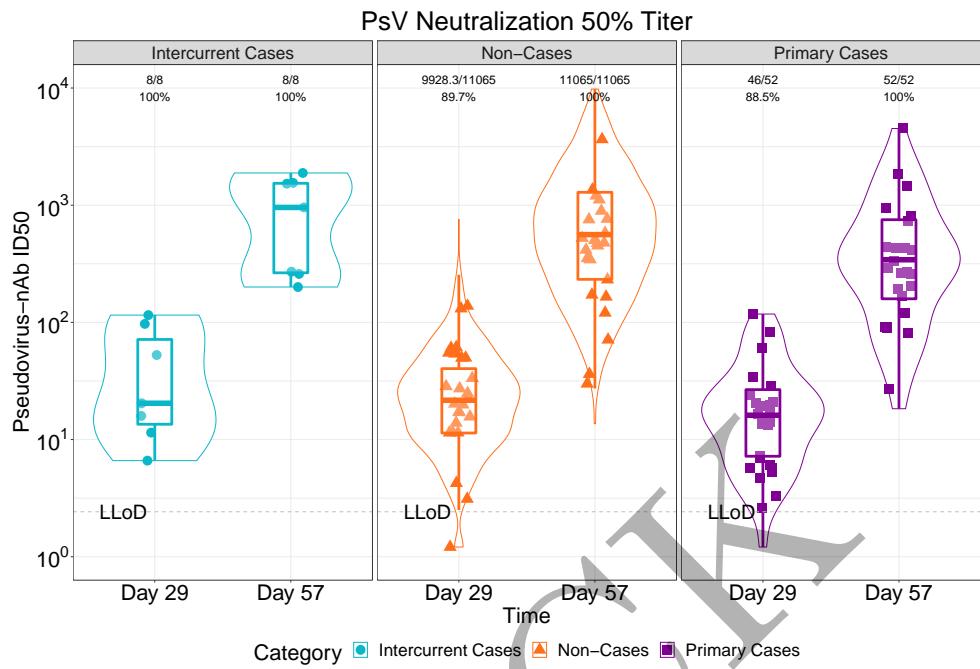


Figure 3.27: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm (version 1)

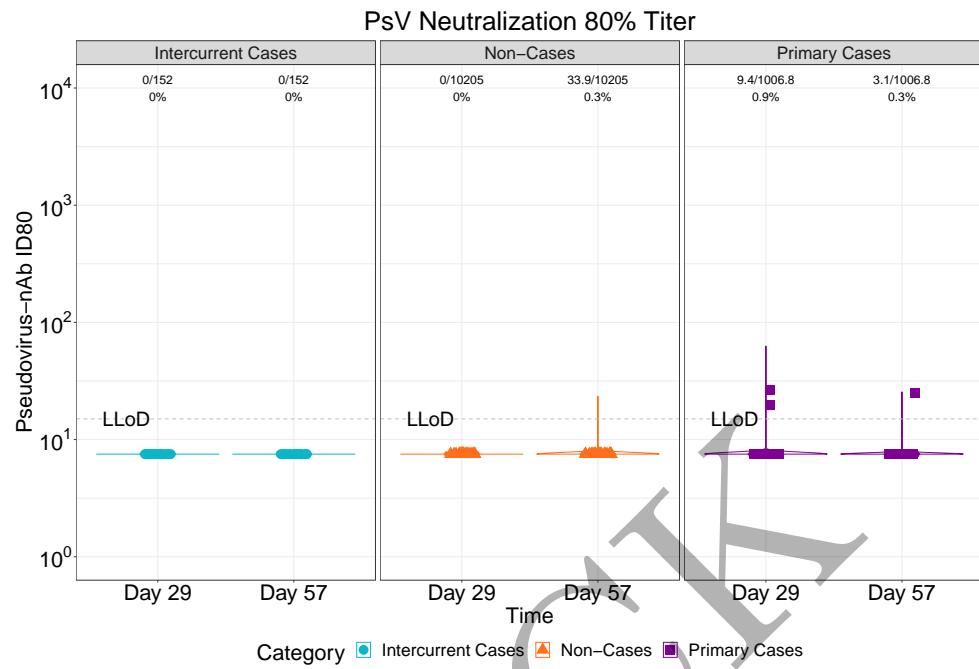


Figure 3.28: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm (version 1)

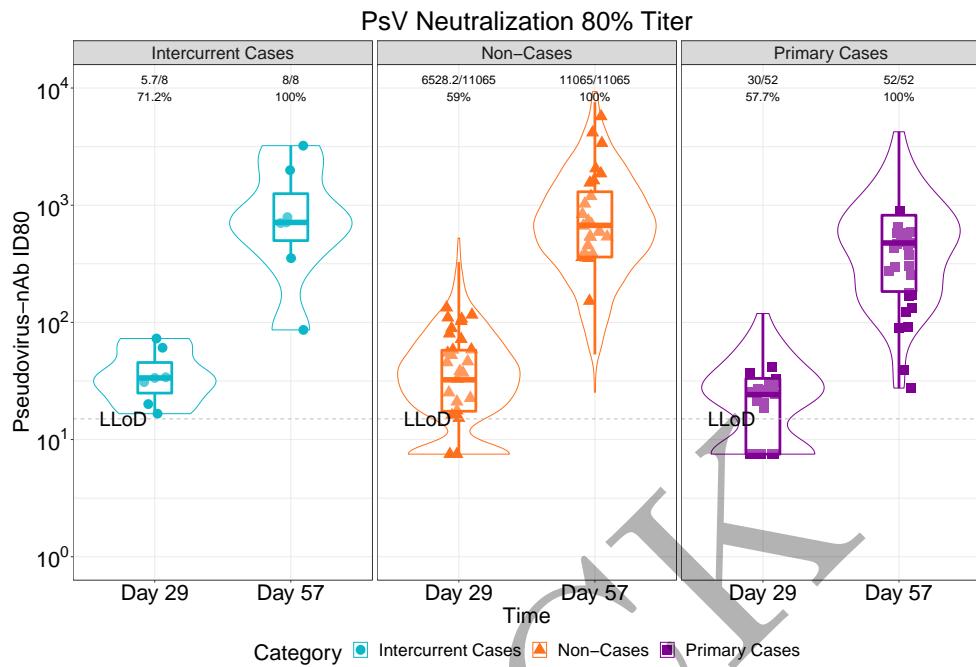


Figure 3.29: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm (version 1)

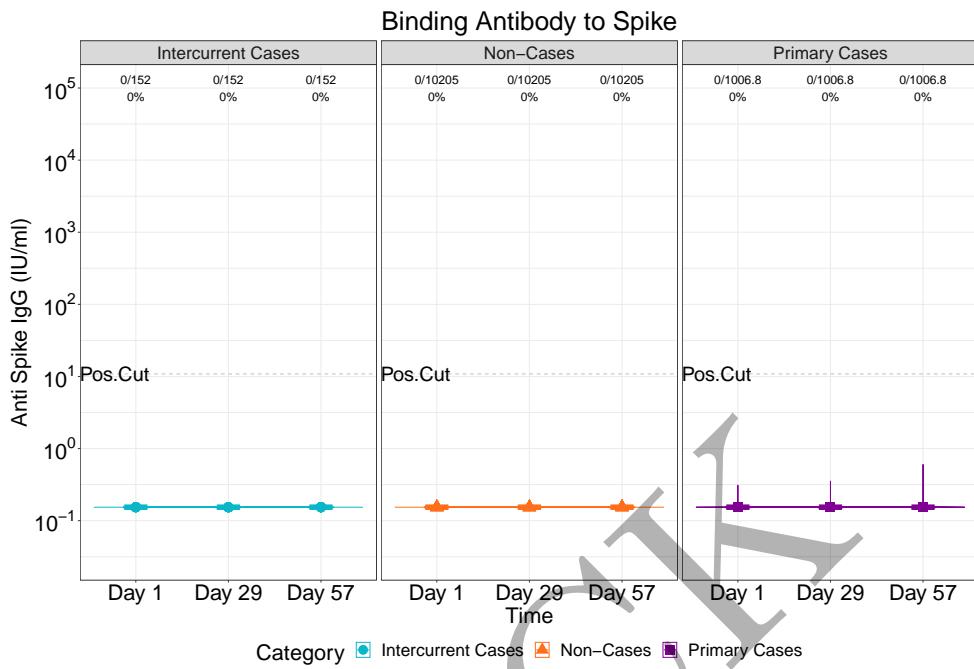


Figure 3.30: lineplots of Binding Antibody to Spike: baseline negative placebo arm (version 2)

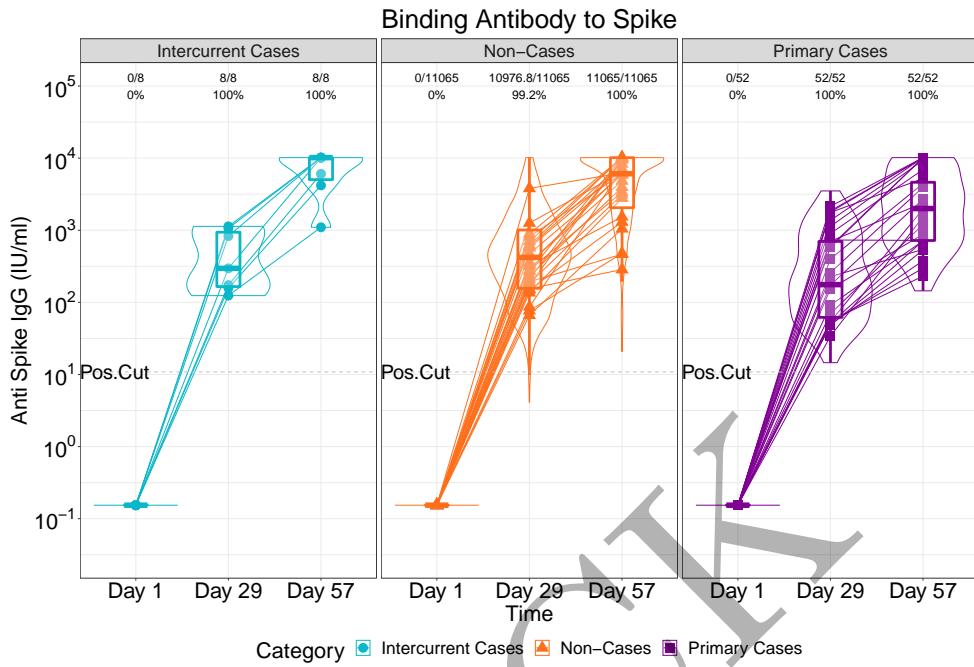


Figure 3.31: lineplots of Binding Antibody to Spike: baseline negative vaccine arm (version 2)

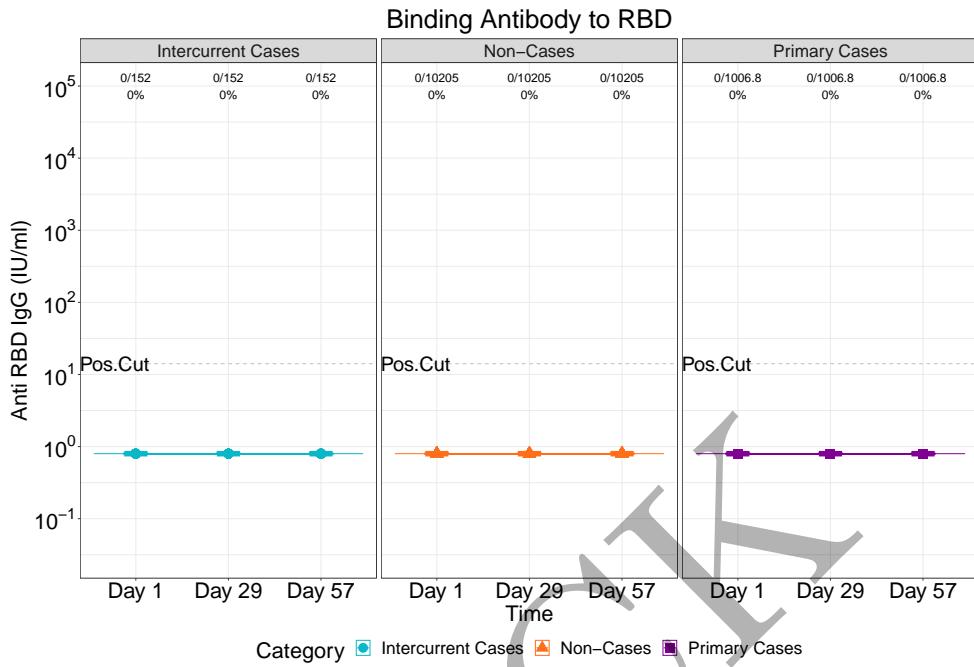


Figure 3.32: lineplots of Binding Antibody to RBD: baseline negative placebo arm (version 2)

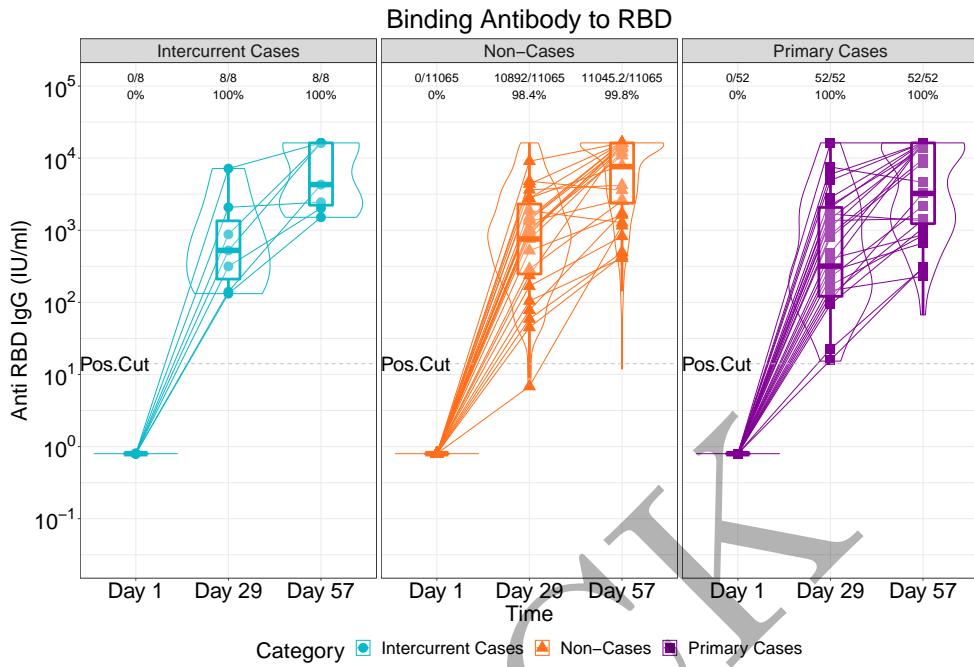


Figure 3.33: lineplots of Binding Antibody to RBD: baseline negative vaccine arm (version 2)

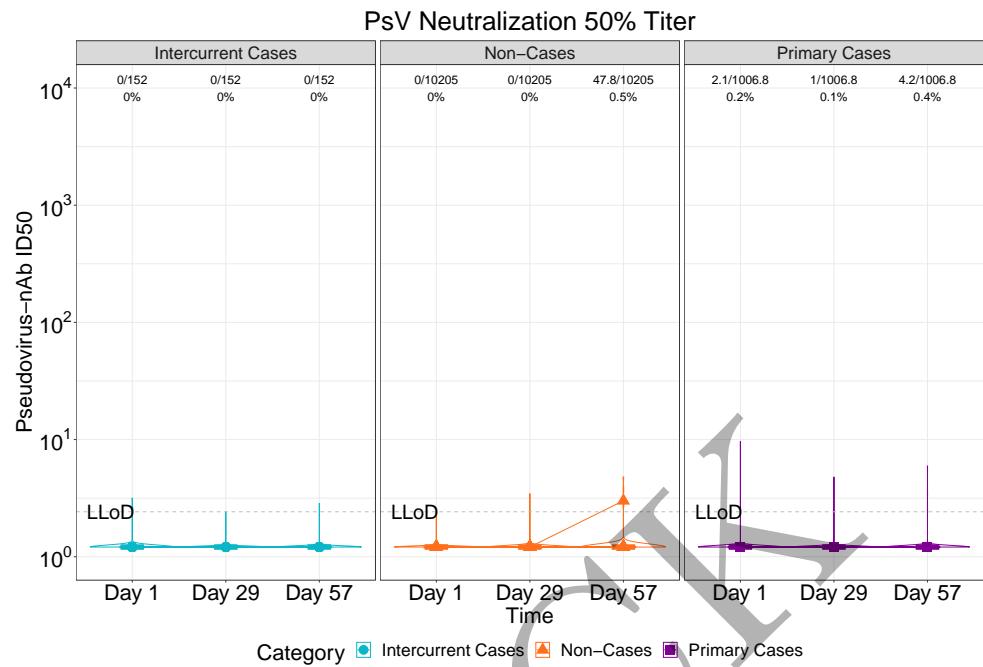


Figure 3.34: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm (version 2)

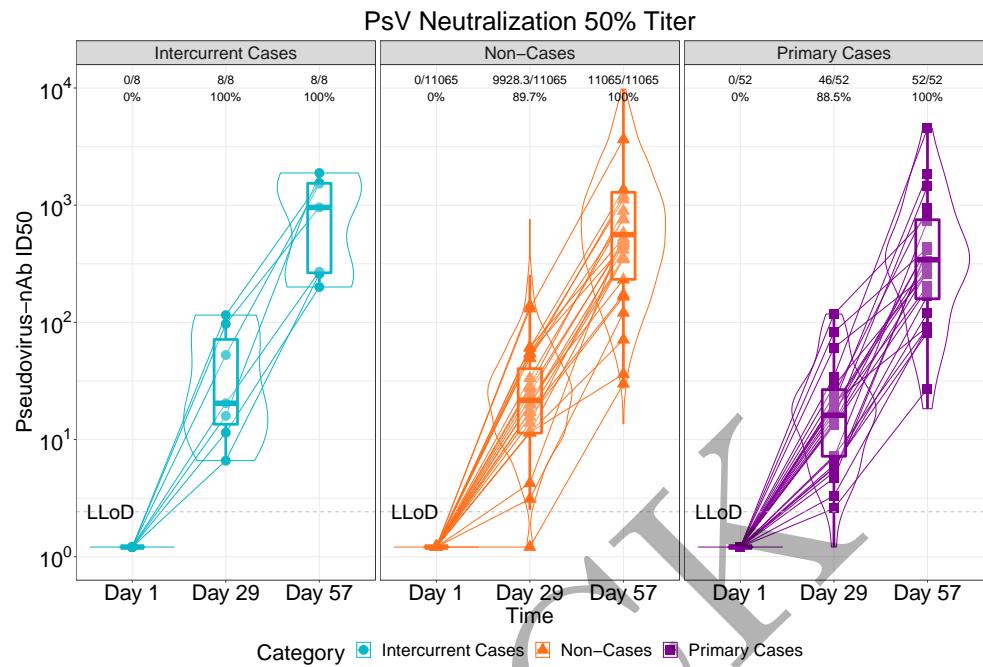


Figure 3.35: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm (version 2)

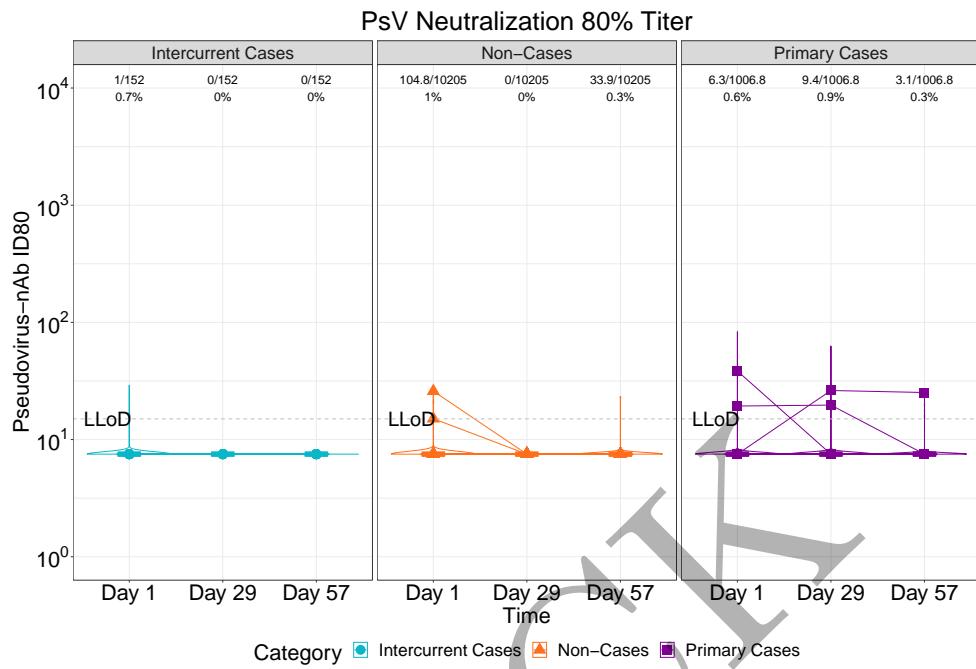


Figure 3.36: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm (version 2)

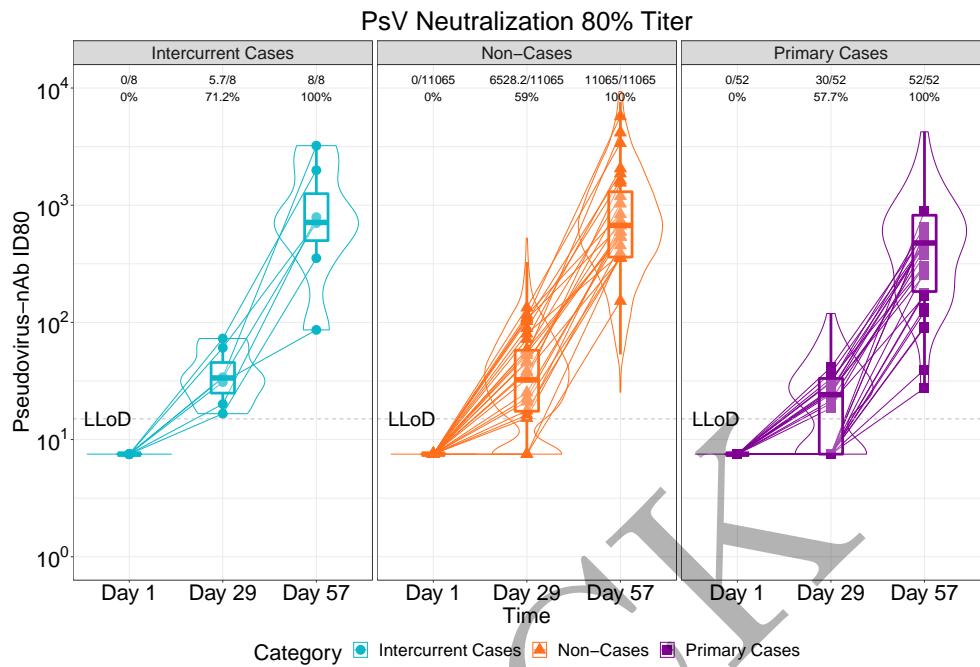


Figure 3.37: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm (version 2)

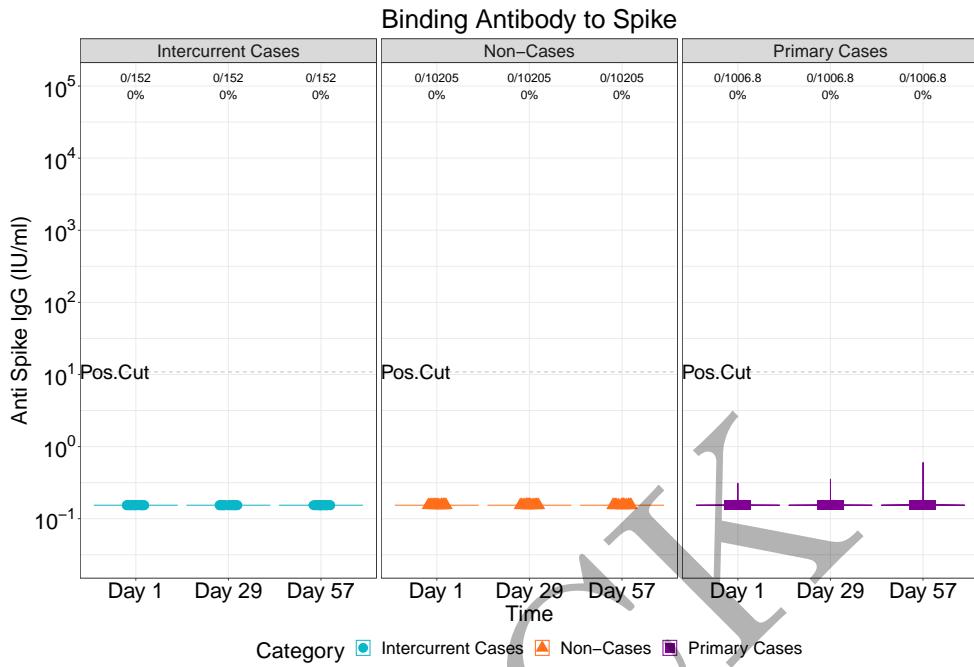


Figure 3.38: violinplots of Binding Antibody to Spike: baseline negative placebo arm (version 2)

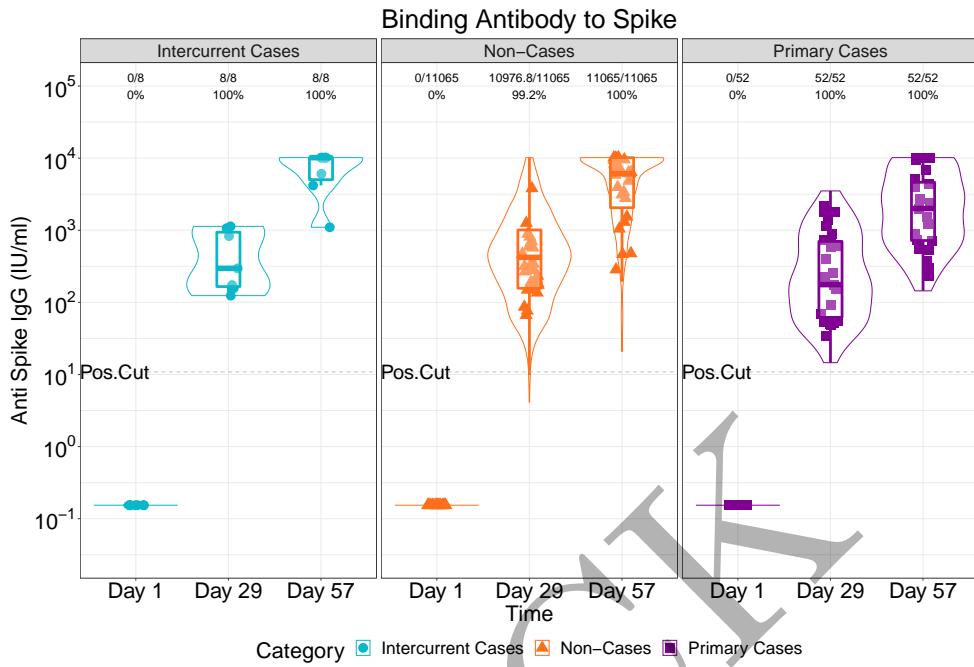


Figure 3.39: violinplots of Binding Antibody to Spike: baseline negative vaccine arm (version 2)

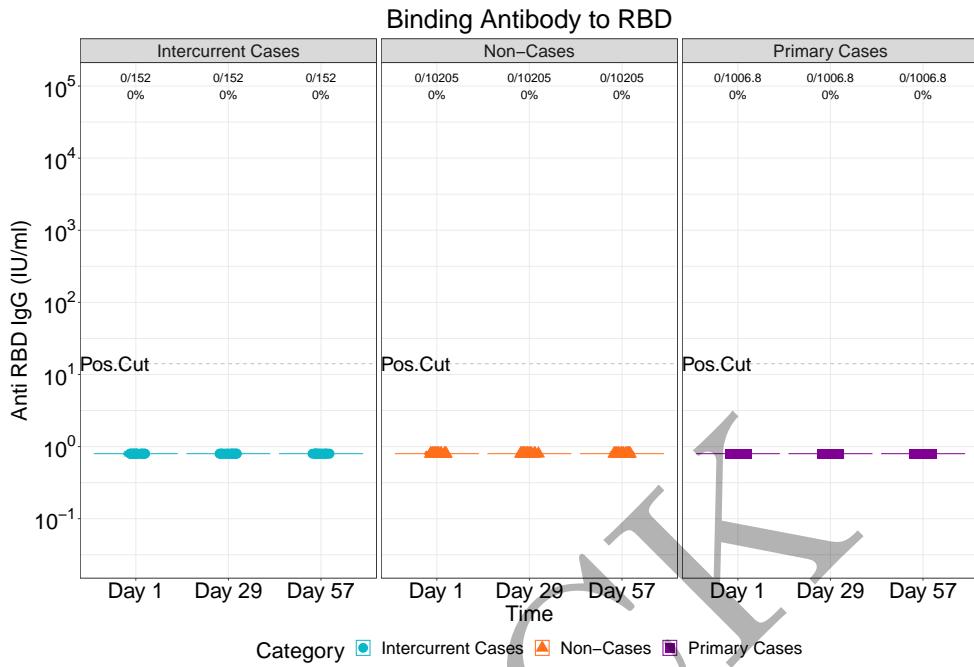


Figure 3.40: violinplots of Binding Antibody to RBD: baseline negative placebo arm (version 2)

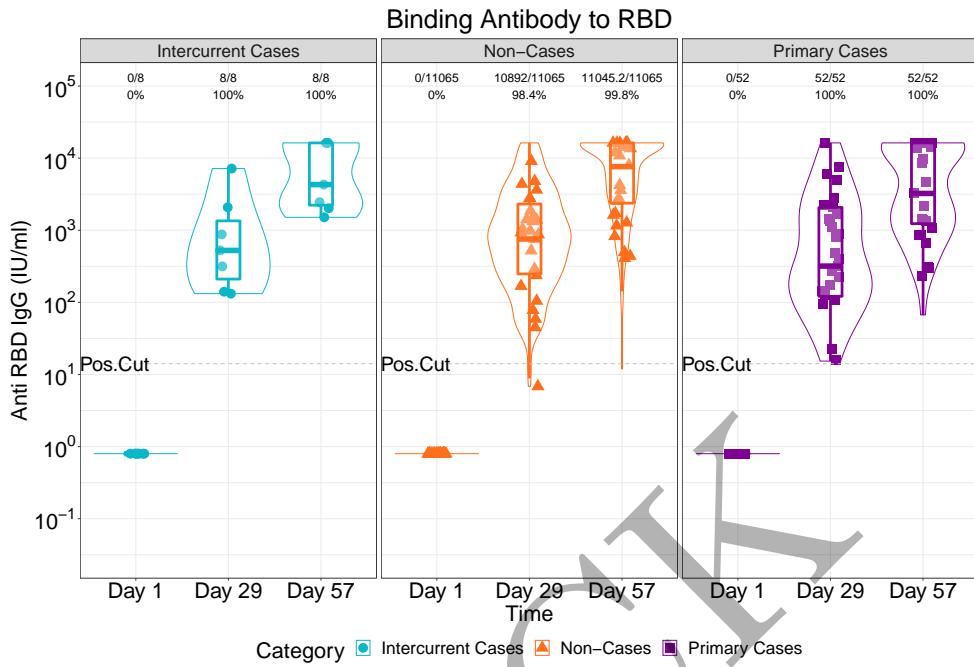


Figure 3.41: violinplots of Binding Antibody to RBD: baseline negative vaccine arm (version 2)

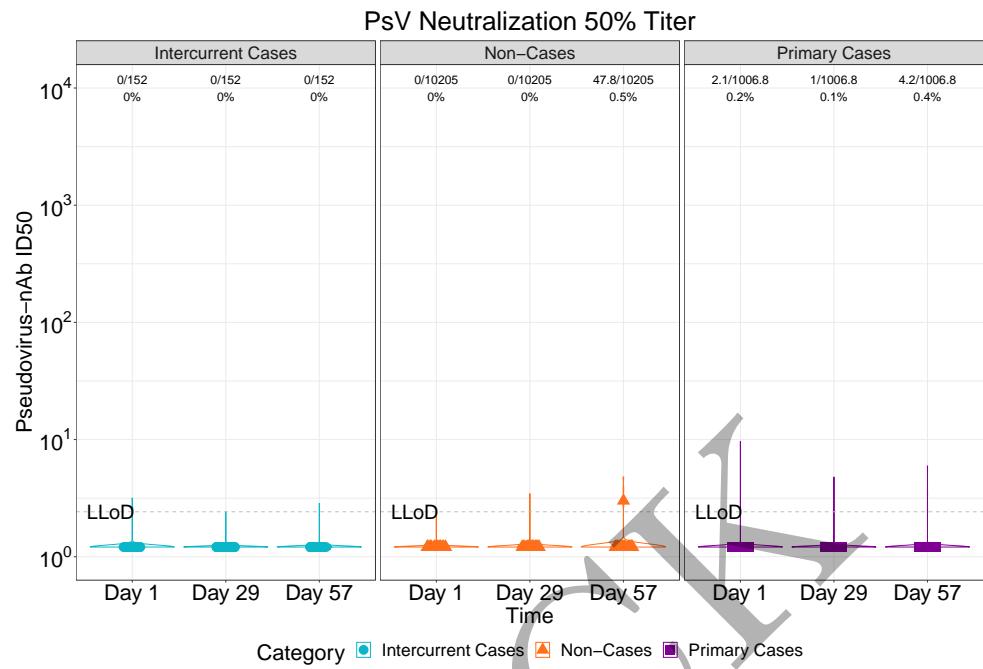


Figure 3.42: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm (version 2)

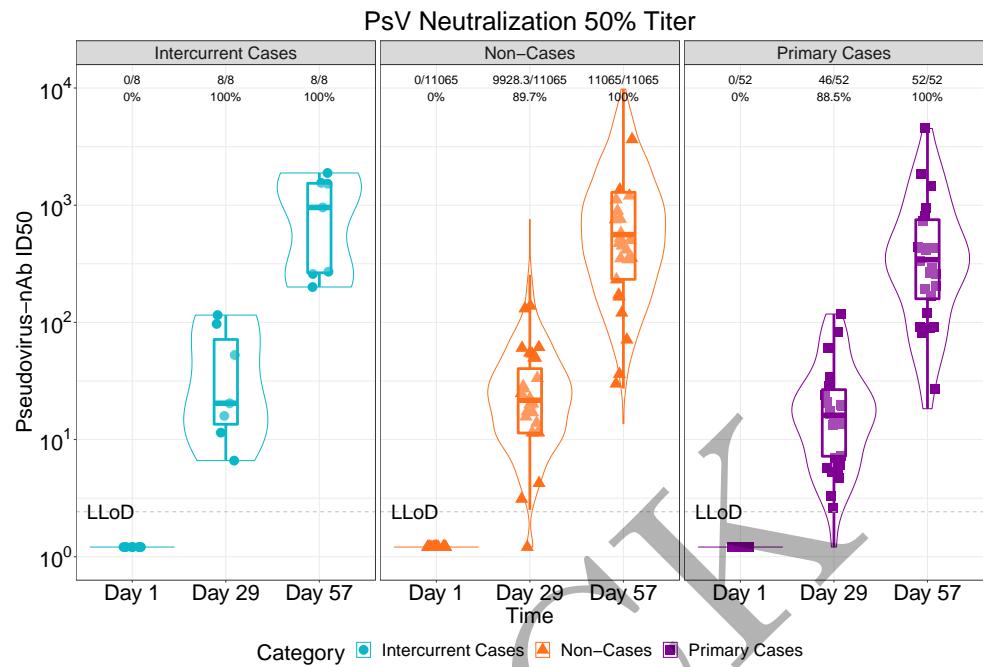


Figure 3.43: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm (version 2)

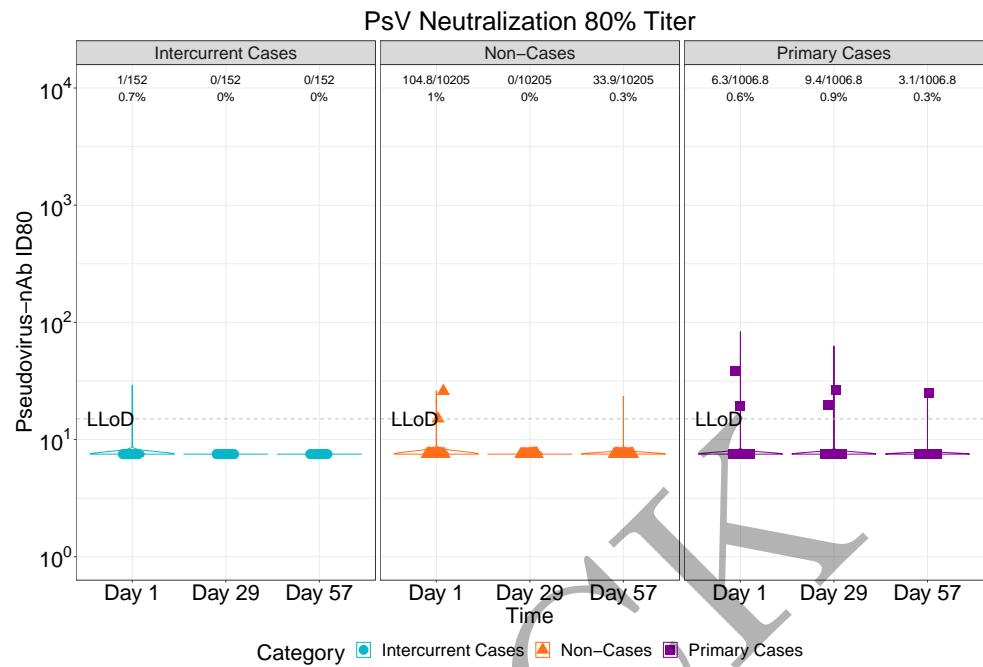


Figure 3.44: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm (version 2)

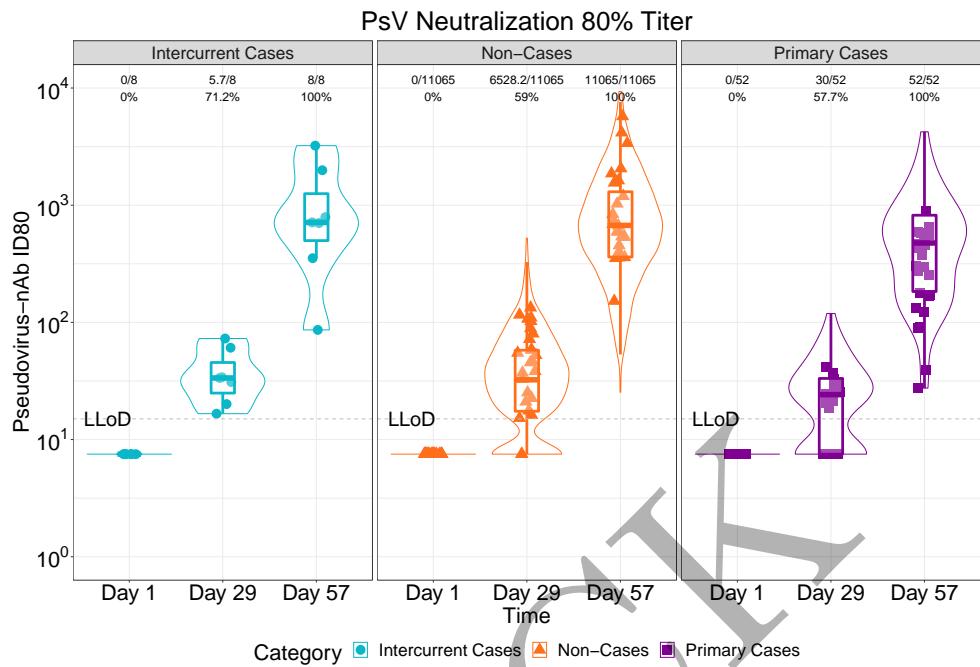


Figure 3.45: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm (version 2)

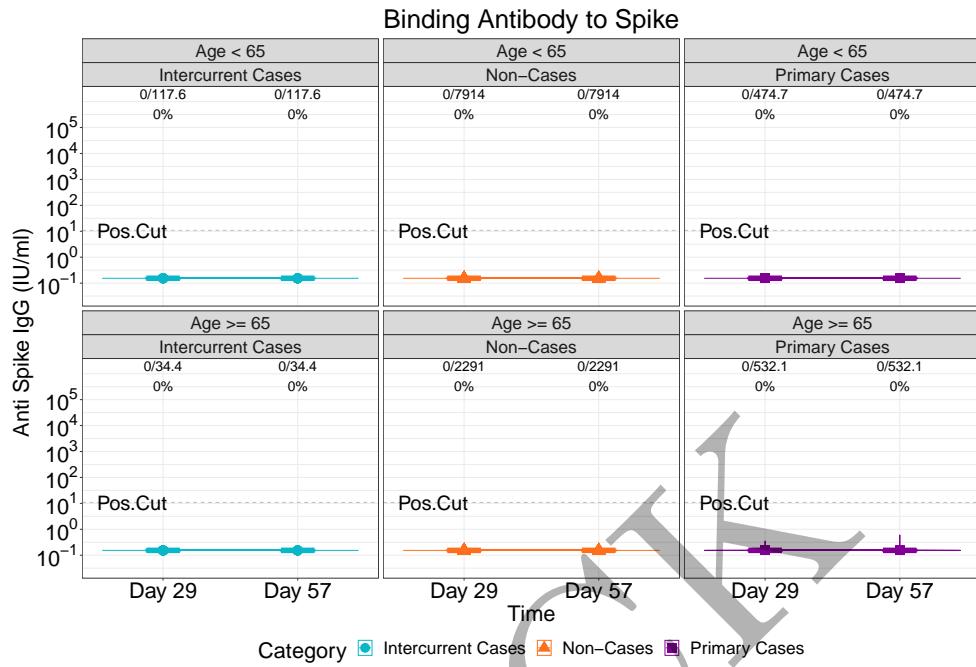


Figure 3.46: lineplots of Binding Antibody to Spike: baseline negative placebo arm by age (version 1)

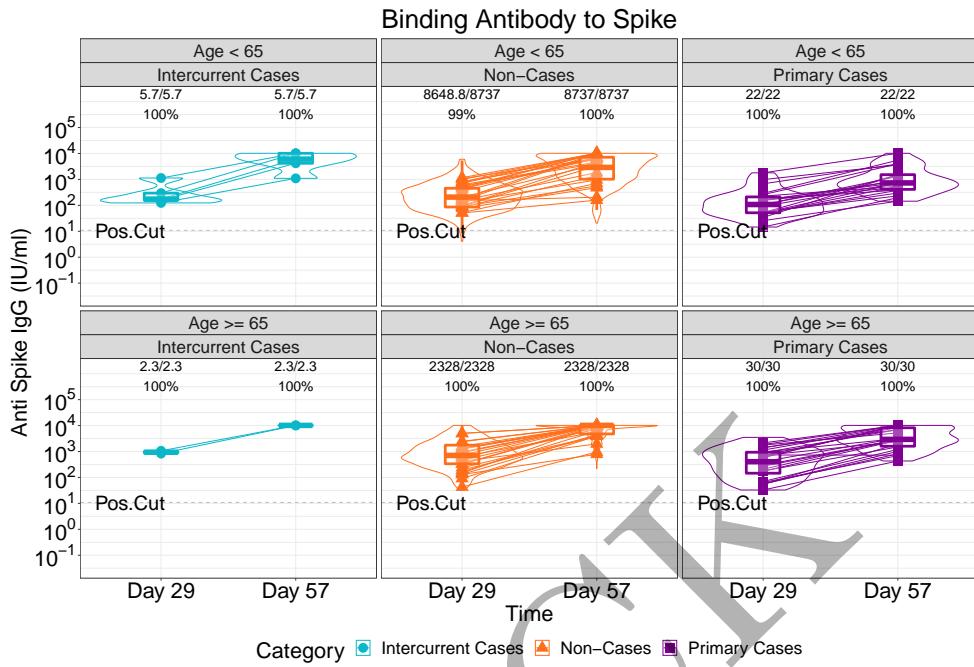


Figure 3.47: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by age (version 1)

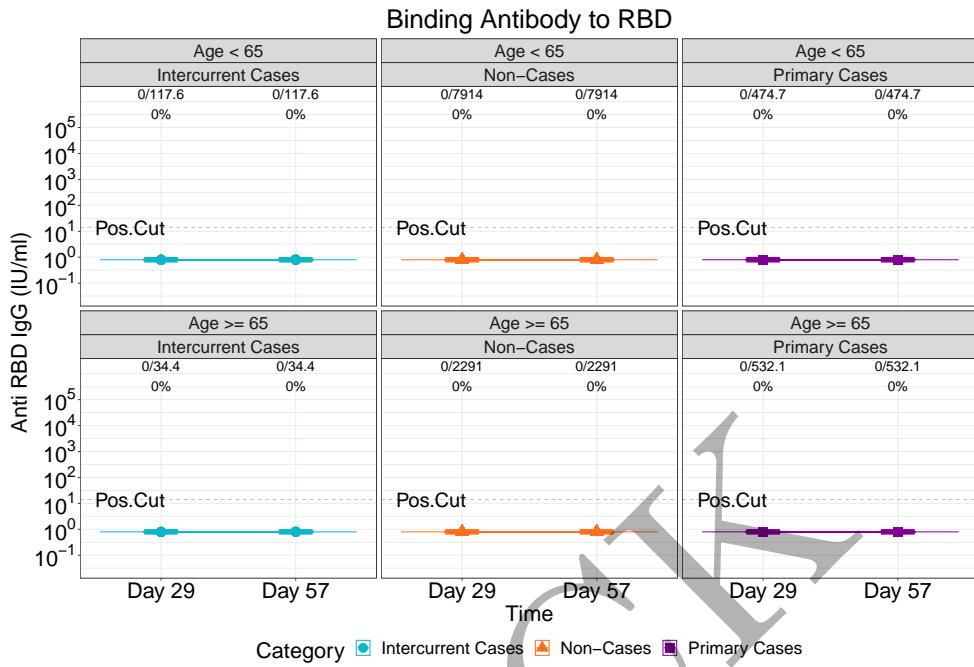


Figure 3.48: lineplots of Binding Antibody to RBD: baseline negative placebo arm by age (version 1)

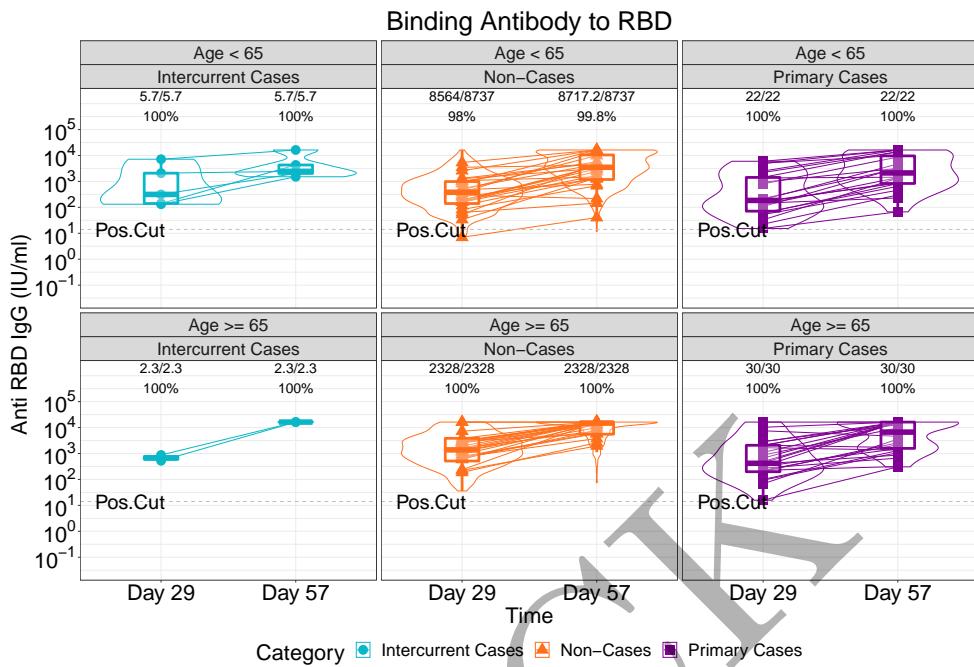


Figure 3.49: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by age (version 1)

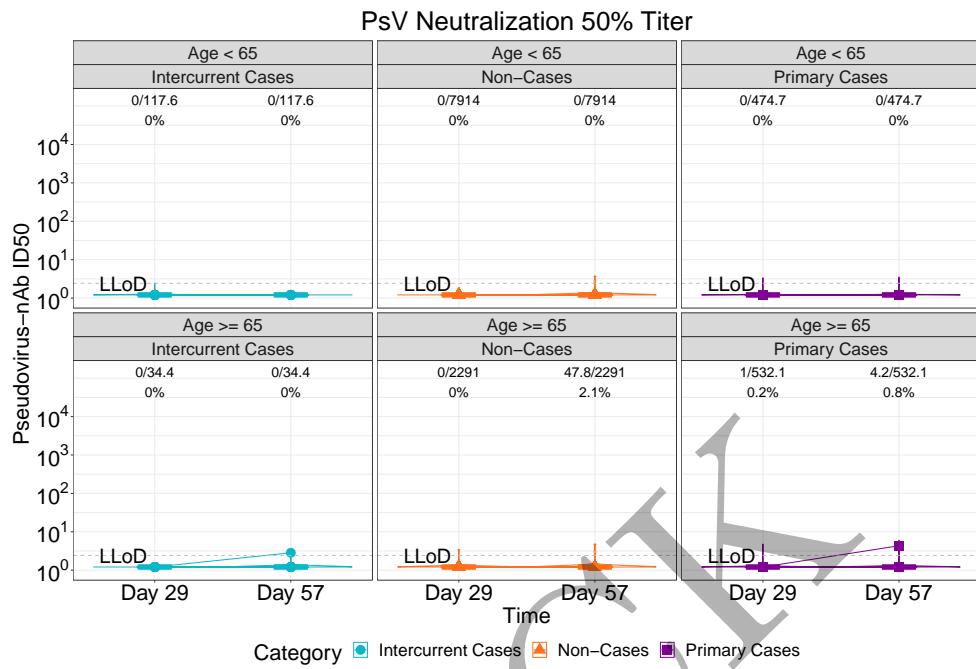


Figure 3.50: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age (version 1)

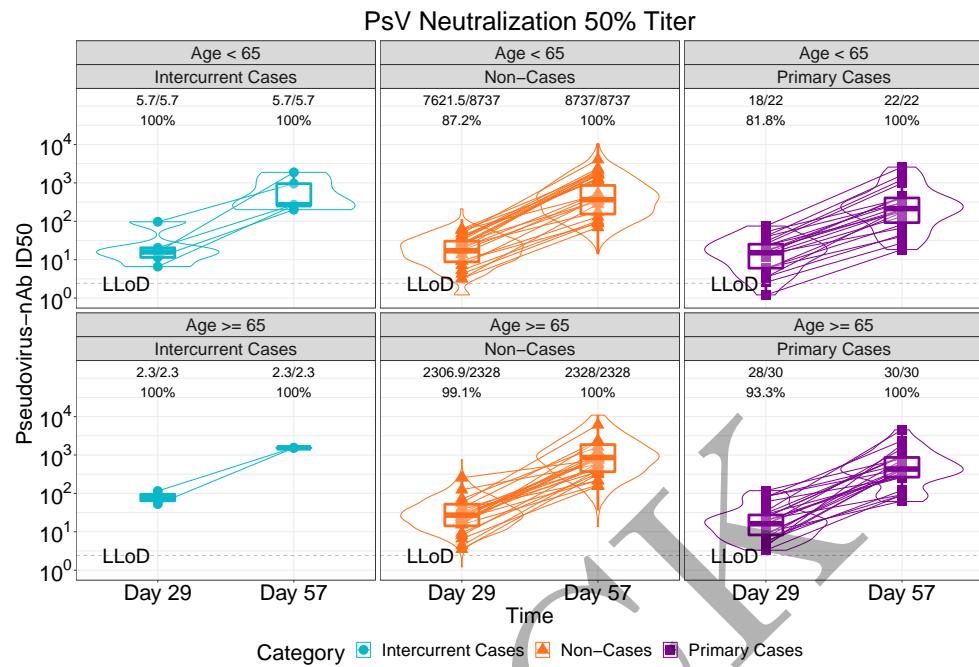


Figure 3.51: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age (version 1)

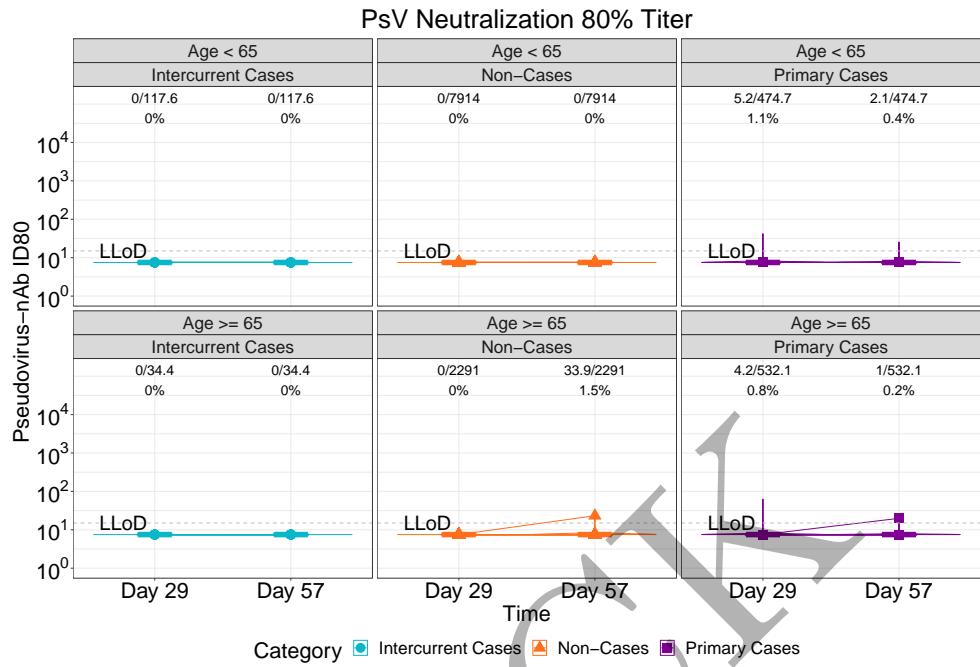


Figure 3.52: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age (version 1)

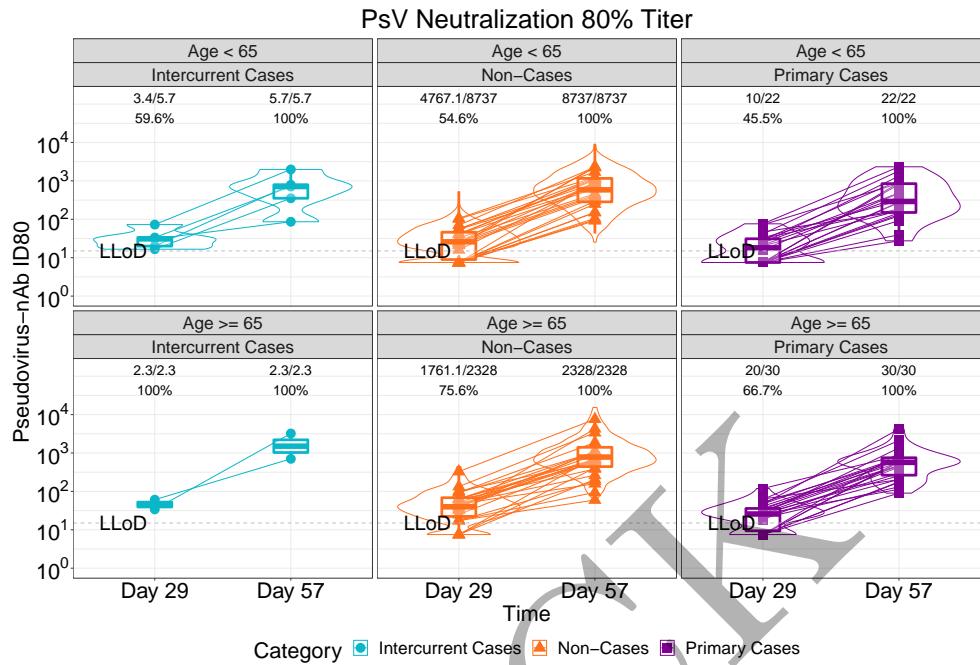


Figure 3.53: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age (version 1)

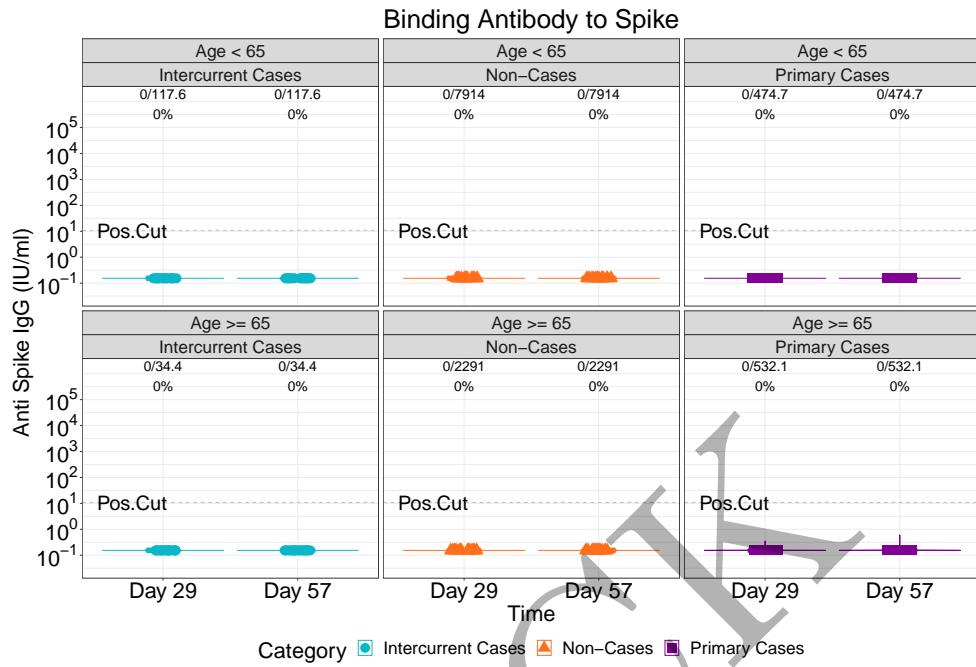


Figure 3.54: violinplots of Binding Antibody to Spike: baseline negative placebo arm by age (version 1)

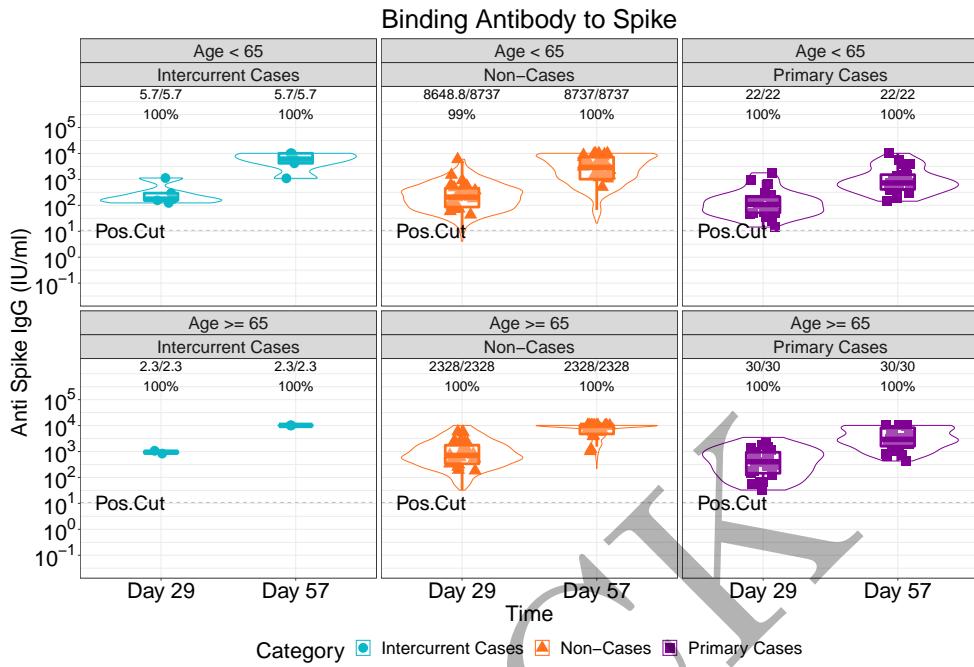


Figure 3.55: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by age (version 1)

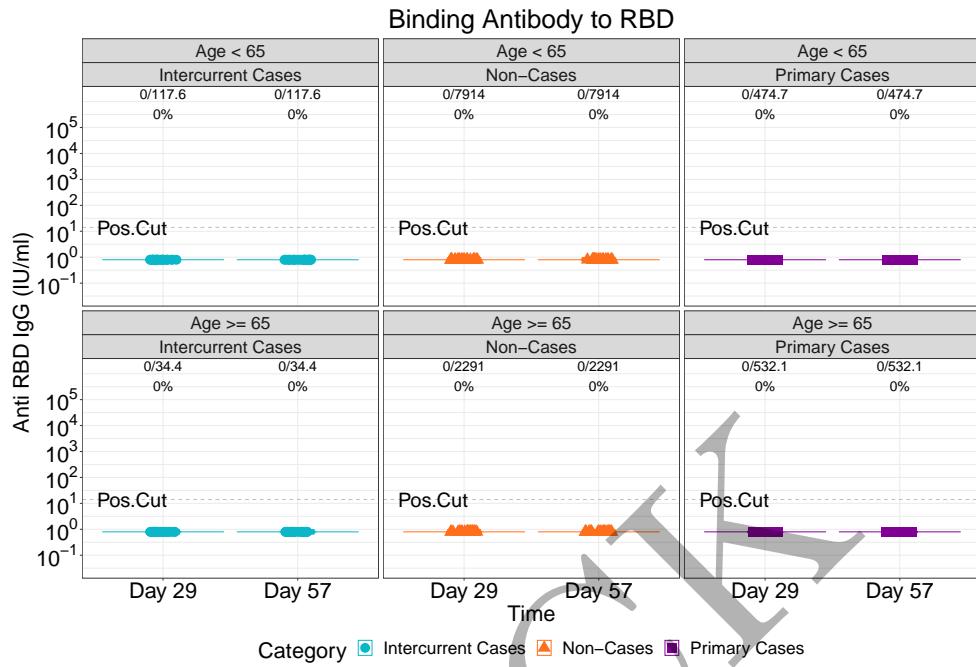


Figure 3.56: violinplots of Binding Antibody to RBD: baseline negative placebo arm by age (version 1)

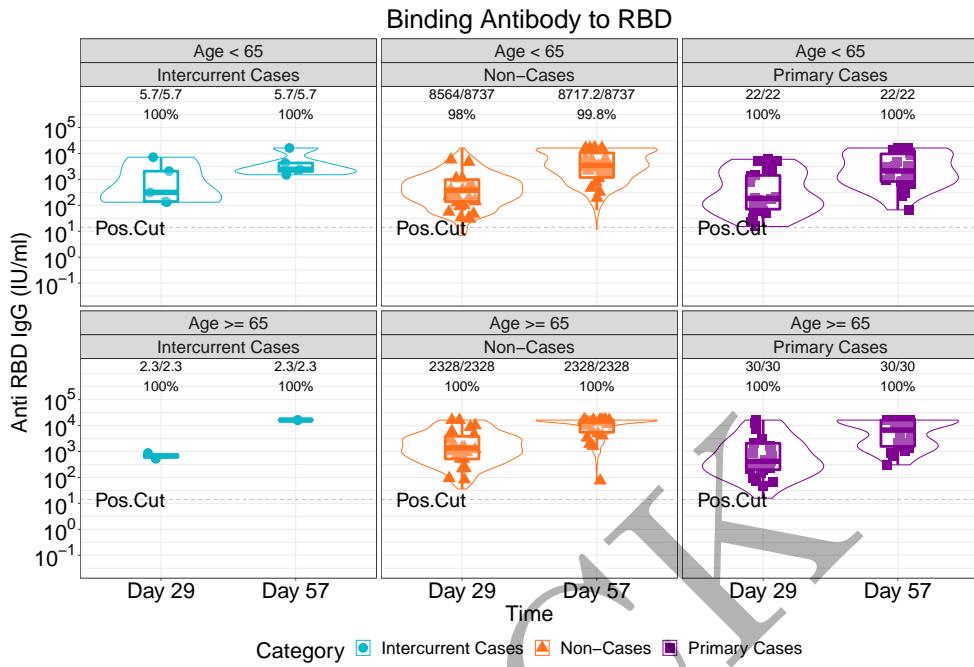


Figure 3.57: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by age (version 1)

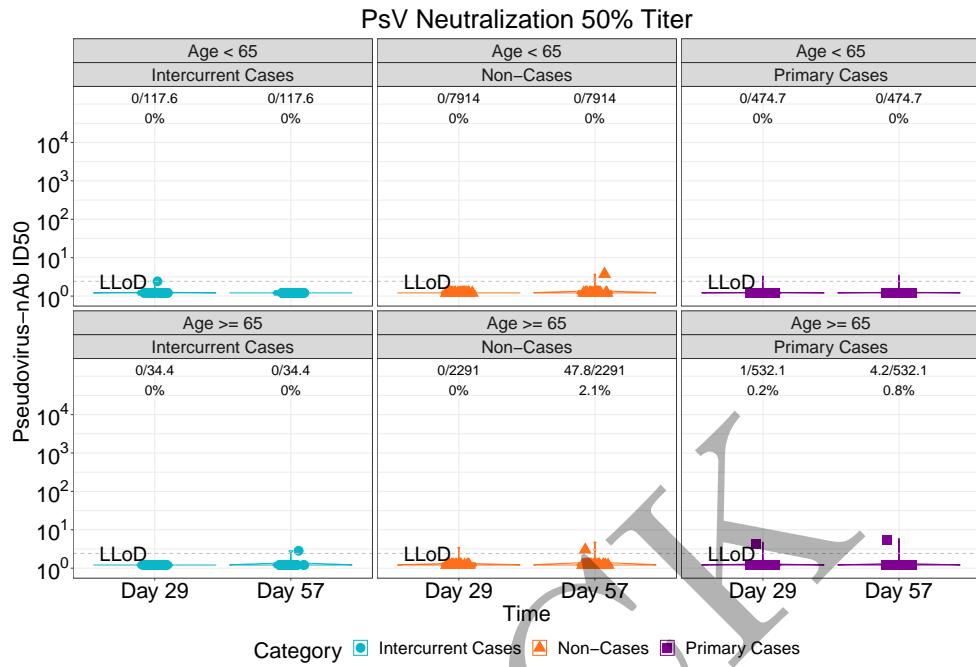


Figure 3.58: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age (version 1)

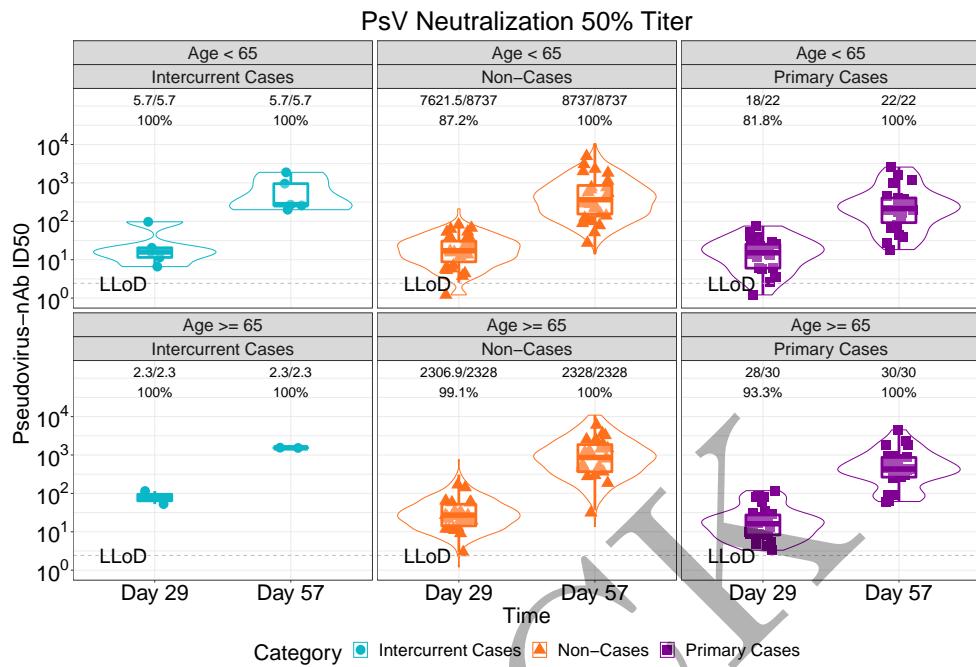


Figure 3.59: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age (version 1)

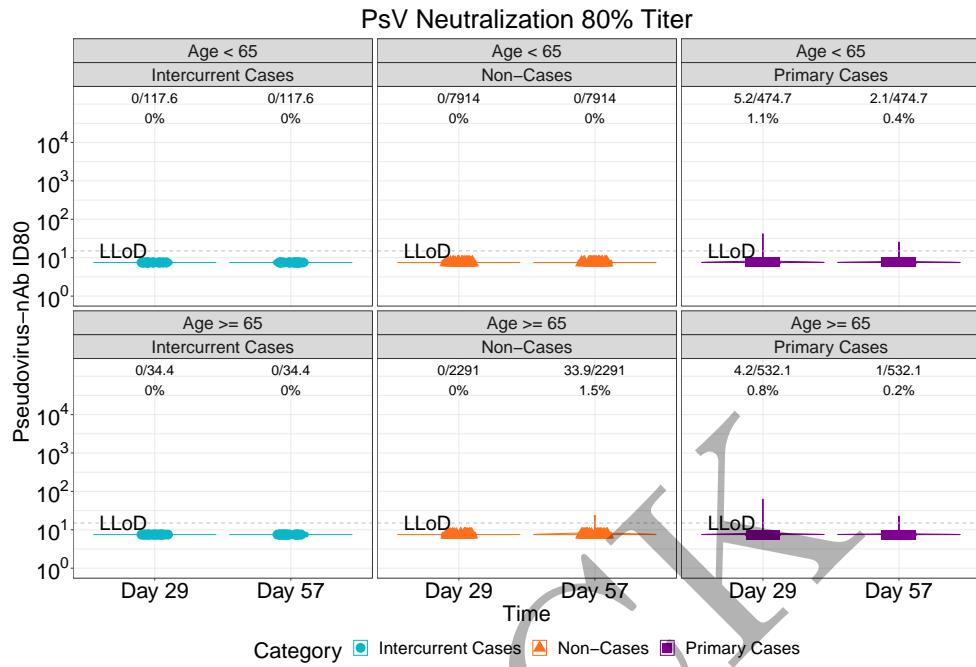


Figure 3.60: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age (version 1)

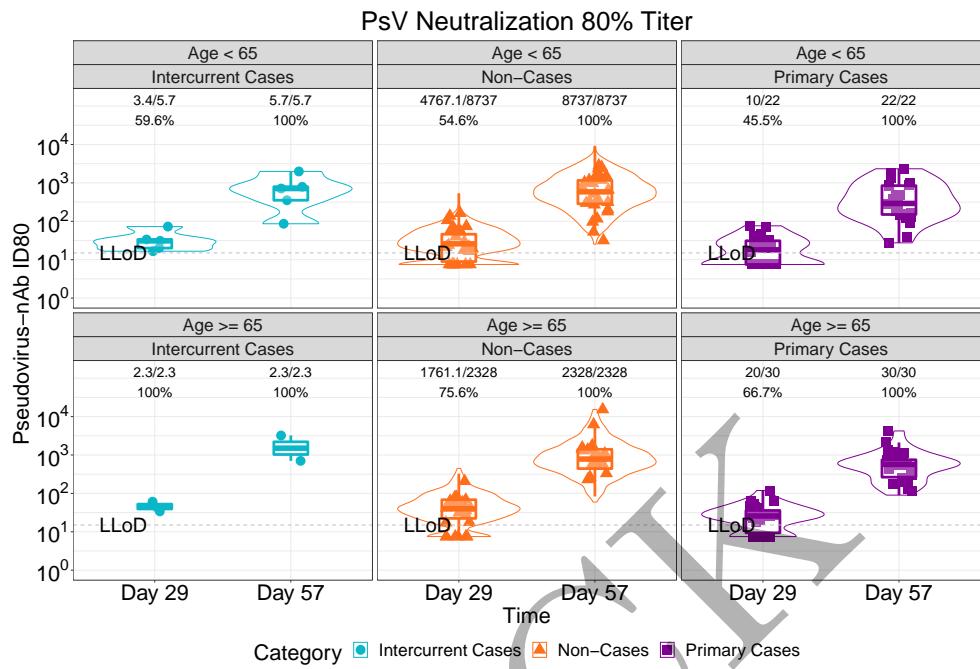


Figure 3.61: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age (version 1)

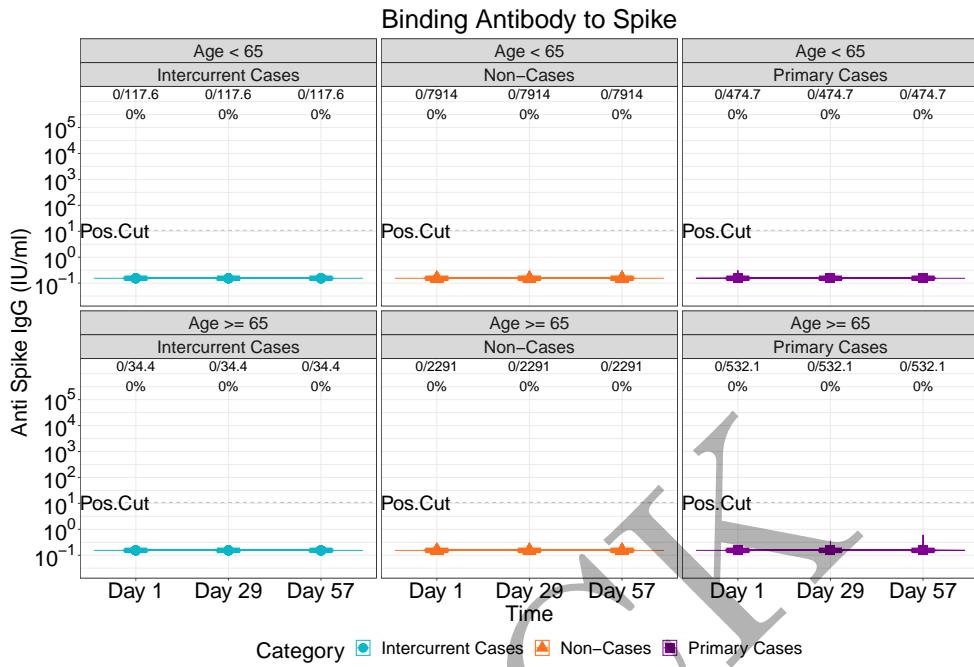


Figure 3.62: lineplots of Binding Antibody to Spike: baseline negative placebo arm by age (version 2)

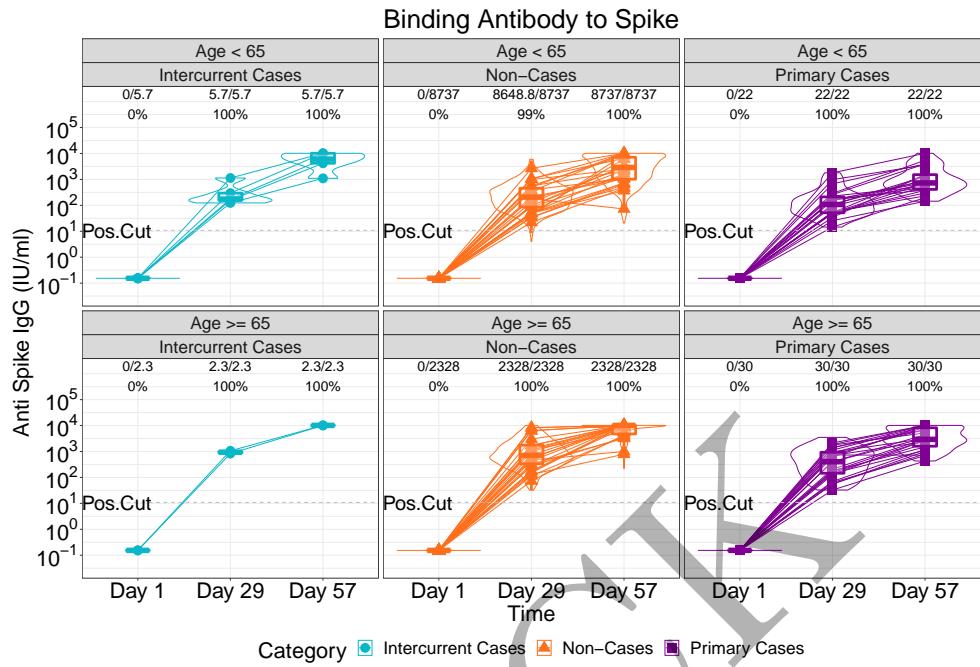


Figure 3.63: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by age (version 2)

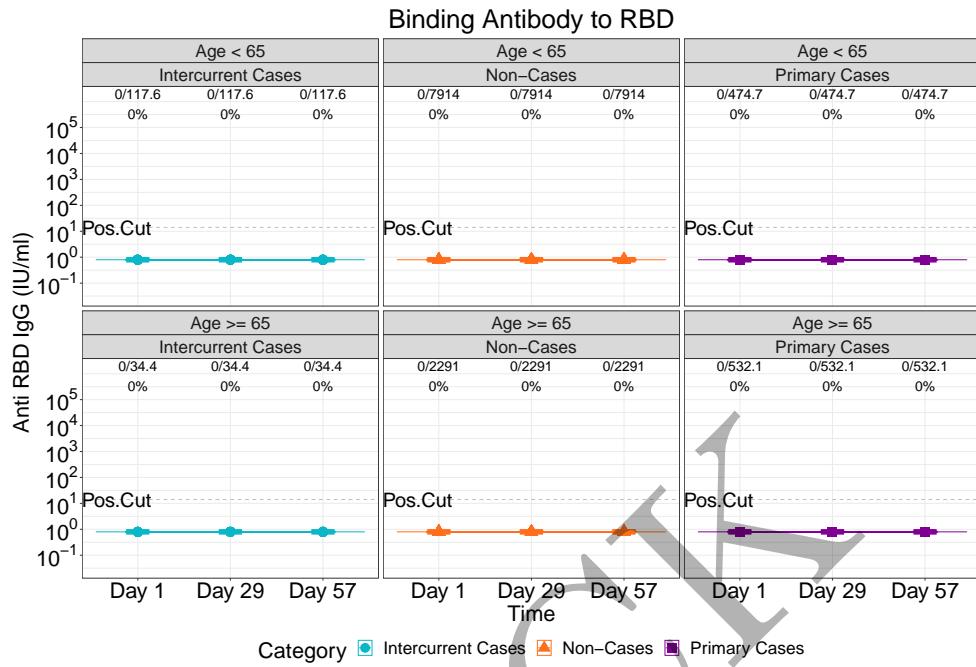


Figure 3.64: lineplots of Binding Antibody to RBD: baseline negative placebo arm by age (version 2)

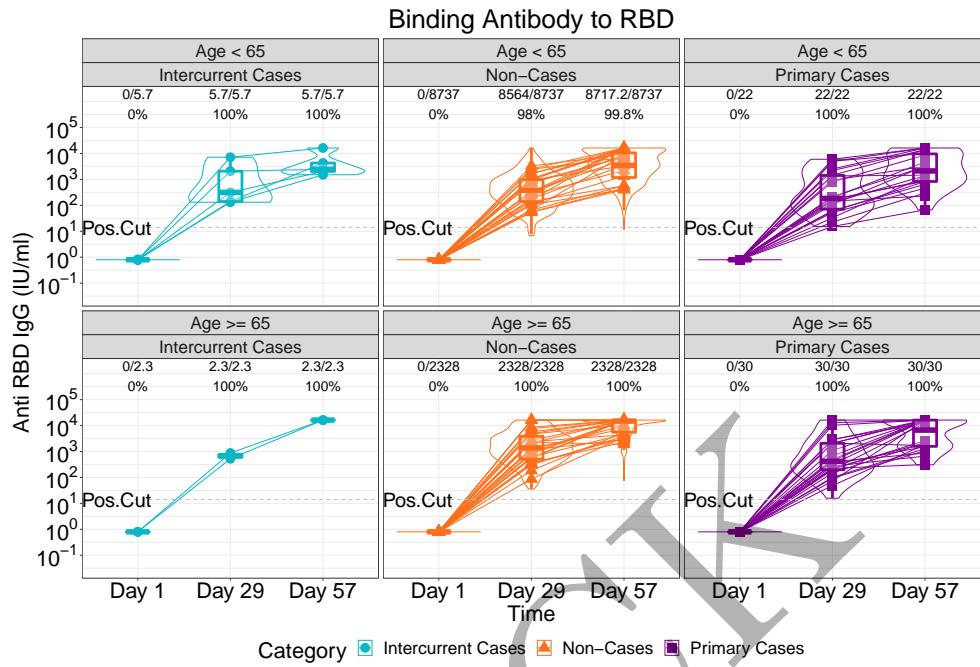


Figure 3.65: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by age (version 2)

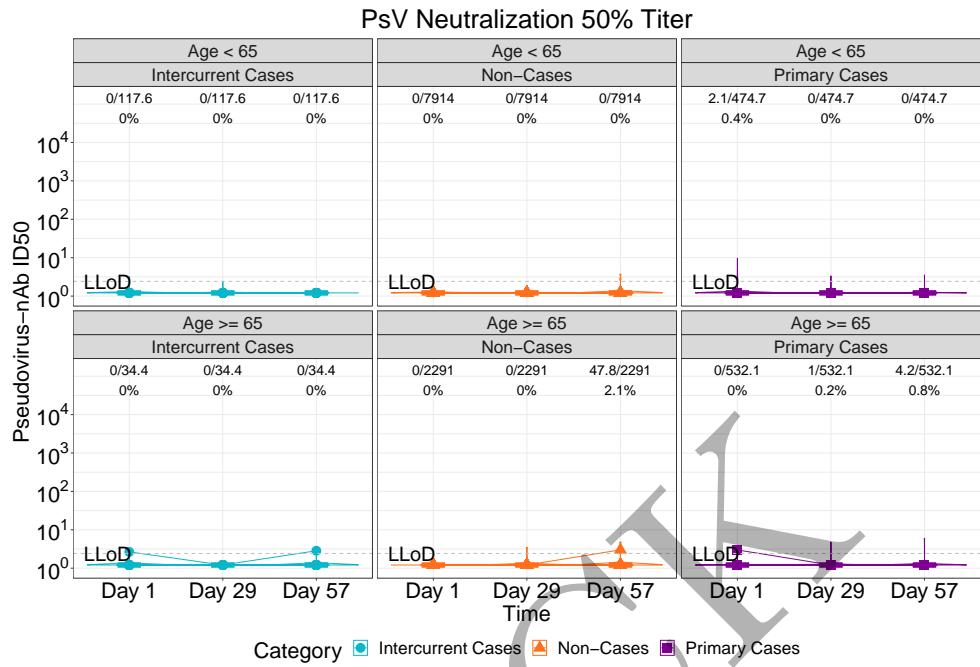


Figure 3.66: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age (version 2)

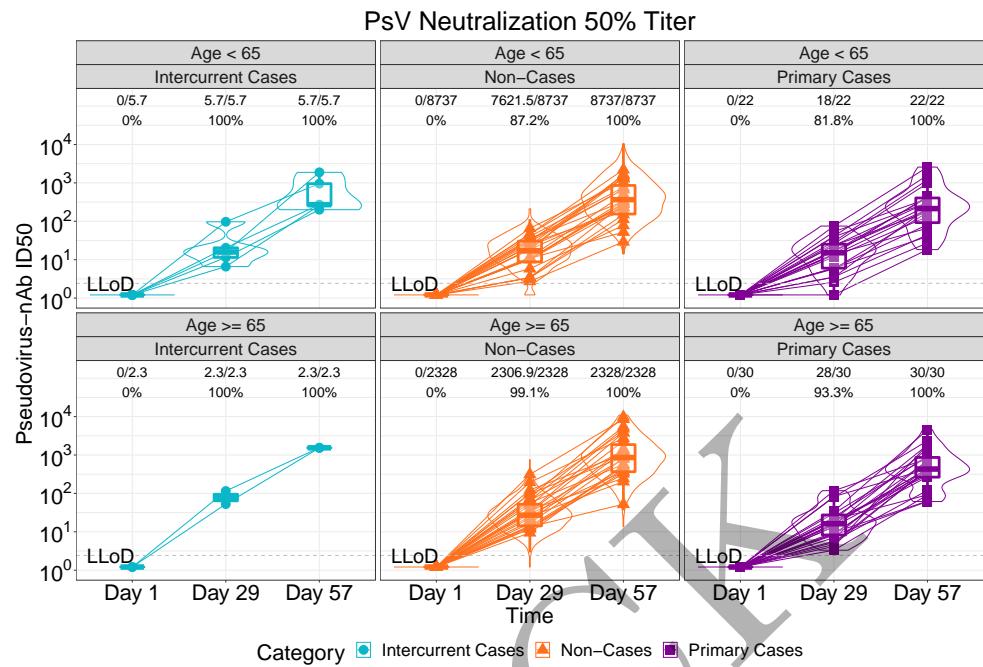


Figure 3.67: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age (version 2)

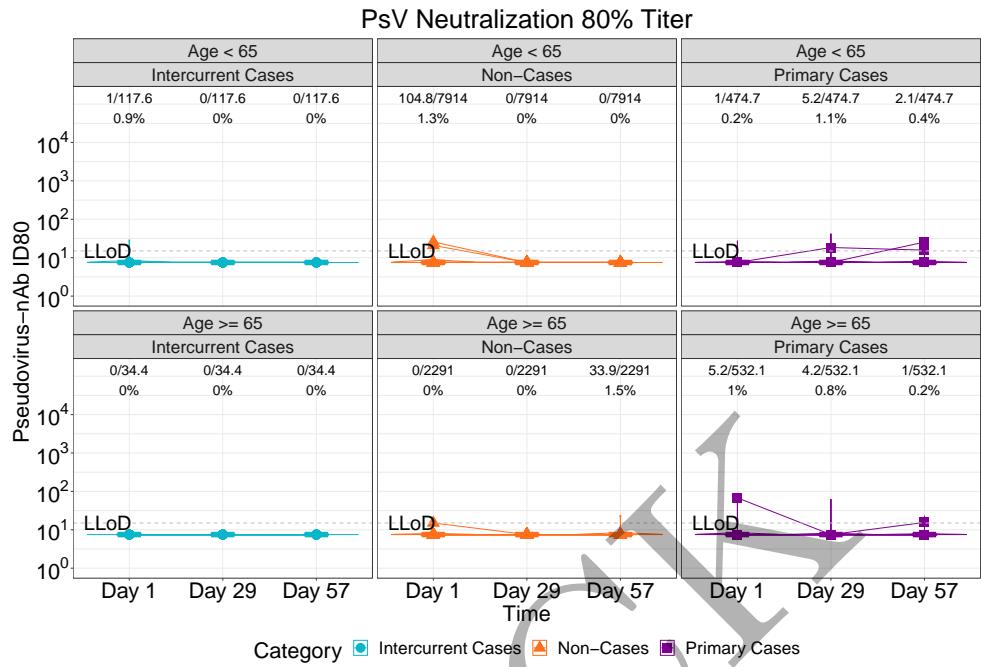


Figure 3.68: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age (version 2)

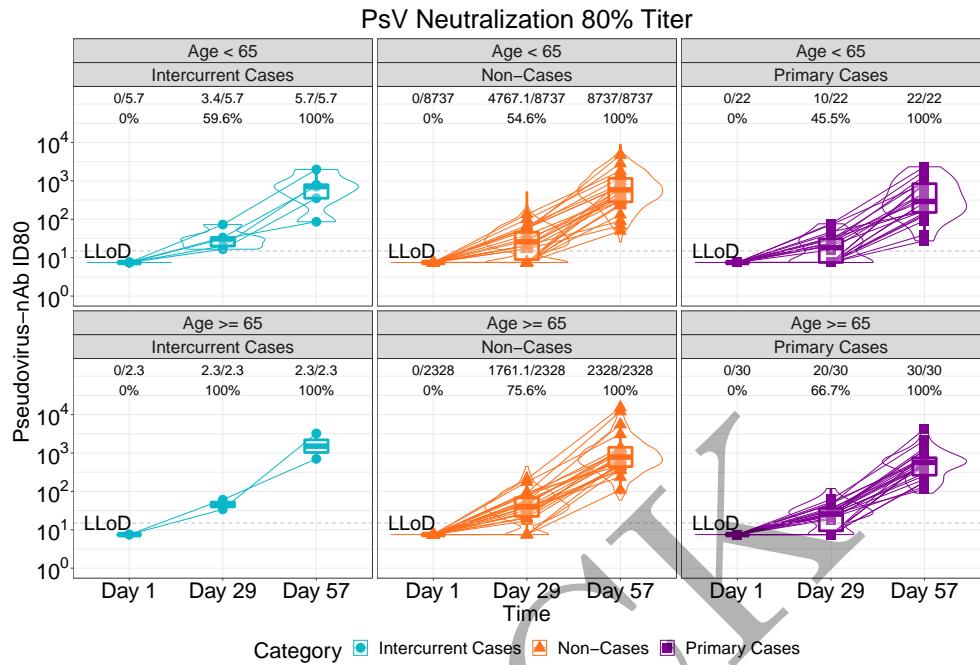


Figure 3.69: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age (version 2)

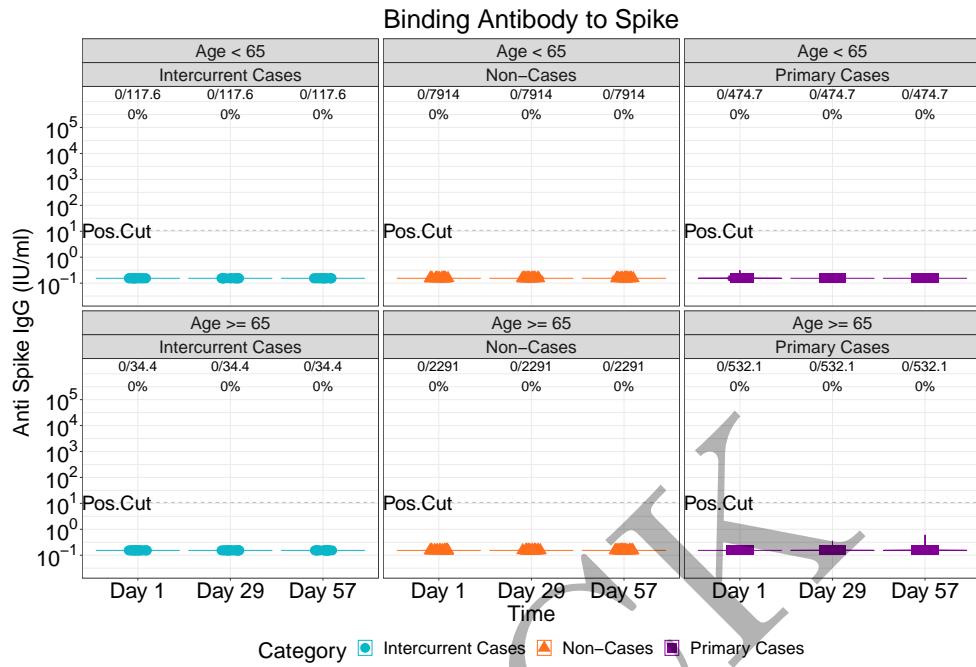


Figure 3.70: violinplots of Binding Antibody to Spike: baseline negative placebo arm by age (version 2)

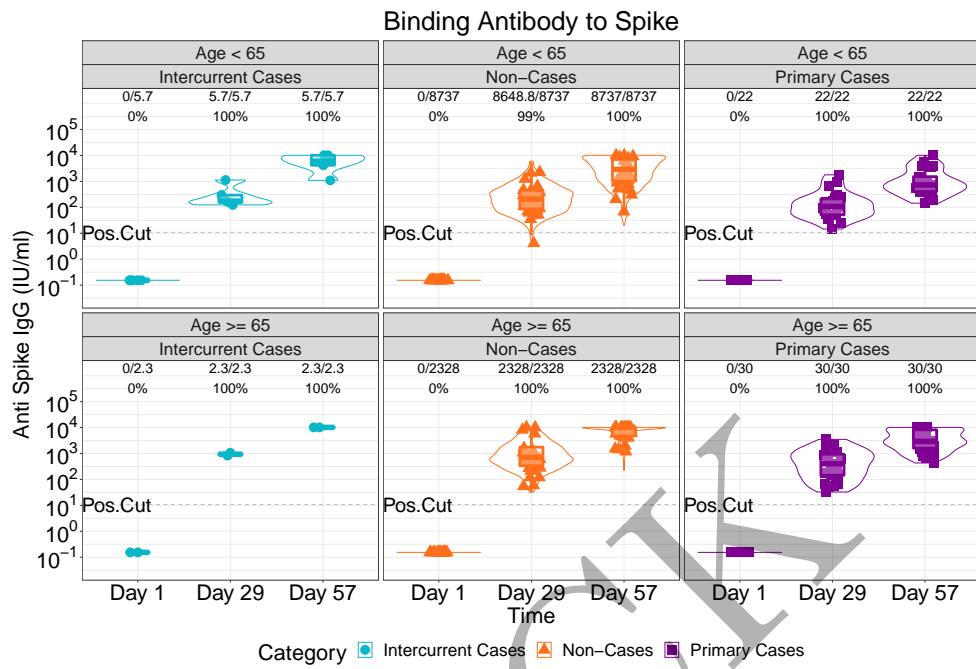


Figure 3.71: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by age (version 2)

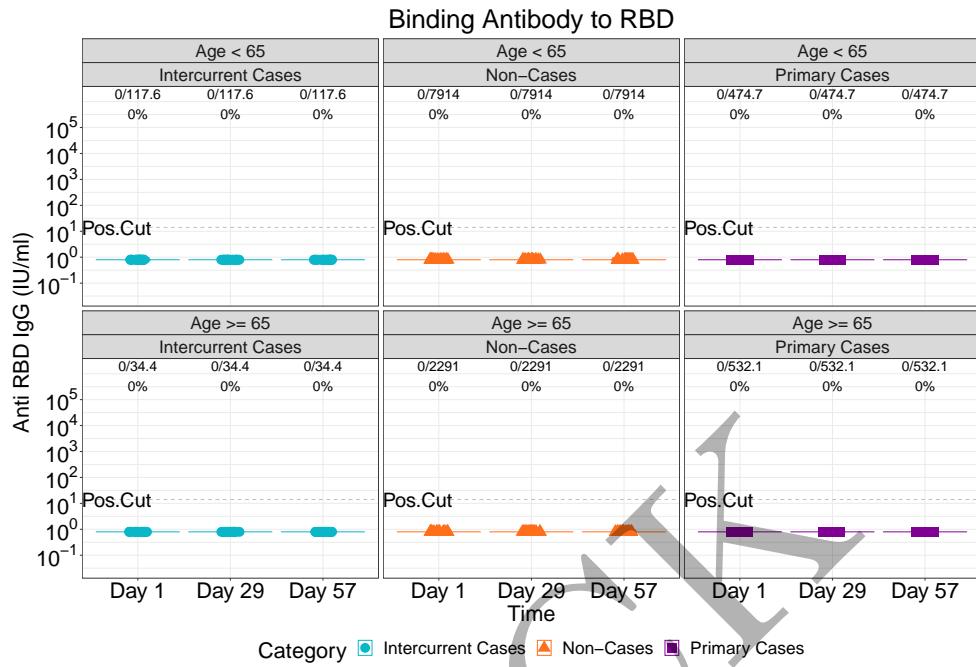


Figure 3.72: violinplots of Binding Antibody to RBD: baseline negative placebo arm by age (version 2)

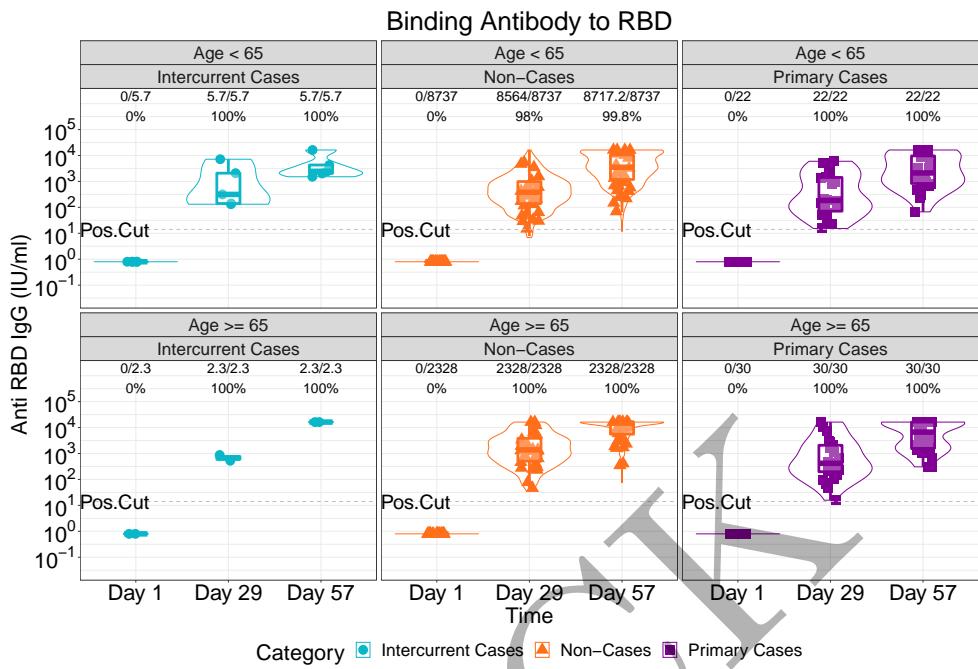


Figure 3.73: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by age (version 2)

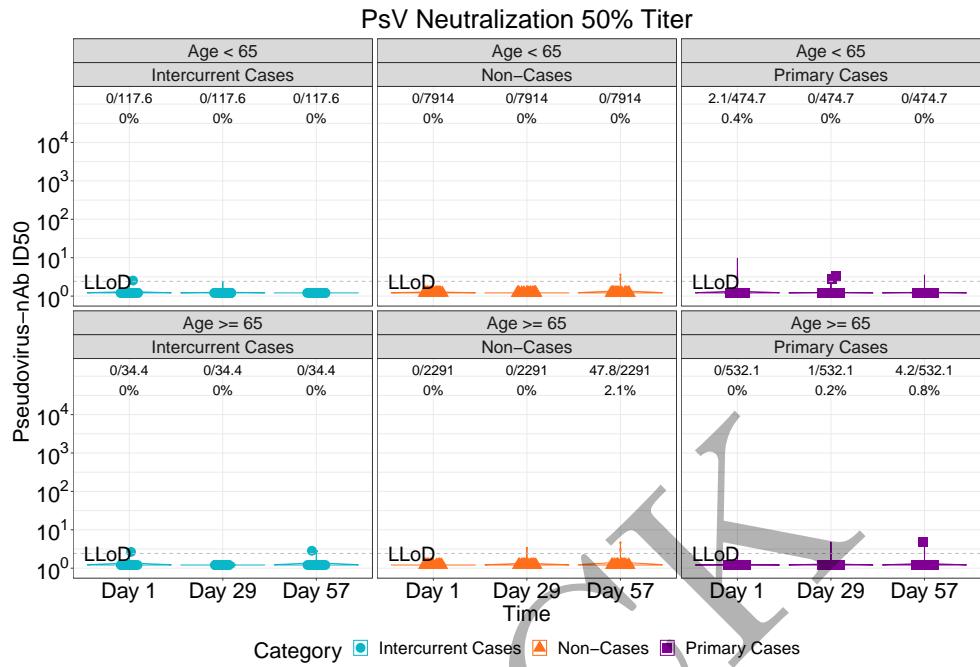


Figure 3.74: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age (version 2)

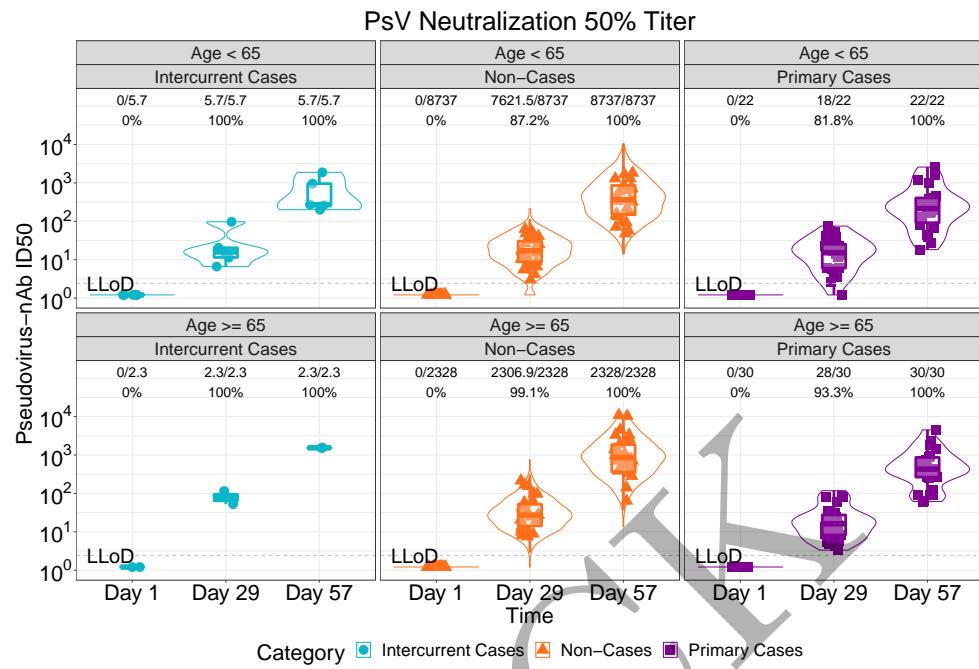


Figure 3.75: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age (version 2)

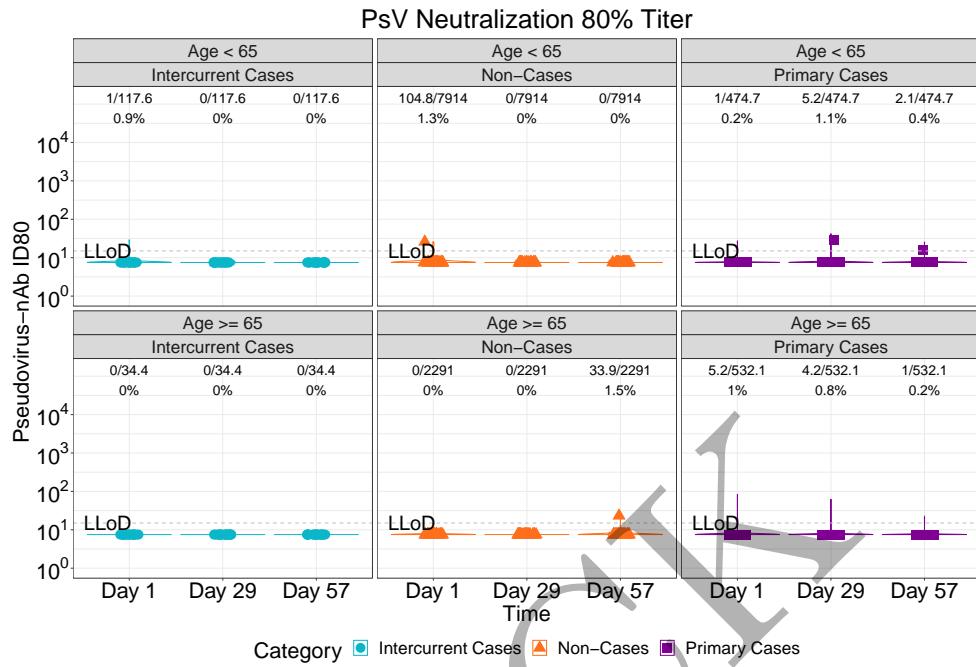


Figure 3.76: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age (version 2)

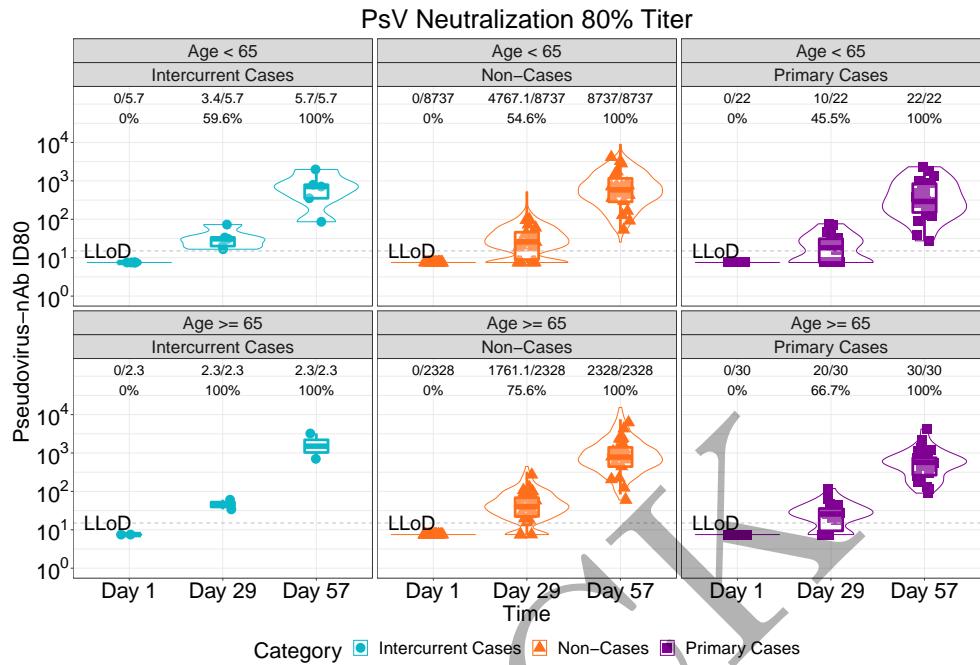


Figure 3.77: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age (version 2)

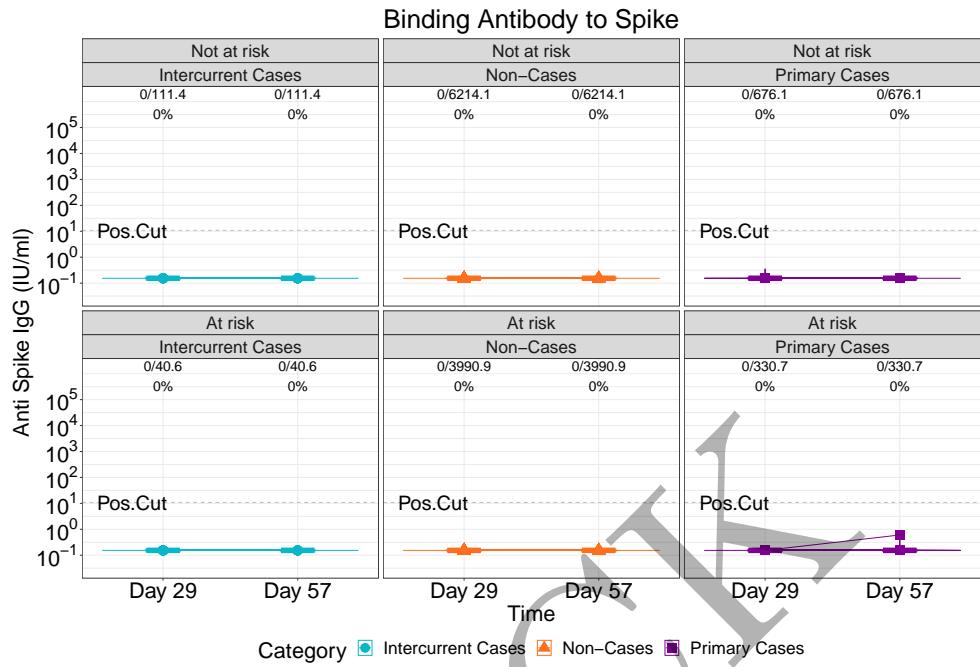


Figure 3.78: lineplots of Binding Antibody to Spike: baseline negative placebo arm by risk condition (version 1)

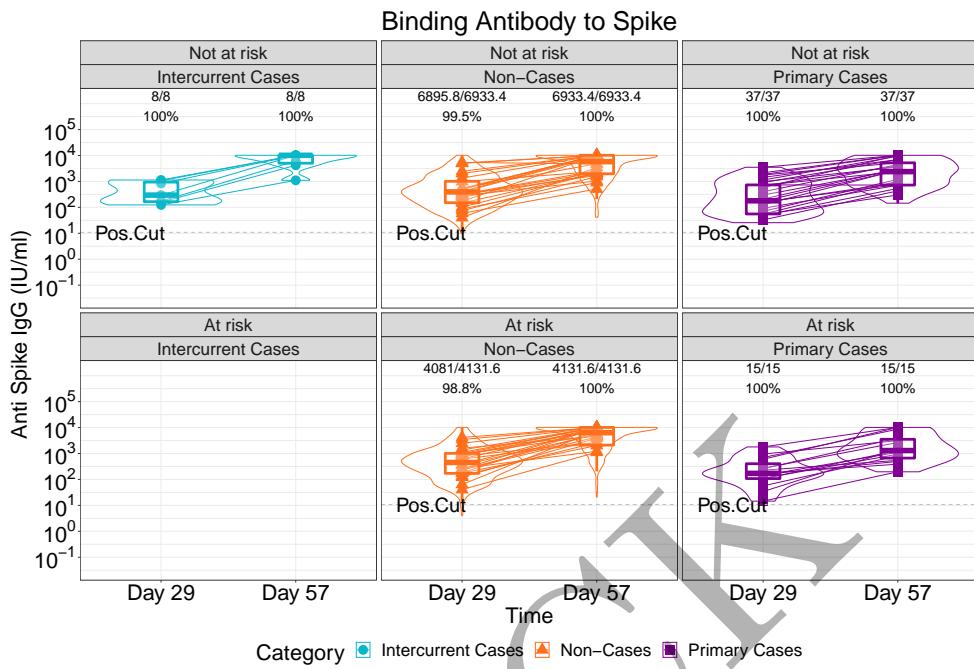


Figure 3.79: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by risk condition (version 1)

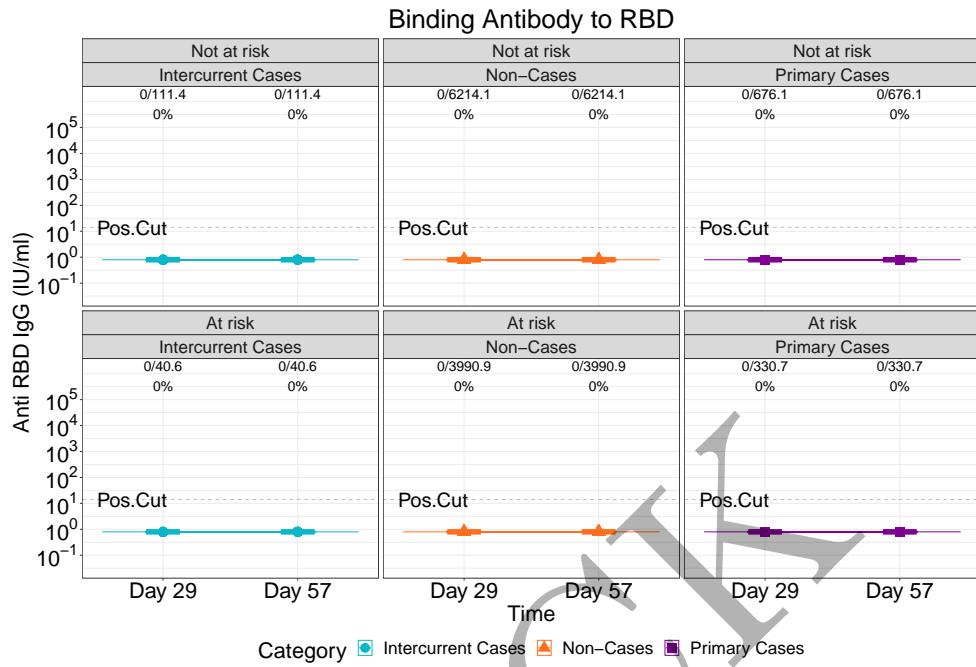


Figure 3.80: lineplots of Binding Antibody to RBD: baseline negative placebo arm by risk condition (version 1)

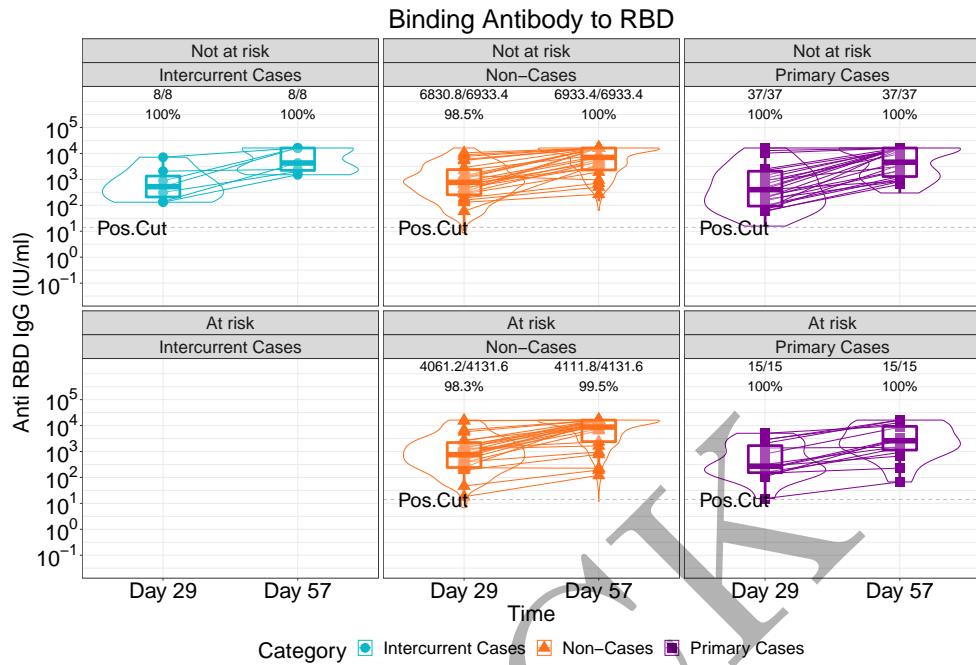


Figure 3.81: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by risk condition (version 1)

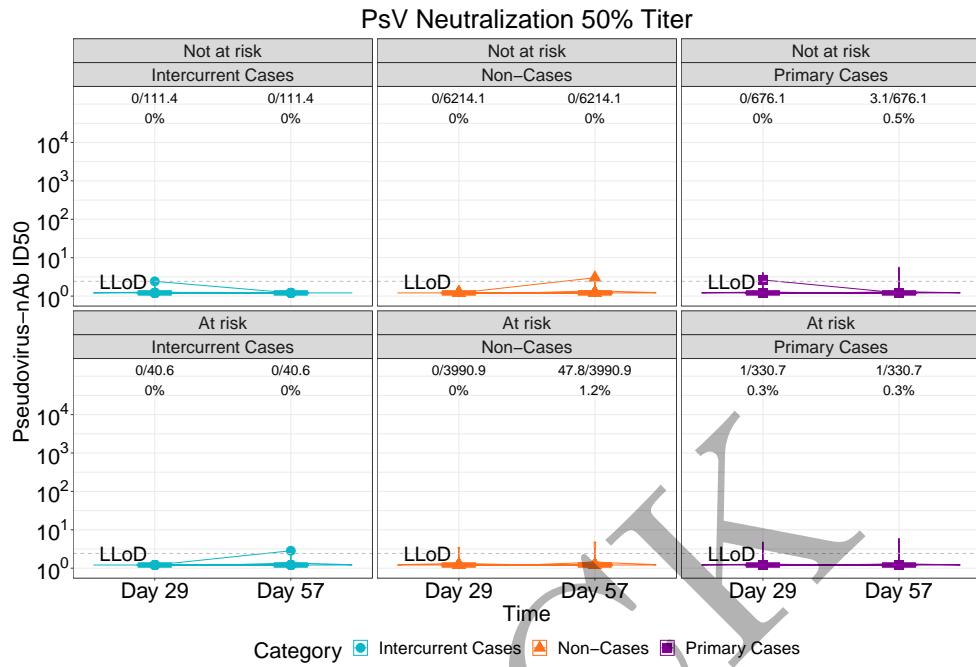


Figure 3.82: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by risk condition (version 1)

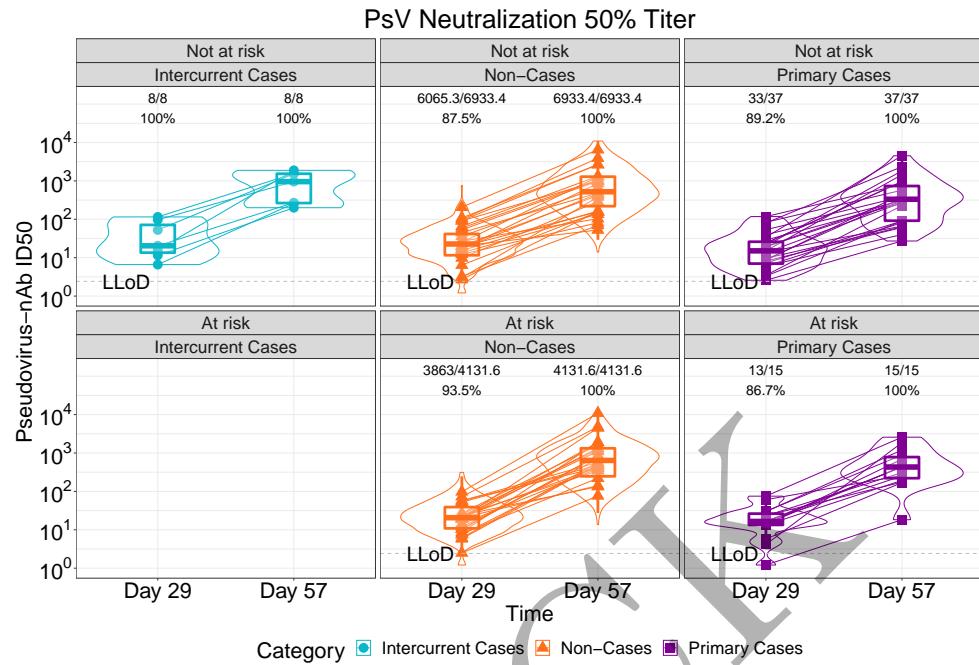


Figure 3.83: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by risk condition (version 1)

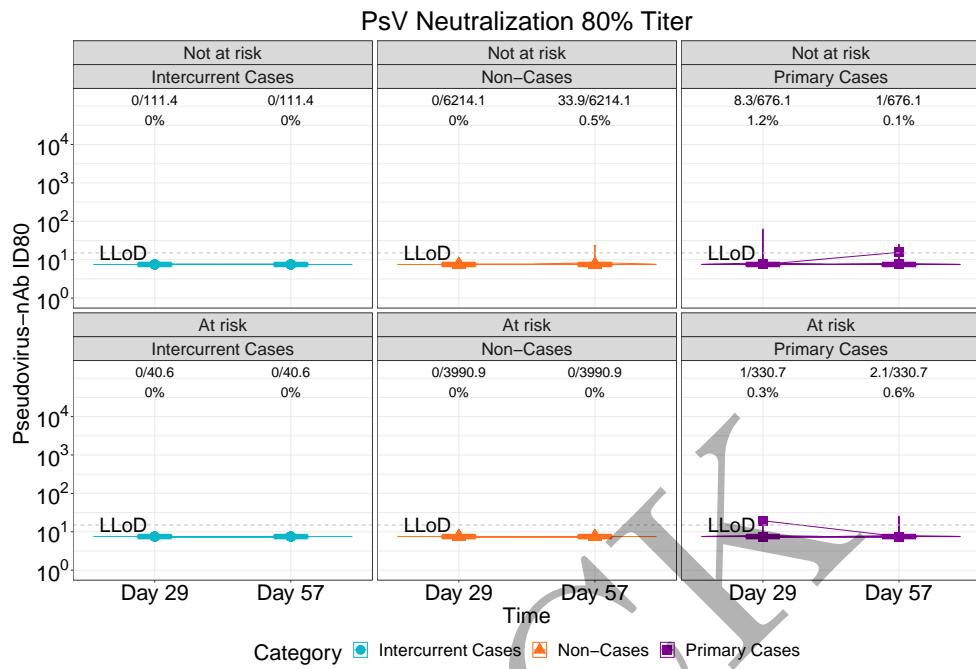


Figure 3.84: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by risk condition (version 1)

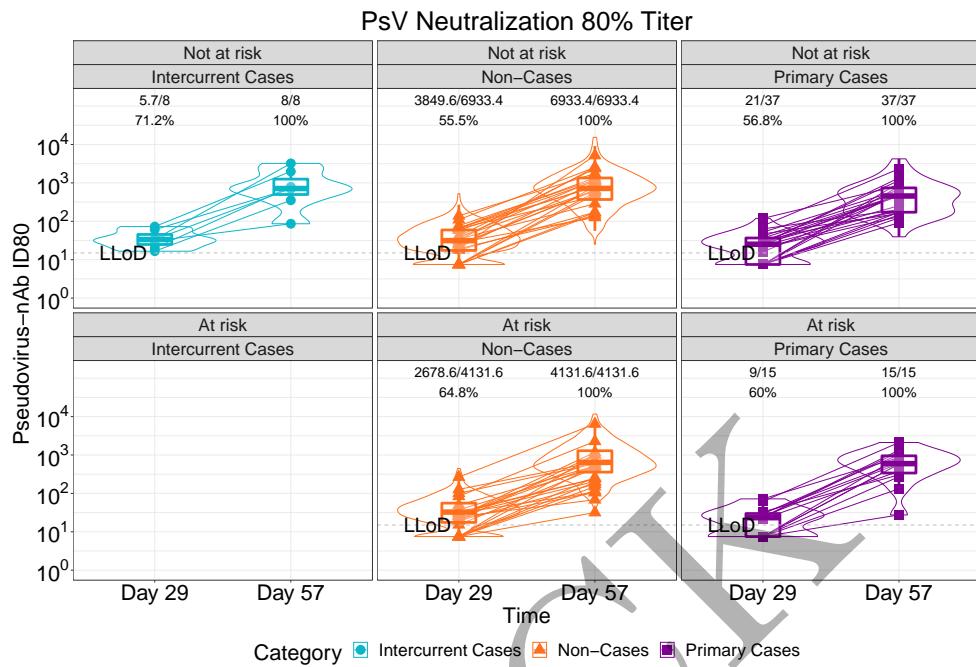


Figure 3.85: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by risk condition (version 1)

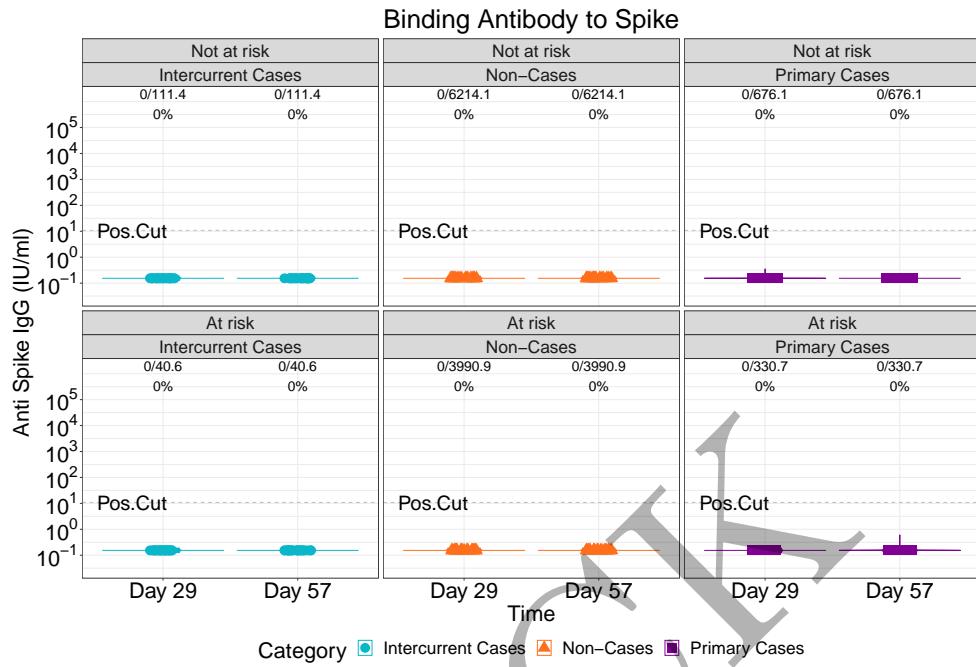


Figure 3.86: violinplots of Binding Antibody to Spike: baseline negative placebo arm by risk condition (version 1)

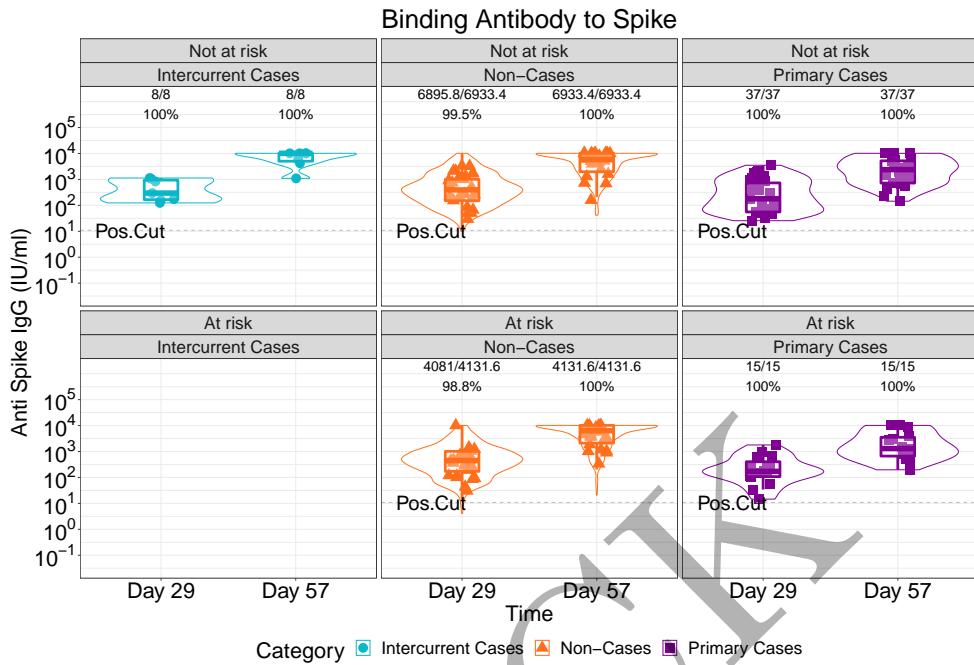


Figure 3.87: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by risk condition (version 1)

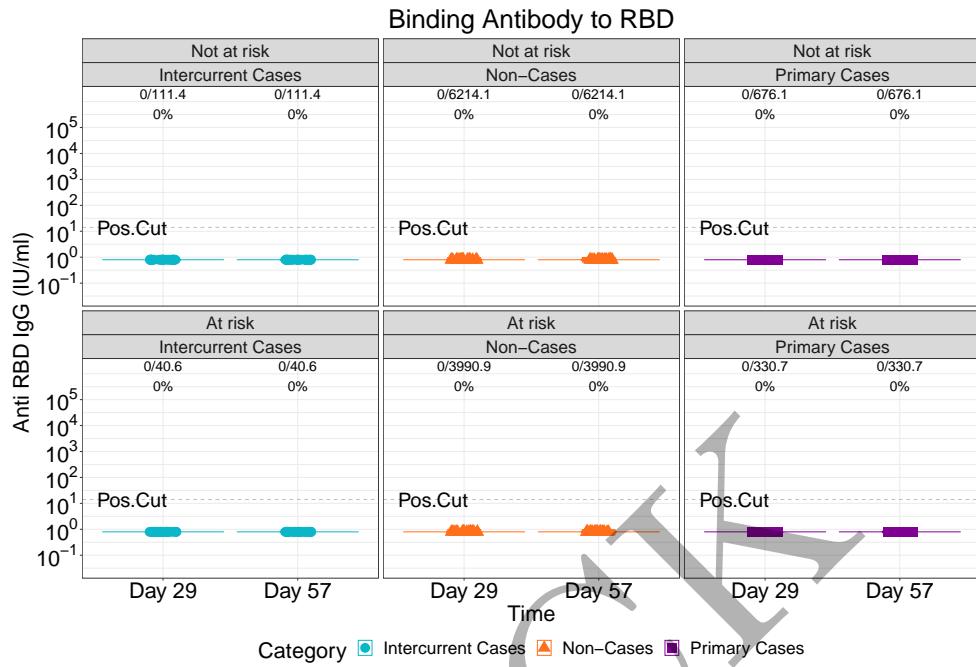


Figure 3.88: violinplots of Binding Antibody to RBD: baseline negative placebo arm by risk condition (version 1)

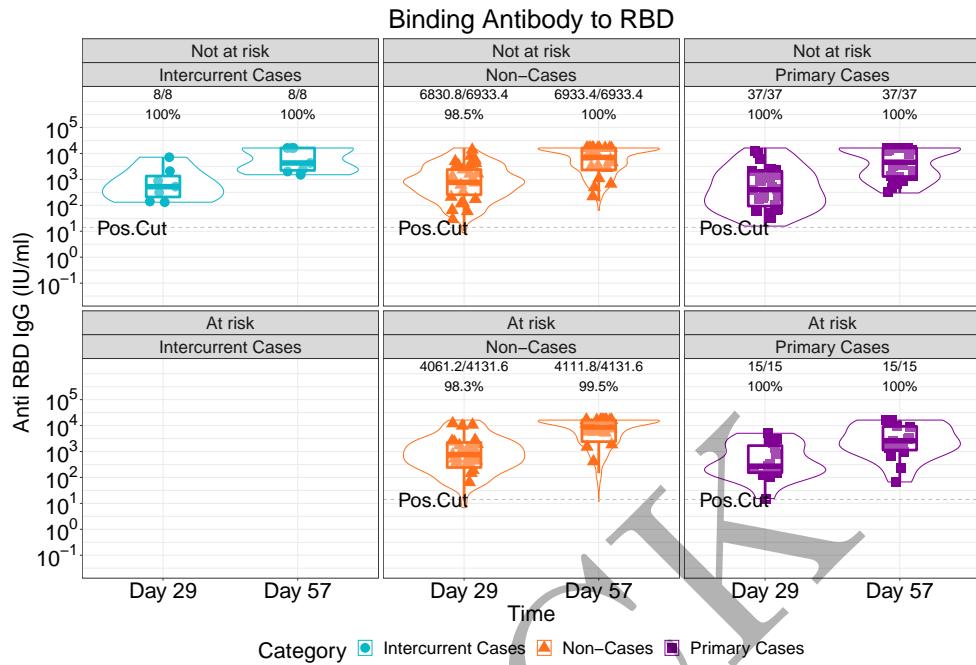


Figure 3.89: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by risk condition (version 1)

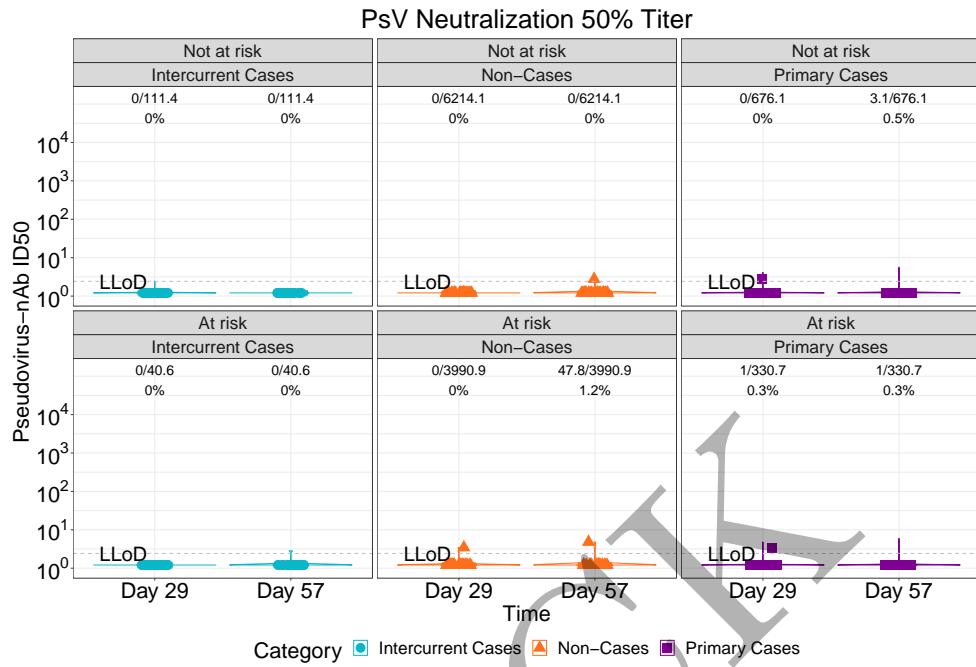


Figure 3.90: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by risk condition (version 1)

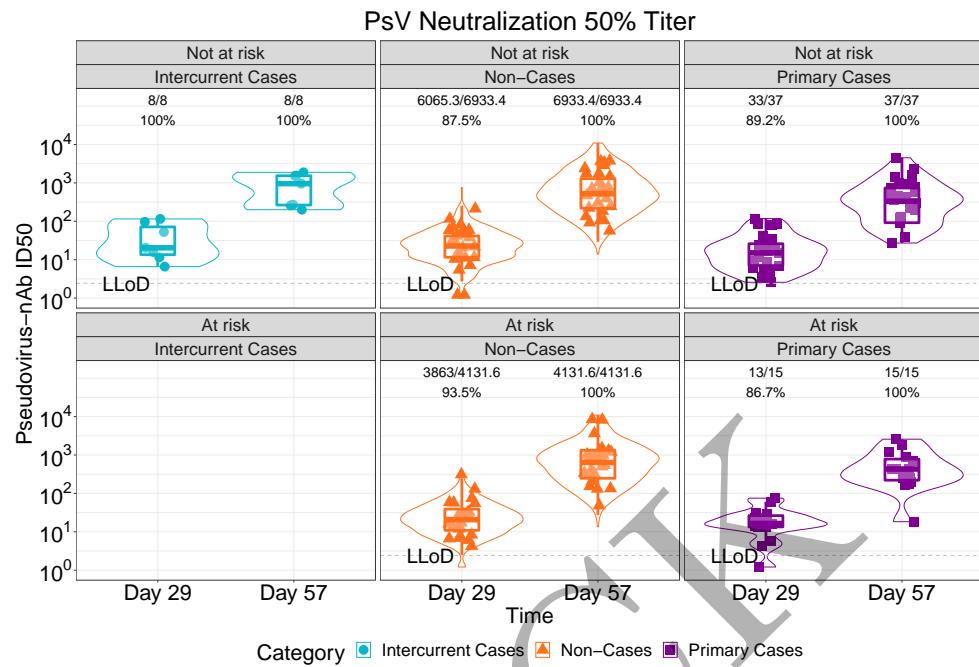


Figure 3.91: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by risk condition (version 1)

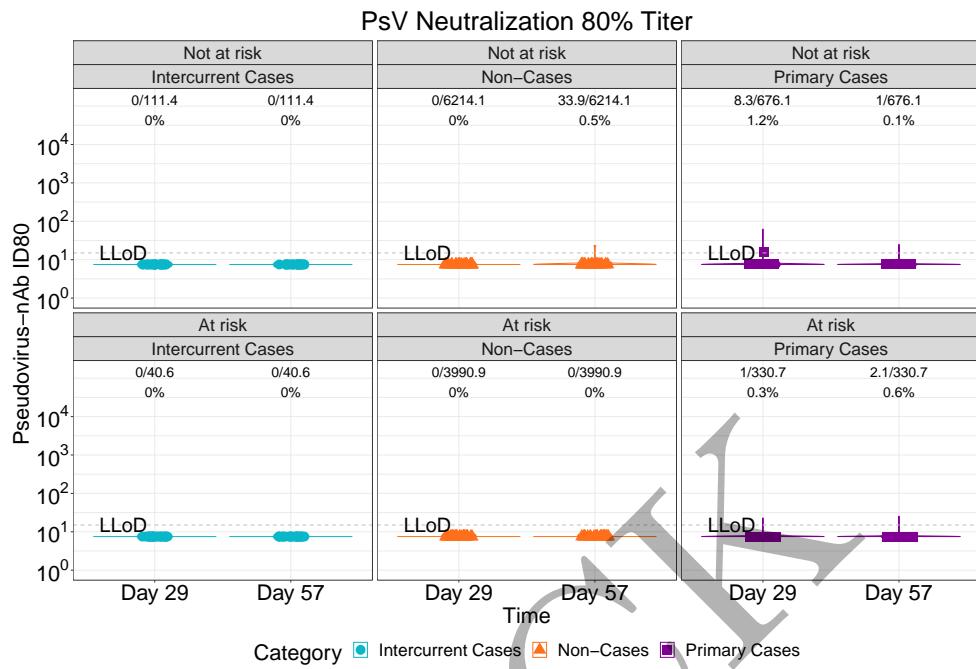


Figure 3.92: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by risk condition (version 1)

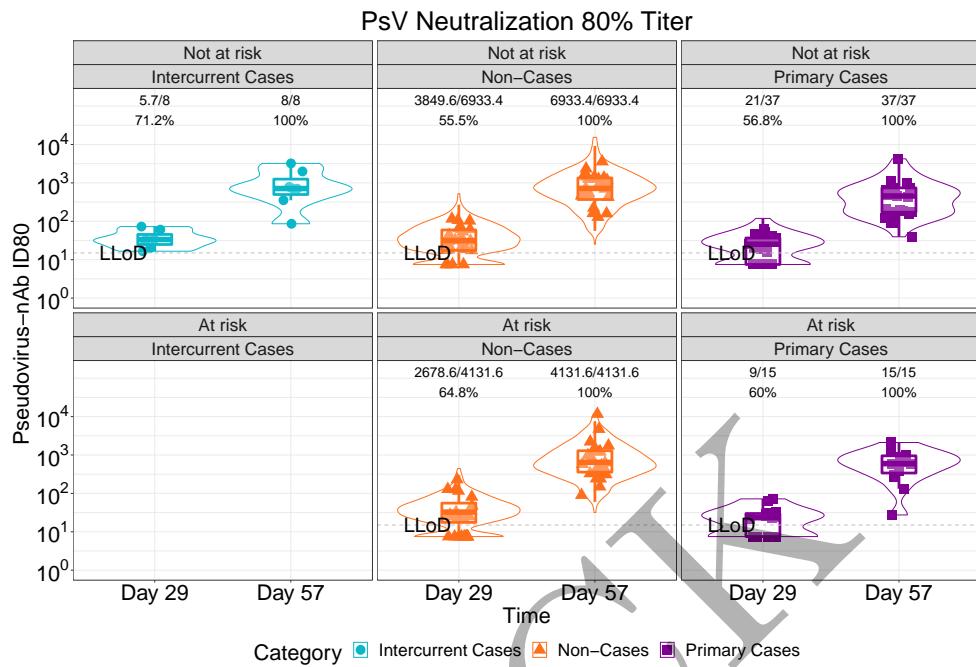


Figure 3.93: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by risk condition (version 1)

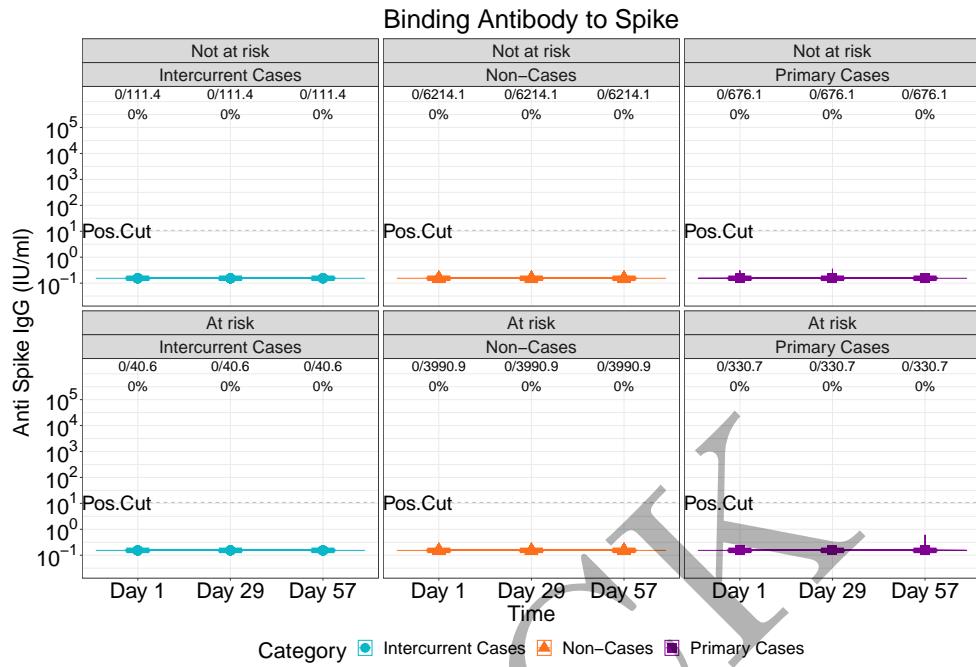


Figure 3.94: lineplots of Binding Antibody to Spike: baseline negative placebo arm by risk condition (version 2)

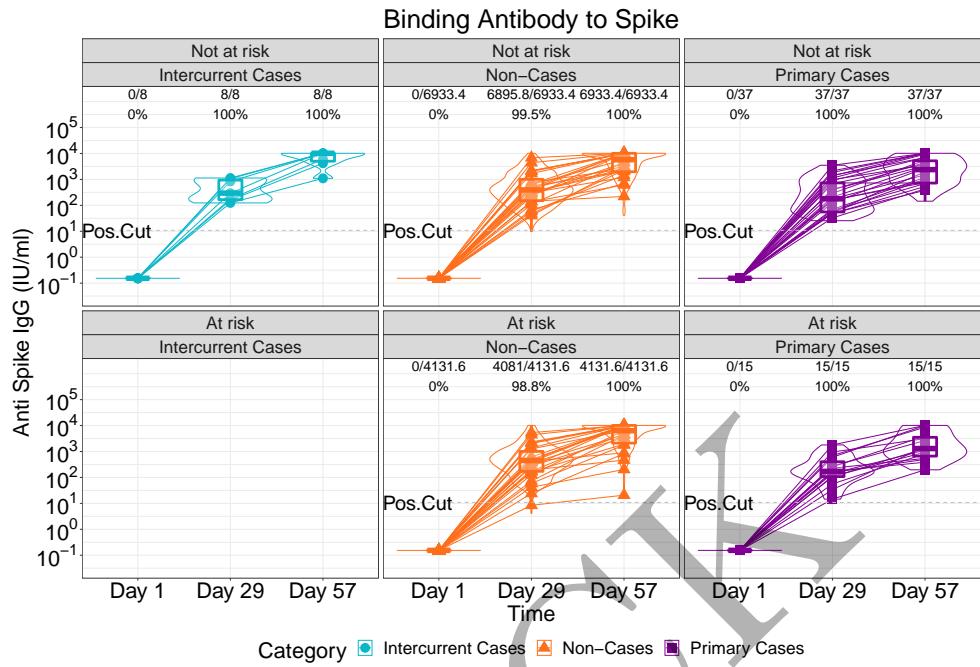


Figure 3.95: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by risk condition (version 2)

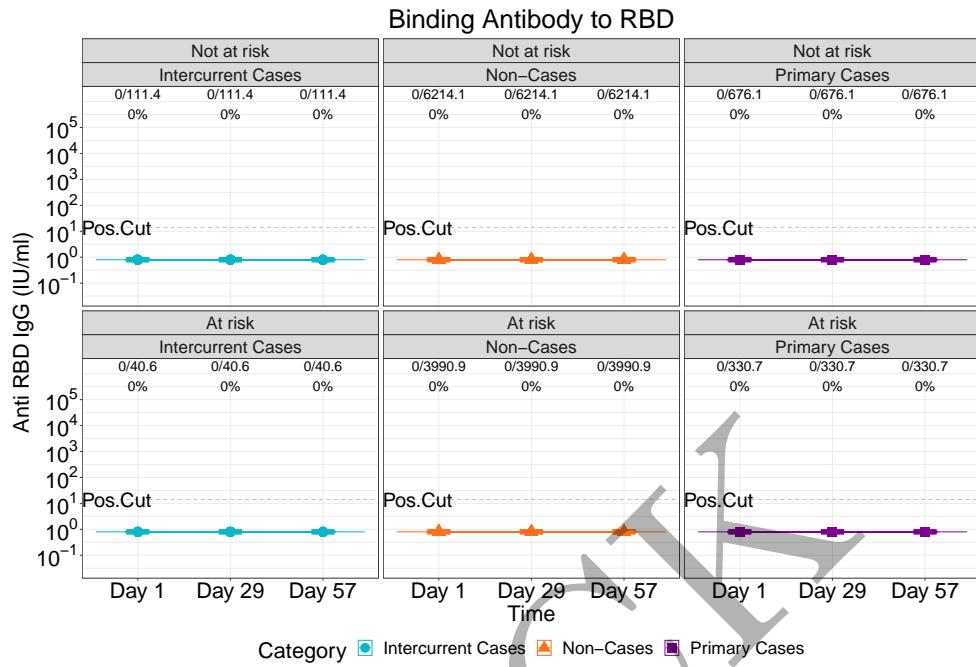


Figure 3.96: lineplots of Binding Antibody to RBD: baseline negative placebo arm by risk condition (version 2)

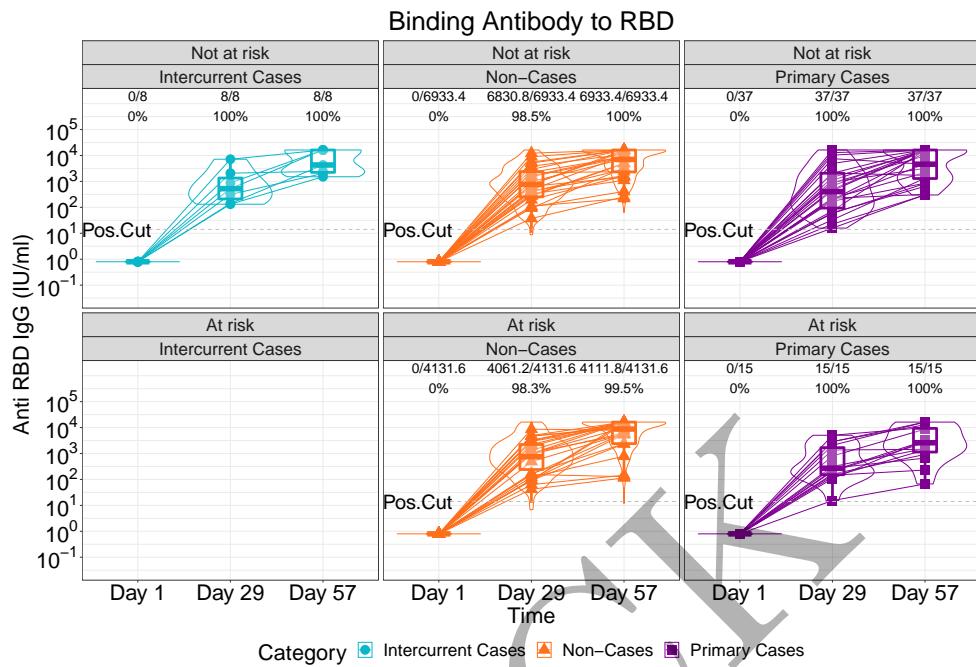


Figure 3.97: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by risk condition (version 2)

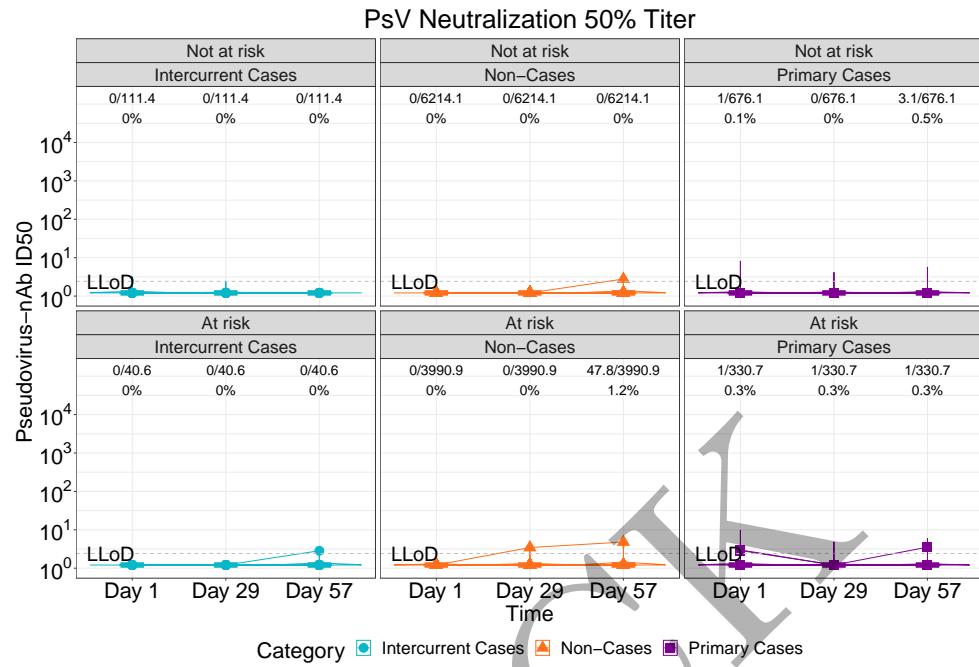


Figure 3.98: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by risk condition (version 2)

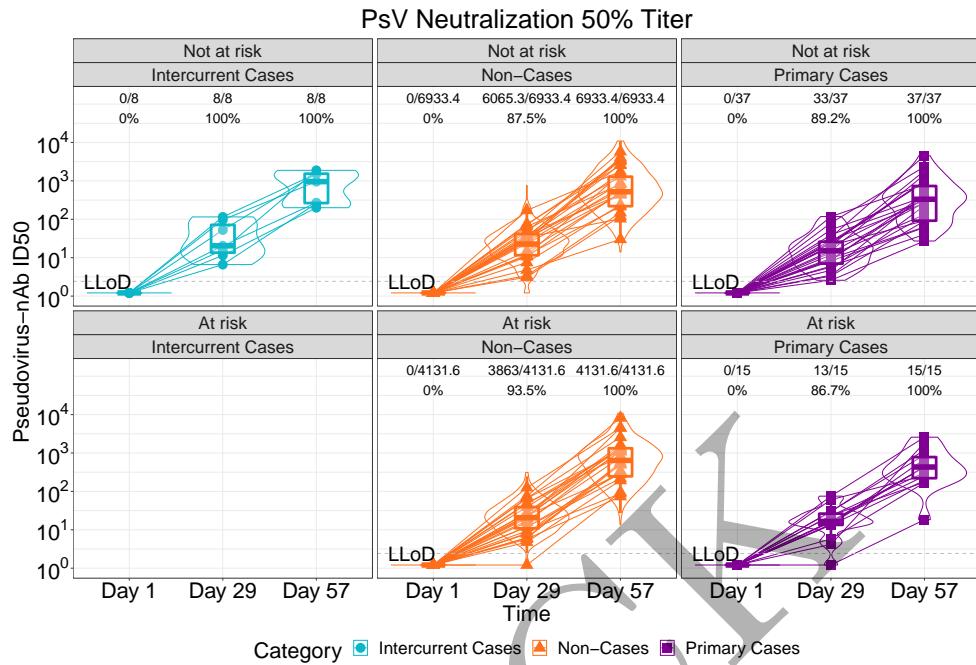


Figure 3.99: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by risk condition (version 2)

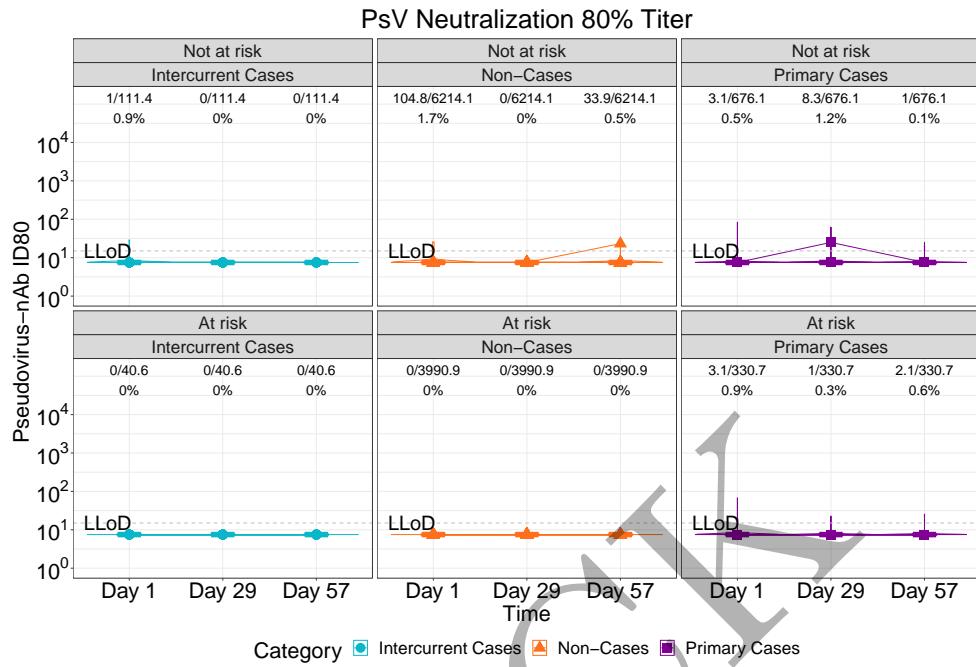


Figure 3.100: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by risk condition (version 2)

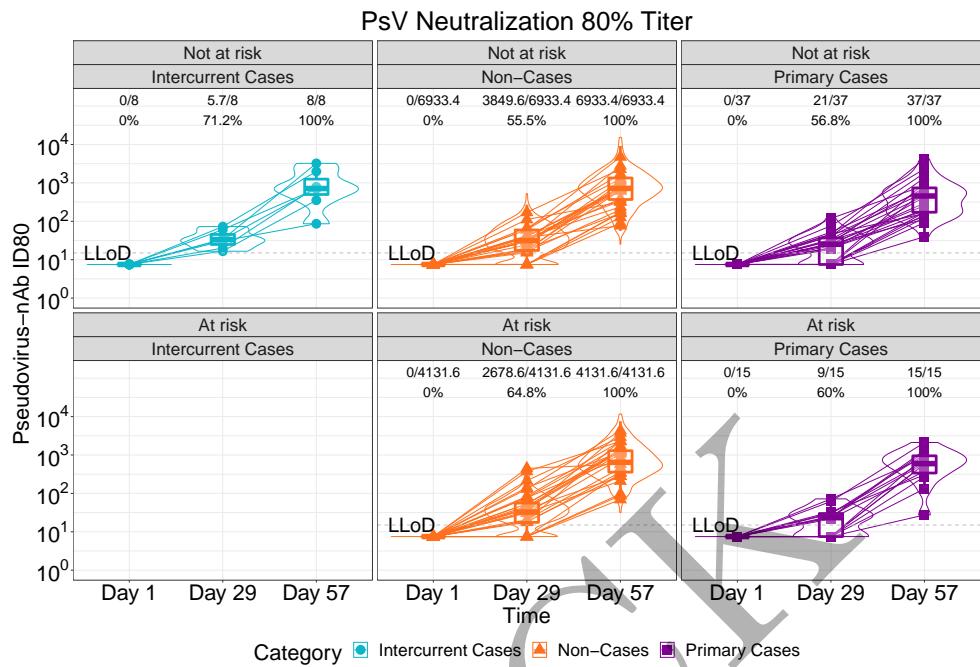


Figure 3.101: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by risk condition (version 2)

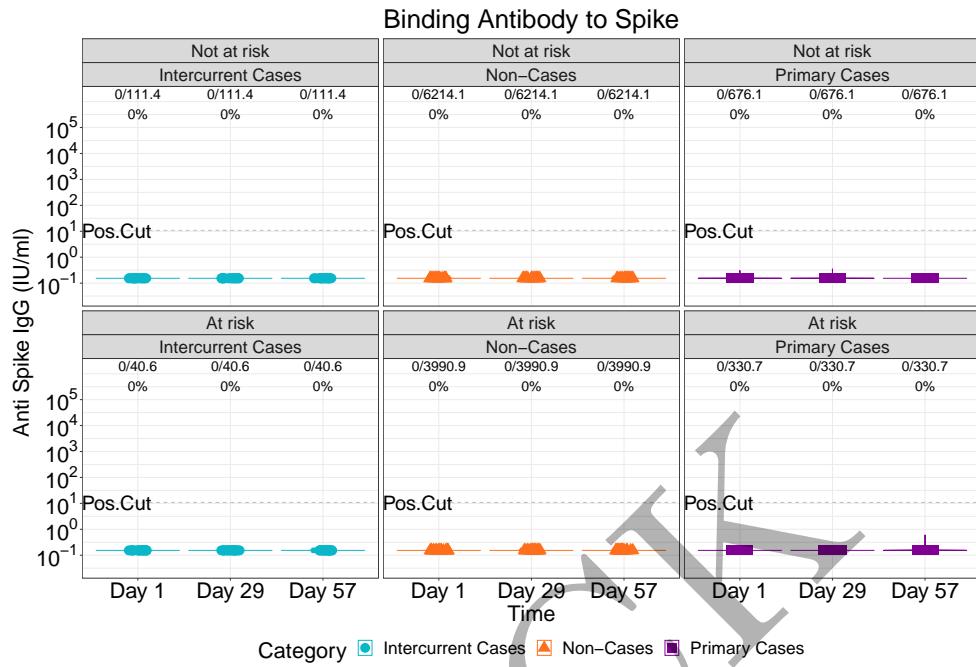


Figure 3.102: violinplots of Binding Antibody to Spike: baseline negative placebo arm by risk condition (version 2)

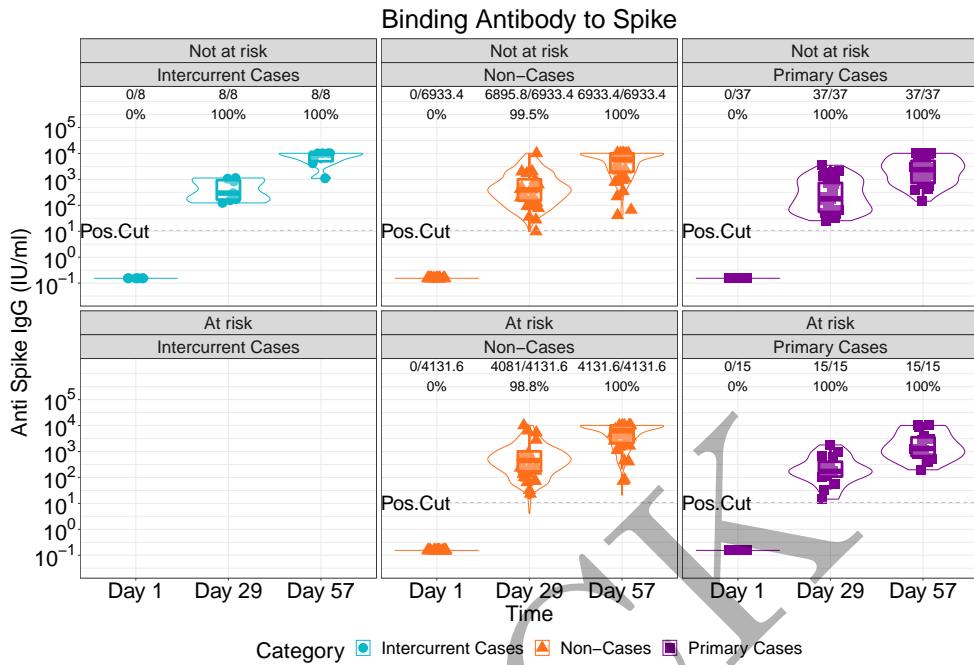


Figure 3.103: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by risk condition (version 2)

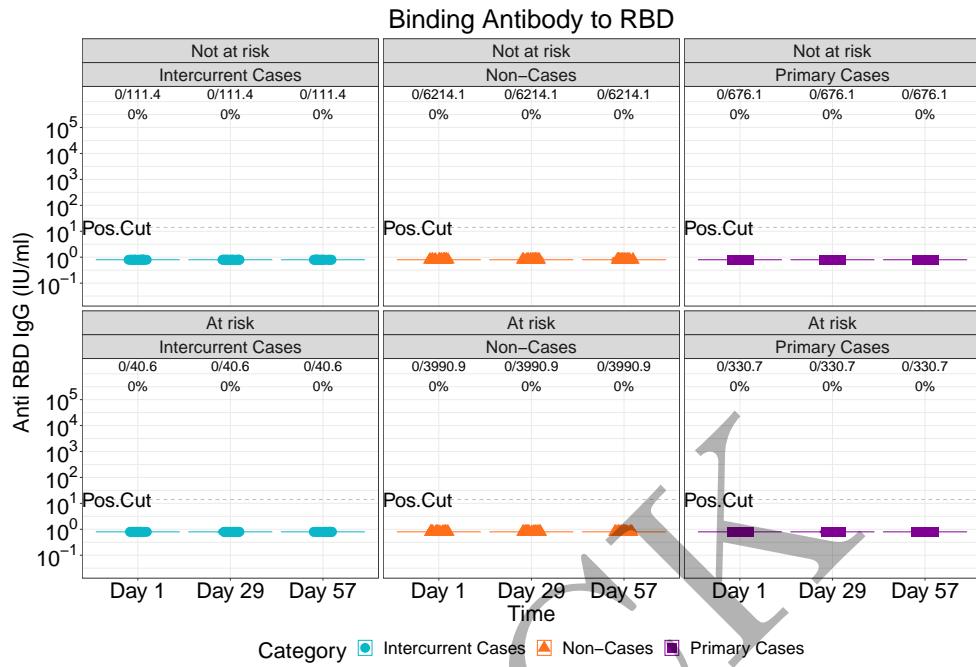


Figure 3.104: violinplots of Binding Antibody to RBD: baseline negative placebo arm by risk condition (version 2)

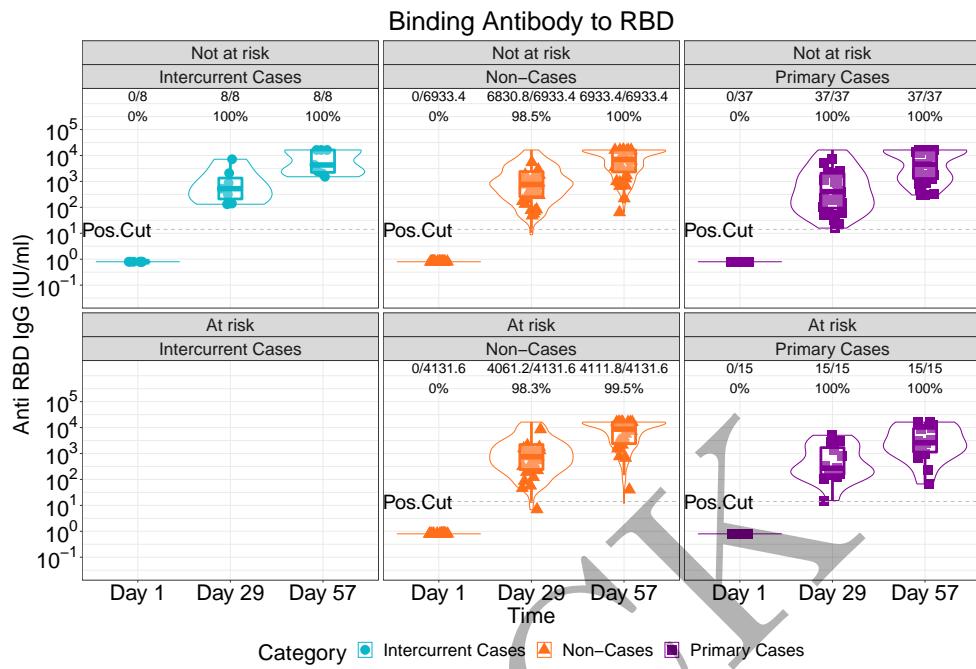


Figure 3.105: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by risk condition (version 2)

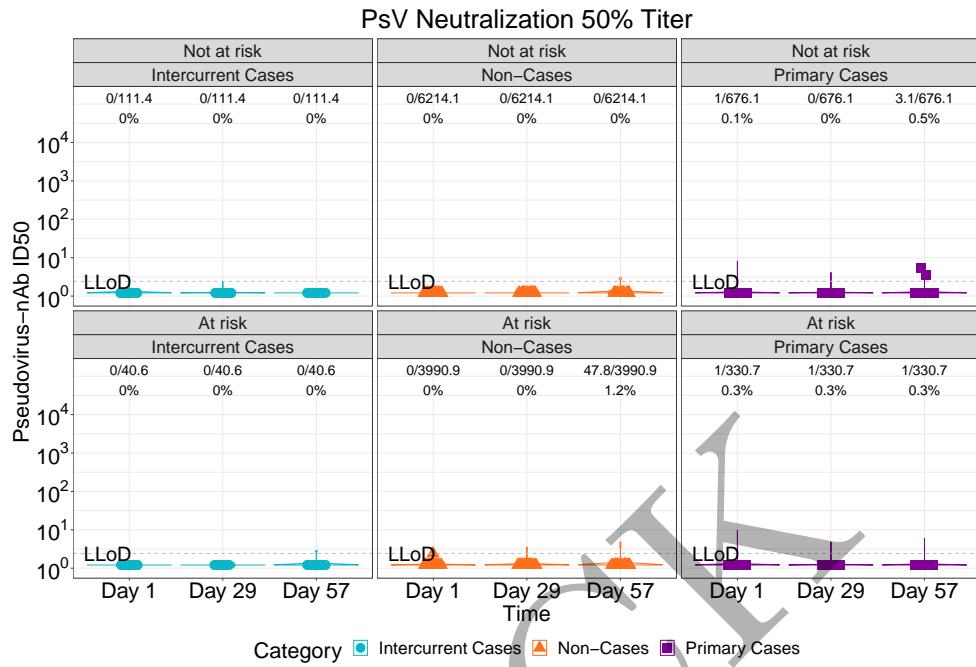


Figure 3.106: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by risk condition (version 2)

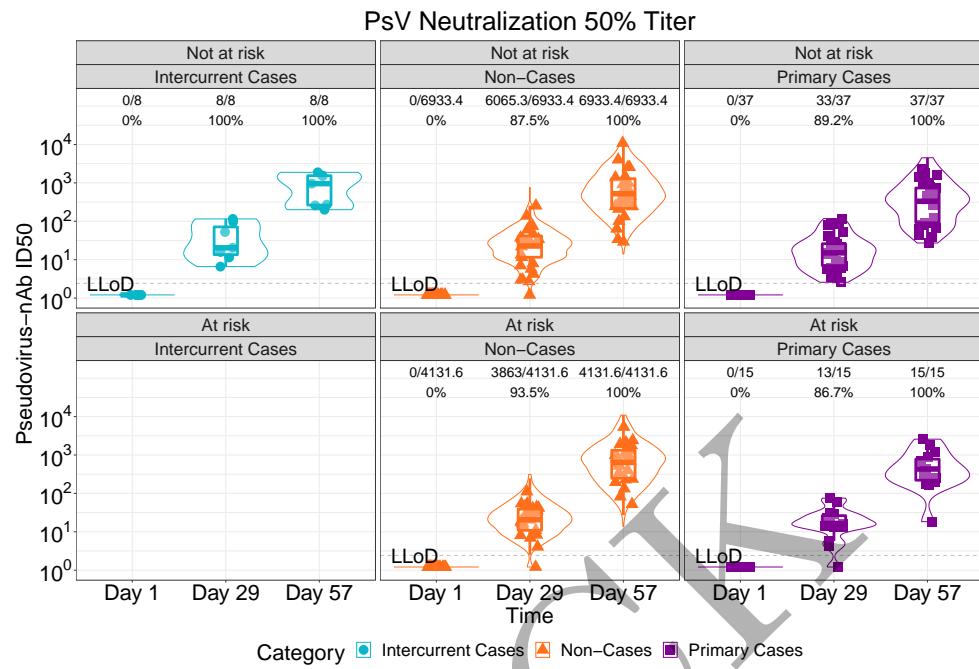


Figure 3.107: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by risk condition (version 2)

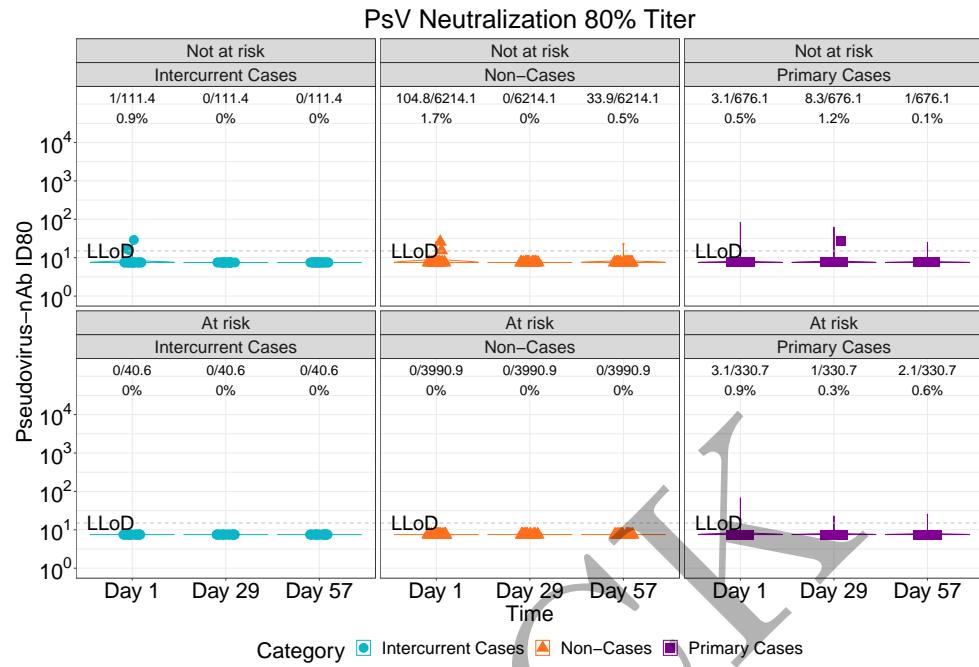


Figure 3.108: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by risk condition (version 2)

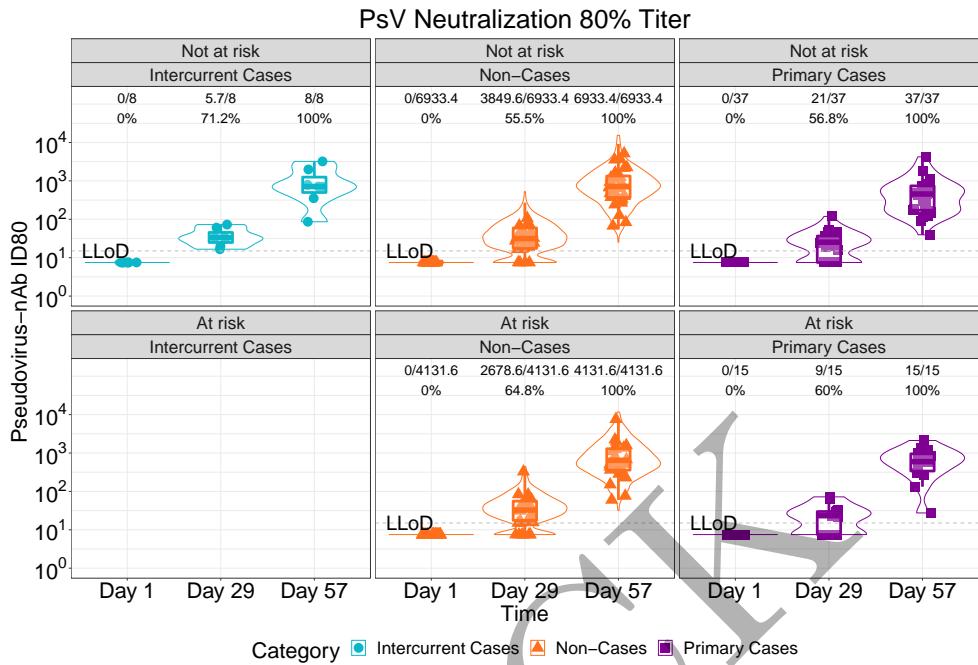


Figure 3.109: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by risk condition (version 2)

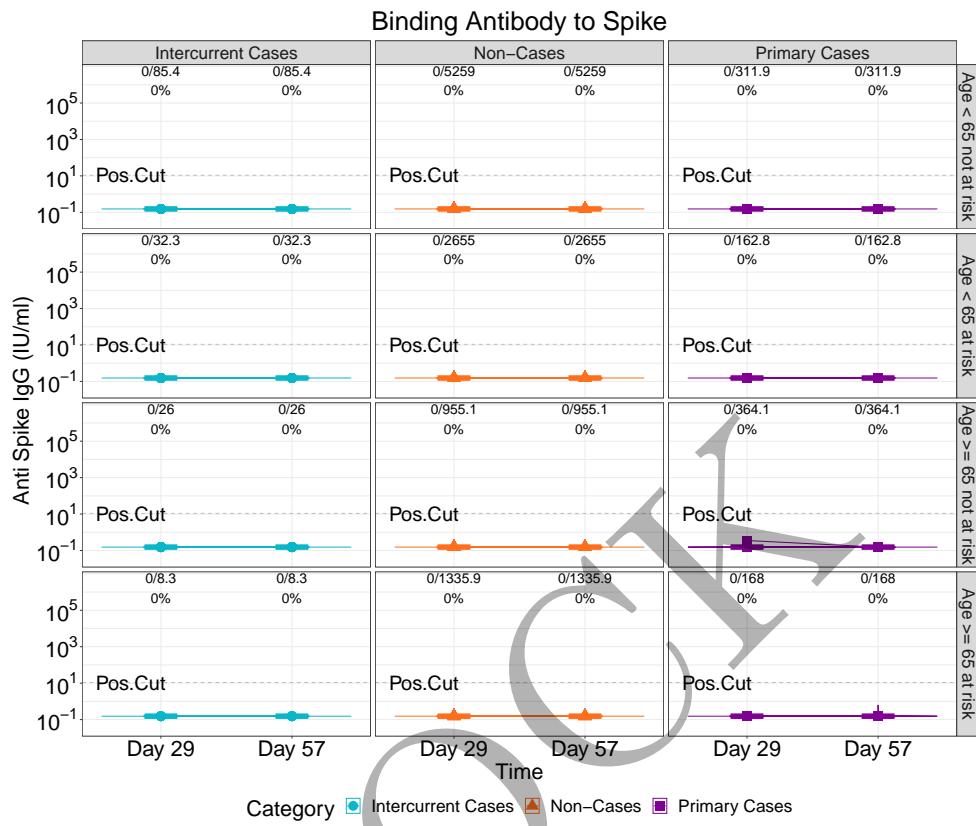


Figure 3.110: lineplots of Binding Antibody to Spike: baseline negative placebo arm by age and risk condition (version 1)

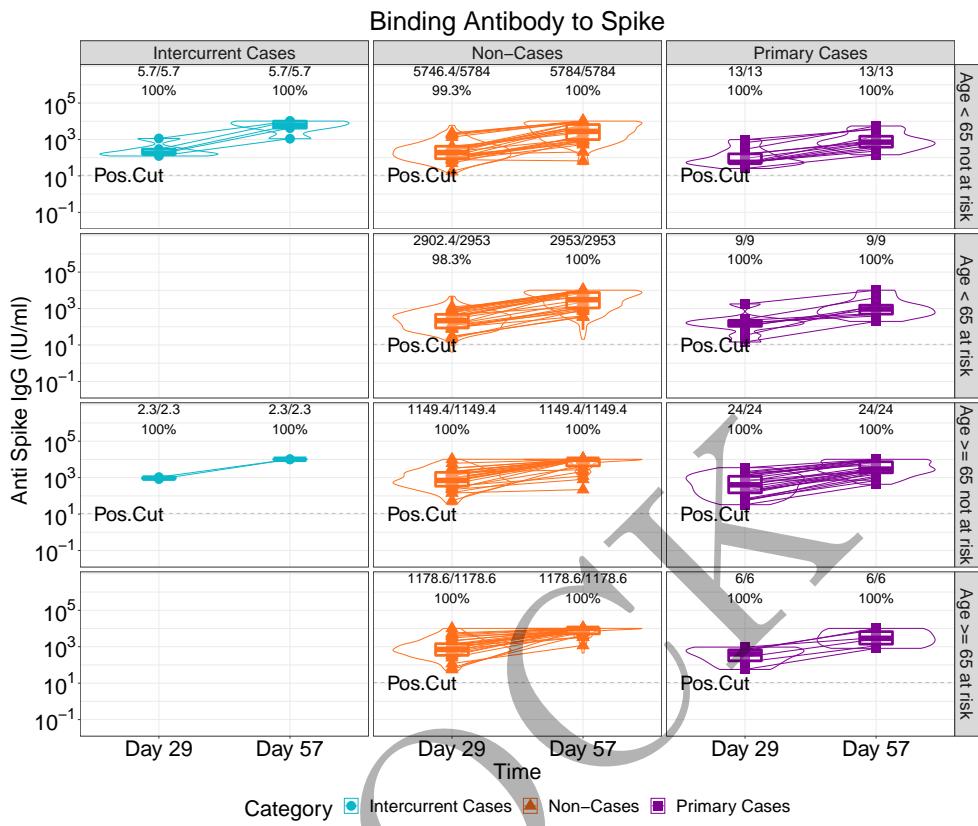


Figure 3.111: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by age and risk condition (version 1)

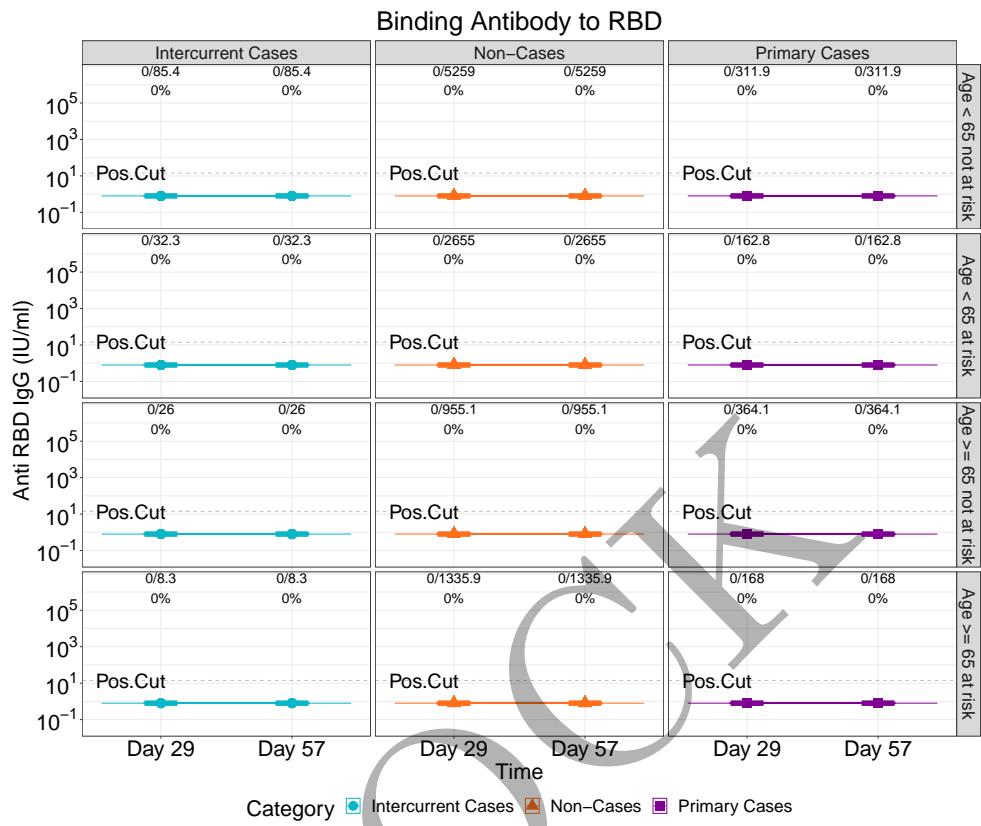


Figure 3.112: lineplots of Binding Antibody to RBD: baseline negative placebo arm by age and risk condition (version 1)

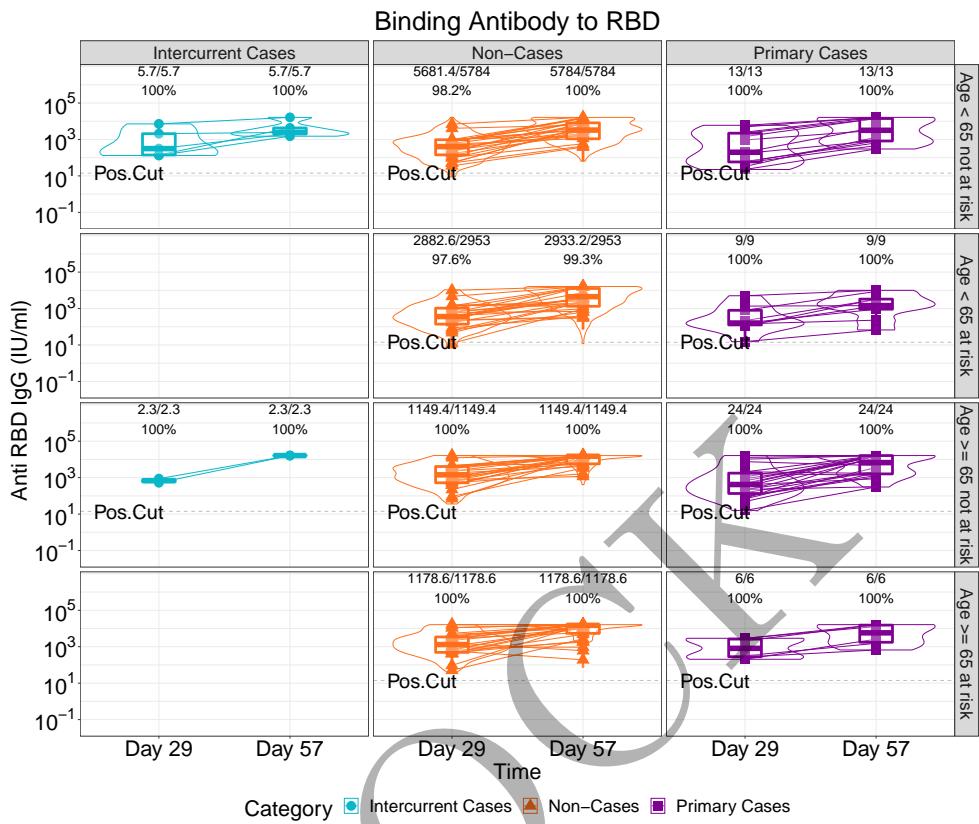


Figure 3.113: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by age and risk condition (version 1)

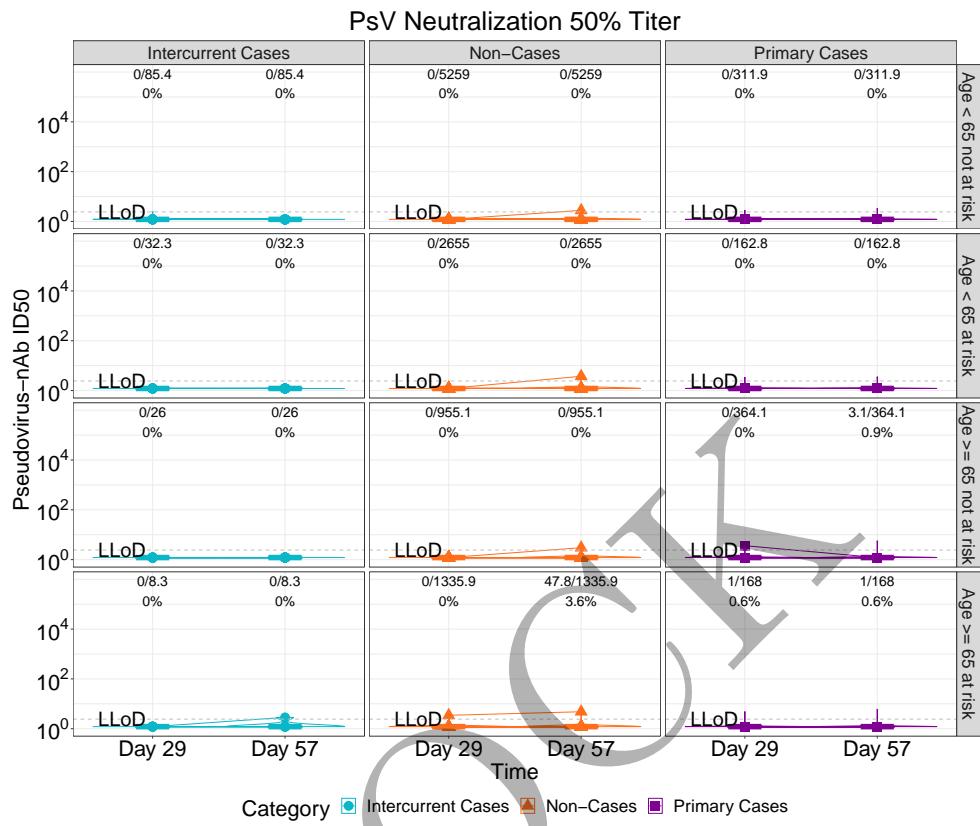


Figure 3.114: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age and risk condition (version 1)

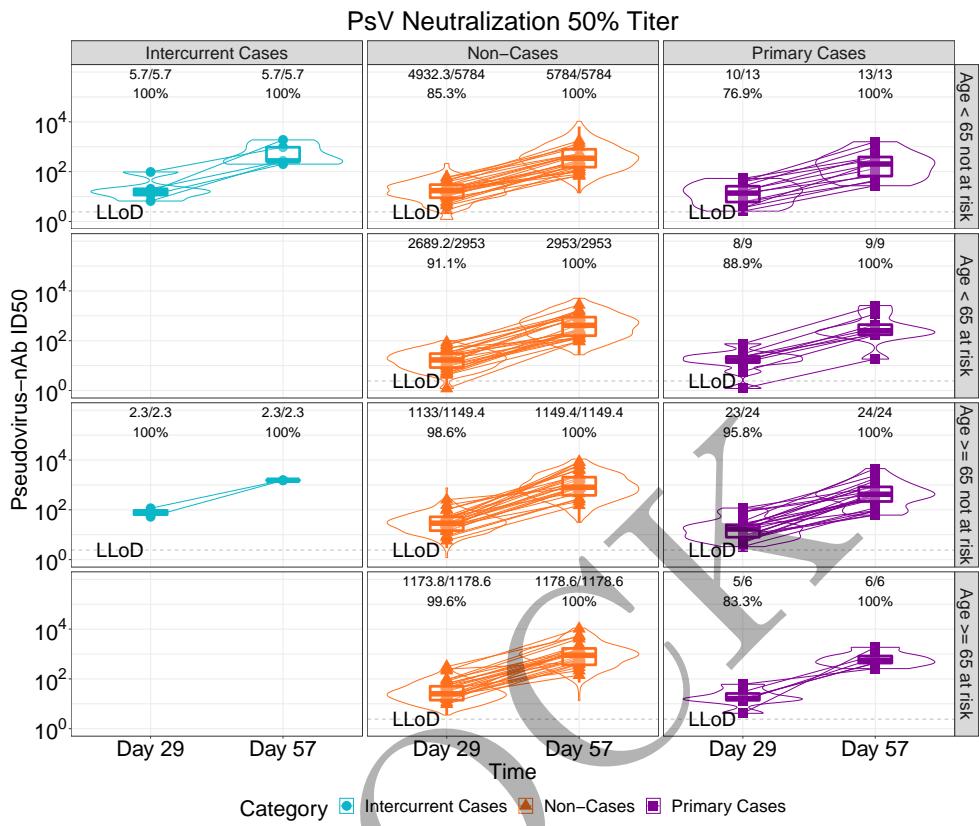


Figure 3.115: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age and risk condition (version 1)

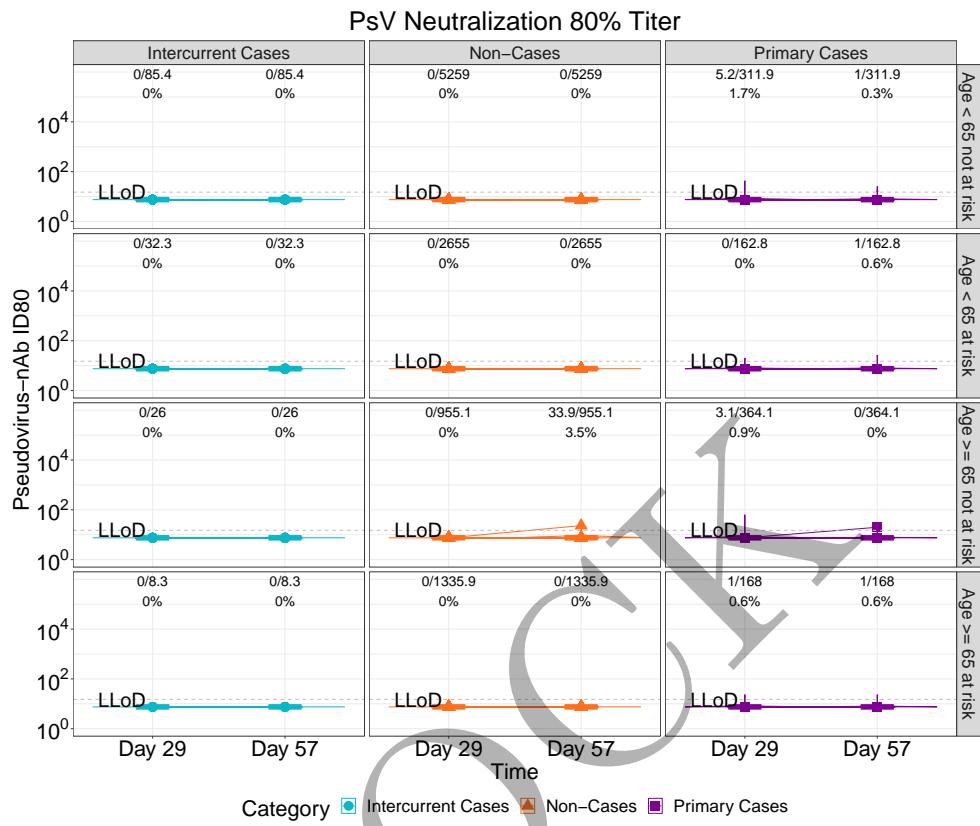


Figure 3.116: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age and risk condition (version 1)

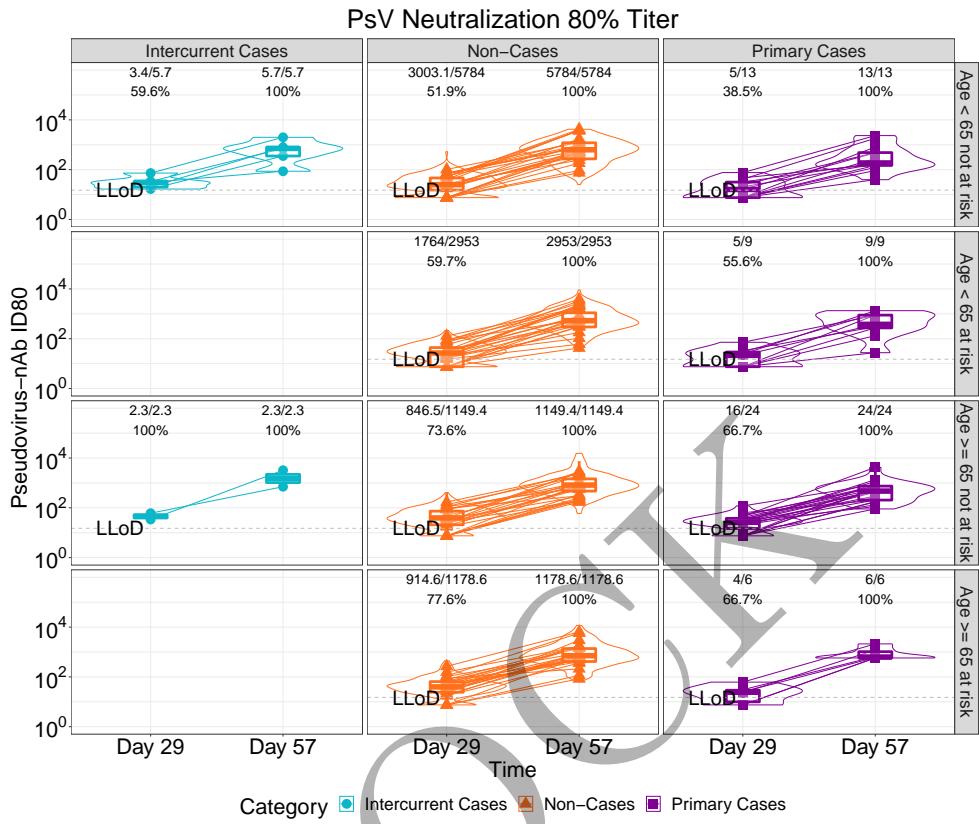


Figure 3.117: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age and risk condition (version 1)

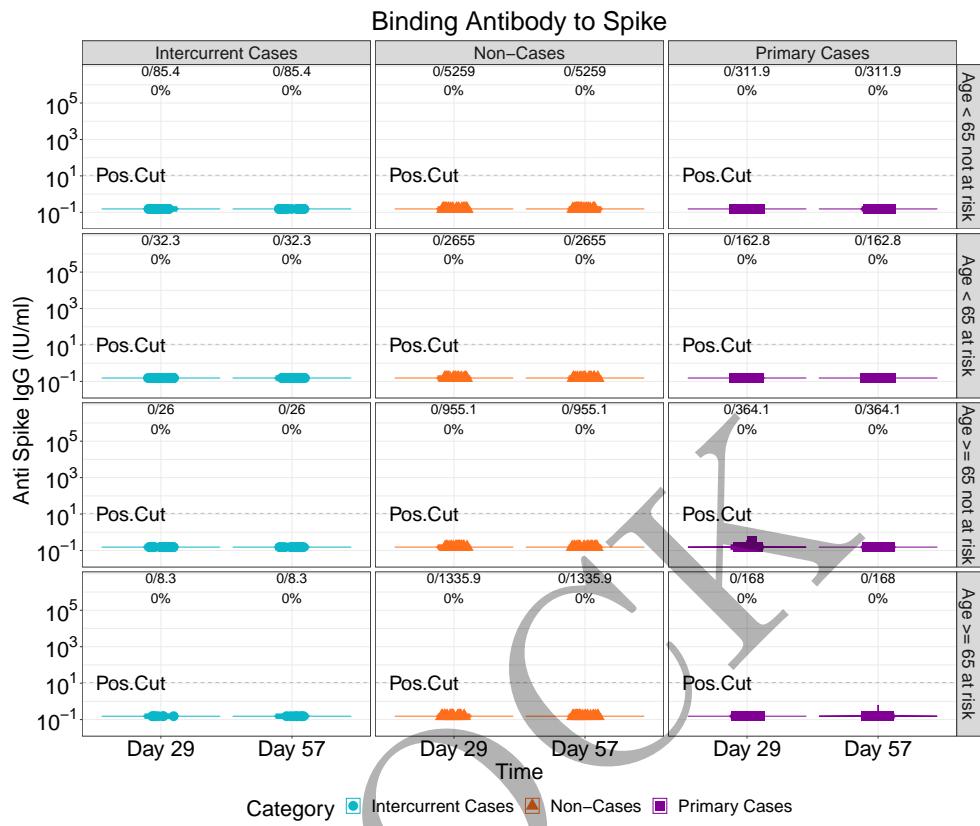


Figure 3.118: violinplots of Binding Antibody to Spike: baseline negative placebo arm by age and risk condition (version 1)

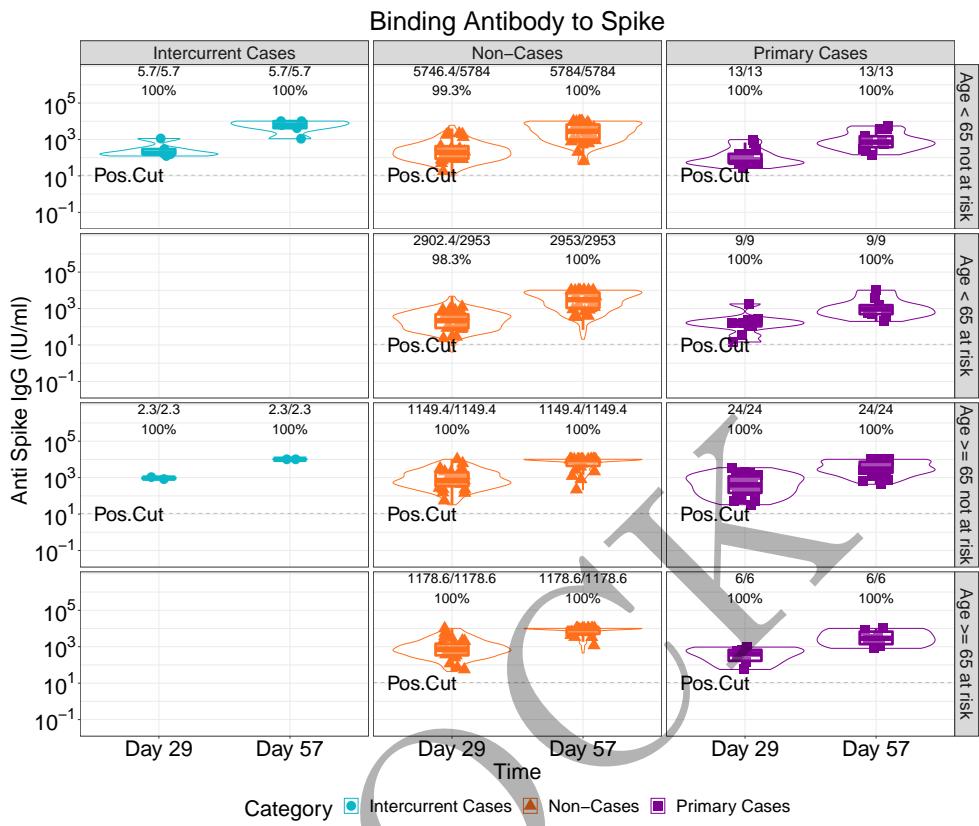


Figure 3.119: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by age and risk condition (version 1)

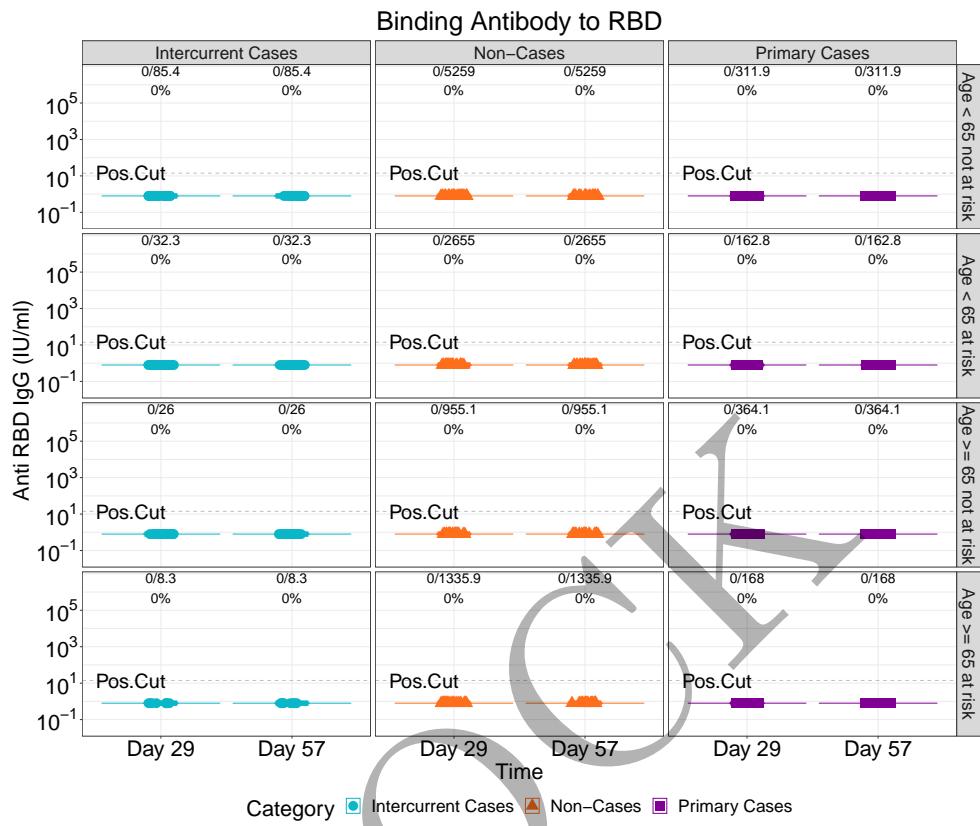


Figure 3.120: violinplots of Binding Antibody to RBD: baseline negative placebo arm by age and risk condition (version 1)

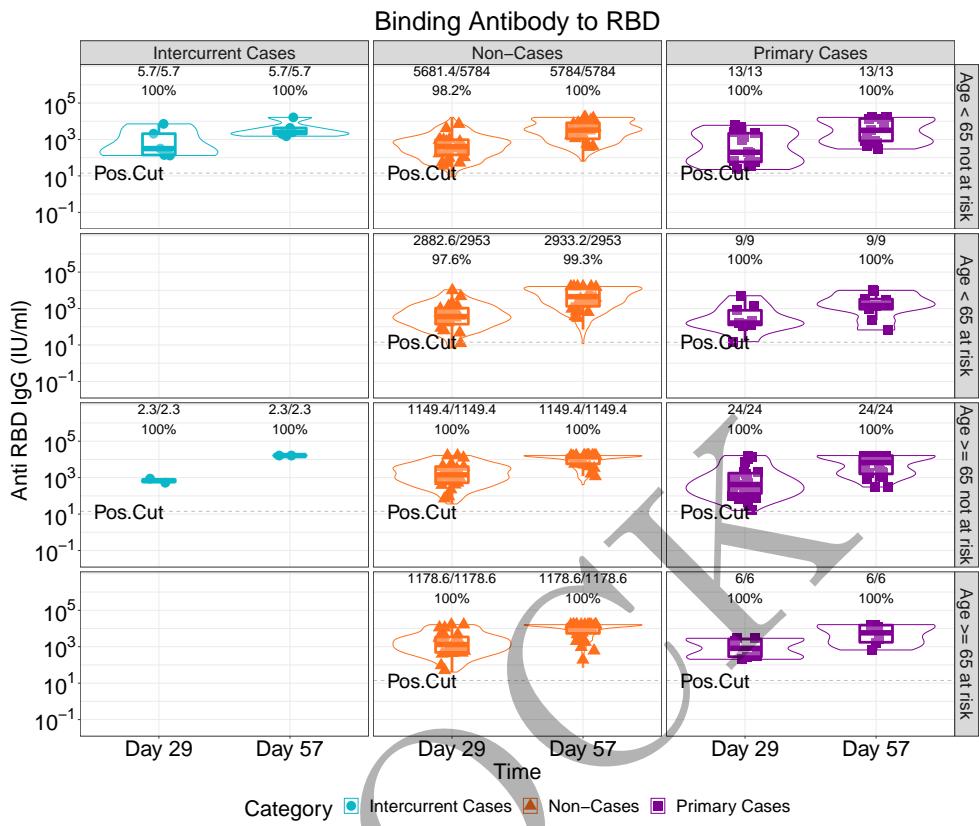


Figure 3.121: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by age and risk condition (version 1)

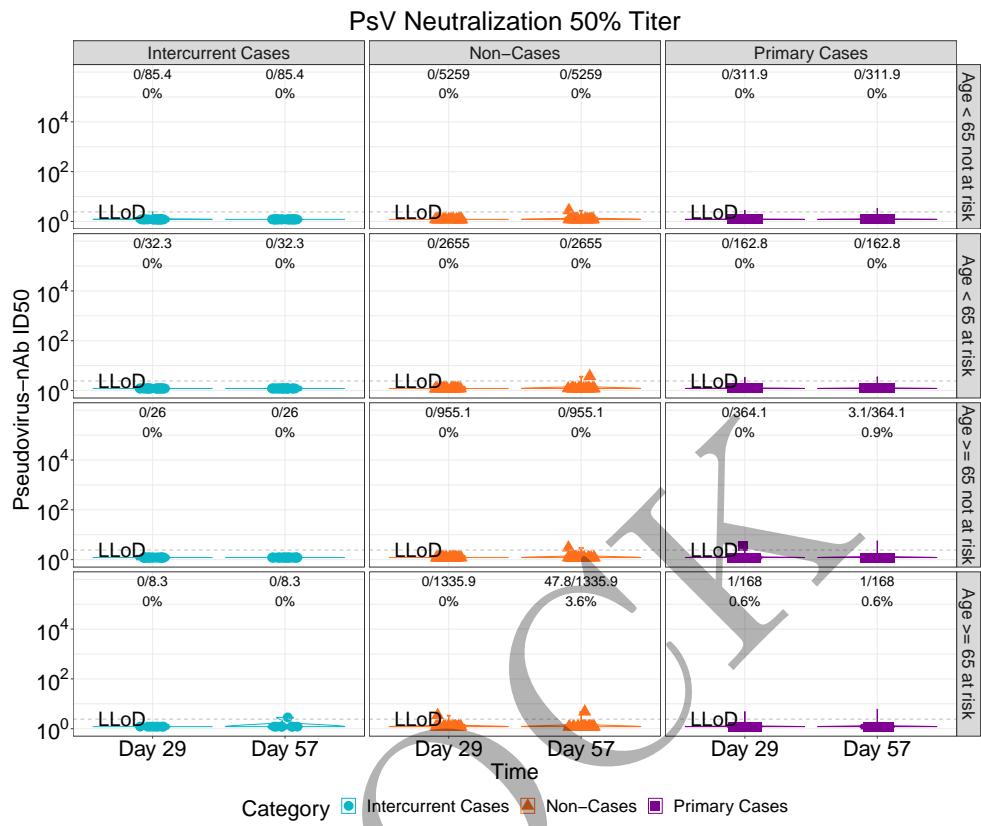


Figure 3.122: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age and risk condition (version 1)

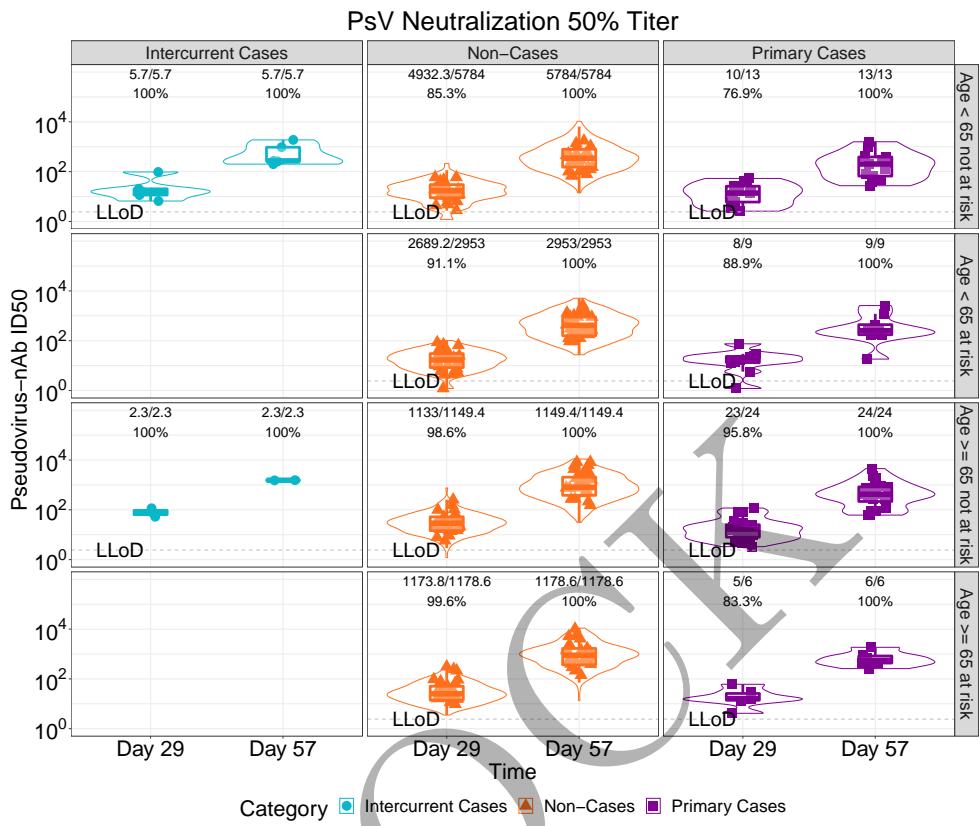


Figure 3.123: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age and risk condition (version 1)

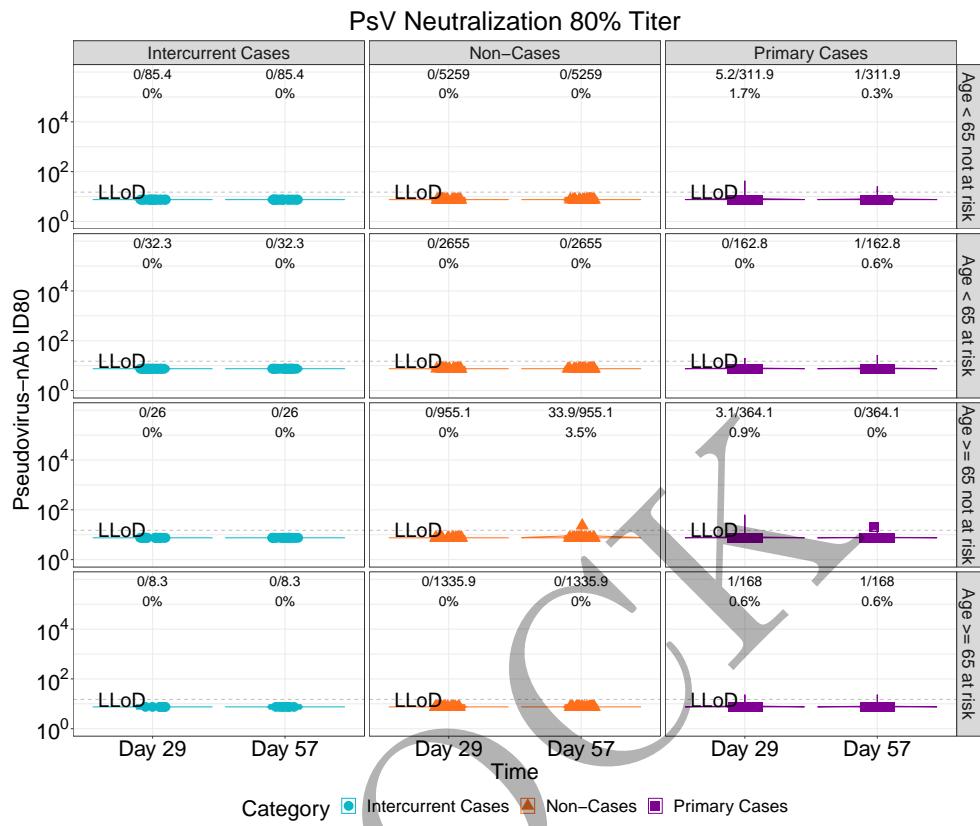


Figure 3.124: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age and risk condition (version 1)

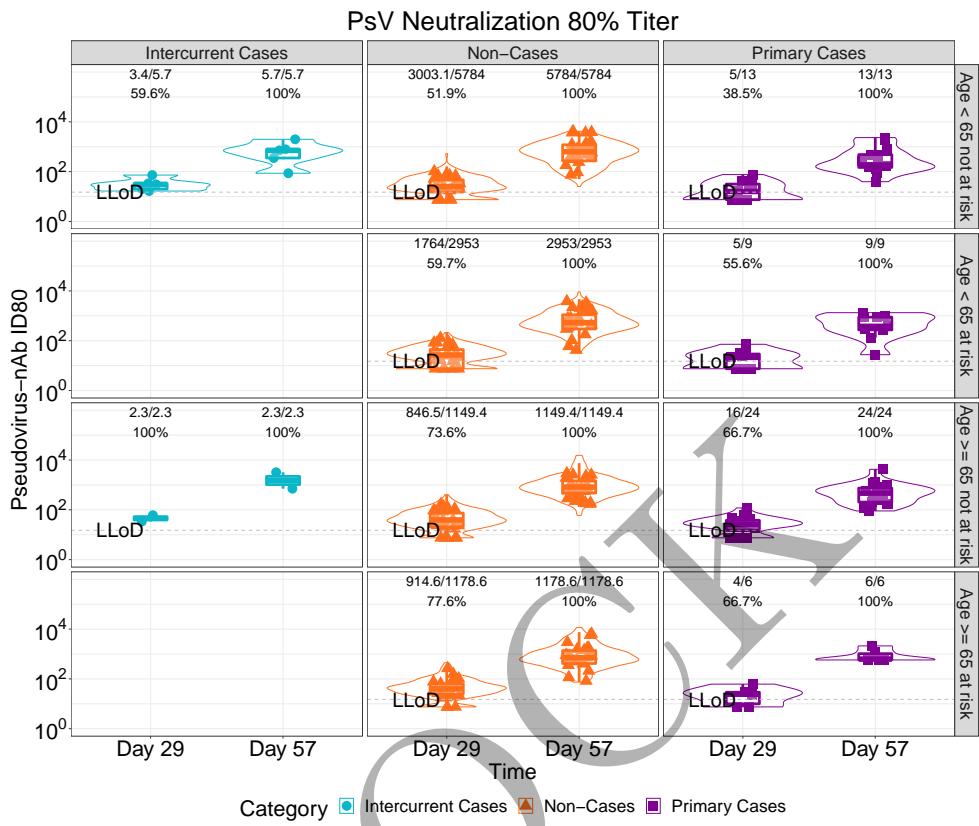


Figure 3.125: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age and risk condition (version 1)

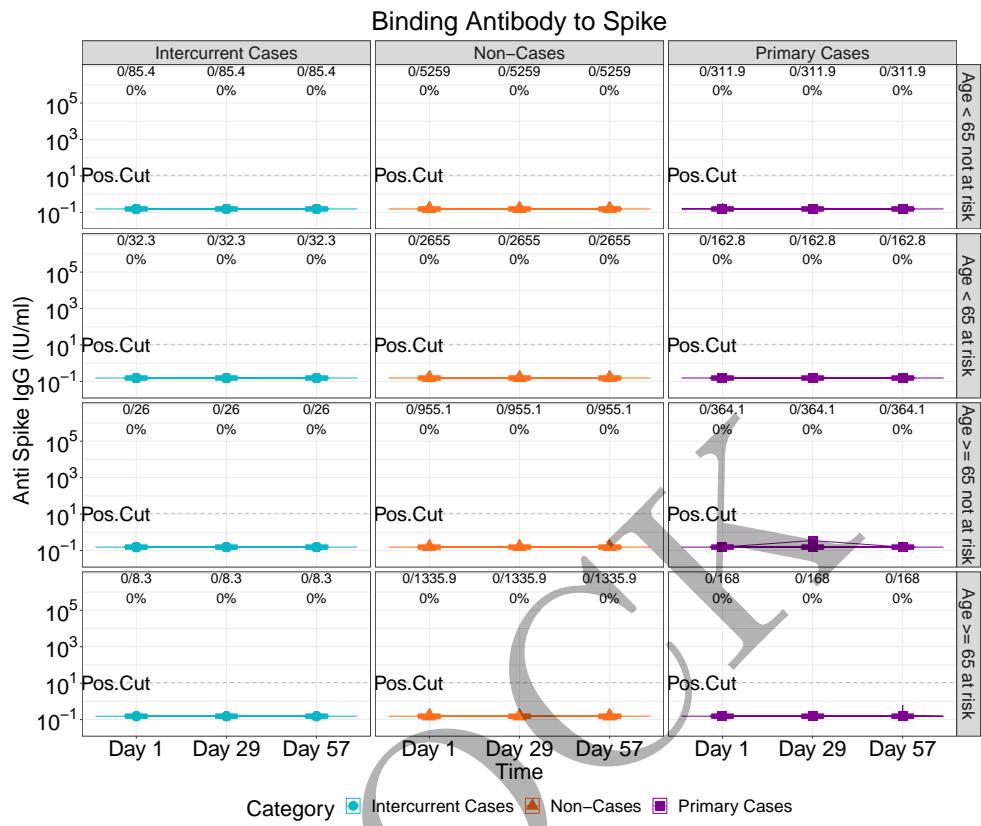


Figure 3.126: lineplots of Binding Antibody to Spike: baseline negative placebo arm by age and risk condition (version 2)

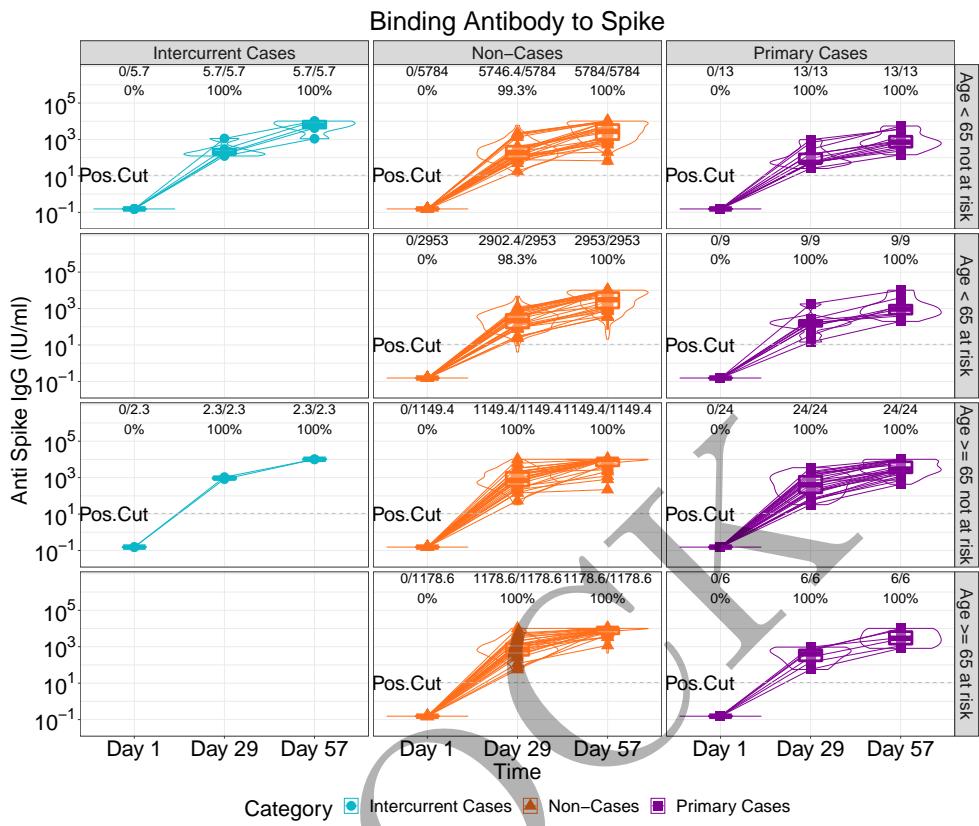


Figure 3.127: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by age and risk condition (version 2)

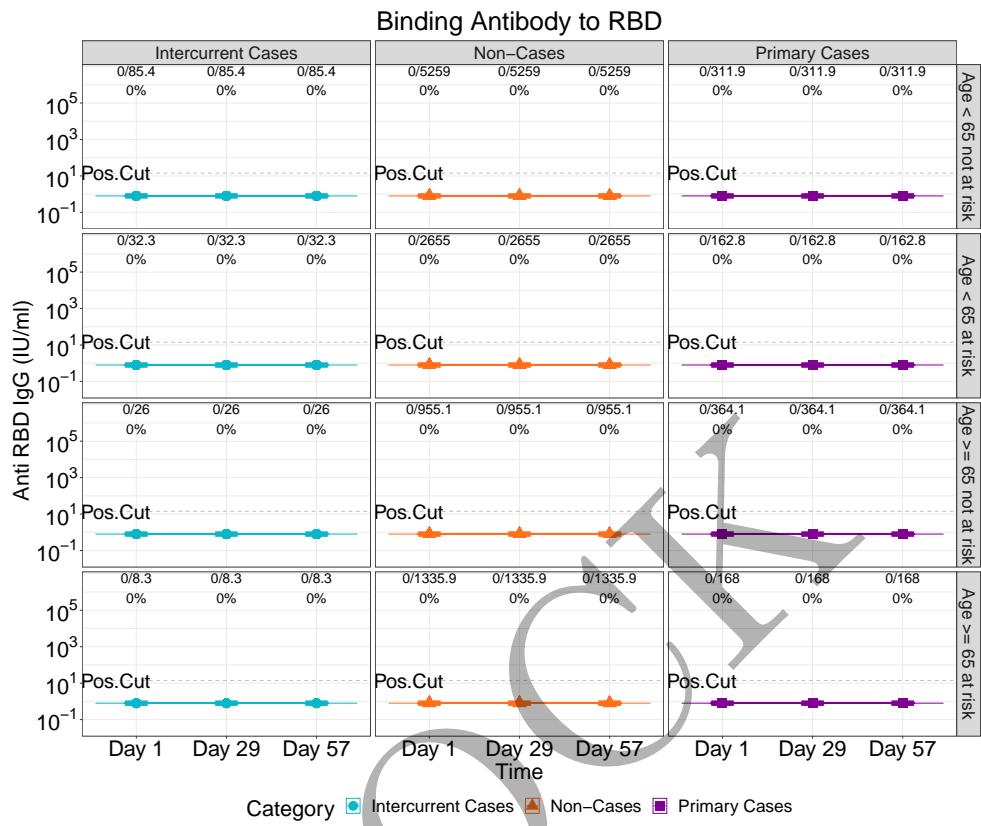


Figure 3.128: lineplots of Binding Antibody to RBD: baseline negative placebo arm by age and risk condition (version 2)

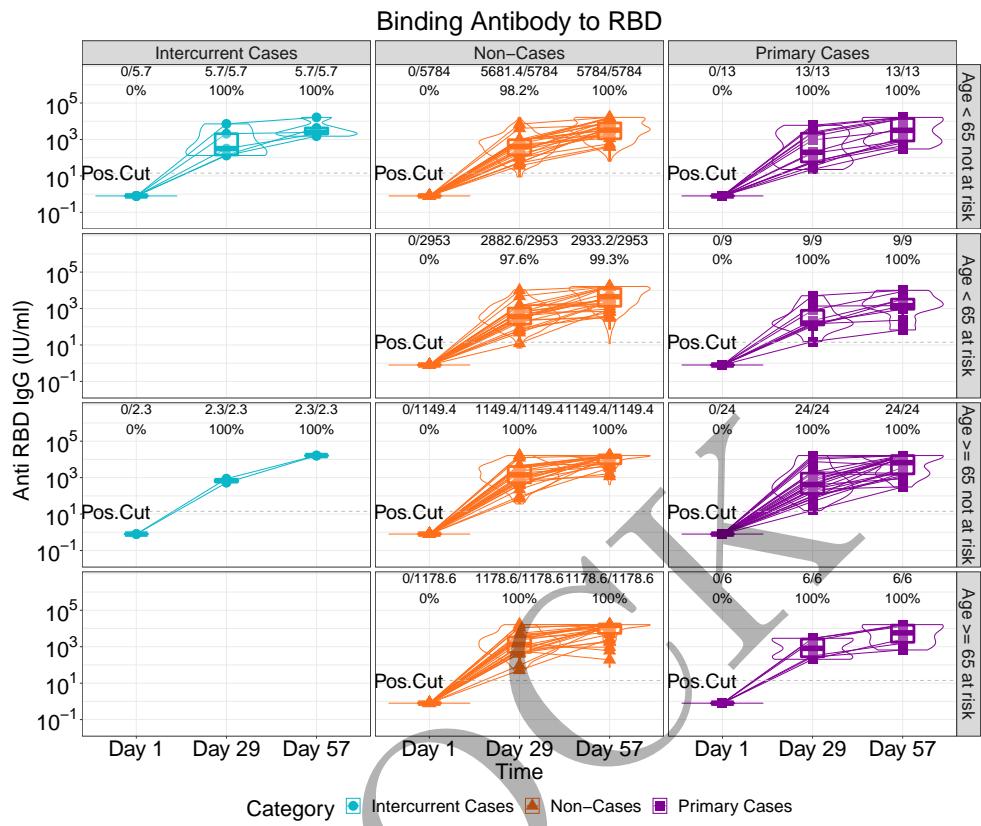


Figure 3.129: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by age and risk condition (version 2)

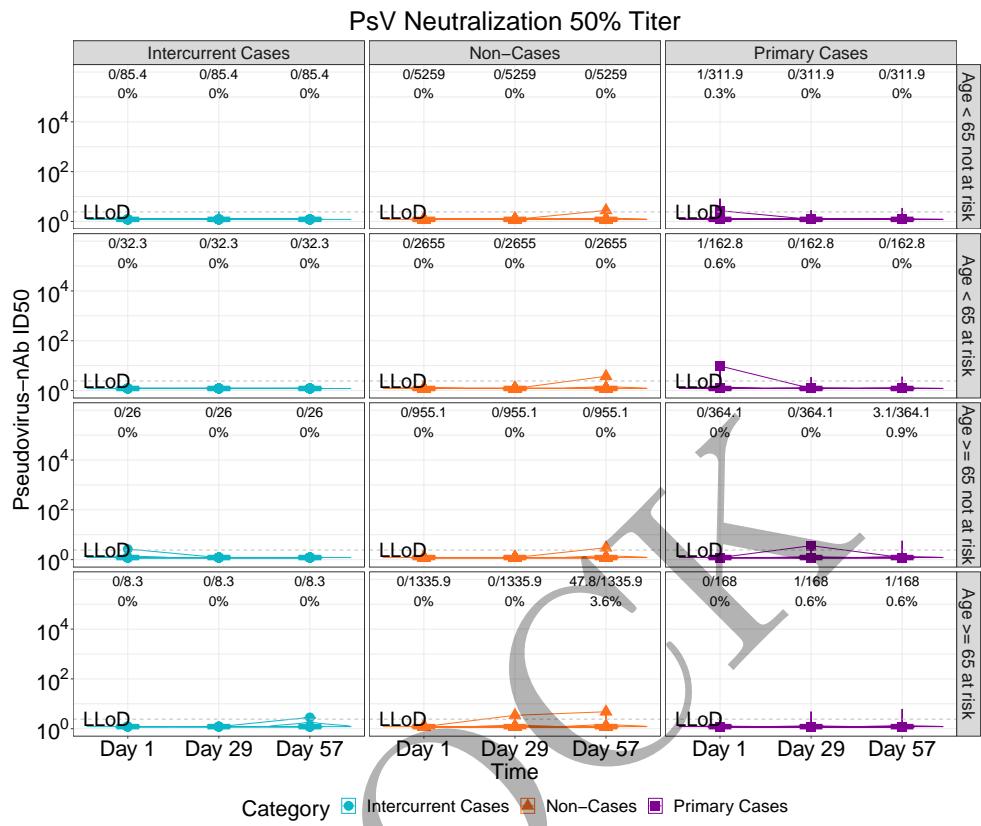


Figure 3.130: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age and risk condition (version 2)

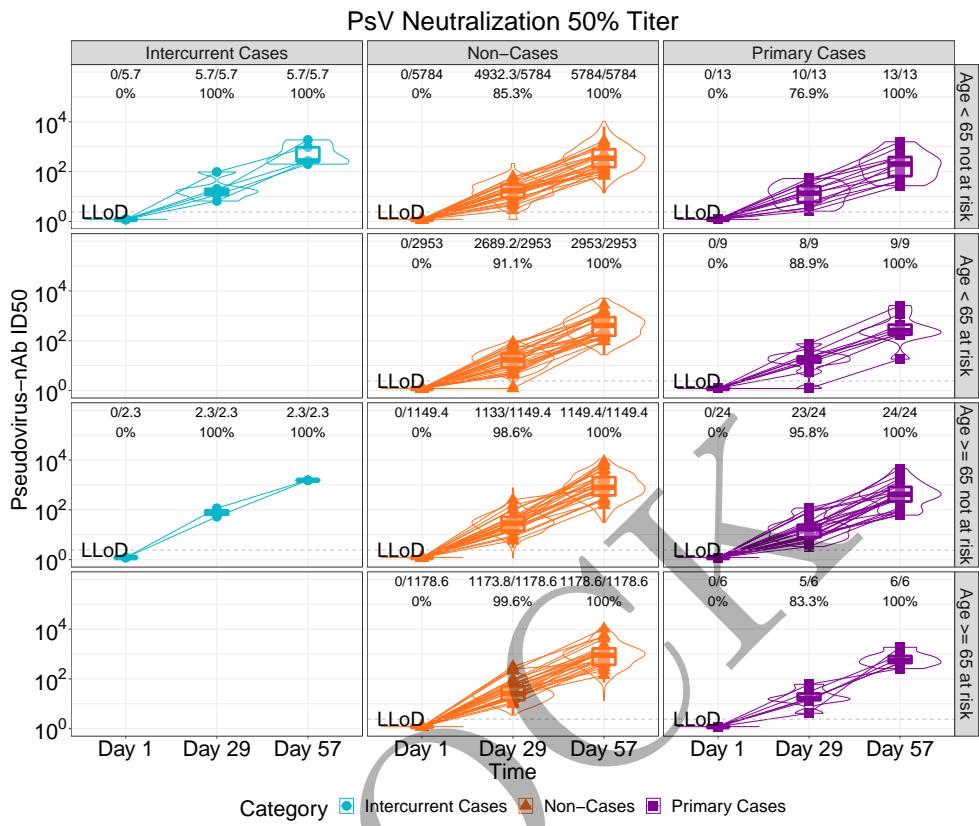


Figure 3.131: lineplots of Pseudovirus Neutralization ID₅₀: baseline negative vaccine arm by age and risk condition (version 2)

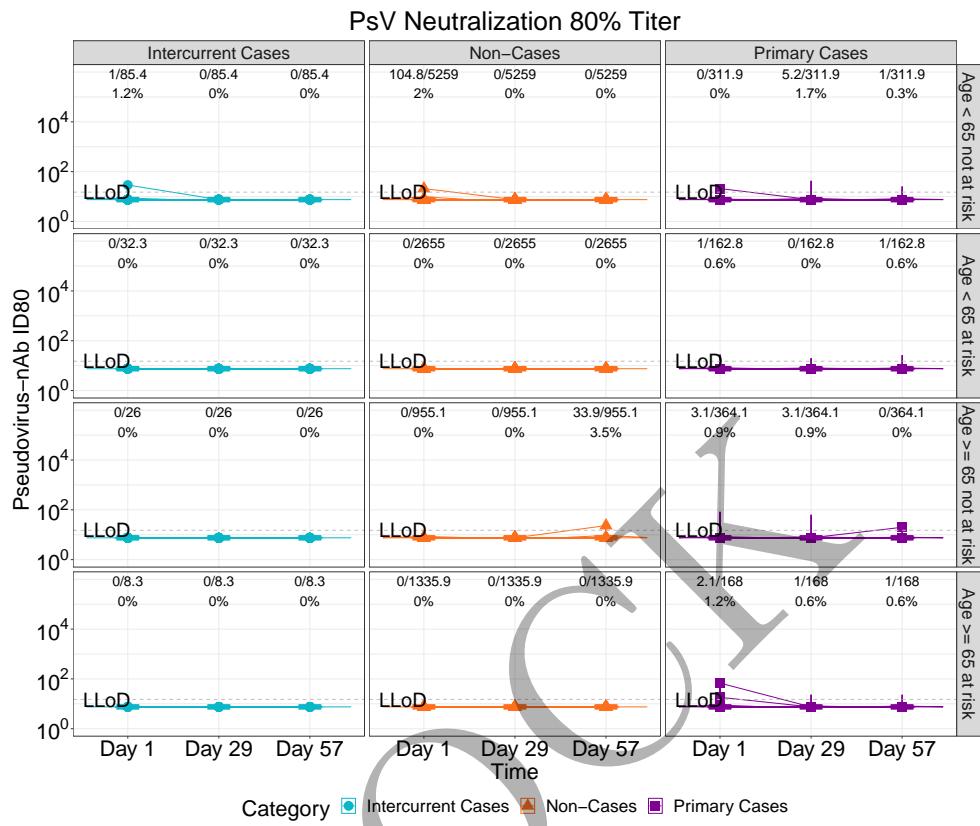


Figure 3.132: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age and risk condition (version 2)

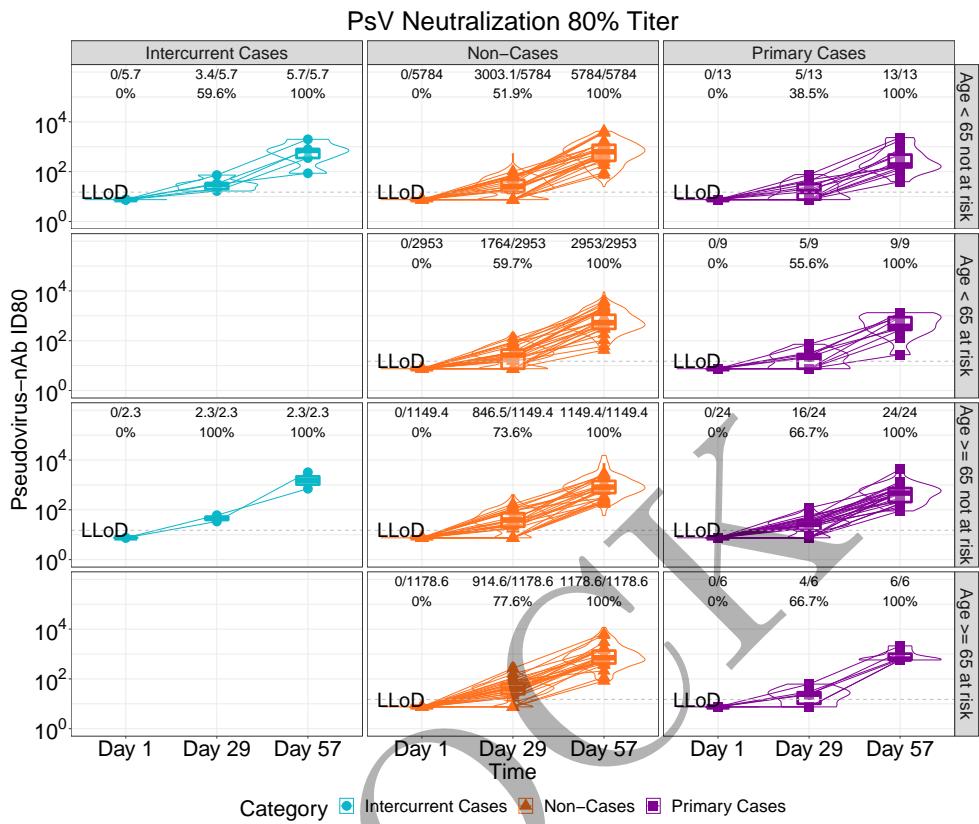


Figure 3.133: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age and risk condition (version 2)

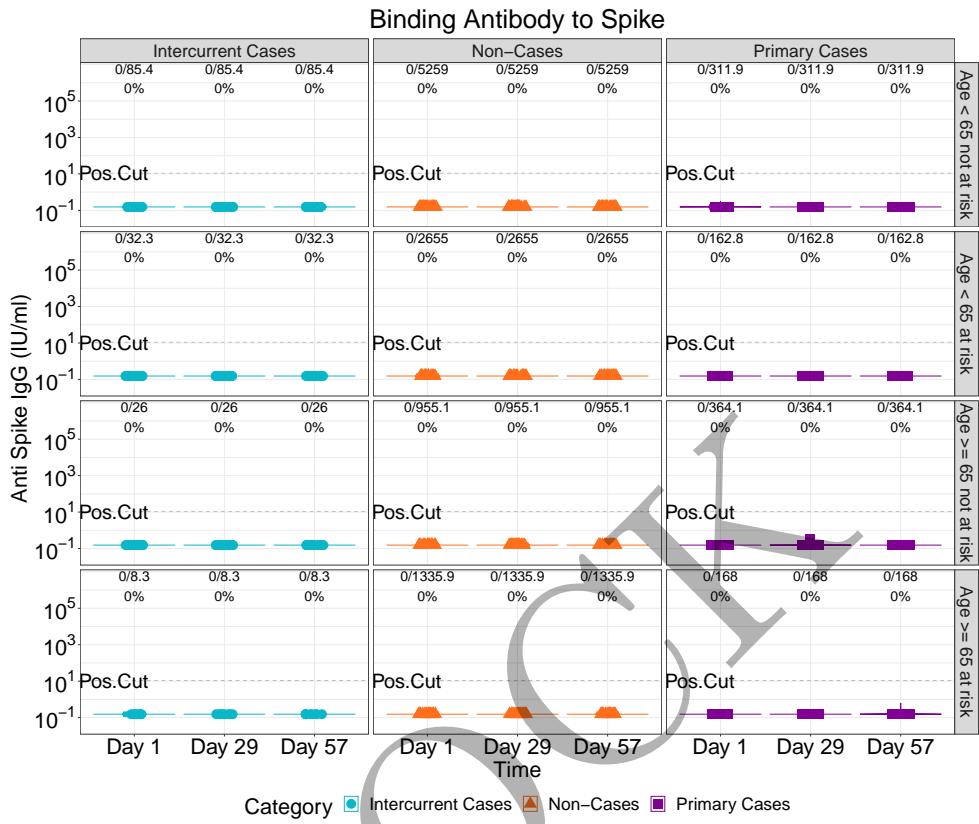


Figure 3.134: violinplots of Binding Antibody to Spike: baseline negative placebo arm by age and risk condition (version 2)

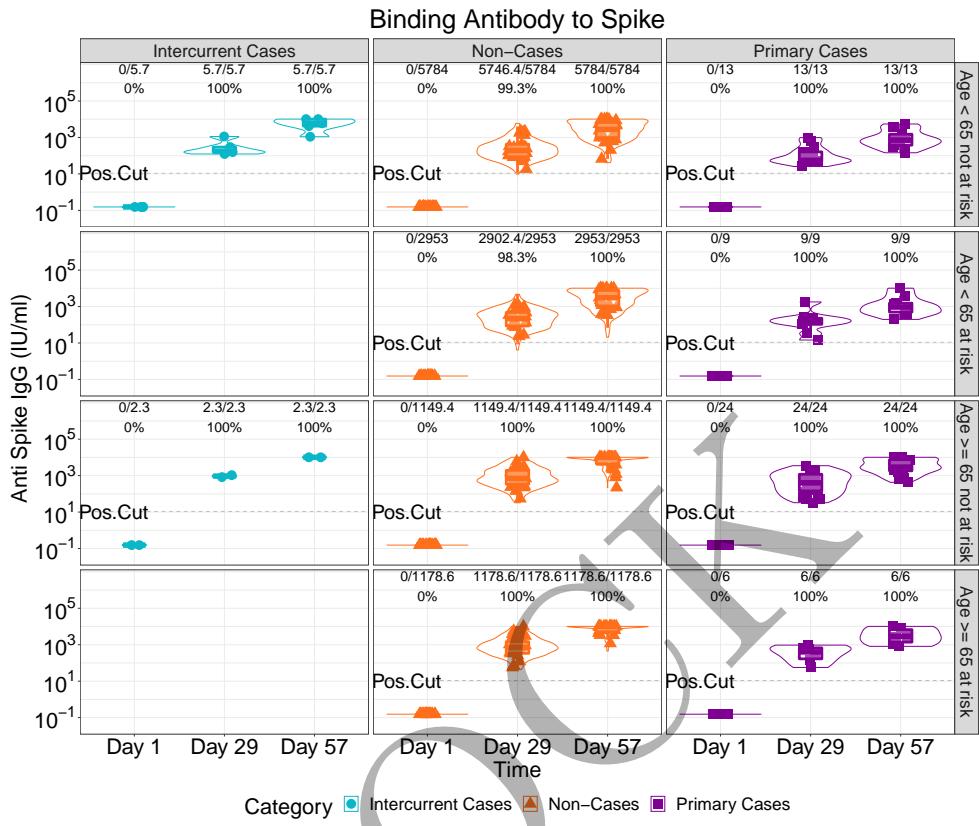


Figure 3.135: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by age and risk condition (version 2)

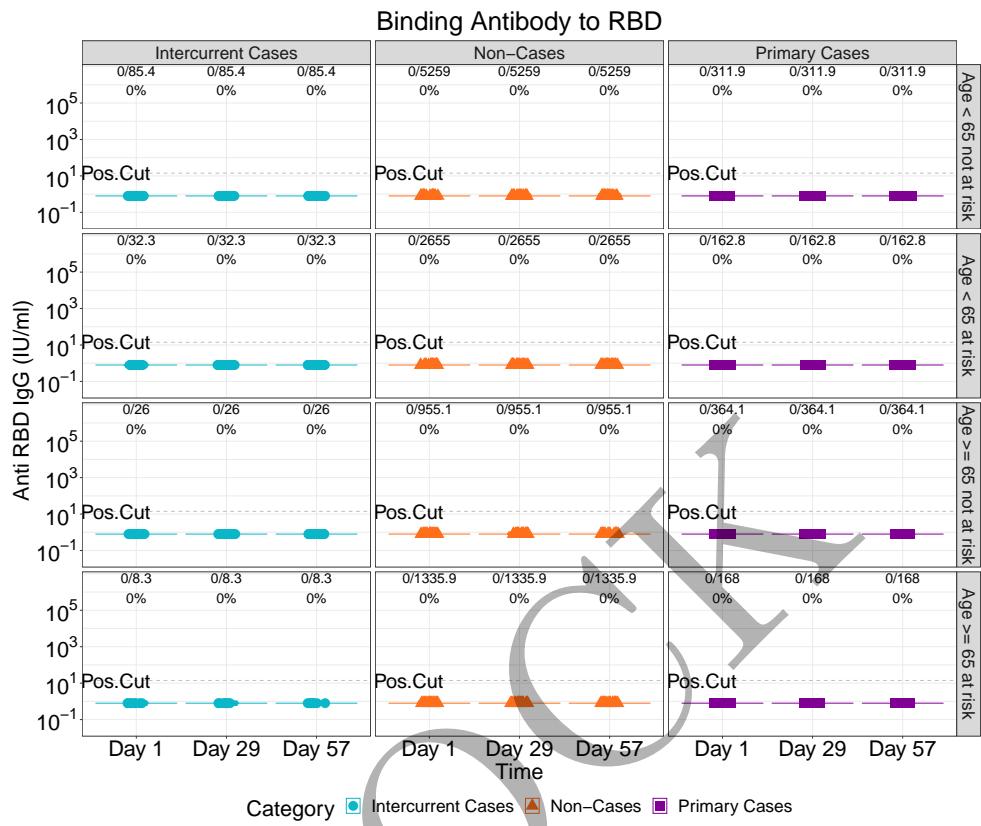


Figure 3.136: violinplots of Binding Antibody to RBD: baseline negative placebo arm by age and risk condition (version 2)

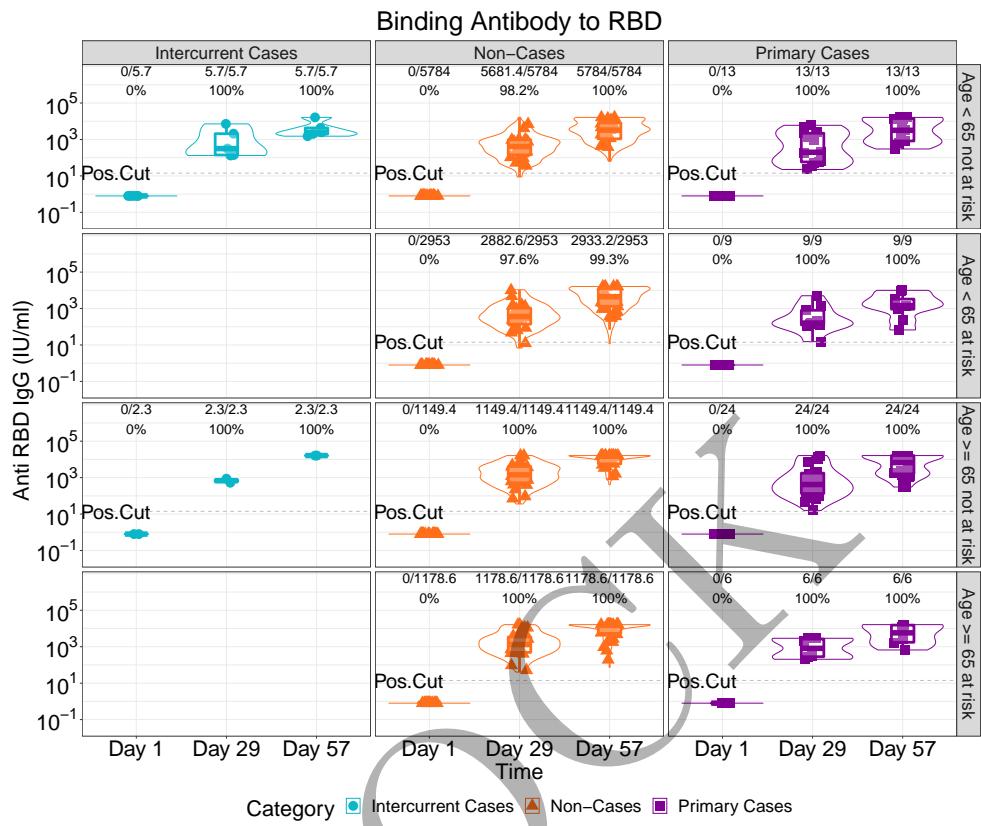


Figure 3.137: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by age and risk condition (version 2)

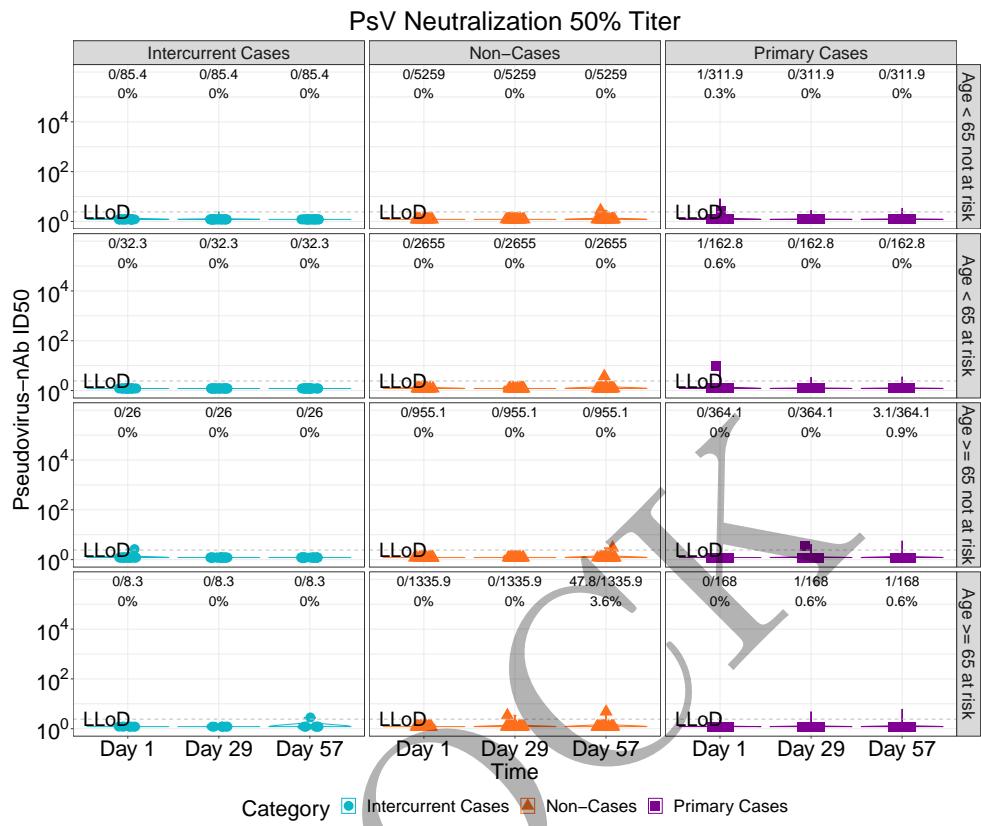


Figure 3.138: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by age and risk condition (version 2)

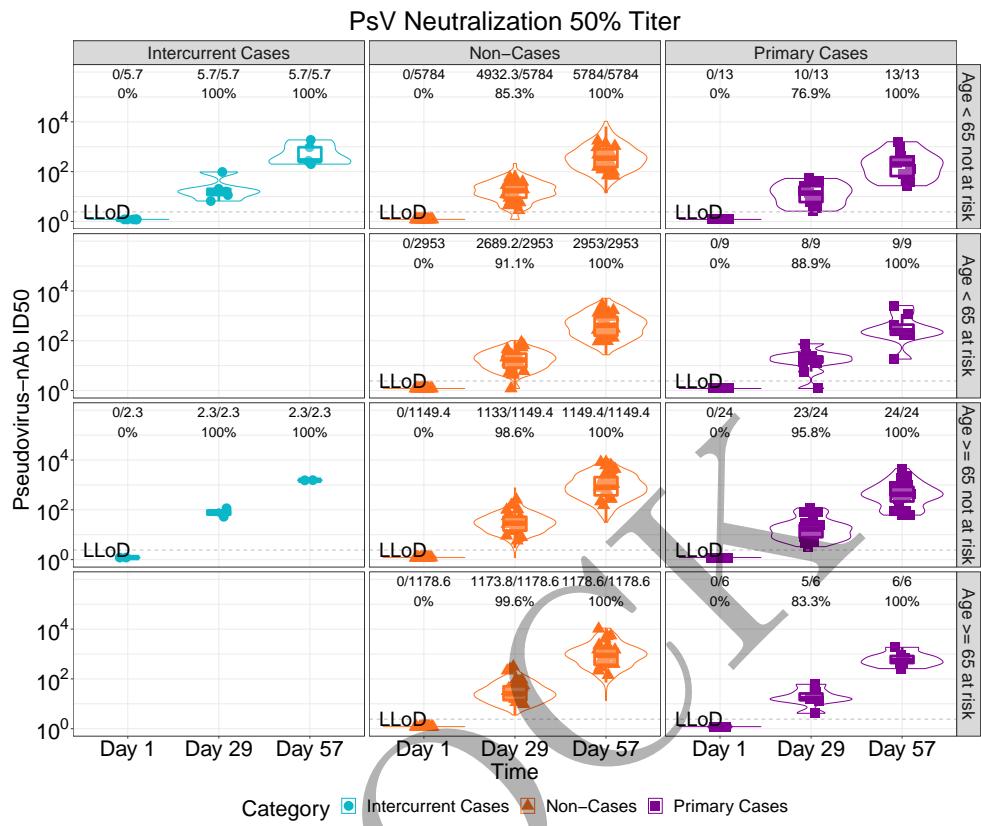


Figure 3.139: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by age and risk condition (version 2)

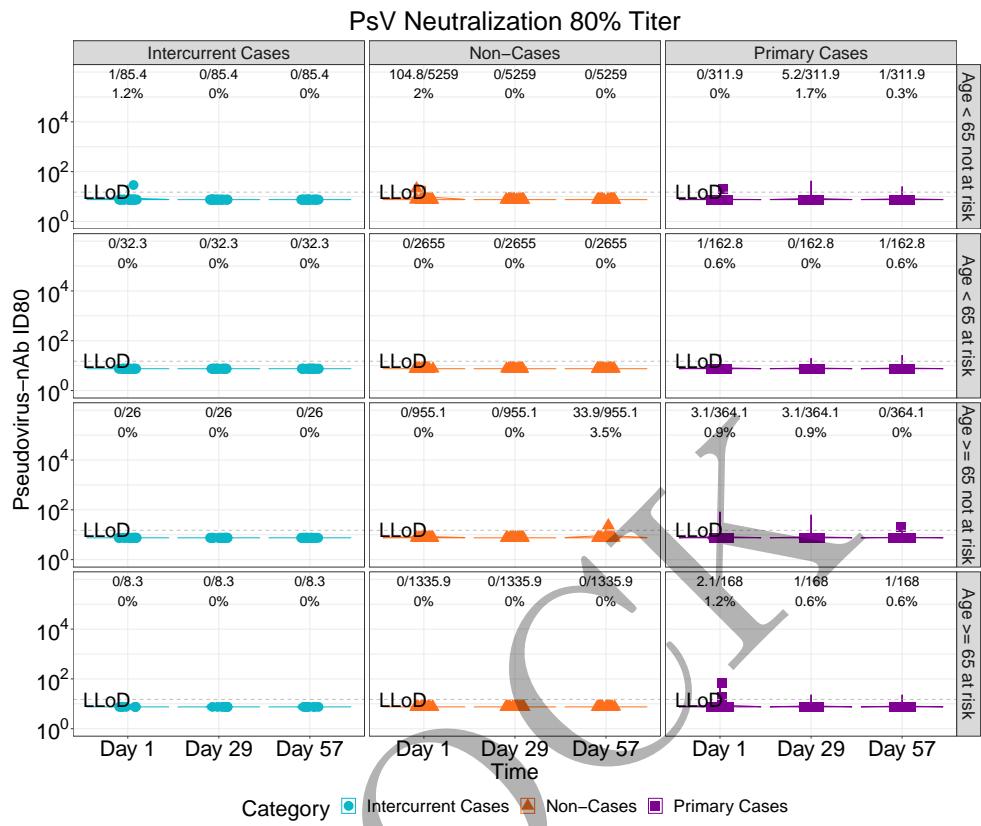


Figure 3.140: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by age and risk condition (version 2)

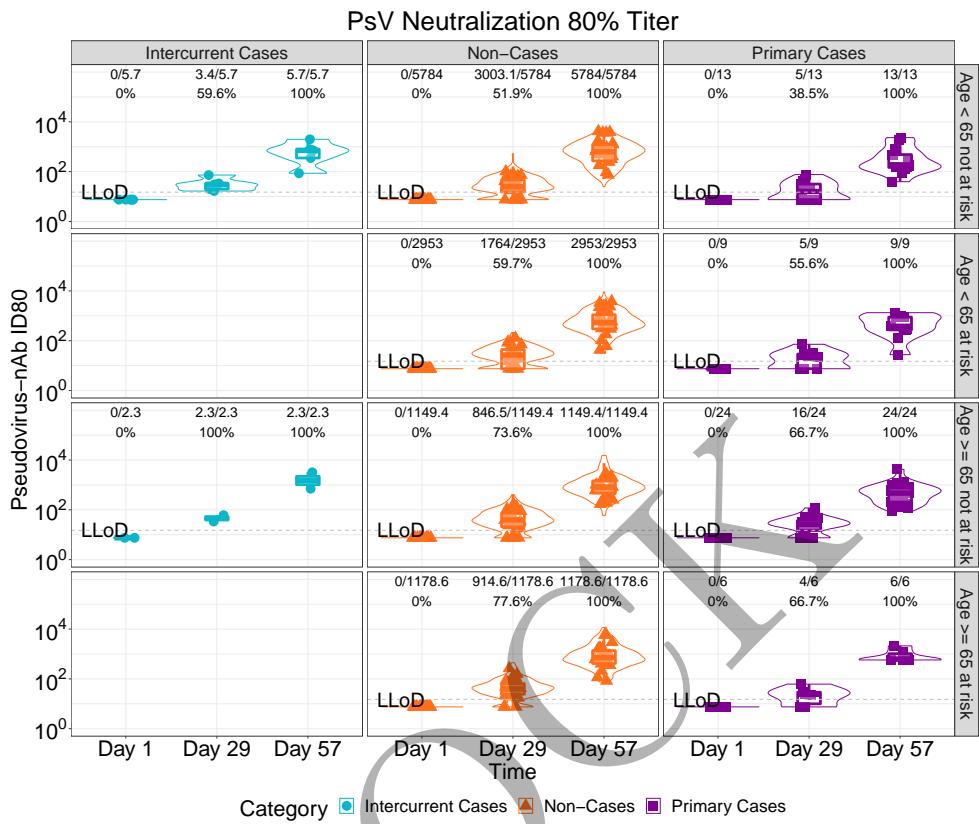


Figure 3.141: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by age and risk condition (version 2)

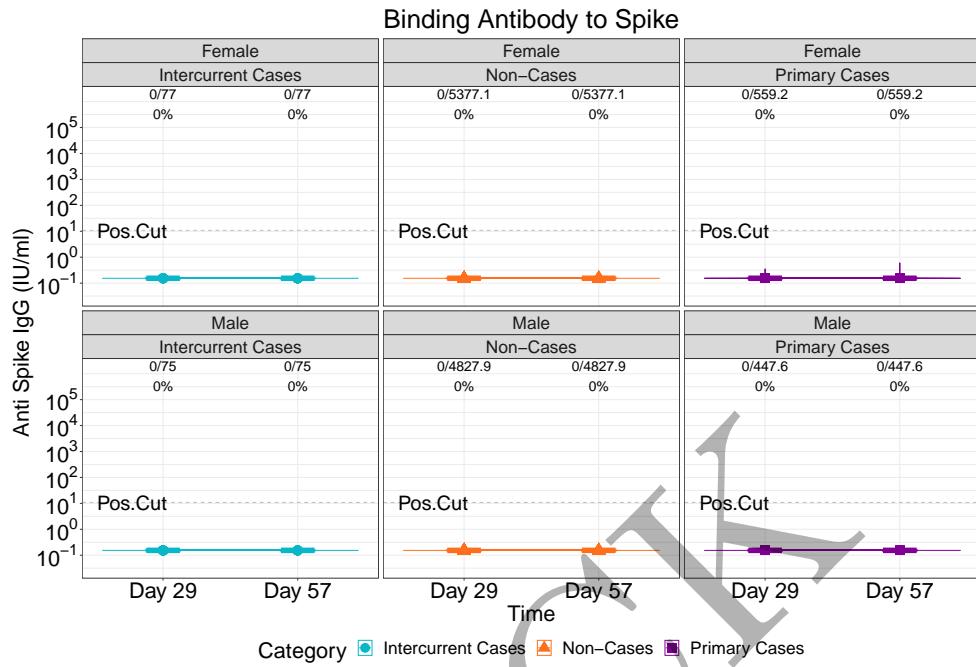


Figure 3.142: lineplots of Binding Antibody to Spike: baseline negative placebo arm by sex assigned at birth (version 1)

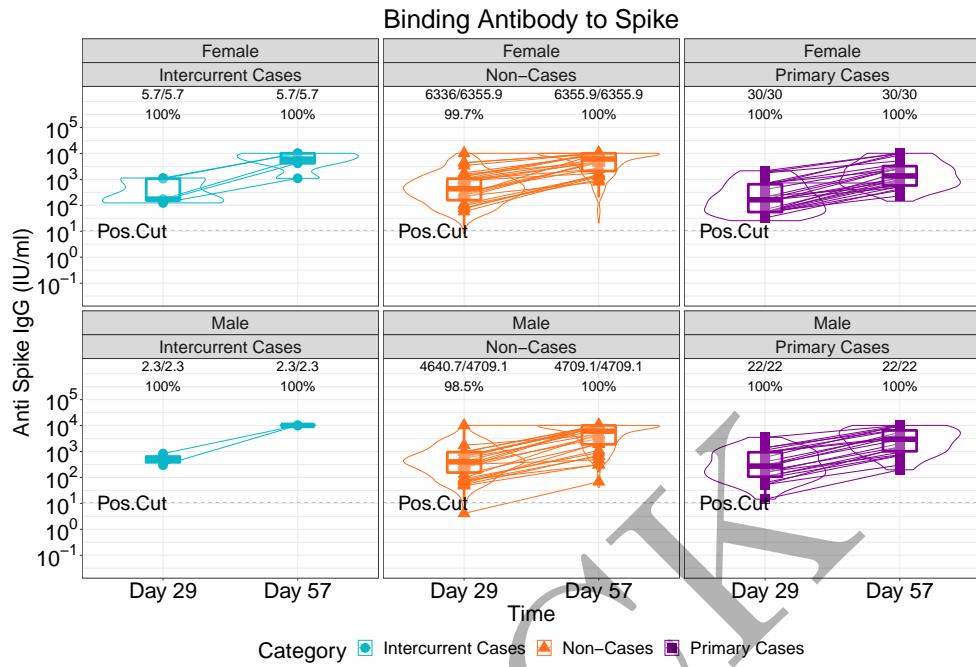


Figure 3.143: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by sex assigned at birth (version 1)

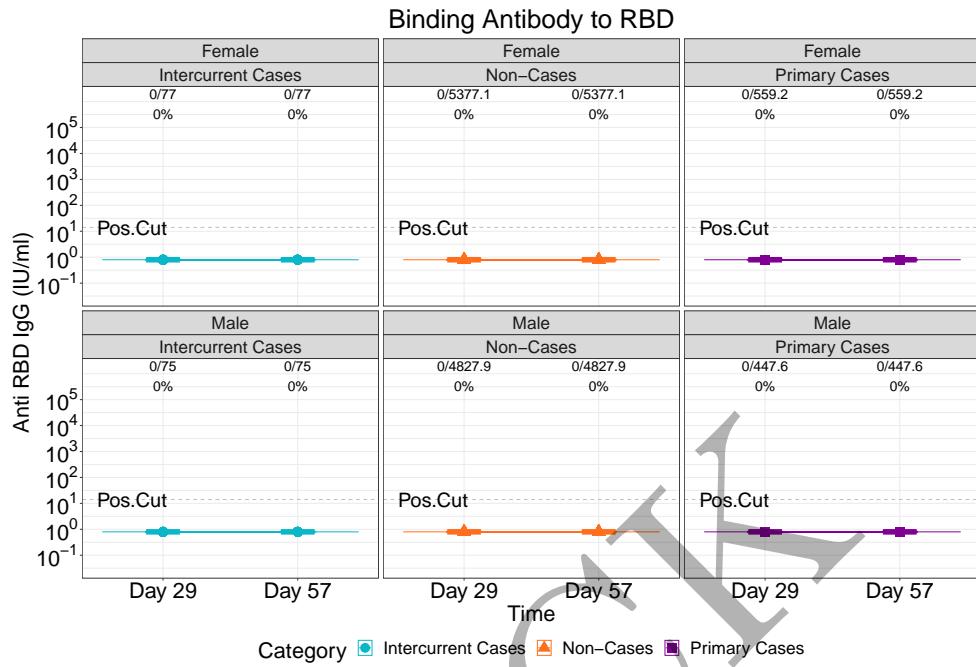


Figure 3.144: lineplots of Binding Antibody to RBD: baseline negative placebo arm by sex assigned at birth (version 1)

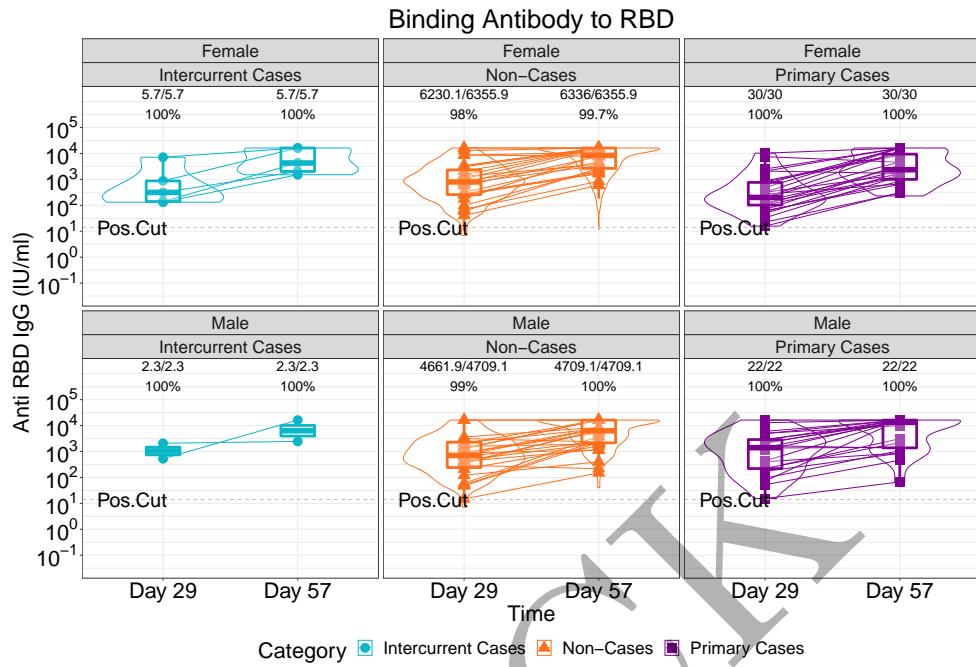


Figure 3.145: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by sex assigned at birth (version 1)

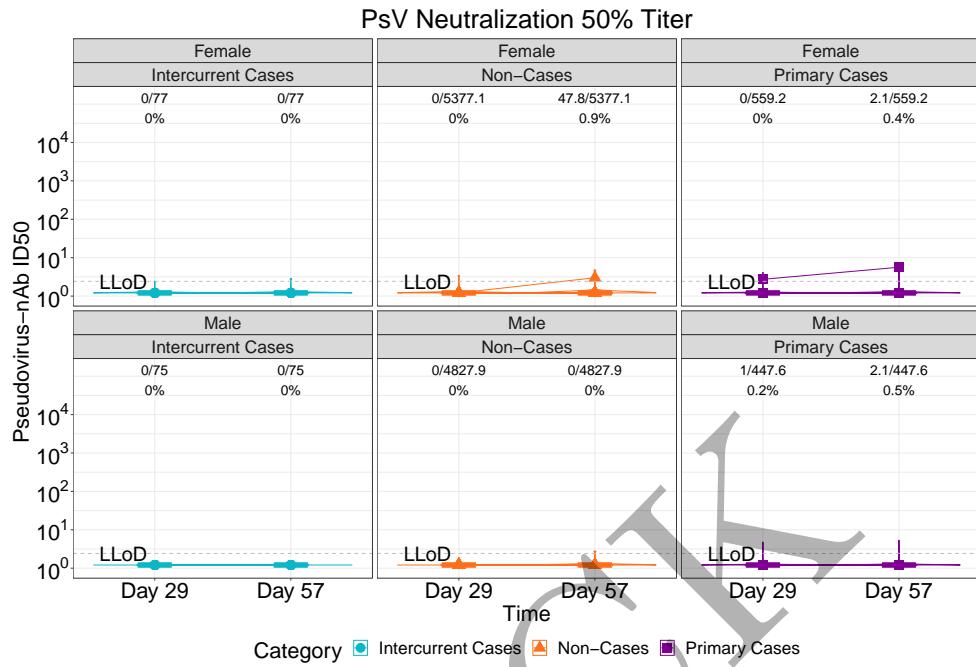


Figure 3.146: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by sex assigned at birth (version 1)

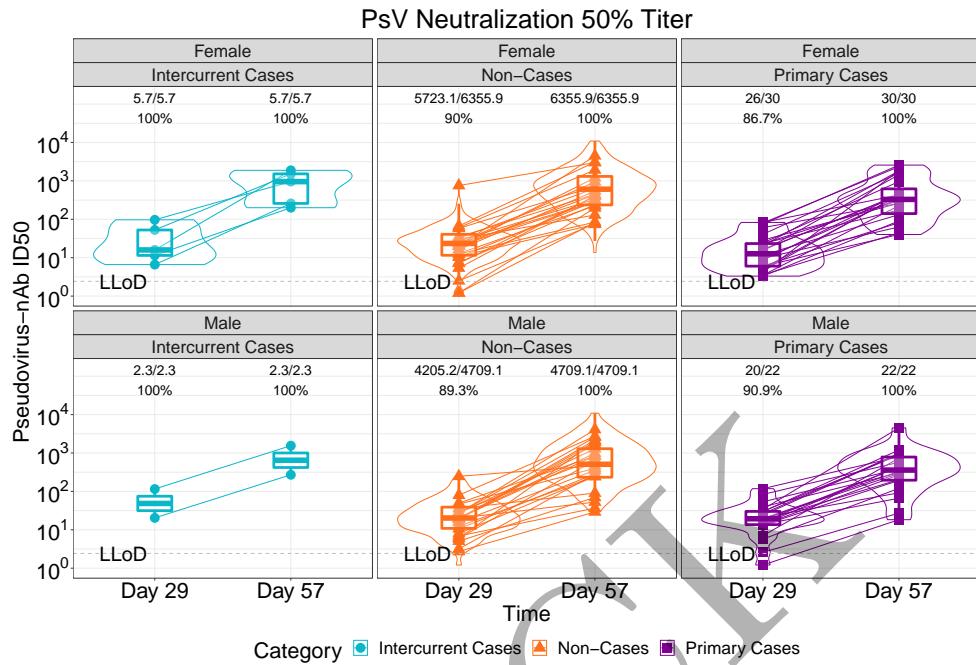


Figure 3.147: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by sex assigned at birth (version 1)

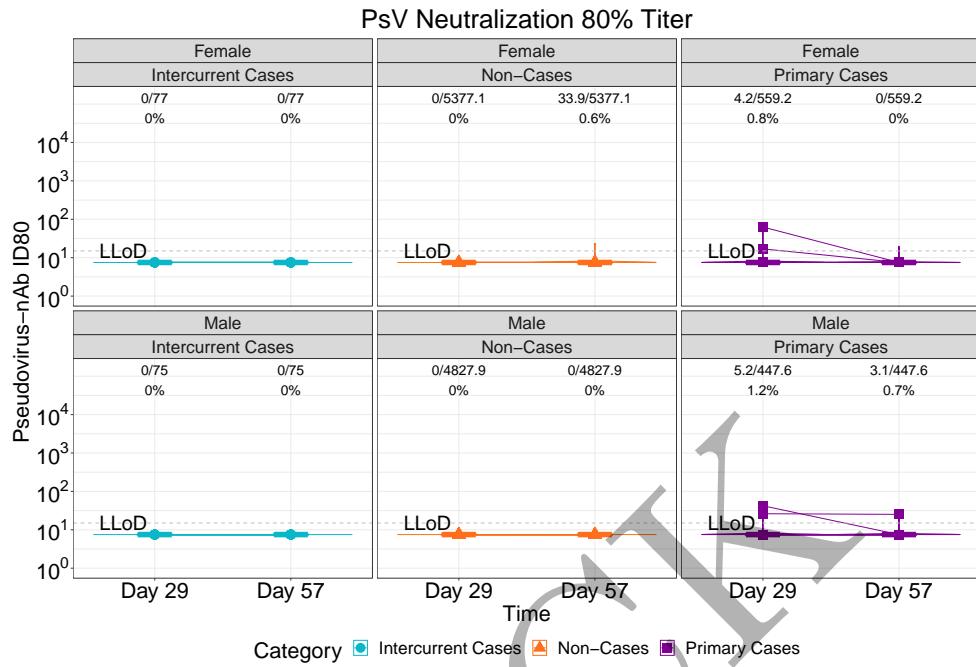


Figure 3.148: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by sex assigned at birth (version 1)

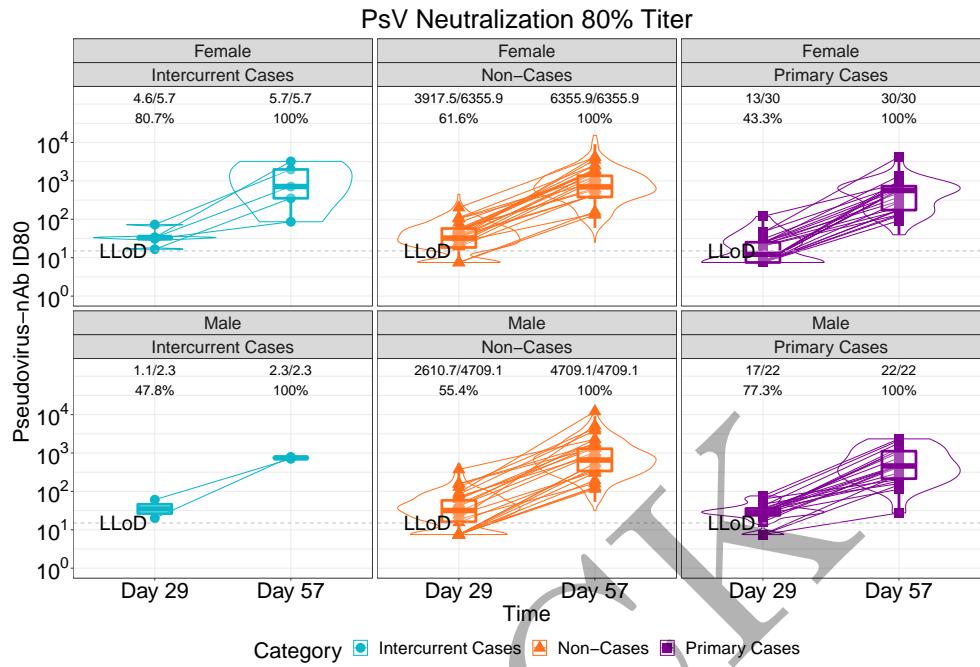


Figure 3.149: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by sex assigned at birth (version 1)

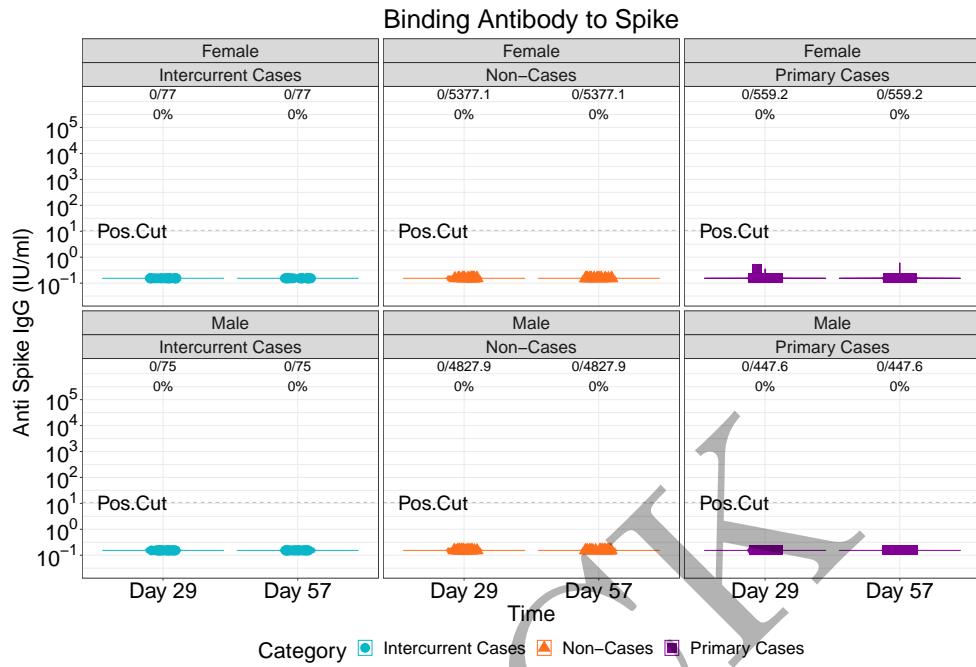


Figure 3.150: violinplots of Binding Antibody to Spike: baseline negative placebo arm by sex assigned at birth (version 1)

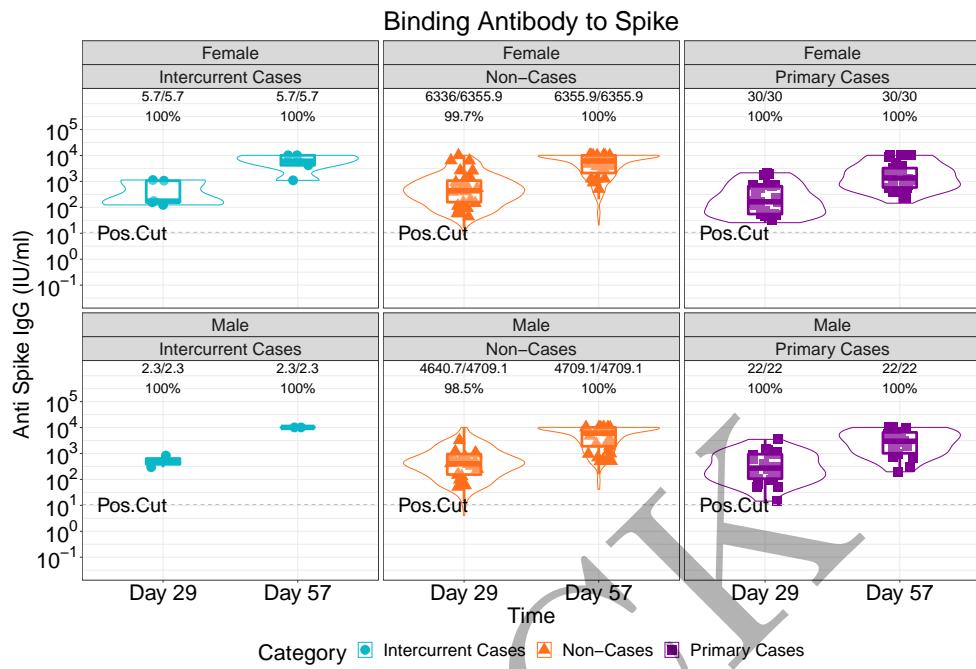


Figure 3.151: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by sex assigned at birth (version 1)

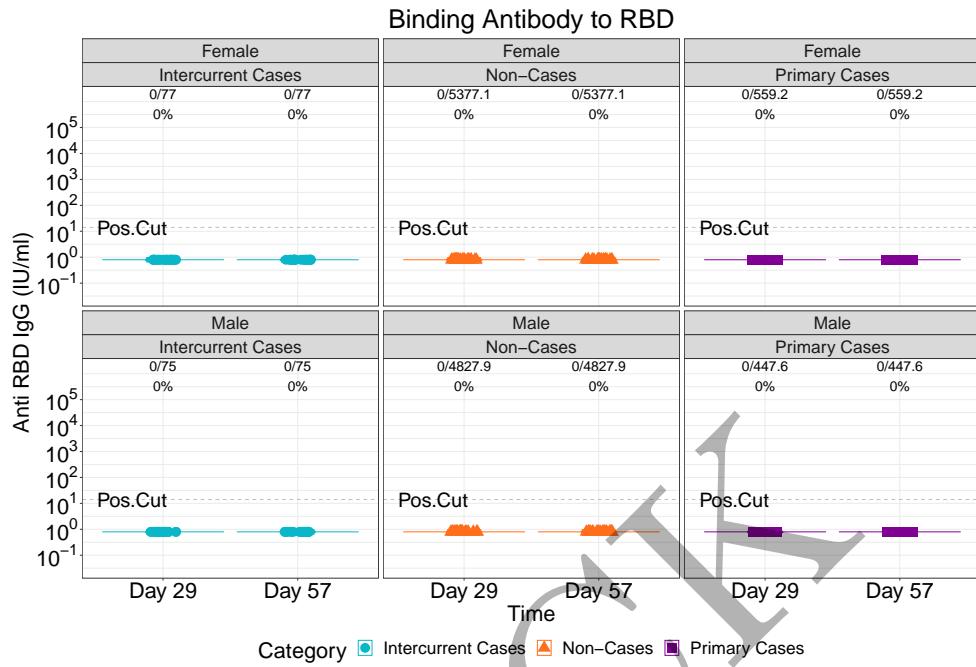


Figure 3.152: violinplots of Binding Antibody to RBD: baseline negative placebo arm by sex assigned at birth (version 1)

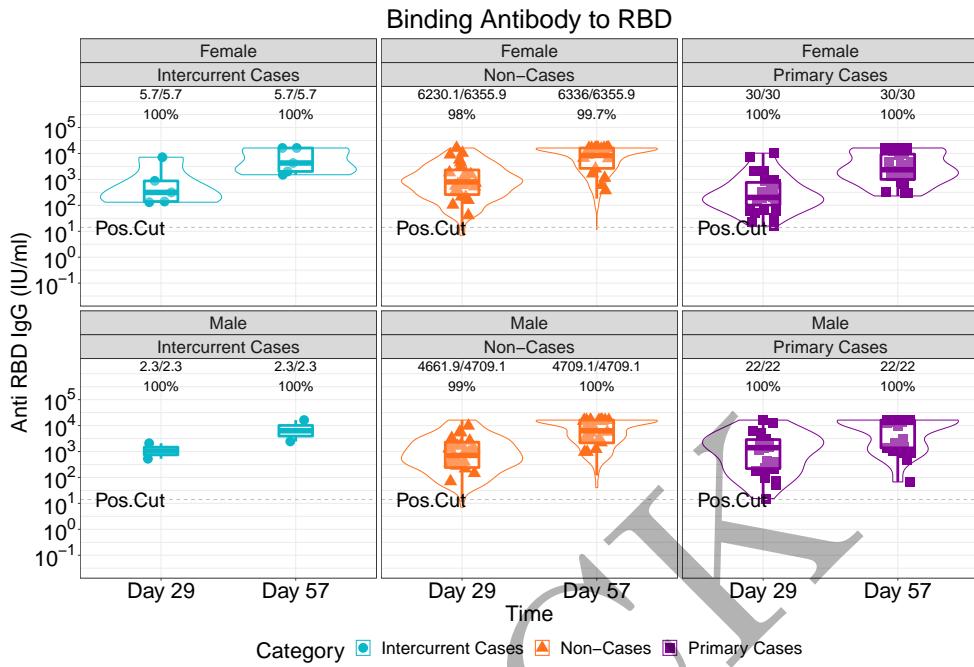


Figure 3.153: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by sex assigned at birth (version 1)

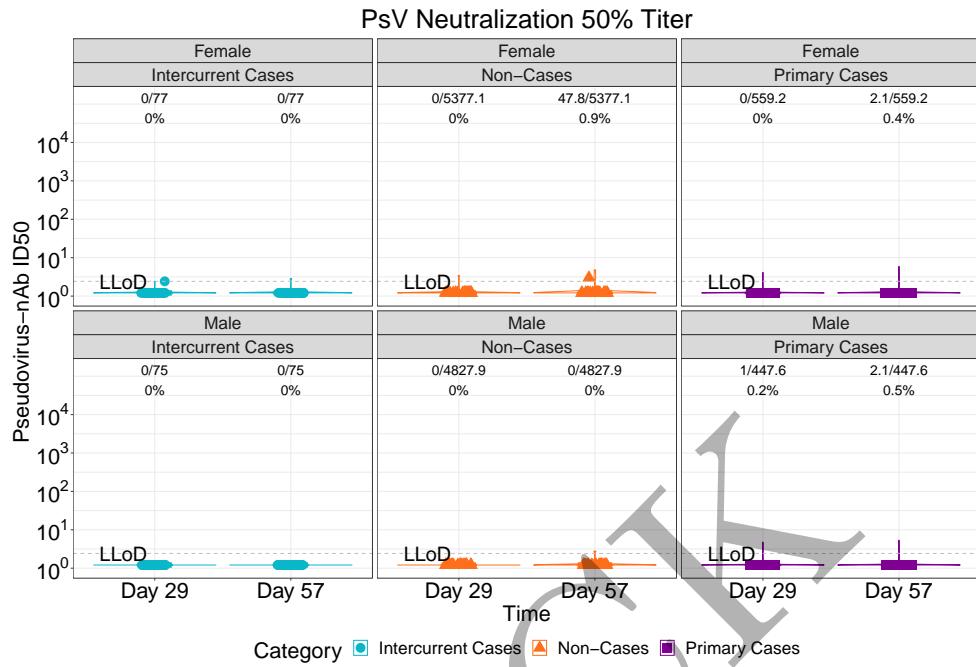


Figure 3.154: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by sex assigned at birth (version 1)

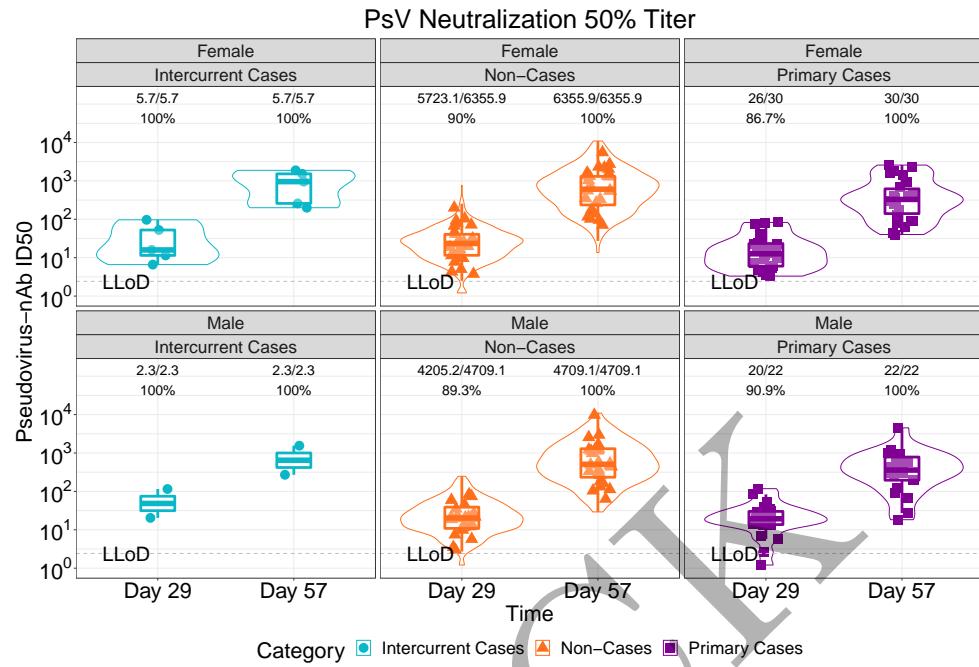


Figure 3.155: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by sex assigned at birth (version 1)

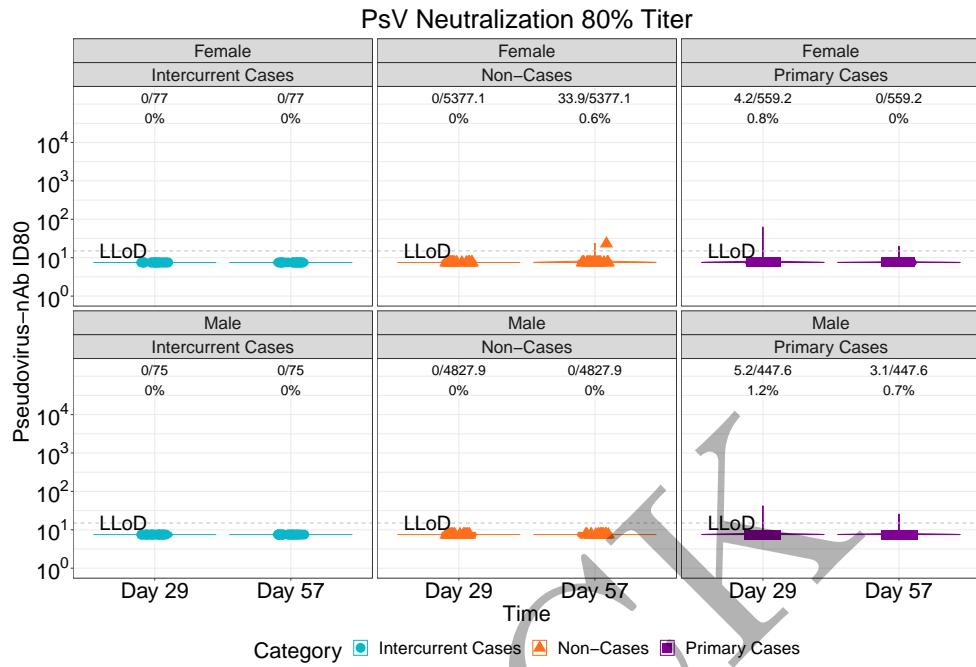


Figure 3.156: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by sex assigned at birth (version 1)

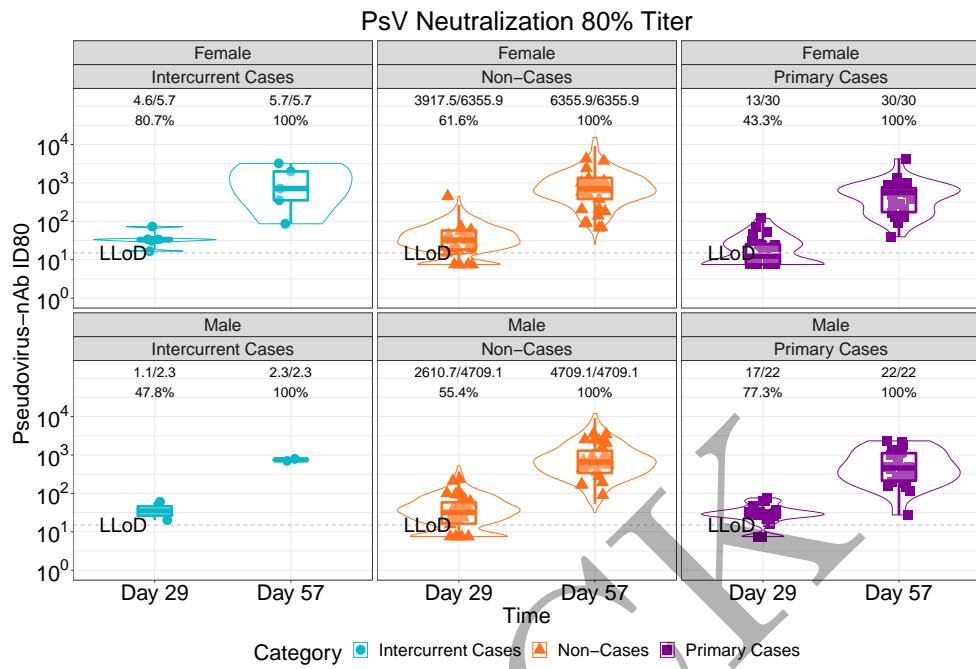


Figure 3.157: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by sex assigned at birth (version 1)

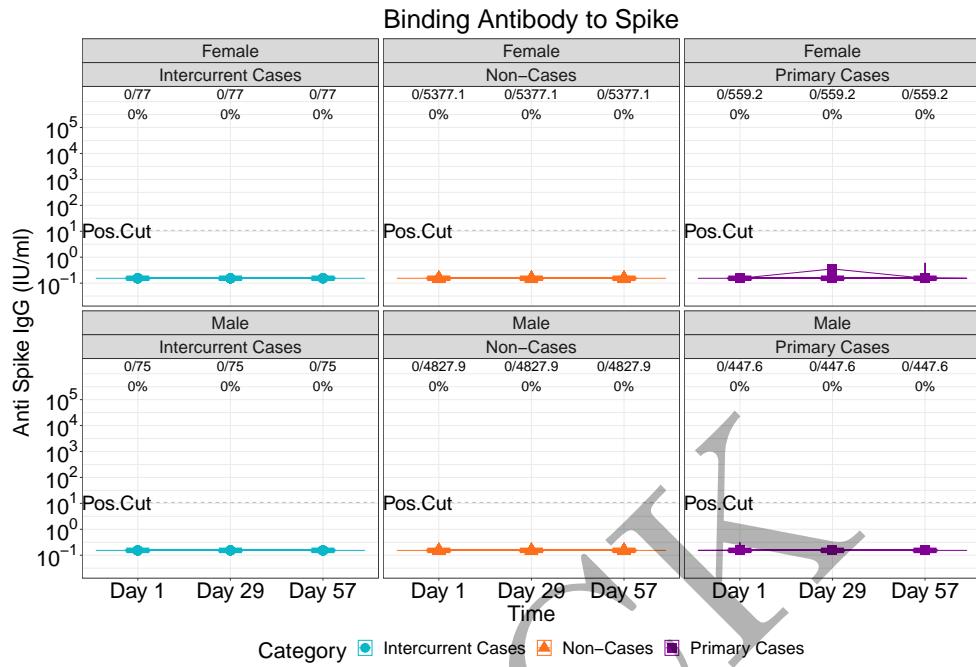


Figure 3.158: lineplots of Binding Antibody to Spike: baseline negative placebo arm by sex assigned at birth (version 2)

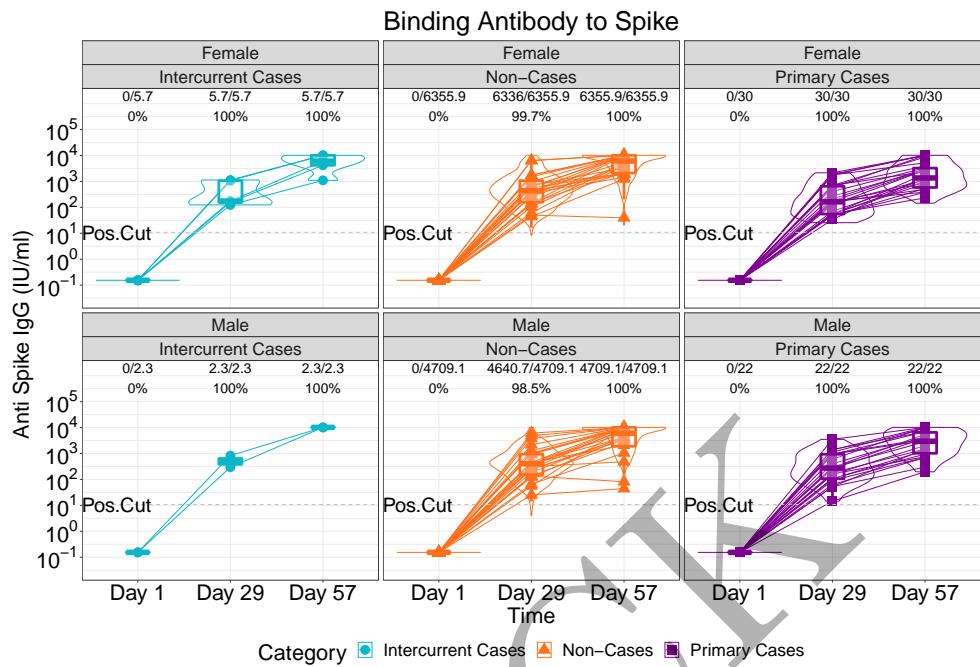


Figure 3.159: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by sex assigned at birth (version 2)

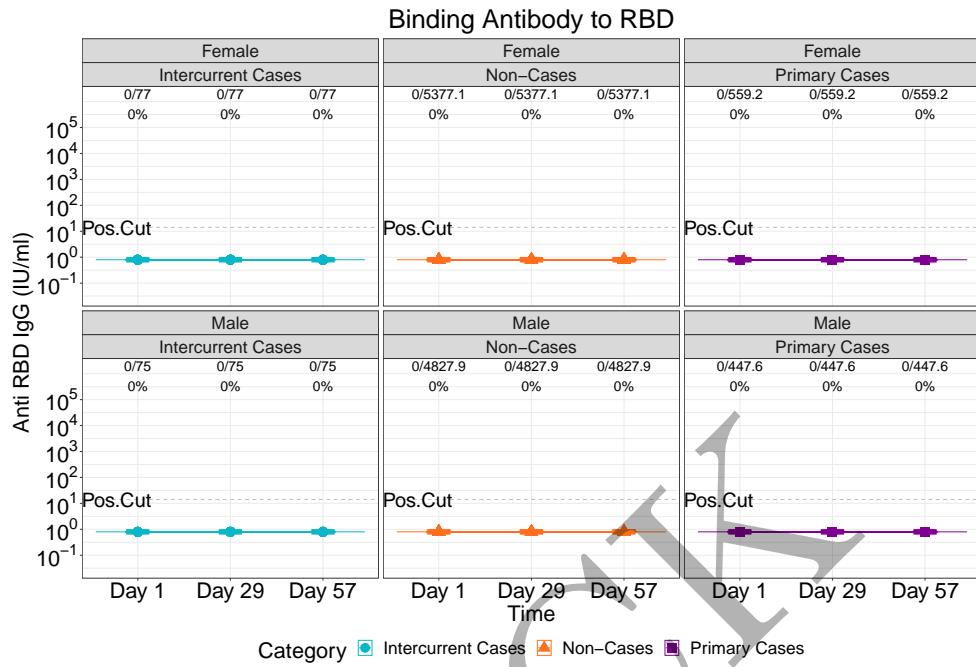


Figure 3.160: lineplots of Binding Antibody to RBD: baseline negative placebo arm by sex assigned at birth (version 2)

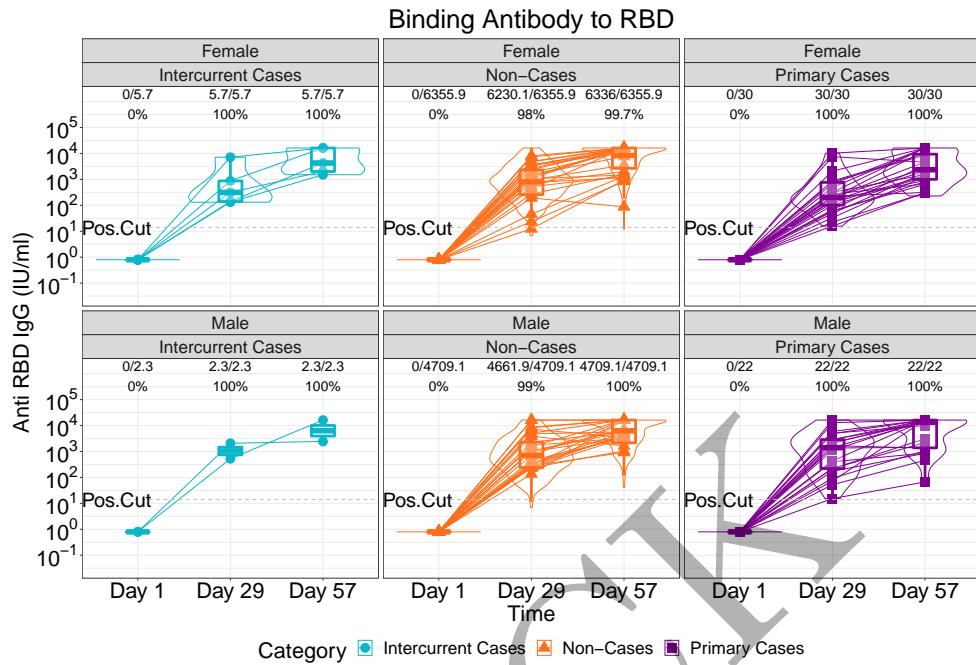


Figure 3.161: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by sex assigned at birth (version 2)

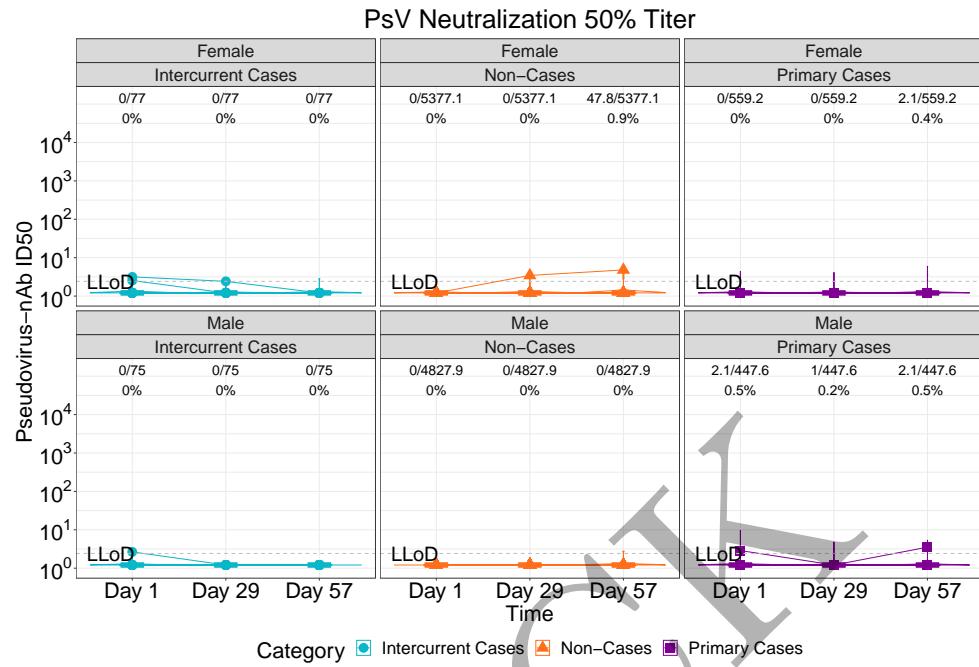


Figure 3.162: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by sex assigned at birth (version 2)

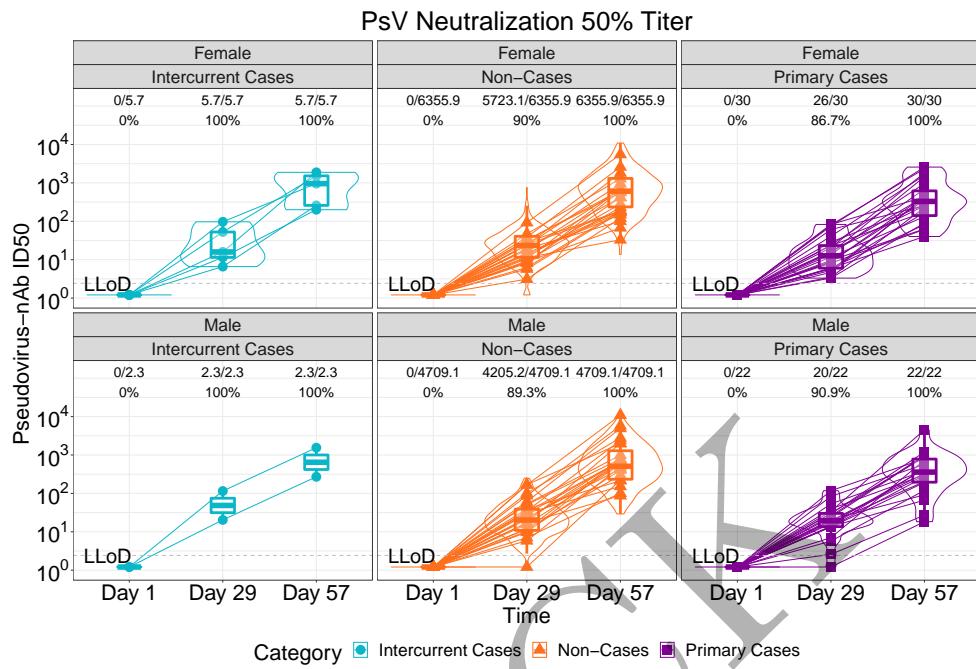


Figure 3.163: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by sex assigned at birth (version 2)

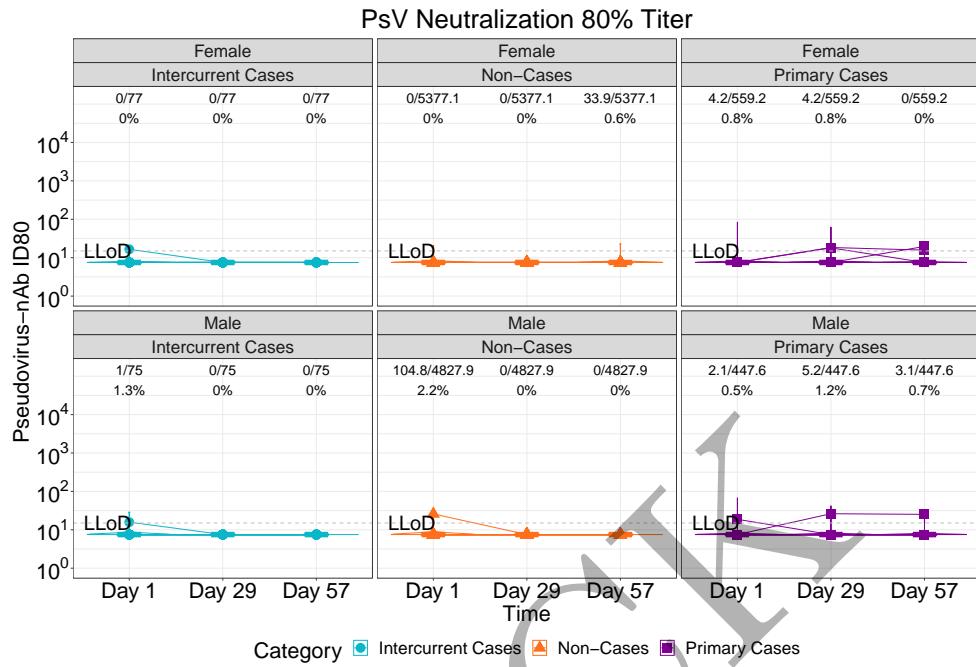


Figure 3.164: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by sex assigned at birth (version 2)

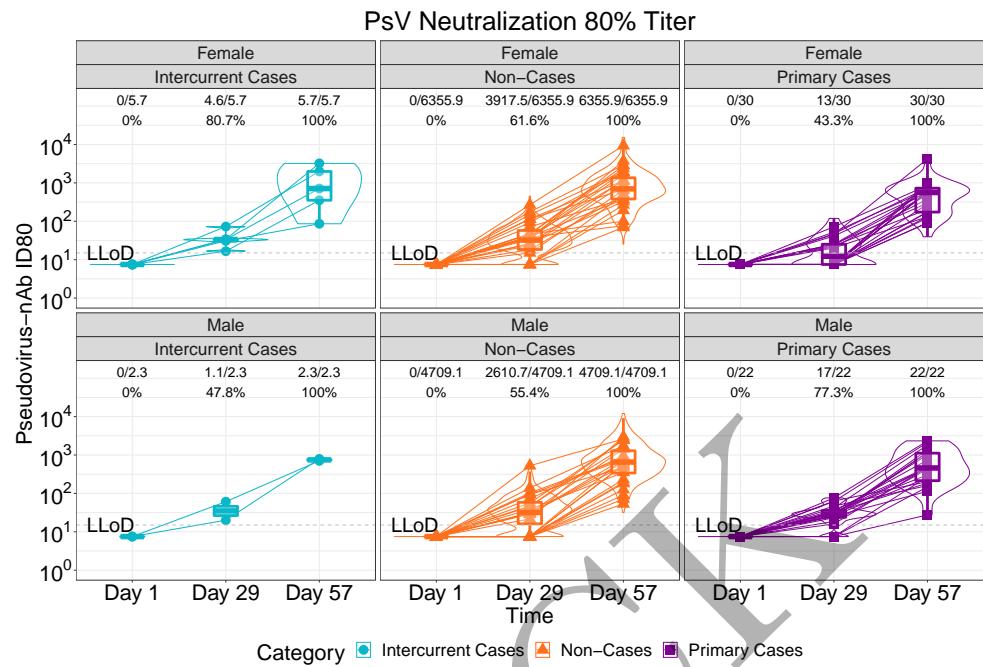


Figure 3.165: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by sex assigned at birth (version 2)

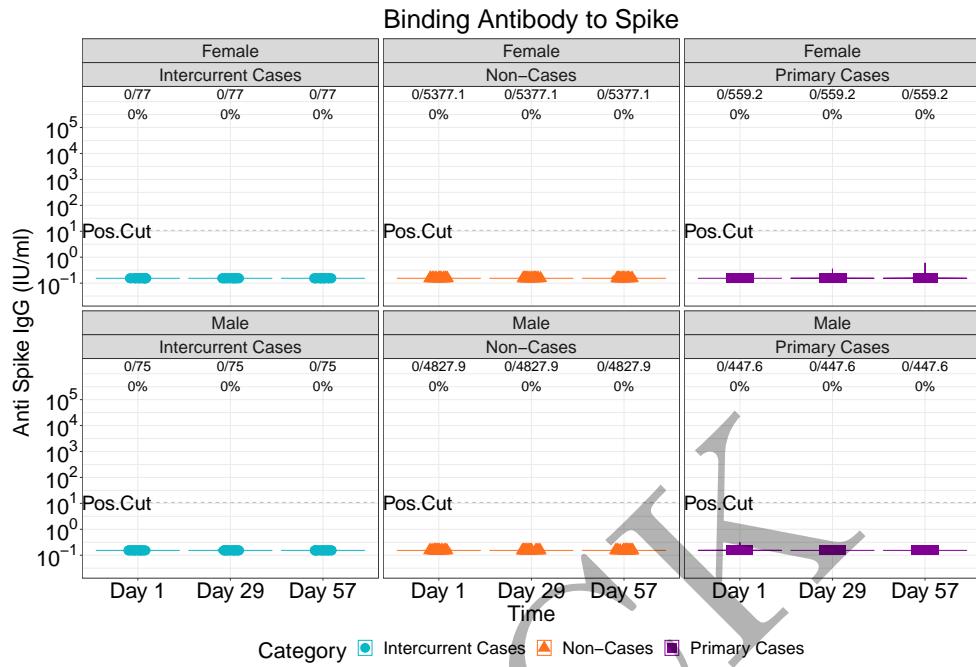


Figure 3.166: violinplots of Binding Antibody to Spike: baseline negative placebo arm by sex assigned at birth (version 2)

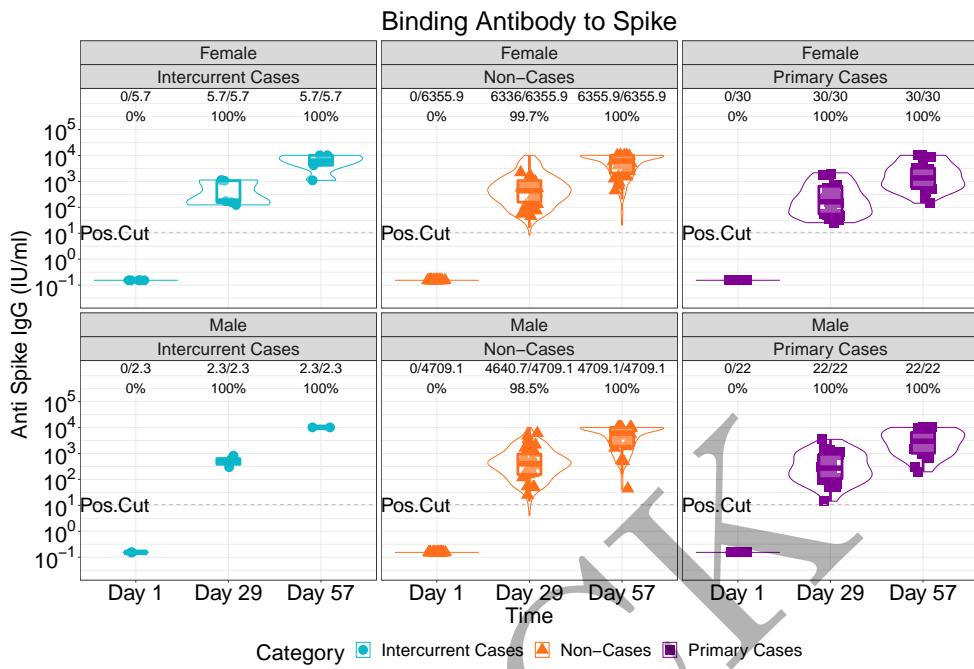


Figure 3.167: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by sex assigned at birth (version 2)

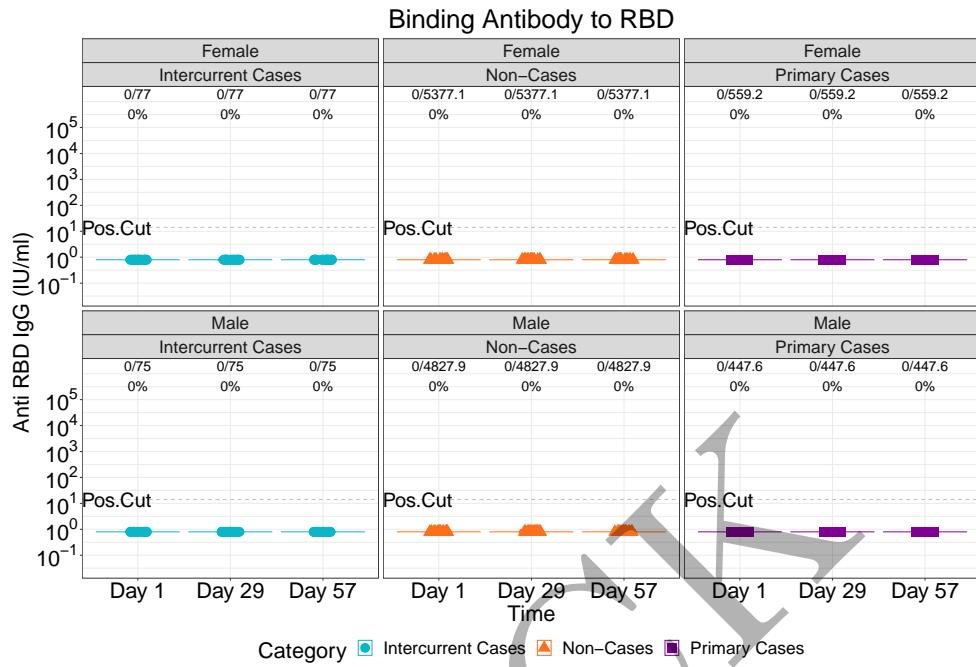


Figure 3.168: violinplots of Binding Antibody to RBD: baseline negative placebo arm by sex assigned at birth (version 2)

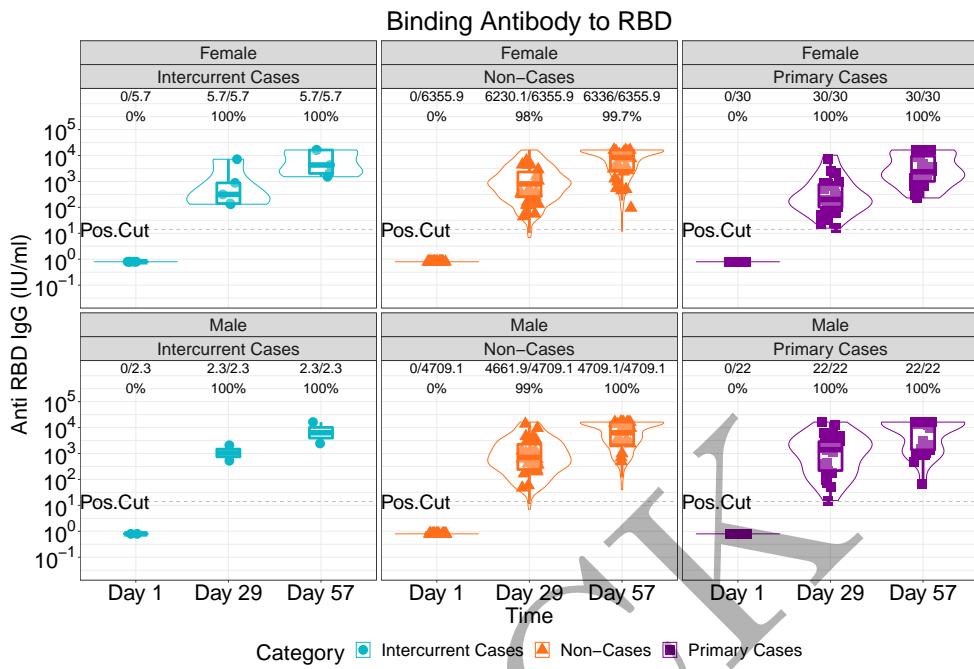


Figure 3.169: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by sex assigned at birth (version 2)

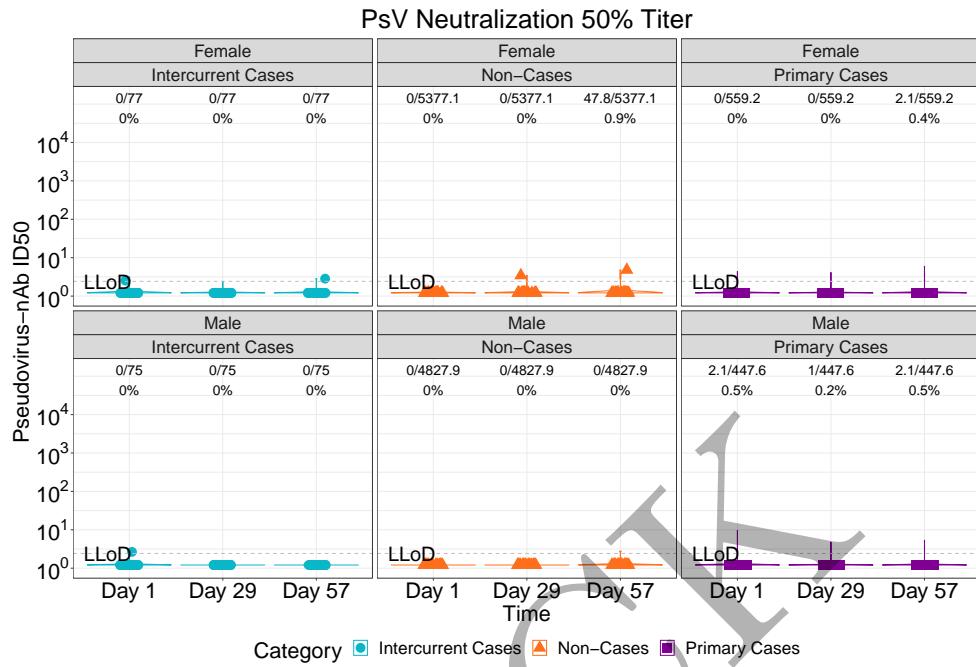


Figure 3.170: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by sex assigned at birth (version 2)

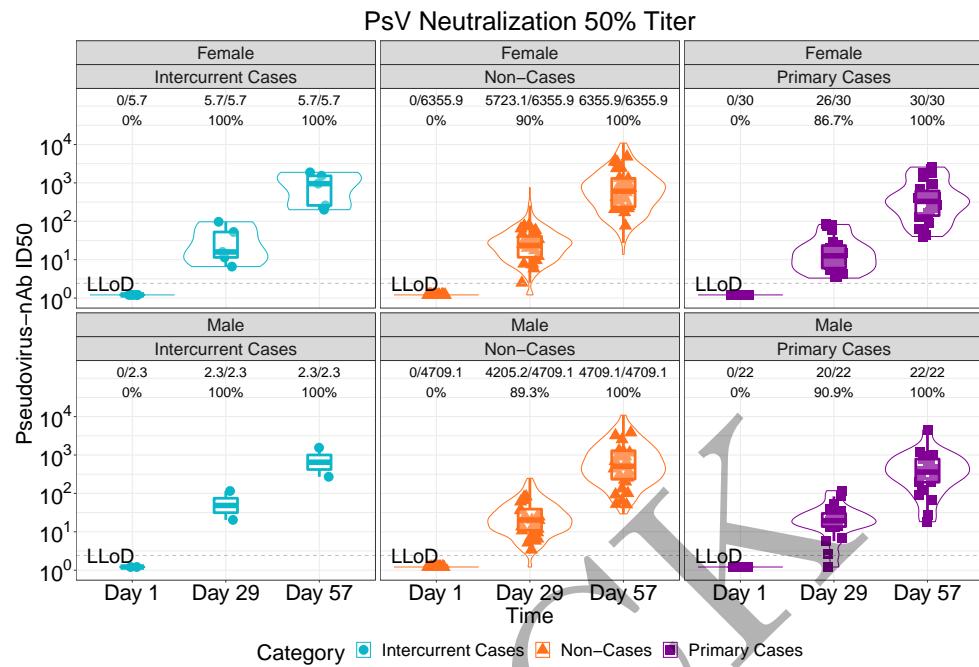


Figure 3.171: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by sex assigned at birth (version 2)

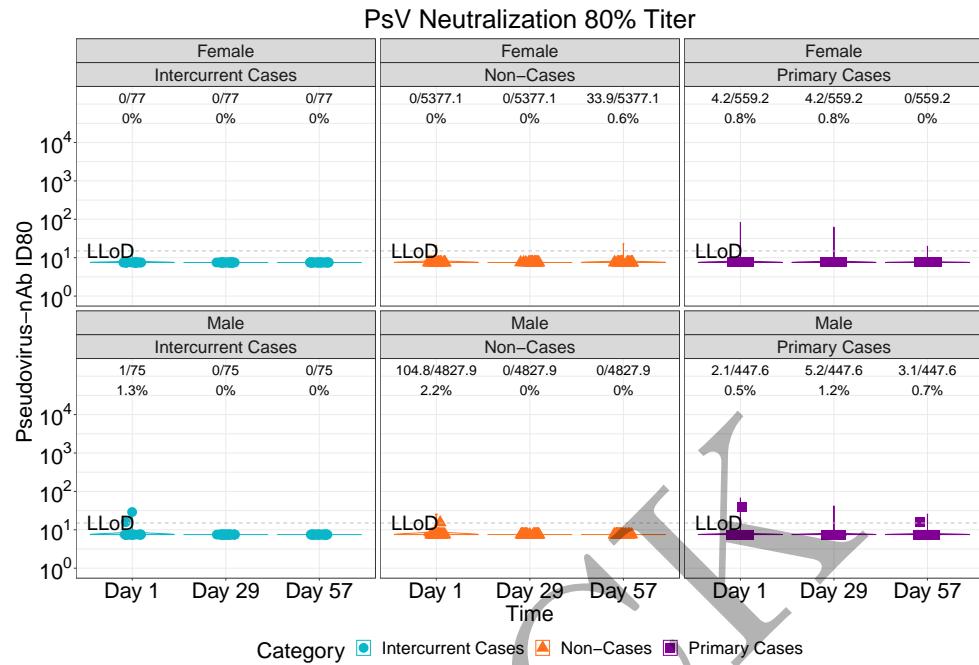


Figure 3.172: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by sex assigned at birth (version 2)

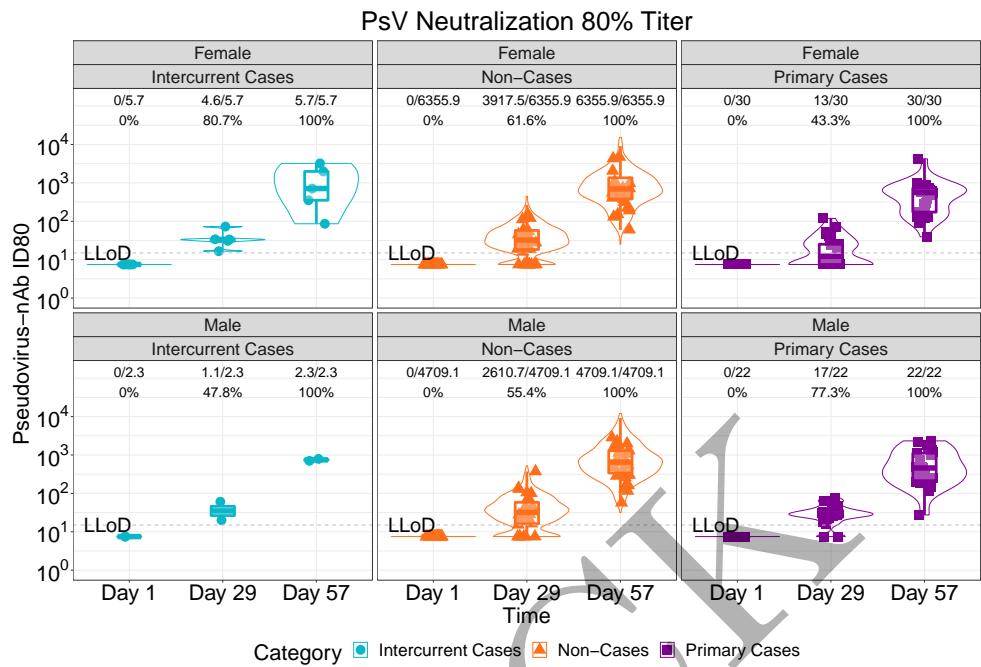


Figure 3.173: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by sex assigned at birth (version 2)

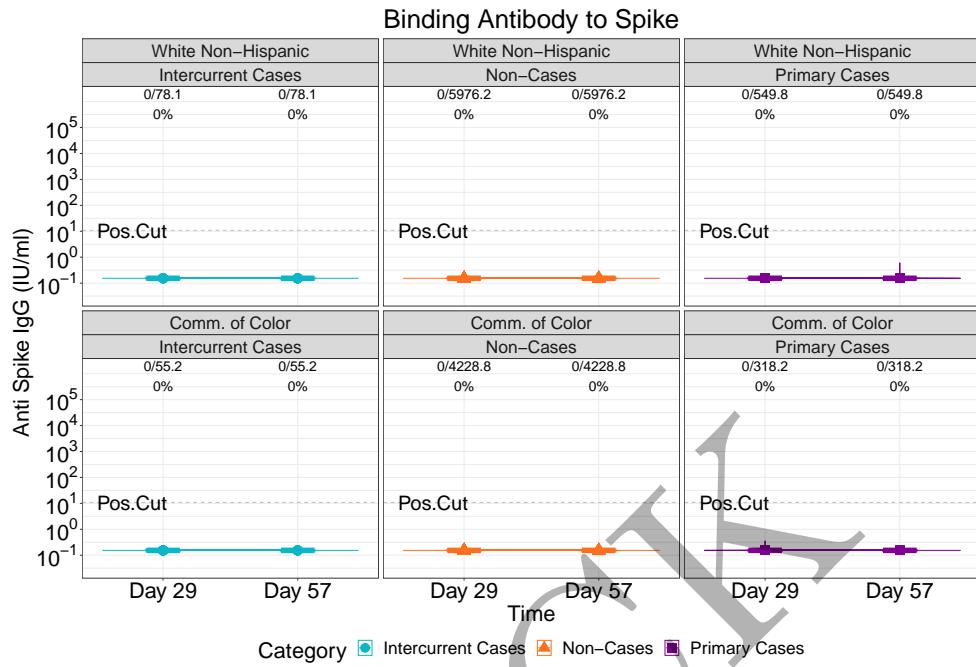


Figure 3.174: lineplots of Binding Antibody to Spike: baseline negative placebo arm by race and ethnic group (version 1)

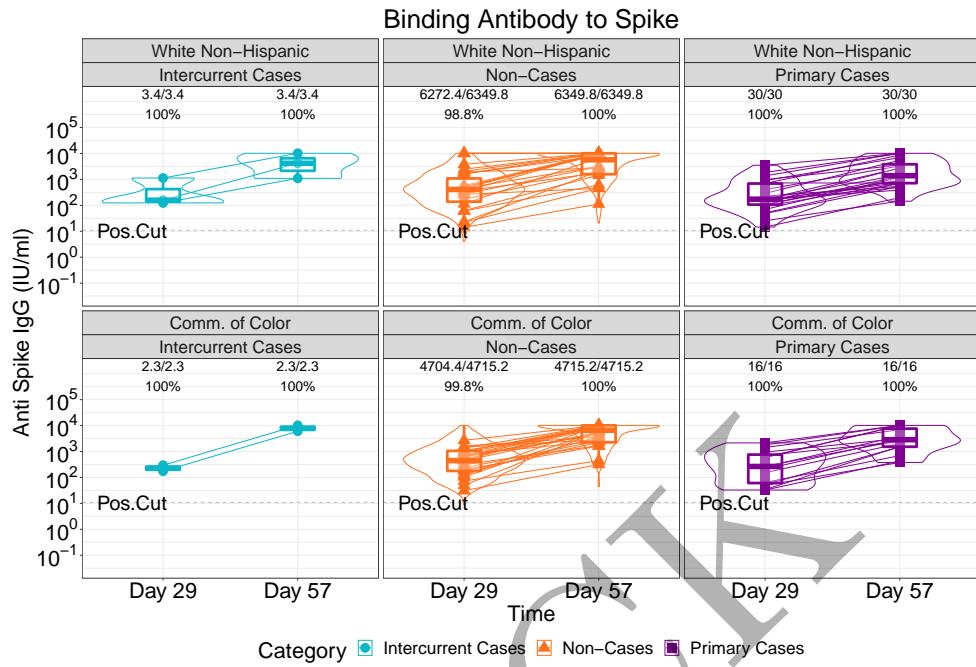


Figure 3.175: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by race and ethnic group (version 1)

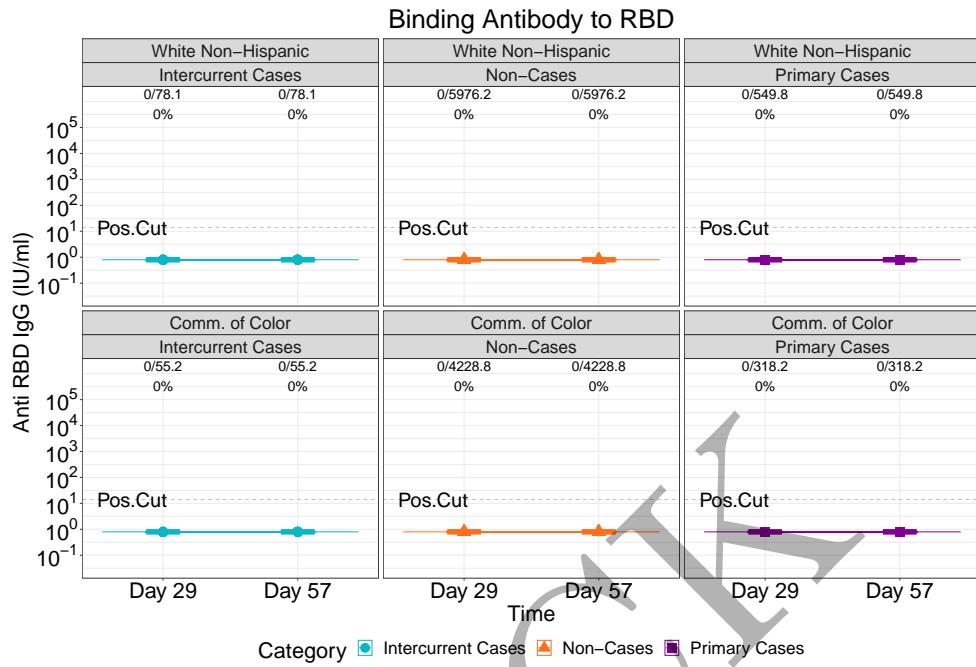


Figure 3.176: lineplots of Binding Antibody to RBD: baseline negative placebo arm by race and ethnic group (version 1)

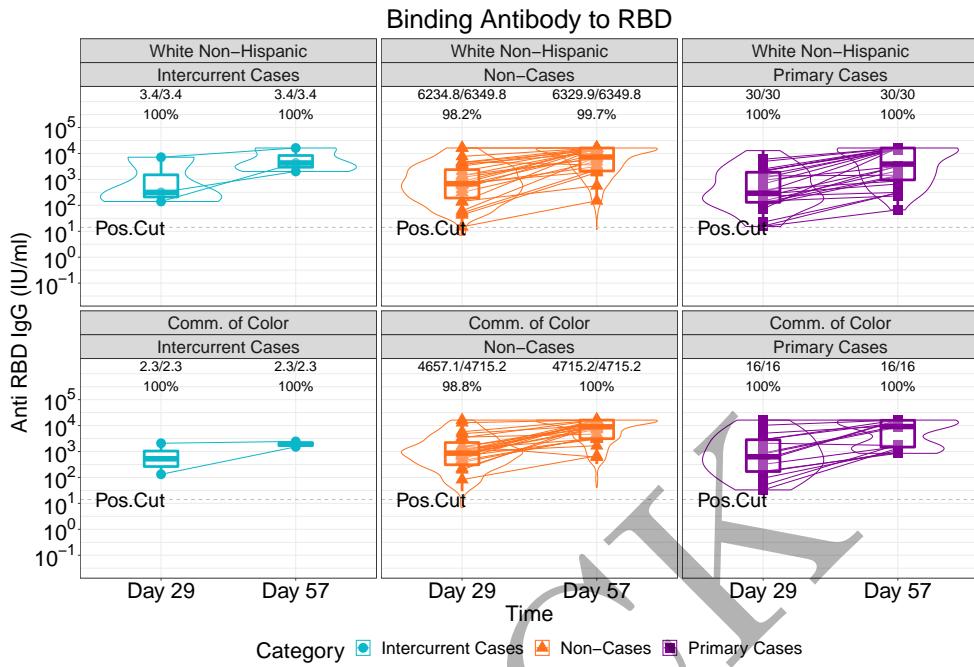


Figure 3.177: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by race and ethnic group (version 1)

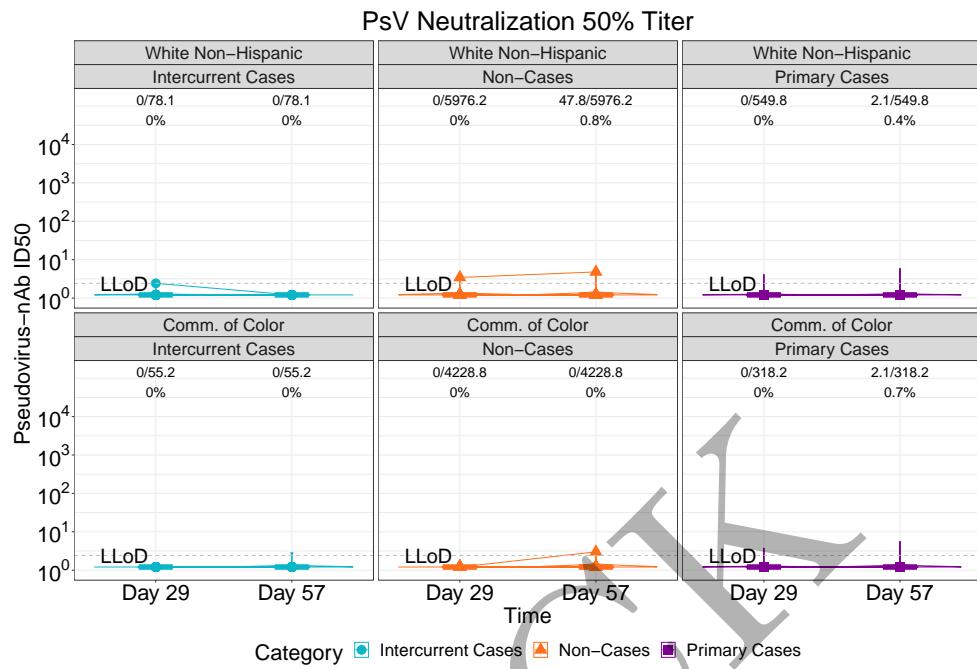


Figure 3.178: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by race and ethnic group (version 1)

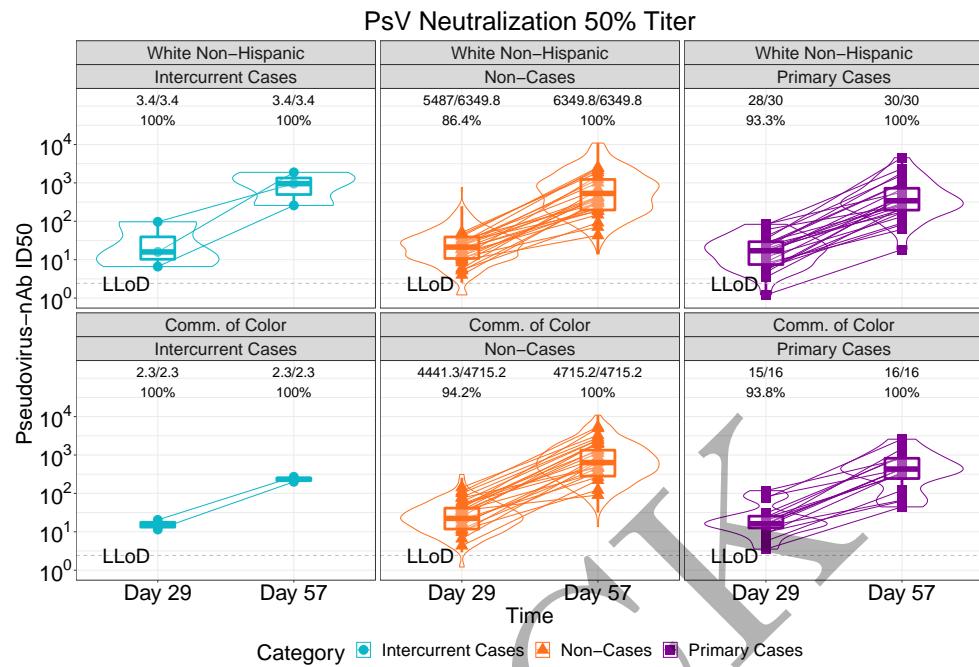


Figure 3.179: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by race and ethnic group (version 1)

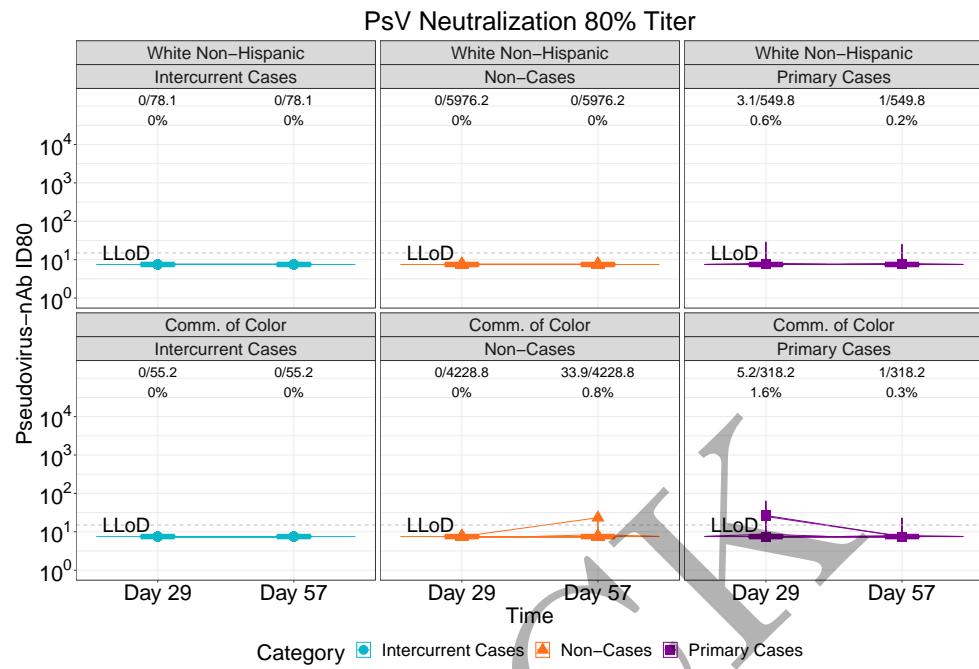


Figure 3.180: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by race and ethnic group (version 1)

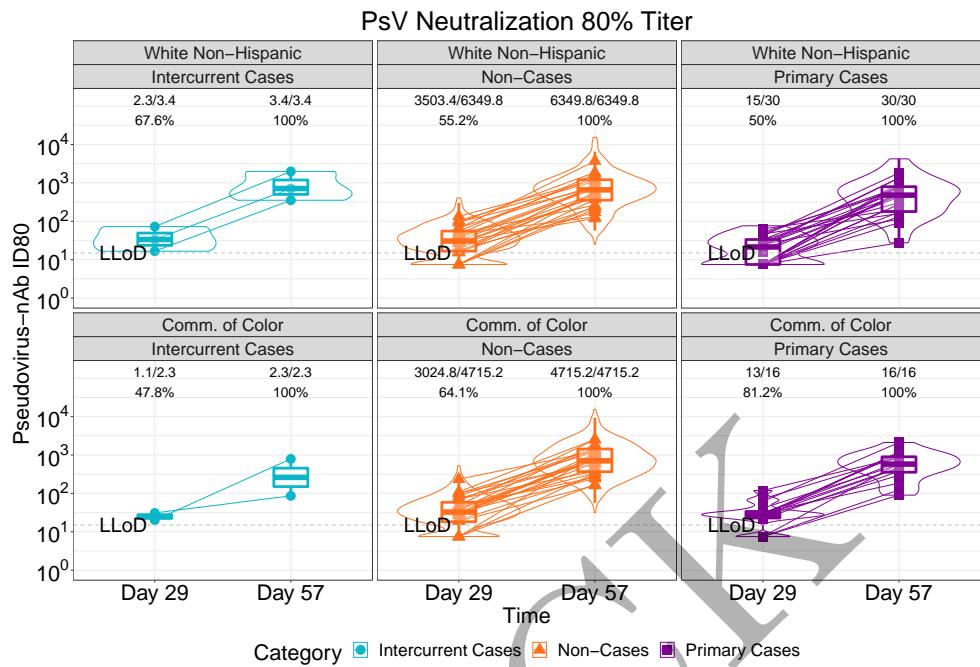


Figure 3.181: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by race and ethnic group (version 1)

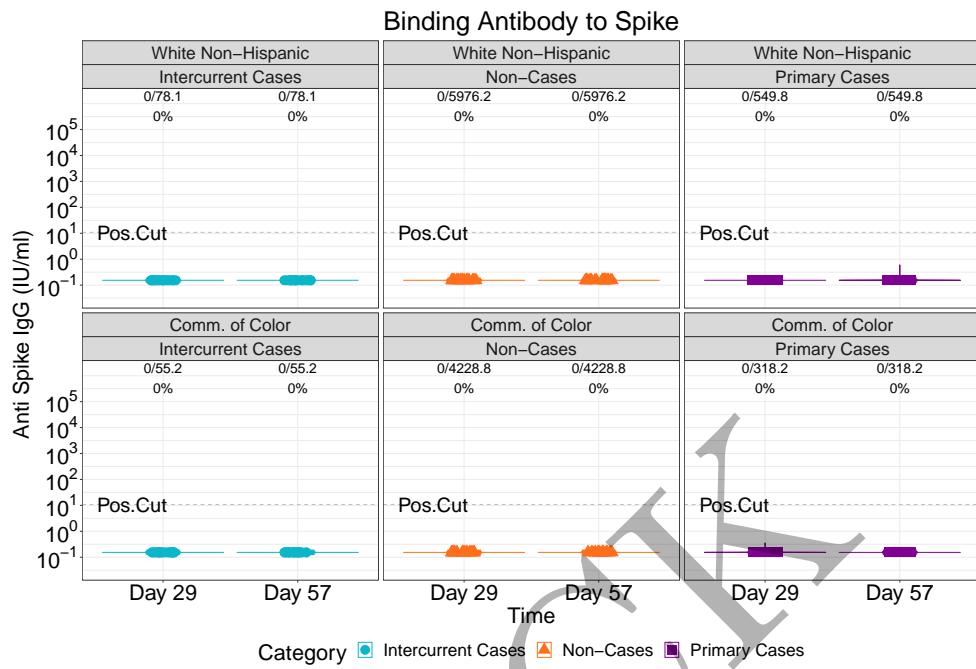


Figure 3.182: violinplots of Binding Antibody to Spike: baseline negative placebo arm by race and ethnic group (version 1)

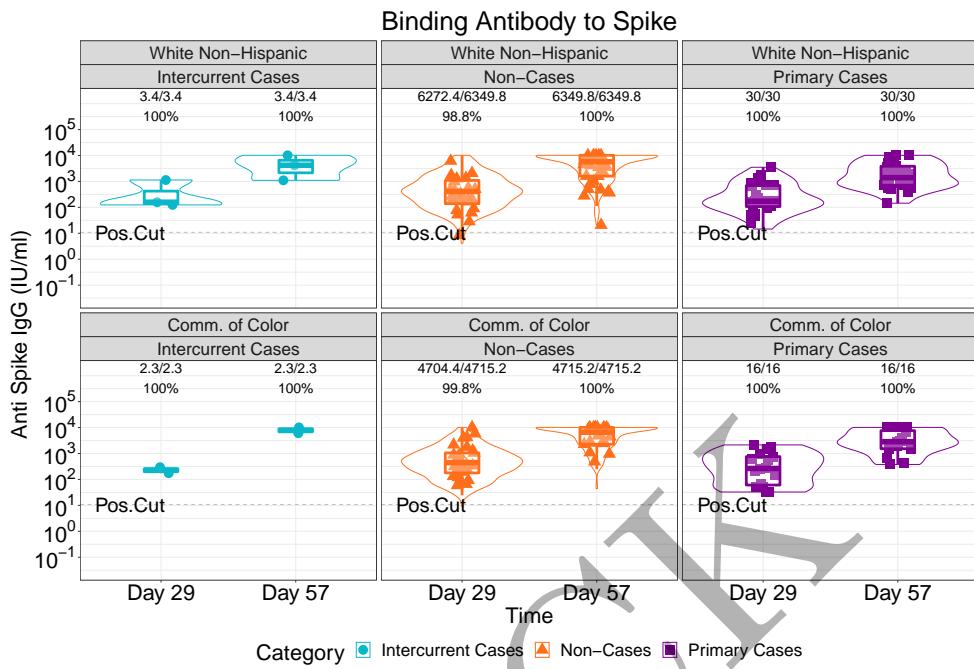


Figure 3.183: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by race and ethnic group (version 1)

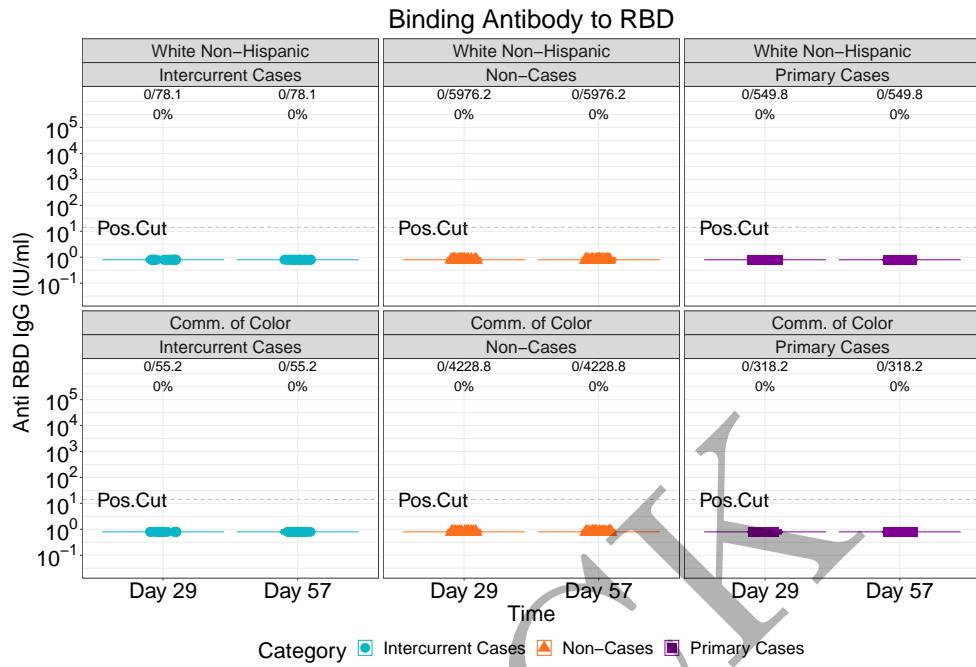


Figure 3.184: violinplots of Binding Antibody to RBD: baseline negative placebo arm by race and ethnic group (version 1)

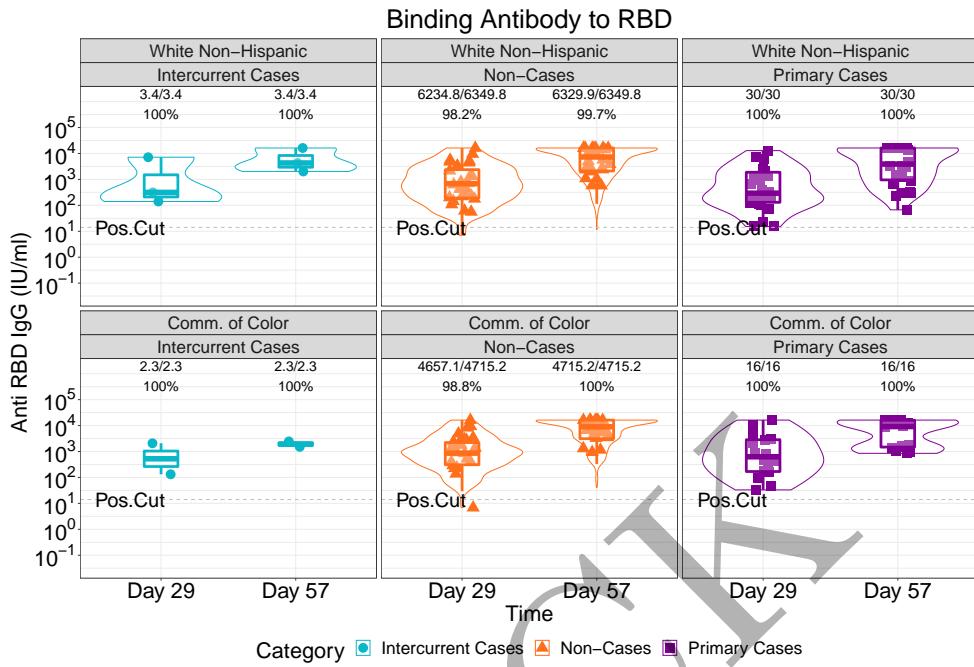


Figure 3.185: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by race and ethnic group (version 1)

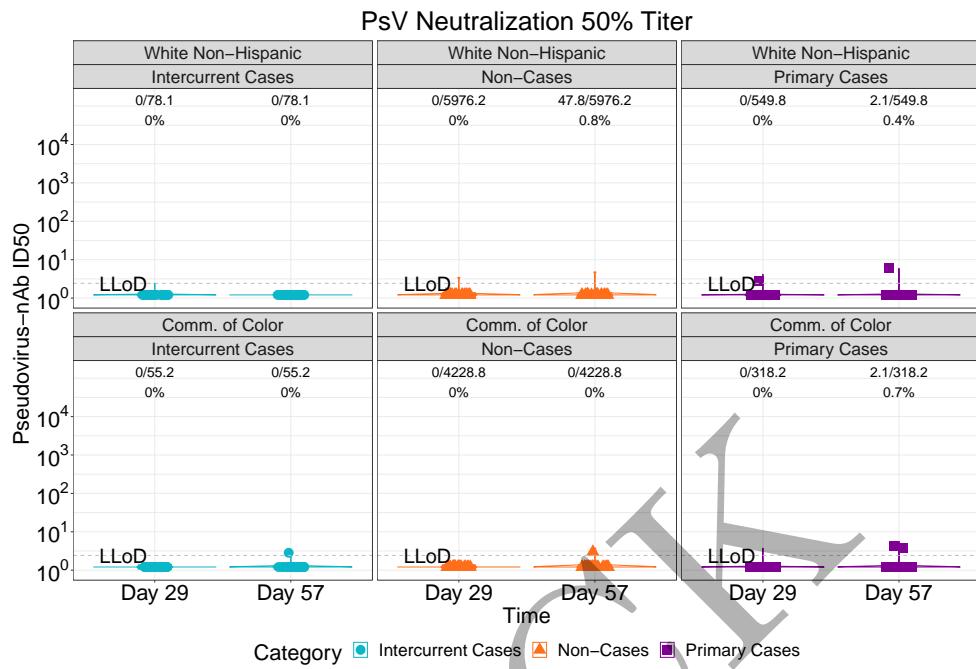


Figure 3.186: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by race and ethnic group (version 1)

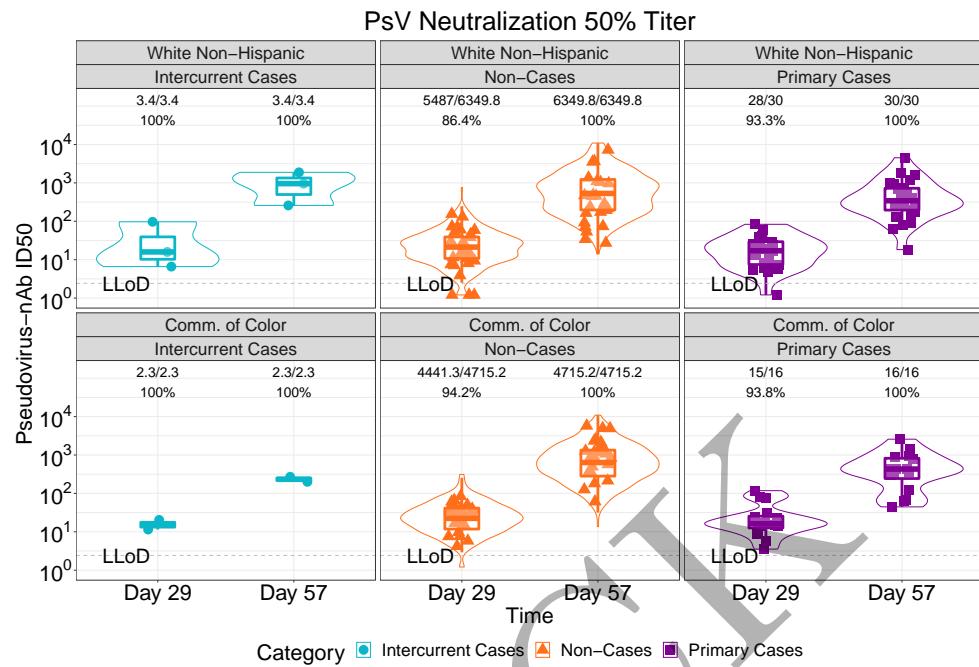


Figure 3.187: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by race and ethnic group (version 1)

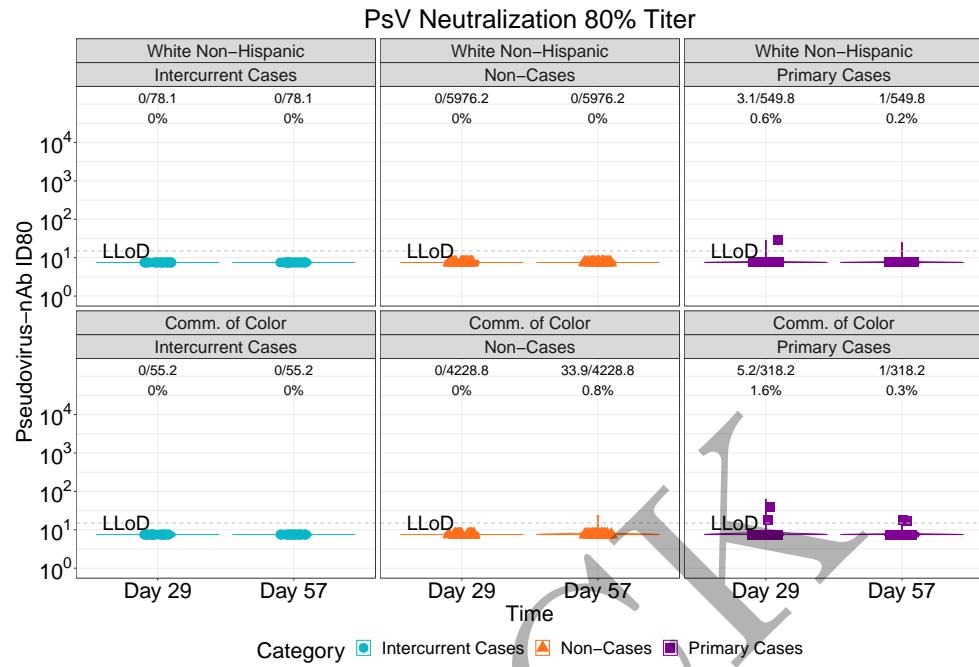


Figure 3.188: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by race and ethnic group (version 1)

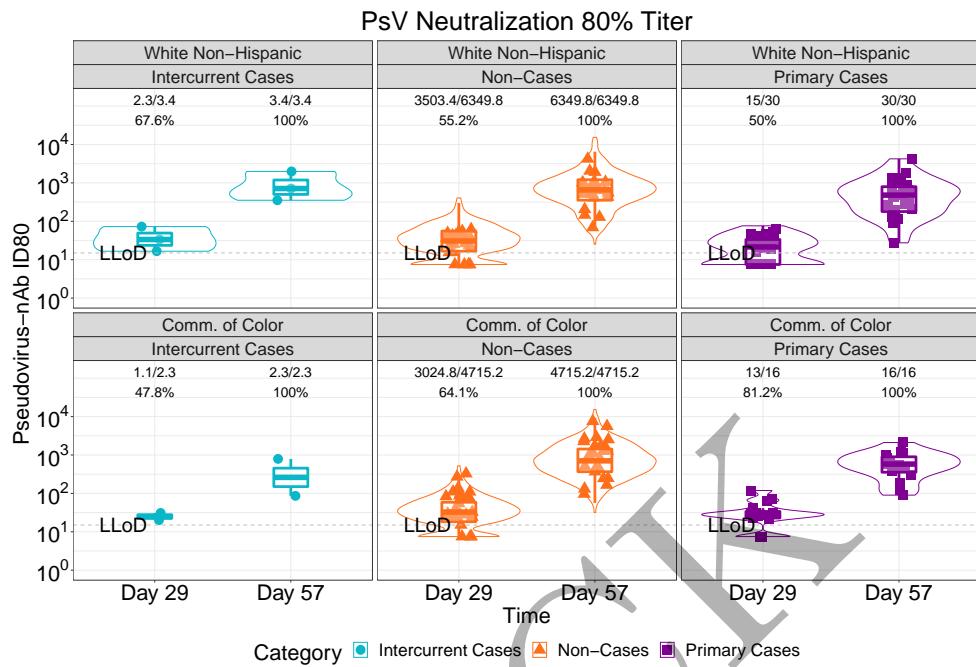


Figure 3.189: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by race and ethnic group (version 1)

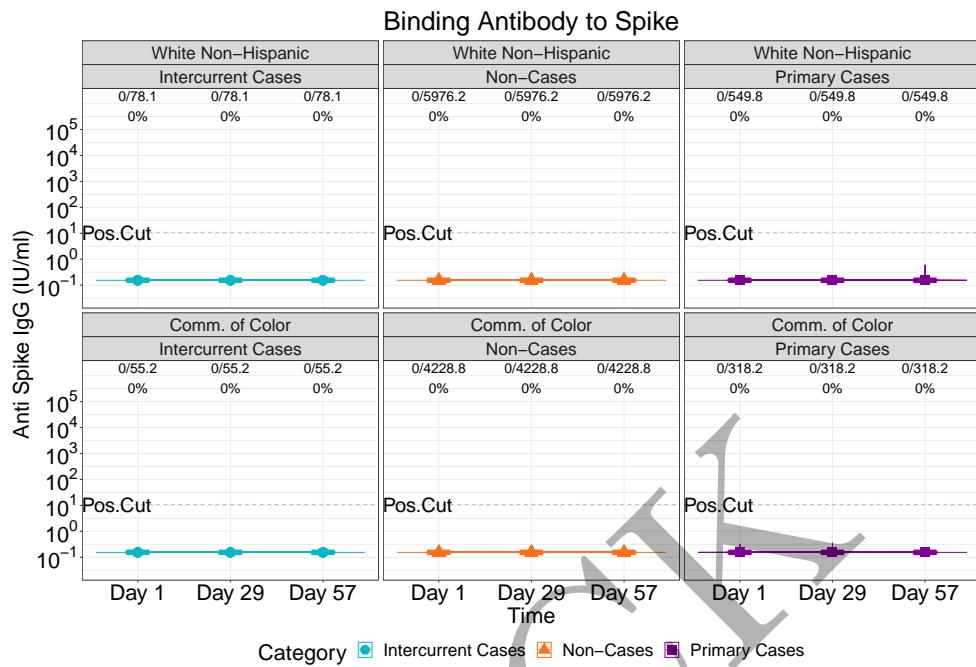


Figure 3.190: lineplots of Binding Antibody to Spike: baseline negative placebo arm by race and ethnic group (version 2)

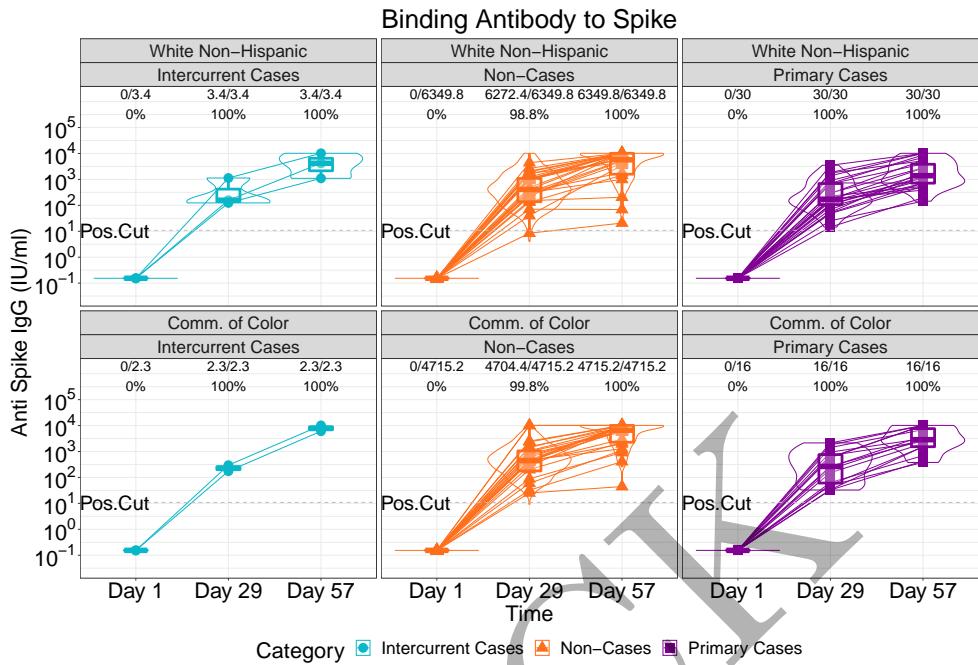


Figure 3.191: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by race and ethnic group (version 2)

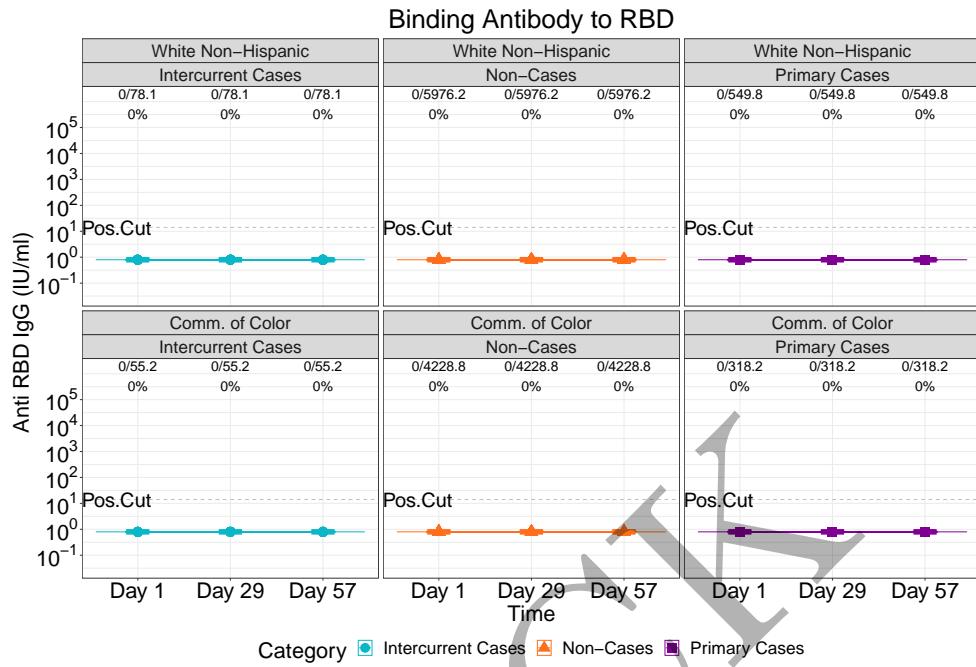


Figure 3.192: lineplots of Binding Antibody to RBD: baseline negative placebo arm by race and ethnic group (version 2)

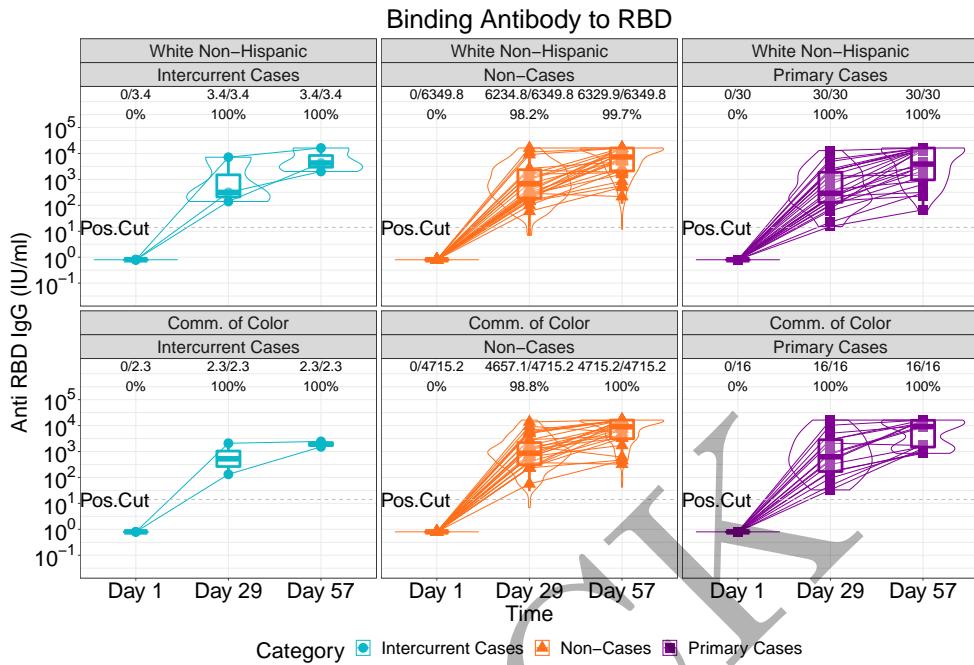


Figure 3.193: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by race and ethnic group (version 2)

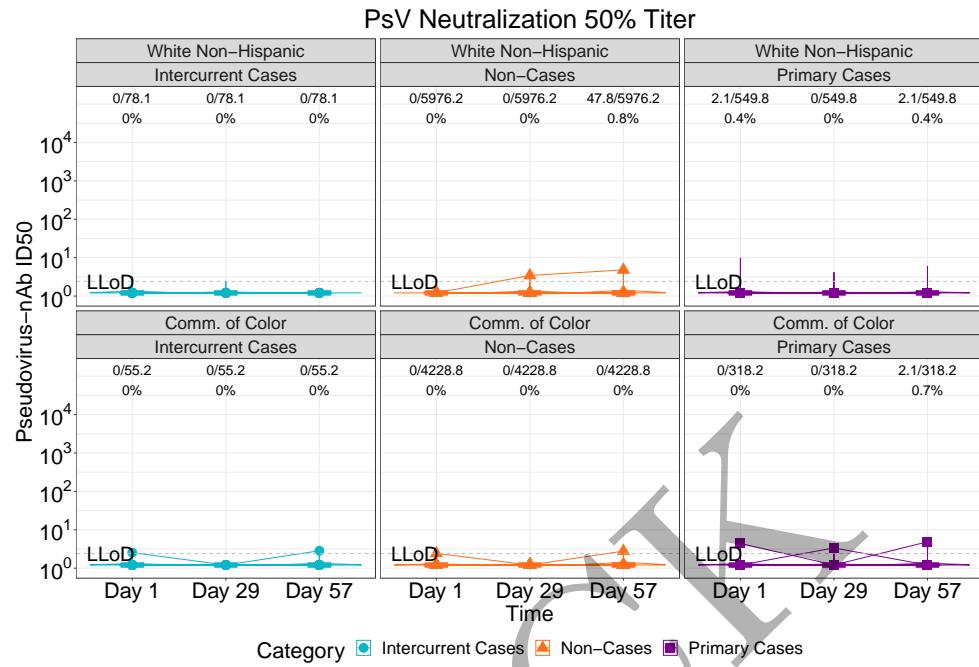


Figure 3.194: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by race and ethnic group (version 2)

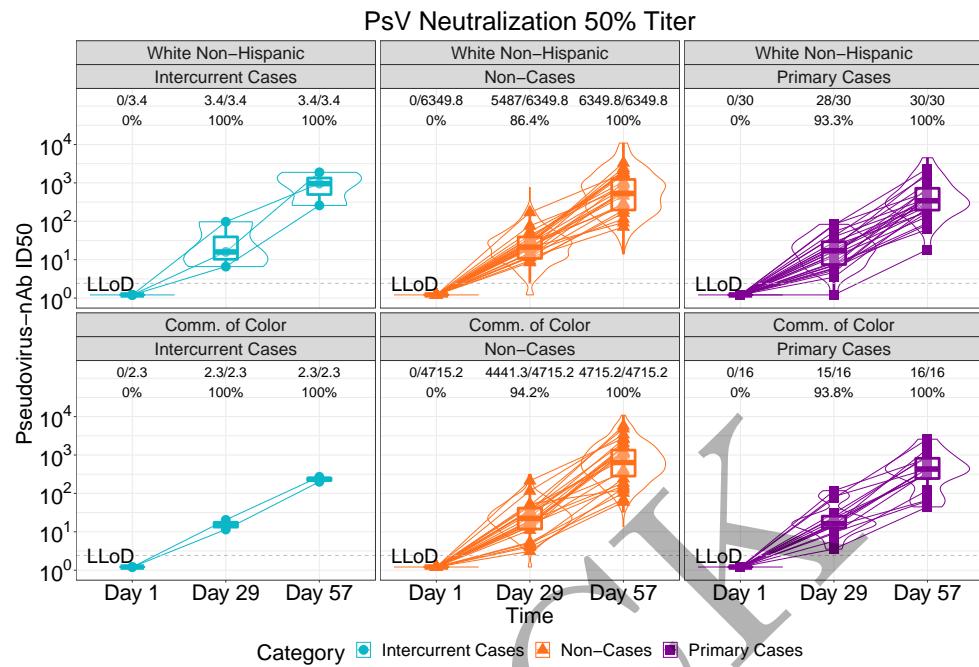


Figure 3.195: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by race and ethnic group (version 2)

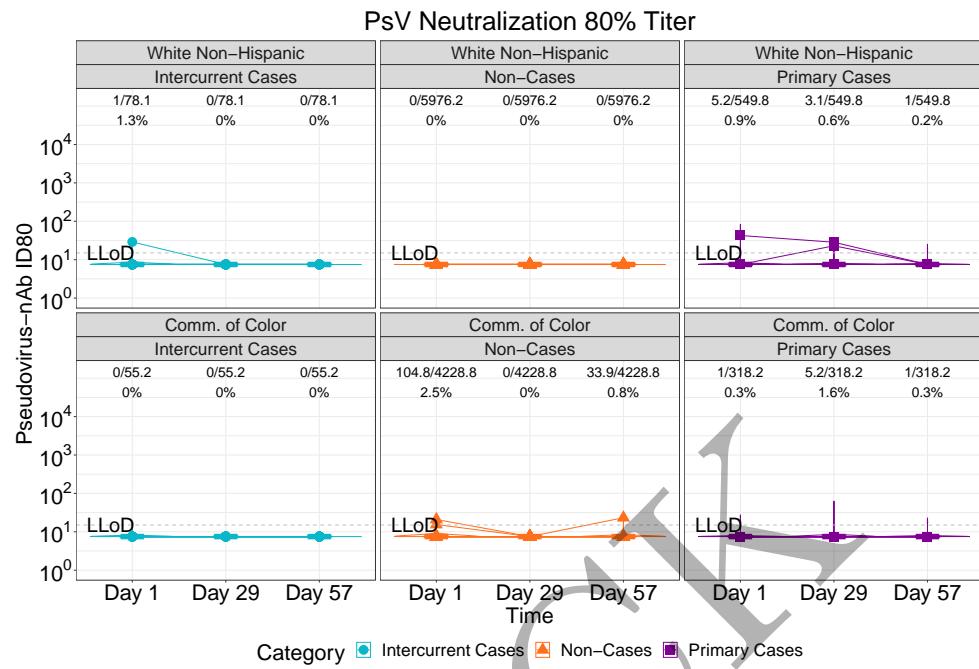


Figure 3.196: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by race and ethnic group (version 2)

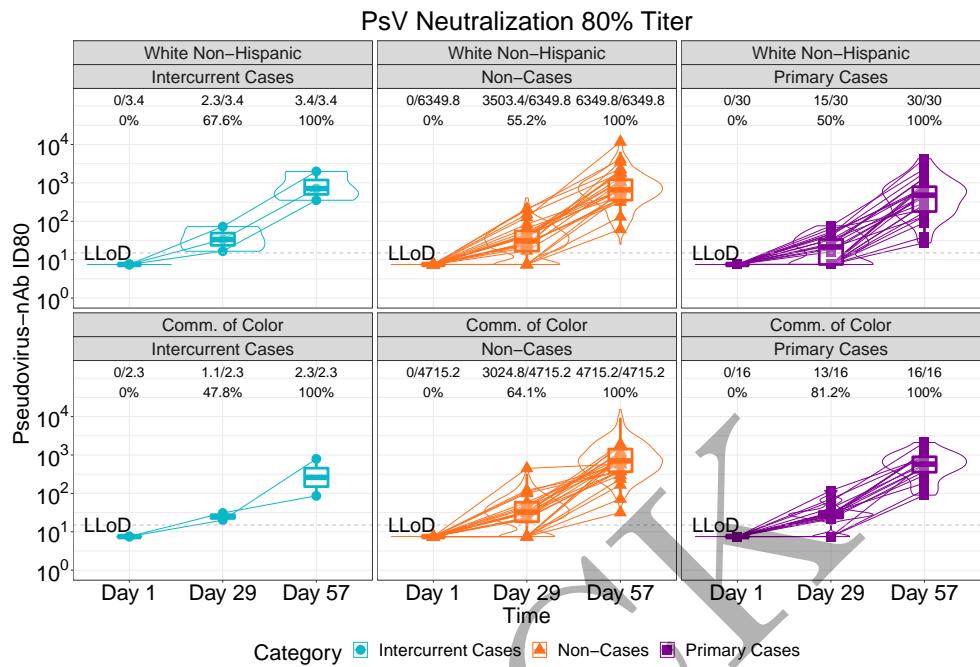


Figure 3.197: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by race and ethnic group (version 2)

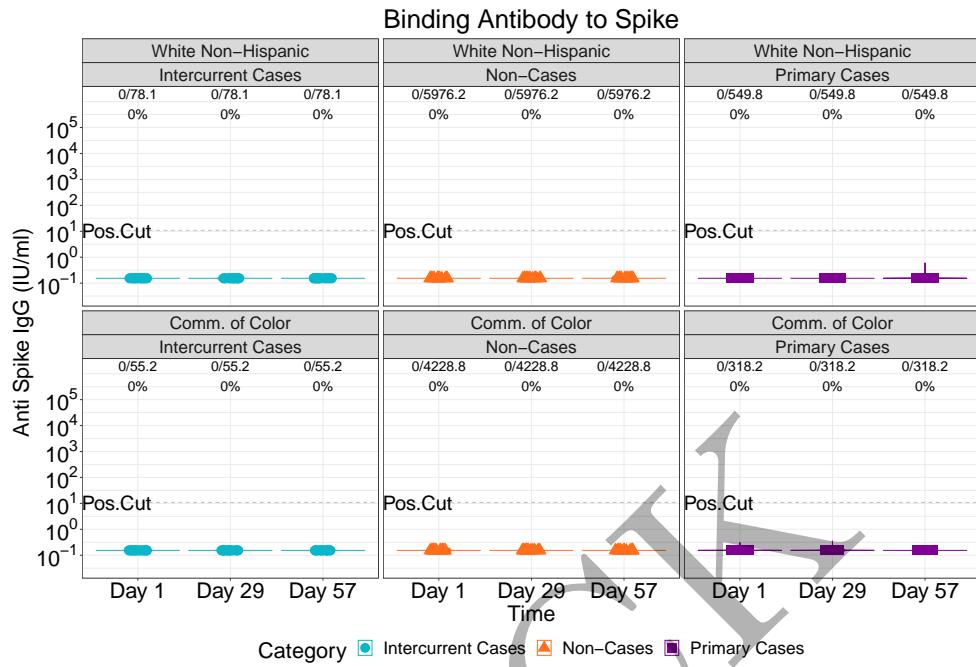


Figure 3.198: violinplots of Binding Antibody to Spike: baseline negative placebo arm by race and ethnic group (version 2)

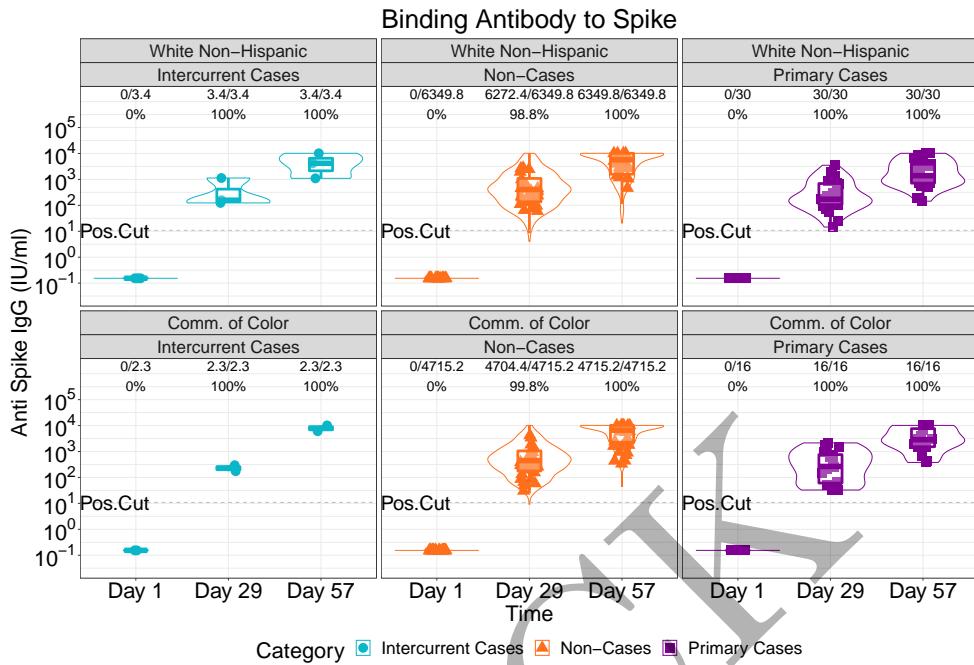


Figure 3.199: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by race and ethnic group (version 2)

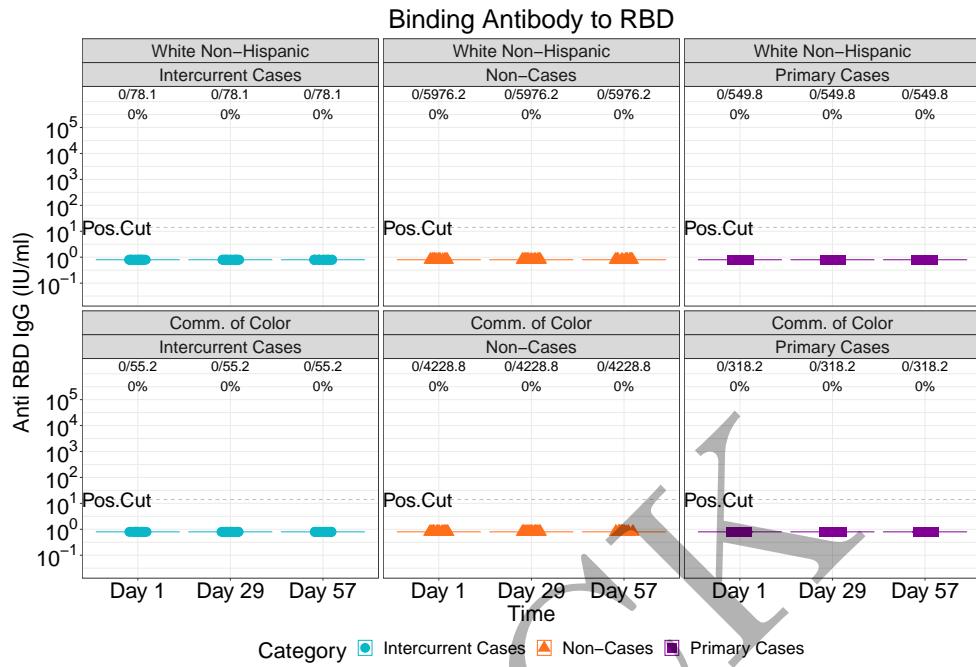


Figure 3.200: violinplots of Binding Antibody to RBD: baseline negative placebo arm by race and ethnic group (version 2)

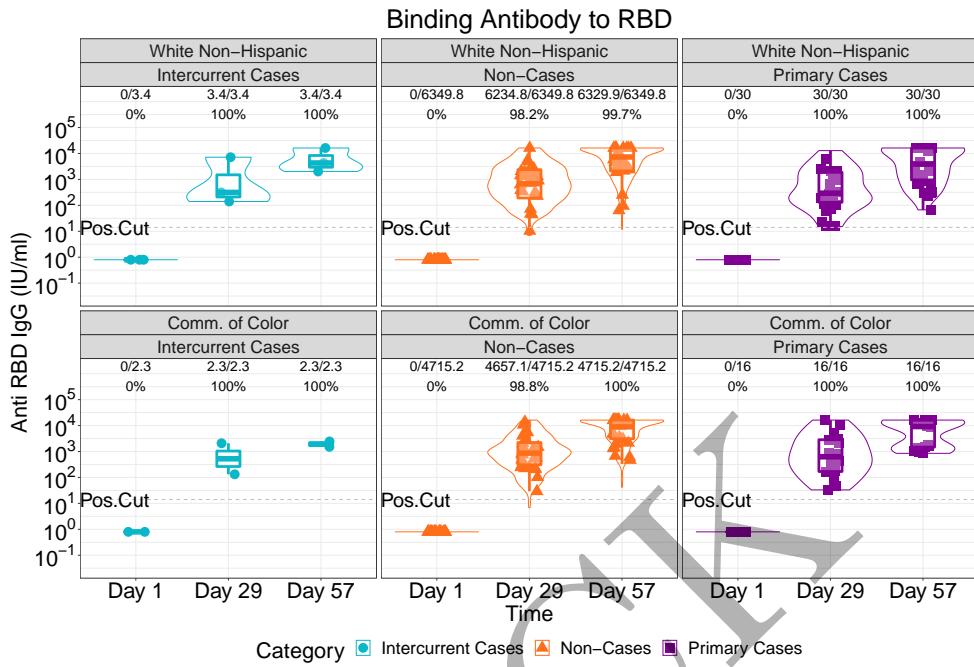


Figure 3.201: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by race and ethnic group (version 2)

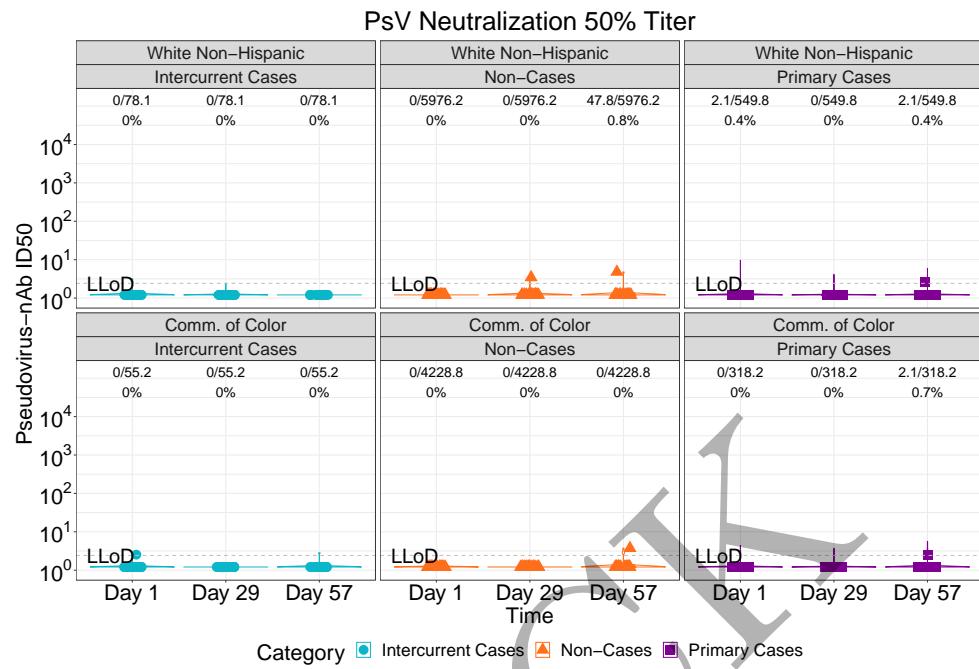


Figure 3.202: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by race and ethnic group (version 2)

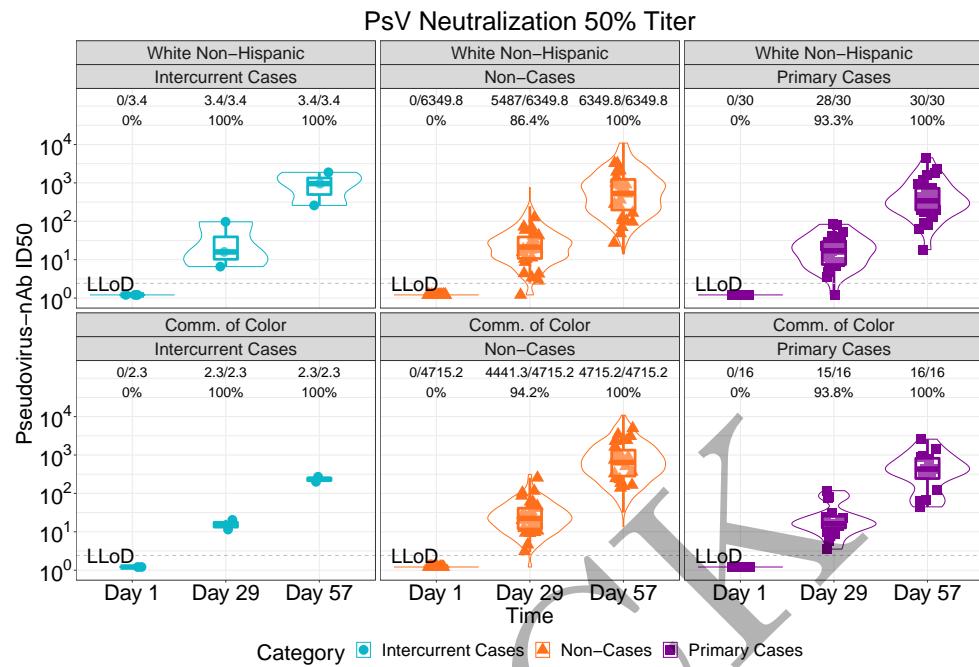


Figure 3.203: violinplots of Pseudovirus Neutralization ID₅₀: baseline negative vaccine arm by race and ethnic group (version 2)

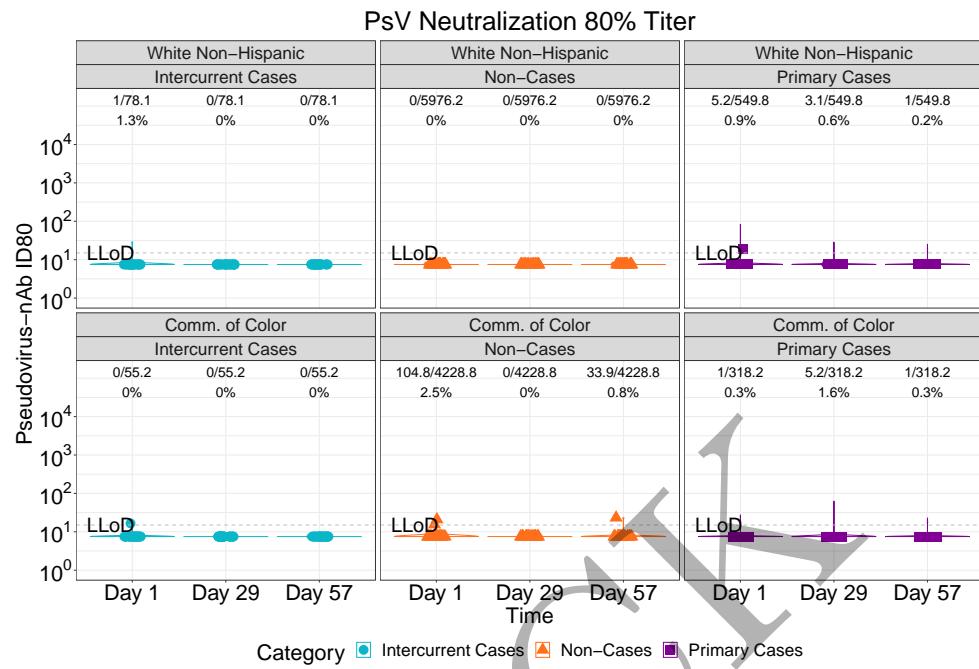


Figure 3.204: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by race and ethnic group (version 2)

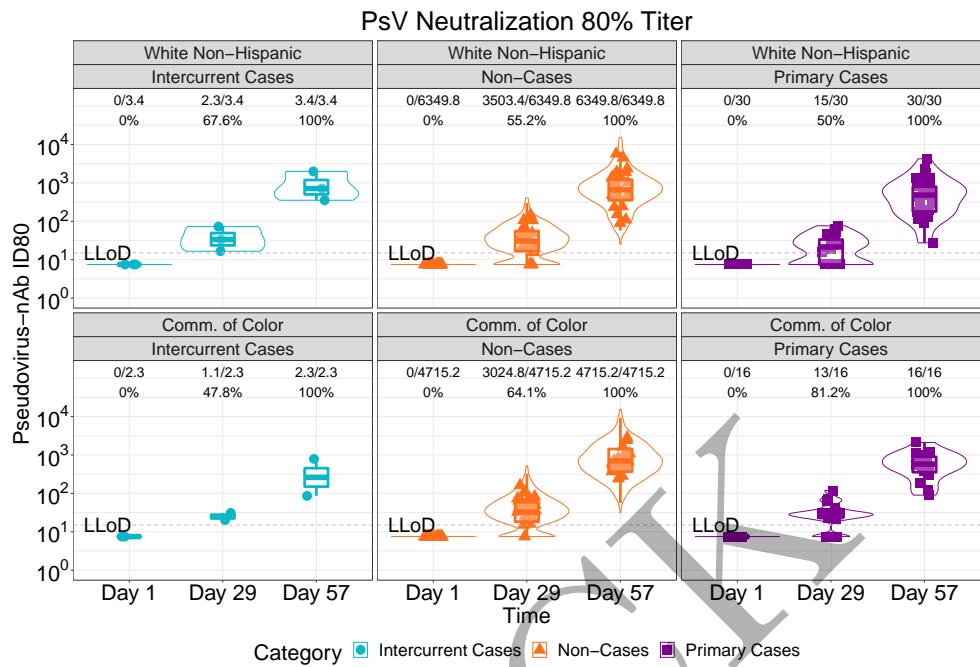


Figure 3.205: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by race and ethnic group (version 2)

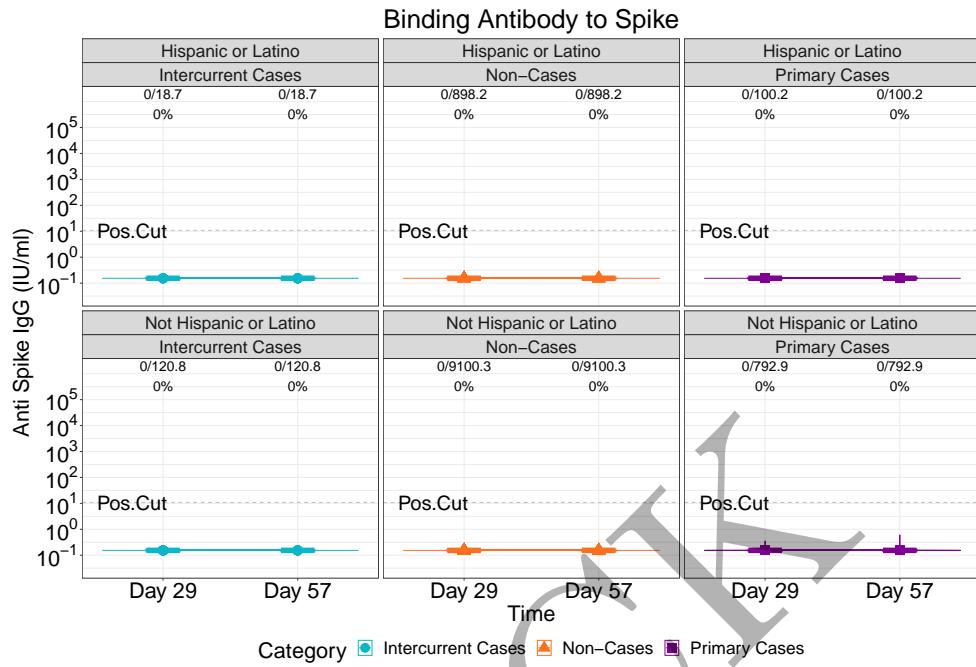


Figure 3.206: lineplots of Binding Antibody to Spike: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)

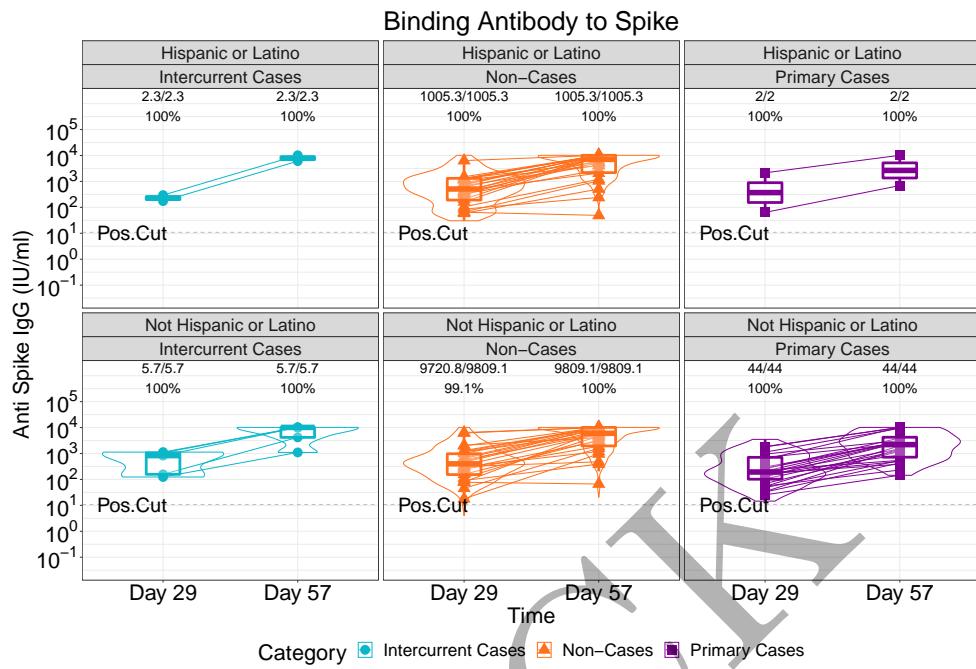


Figure 3.207: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)

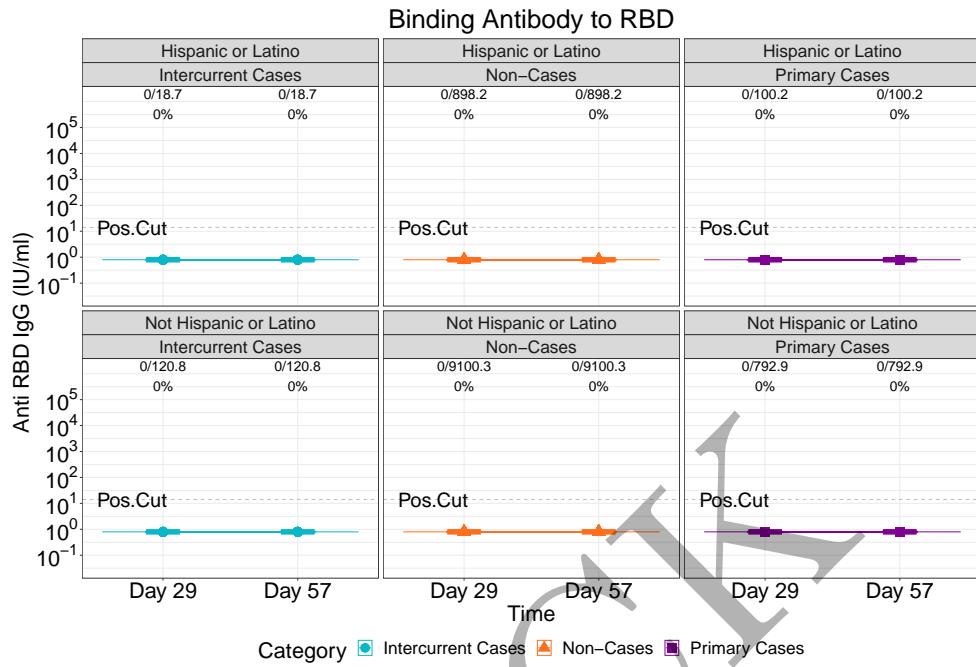


Figure 3.208: lineplots of Binding Antibody to RBD: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)

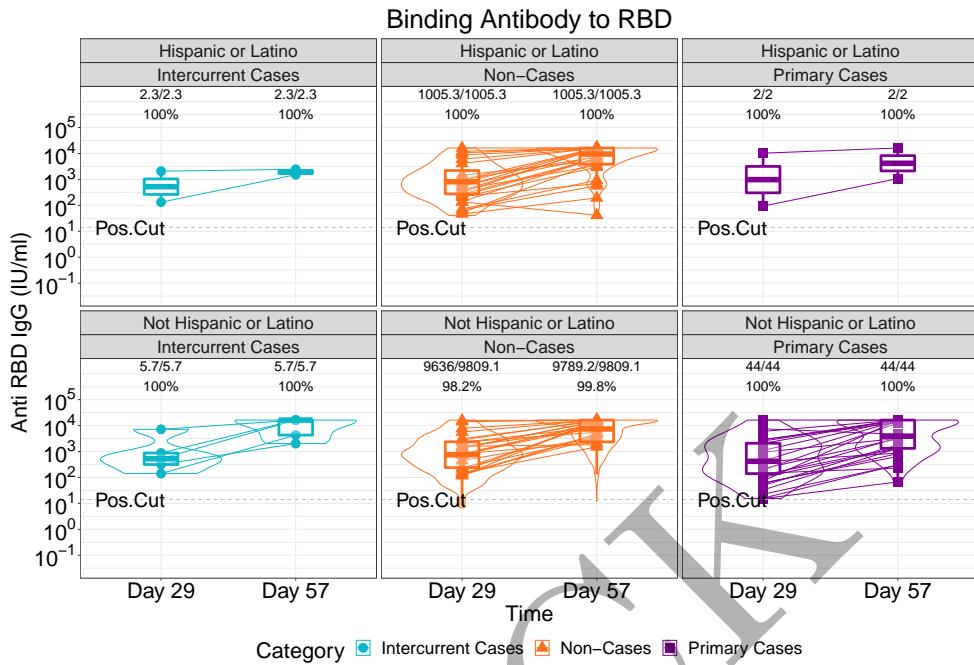


Figure 3.209: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)

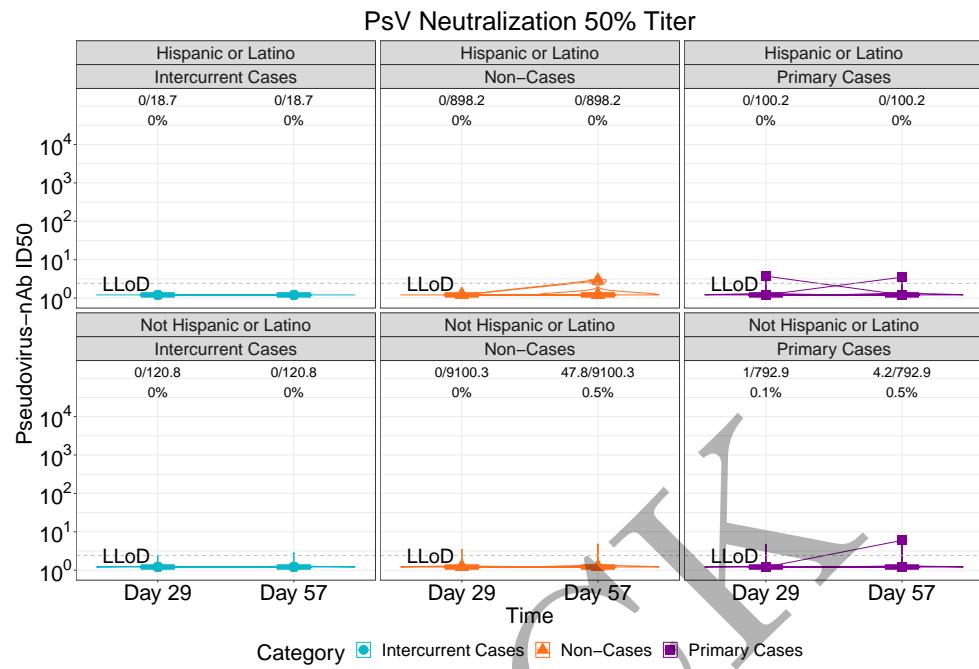


Figure 3.210: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)

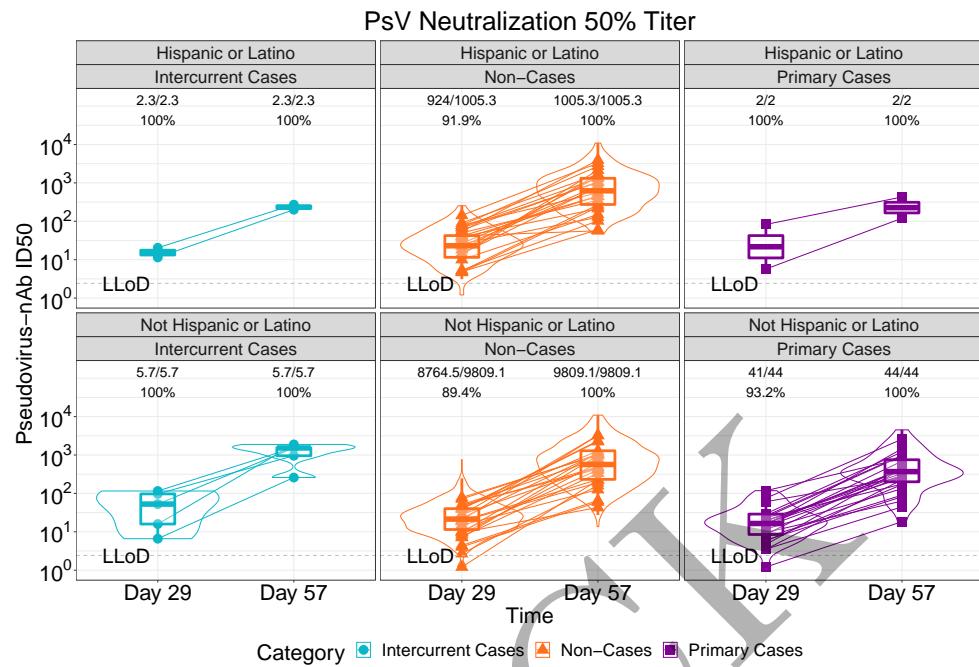


Figure 3.211: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)

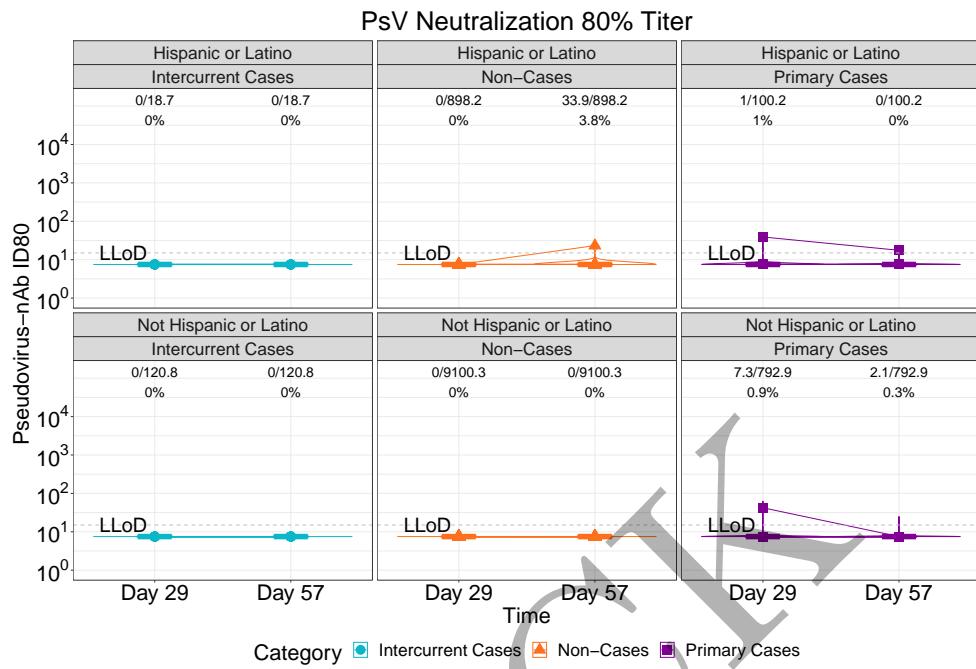


Figure 3.212: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)

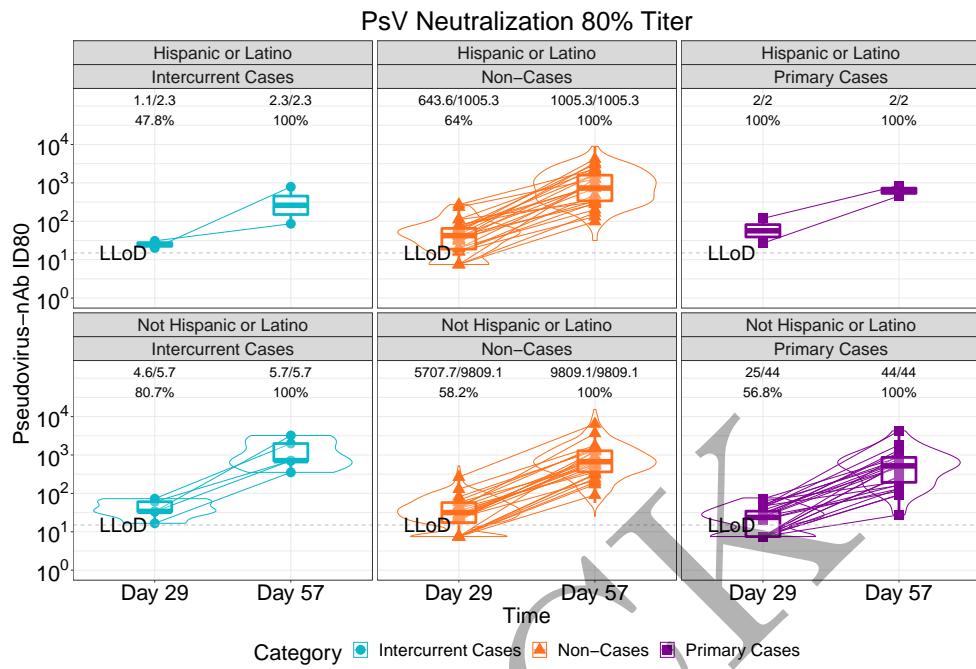


Figure 3.213: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)

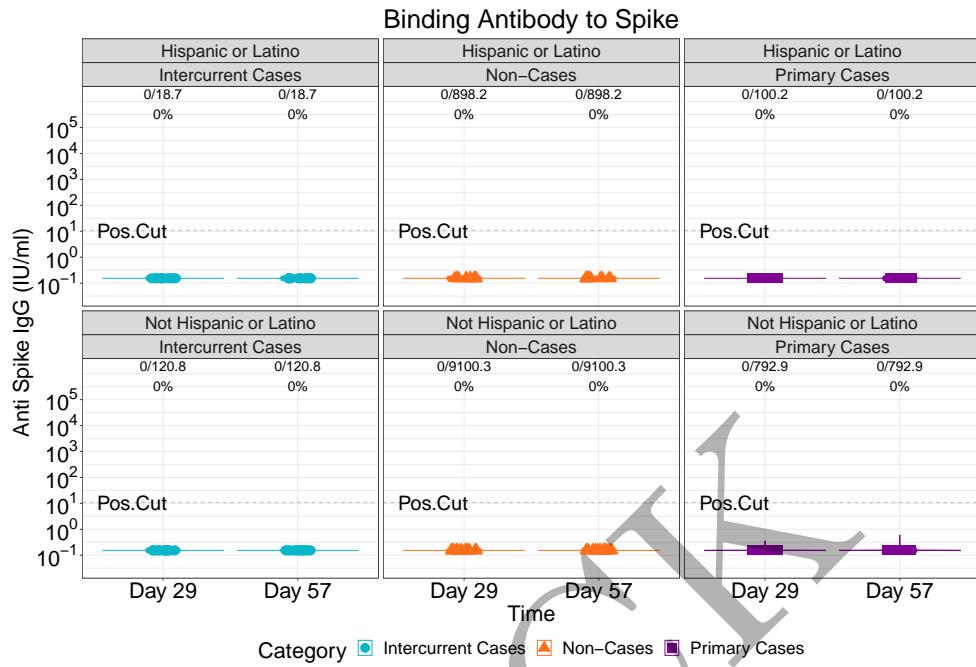


Figure 3.214: violinplots of Binding Antibody to Spike: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)

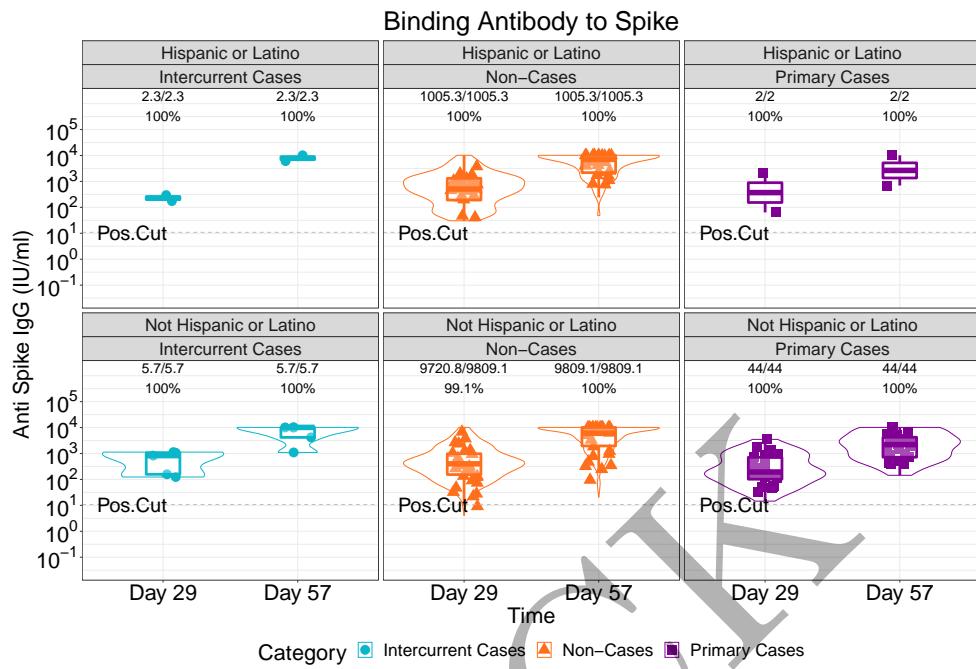


Figure 3.215: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)

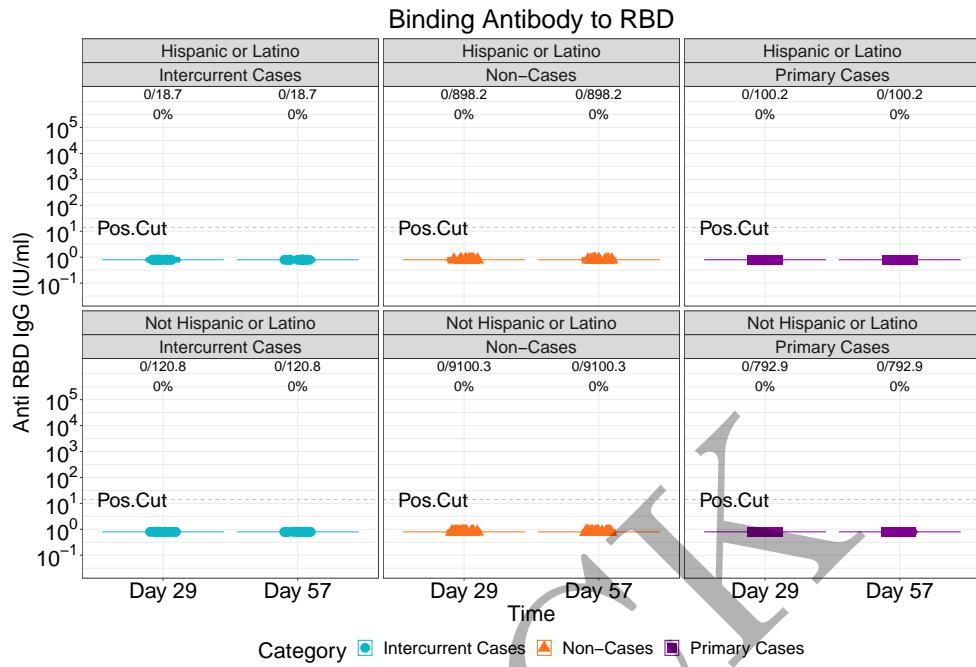


Figure 3.216: violinplots of Binding Antibody to RBD: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)

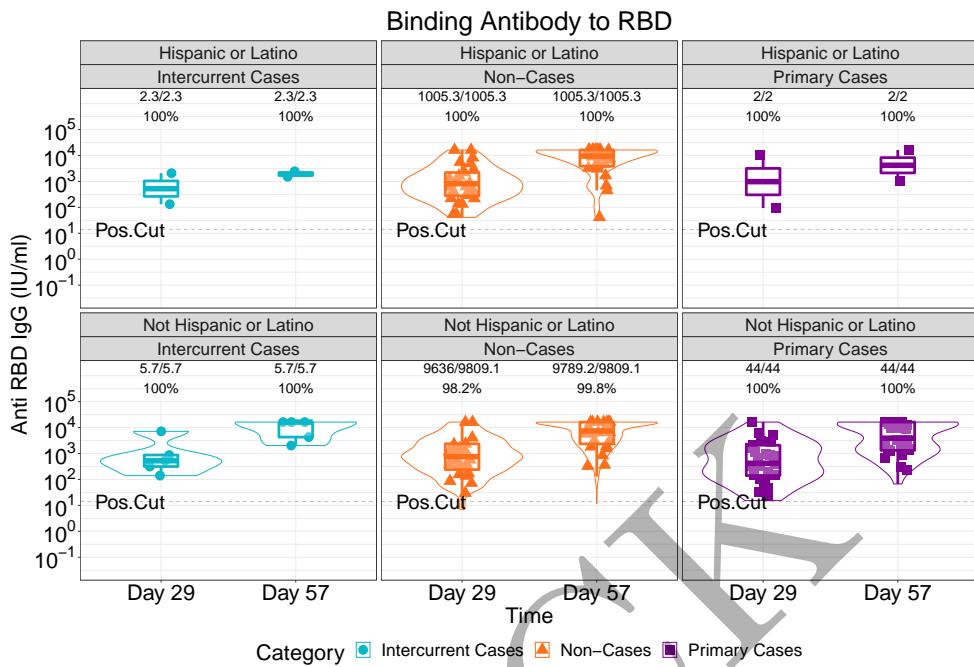


Figure 3.217: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)

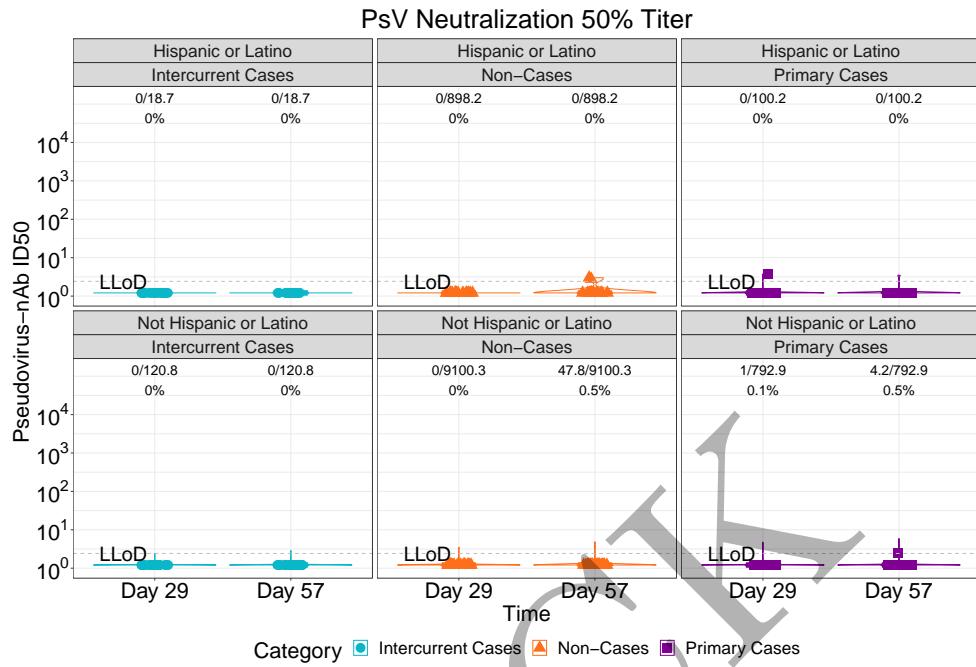


Figure 3.218: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)

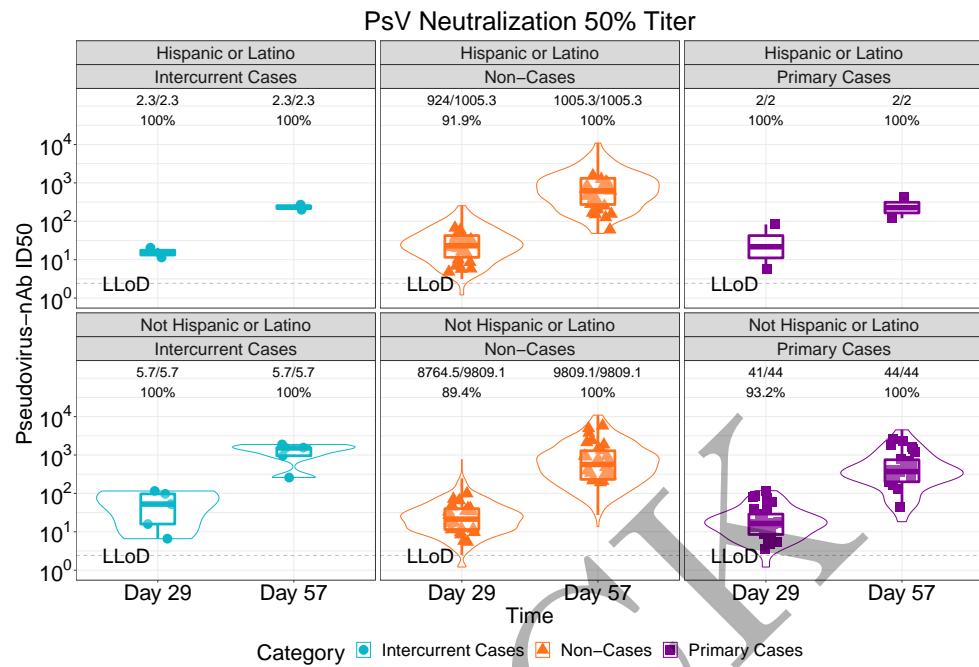


Figure 3.219: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)

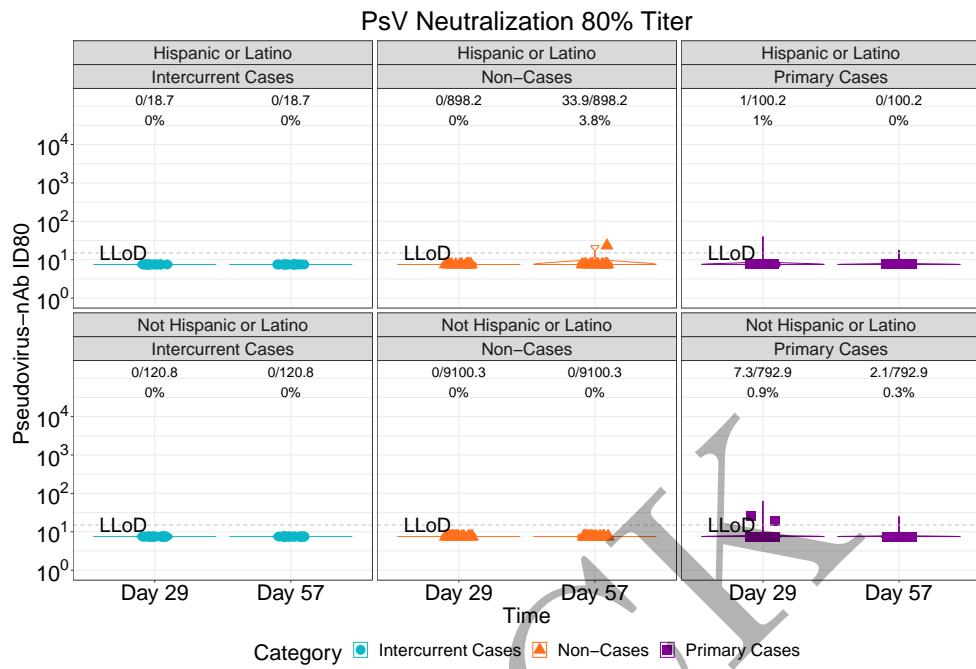


Figure 3.220: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 1)

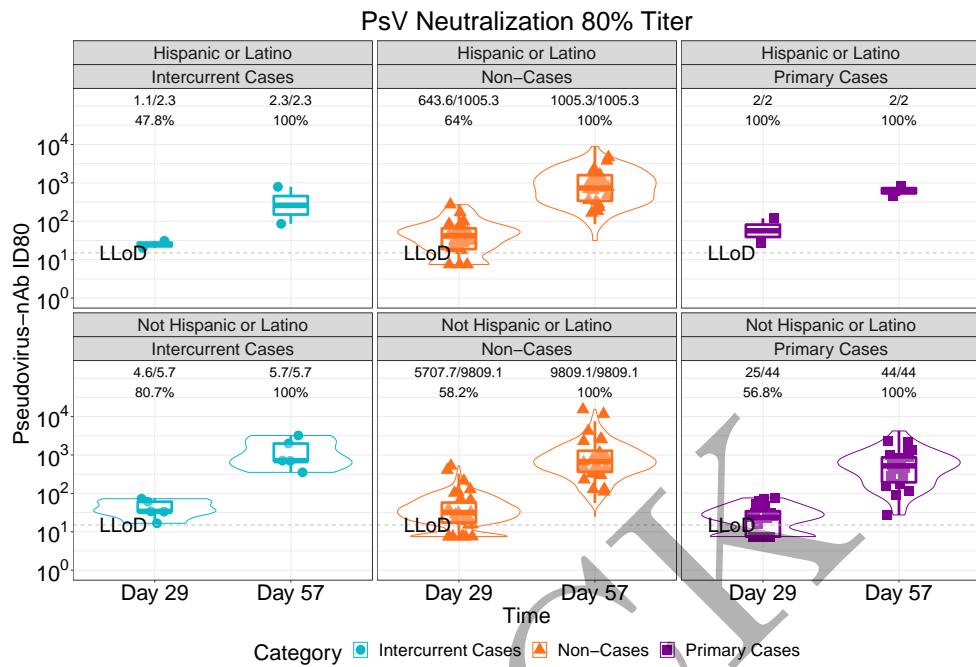


Figure 3.221: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 1)

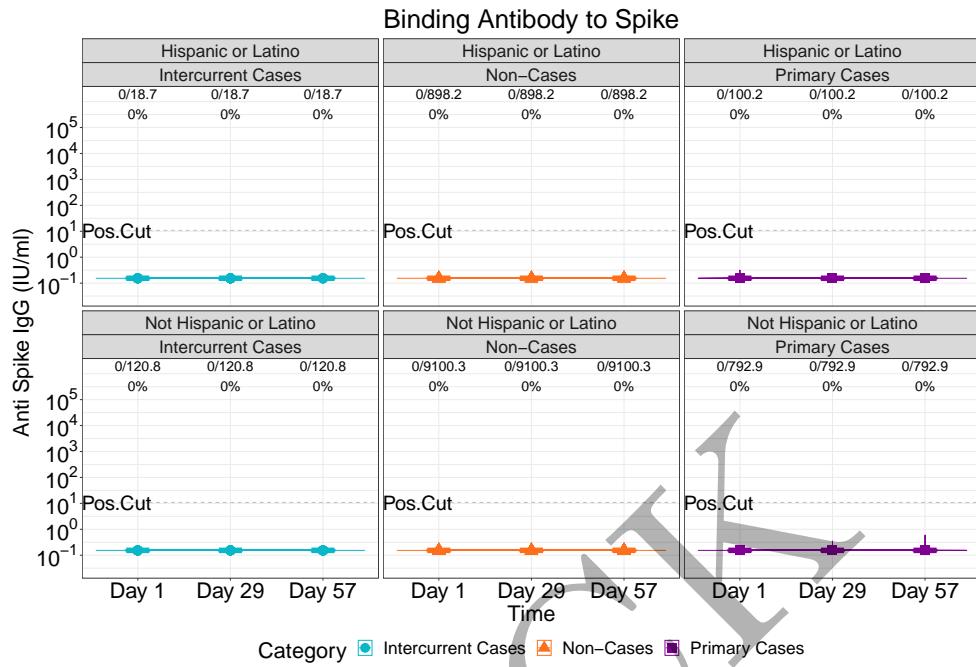


Figure 3.222: lineplots of Binding Antibody to Spike: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)

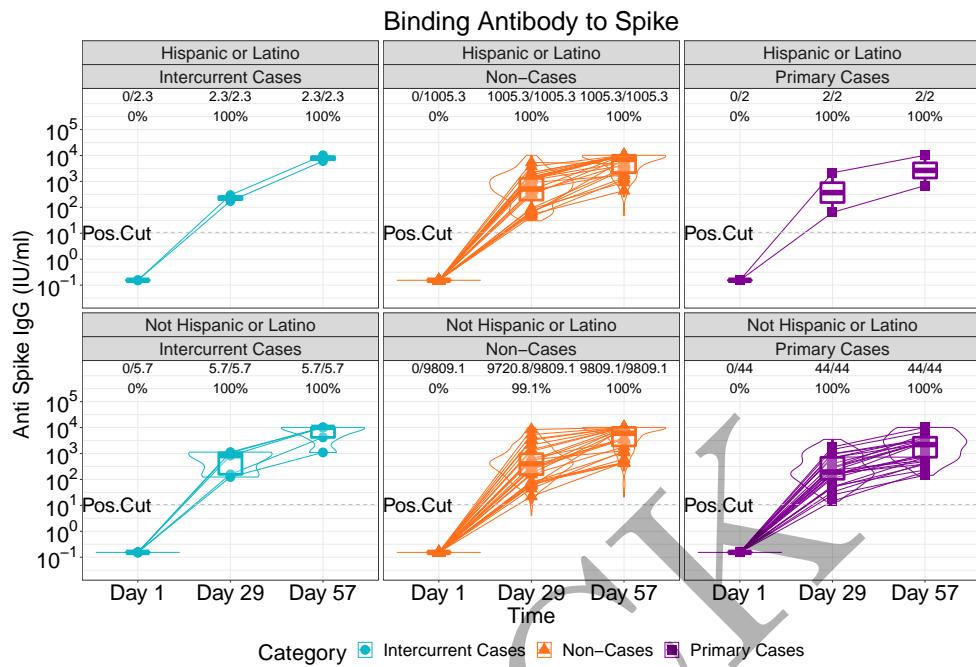


Figure 3.223: lineplots of Binding Antibody to Spike: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)

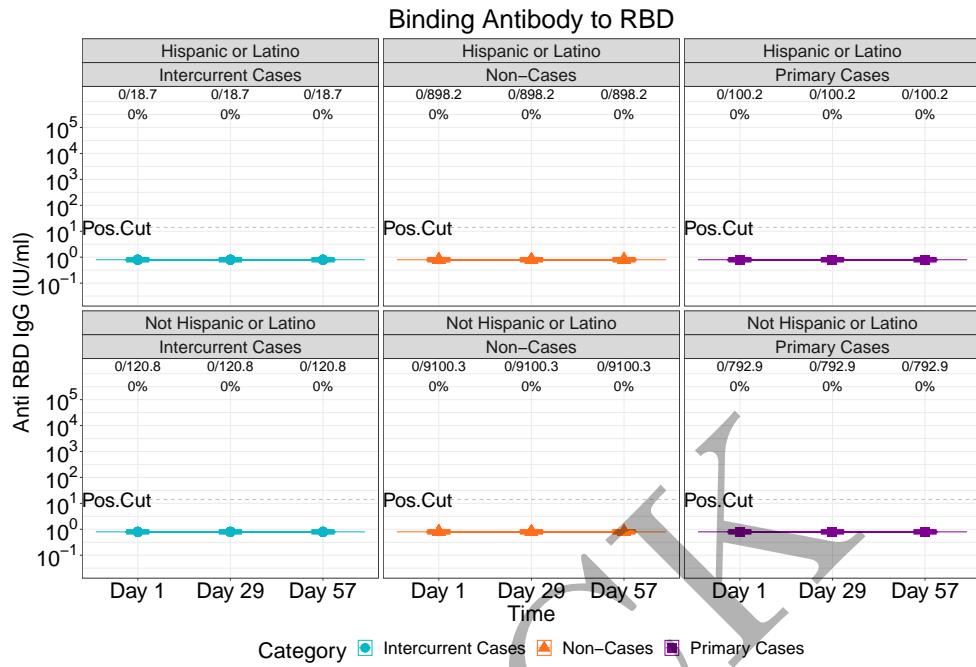


Figure 3.224: lineplots of Binding Antibody to RBD: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)

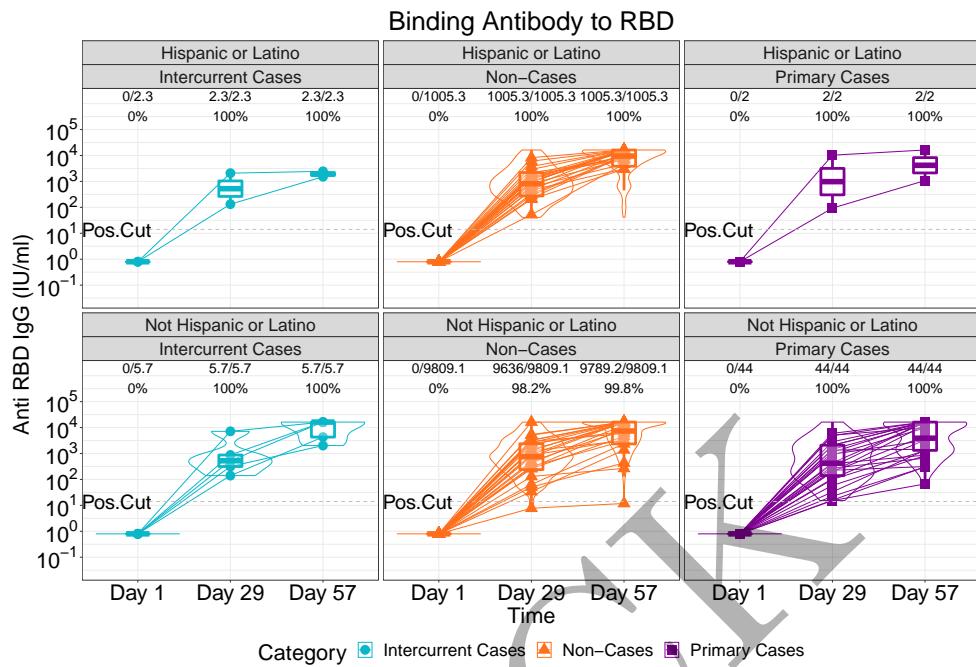


Figure 3.225: lineplots of Binding Antibody to RBD: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)

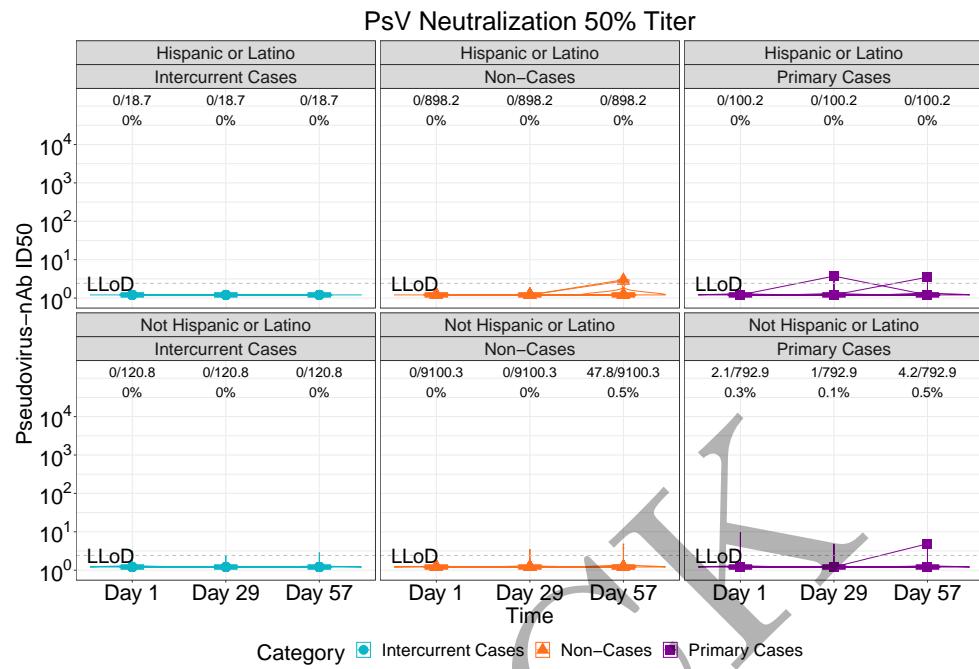


Figure 3.226: lineplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)

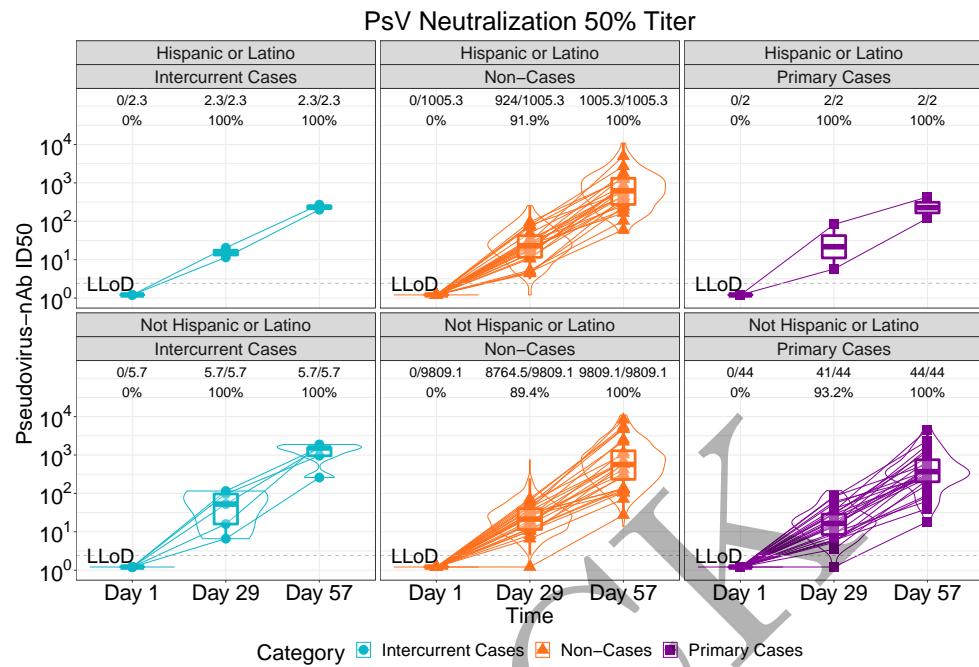


Figure 3.227: lineplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)

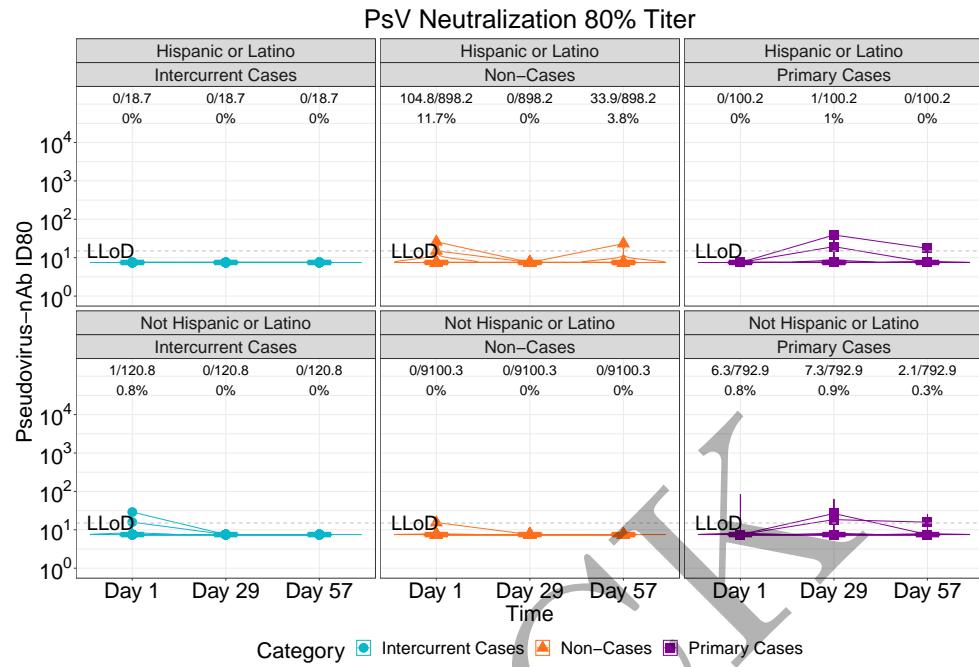


Figure 3.228: lineplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)

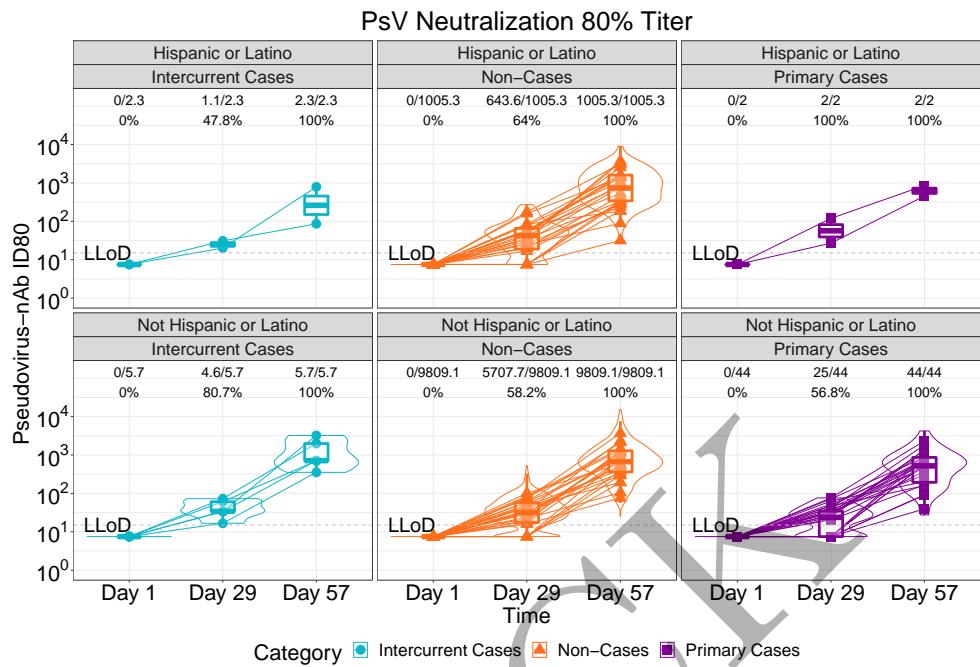


Figure 3.229: lineplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)

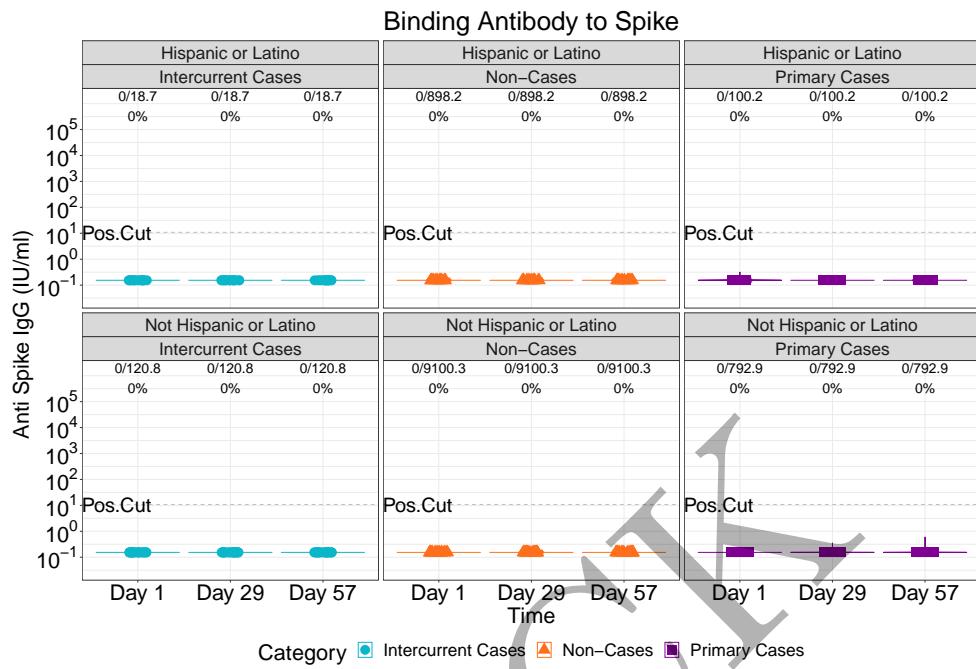


Figure 3.230: violinplots of Binding Antibody to Spike: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)

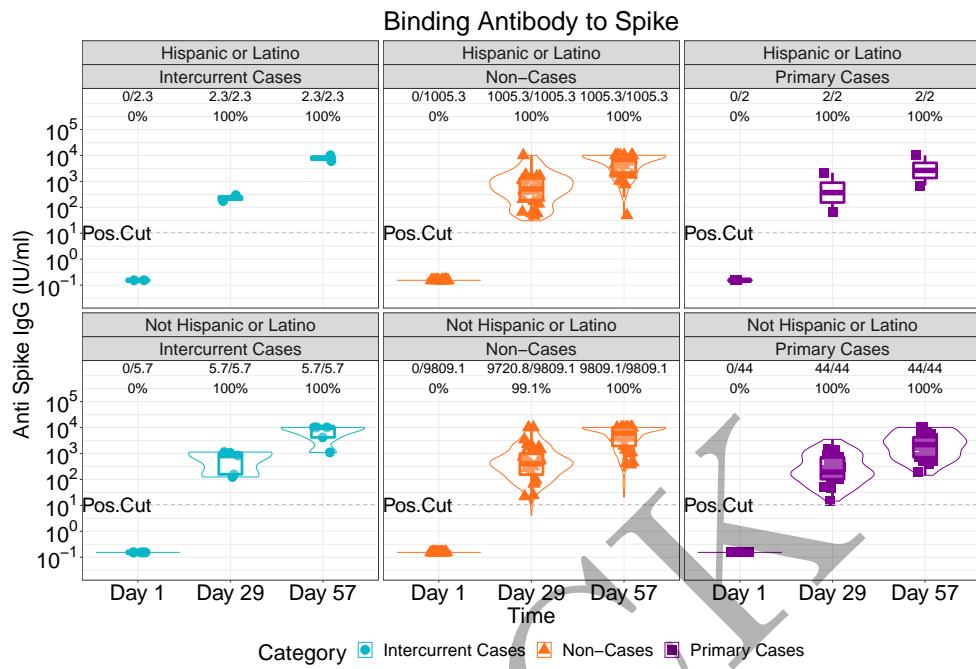


Figure 3.231: violinplots of Binding Antibody to Spike: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)

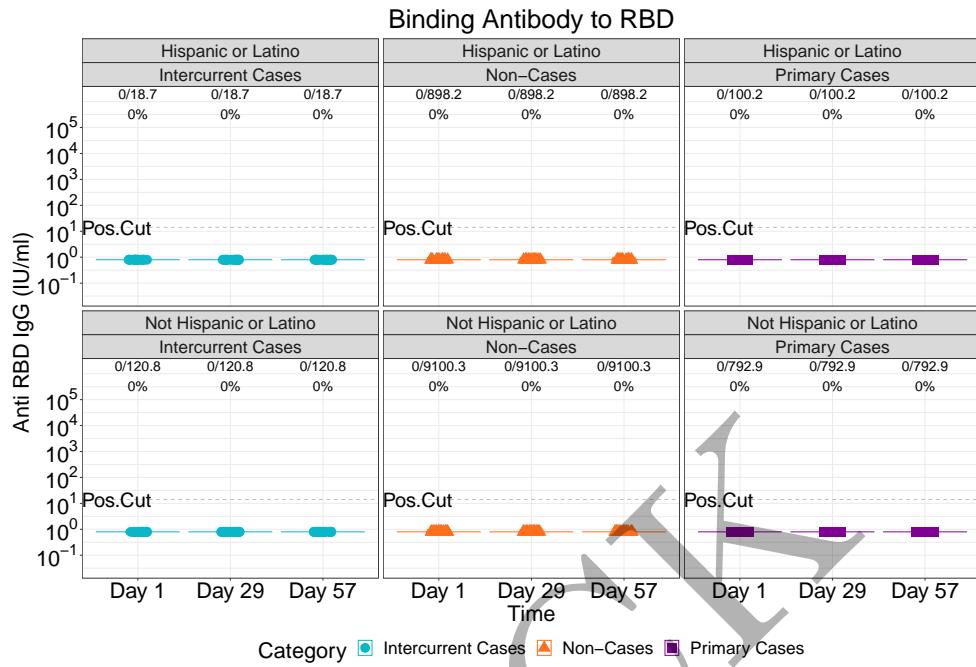


Figure 3.232: violinplots of Binding Antibody to RBD: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)

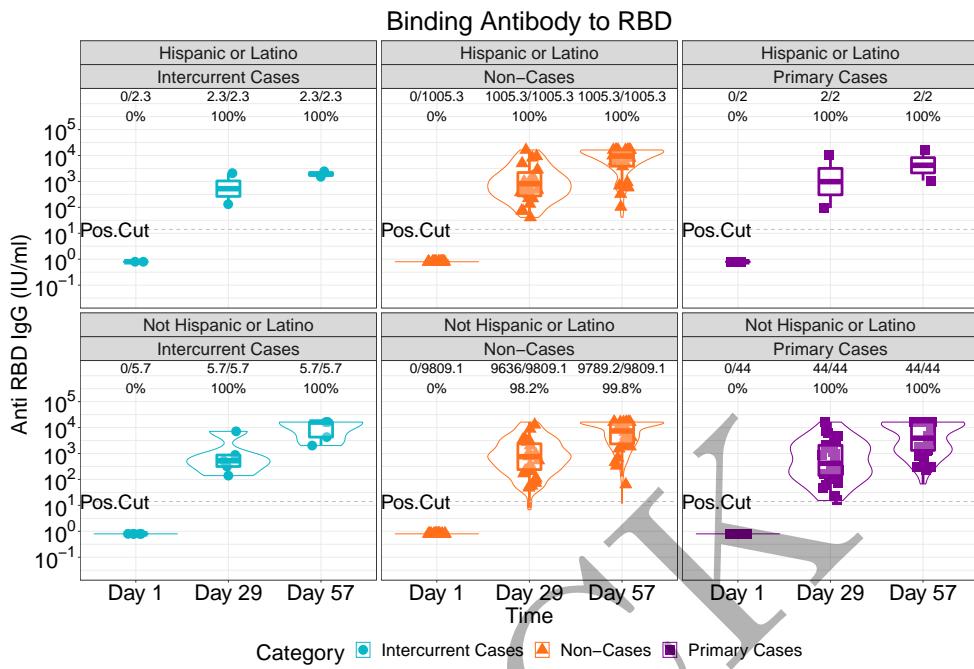


Figure 3.233: violinplots of Binding Antibody to RBD: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)

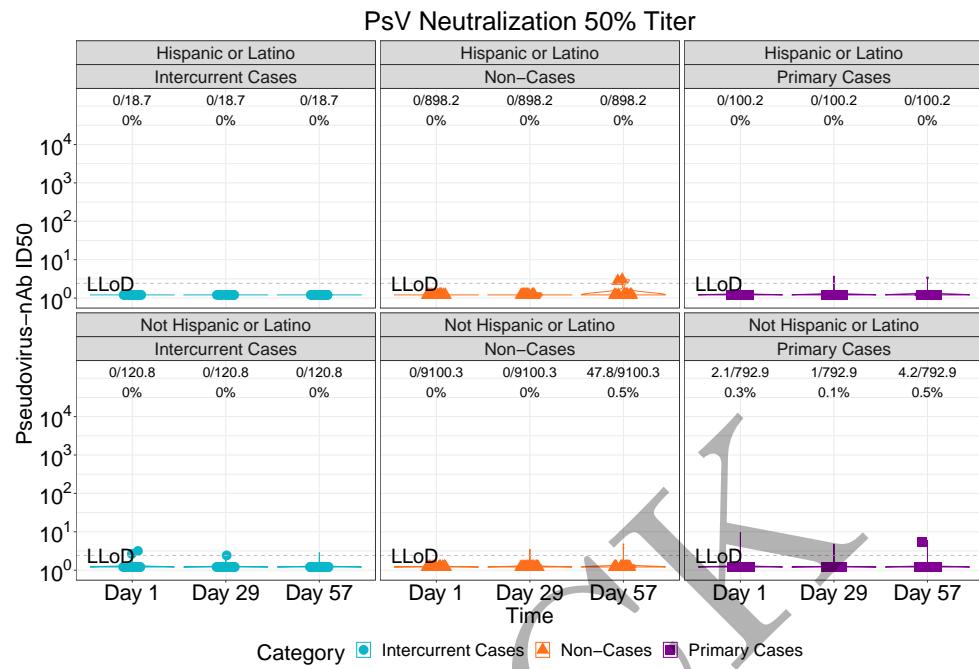


Figure 3.234: violinplots of Pseudovirus Neutralization ID50: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)

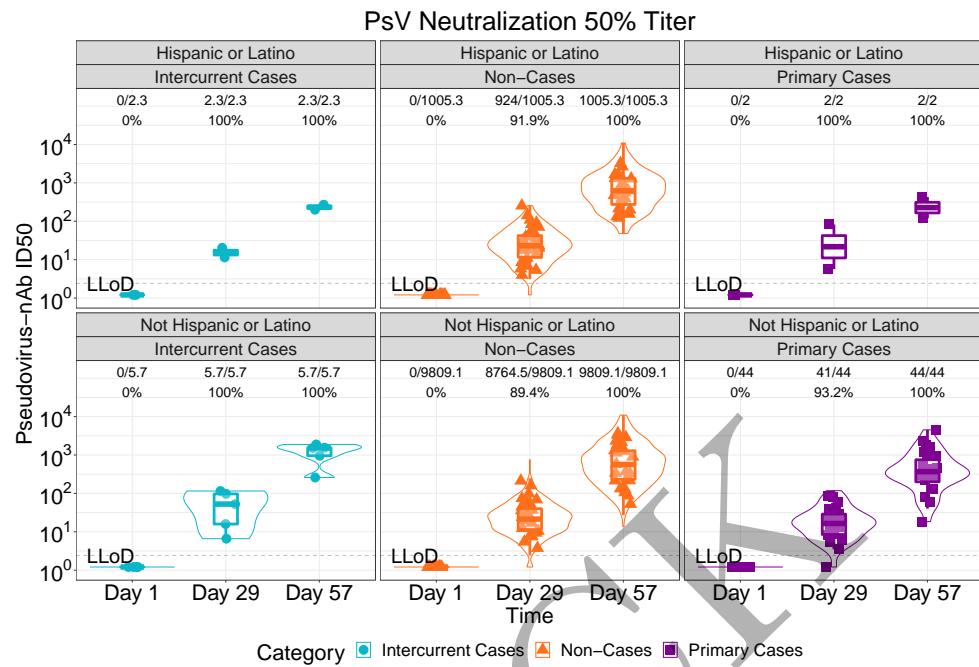


Figure 3.235: violinplots of Pseudovirus Neutralization ID50: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)

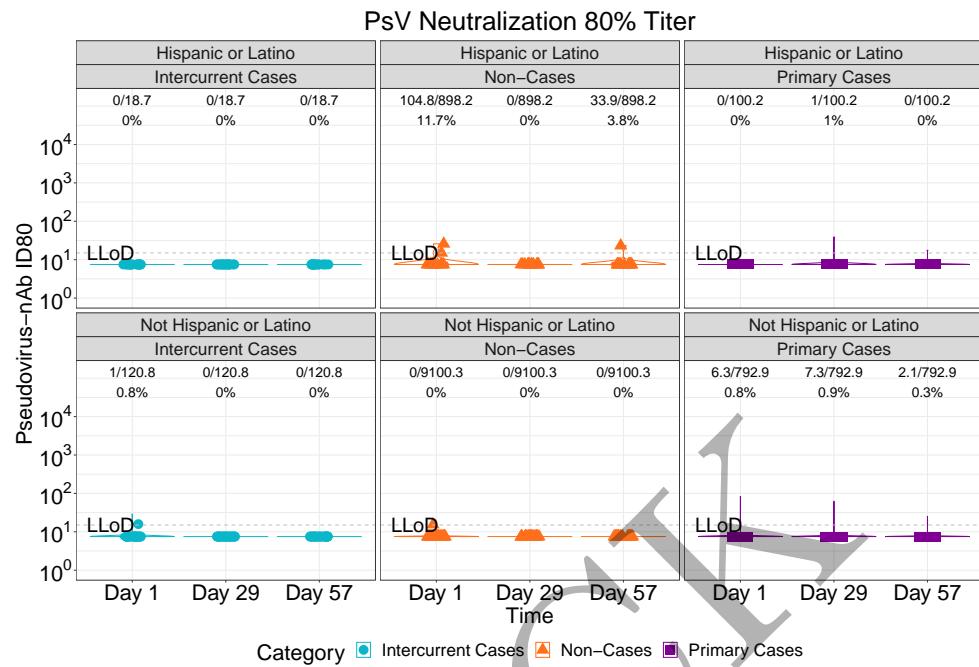


Figure 3.236: violinplots of Pseudovirus Neutralization ID80: baseline negative placebo arm by dichotomous classification of race and ethnic group (version 2)

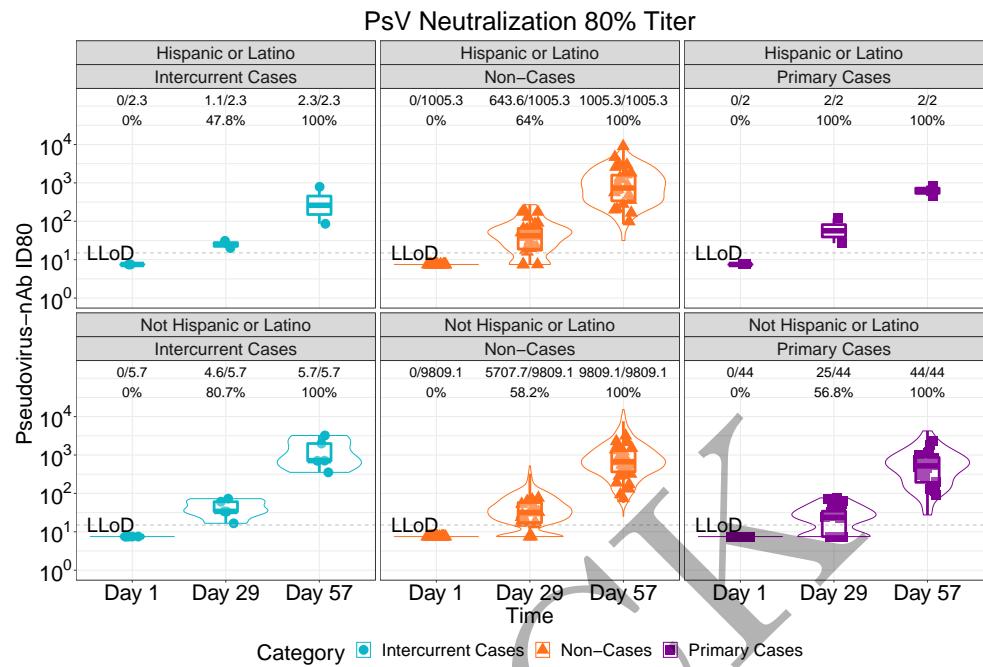


Figure 3.237: violinplots of Pseudovirus Neutralization ID80: baseline negative vaccine arm by dichotomous classification of race and ethnic group (version 2)

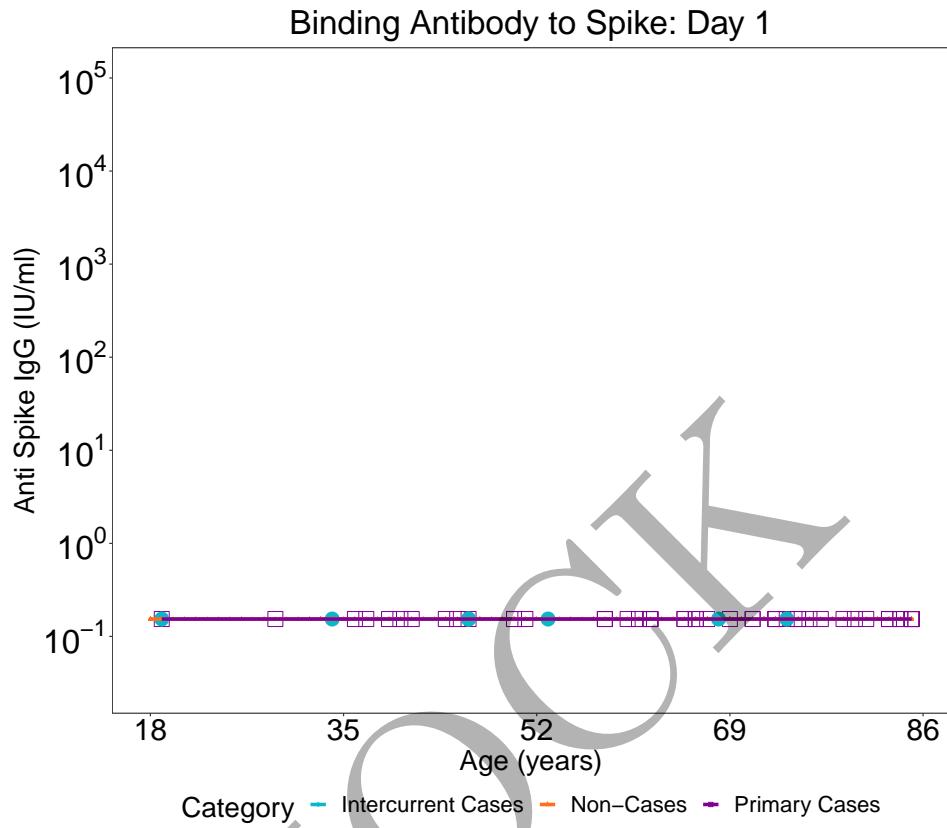


Figure 3.238: scatterplots of Binding Antibody to Spike vs Age: baseline negative vaccine arm at day 1

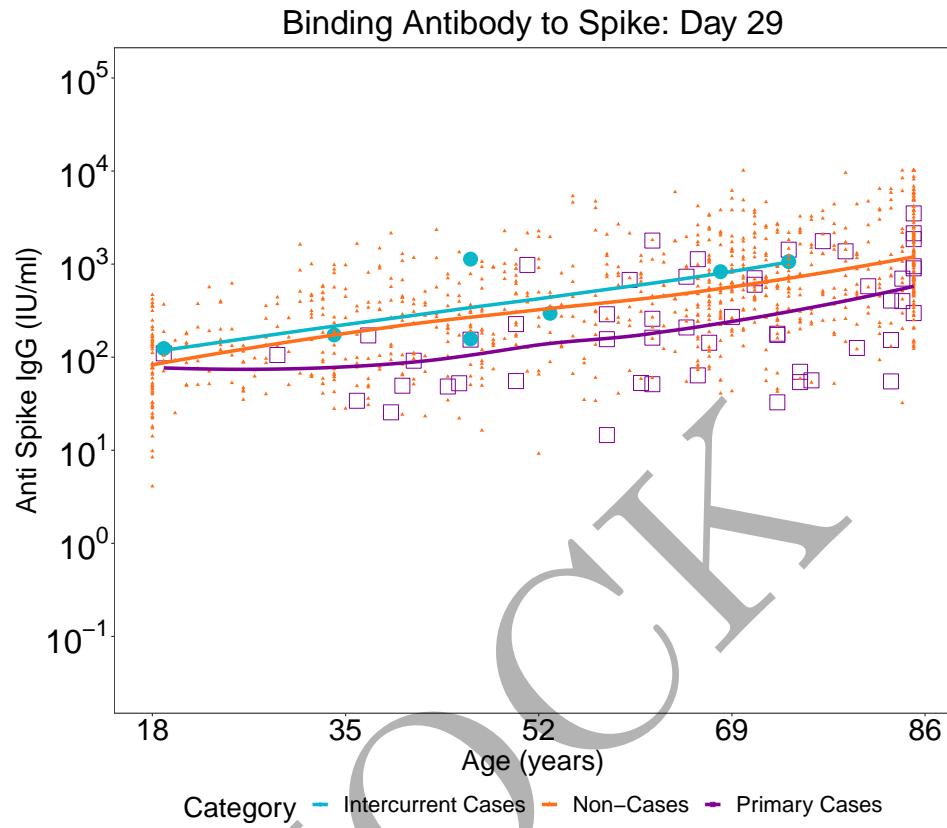


Figure 3.239: scatterplots of Binding Antibody to Spike vs Age: baseline negative vaccine arm at day 29

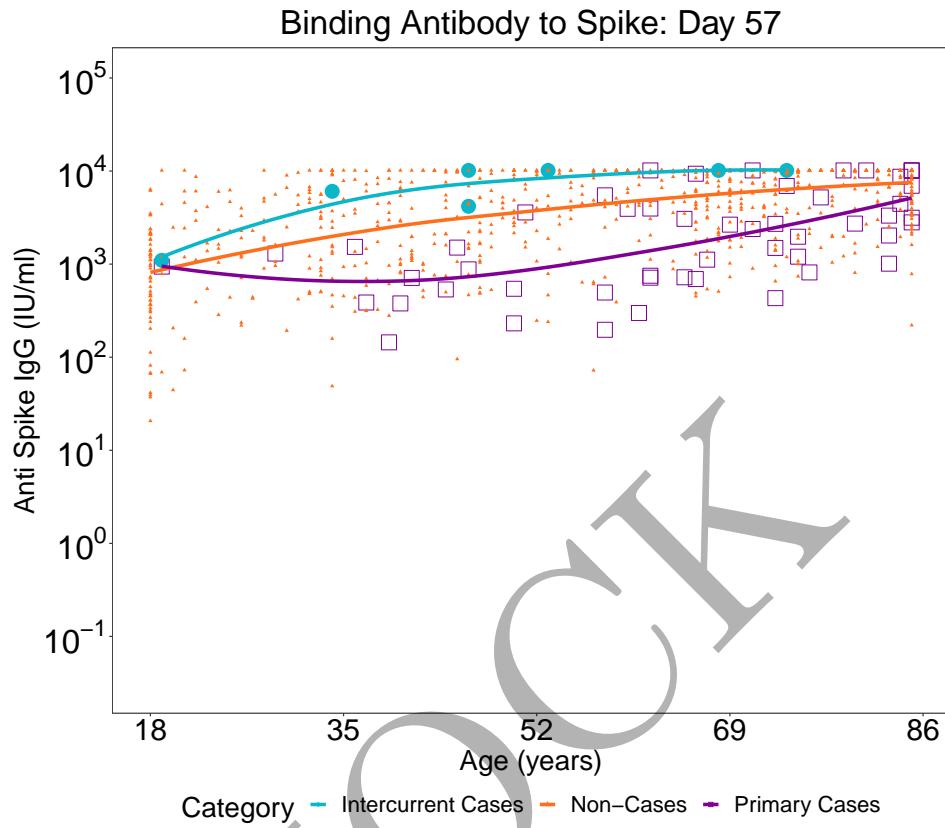


Figure 3.240: scatterplots of Binding Antibody to Spike vs Age: baseline negative vaccine arm at day 57

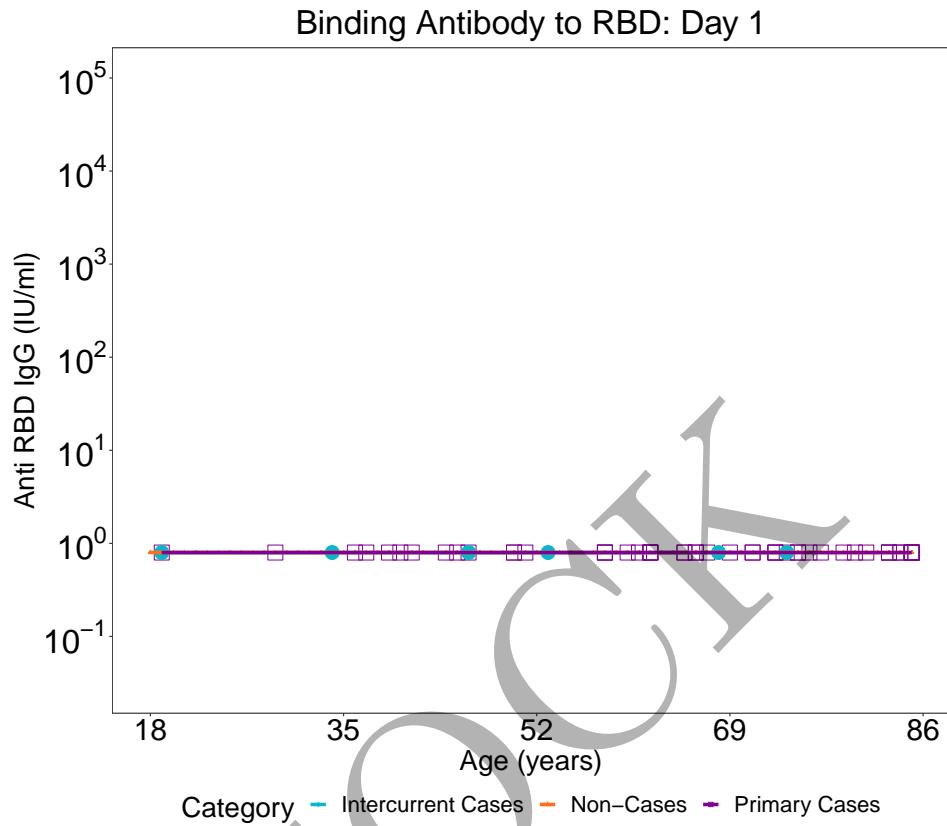


Figure 3.241: scatterplots of Binding Antibody to RBD vs Age: baseline negative vaccine arm at day 1

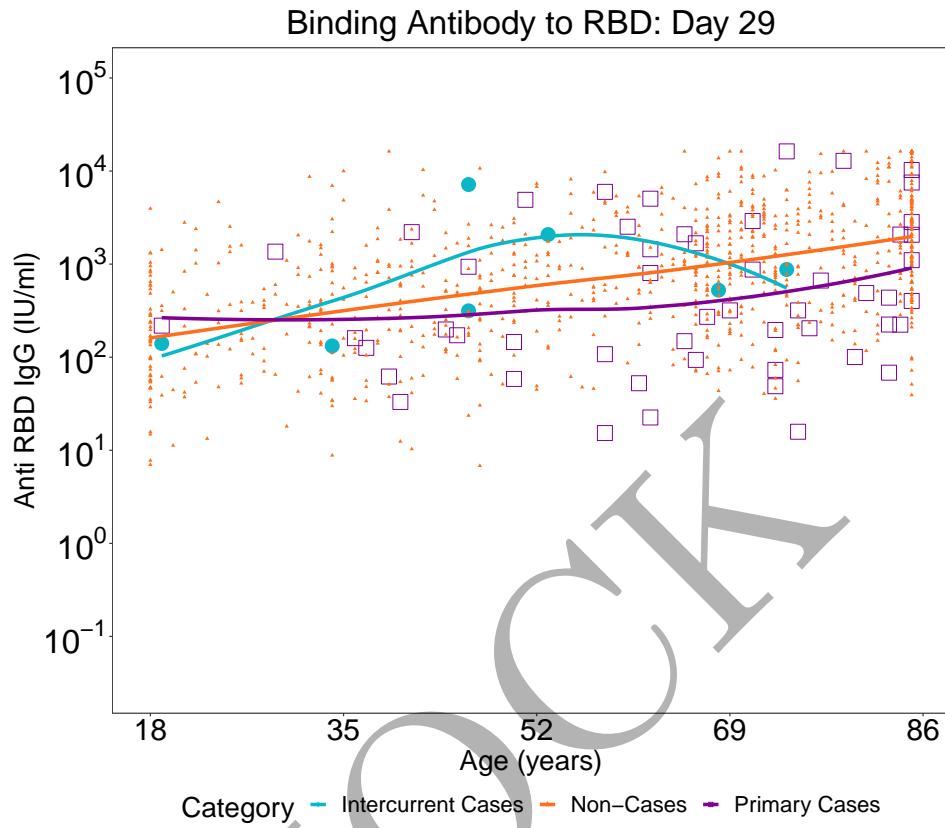


Figure 3.242: scatterplots of Binding Antibody to RBD vs Age: baseline negative vaccine arm at day 29

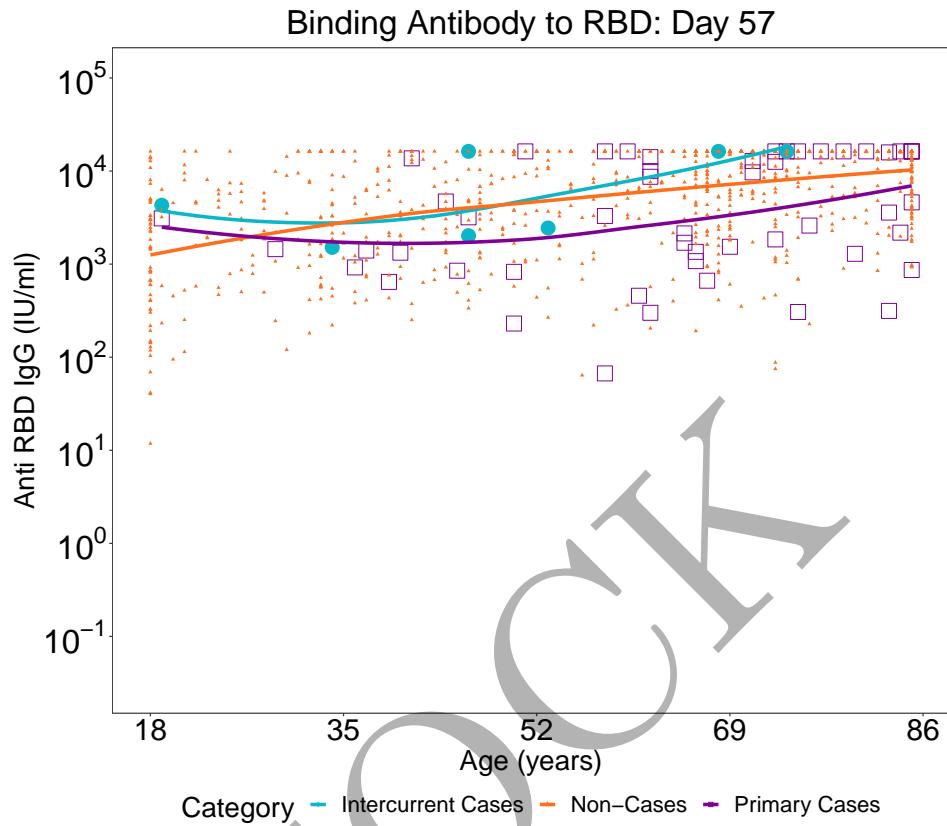


Figure 3.243: scatterplots of Binding Antibody to RBD vs Age: baseline negative vaccine arm at day 57

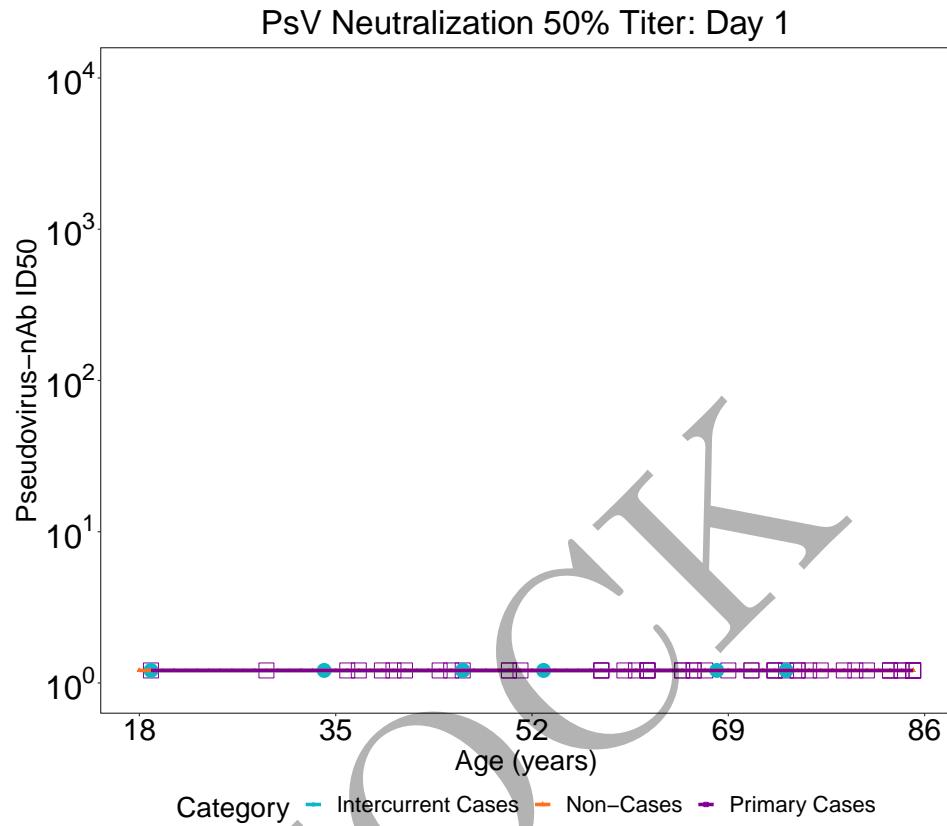


Figure 3.244: scatterplots of Pseudovirus Neutralization ID₅₀ vs Age: baseline negative vaccine arm at day 1

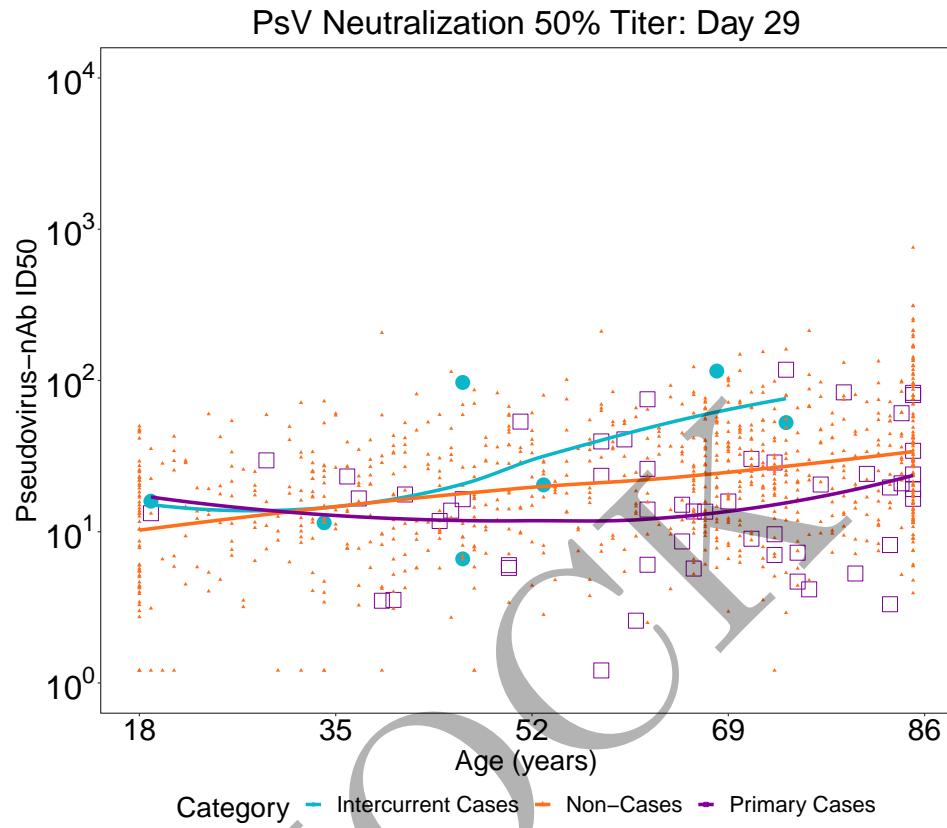


Figure 3.245: scatterplots of Pseudovirus Neutralization ID50 vs Age: baseline negative vaccine arm at day 29

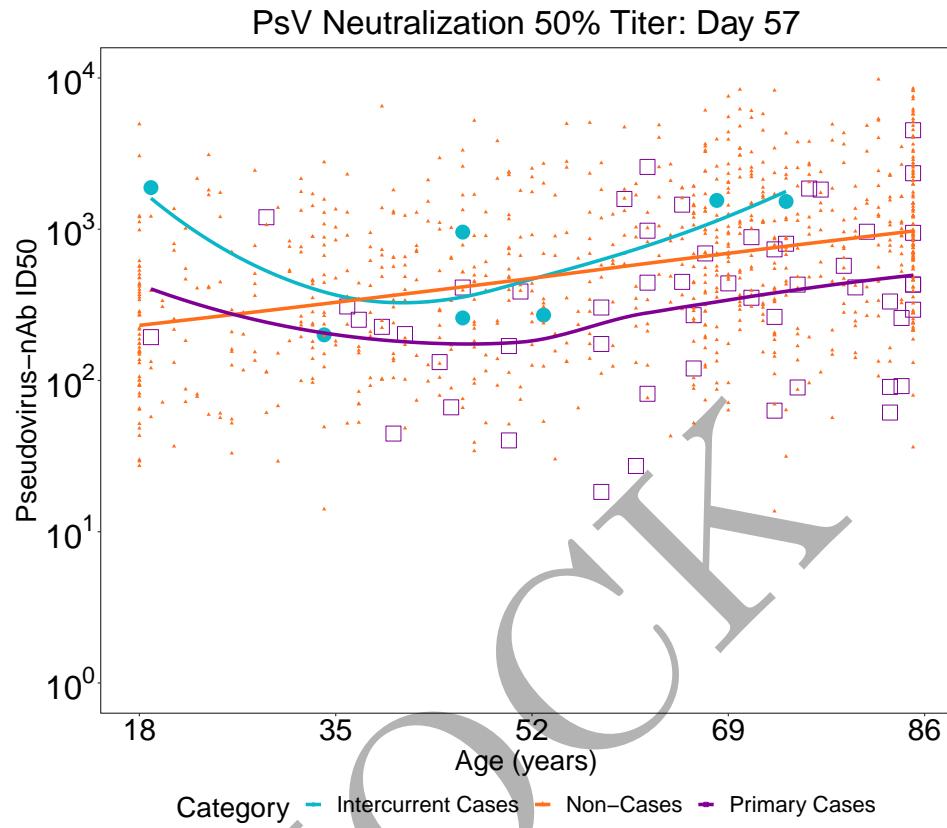


Figure 3.246: scatterplots of Pseudovirus Neutralization ID50 vs Age: baseline negative vaccine arm at day 57

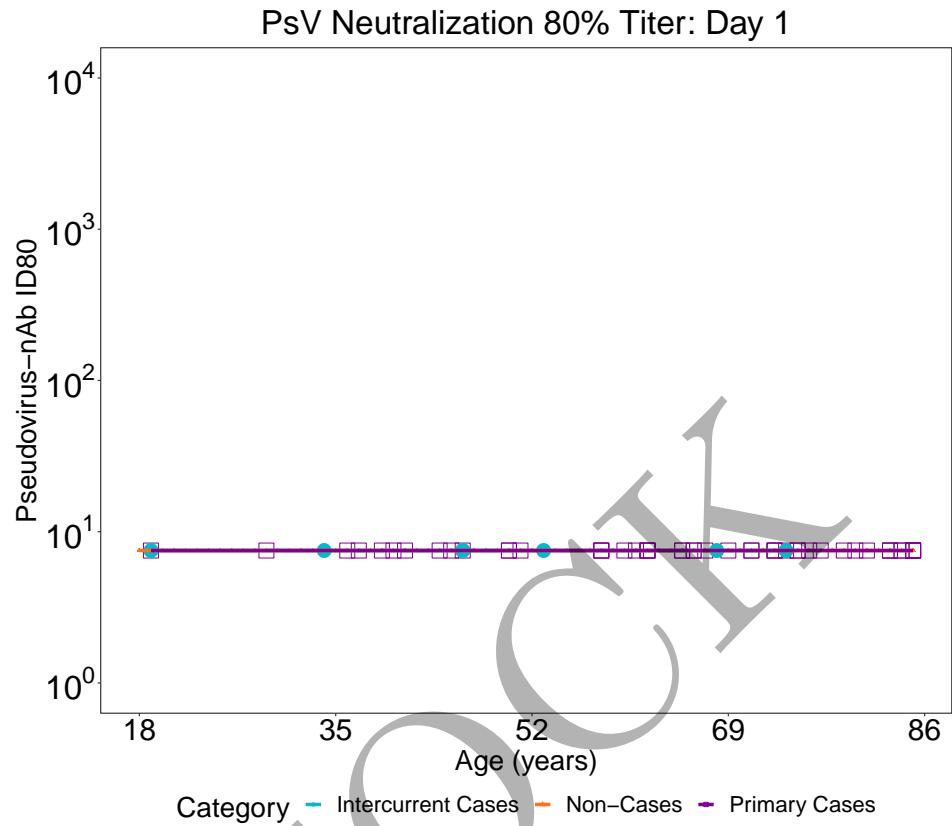


Figure 3.247: scatterplots of Pseudovirus Neutralization ID80 vs Age: baseline negative vaccine arm at day 1

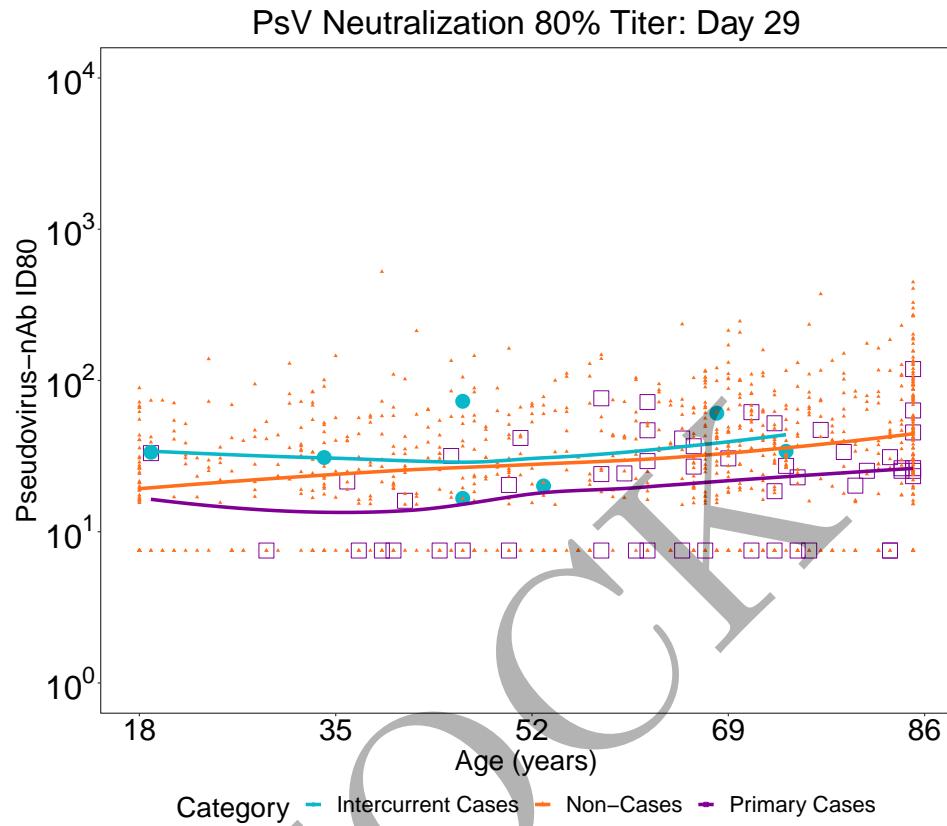


Figure 3.248: scatterplots of Pseudovirus Neutralization ID80 vs Age: baseline negative vaccine arm at day 29

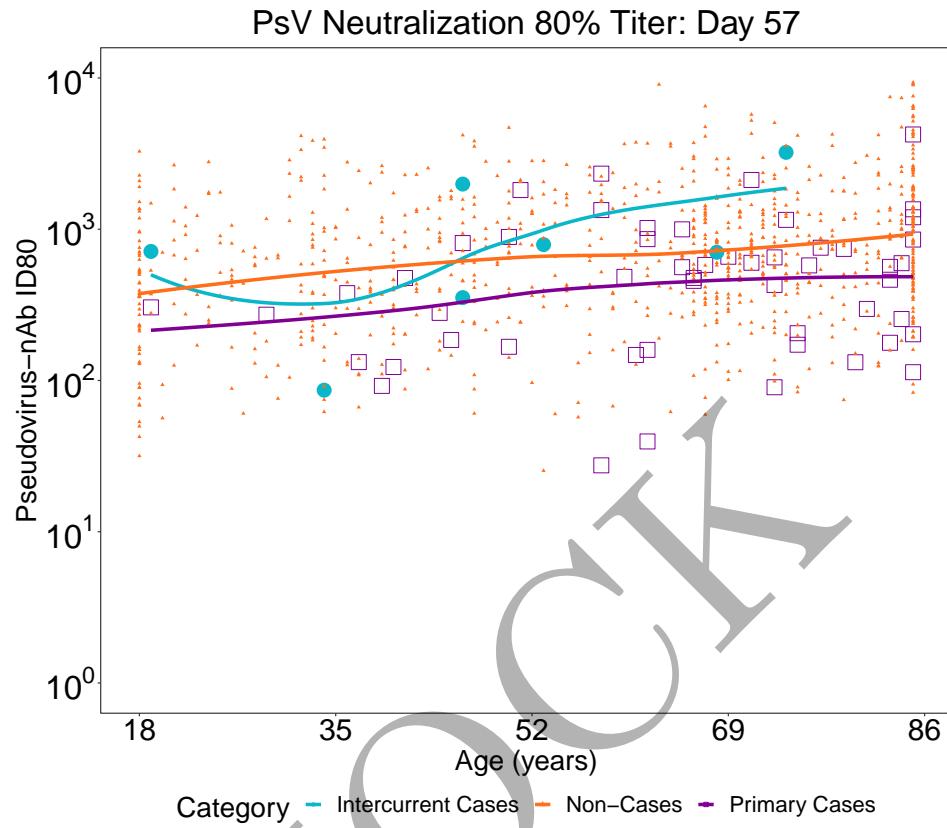


Figure 3.249: scatterplots of Pseudovirus Neutralization ID80 vs Age: baseline negative vaccine arm at day 57

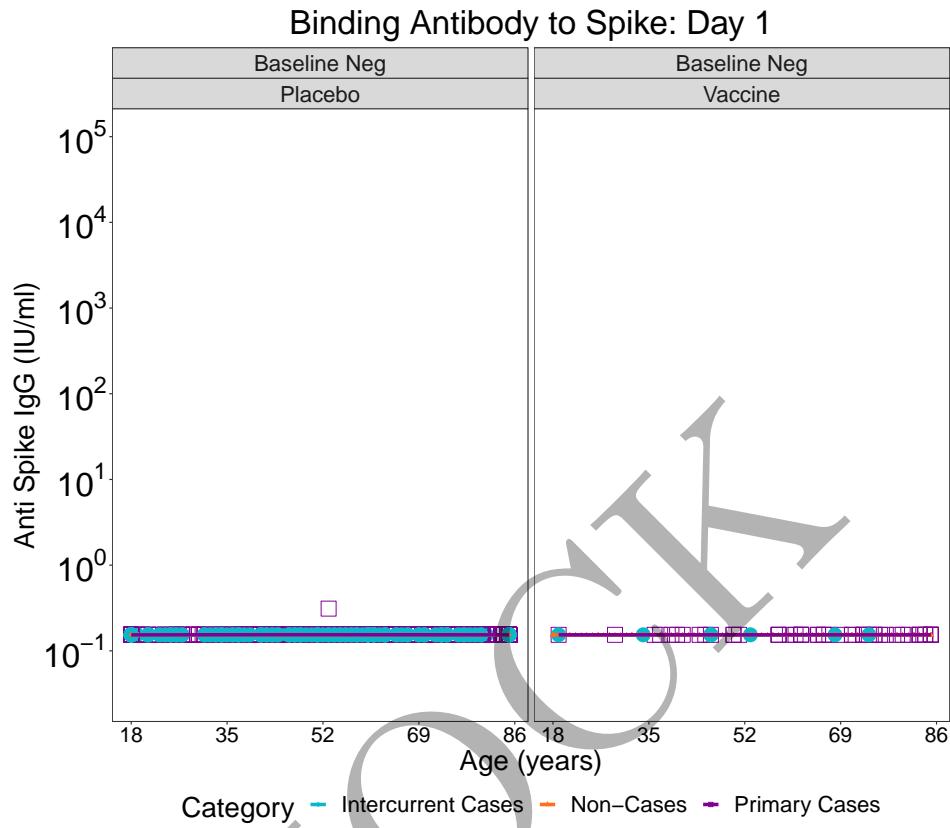


Figure 3.250: scatterplots of Binding Antibody to Spike vs Age: by arm at day 1

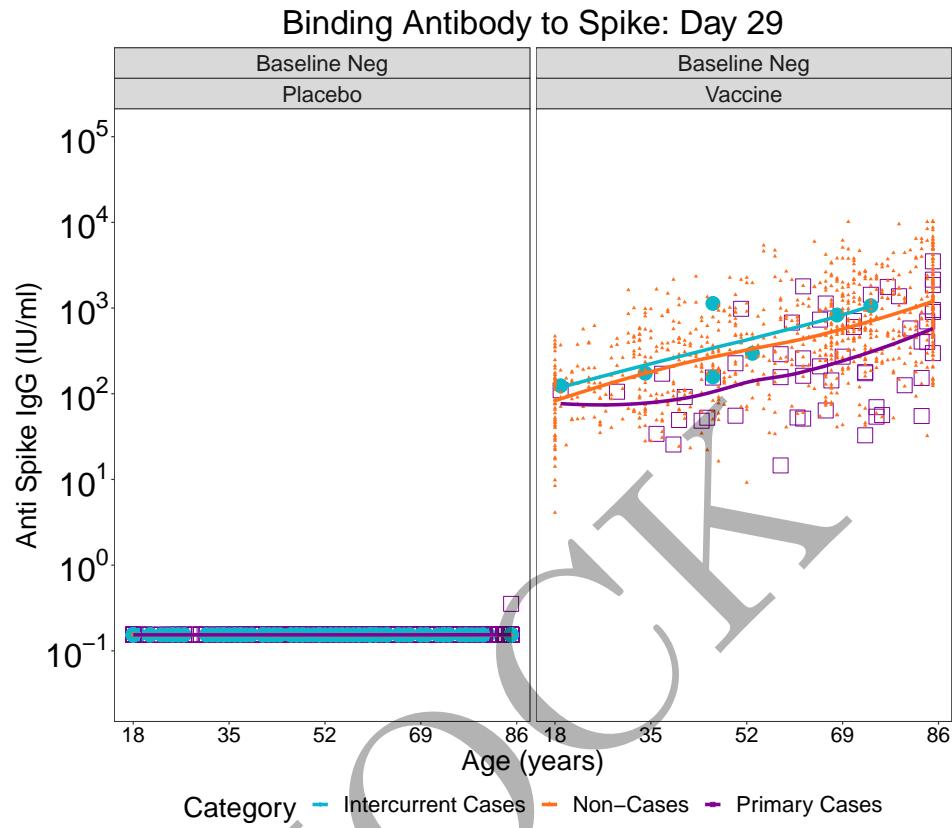


Figure 3.251: scatterplots of Binding Antibody to Spike vs Age: by arm at day 29

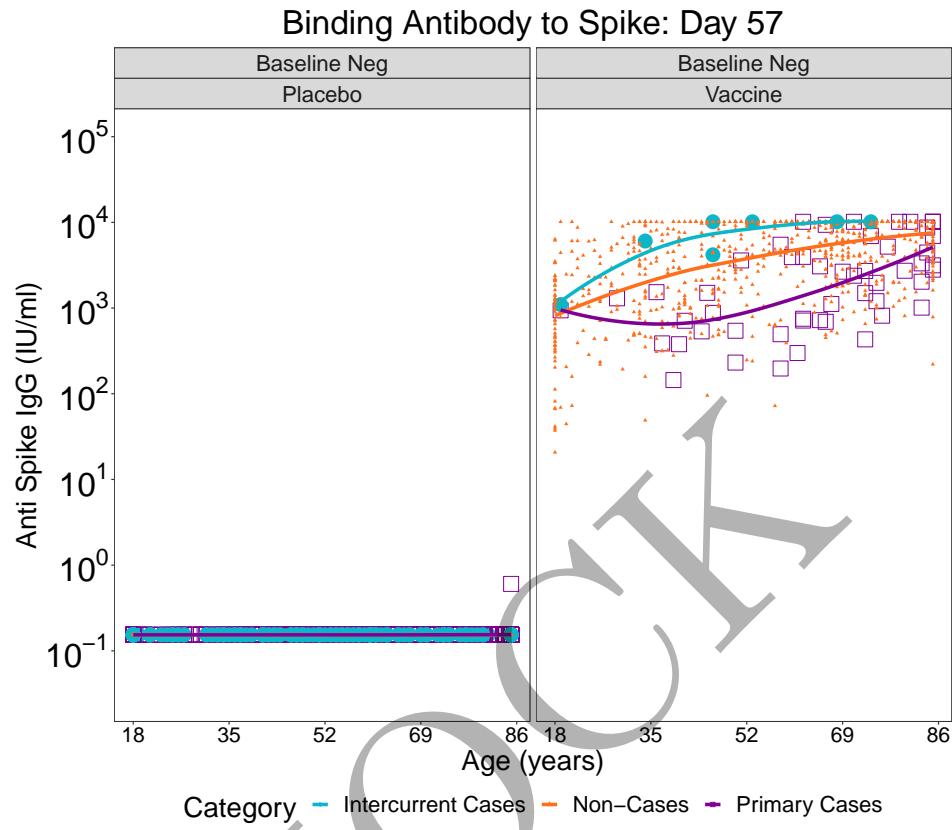


Figure 3.252: scatterplots of Binding Antibody to Spike vs Age: by arm at day 57

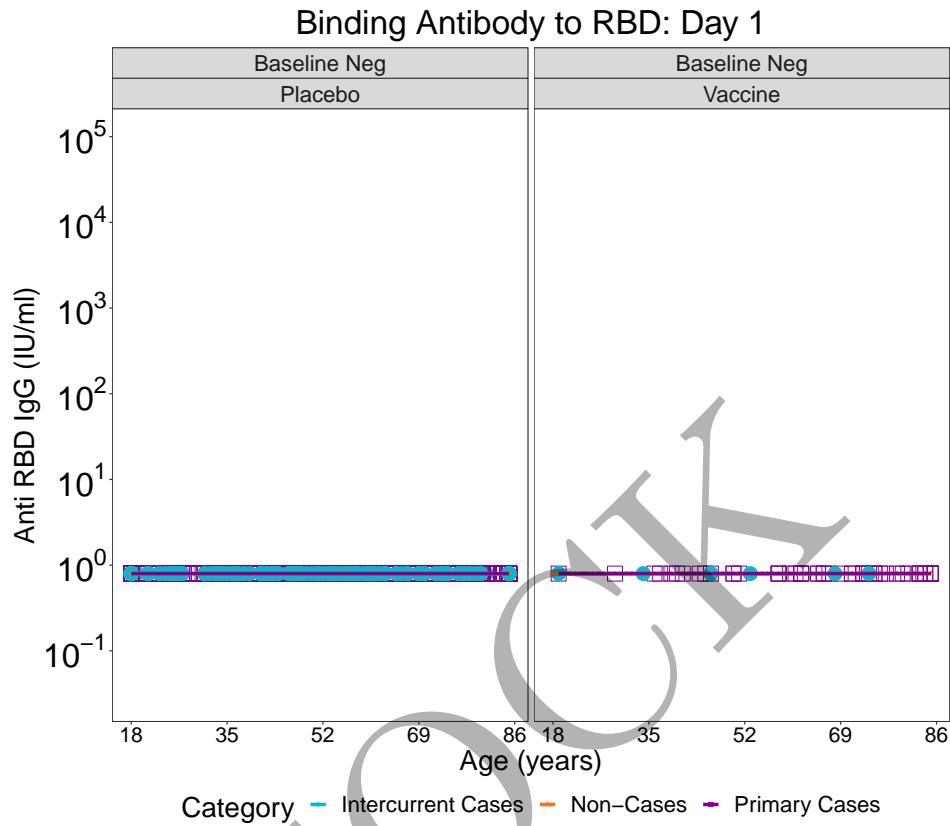


Figure 3.253: scatterplots of Binding Antibody to RBD vs Age: by arm at day 1

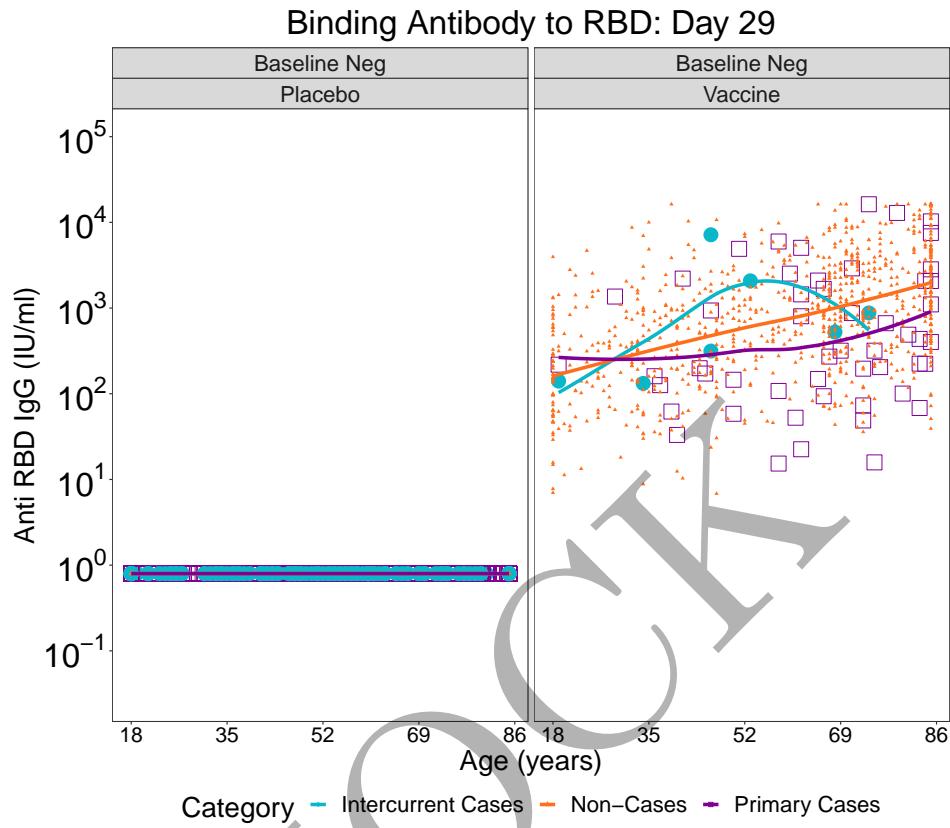


Figure 3.254: scatterplots of Binding Antibody to RBD vs Age: by arm at day 29

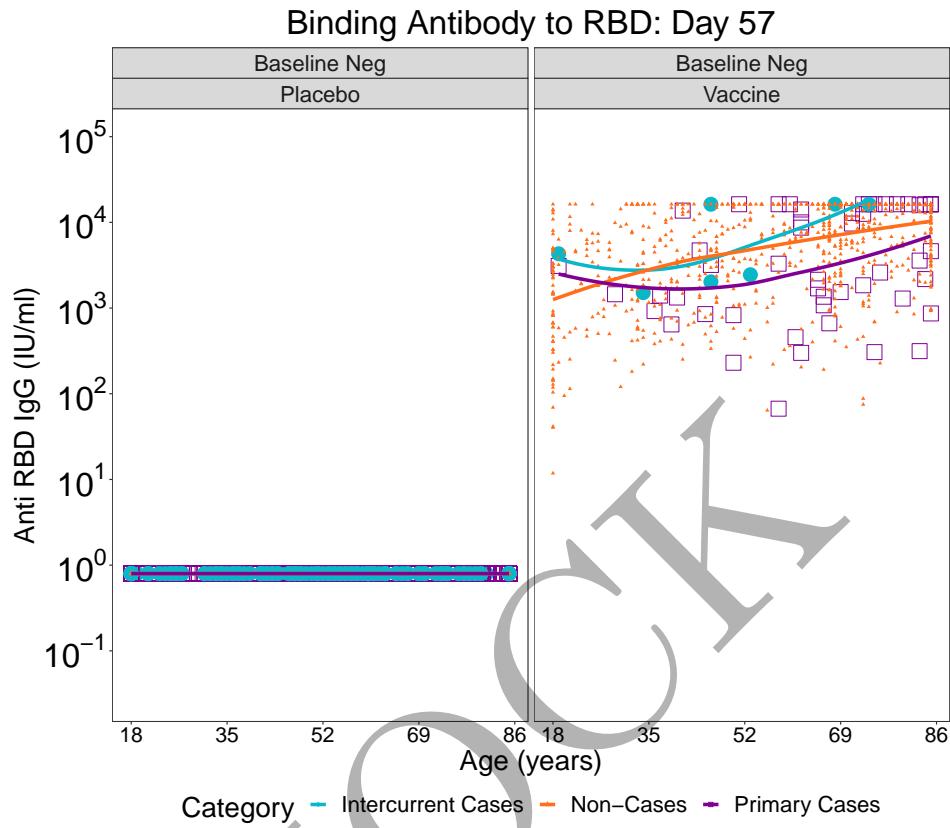


Figure 3.255: scatterplots of Binding Antibody to RBD vs Age: by arm at day 57

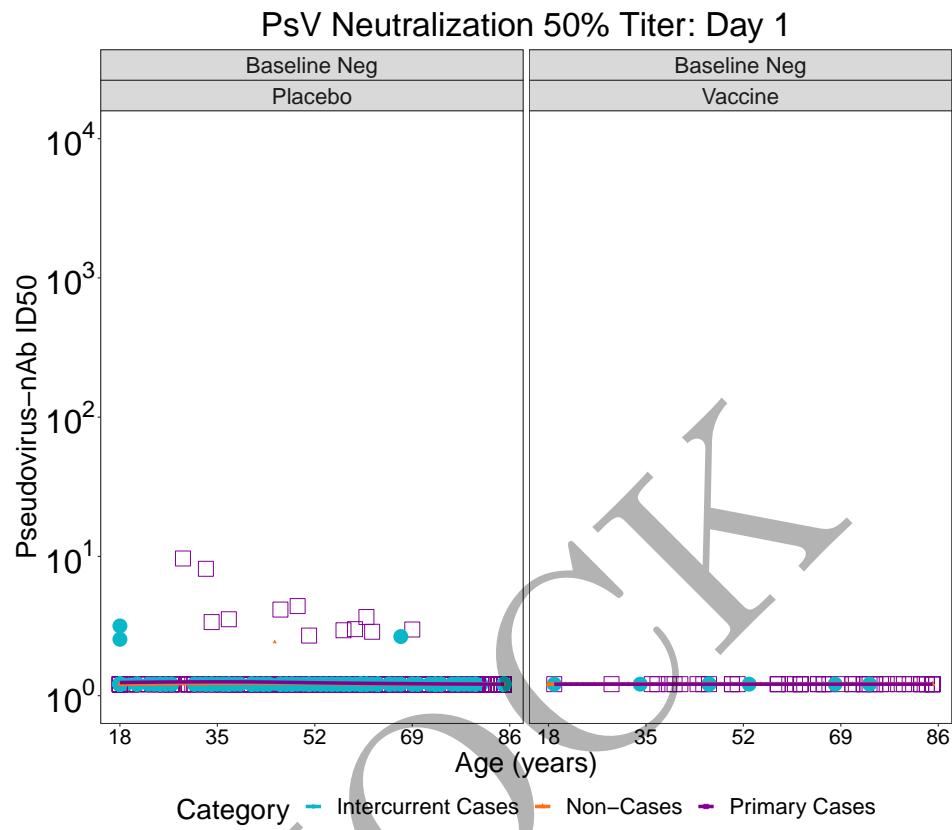


Figure 3.256: scatterplots of Pseudovirus Neutralization ID50 vs Age vs Age: by arm at day 1

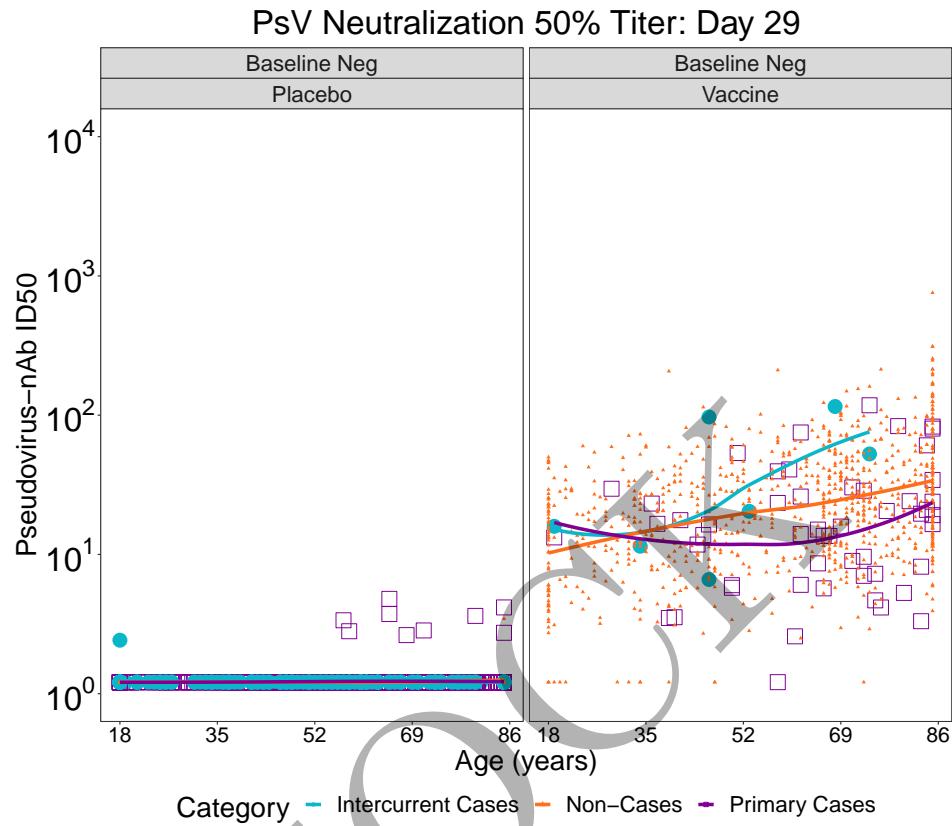


Figure 3.257: scatterplots of Pseudovirus Neutralization ID50 vs Age vs Age: by arm at day 29

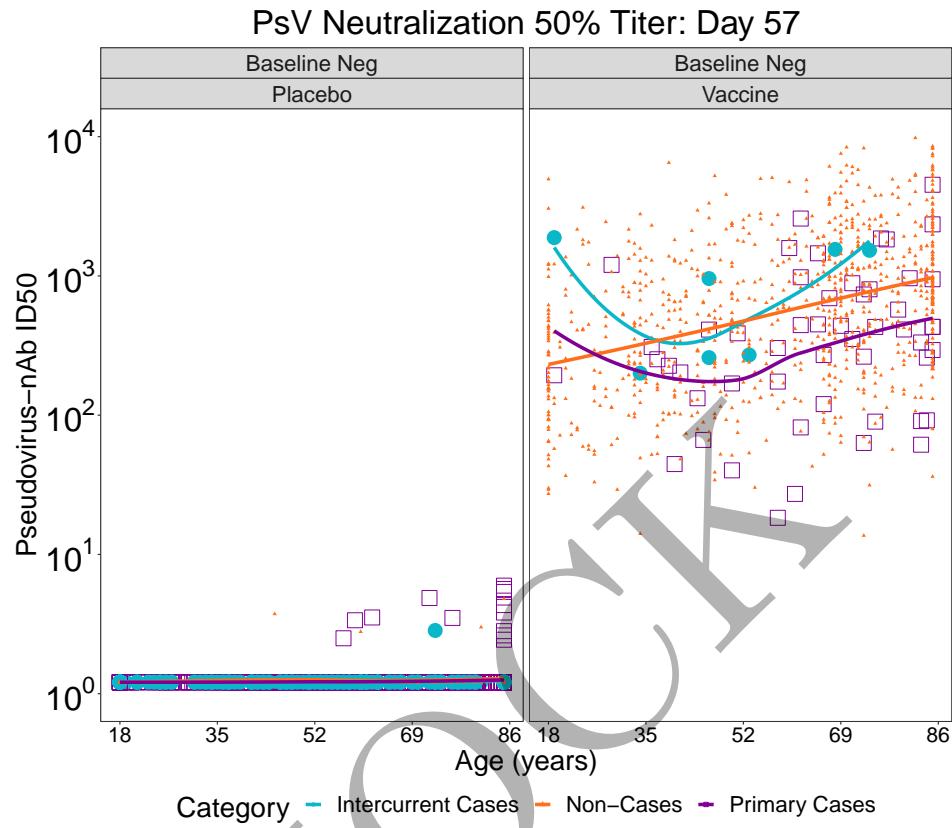


Figure 3.258: scatterplots of Pseudovirus Neutralization ID50 vs Age: by arm at day 57

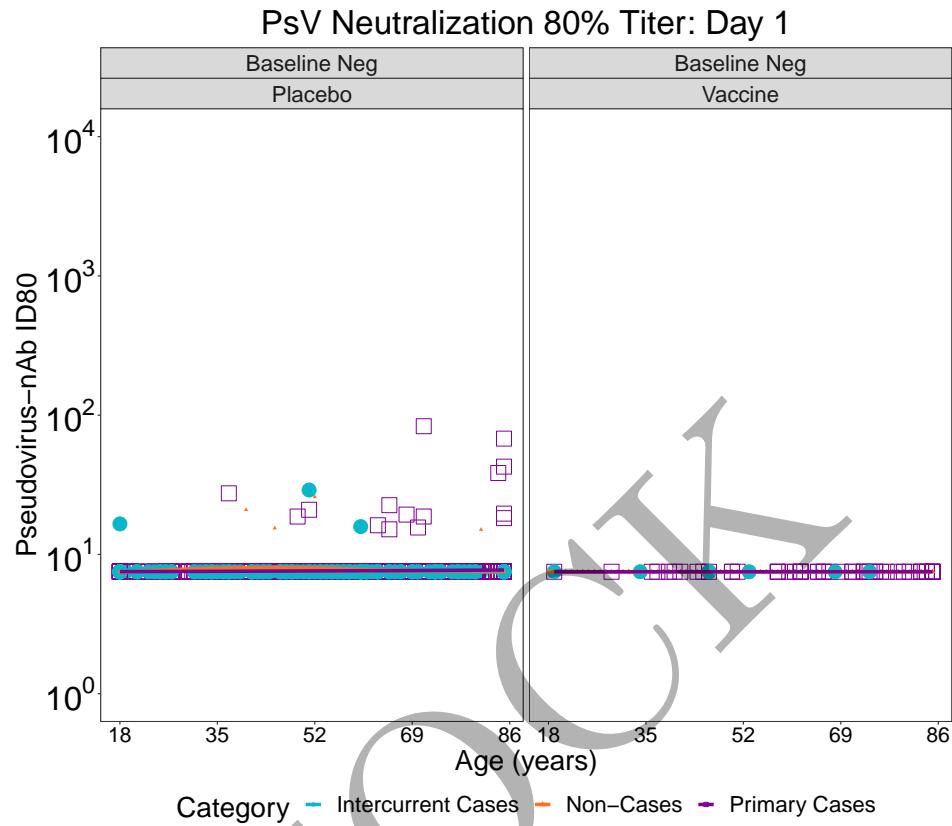


Figure 3.259: scatterplots of Pseudovirus Neutralization ID80 vs Age: by arm at day 1

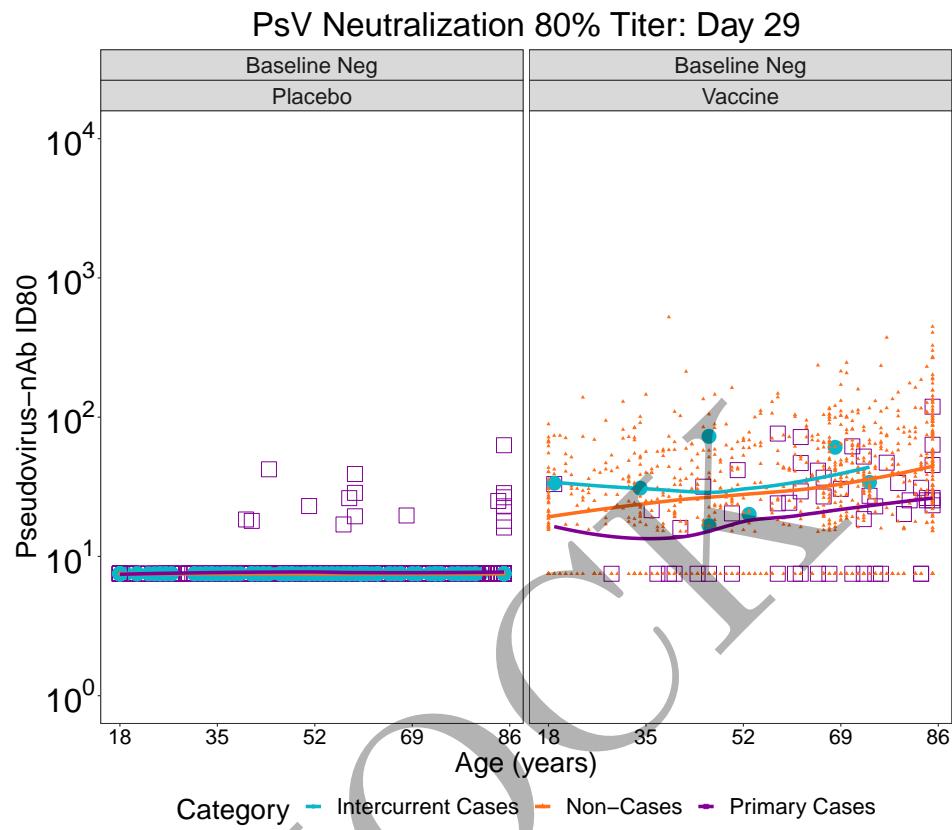


Figure 3.260: scatterplots of Pseudovirus Neutralization ID80 vs Age: by arm at day 29

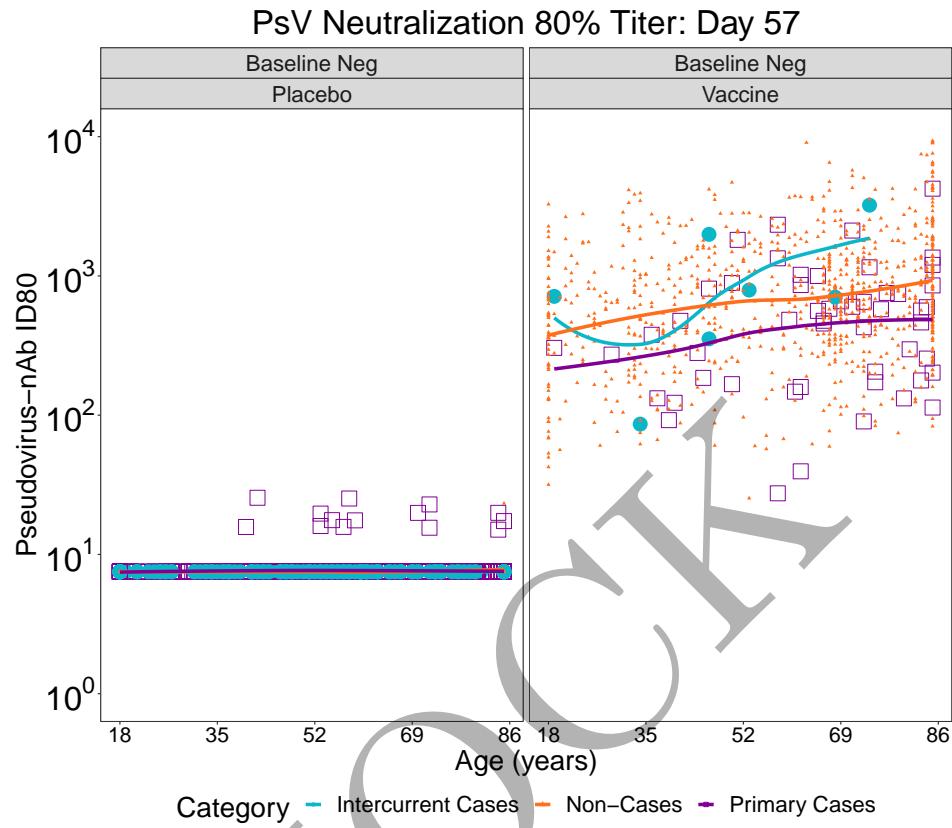


Figure 3.261: scatterplots of Pseudovirus Neutralization ID80 vs Age: by arm at day 57

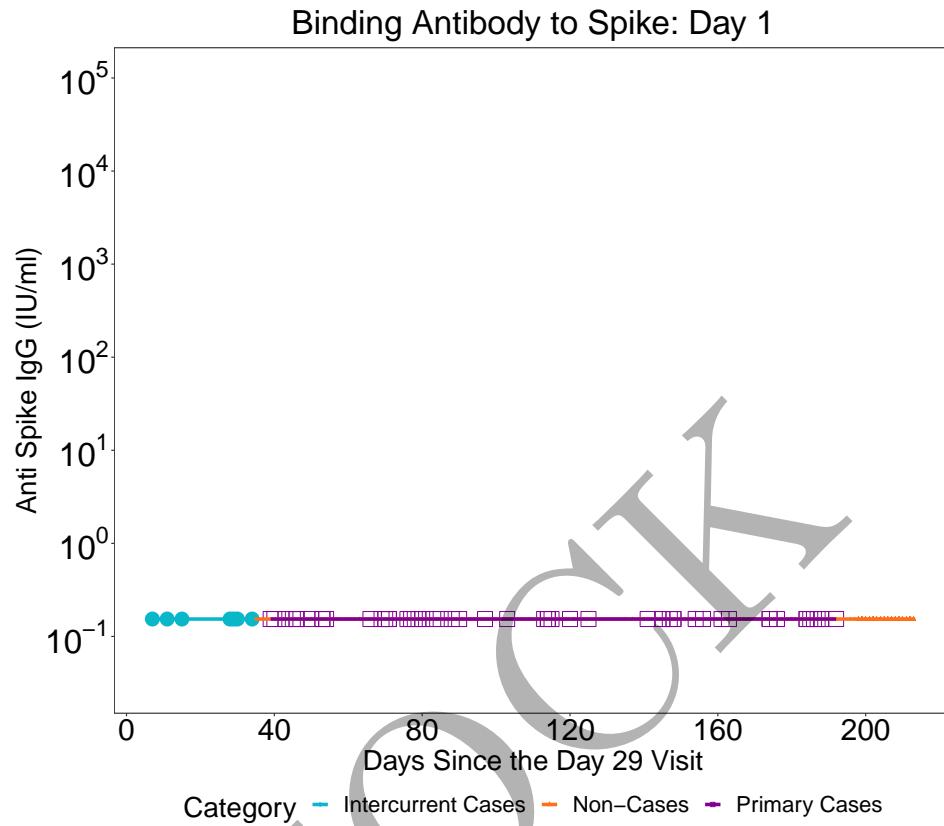


Figure 3.262: scatterplots of Binding Antibody to Spike vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 1

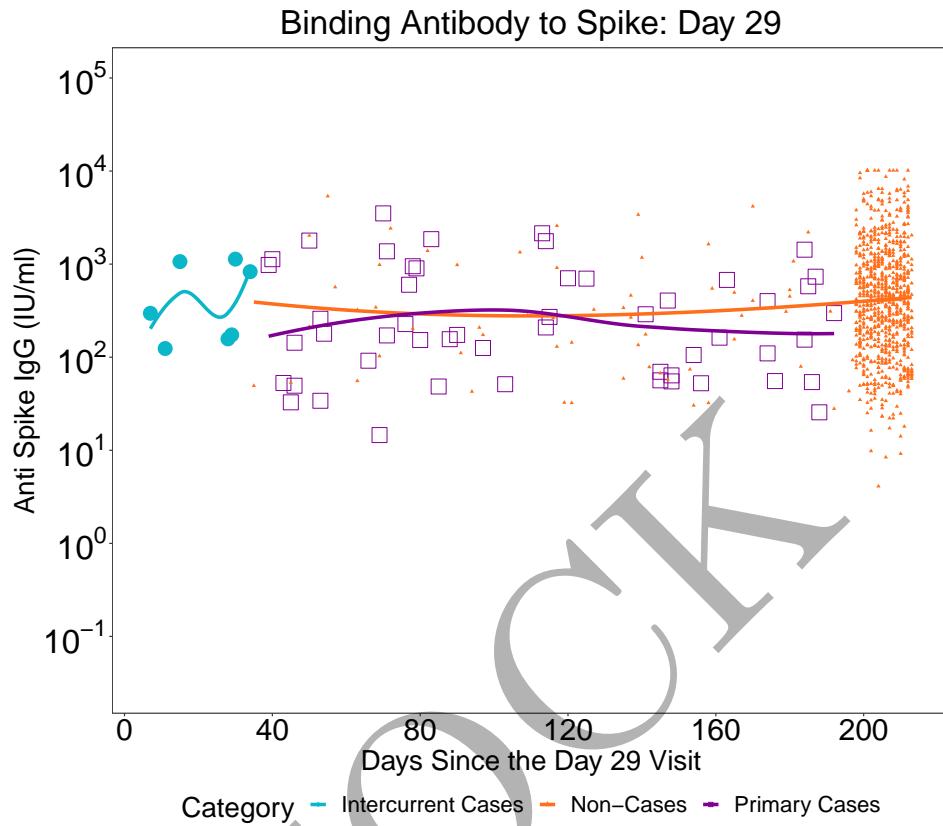


Figure 3.263: scatterplots of Binding Antibody to Spike vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 29

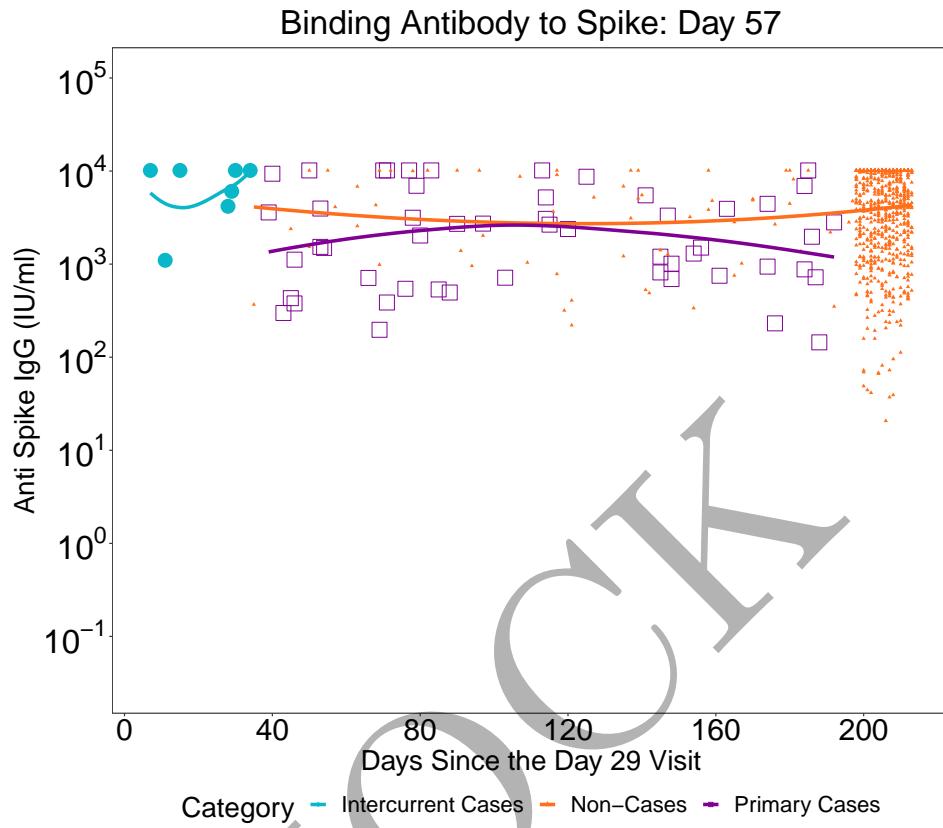


Figure 3.264: scatterplots of Binding Antibody to Spike vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 57

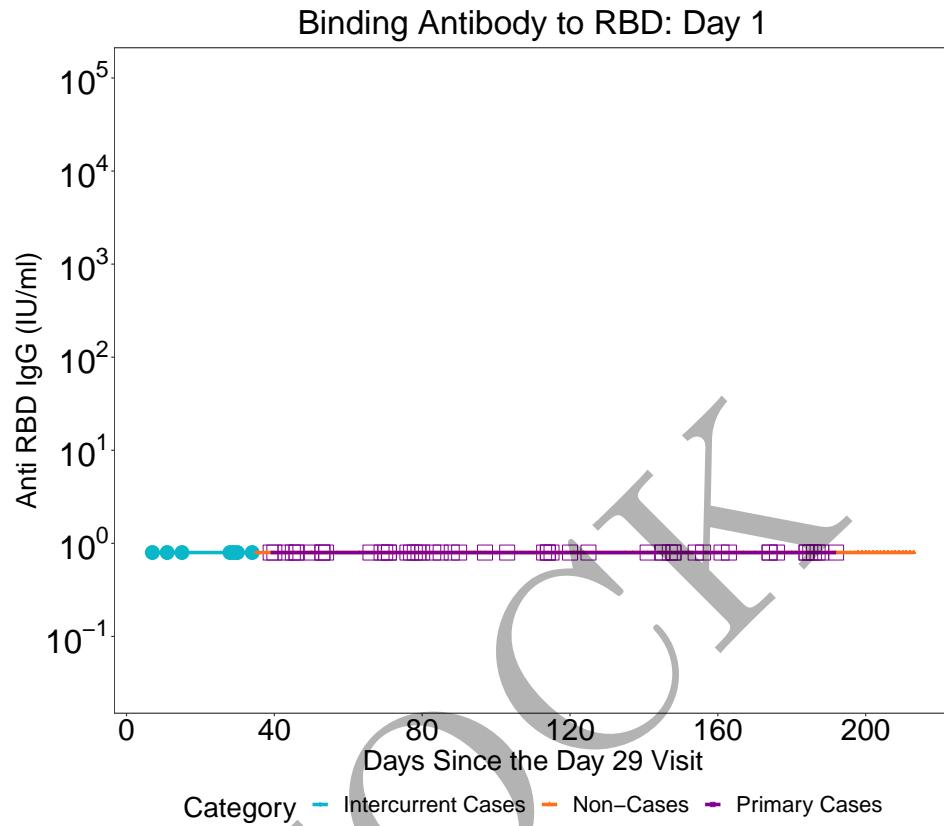


Figure 3.265: scatterplots of Binding Antibody to RBD vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 1

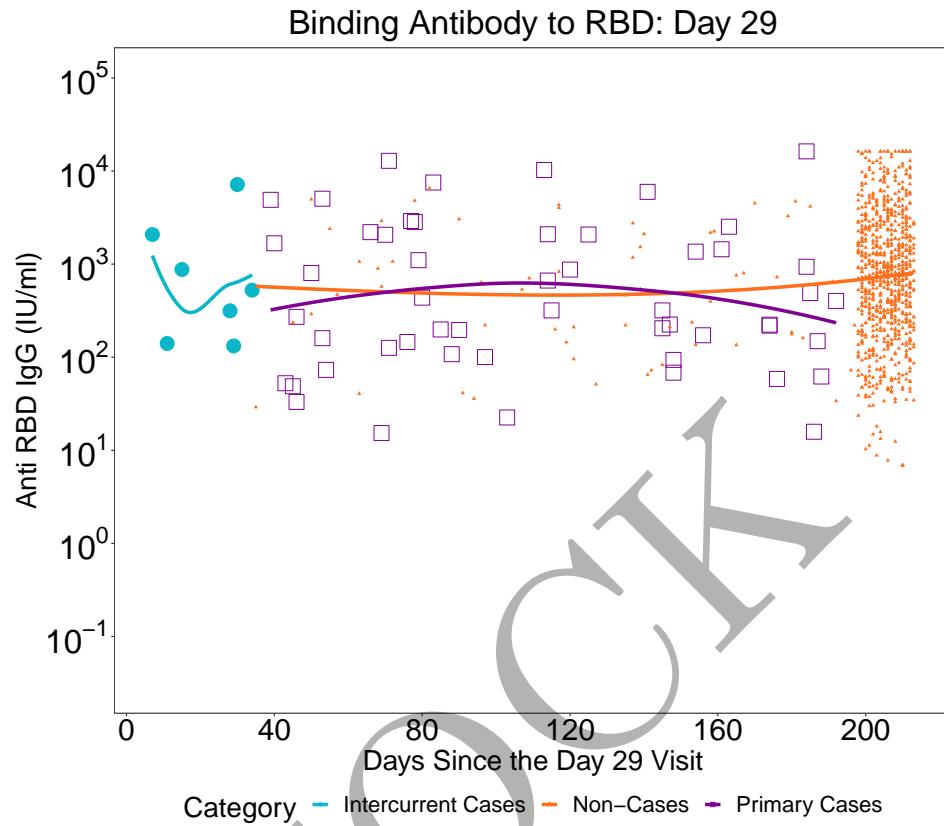


Figure 3.266: scatterplots of Binding Antibody to RBD vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 29

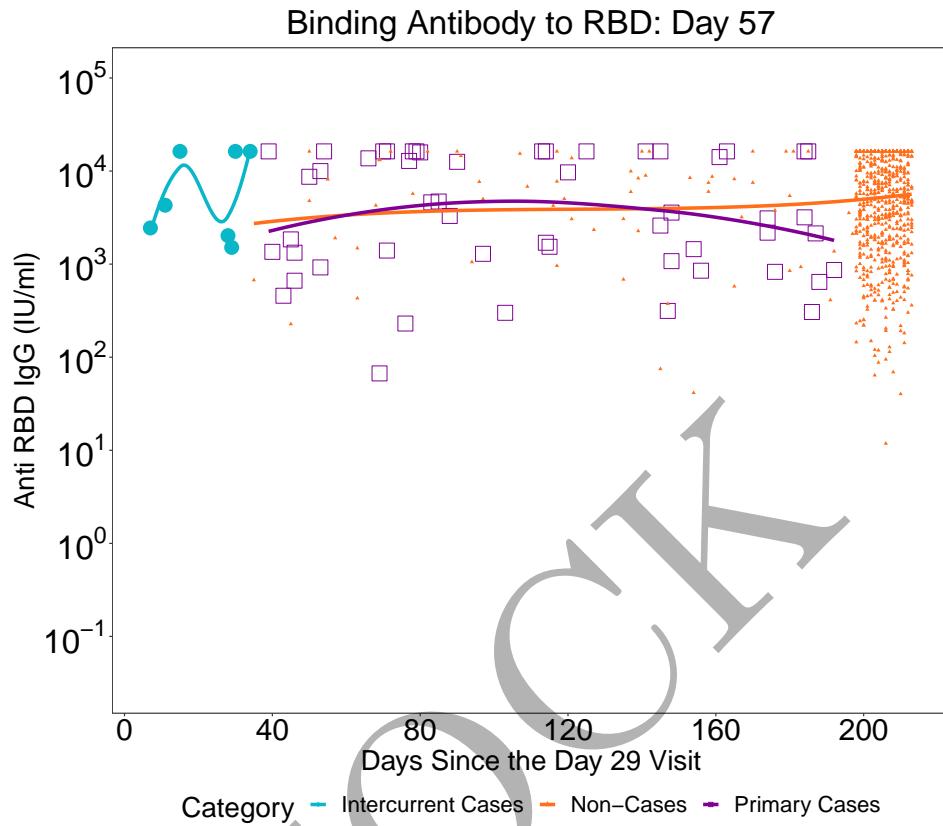


Figure 3.267: scatterplots of Binding Antibody to RBD vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 57

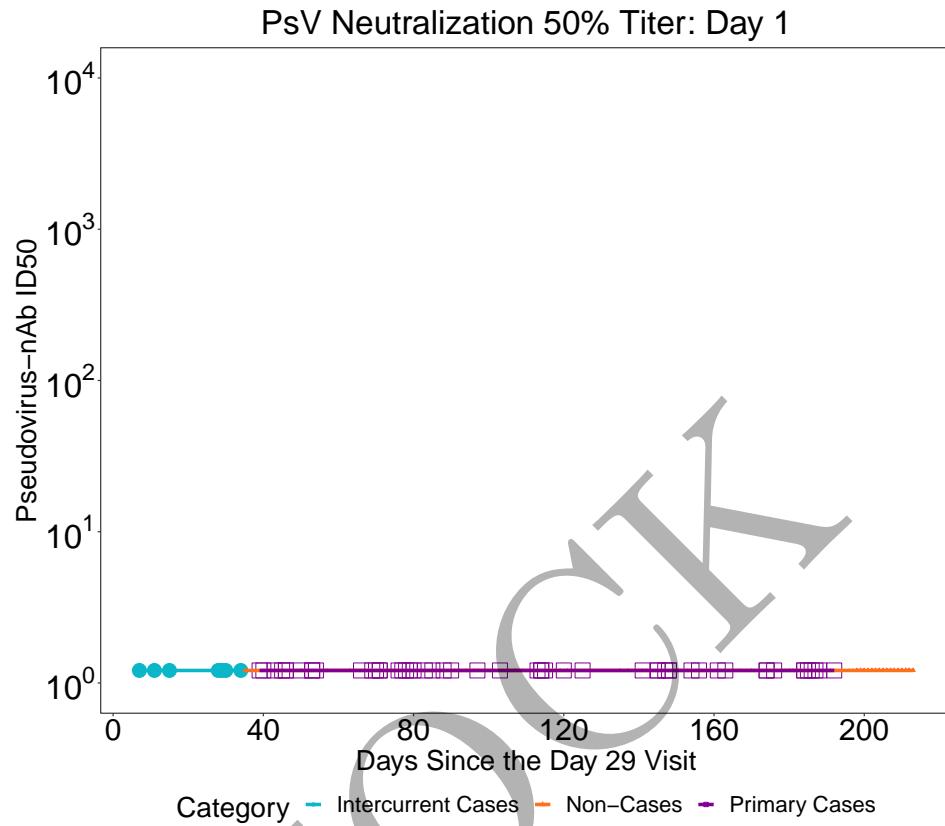


Figure 3.268: scatterplots of Pseudovirus Neutralization ID₅₀ vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 1

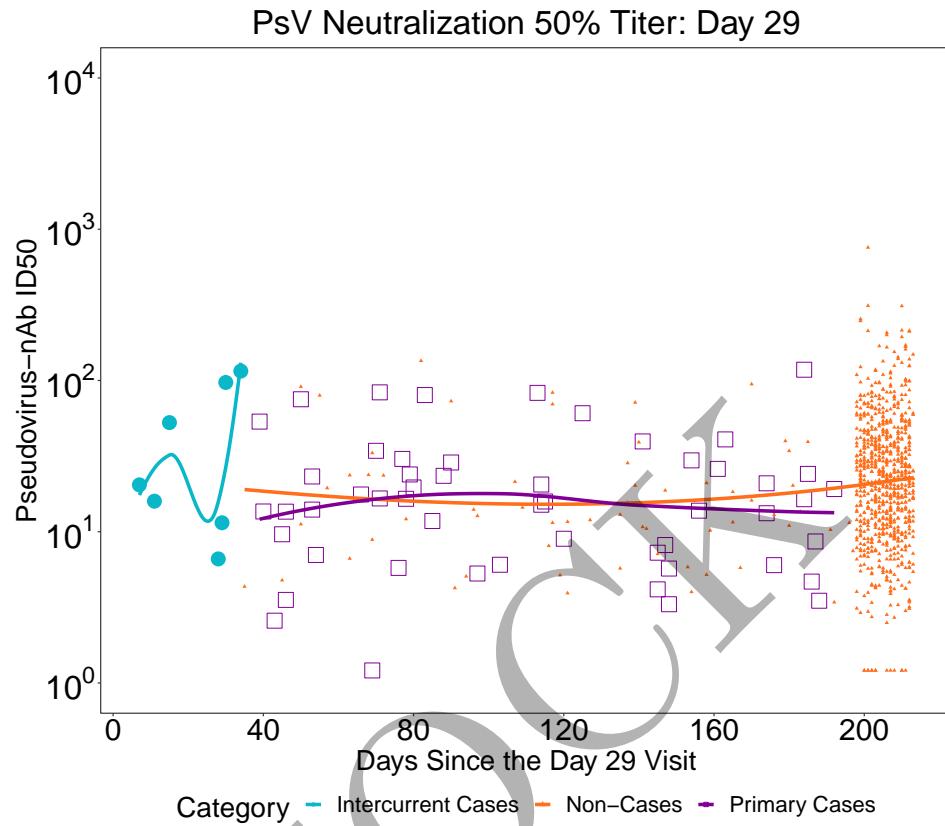


Figure 3.269: scatterplots of Pseudovirus Neutralization ID₅₀ vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 29

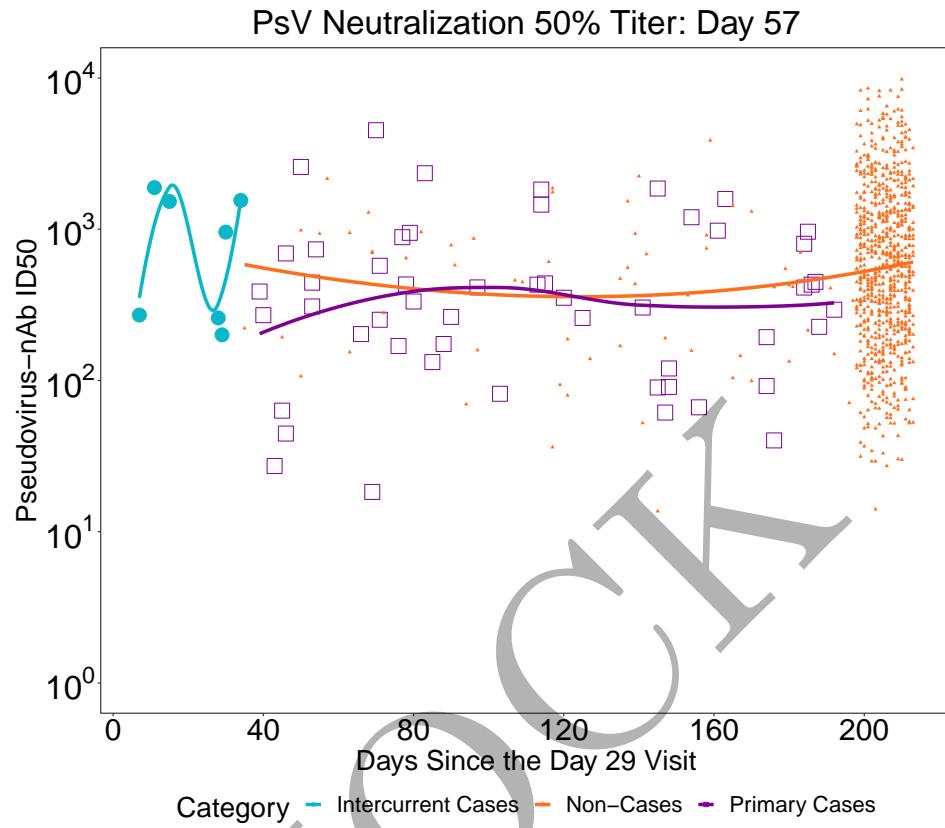


Figure 3.270: scatterplots of Pseudovirus Neutralization ID50 vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 57

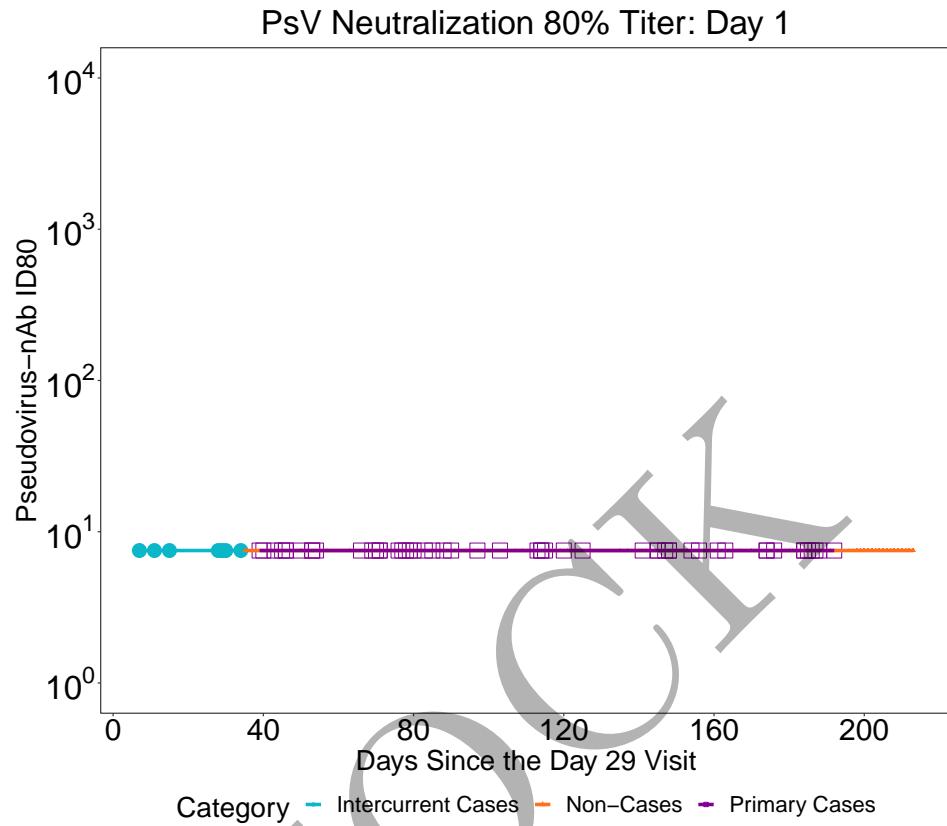


Figure 3.271: scatterplots of Pseudovirus Neutralization ID80 vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 1

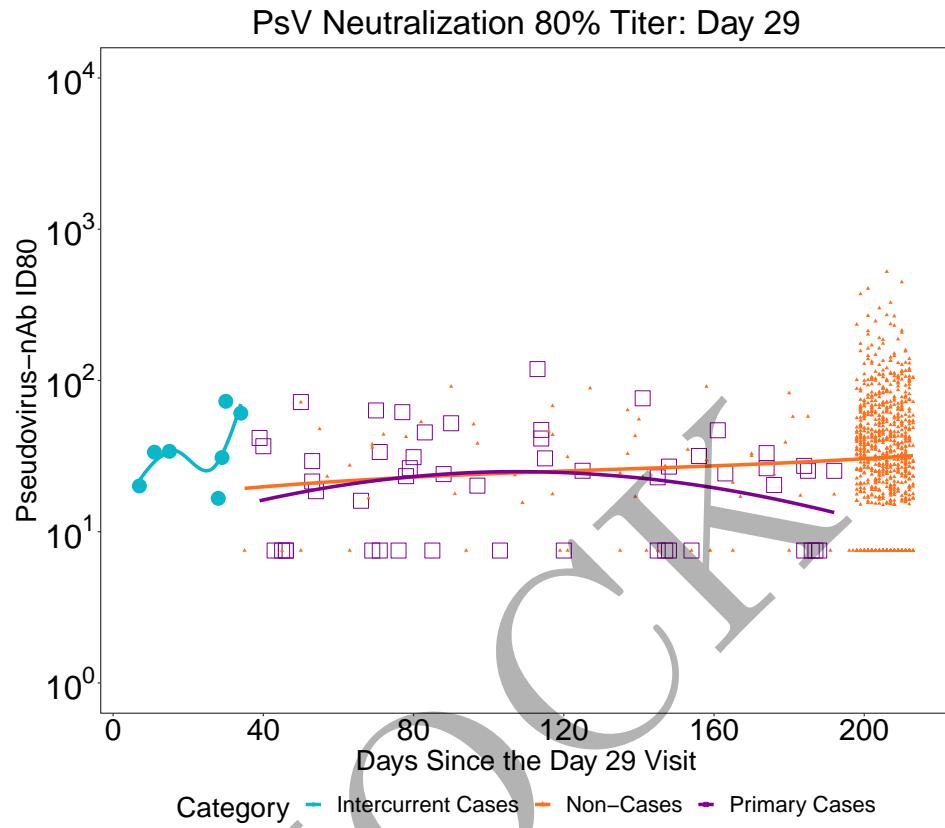


Figure 3.272: scatterplots of Psuedovirus Neutralization ID80 vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 29

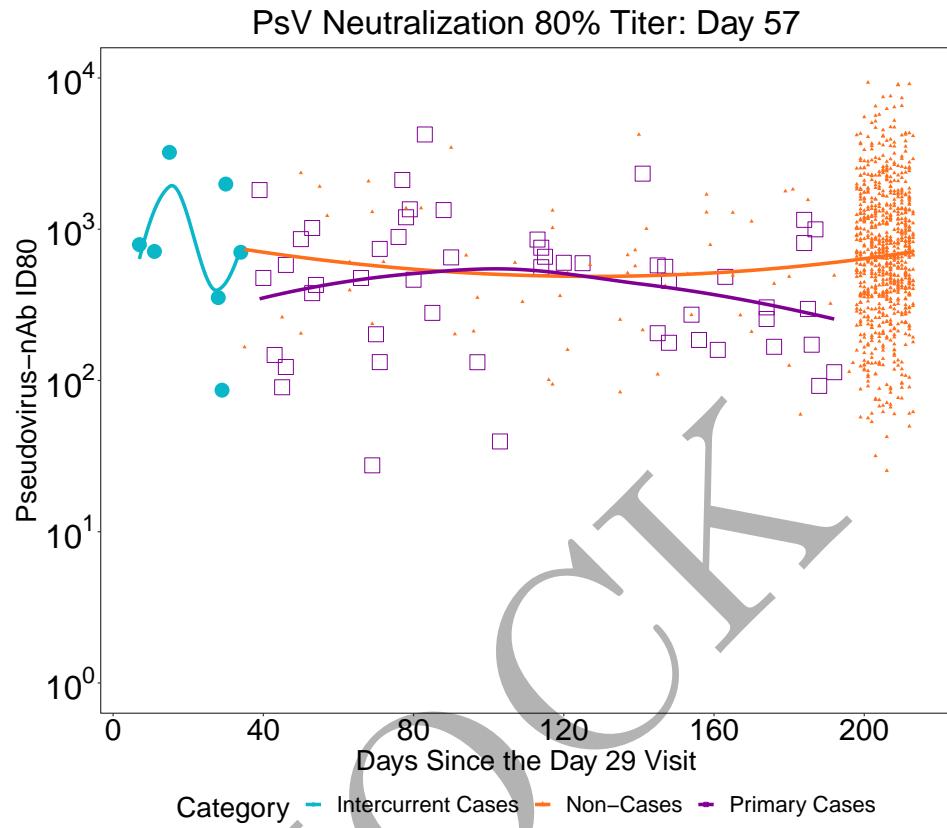


Figure 3.273: scatterplots of Pseudovirus Neutralization ID80 vs Days Since the Day 29 Visit: baseline negative vaccine arm at day 57

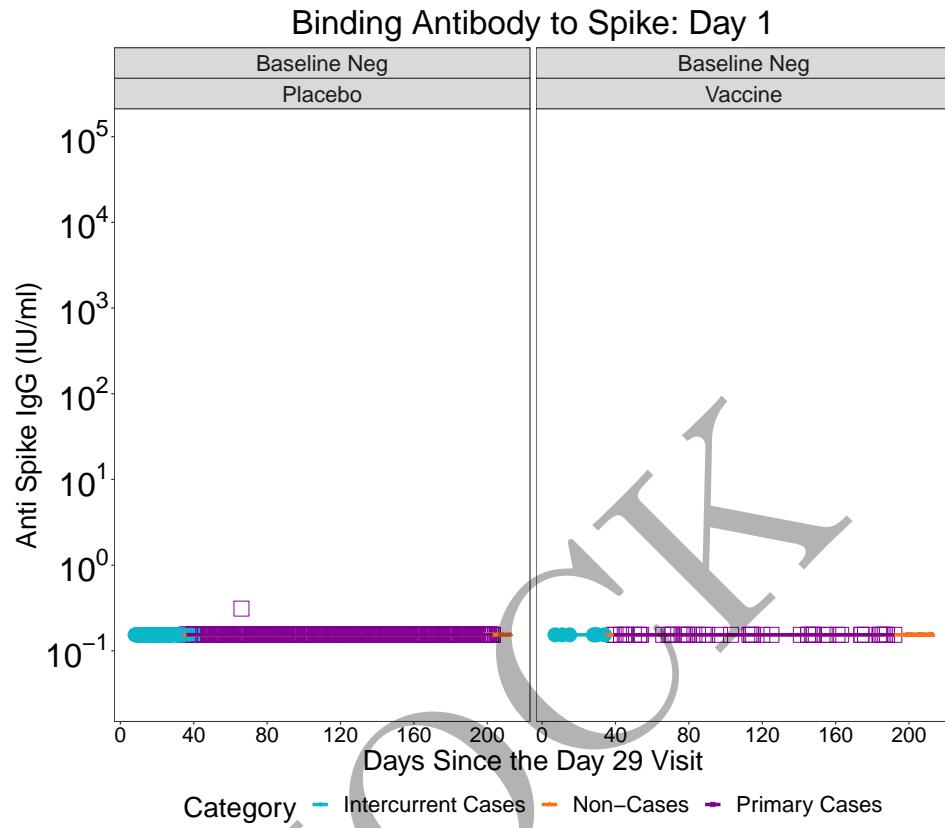


Figure 3.274: scatterplots of Binding Antibody to Spike vs Days Since the Day 29 Visit: by arm at day 1

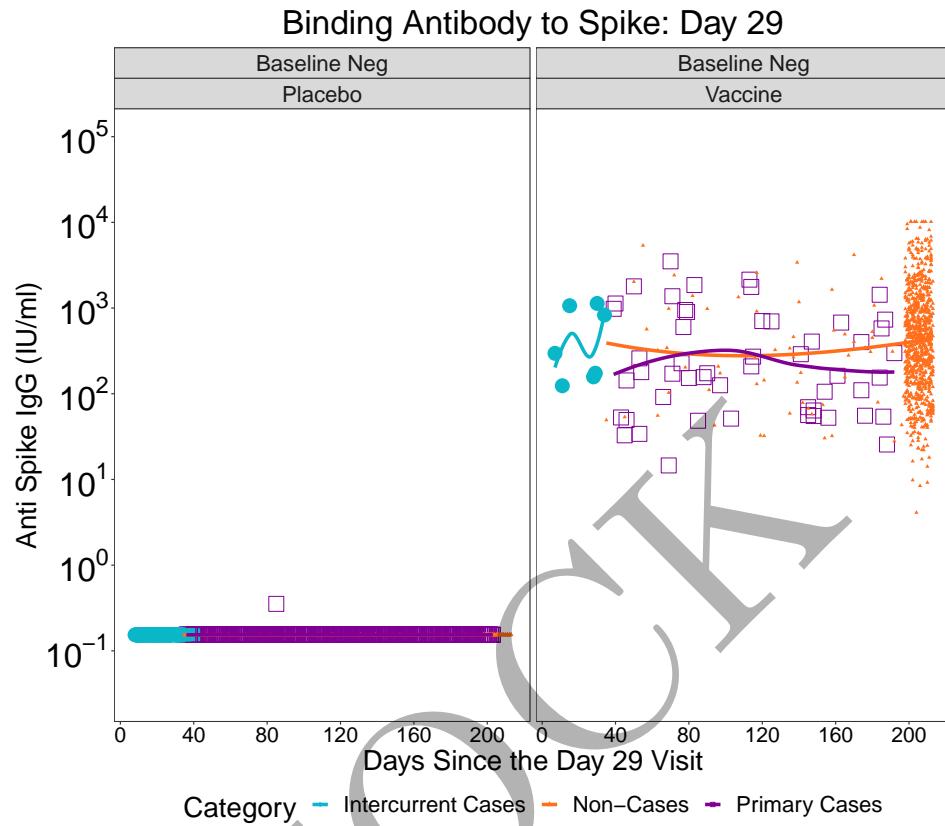


Figure 3.275: scatterplots of Binding Antibody to Spike vs Days Since the Day 29 Visit: by arm at day 29

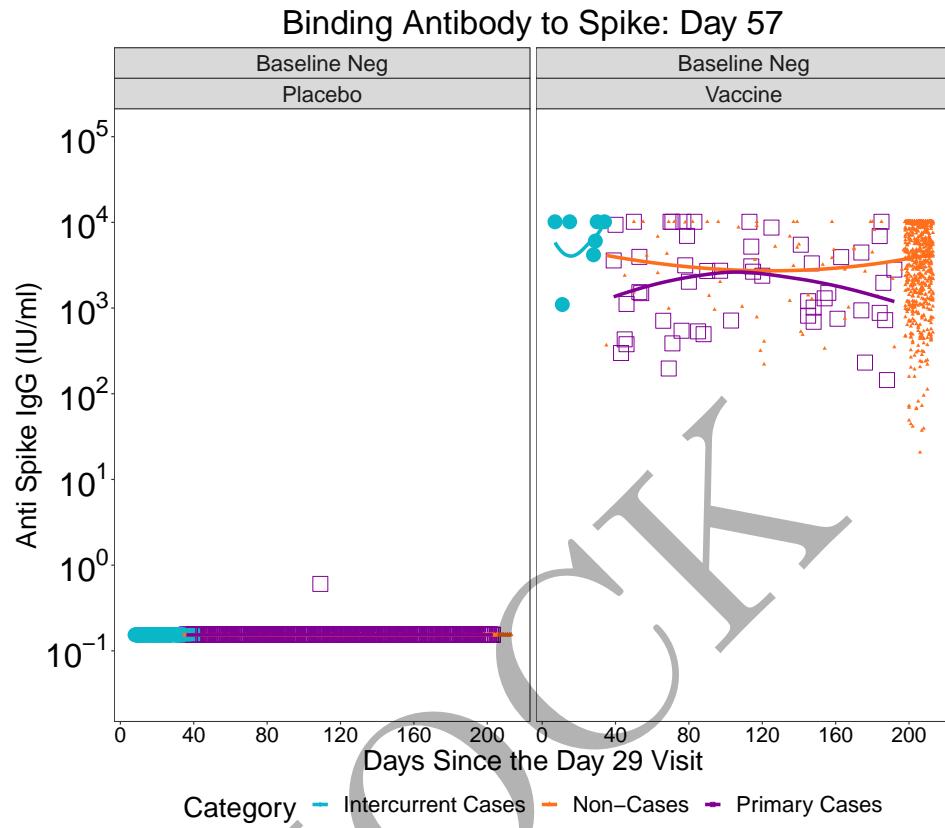


Figure 3.276: scatterplots of Binding Antibody to Spike vs Days Since the Day 29 Visit: by arm at day 57

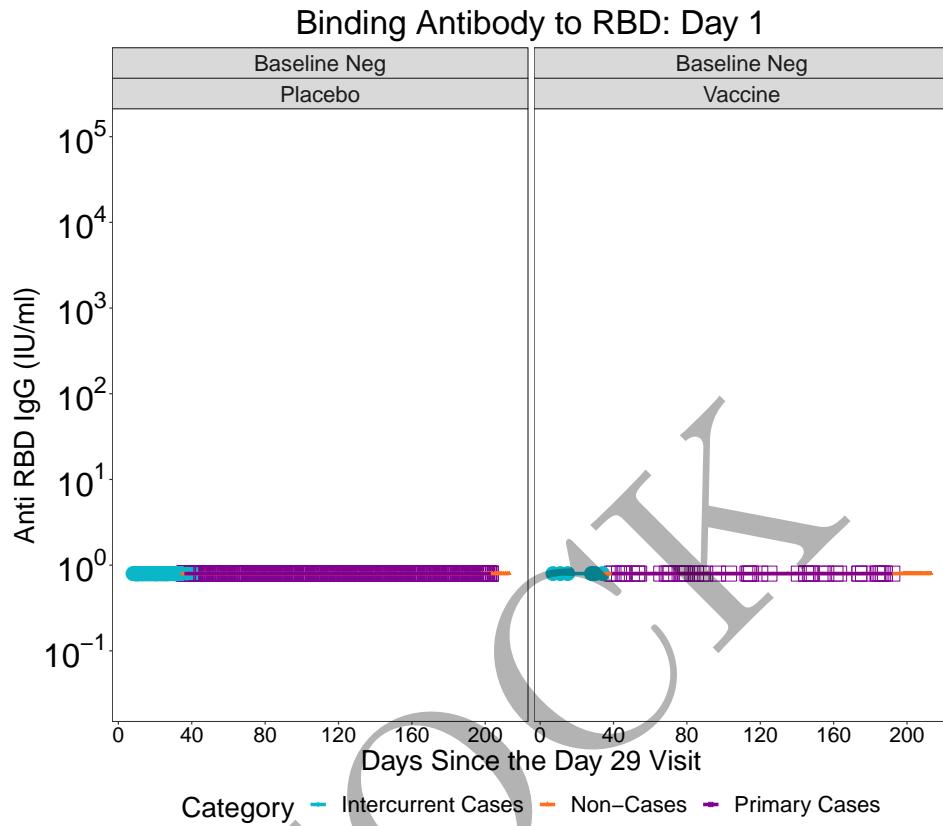


Figure 3.277: scatterplots of Binding Antibody to RBD vs Days Since the Day 29 Visit: by arm at day 1

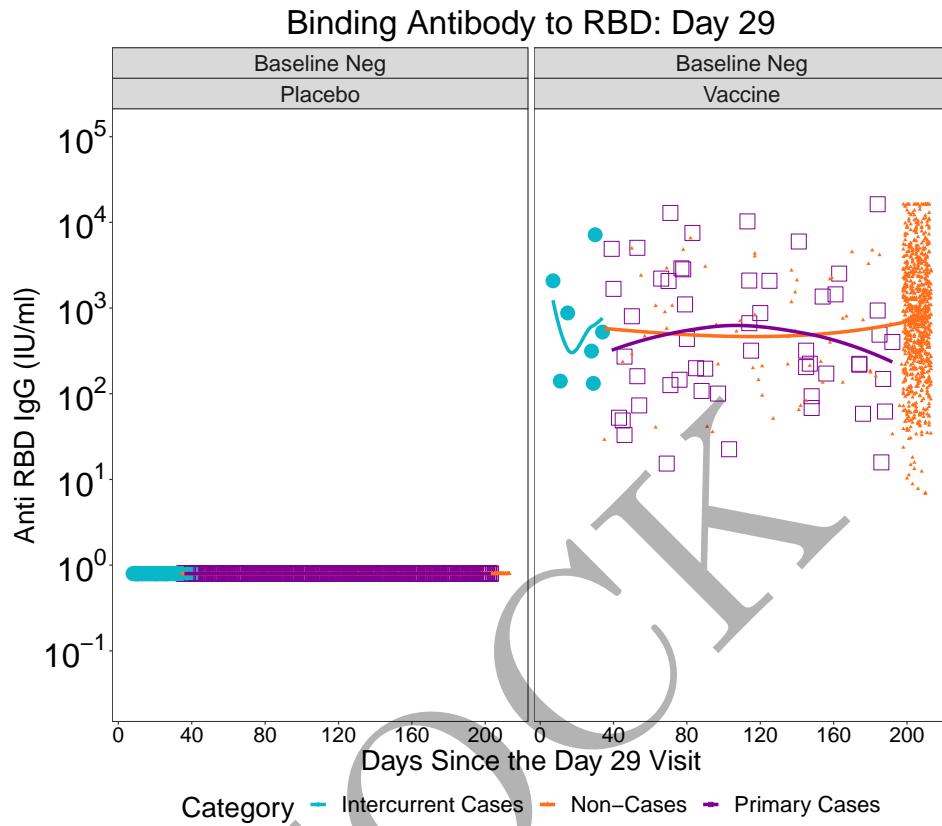


Figure 3.278: scatterplots of Binding Antibody to RBD vs Days Since the Day 29 Visit: by arm at day 29

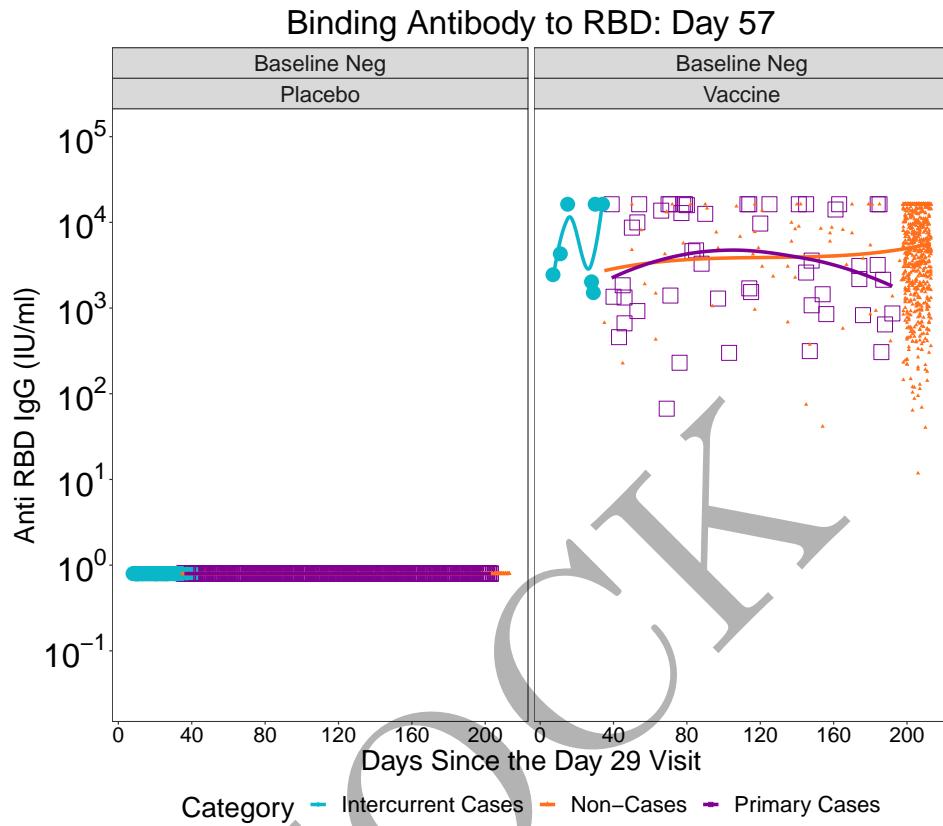


Figure 3.279: scatterplots of Binding Antibody to RBD vs Days Since the Day 29 Visit: by arm at day 57

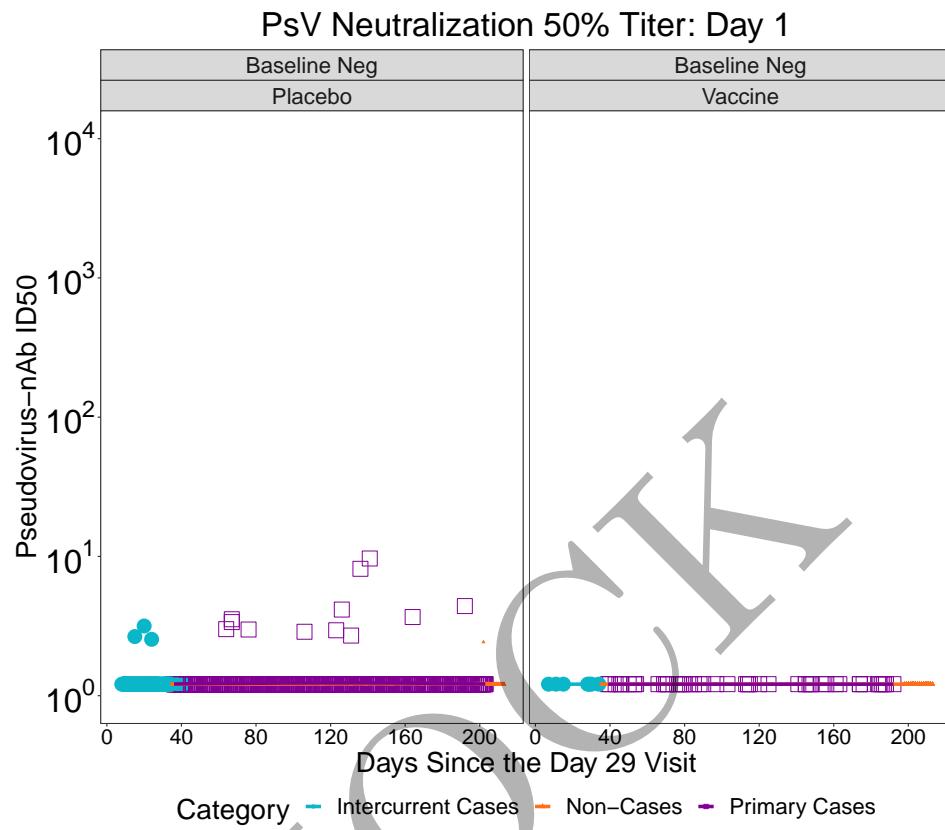


Figure 3.280: scatterplots of Pseudovirus Neutralization ID50 vs Days Since the Day 29 Visit vs Days Since the Day 29 Visit: by arm at day 1

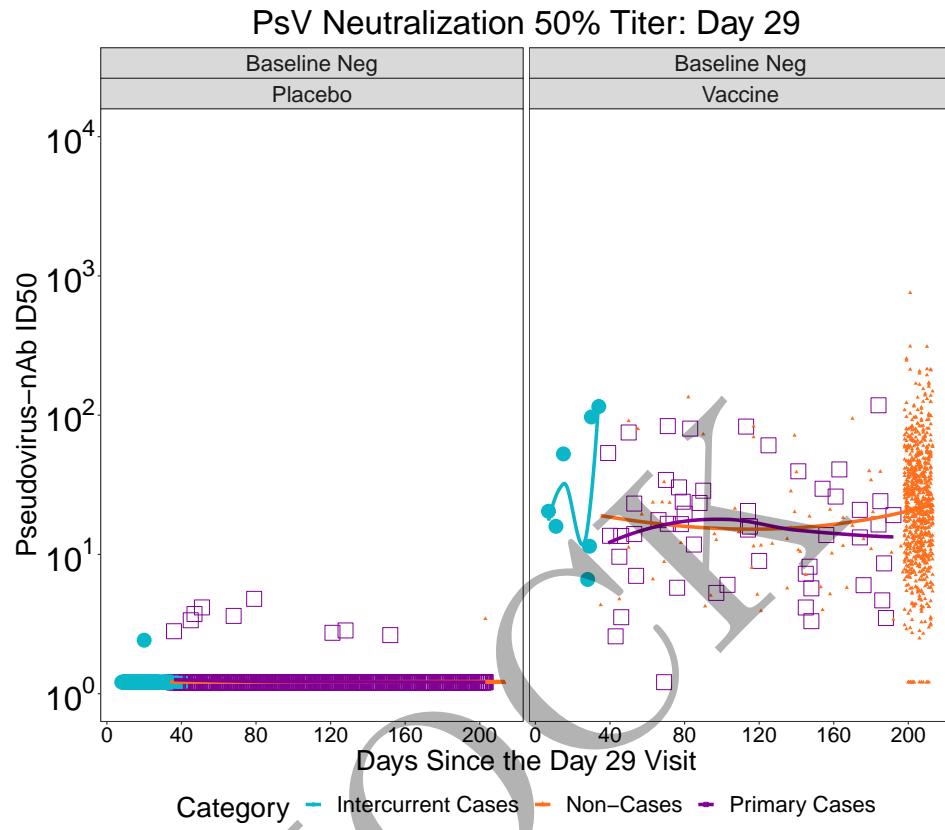


Figure 3.281: scatterplots of Pseudovirus Neutralization ID50 vs Days Since the Day 29 Visit vs Days Since the Day 29 Visit: by arm at day 29

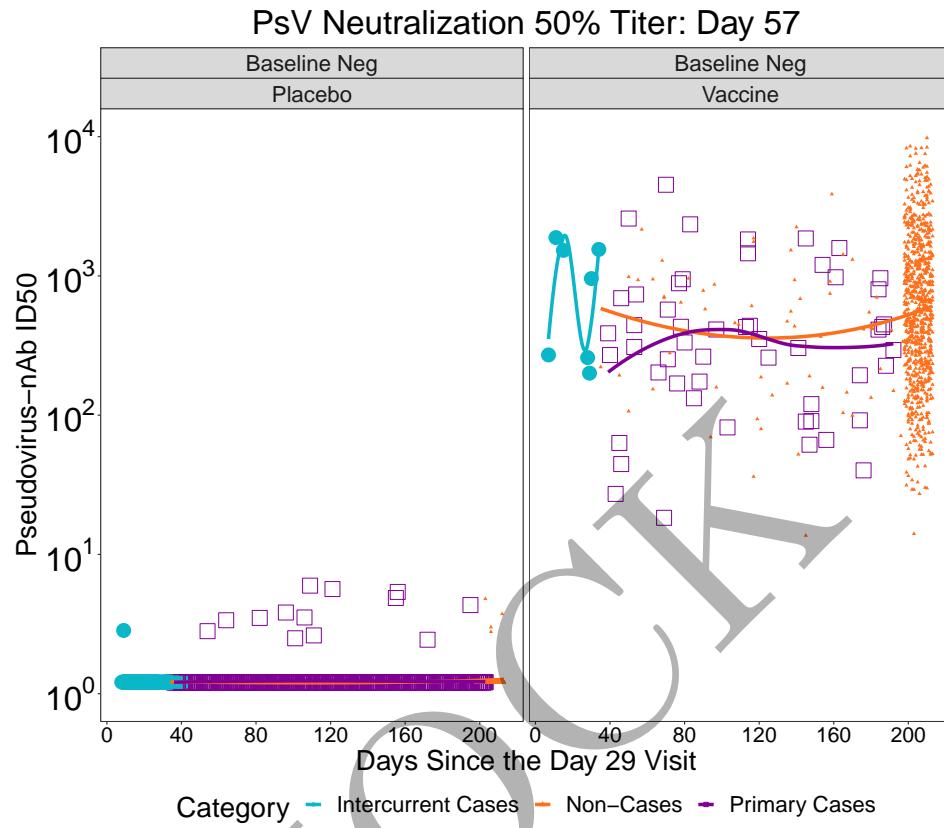


Figure 3.282: scatterplots of Pseudovirus Neutralization ID50 vs Days Since the Day 29 Visit: by arm at day 57

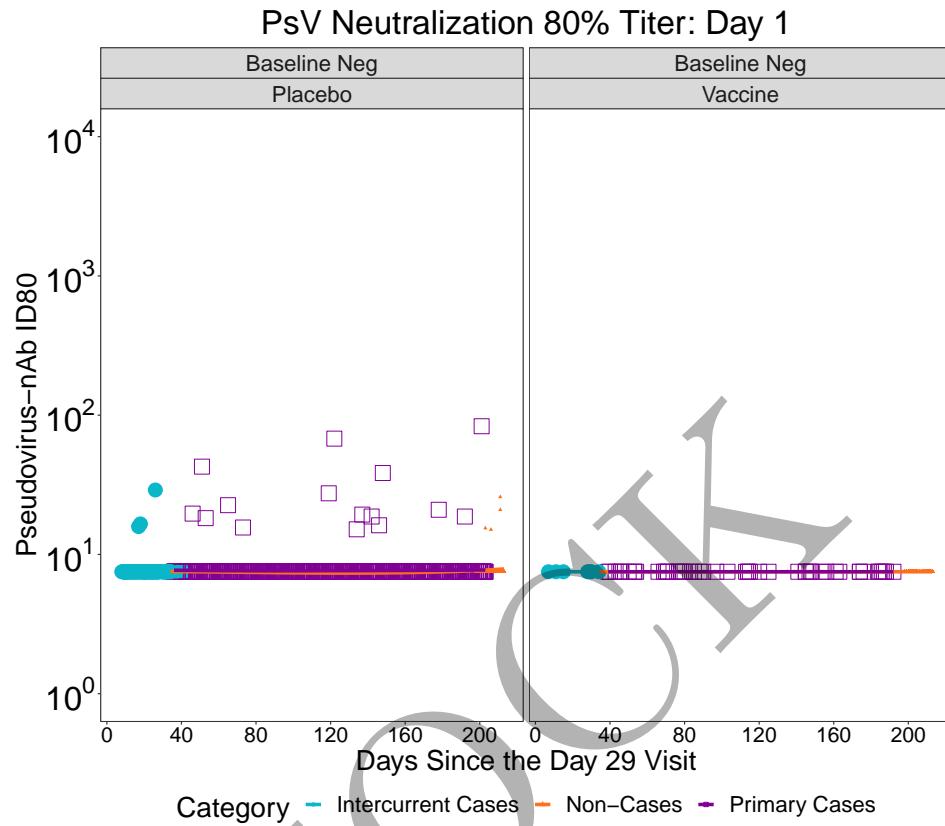


Figure 3.283: scatterplots of Pseudovirus Neutralization ID80 vs Days Since the Day 29 Visit: by arm at day 1

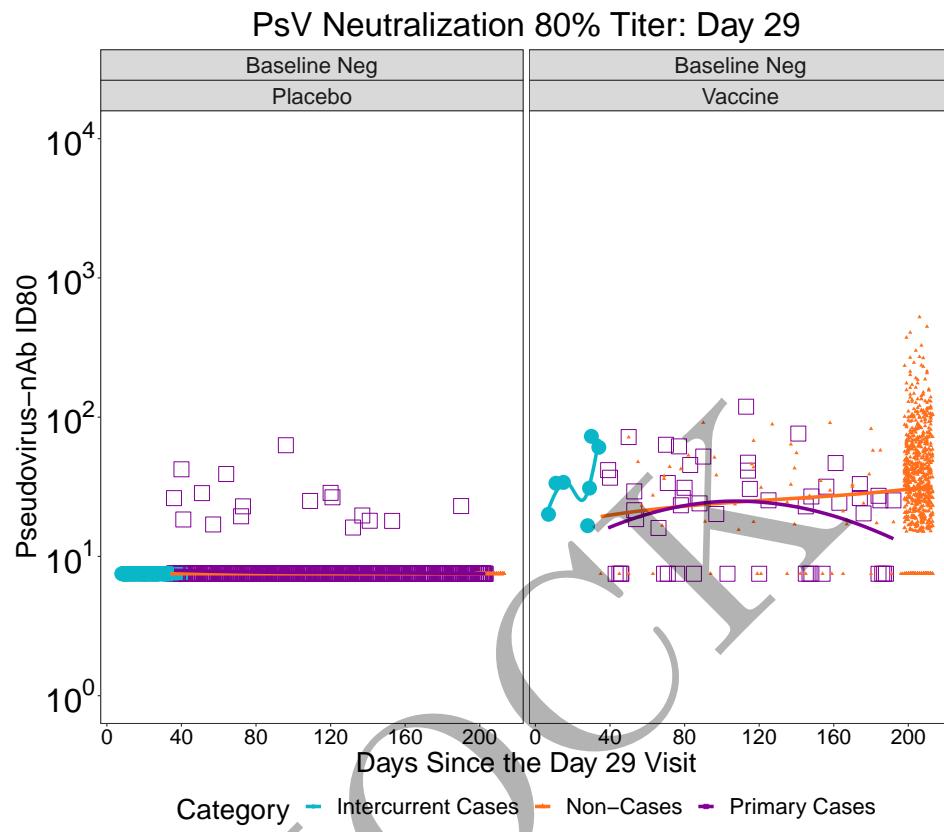


Figure 3.284: scatterplots of Pseudovirus Neutralization ID80 vs Days Since the Day 29 Visit: by arm at day 29

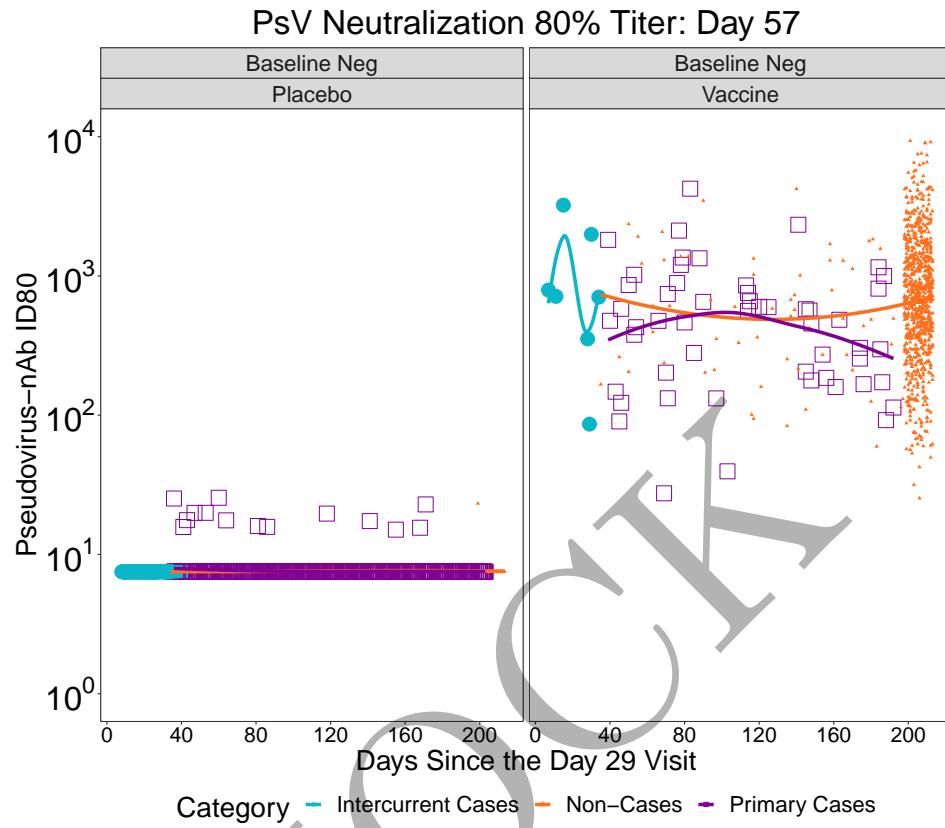


Figure 3.285: scatterplots of Pseudovirus Neutralization ID80 vs Days Since the Day 29 Visit: by arm at day 57

Chapter 4

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.

4.1 Hazard ratios

Table 4.1: 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*

MockCOVE Immunologic Marker	No. cases / No. at-risk**	HR per 10-fold incr. Pt. Est.	95% CI	P-value (2-sided)	q-value ***	FWER
Anti Spike IgG (IU/ml)	52/11,117	0.20	(0.12-0.36)	<0.001	<0.001	<0.001
Anti RBD IgG (IU/ml)	52/11,117	0.43	(0.25-0.74)	0.003	<0.001	<0.001
Pseudovirus-nAb ID50	52/11,117	0.32	(0.17-0.60)	<0.001	<0.001	<0.001
Pseudovirus-nAb ID80	52/11,117	0.35	(0.19-0.64)	<0.001	N/A	N/A

*Baseline covariates adjusted for: baseline risk score, at risk or not, community of color or not. Maximum failure event time 164 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.

***q-value and FWER (family-wide error rate) are computed over the set of p-values both for quantitative markers and categorical markers (excluding ID80) using the Westfall and Young permutation method (5 replicates).

Table 4.2: 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*

MockCOVE Immunologic Marker	Tertile	No. cases / No. at-risk**	Attack rate	Pt. Est.	Haz. Ratio 95% CI	P-value (2-sided)	Overall P- value***	Overall q- value †	Overall FWER
Anti Spike IgG (IU/ml)	Lower	27/4,235	0.0064	1	N/A	N/A	<0.001	N/A	N/A
	Middle	18/4,243	0.0042	0.30	(0.16-0.59)	<0.001			
	Upper	7/2,638	0.0027	0.08	(0.03-0.21)	<0.001			
Anti RBD IgG (IU/ml)	Lower	24/4,242	0.0057	1	N/A	N/A	0.003	N/A	N/A
	Middle	14/4,209	0.0033	0.32	(0.15-0.71)	0.005			
	Upper	14/2,666	0.0053	0.29	(0.13-0.64)	0.002			
Pseudovirus-nAb ID50	Lower	18/3,697	0.0049	1	N/A	N/A	0.036	N/A	N/A
	Middle	20/3,701	0.0054	0.80	(0.39-1.65)	0.553			
	Upper	14/3,719	0.0038	0.36	(0.16-0.83)	0.015			
Pseudovirus-nAb ID80	Lower	22/3,724	0.0059	1	N/A	N/A	0.009	N/A	N/A
	Middle	20/3,707	0.0054	0.67	(0.35-1.28)	0.223			
	Upper	10/3,687	0.0027	0.29	(0.13-0.64)	0.002			
Placebo		1010/11,217	0.0900						

*Baseline covariates adjusted for: baseline risk score, at risk or not, community of color or not. Maximum failure event time 164 days. Cutpoints: Anti Spike IgG (IU/ml) [3.34, 4.01], Anti RBD IgG (IU/ml) [3.48, 4.21], Pseudovirus-nAb ID50 [2.37, 2.86], Pseudovirus-nAb ID80 [2.58, 2.96], all on the log10 scale.

**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.

† q-value and FWER (family-wide error rate) are computed over the set of p-values both for quantitative markers and categorical markers (excluding ID80) using the Westfall and Young permutation method (5 replicates).

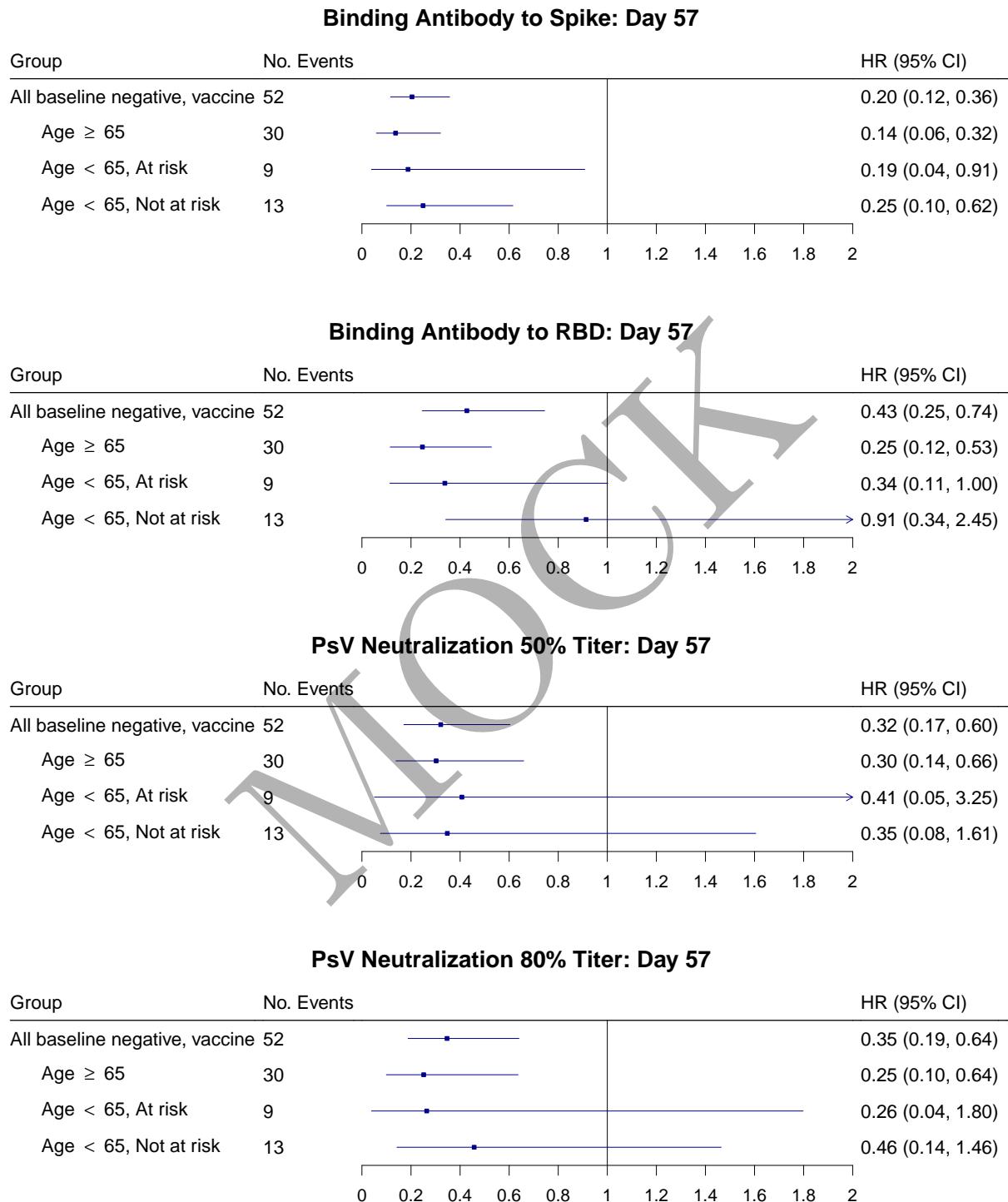


Figure 4.1: Forest plots of hazard ratios per 10-fold increase in the marker among baseline negative vaccine recipients and subgroups with 95% point-wise confidence intervals.

Binding Antibody to Spike: Day 57

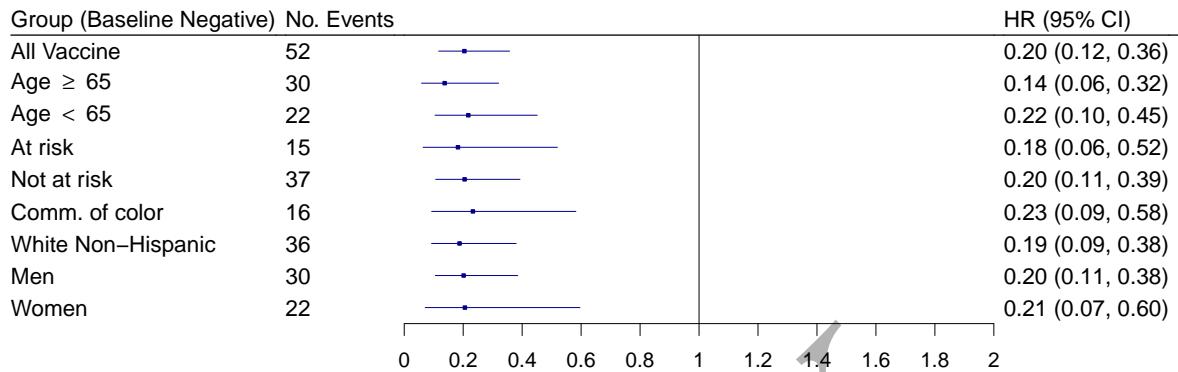


Figure 4.2: Forest plots of hazard ratios per 10-fold increase in the Day 57 binding Ab to spike markers among baseline negative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

Binding Antibody to RBD: Day 57

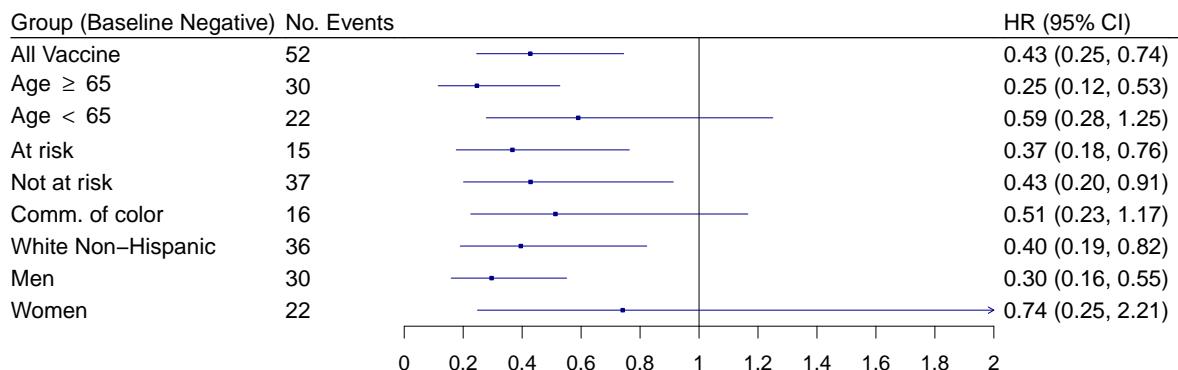


Figure 4.3: Forest plots of hazard ratios per 10-fold increase in the Day 57 binding Ab to RBD markers among baseline negative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

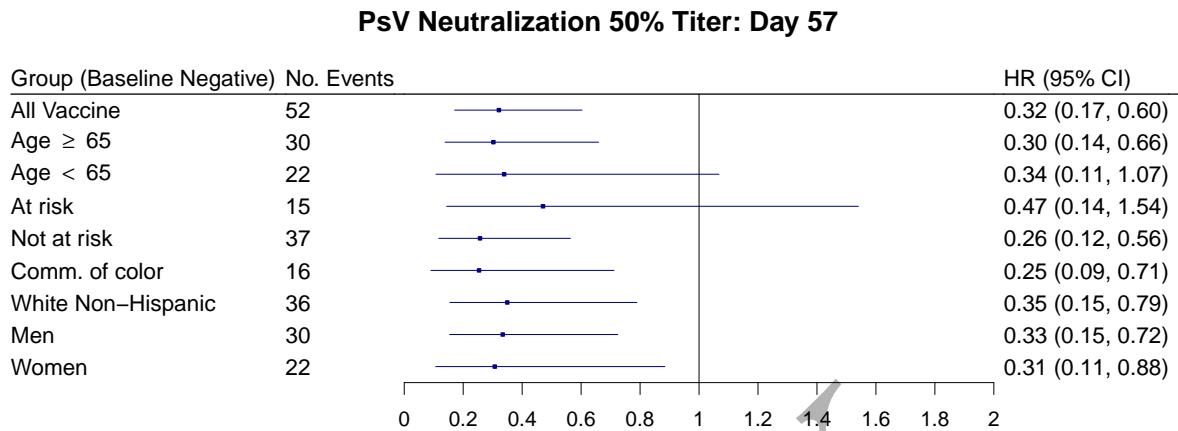


Figure 4.4: Forest plots of hazard ratios per 10-fold increase in the Day 57 pseudo neut ID50 markers among baseline negative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

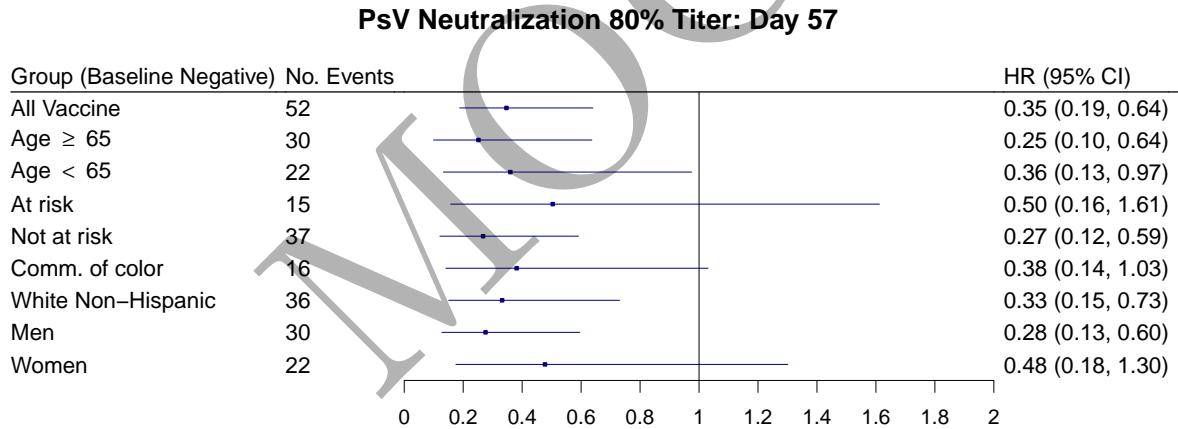


Figure 4.5: Forest plots of hazard ratios per 10-fold increase in the Day 57 pseudo neut ID80 markers among baseline negative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

4.2 Marginalized risk and controlled vaccine efficacy plots

MOCK

Table 4.3: Analysis of Day 57 markers (upper vs. lower tertile) as a CoR and a controlled risk CoP.

Trial	marginalized risk			controlled risk			$e(0,1)^2$
	ratio $RR_M(0,1)$	Point Est.	95% CI	ratio $RR_C(0,1)^1$	Point Est.	95% CI	
Anti Spike IgG (IU/ml)	0.09	0.06–0.14	0.11	0.07–0.18	22.8	14.0	
Anti RBD IgG (IU/ml)	0.29	0.27–0.39	0.39	0.36–0.51	6.3	4.6	
Pseudovirus-nAb ID50	0.37	0.25–0.49	0.49	0.34–0.65	4.9	3.5	
Pseudovirus-nAb ID80	0.29	0.13–0.66	0.39	0.18–0.88	6.2	2.4	

¹Conservative (upper bound) estimate assuming unmeasured confounding at level $RR_{UD}(0,1) = RR_{EU}(0,1) = 2$ and thus $B(0,1) = 4/3$.

²E-values are computed for upper tertile ($s = 1$) vs. lower tertile ($s = 0$) biomarker subgroups after controlling for baseline risk score, at risk or not, community of color or not; UL = upper limit.

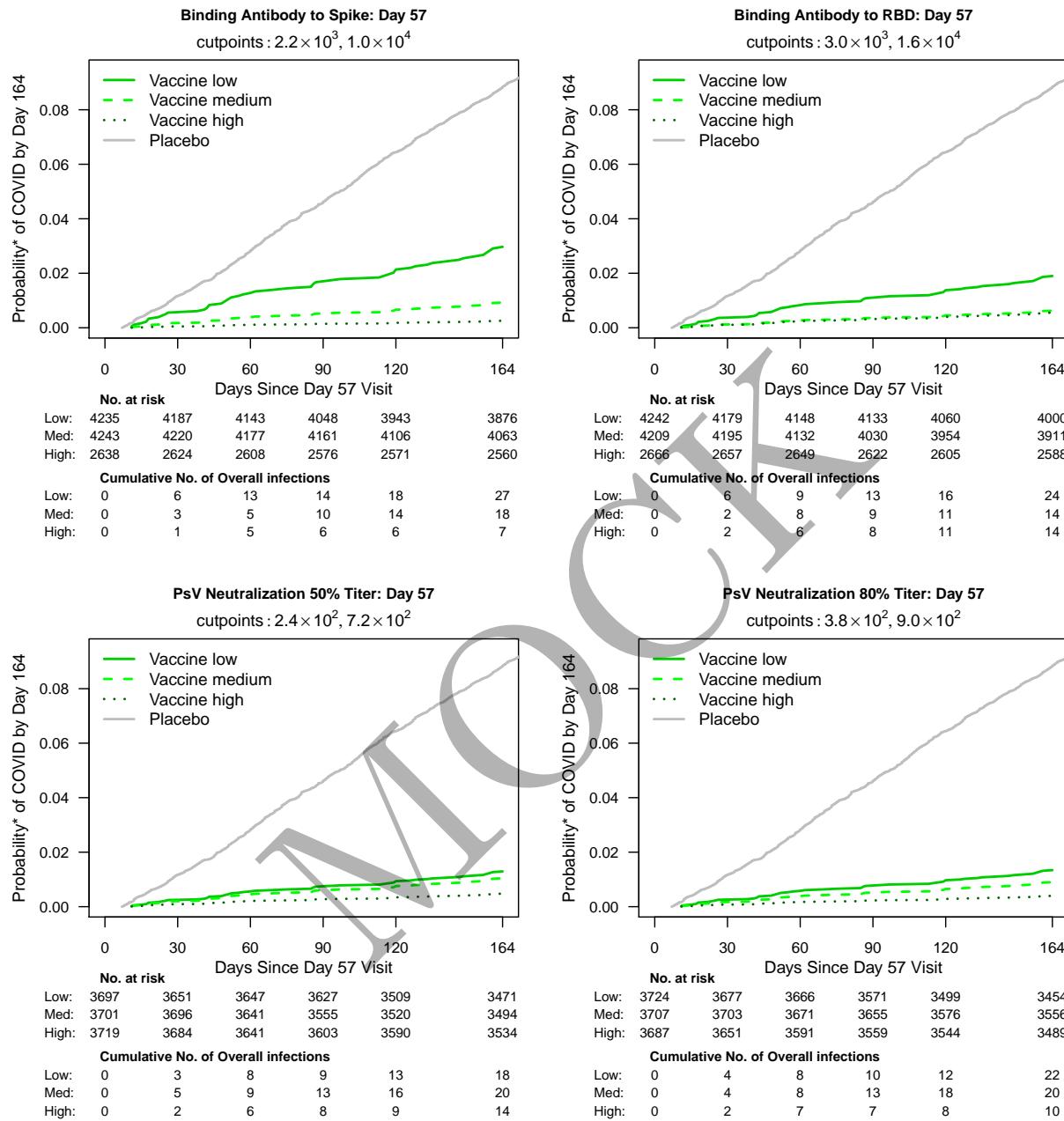


Figure 4.6: Marginalized cumulative incidence rate curves for trichotomized Day 57 markers among baseline negative vaccine recipients. The gray line is the overall cumulative incidence rate curve in the placebo arm.

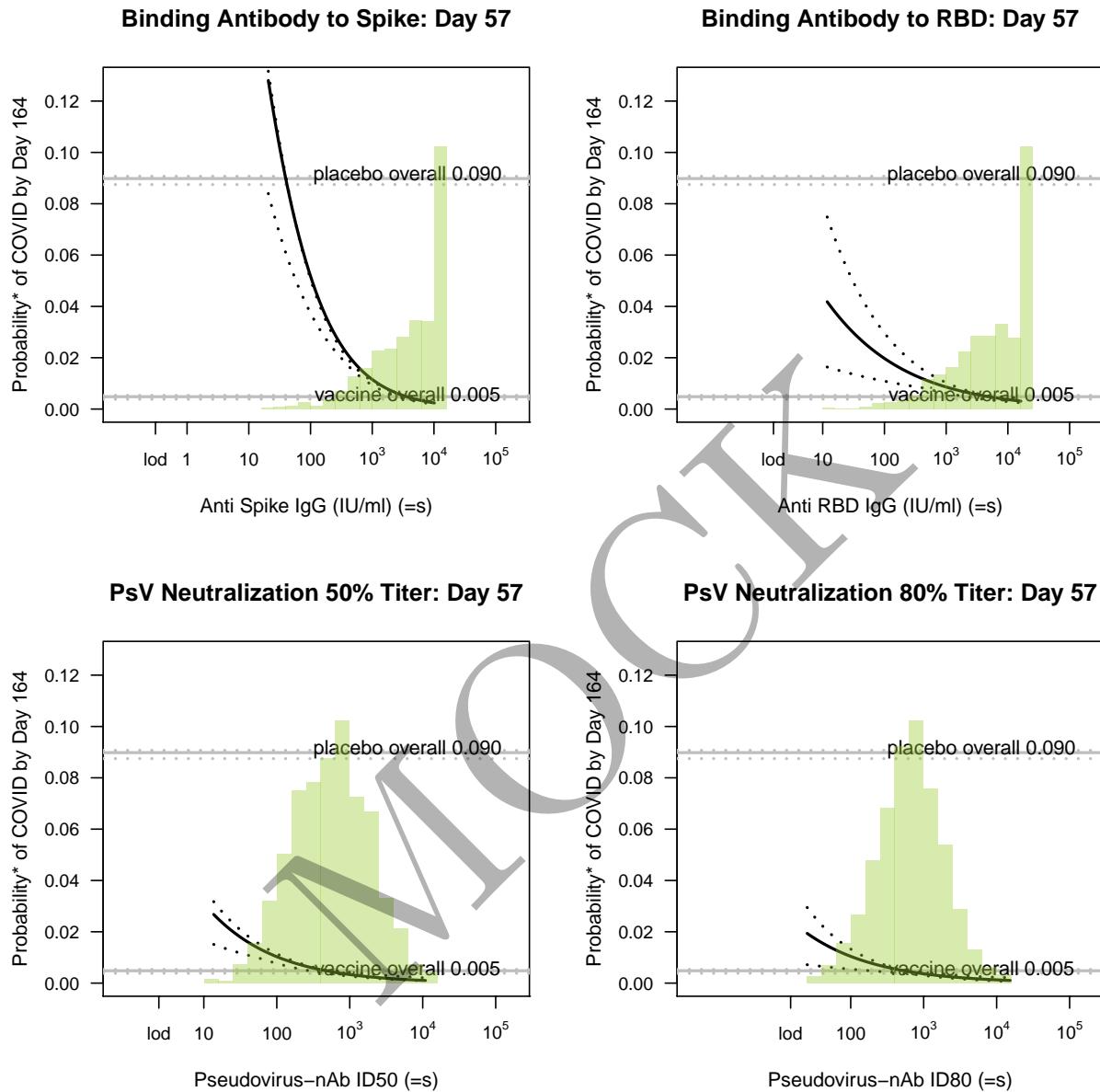


Figure 4.7: Marginalized cumulative risk by Day 164 as functions of Day 57 markers (=s) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates). The horizontal lines indicate the overall cumulative risk of the placebo and vaccine arms by Day 164 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4, 15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.

Table 4.4: Marginalized cumulative risk by Day 164 as functions of Day 57 markers (=s) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence intervals (5 replicates).

	Anti Spike IgG (IU/ml)		Anti RBD IgG (IU/ml)		Pseudovirus-nAb ID50		Pseudovirus-nAb ID80
s	Estimate	s	Estimate	s	Estimate	s	Estimate
21	.1280 (.0840,.1317)	12	.0418 (.0164,.0749)	14	.0268 (.0151,.0317)	25	.0194 (.0072,.0295)
371	.0223 (.0179,.0207)	407	.0119 (.0083,.0156)	71	.0121 (.0089,.0136)	108	.0101 (.0054,.0127)
624	.0158 (.0127,.0146)	706	.0097 (.0069,.0121)	106	.0100 (.0075,.0110)	161	.0084 (.0050,.0101)
653	.0153 (.0124,.0142)	763	.0095 (.0068,.0117)	113	.0097 (.0072,.0107)	166	.0083 (.0049,.0099)
960	.0118 (.0096,.0111)	1139	.0082 (.0059,.0097)	150	.0084 (.0064,.0092)	216	.0073 (.0046,.0085)
1245	.0099 (.0080,.0095)	1709	.0071 (.0052,.0080)	186	.0076 (.0058,.0082)	278	.0065 (.0044,.0073)
1297	.0097 (.0078,.0092)	1817	.0069 (.0051,.0078)	191	.0075 (.0057,.0081)	285	.0065 (.0044,.0072)
1813	.0077 (.0062,.0075)	2345	.0063 (.0046,.0069)	230	.0069 (.0052,.0073)	346	.0059 (.0042,.0064)
2358	.0064 (.0052,.0064)	3153	.0056 (.0042,.0060)	281	.0062 (.0048,.0066)	388	.0056 (.0041,.0061)
2957	.0055 (.0044,.0056)	3607	.0054 (.0040,.0057)	330	.0057 (.0044,.0061)	440	.0053 (.0040,.0058)
3059	.0054 (.0043,.0055)	3822	.0053 (.0039,.0056)	336	.0057 (.0044,.0060)	445	.0053 (.0040,.0058)
3911	.0046 (.0036,.0048)	4825	.0048 (.0036,.0053)	399	.0052 (.0041,.0056)	511	.0050 (.0039,.0055)
4553	.0041 (.0033,.0044)	6262	.0044 (.0033,.0050)	454	.0049 (.0038,.0054)	581	.0047 (.0038,.0052)
4573	.0041 (.0033,.0044)	6264	.0044 (.0033,.0050)	458	.0049 (.0038,.0054)	584	.0047 (.0038,.0052)
5612	.0036 (.0028,.0039)	7764	.0041 (.0031,.0048)	547	.0045 (.0035,.0051)	658	.0044 (.0036,.0050)
6915	.0031 (.0025,.0035)	9644	.0038 (.0029,.0046)	670	.0041 (.0032,.0048)	745	.0042 (.0034,.0048)
6937	.0031 (.0024,.0035)	9688	.0037 (.0029,.0046)	673	.0041 (.0032,.0048)	749	.0042 (.0034,.0048)
8690	.0026 (.0021,.0030)	12197	.0034 (.0027,.0044)	768	.0038 (.0030,.0046)	839	.0040 (.0032,.0046)
10019	.0024 (.0019,.0028)	14857	.0032 (.0025,.0043)	900	.0035 (.0028,.0044)	949	.0037 (.0030,.0044)
10145	.0024 (.0019,.0028)	15353	.0032 (.0025,.0042)	909	.0035 (.0028,.0043)	958	.0037 (.0030,.0044)
10156	.0024 (.0019,.0028)	16269	.0031 (.0024,.0042)	1056	.0033 (.0026,.0042)	1099	.0035 (.0028,.0042)
10156	.0024 (.0019,.0028)	16269	.0031 (.0024,.0042)	1255	.0030 (.0024,.0039)	1270	.0033 (.0026,.0040)
10156	.0024 (.0019,.0028)	16269	.0031 (.0024,.0042)	1491	.0027 (.0022,.0037)	1452	.0031 (.0025,.0038)
10156	.0024 (.0019,.0028)	16269	.0031 (.0024,.0042)	1599	.0027 (.0022,.0037)	1551	.0030 (.0024,.0037)
10156	.0024 (.0019,.0028)	16269	.0031 (.0024,.0042)	2027	.0024 (.0019,.0034)	1840	.0028 (.0022,.0035)
10156	.0024 (.0019,.0028)	16269	.0031 (.0024,.0042)	2440	.0022 (.0018,.0032)	2349	.0025 (.0019,.0032)
10156	.0024 (.0019,.0028)	16269	.0031 (.0024,.0042)	2511	.0021 (.0018,.0032)	2367	.0025 (.0019,.0032)
10156	.0024 (.0019,.0028)	16269	.0031 (.0024,.0042)	3958	.0017 (.0014,.0028)	3571	.0020 (.0015,.0028)
10156	.0024 (.0019,.0028)	16269	.0031 (.0024,.0042)	10919	.0010 (.0009,.0021)	15368	.0010 (.0006,.0021)

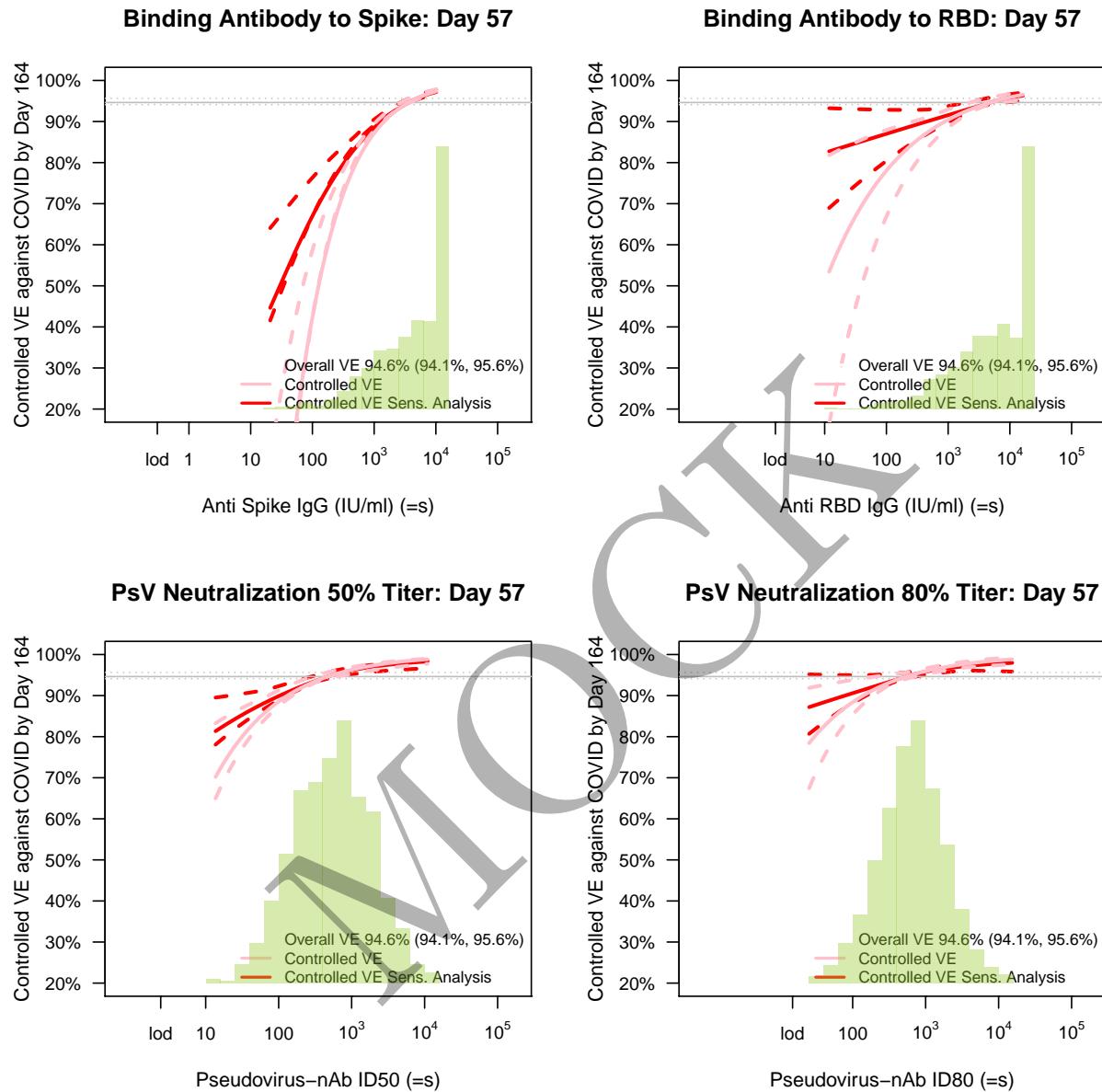


Figure 4.8: Controlled VE with sensitivity analysis as functions of Day 57 markers (=s) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates). Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4, 15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.

Table 4.5: Controlled VE as functions of Day 57 markers (=s) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence intervals (5 replicates).

	Anti Spike IgG (IU/ml)		Anti RBD IgG (IU/ml)		Pseudovirus-nAb ID50		Pseudovirus-nAb ID80
s	Estimate	s	Estimate	s	Estimate	s	Estimate
21	-0.4257 (-0.5049,.0745)	12	.5344 (.1630,.8179)	14	.7021 (.6498,.8326)	25	.7843 (.6746,.9187)
371	0.7513 (0.7636,.8002)	407	.8675 (.8255,.9077)	71	.8652 (.8501,.8993)	108	.8880 (.8604,.9391)
624	0.8239 (0.8363,.8553)	706	.8915 (.8647,.9208)	106	.8888 (.8781,.9152)	161	.9064 (.8890,.9437)
653	0.8291 (0.8412,.8596)	763	.8945 (.8695,.9228)	113	.8923 (.8823,.9176)	166	.9078 (.8911,.9440)
960	0.8681 (0.8754,.8913)	1139	.9088 (.8916,.9325)	150	.9061 (.8985,.9274)	216	.9182 (.9068,.9470)
1245	0.8893 (0.8940,.9086)	1709	.9213 (.9103,.9411)	186	.9153 (.9092,.9340)	278	.9271 (.9195,.9498)
1297	0.8923 (0.8967,.9111)	1817	.9231 (.9128,.9423)	191	.9164 (.9106,.9349)	285	.9279 (.9206,.9500)
1813	0.9142 (0.9160,.9294)	2345	.9299 (.9226,.9470)	230	.9237 (.9190,.9402)	346	.9340 (.9291,.9520)
2358	0.9282 (0.9286,.9411)	3153	.9371 (.9326,.9520)	281	.9308 (.9271,.9454)	388	.9374 (.9330,.9532)
2957	0.9385 (0.9377,.9496)	3607	.9401 (.9365,.9541)	330	.9360 (.9329,.9493)	440	.9409 (.9361,.9544)
3059	0.9399 (0.9389,.9508)	3822	.9414 (.9381,.9550)	336	.9366 (.9335,.9497)	445	.9412 (.9363,.9545)
3911	0.9492 (0.9469,.9585)	4825	.9462 (.9412,.9584)	399	.9417 (.9380,.9535)	511	.9448 (.9395,.9558)
4553	0.9542 (0.9514,.9626)	6262	.9511 (.9442,.9619)	454	.9452 (.9404,.9561)	581	.9479 (.9422,.9569)
4573	0.9543 (0.9515,.9627)	6264	.9511 (.9442,.9619)	458	.9455 (.9406,.9563)	584	.9480 (.9423,.9570)
5612	0.9603 (0.9569,.9677)	7764	.9548 (.9465,.9646)	547	.9500 (.9437,.9597)	658	.9508 (.9446,.9589)
6915	0.9656 (0.9617,.9720)	9644	.9582 (.9487,.9670)	670	.9547 (.9471,.9633)	745	.9535 (.9469,.9612)
6937	0.9657 (0.9618,.9721)	9688	.9583 (.9488,.9671)	673	.9549 (.9472,.9634)	749	.9536 (.9470,.9613)
8690	0.9706 (0.9664,.9762)	12197	.9617 (.9510,.9695)	768	.9577 (.9493,.9655)	839	.9560 (.9490,.9632)
10019	0.9733 (0.9691,.9786)	14857	.9644 (.9528,.9716)	900	.9608 (.9517,.9679)	949	.9584 (.9511,.9653)
10145	0.9736 (0.9693,.9788)	15353	.9648 (.9531,.9719)	909	.9611 (.9519,.9681)	958	.9585 (.9513,.9655)
10156	0.9736 (0.9693,.9788)	16269	.9655 (.9537,.9725)	1056	.9638 (.9540,.9702)	1099	.9611 (.9535,.9678)
10156	0.9736 (0.9693,.9788)	16269	.9655 (.9537,.9725)	1255	.9667 (.9564,.9725)	1270	.9636 (.9558,.9701)
10156	0.9736 (0.9693,.9788)	16269	.9655 (.9537,.9725)	1491	.9694 (.9586,.9746)	1452	.9657 (.9577,.9720)
10156	0.9736 (0.9693,.9788)	16269	.9655 (.9537,.9725)	1599	.9705 (.9595,.9754)	1551	.9668 (.9587,.9729)
10156	0.9736 (0.9693,.9788)	16269	.9655 (.9537,.9725)	2027	.9737 (.9623,.9779)	1840	.9693 (.9610,.9751)
10156	0.9736 (0.9693,.9788)	16269	.9655 (.9537,.9725)	2440	.9760 (.9644,.9797)	2349	.9725 (.9640,.9781)
10156	0.9736 (0.9693,.9788)	16269	.9655 (.9537,.9725)	2511	.9763 (.9647,.9800)	2367	.9726 (.9641,.9782)
10156	0.9736 (0.9693,.9788)	16269	.9655 (.9537,.9725)	3958	.9811 (.9692,.9838)	3571	.9773 (.9686,.9830)
10156	0.9736 (0.9693,.9788)	16269	.9655 (.9537,.9725)	10919	.9885 (.9772,.9900)	15368	.9884 (.9761,.9929)

Table 4.6: Controlled VE with sensitivity analysis as functions of Day 57 markers (=s) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence intervals (5 replicates).

	Anti Spike IgG (IU/ml)		Anti RBD IgG (IU/ml)		Pseudovirus-nAb ID50		Pseudovirus-nAb ID80
s	Estimate	s	Estimate	s	Estimate	s	Estimate
21	.4464 (.4156,.6406)	12	.8274 (.6897,.9325)	14	.8134 (.7807,.8951)	25	.8720 (.8069,.9517)
371	.8112 (.8206,.8484)	407	.8980 (.8657,.9289)	71	.8863 (.8736,.9151)	108	.9077 (.8850,.9499)
624	.8531 (.8634,.8793)	706	.9088 (.8863,.9334)	106	.9008 (.8913,.9244)	161	.9172 (.9019,.9502)
653	.8563 (.8665,.8819)	763	.9103 (.8891,.9344)	113	.9031 (.8941,.9258)	166	.9180 (.9033,.9503)
960	.8822 (.8887,.9029)	1139	.9181 (.9027,.9394)	150	.9126 (.9056,.9324)	216	.9244 (.9137,.9510)
1245	.8976 (.9019,.9155)	1709	.9260 (.9156,.9446)	186	.9194 (.9136,.9372)	278	.9304 (.9231,.9520)
1297	.8999 (.9039,.9174)	1817	.9272 (.9175,.9454)	191	.9203 (.9147,.9379)	285	.9309 (.9240,.9521)
1813	.9173 (.9189,.9319)	2345	.9322 (.9251,.9487)	230	.9260 (.9215,.9420)	346	.9356 (.9308,.9532)
2358	.9293 (.9297,.9420)	3153	.9379 (.9334,.9526)	281	.9320 (.9283,.9463)	388	.9383 (.9340,.9539)
2957	.9387 (.9379,.9498)	3607	.9405 (.9369,.9544)	330	.9366 (.9334,.9497)	440	.9413 (.9365,.9547)
3059	.9401 (.9391,.9509)	3822	.9416 (.9384,.9552)	336	.9371 (.9340,.9501)	445	.9416 (.9368,.9548)
3911	.9492 (.9469,.9584)	4825	.9462 (.9412,.9584)	399	.9418 (.9381,.9536)	511	.9449 (.9396,.9558)
4553	.9541 (.9512,.9625)	6262	.9509 (.9441,.9618)	454	.9452 (.9404,.9561)	581	.9479 (.9422,.9569)
4573	.9542 (.9513,.9626)	6264	.9509 (.9441,.9618)	458	.9455 (.9406,.9563)	584	.9480 (.9423,.9570)
5612	.9598 (.9563,.9672)	7764	.9542 (.9459,.9641)	547	.9500 (.9437,.9597)	658	.9507 (.9446,.9589)
6915	.9646 (.9606,.9712)	9644	.9572 (.9474,.9662)	670	.9544 (.9467,.9630)	745	.9532 (.9466,.9609)
6937	.9647 (.9607,.9713)	9688	.9572 (.9475,.9662)	673	.9545 (.9468,.9631)	749	.9533 (.9467,.9610)
8690	.9691 (.9647,.9750)	12197	.9600 (.9488,.9682)	768	.9571 (.9486,.9650)	839	.9554 (.9484,.9628)
10019	.9715 (.9669,.9771)	14857	.9620 (.9498,.9697)	900	.9599 (.9505,.9671)	949	.9575 (.9501,.9646)
10145	.9717 (.9671,.9773)	15353	.9624 (.9499,.9700)	909	.9600 (.9506,.9673)	958	.9576 (.9502,.9647)
10156	.9717 (.9671,.9773)	16269	.9629 (.9502,.9704)	1056	.9624 (.9523,.9691)	1099	.9597 (.9519,.9666)
10156	.9717 (.9671,.9773)	16269	.9629 (.9502,.9704)	1255	.9649 (.9540,.9710)	1270	.9616 (.9534,.9685)
10156	.9717 (.9671,.9773)	16269	.9629 (.9502,.9704)	1491	.9672 (.9556,.9727)	1452	.9633 (.9548,.9700)
10156	.9717 (.9671,.9773)	16269	.9629 (.9502,.9704)	1599	.9680 (.9561,.9733)	1551	.9641 (.9554,.9708)
10156	.9717 (.9671,.9773)	16269	.9629 (.9502,.9704)	2027	.9707 (.9580,.9754)	1840	.9660 (.9568,.9725)
10156	.9717 (.9671,.9773)	16269	.9629 (.9502,.9704)	2440	.9726 (.9593,.9768)	2349	.9683 (.9585,.9747)
10156	.9717 (.9671,.9773)	16269	.9629 (.9502,.9704)	2511	.9729 (.9595,.9770)	2367	.9684 (.9585,.9748)
10156	.9717 (.9671,.9773)	16269	.9629 (.9502,.9704)	3958	.9768 (.9621,.9800)	3571	.9717 (.9608,.9788)
10156	.9717 (.9671,.9773)	16269	.9629 (.9502,.9704)	10919	.9831 (.9665,.9853)	15368	.9797 (.9583,.9877)

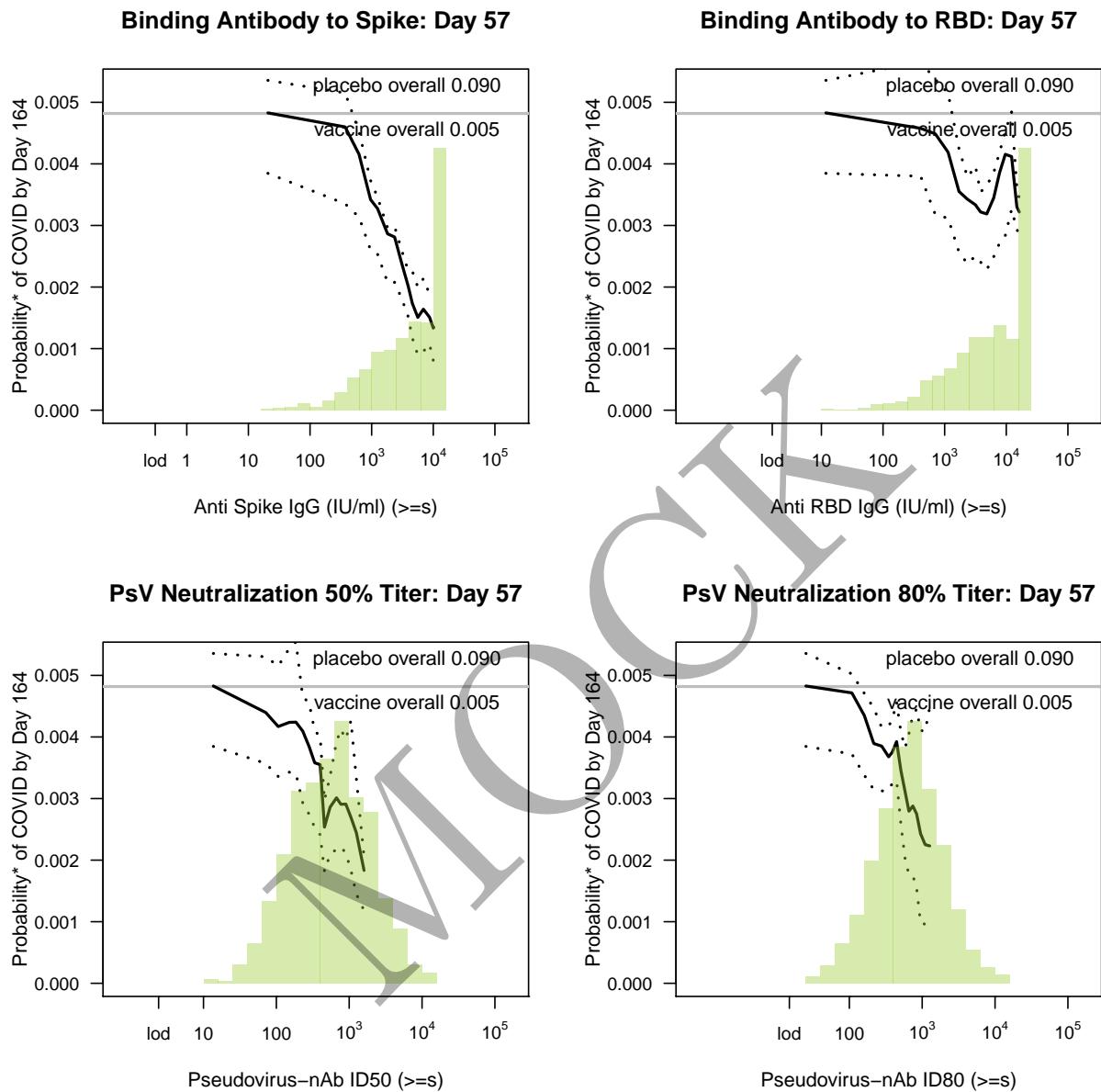


Figure 4.9: Marginalized cumulative risk by Day 164 as functions of Day 57 markers above a threshold ($\geq s$) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence bands (at least 5 cases are required, 5 replicates). The horizontal lines indicate the overall cumulative risk of the vaccine arm by Day 164 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. $l_{od} = 0.3, 1.6, 2.4, 15$ for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.

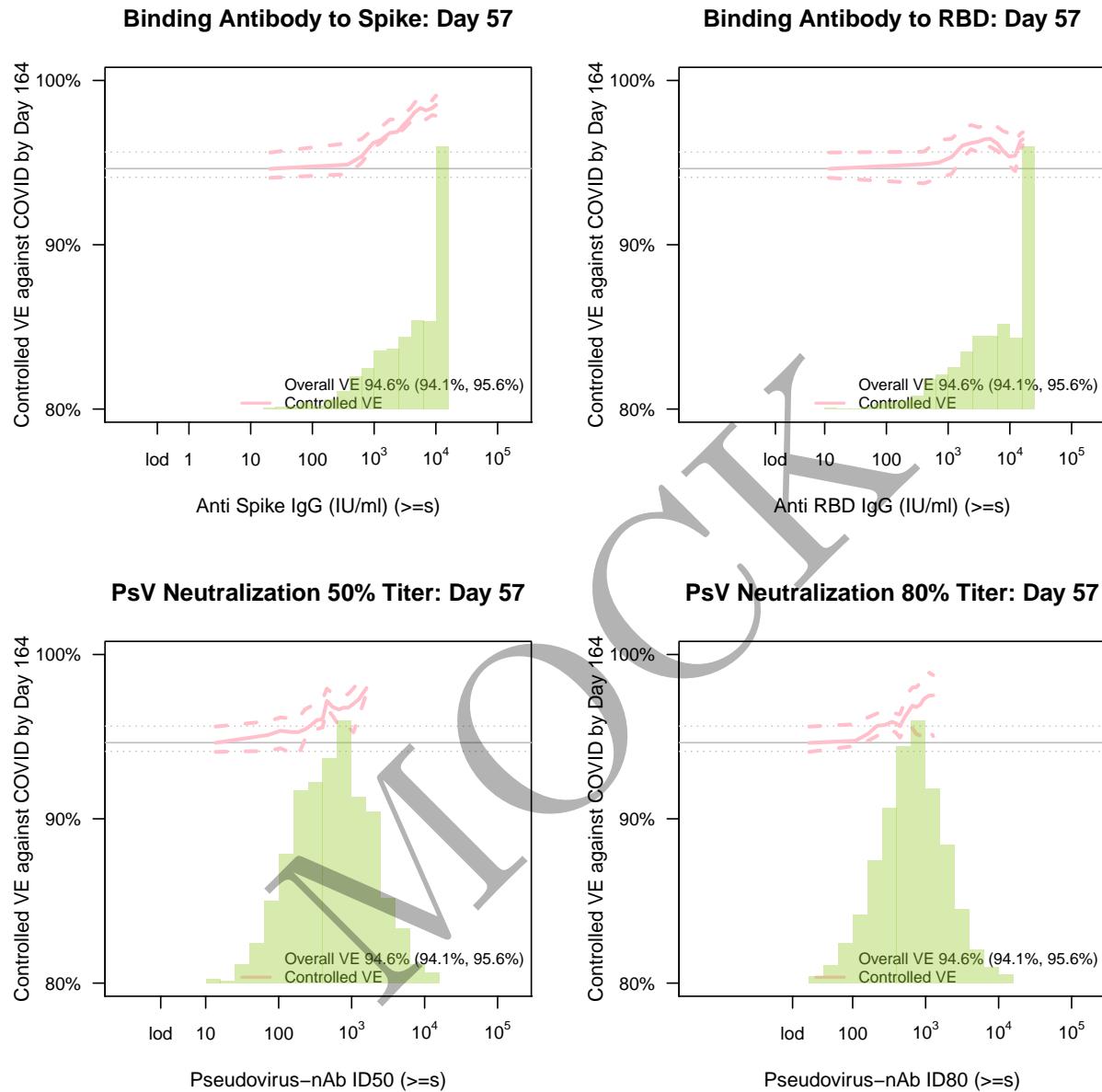


Figure 4.10: Controlled VE as functions of Day 57 markers ($\geq s$) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates). Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4, 15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.

Chapter 5

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.

5.1 Hazard ratios

Table 5.1: 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*

MockCOVE Immunologic Marker	No. cases / No. at-risk**	HR per 10-fold incr. Pt. Est.	95% CI	P-value (2-sided)	q-value ***	FWER
Anti Spike IgG (IU/ml)	60/11,157	0.31	(0.17-0.54)	<0.001	<0.001	<0.001
Anti RBD IgG (IU/ml)	60/11,157	0.50	(0.30-0.85)	0.010	<0.001	<0.001
Pseudovirus-nAb ID50	60/11,157	0.43	(0.22-0.86)	0.016	<0.001	<0.001
Pseudovirus-nAb ID80	60/11,157	0.35	(0.18-0.68)	0.002	N/A	N/A

*Baseline covariates adjusted for: baseline risk score, at risk or not, community of color or not. Maximum failure event time 192 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.

***q-value and FWER (family-wide error rate) are computed over the set of p-values both for quantitative markers and categorical markers (excluding ID80) using the Westfall and Young permutation method (5 replicates).

Table 5.2: 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*

MockCOVE Immunologic Marker	Tertile	No. cases / No. at-risk**	Attack rate	Pt. Est.	Haz. Ratio 95% CI	P-value (2-sided)	Overall P- value***	Overall q- value †	Overall FWER
Anti Spike IgG (IU/ml)	Lower	20/3,702	0.0054	1	N/A	N/A	0.004	N/A	N/A
	Middle	19/3,705	0.0051	0.57	(0.28-1.16)	0.121			
	Upper	20/3,750	0.0053	0.26	(0.11-0.58)	<0.001			
Anti RBD IgG (IU/ml)	Lower	26/3,722	0.0070	1	N/A	N/A	0.001	N/A	N/A
	Middle	13/3,740	0.0035	0.33	(0.16-0.67)	0.002			
	Upper	20/3,695	0.0054	0.29	(0.14-0.61)	0.001			
Pseudovirus-nAb ID50	Lower	20/3,690	0.0054	1	N/A	N/A	0.053	N/A	N/A
	Middle	23/3,749	0.0061	0.97	(0.50-1.89)	0.933			
	Upper	16/3,718	0.0043	0.45	(0.21-0.96)	0.038			
Pseudovirus-nAb ID80	Lower	20/3,754	0.0053	1	N/A	N/A	0.028	N/A	N/A
	Middle	26/3,719	0.0070	1.15	(0.61-2.17)	0.674			
	Upper	13/3,685	0.0035	0.45	(0.21-0.96)	0.038			
Placebo		1169/11,426	0.1023						

*Baseline covariates adjusted for: baseline risk score, at risk or not, community of color or not. Maximum failure event time 192 days. Cutpoints: Anti Spike IgG (IU/ml) [2.14, 2.65], Anti RBD IgG (IU/ml) [2.37, 2.98], Pseudovirus-nAb ID50 [1.07, 1.45], Pseudovirus-nAb ID80 [1.26, 1.61], all on the log10 scale.

**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.

† q-value and FWER (family-wide error rate) are computed over the set of p-values both for quantitative markers and categorical markers (excluding ID80) using the Westfall and Young permutation method (5 replicates).

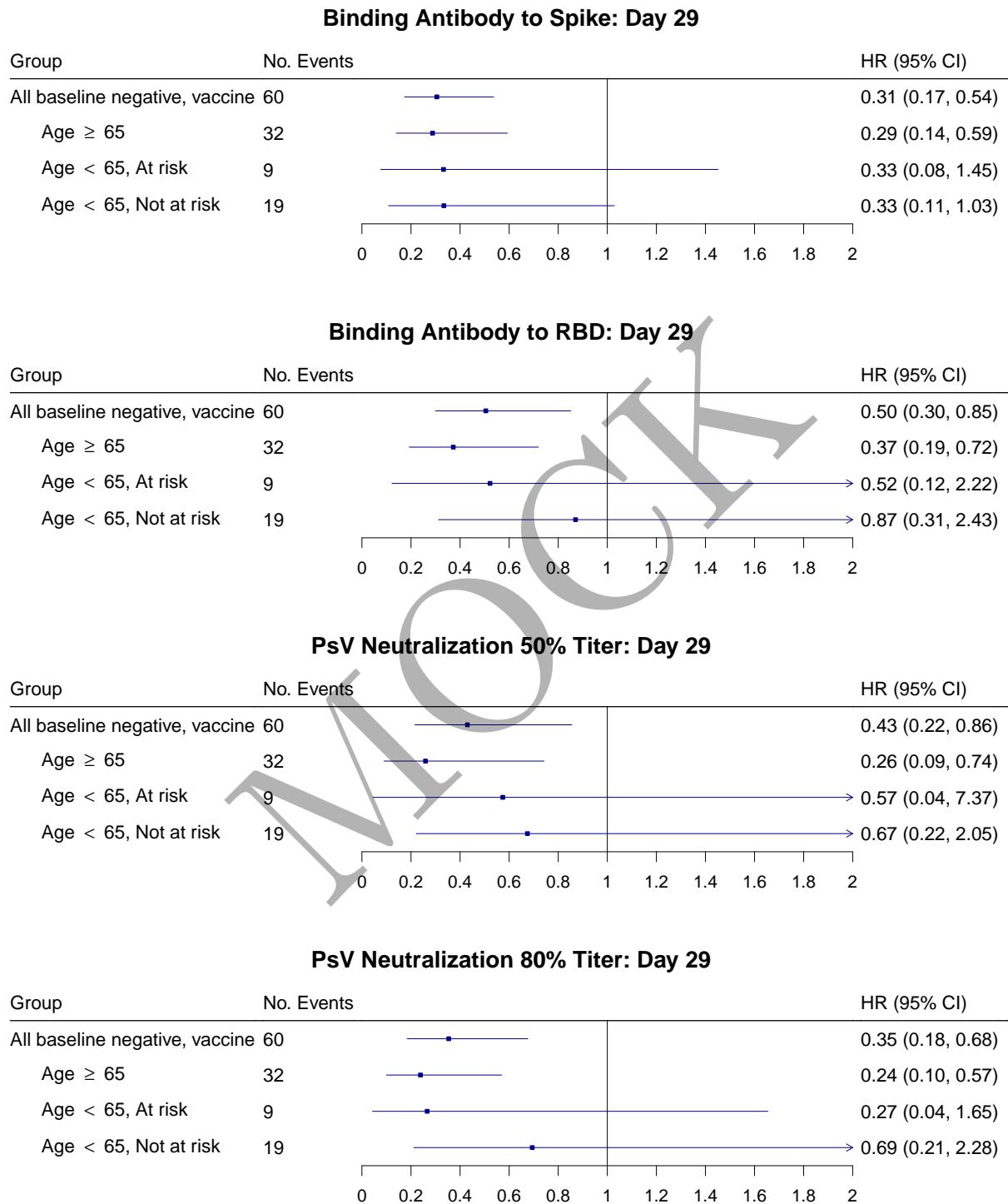


Figure 5.1: Forest plots of hazard ratios per 10-fold increase in the marker among baseline negative vaccine recipients and subgroups with 95% point-wise confidence intervals.

Binding Antibody to Spike: Day 29

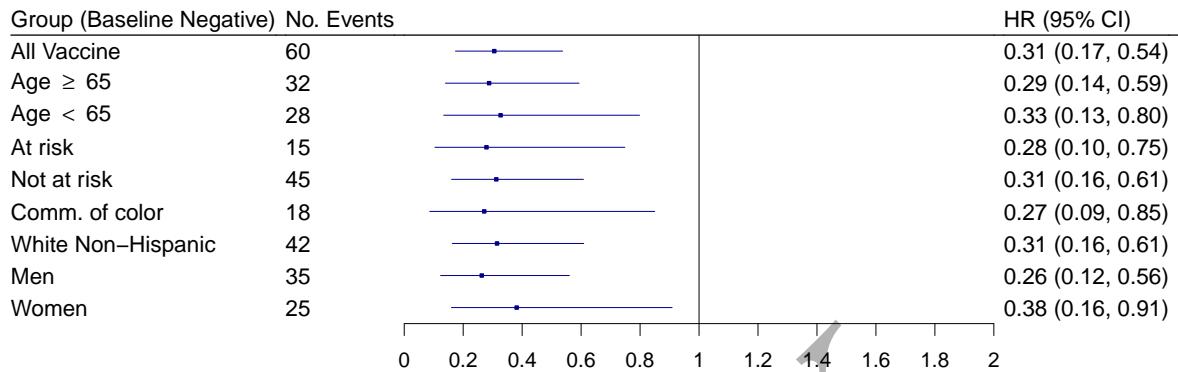


Figure 5.2: Forest plots of hazard ratios per 10-fold increase in the Day 29 binding Ab to spike markers among baseline negative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

Binding Antibody to RBD: Day 29

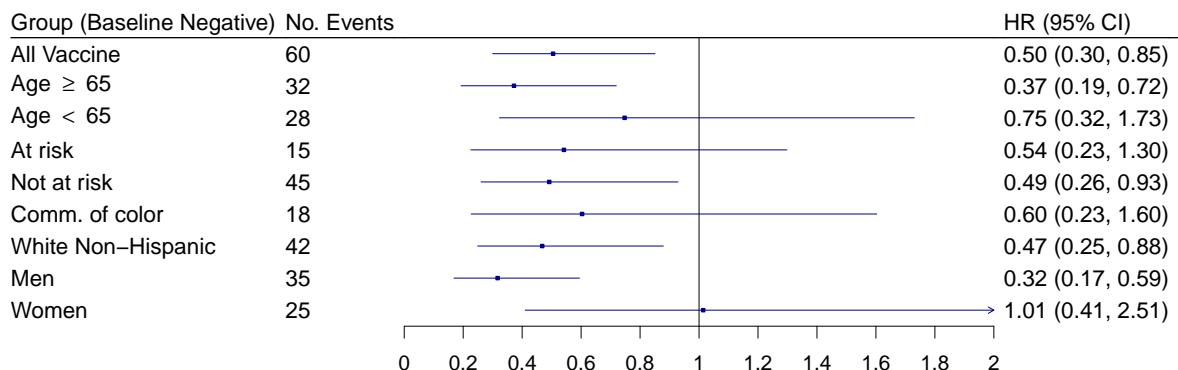


Figure 5.3: Forest plots of hazard ratios per 10-fold increase in the Day 29 binding Ab to RBD markers among baseline negative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

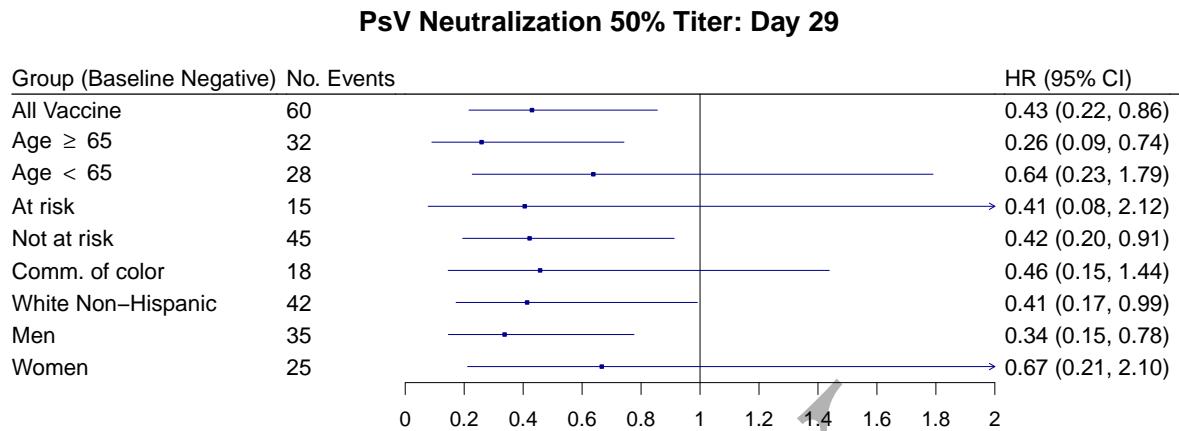


Figure 5.4: Forest plots of hazard ratios per 10-fold increase in the Day 29 pseudo neut ID50 markers among baseline negative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

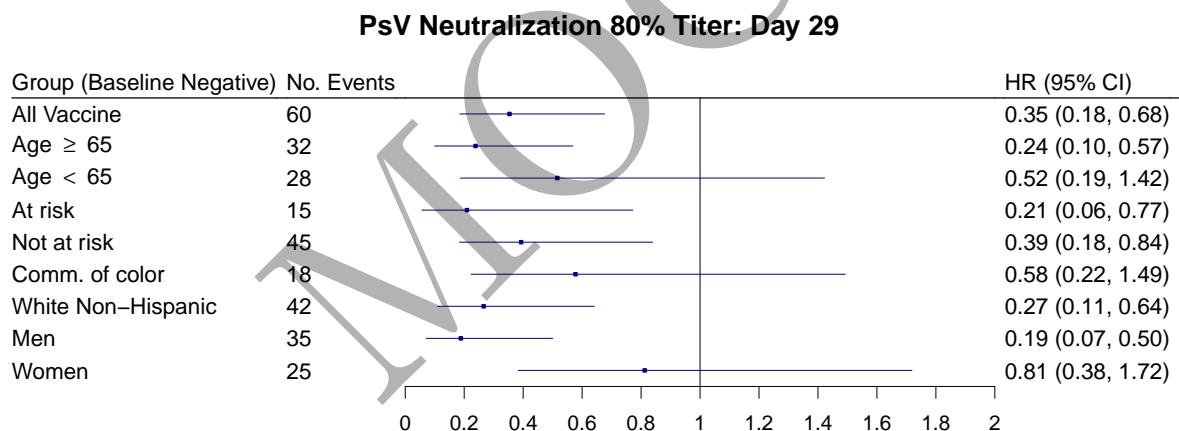


Figure 5.5: Forest plots of hazard ratios per 10-fold increase in the Day 29 pseudo neut ID80 markers among baseline negative vaccine recipients (top row) and eight subpopulations (row 2-9) with 95% point-wise confidence intervals.

5.2 Marginalized risk and controlled vaccine efficacy plots

MOCK

Table 5.3: Analysis of Day 29 markers (upper vs. lower tertile) as a CoR and a controlled risk CoP.

Trial	marginalized risk			controlled risk			$e(0,1)^2$
	ratio $RR_M(0,1)$	Point Est.	95% CI	ratio $RR_C(0,1)^1$	Point Est.	95% CI	
Anti Spike IgG (IU/ml)	0.26	0.13–0.70	0.35	0.17–0.94	7.1	2.2	
Anti RBD IgG (IU/ml)	0.29	0.17–0.50	0.39	0.22–0.67	6.3	3.4	
Pseudovirus-nAb ID50	0.45	0.28–0.65	0.61	0.37–0.87	3.8	2.4	
Pseudovirus-nAb ID80	0.45	0.30–0.84	0.60	0.40–1.12	3.8	1.7	

¹Conservative (upper bound) estimate assuming unmeasured confounding at level $RR_{UD}(0,1) = RR_{EU}(0,1) = 2$ and thus $B(0,1) = 4/3$.

²E-values are computed for upper tertile ($s = 1$) vs. lower tertile ($s = 0$) biomarker subgroups after controlling for baseline risk score, at risk or not, community of color or not; UL = upper limit.

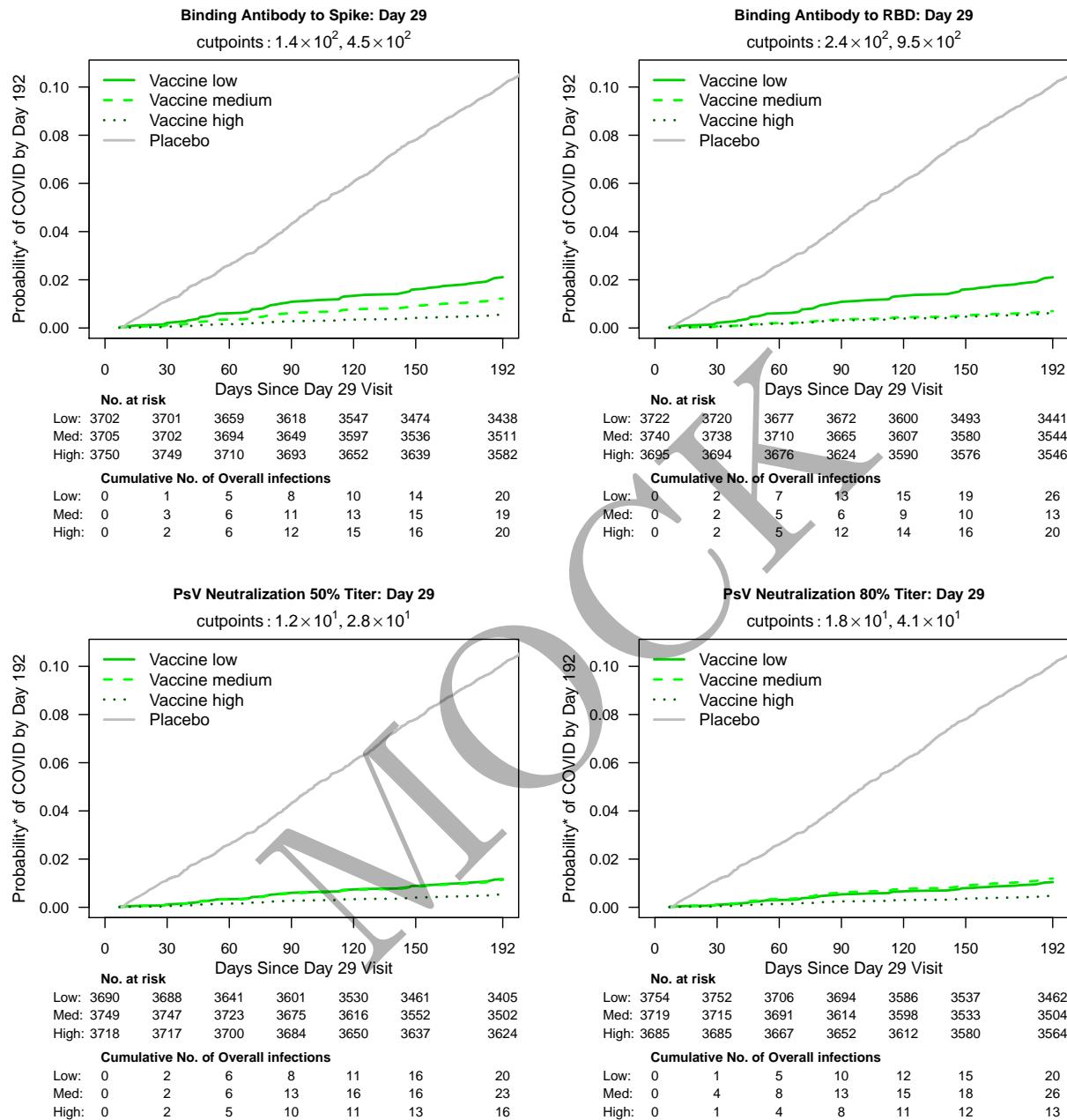


Figure 5.6: Marginalized cumulative incidence rate curves for trichotomized Day 29 markers among baseline negative vaccine recipients. The gray line is the overall cumulative incidence rate curve in the placebo arm.

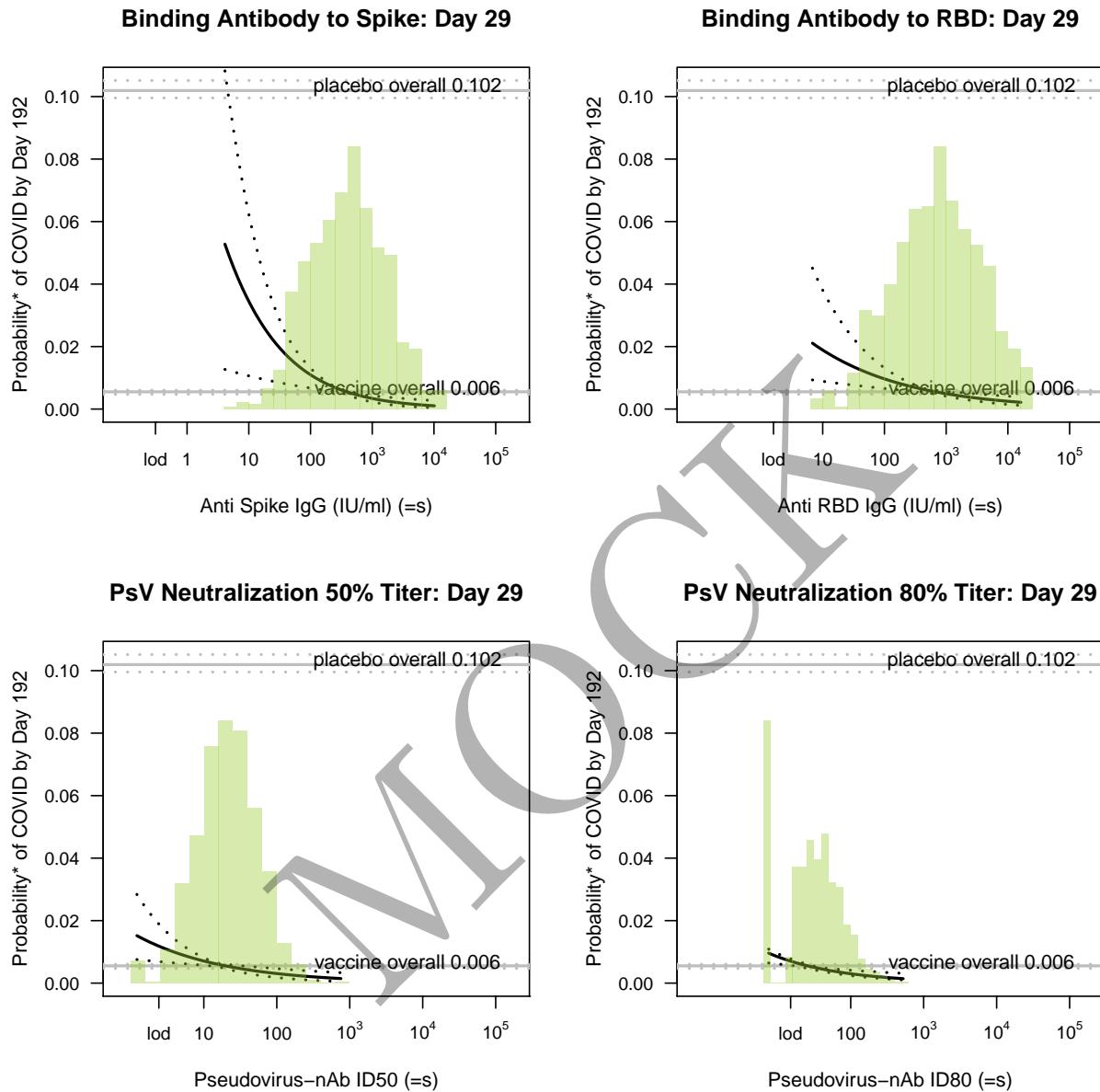


Figure 5.7: Marginalized cumulative risk by Day 192 as functions of Day 29 markers (=s) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates). The horizontal lines indicate the overall cumulative risk of the placebo and vaccine arms by Day 192 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4, 15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.

Table 5.4: Marginalized cumulative risk by Day 192 as functions of Day 29 markers (=s) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence intervals (5 replicates).

	Anti Spike IgG (IU/ml)	Anti RBD IgG (IU/ml)	Pseudovirus-nAb ID50	Pseudovirus-nAb ID80	
s	Estimate	s	Estimate	s	Estimate
4	.0528 (.0127,.1082)	7	.0211 (.0093,.0451)	1	.0152 (.0075,.0284)
43	.0168 (.0079,.0229)	49	.0119 (.0072,.0184)	4	.0097 (.0064,.0136)
62	.0140 (.0074,.0180)	74	.0105 (.0068,.0151)	6	.0086 (.0061,.0111)
64	.0138 (.0073,.0176)	78	.0104 (.0068,.0148)	6	.0085 (.0061,.0110)
84	.0119 (.0069,.0146)	125	.0090 (.0064,.0118)	8	.0077 (.0059,.0094)
115	.0102 (.0065,.0119)	175	.0082 (.0061,.0101)	10	.0072 (.0058,.0083)
121	.0100 (.0065,.0115)	188	.0080 (.0061,.0098)	10	.0071 (.0057,.0082)
144	.0091 (.0062,.0102)	230	.0076 (.0059,.0089)	11	.0068 (.0056,.0076)
183	.0081 (.0060,.0087)	306	.0070 (.0057,.0078)	12	.0065 (.0055,.0072)
224	.0073 (.0057,.0076)	376	.0065 (.0055,.0071)	14	.0063 (.0054,.0067)
231	.0072 (.0057,.0075)	386	.0065 (.0055,.0070)	14	.0062 (.0054,.0066)
271	.0066 (.0055,.0069)	474	.0061 (.0054,.0064)	17	.0059 (.0051,.0063)
333	.0060 (.0051,.0062)	603	.0057 (.0050,.0061)	19	.0056 (.0048,.0061)
336	.0059 (.0050,.0062)	608	.0057 (.0050,.0061)	19	.0056 (.0048,.0061)
408	.0054 (.0044,.0057)	755	.0053 (.0046,.0059)	21	.0054 (.0044,.0060)
474	.0050 (.0039,.0053)	909	.0050 (.0043,.0057)	24	.0051 (.0041,.0058)
475	.0050 (.0039,.0053)	912	.0050 (.0042,.0057)	24	.0051 (.0041,.0058)
564	.0045 (.0035,.0049)	1091	.0048 (.0039,.0056)	27	.0049 (.0039,.0057)
689	.0041 (.0030,.0046)	1357	.0045 (.0036,.0054)	30	.0048 (.0036,.0056)
693	.0041 (.0030,.0046)	1395	.0045 (.0036,.0054)	30	.0047 (.0036,.0056)
846	.0037 (.0026,.0044)	1760	.0042 (.0032,.0052)	34	.0045 (.0034,.0055)
1044	.0033 (.0022,.0042)	2270	.0039 (.0029,.0051)	40	.0043 (.0031,.0054)
1294	.0030 (.0019,.0040)	2891	.0036 (.0026,.0049)	45	.0041 (.0028,.0053)
1345	.0029 (.0018,.0040)	2921	.0036 (.0026,.0049)	46	.0040 (.0028,.0052)
1785	.0025 (.0015,.0038)	4073	.0032 (.0023,.0047)	55	.0038 (.0025,.0051)
2228	.0023 (.0012,.0036)	5444	.0030 (.0020,.0045)	71	.0035 (.0022,.0049)
2295	.0022 (.0012,.0036)	5613	.0030 (.0019,.0045)	72	.0034 (.0022,.0049)
4150	.0016 (.0008,.0032)	9730	.0025 (.0015,.0041)	97	.0031 (.0018,.0046)
10156	.0010 (.0004,.0027)	16269	.0022 (.0012,.0039)	757	.0015 (.0005,.0033)
				524	.0014 (.0010,.0031)

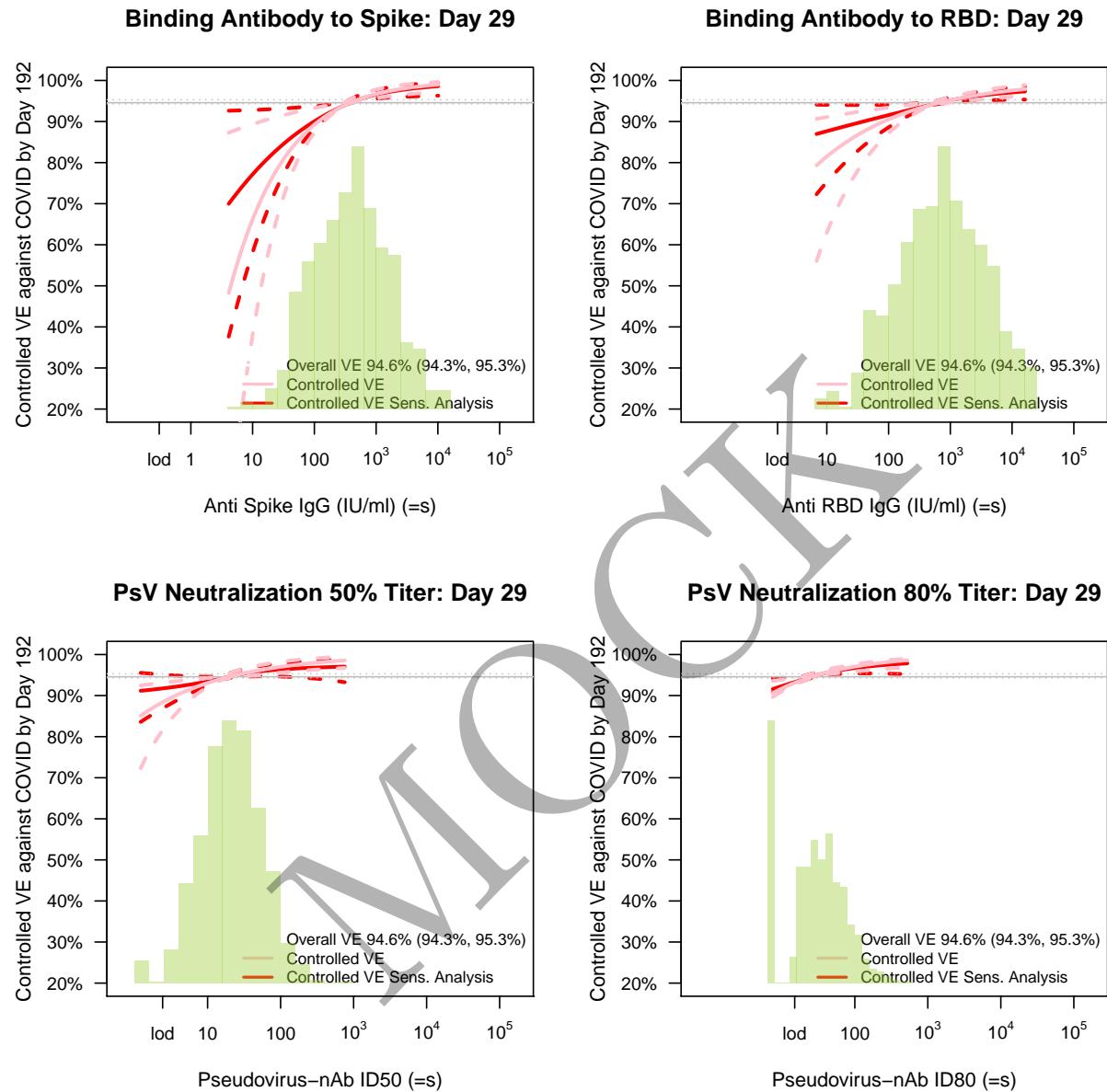


Figure 5.8: Controlled VE with sensitivity analysis as functions of Day 29 markers ($=s$) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates). Histograms of the immunological markers in the vaccine arm are overlaid. $l_{od} = 0.3, 1.6, 2.4, 15$ for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.

Table 5.5: Controlled VE as functions of Day 29 markers (=s) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence intervals (5 replicates).

	Anti Spike IgG (IU/ml)		Anti RBD IgG (IU/ml)		Pseudovirus-nAb ID50		Pseudovirus-nAb ID80
s	Estimate	s	Estimate	s	Estimate	s	Estimate
4	.4822 (-.0755,.8730)	7	.7932 (.5605,.9065)	1	.8510 (.7232,.9248)	8	.9060 (.8964,.9356)
43	.8353 (.7722,.9204)	49	.8831 (.8205,.9276)	4	.9051 (.8676,.9360)	8	.9060 (.8964,.9356)
62	.8631 (.8246,.9260)	74	.8967 (.8526,.9314)	6	.9159 (.8915,.9387)	8	.9060 (.8964,.9356)
64	.8651 (.8280,.9264)	78	.8981 (.8558,.9318)	6	.9165 (.8928,.9389)	8	.9060 (.8964,.9356)
84	.8828 (.8572,.9304)	125	.9113 (.8846,.9359)	8	.9240 (.9083,.9409)	8	.9060 (.8964,.9356)
115	.8997 (.8838,.9345)	175	.9195 (.9014,.9386)	10	.9295 (.9189,.9425)	8	.9060 (.8964,.9356)
121	.9021 (.8875,.9352)	188	.9212 (.9047,.9392)	10	.9299 (.9197,.9426)	15	.9315 (.9268,.9432)
144	.9107 (.9004,.9374)	230	.9258 (.9135,.9408)	11	.9333 (.9261,.9436)	17	.9347 (.9305,.9444)
183	.9208 (.9152,.9403)	306	.9317 (.9244,.9429)	12	.9358 (.9302,.9446)	19	.9386 (.9349,.9468)
224	.9286 (.9257,.9426)	376	.9358 (.9312,.9445)	14	.9386 (.9350,.9458)	22	.9417 (.9384,.9496)
231	.9296 (.9272,.9430)	386	.9363 (.9321,.9447)	14	.9390 (.9356,.9460)	22	.9422 (.9389,.9500)
271	.9351 (.9344,.9448)	474	.9400 (.9381,.9464)	17	.9423 (.9404,.9495)	25	.9452 (.9423,.9528)
333	.9416 (.9408,.9495)	603	.9441 (.9420,.9503)	19	.9447 (.9418,.9525)	28	.9474 (.9448,.9548)
336	.9419 (.9411,.9498)	608	.9442 (.9420,.9504)	19	.9448 (.9419,.9526)	28	.9476 (.9450,.9550)
408	.9473 (.9461,.9562)	755	.9477 (.9440,.9544)	21	.9473 (.9434,.9559)	31	.9501 (.9478,.9573)
474	.9512 (.9495,.9608)	909	.9505 (.9454,.9577)	24	.9496 (.9445,.9589)	35	.9526 (.9501,.9597)
475	.9513 (.9495,.9609)	912	.9505 (.9454,.9578)	24	.9496 (.9445,.9589)	35	.9527 (.9501,.9597)
564	.9554 (.9521,.9656)	1091	.9530 (.9467,.9608)	27	.9518 (.9455,.9617)	39	.9553 (.9515,.9621)
689	.9597 (.9541,.9704)	1357	.9560 (.9483,.9642)	30	.9534 (.9463,.9638)	43	.9568 (.9522,.9635)
693	.9598 (.9541,.9705)	1395	.9563 (.9485,.9646)	30	.9536 (.9465,.9641)	43	.9569 (.9522,.9637)
846	.9637 (.9559,.9746)	1760	.9592 (.9501,.9678)	34	.9557 (.9475,.9666)	47	.9588 (.9530,.9654)
1044	.9674 (.9577,.9783)	2270	.9622 (.9518,.9710)	40	.9580 (.9488,.9694)	55	.9615 (.9542,.9679)
1294	.9708 (.9594,.9815)	2891	.9648 (.9534,.9741)	45	.9600 (.9499,.9717)	63	.9636 (.9552,.9699)
1345	.9714 (.9597,.9820)	2921	.9649 (.9534,.9742)	46	.9603 (.9501,.9721)	64	.9640 (.9554,.9703)
1785	.9753 (.9619,.9854)	4073	.9682 (.9555,.9780)	55	.9627 (.9514,.9748)	74	.9662 (.9565,.9724)
2228	.9779 (.9635,.9877)	5444	.9708 (.9572,.9809)	71	.9661 (.9534,.9784)	90	.9692 (.9579,.9751)
2295	.9783 (.9638,.9879)	5613	.9711 (.9574,.9812)	72	.9662 (.9535,.9785)	92	.9694 (.9580,.9752)
4150	.9840 (.9677,.9923)	9730	.9754 (.9605,.9855)	97	.9697 (.9557,.9820)	120	.9728 (.9599,.9784)
10156	.9899 (.9729,.9960)	16269	.9789 (.9632,.9887)	757	.9857 (.9673,.9947)	524	.9860 (.9688,.9898)

Table 5.6: Controlled VE with sensitivity analysis as functions of Day 29 markers (=s) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence intervals (5 replicates).

	Anti Spike IgG (IU/ml)		Anti RBD IgG (IU/ml)		Pseudovirus-nAb ID50		Pseudovirus-nAb ID80
s	Estimate	s	Estimate	s	Estimate	s	Estimate
4	.6998 (.3763,.9263)	7	.8697 (.7230,.9411)	1	.9117 (.8359,.9554)	8	.9160 (.9074,.9424)
43	.8617 (.8087,.9332)	49	.9038 (.8522,.9404)	4	.9232 (.8928,.9482)	8	.9160 (.9074,.9424)
62	.8797 (.8458,.9350)	74	.9108 (.8727,.9408)	6	.9272 (.9061,.9469)	8	.9160 (.9074,.9424)
64	.8810 (.8483,.9351)	78	.9116 (.8749,.9408)	6	.9274 (.9068,.9469)	8	.9160 (.9074,.9424)
84	.8934 (.8701,.9367)	125	.9193 (.8950,.9417)	8	.9309 (.9165,.9462)	8	.9160 (.9074,.9424)
115	.9060 (.8911,.9386)	175	.9247 (.9077,.9425)	10	.9338 (.9239,.9460)	8	.9160 (.9074,.9424)
121	.9078 (.8941,.9389)	188	.9258 (.9103,.9427)	10	.9340 (.9244,.9460)	15	.9333 (.9288,.9447)
144	.9146 (.9048,.9402)	230	.9291 (.9173,.9434)	11	.9361 (.9292,.9460)	17	.9359 (.9318,.9454)
183	.9230 (.9176,.9420)	306	.9336 (.9264,.9445)	12	.9377 (.9324,.9463)	19	.9392 (.9356,.9473)
224	.9297 (.9269,.9436)	376	.9368 (.9324,.9455)	14	.9398 (.9362,.9468)	22	.9419 (.9387,.9498)
231	.9307 (.9282,.9438)	386	.9373 (.9331,.9456)	14	.9401 (.9368,.9469)	22	.9424 (.9392,.9502)
271	.9357 (.9349,.9452)	474	.9405 (.9385,.9468)	17	.9427 (.9408,.9498)	25	.9453 (.9424,.9528)
333	.9417 (.9410,.9496)	603	.9442 (.9421,.9504)	19	.9448 (.9420,.9526)	28	.9474 (.9448,.9548)
336	.9420 (.9412,.9499)	608	.9443 (.9421,.9505)	19	.9449 (.9420,.9527)	28	.9476 (.9450,.9550)
408	.9473 (.9461,.9562)	755	.9477 (.9440,.9544)	21	.9473 (.9434,.9559)	31	.9500 (.9477,.9573)
474	.9512 (.9494,.9608)	909	.9504 (.9453,.9577)	24	.9495 (.9444,.9588)	35	.9524 (.9499,.9595)
475	.9512 (.9495,.9609)	912	.9504 (.9454,.9577)	24	.9495 (.9444,.9589)	35	.9524 (.9499,.9595)
564	.9551 (.9519,.9654)	1091	.9528 (.9465,.9606)	27	.9514 (.9452,.9615)	39	.9548 (.9510,.9617)
689	.9592 (.9535,.9700)	1357	.9554 (.9477,.9637)	30	.9528 (.9457,.9633)	43	.9561 (.9514,.9630)
693	.9593 (.9535,.9701)	1395	.9557 (.9478,.9641)	30	.9530 (.9457,.9636)	43	.9562 (.9515,.9631)
846	.9629 (.9548,.9740)	1760	.9582 (.9489,.9670)	34	.9546 (.9463,.9658)	47	.9578 (.9519,.9646)
1044	.9662 (.9560,.9774)	2270	.9607 (.9499,.9699)	40	.9563 (.9467,.9681)	55	.9600 (.9525,.9667)
1294	.9692 (.9571,.9804)	2891	.9627 (.9507,.9726)	45	.9577 (.9469,.9701)	63	.9618 (.9529,.9684)
1345	.9697 (.9573,.9809)	2921	.9628 (.9507,.9727)	46	.9579 (.9470,.9704)	64	.9621 (.9530,.9687)
1785	.9731 (.9586,.9842)	4073	.9654 (.9516,.9761)	55	.9594 (.9471,.9726)	74	.9638 (.9533,.9704)
2228	.9754 (.9594,.9863)	5444	.9673 (.9522,.9786)	71	.9614 (.9470,.9754)	90	.9661 (.9537,.9726)
2295	.9757 (.9595,.9865)	5613	.9675 (.9522,.9789)	72	.9615 (.9470,.9755)	92	.9662 (.9537,.9727)
4150	.9807 (.9612,.9907)	9730	.9707 (.9530,.9828)	97	.9634 (.9464,.9783)	120	.9688 (.9539,.9752)
10156	.9862 (.9630,.9946)	16269	.9733 (.9534,.9857)	757	.9705 (.9326,.9890)	524	.9785 (.9520,.9844)

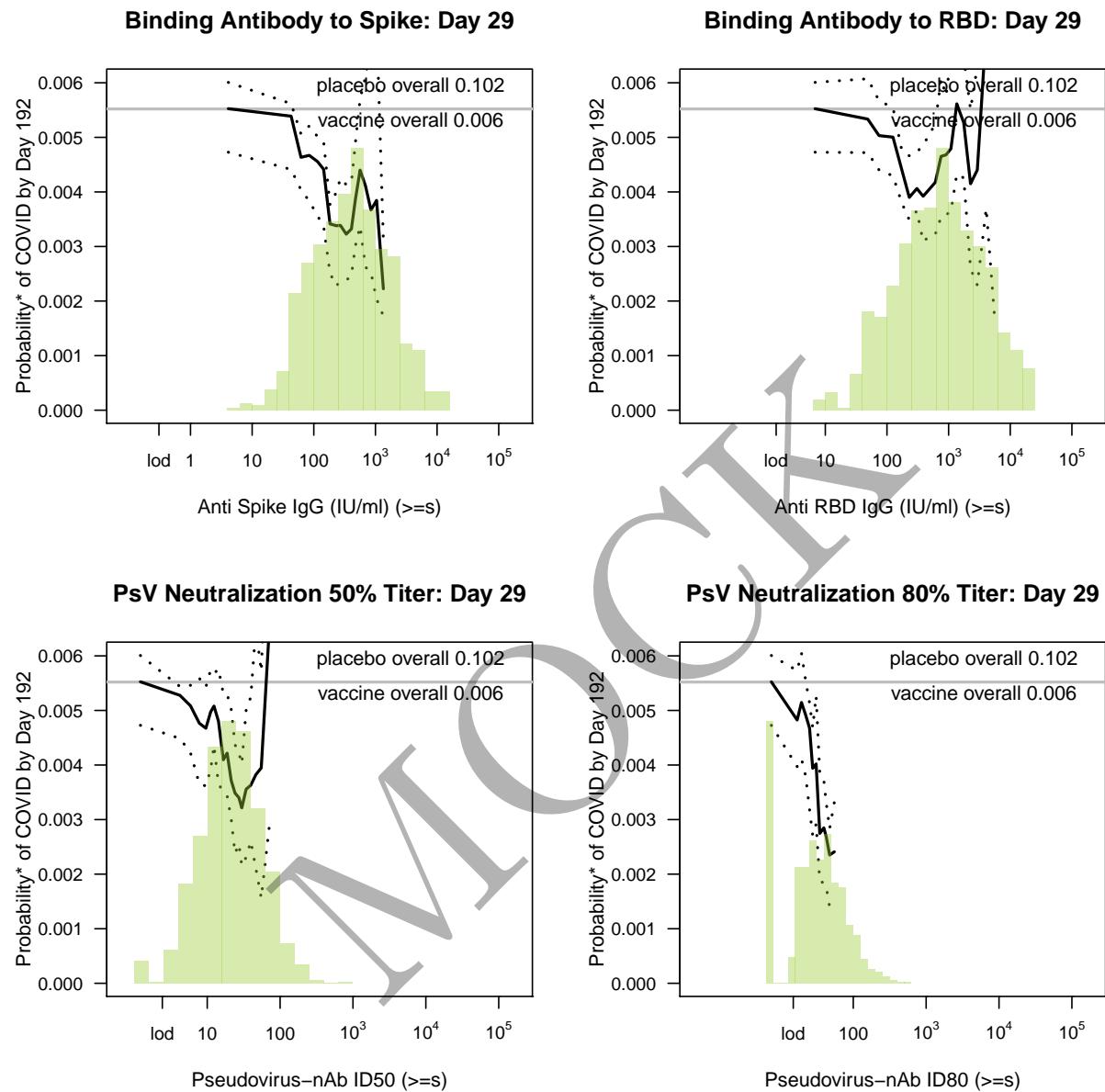


Figure 5.9: Marginalized cumulative risk by Day 192 as functions of Day 29 markers above a threshold ($\geq s$) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence bands (at least 5 cases are required, 5 replicates). The horizontal lines indicate the overall cumulative risk of the vaccine arm by Day 192 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. $l_{od} = 0.3, 1.6, 2.4, 15$ for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.

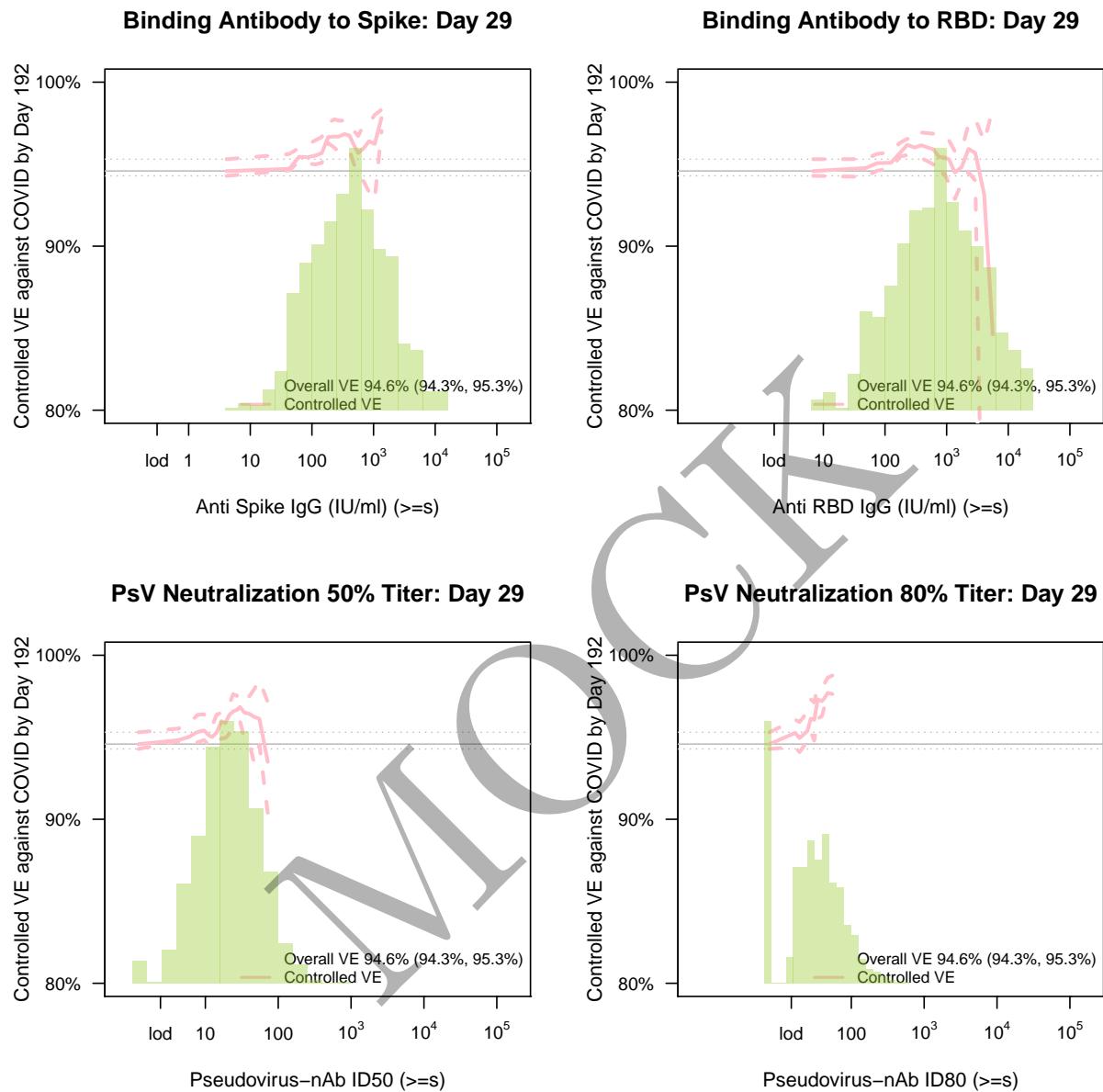


Figure 5.10: Controlled VE as functions of Day 29 markers ($\geq s$) among baseline negative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates). Histograms of the immunological markers in the vaccine arm are overlaid. $l_{od} = 0.3, 1.6, 2.4, 15$ for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.

Chapter 6

Univariate CoR: Nonparametric Threshold Modeling ($>= s$)

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

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

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

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

MOCK

6.1.1 Day 57 Spike protein binding antibody

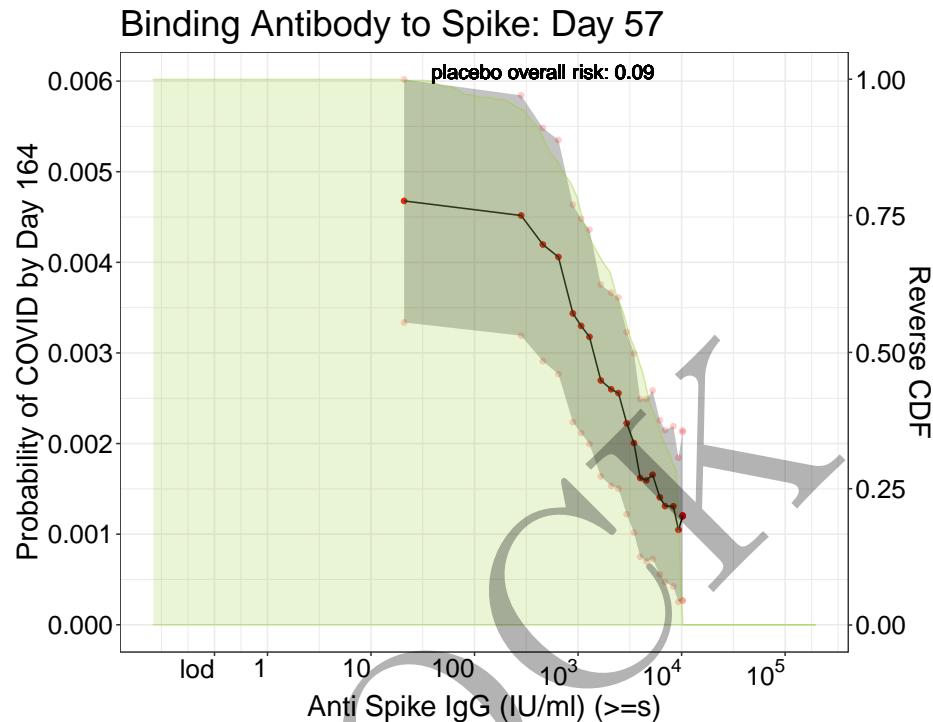


Figure 6.1: Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table 6.1: Table of risk estimates for a range of thresholds of Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.316	$2.07 * 10^1$	0.00468	0.00334	0.00602
2.657	$4.54 * 10^2$	0.00420	0.00291	0.00548
2.951	$8.93 * 10^2$	0.00344	0.00224	0.00464
3.221	$1.66 * 10^3$	0.00270	0.00164	0.00375
3.394	$2.48 * 10^3$	0.00256	0.00150	0.00361
3.544	$3.50 * 10^3$	0.00201	0.00102	0.00299
3.658	$4.55 * 10^3$	0.00159	0.00070	0.00249
3.841	$6.93 * 10^3$	0.00131	0.00047	0.00215
3.973	$9.40 * 10^3$	0.00105	0.00025	0.00184
4.007	$1.02 * 10^4$	0.00121	0.00027	0.00215

6.1.2 Day 57 RBD binding antibody

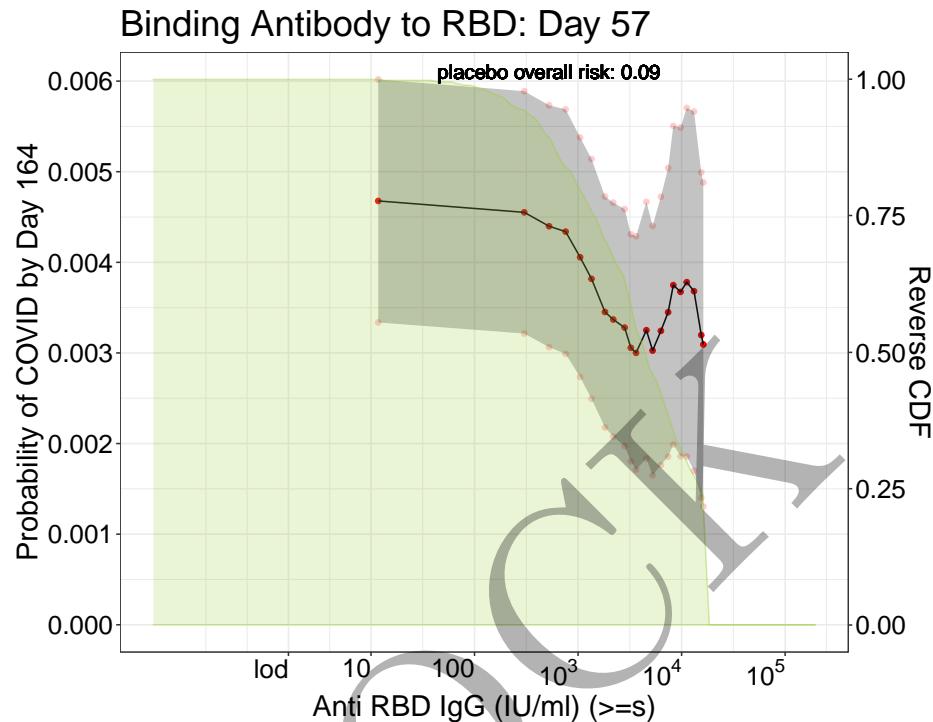


Figure 6.2: Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table 6.2: Table of risk estimates for a range of thresholds of Day 57 RBD binding antibody levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.073	$1.18 * 10^1$	0.00468	0.00334	0.00602
2.715	$5.19 * 10^2$	0.00440	0.00306	0.00573
3.022	$1.05 * 10^3$	0.00406	0.00273	0.00538
3.338	$2.18 * 10^3$	0.00337	0.00208	0.00466
3.514	$3.27 * 10^3$	0.00306	0.00180	0.00431
3.657	$4.54 * 10^3$	0.00325	0.00183	0.00467
3.797	$6.27 * 10^3$	0.00324	0.00176	0.00472
3.986	$9.68 * 10^3$	0.00367	0.00186	0.00549
4.125	$1.33 * 10^4$	0.00368	0.00170	0.00566
4.211	$1.63 * 10^4$	0.00309	0.00131	0.00488

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

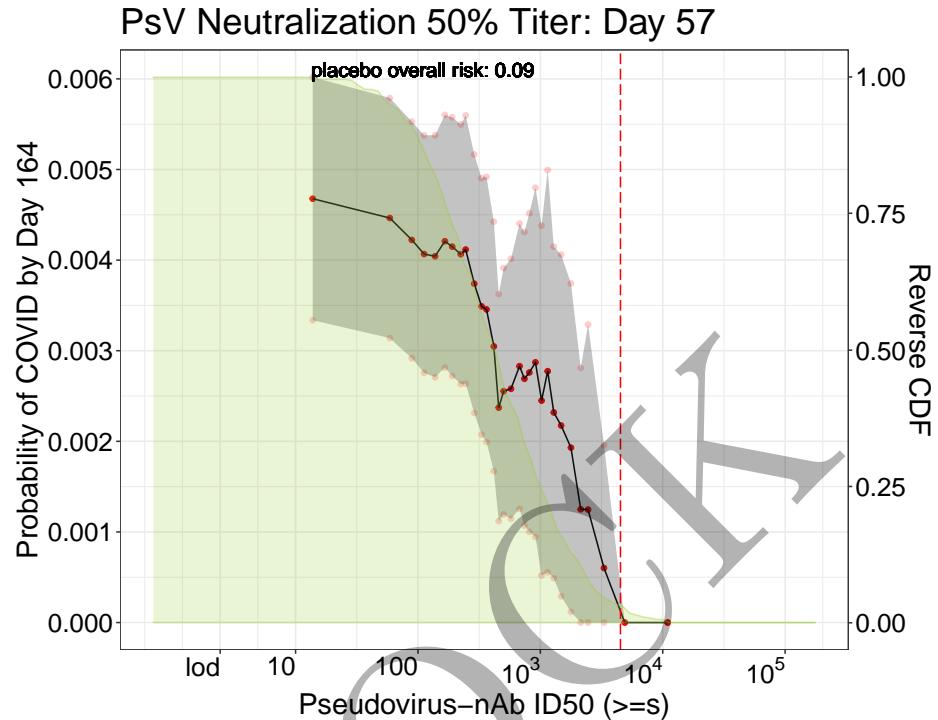


Figure 6.3: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table 6.3: 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
1.135	$1.36 * 10^1$	0.00468	0.00334	0.00602
2.055	$1.14 * 10^2$	0.00407	0.00276	0.00538
2.281	$1.91 * 10^2$	0.00415	0.00272	0.00558
2.519	$3.30 * 10^2$	0.00349	0.00207	0.00490
2.657	$4.54 * 10^2$	0.00237	0.00112	0.00362
2.828	$6.73 * 10^2$	0.00283	0.00125	0.00440
2.959	$9.10 * 10^2$	0.00287	0.00095	0.00480
3.174	$1.49 * 10^3$	0.00217	0.00029	0.00406
3.387	$2.44 * 10^3$	0.00125	0.00000	0.00329
4.038	$1.09 * 10^4$	0.00000	0.00000	NA

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

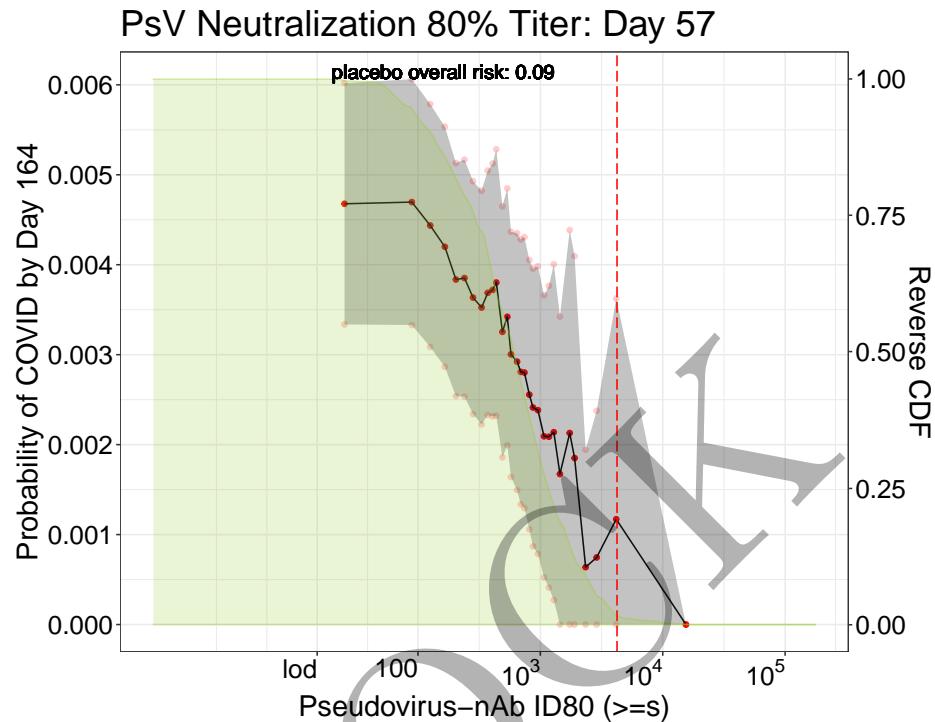


Figure 6.4: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table 6.4: 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
1.403	$2.53 * 10^1$	0.00468	0.00334	0.00602
2.220	$1.66 * 10^2$	0.00420	0.00286	0.00553
2.455	$2.85 * 10^2$	0.00363	0.00234	0.00493
2.644	$4.41 * 10^2$	0.00380	0.00232	0.00528
2.764	$5.81 * 10^2$	0.00300	0.00164	0.00437
2.874	$7.48 * 10^2$	0.00280	0.00129	0.00431
2.981	$9.57 * 10^2$	0.00238	0.00078	0.00398
3.162	$1.45 * 10^3$	0.00167	0.00000	0.00342
3.371	$2.35 * 10^3$	0.00064	0.00000	0.00194
4.187	$1.54 * 10^4$	0.00000	0.00000	NA

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

MOCK

6.2.1 Day 29 Spike protein antibody

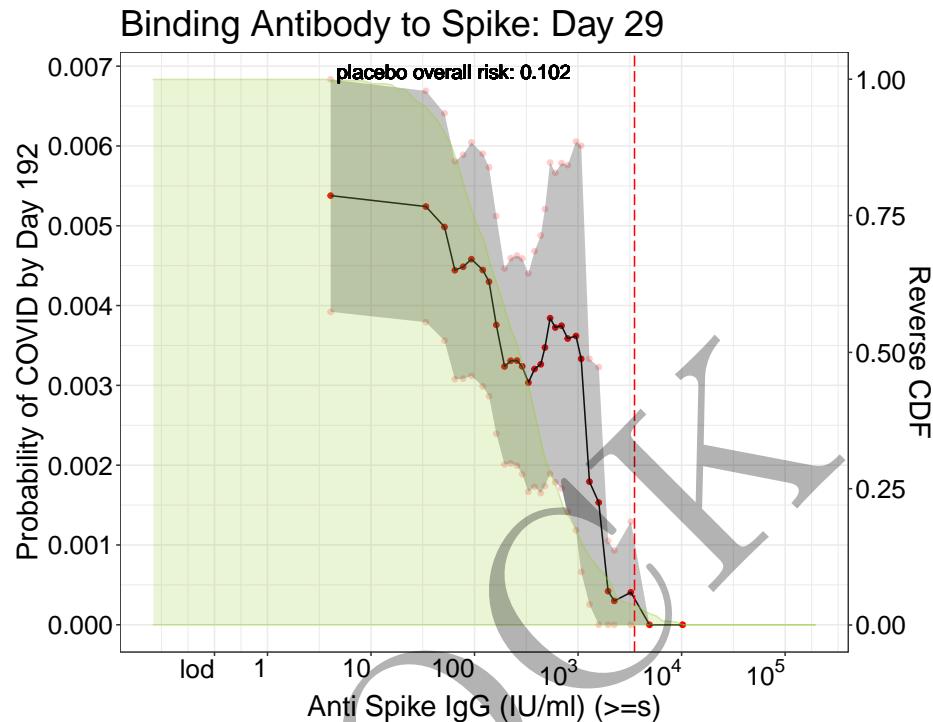


Figure 6.5: Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table 6.5: Table of risk estimates for a range of thresholds of Day 29 Spike protein antibody levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.613	4.10×10^0	0.00538	0.00392	0.00683
1.805	6.38×10^1	0.00444	0.00308	0.00581
2.081	1.21×10^2	0.00445	0.00299	0.00590
2.351	2.24×10^2	0.00331	0.00202	0.00459
2.522	3.33×10^2	0.00303	0.00167	0.00440
2.677	4.75×10^2	0.00347	0.00174	0.00521
2.841	6.93×10^2	0.00375	0.00171	0.00579
3.112	1.29×10^3	0.00179	0.00025	0.00333
3.348	2.23×10^3	0.00030	0.00000	0.00093
4.007	1.02×10^4	0.00000	0.00000	NA

6.2.2 Day 29 RBD binding antibody

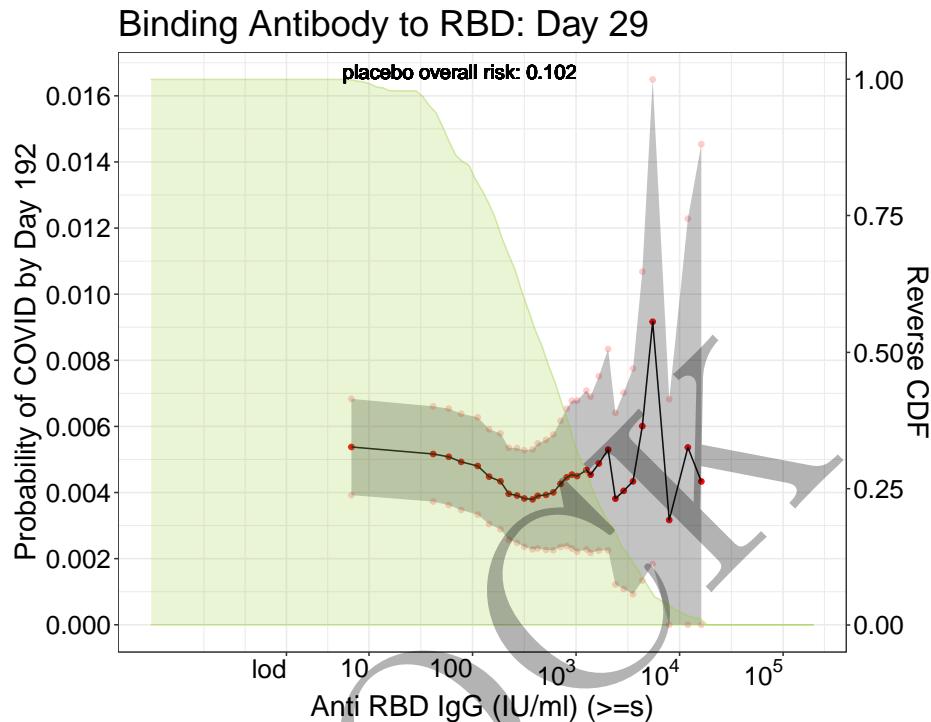


Figure 6.6: Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table 6.6: Table of risk estimates for a range of thresholds of Day 29 RBD binding antibody levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.834	$6.82 * 10^0$	0.00538	0.00392	0.00683
1.892	$7.80 * 10^1$	0.00493	0.00347	0.00638
2.273	$1.87 * 10^2$	0.00434	0.00289	0.00579
2.575	$3.76 * 10^2$	0.00379	0.00228	0.00531
2.780	$6.03 * 10^2$	0.00401	0.00225	0.00576
2.960	$9.12 * 10^2$	0.00454	0.00231	0.00678
3.144	$1.39 * 10^3$	0.00454	0.00218	0.00691
3.461	$2.89 * 10^3$	0.00405	0.00108	0.00702
3.736	$5.45 * 10^3$	0.00917	0.00184	0.01650
4.211	$1.63 * 10^4$	0.00434	0.00000	0.01454

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

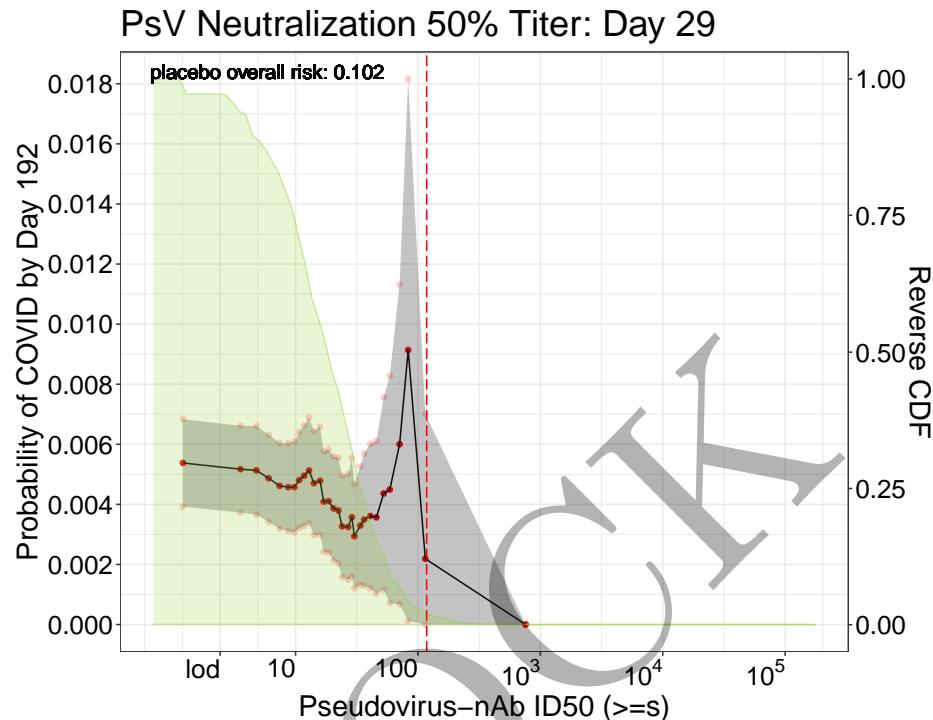


Figure 6.7: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table 6.7: 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
0.083	$1.21 * 10^0$	0.00538	0.00392	0.00683
0.779	$6.01 * 10^0$	0.00487	0.00342	0.00632
0.988	$9.73 * 10^0$	0.00458	0.00307	0.00608
1.147	$1.40 * 10^1$	0.00470	0.00297	0.00643
1.271	$1.87 * 10^1$	0.00411	0.00239	0.00582
1.382	$2.41 * 10^1$	0.00327	0.00158	0.00496
1.481	$3.03 * 10^1$	0.00294	0.00121	0.00467
1.656	$4.53 * 10^1$	0.00357	0.00104	0.00610
1.852	$7.11 * 10^1$	0.00600	0.00068	0.01132
2.879	$7.57 * 10^2$	0.00000	0.00000	NA

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

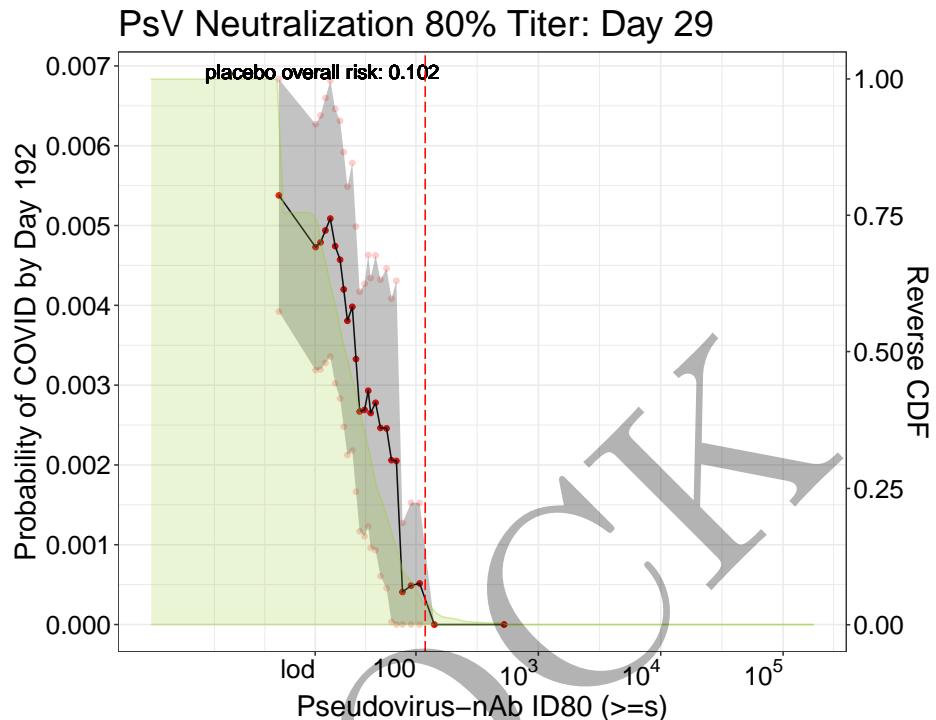


Figure 6.8: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table 6.8: 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
0.876	$7.52 * 10^0$	0.00538	0.00392	0.00683
1.260	$1.82 * 10^1$	0.00494	0.00328	0.00660
1.339	$2.18 * 10^1$	0.00474	0.00302	0.00646
1.440	$2.75 * 10^1$	0.00381	0.00212	0.00549
1.541	$3.48 * 10^1$	0.00267	0.00117	0.00417
1.610	$4.07 * 10^1$	0.00293	0.00123	0.00463
1.707	$5.09 * 10^1$	0.00246	0.00061	0.00432
1.839	$6.90 * 10^1$	0.00205	0.00000	0.00431
1.956	$9.04 * 10^1$	0.00049	0.00000	0.00153
2.719	$5.24 * 10^2$	0.00000	0.00000	NA

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

MOCK

6.3.1 Day 57 Spike protein binding antibody

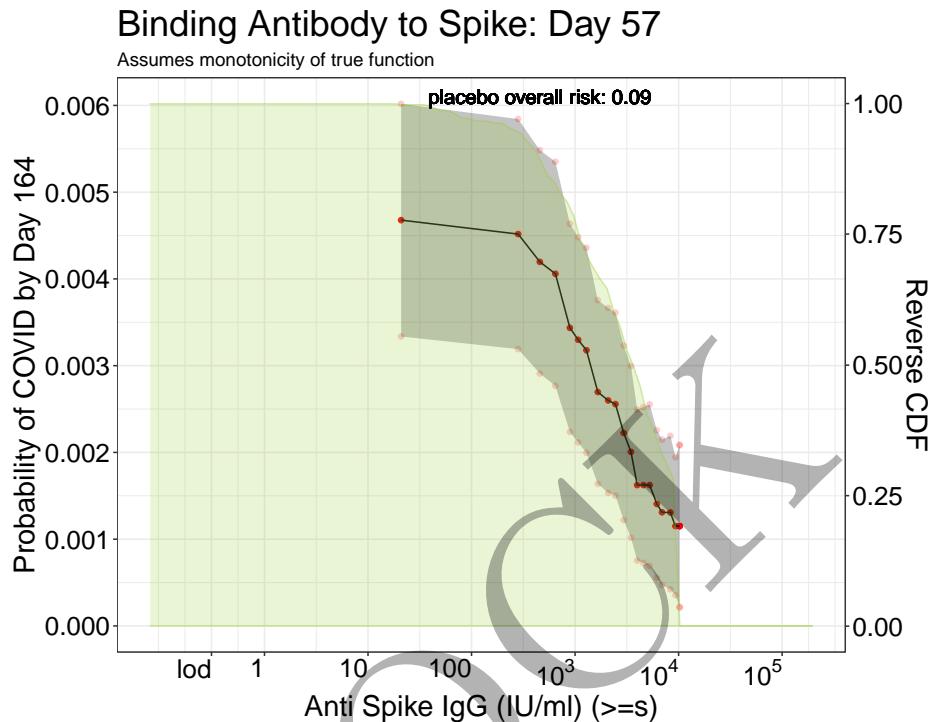


Figure 6.9: Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 6.9: Table of monotone-corrected risk estimates for a range of thresholds of Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.316	$2.07 * 10^1$	0.00468	0.00334	0.00602
2.657	$4.54 * 10^2$	0.00420	0.00291	0.00548
2.951	$8.93 * 10^2$	0.00344	0.00224	0.00464
3.221	$1.66 * 10^3$	0.00270	0.00164	0.00375
3.394	$2.48 * 10^3$	0.00256	0.00150	0.00361
3.544	$3.50 * 10^3$	0.00201	0.00102	0.00299
3.658	$4.55 * 10^3$	0.00162	0.00073	0.00252
3.841	$6.93 * 10^3$	0.00131	0.00047	0.00215
3.973	$9.40 * 10^3$	0.00115	0.00035	0.00195
4.007	$1.02 * 10^4$	0.00115	0.00021	0.00209

6.3.2 Day 57 RBD binding antibody

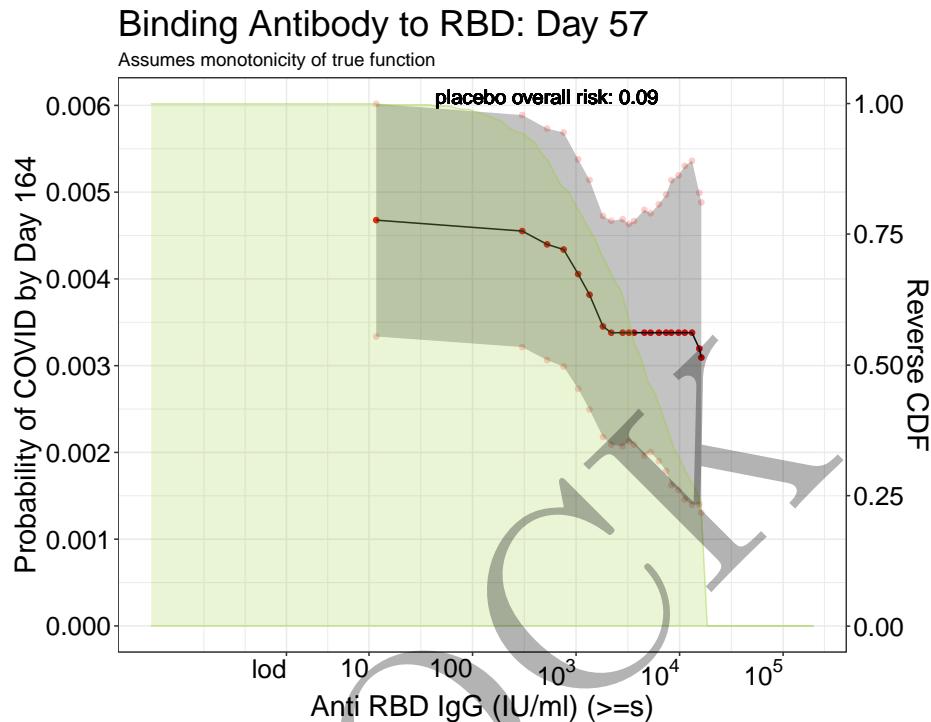


Figure 6.10: Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 6.10: Table of monotone-corrected risk estimates for a range of thresholds of Day 57 RBD binding antibody levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.073	$1.18 * 10^1$	0.00468	0.00334	0.00602
2.715	$5.19 * 10^2$	0.00440	0.00306	0.00573
3.022	$1.05 * 10^3$	0.00406	0.00273	0.00538
3.338	$2.18 * 10^3$	0.00338	0.00209	0.00467
3.514	$3.27 * 10^3$	0.00338	0.00213	0.00463
3.657	$4.54 * 10^3$	0.00338	0.00196	0.00480
3.797	$6.27 * 10^3$	0.00338	0.00190	0.00486
3.986	$9.68 * 10^3$	0.00338	0.00157	0.00519
4.125	$1.33 * 10^4$	0.00338	0.00140	0.00536
4.211	$1.63 * 10^4$	0.00309	0.00131	0.00488

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

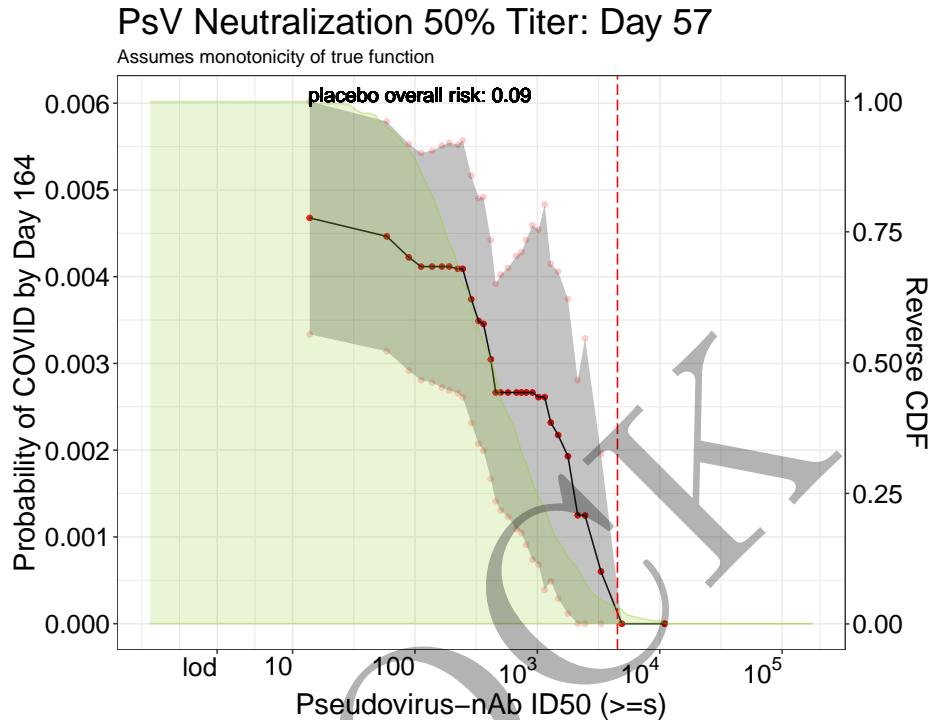


Figure 6.11: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 6.11: 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
1.135	1.36×10^1	0.00468	0.00334	0.00602
2.055	1.14×10^2	0.00412	0.00281	0.00543
2.281	1.91×10^2	0.00412	0.00269	0.00554
2.519	3.30×10^2	0.00349	0.00207	0.00490
2.657	4.54×10^2	0.00267	0.00141	0.00392
2.828	6.73×10^2	0.00267	0.00109	0.00424
2.959	9.10×10^2	0.00267	0.00074	0.00459
3.174	1.49×10^3	0.00217	0.00029	0.00406
3.387	2.44×10^3	0.00125	0.00000	0.00329
4.038	1.09×10^4	0.00000	0.00000	NA

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

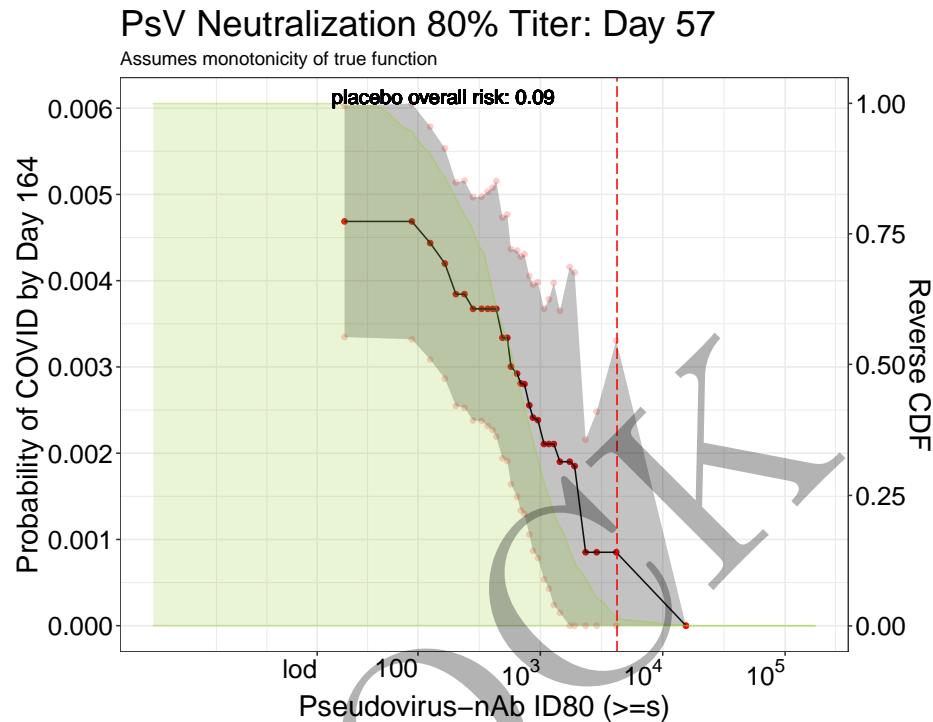


Figure 6.12: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 6.12: 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
1.403	$2.53 * 10^1$	0.00469	0.00335	0.00603
2.220	$1.66 * 10^2$	0.00420	0.00286	0.00553
2.455	$2.85 * 10^2$	0.00367	0.00238	0.00497
2.644	$4.41 * 10^2$	0.00367	0.00219	0.00515
2.764	$5.81 * 10^2$	0.00300	0.00164	0.00437
2.874	$7.48 * 10^2$	0.00280	0.00129	0.00431
2.981	$9.57 * 10^2$	0.00238	0.00078	0.00398
3.162	$1.45 * 10^3$	0.00190	0.00015	0.00365
3.371	$2.35 * 10^3$	0.00085	0.00000	0.00216
4.187	$1.54 * 10^4$	0.00000	0.00000	NA

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

MOCK

6.4.1 Day 29 Spike protein antibody

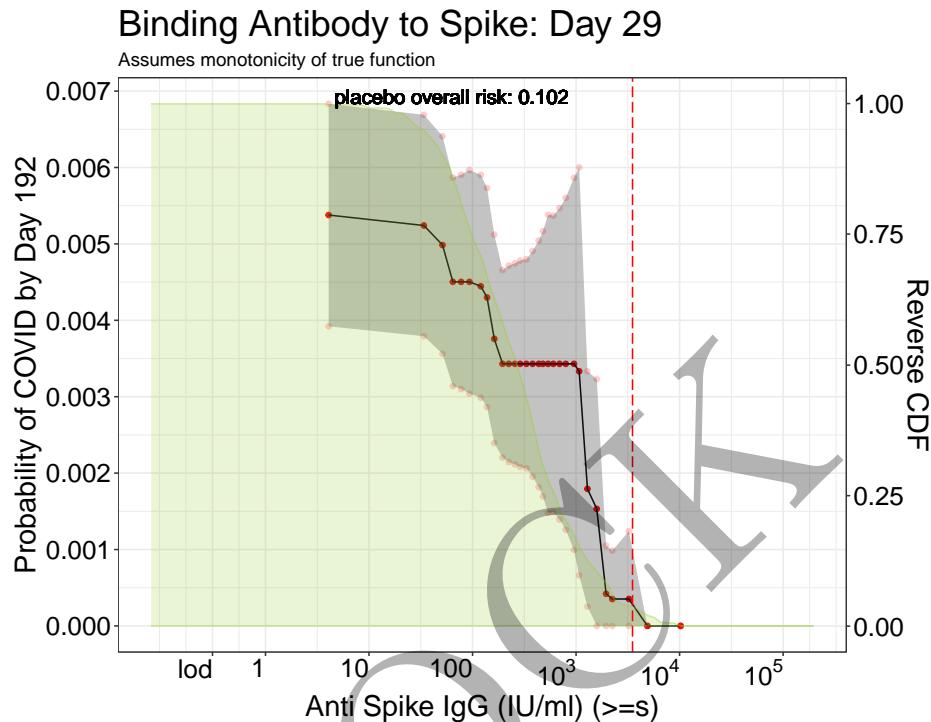


Figure 6.13: Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 6.13: Table of monotone-corrected risk estimates for a range of thresholds of Day 29 Spike protein antibody levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.613	4.10×10^0	0.00538	0.00392	0.00683
1.805	6.38×10^1	0.00450	0.00314	0.00587
2.081	1.21×10^2	0.00445	0.00299	0.00590
2.351	2.24×10^2	0.00343	0.00214	0.00472
2.522	3.33×10^2	0.00343	0.00206	0.00480
2.677	4.75×10^2	0.00343	0.00169	0.00517
2.841	6.93×10^2	0.00343	0.00139	0.00547
3.112	1.29×10^3	0.00179	0.00025	0.00333
3.348	2.23×10^3	0.00035	0.00000	0.00099
4.007	1.02×10^4	0.00000	0.00000	NA

6.4.2 Day 29 RBD binding antibody

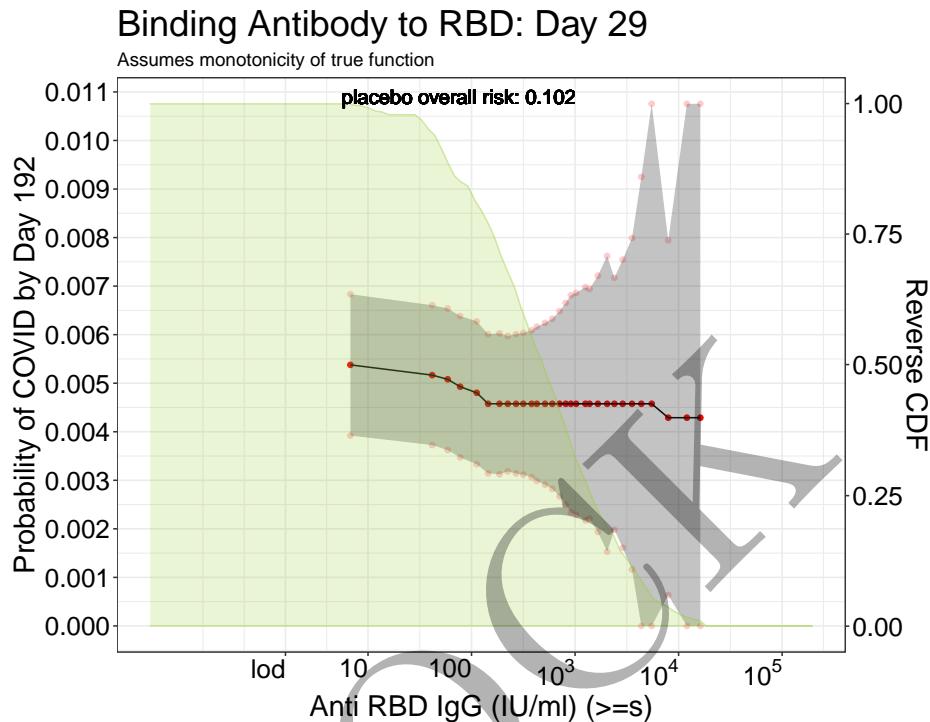


Figure 6.14: Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 6.14: Table of monotone-corrected risk estimates for a range of thresholds of Day 29 RBD binding antibody levels with pointwise 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.834	$6.82 * 10^0$	0.00538	0.00392	0.00683
1.892	$7.80 * 10^1$	0.00493	0.00347	0.00638
2.273	$1.87 * 10^2$	0.00458	0.00313	0.00603
2.575	$3.76 * 10^2$	0.00458	0.00306	0.00609
2.780	$6.03 * 10^2$	0.00458	0.00282	0.00633
2.960	$9.12 * 10^2$	0.00458	0.00234	0.00681
3.144	$1.39 * 10^3$	0.00458	0.00221	0.00694
3.461	$2.89 * 10^3$	0.00458	0.00161	0.00755
3.736	$5.45 * 10^3$	0.00458	0.00000	0.01191
4.211	$1.63 * 10^4$	0.00429	0.00000	0.01449

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

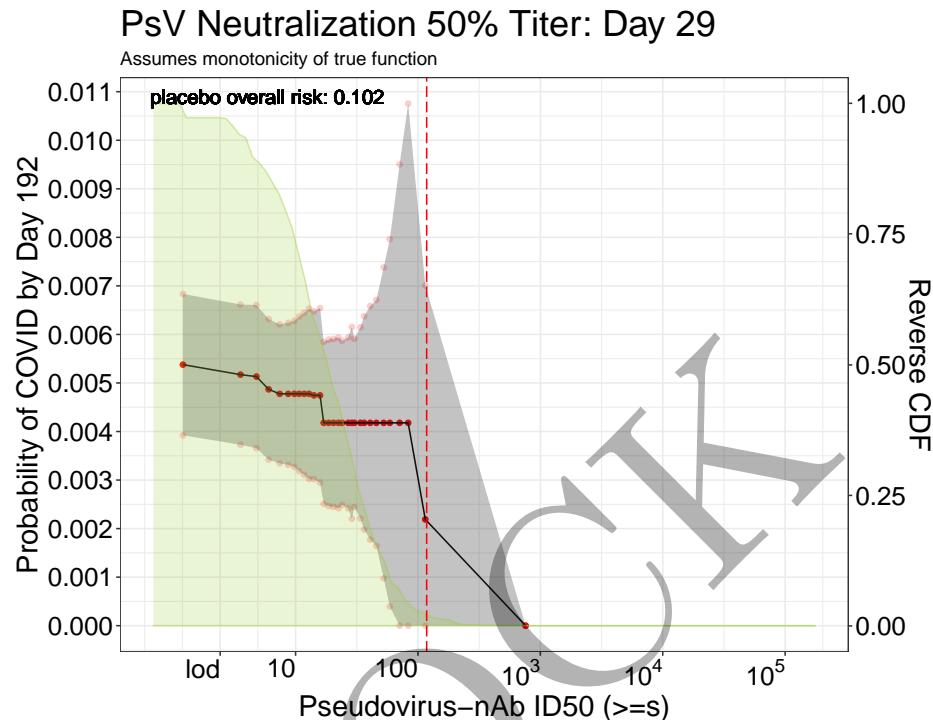


Figure 6.15: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 6.15: 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
0.083	$1.21 * 10^0$	0.00538	0.00392	0.00683
0.779	$6.01 * 10^0$	0.00487	0.00342	0.00632
0.988	$9.73 * 10^0$	0.00478	0.00327	0.00628
1.147	$1.40 * 10^1$	0.00474	0.00302	0.00647
1.271	$1.87 * 10^1$	0.00418	0.00246	0.00589
1.382	$2.41 * 10^1$	0.00418	0.00249	0.00587
1.481	$3.03 * 10^1$	0.00418	0.00244	0.00591
1.656	$4.53 * 10^1$	0.00418	0.00164	0.00671
1.852	$7.11 * 10^1$	0.00418	0.00000	0.00950
2.879	$7.57 * 10^2$	0.00000	0.00000	NA

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

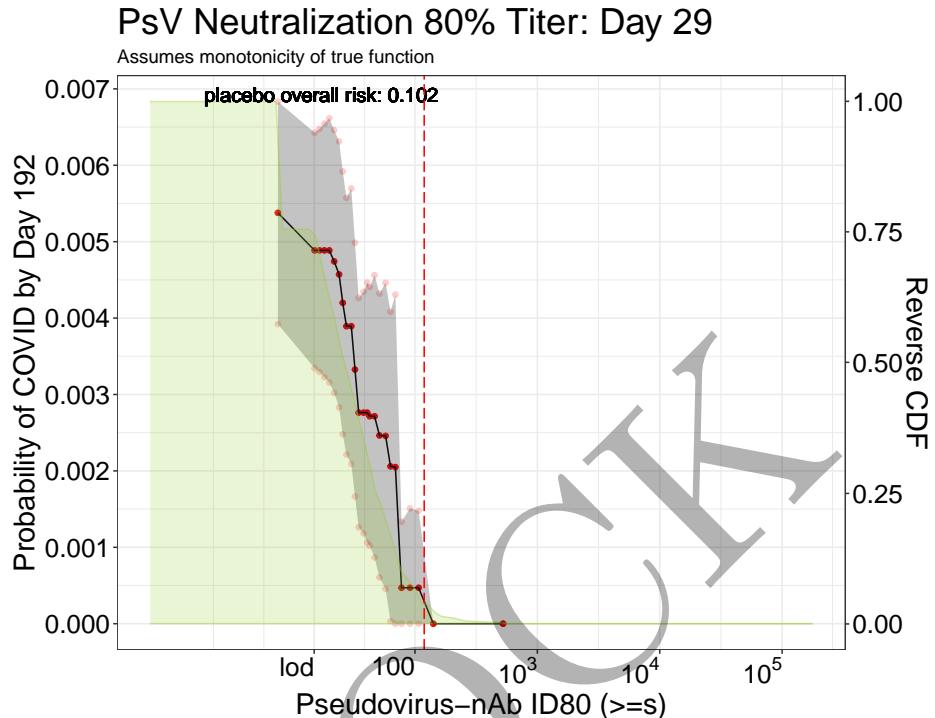


Figure 6.16: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 6.16: 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
0.876	$7.52 * 10^0$	0.00538	0.00392	0.00683
1.260	$1.82 * 10^1$	0.00489	0.00323	0.00655
1.339	$2.18 * 10^1$	0.00474	0.00302	0.00646
1.440	$2.75 * 10^1$	0.00389	0.00221	0.00557
1.541	$3.48 * 10^1$	0.00276	0.00126	0.00426
1.610	$4.07 * 10^1$	0.00276	0.00106	0.00446
1.707	$5.09 * 10^1$	0.00246	0.00061	0.00432
1.839	$6.90 * 10^1$	0.00205	0.00000	0.00431
1.956	$9.04 * 10^1$	0.00047	0.00000	0.00151
2.719	$5.24 * 10^2$	0.00000	0.00000	NA

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

MOCK

6.5.1 Day 57 Spike protein binding antibody

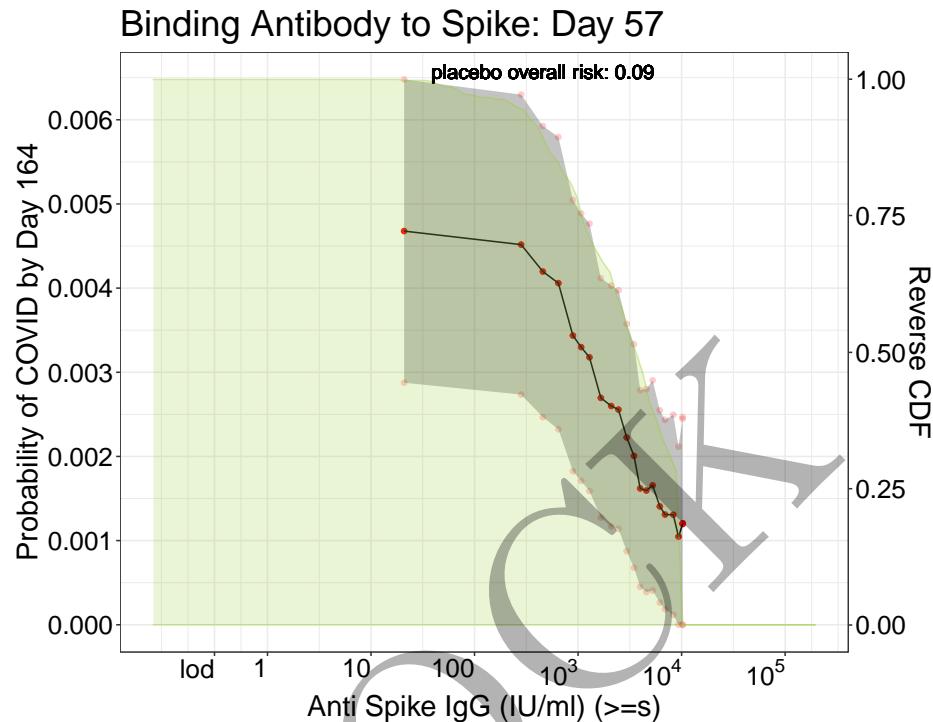


Figure 6.17: Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table 6.17: Table of risk estimates for a range of thresholds of Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.316	$2.07 * 10^1$	0.00468	0.00288	0.00648
2.657	$4.54 * 10^2$	0.00420	0.00247	0.00593
2.951	$8.93 * 10^2$	0.00344	0.00182	0.00505
3.221	$1.66 * 10^3$	0.00270	0.00127	0.00412
3.394	$2.48 * 10^3$	0.00256	0.00114	0.00397
3.544	$3.50 * 10^3$	0.00201	0.00068	0.00333
3.658	$4.55 * 10^3$	0.00159	0.00039	0.00280
3.841	$6.93 * 10^3$	0.00131	0.00018	0.00244
3.973	$9.40 * 10^3$	0.00105	0.00000	0.00212
4.007	$1.02 * 10^4$	0.00121	0.00000	0.00247

6.5.2 Day 57 RBD binding antibody

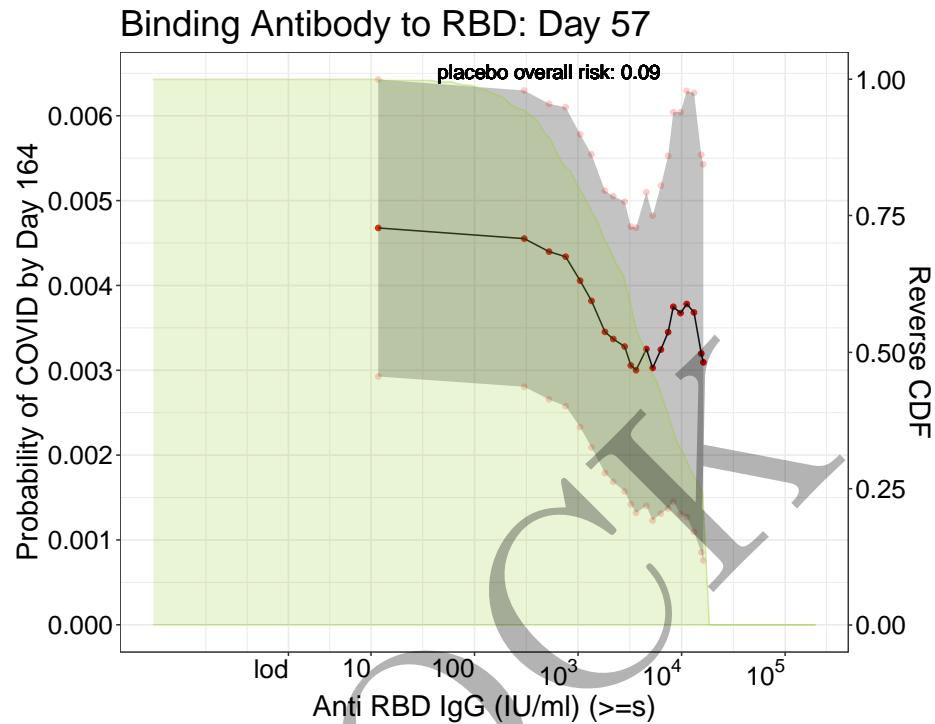


Figure 6.18: Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table 6.18: Table of risk estimates for a range of thresholds of Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.073	$1.18 * 10^1$	0.00468	0.00293	0.00643
2.715	$5.19 * 10^2$	0.00440	0.00266	0.00614
3.022	$1.05 * 10^3$	0.00406	0.00233	0.00578
3.338	$2.18 * 10^3$	0.00337	0.00168	0.00505
3.514	$3.27 * 10^3$	0.00306	0.00142	0.00469
3.657	$4.54 * 10^3$	0.00325	0.00140	0.00510
3.797	$6.27 * 10^3$	0.00324	0.00131	0.00518
3.986	$9.68 * 10^3$	0.00367	0.00131	0.00604
4.125	$1.33 * 10^4$	0.00368	0.00109	0.00627
4.211	$1.63 * 10^4$	0.00309	0.00076	0.00543

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

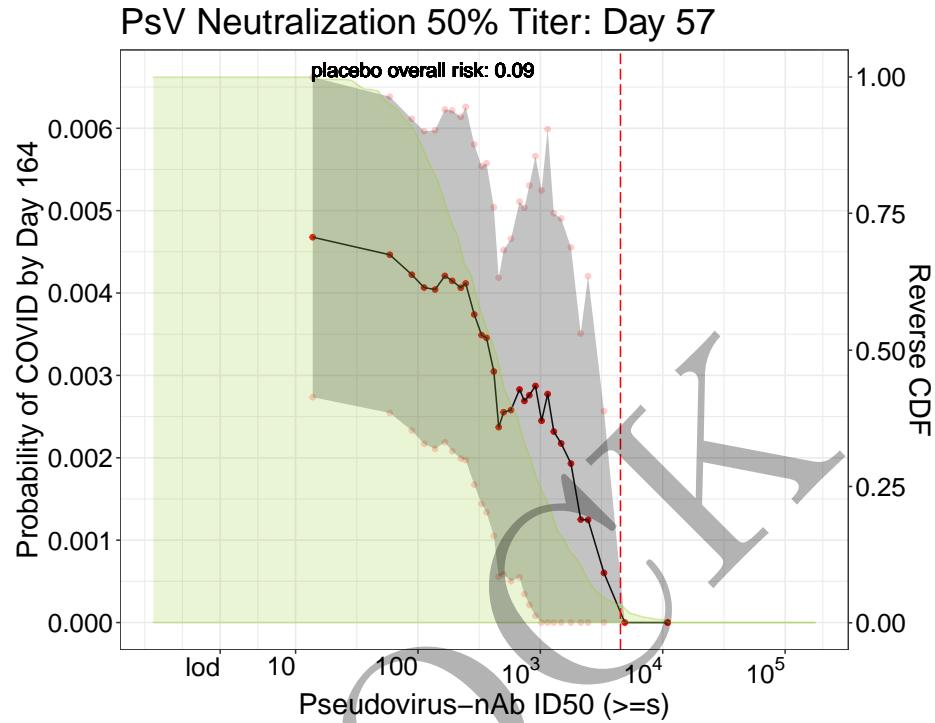


Figure 6.19: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table 6.19: 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
1.135	$1.36 * 10^1$	0.00468	0.00274	0.00662
2.055	$1.14 * 10^2$	0.00407	0.00217	0.00596
2.281	$1.91 * 10^2$	0.00415	0.00208	0.00622
2.519	$3.30 * 10^2$	0.00349	0.00144	0.00554
2.657	$4.54 * 10^2$	0.00237	0.00056	0.00419
2.828	$6.73 * 10^2$	0.00283	0.00055	0.00511
2.959	$9.10 * 10^2$	0.00287	0.00008	0.00566
3.174	$1.49 * 10^3$	0.00217	0.00000	0.00490
3.387	$2.44 * 10^3$	0.00125	0.00000	0.00420
4.038	$1.09 * 10^4$	0.00000	0.00000	NA

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

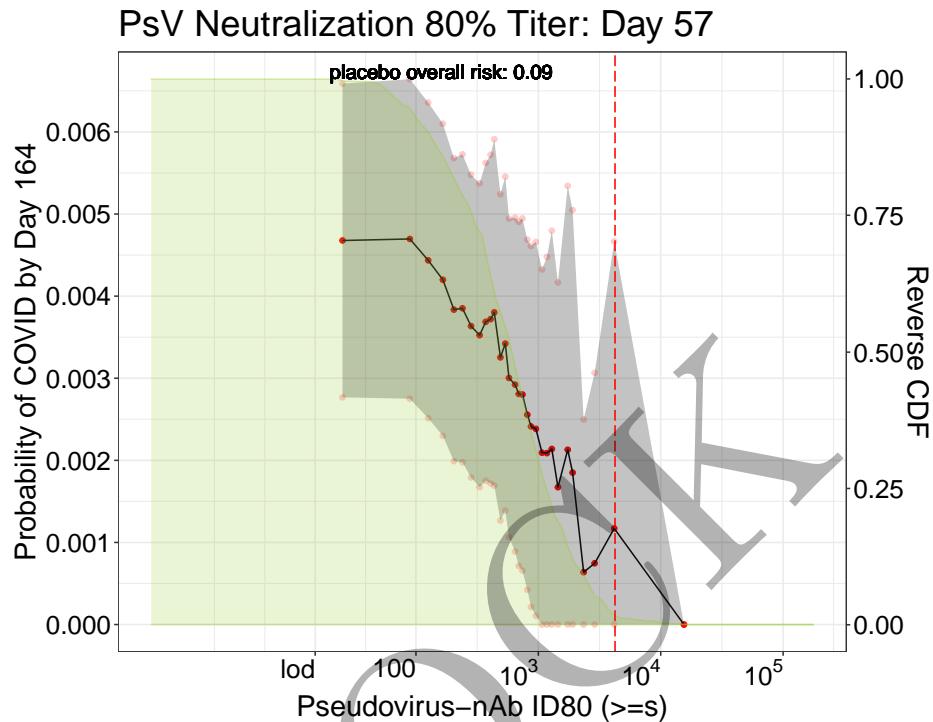


Figure 6.20: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table 6.20: 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
1.403	$2.53 * 10^1$	0.00468	0.00277	0.00659
2.220	$1.66 * 10^2$	0.00420	0.00230	0.00610
2.455	$2.85 * 10^2$	0.00363	0.00179	0.00548
2.644	$4.41 * 10^2$	0.00380	0.00169	0.00591
2.764	$5.81 * 10^2$	0.00300	0.00106	0.00495
2.874	$7.48 * 10^2$	0.00280	0.00066	0.00495
2.981	$9.57 * 10^2$	0.00238	0.00011	0.00466
3.162	$1.45 * 10^3$	0.00167	0.00000	0.00417
3.371	$2.35 * 10^3$	0.00064	0.00000	0.00250
4.187	$1.54 * 10^4$	0.00000	0.00000	NA

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

MOCK

6.6.1 Day 29 Spike protein antibody

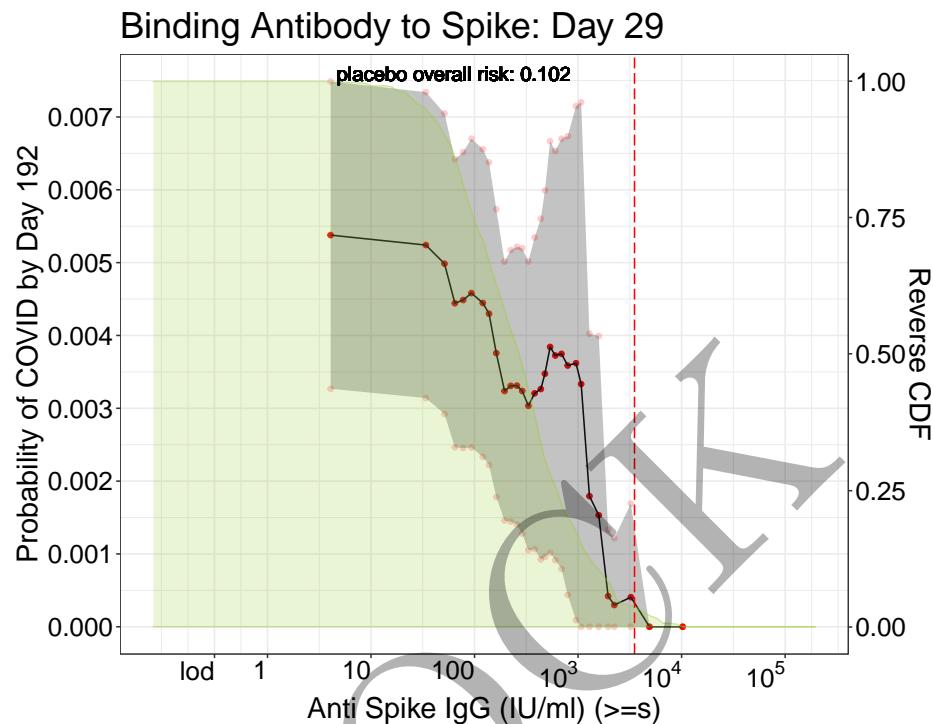


Figure 6.21: Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table 6.21: Table of risk estimates for a range of thresholds of Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.613	4.10×10^0	0.00538	0.00327	0.00749
1.805	6.38×10^1	0.00444	0.00246	0.00642
2.081	1.21×10^2	0.00445	0.00233	0.00656
2.351	2.24×10^2	0.00331	0.00144	0.00517
2.522	3.33×10^2	0.00303	0.00105	0.00502
2.677	4.75×10^2	0.00347	0.00096	0.00599
2.841	6.93×10^2	0.00375	0.00079	0.00670
3.112	1.29×10^3	0.00179	0.00000	0.00403
3.348	2.23×10^3	0.00030	0.00000	0.00122
4.007	1.02×10^4	0.00000	0.00000	NA

6.6.2 Day 29 RBD binding antibody

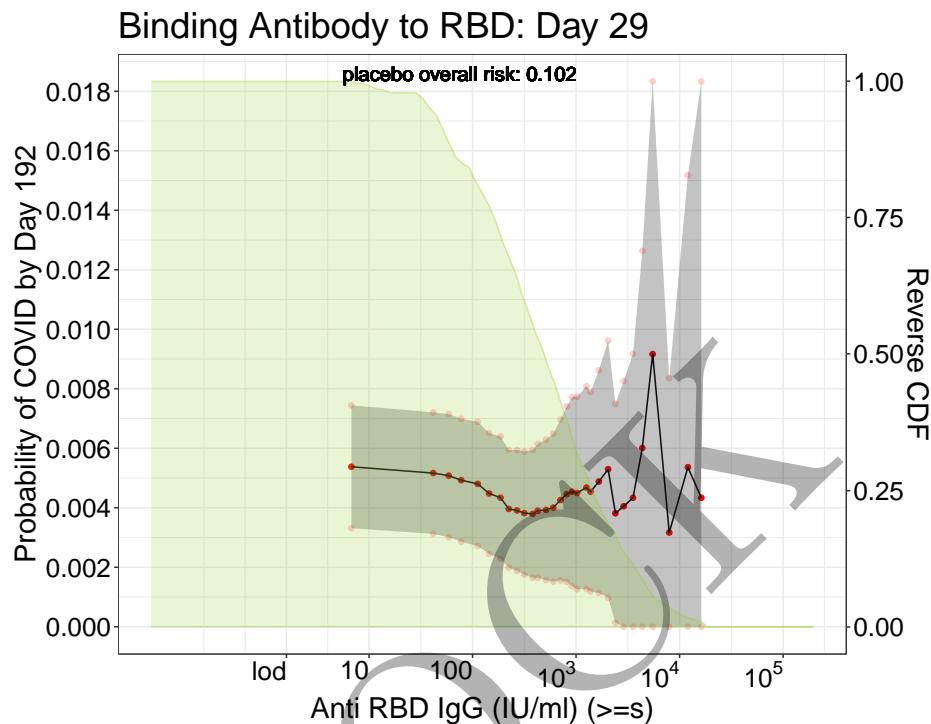


Figure 6.22: Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table 6.22: Table of risk estimates for a range of thresholds of Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.834	$6.82 * 10^0$	0.00538	0.00331	0.00744
1.892	$7.80 * 10^1$	0.00493	0.00286	0.00699
2.273	$1.87 * 10^2$	0.00434	0.00228	0.00640
2.575	$3.76 * 10^2$	0.00379	0.00165	0.00594
2.780	$6.03 * 10^2$	0.00401	0.00152	0.00649
2.960	$9.12 * 10^2$	0.00454	0.00137	0.00771
3.144	$1.39 * 10^3$	0.00454	0.00119	0.00789
3.461	$2.89 * 10^3$	0.00405	0.00000	0.00826
3.736	$5.45 * 10^3$	0.00917	0.00000	0.01956
4.211	$1.63 * 10^4$	0.00434	0.00000	0.01880

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

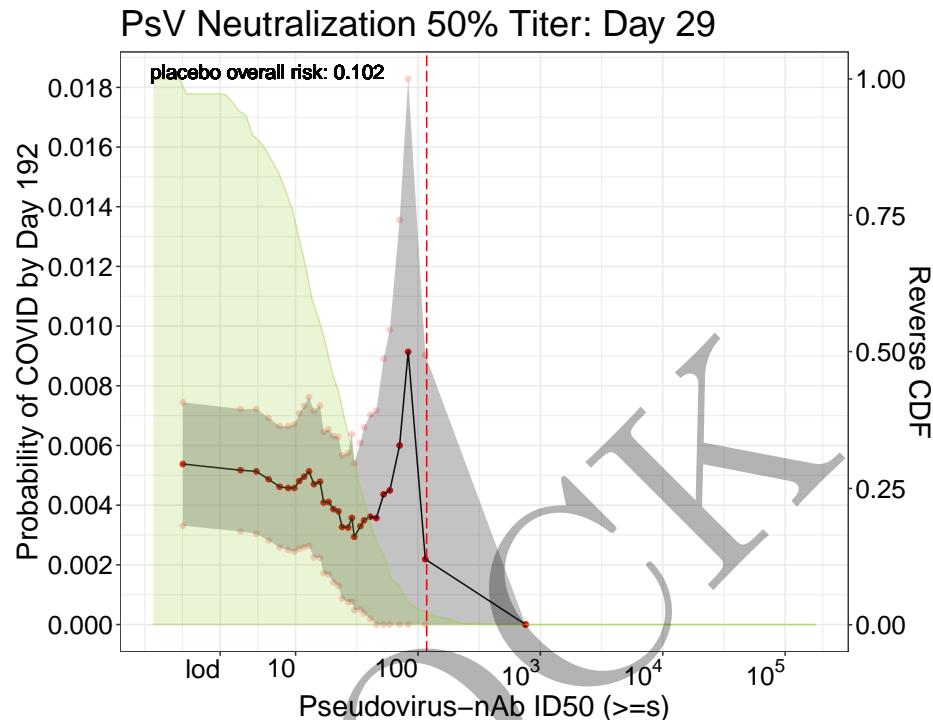


Figure 6.23: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table 6.23: 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
0.083	$1.21 * 10^0$	0.00538	0.00331	0.00744
0.779	$6.01 * 10^0$	0.00487	0.00281	0.00692
0.988	$9.73 * 10^0$	0.00458	0.00244	0.00671
1.147	$1.40 * 10^1$	0.00470	0.00225	0.00716
1.271	$1.87 * 10^1$	0.00411	0.00168	0.00654
1.382	$2.41 * 10^1$	0.00327	0.00087	0.00567
1.481	$3.03 * 10^1$	0.00294	0.00048	0.00540
1.656	$4.53 * 10^1$	0.00357	0.00000	0.00717
1.852	$7.11 * 10^1$	0.00600	0.00000	0.01356
2.879	$7.57 * 10^2$	0.00000	0.00000	NA

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

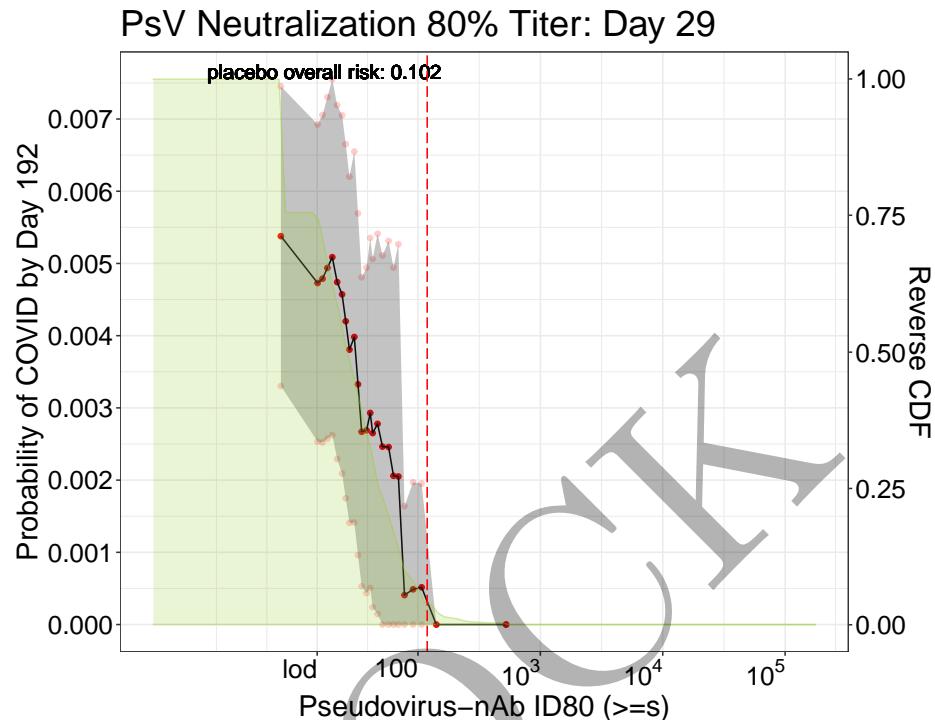


Figure 6.24: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed.

Table 6.24: 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
0.876	7.52 * 10 ⁰	0.00538	0.00330	0.00745
1.260	1.82 * 10 ¹	0.00494	0.00257	0.00730
1.339	2.18 * 10 ¹	0.00474	0.00229	0.00719
1.440	2.75 * 10 ¹	0.00381	0.00141	0.00620
1.541	3.48 * 10 ¹	0.00267	0.00053	0.00481
1.610	4.07 * 10 ¹	0.00293	0.00051	0.00535
1.707	5.09 * 10 ¹	0.00246	0.00000	0.00511
1.839	6.90 * 10 ¹	0.00205	0.00000	0.00527
1.956	9.04 * 10 ¹	0.00049	0.00000	0.00197
2.719	5.24 * 10 ²	0.00000	0.00000	NA

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

MOCK

6.7.1 Day 57 Spike protein binding antibody

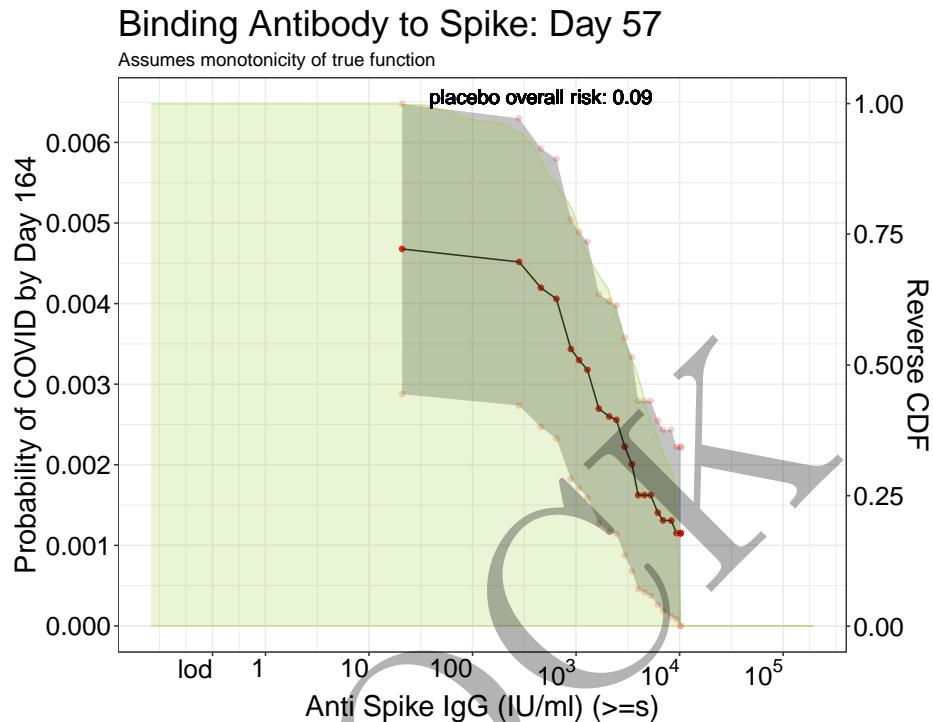


Figure 6.25: Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 6.25: Table of monotone-corrected risk estimates for a range of thresholds of Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.316	$2.07 * 10^1$	0.00468	0.00288	0.00648
2.657	$4.54 * 10^2$	0.00420	0.00247	0.00593
2.951	$8.93 * 10^2$	0.00344	0.00182	0.00505
3.221	$1.66 * 10^3$	0.00270	0.00127	0.00412
3.394	$2.48 * 10^3$	0.00256	0.00114	0.00397
3.544	$3.50 * 10^3$	0.00201	0.00068	0.00333
3.658	$4.55 * 10^3$	0.00162	0.00042	0.00283
3.841	$6.93 * 10^3$	0.00131	0.00018	0.00244
3.973	$9.40 * 10^3$	0.00115	0.00008	0.00222
4.007	$1.02 * 10^4$	0.00115	0.00000	0.00241

6.7.2 Day 57 RBD binding antibody

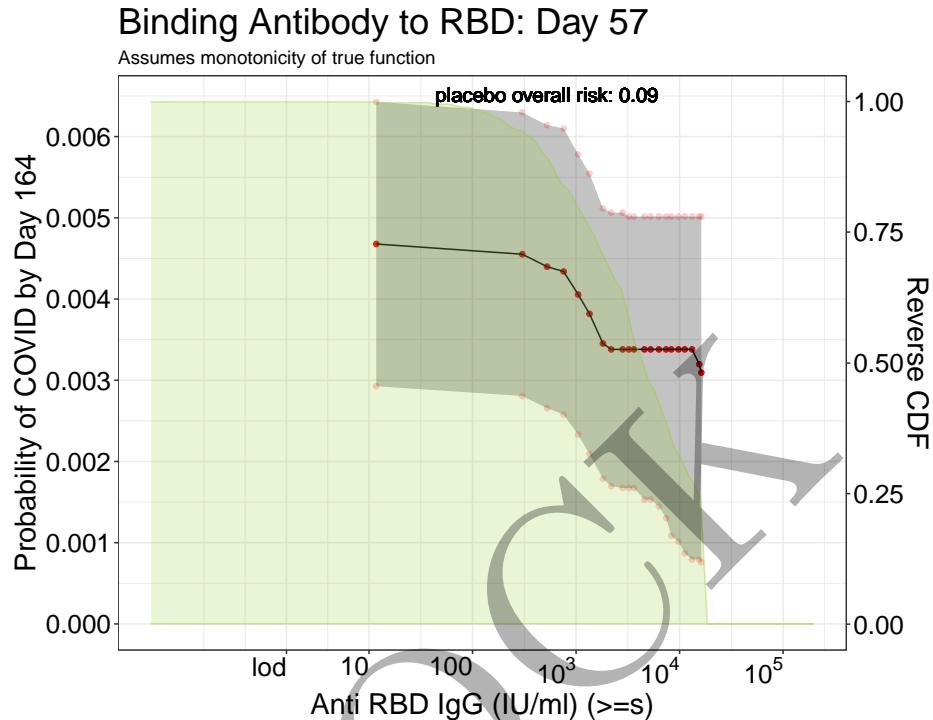


Figure 6.26: Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 6.26: Table of monotone-corrected risk estimates for a range of thresholds of Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
1.073	$1.18 * 10^1$	0.00468	0.00293	0.00643
2.715	$5.19 * 10^2$	0.00440	0.00266	0.00614
3.022	$1.05 * 10^3$	0.00406	0.00233	0.00578
3.338	$2.18 * 10^3$	0.00338	0.00170	0.00506
3.514	$3.27 * 10^3$	0.00338	0.00174	0.00502
3.657	$4.54 * 10^3$	0.00338	0.00153	0.00523
3.797	$6.27 * 10^3$	0.00338	0.00145	0.00531
3.986	$9.68 * 10^3$	0.00338	0.00101	0.00575
4.125	$1.33 * 10^4$	0.00338	0.00079	0.00597
4.211	$1.63 * 10^4$	0.00309	0.00076	0.00543

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

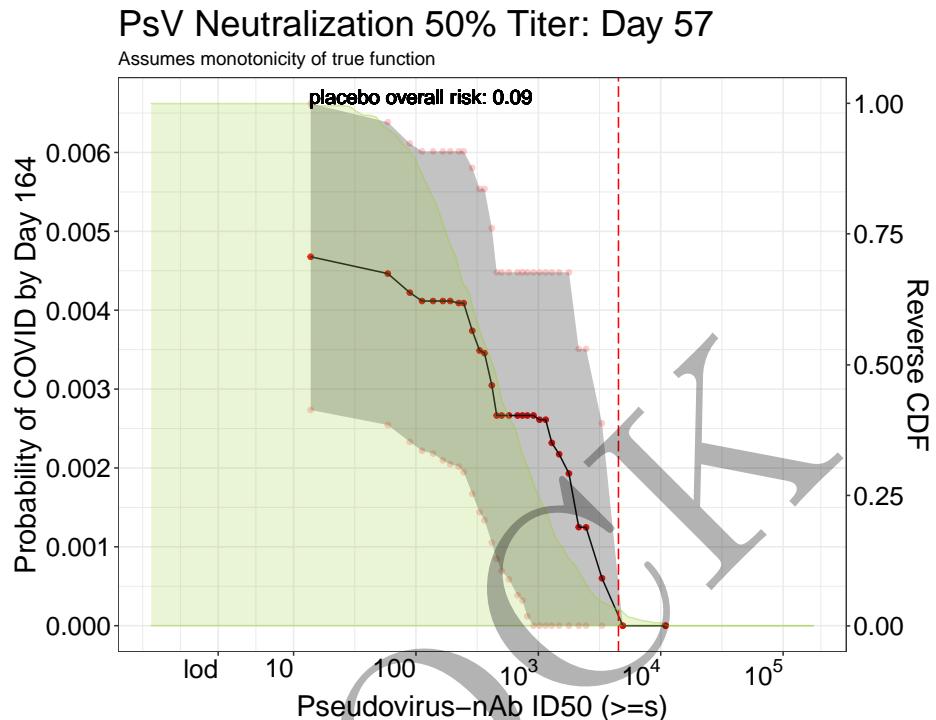


Figure 6.27: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 6.27: 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
1.135	$1.36 * 10^1$	0.00468	0.00274	0.00662
2.055	$1.14 * 10^2$	0.00412	0.00222	0.00601
2.281	$1.91 * 10^2$	0.00412	0.00205	0.00618
2.519	$3.30 * 10^2$	0.00349	0.00144	0.00554
2.657	$4.54 * 10^2$	0.00267	0.00085	0.00448
2.828	$6.73 * 10^2$	0.00267	0.00038	0.00495
2.959	$9.10 * 10^2$	0.00267	0.00000	0.00546
3.174	$1.49 * 10^3$	0.00217	0.00000	0.00490
3.387	$2.44 * 10^3$	0.00125	0.00000	0.00420
4.038	$1.09 * 10^4$	0.00000	0.00000	NA

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

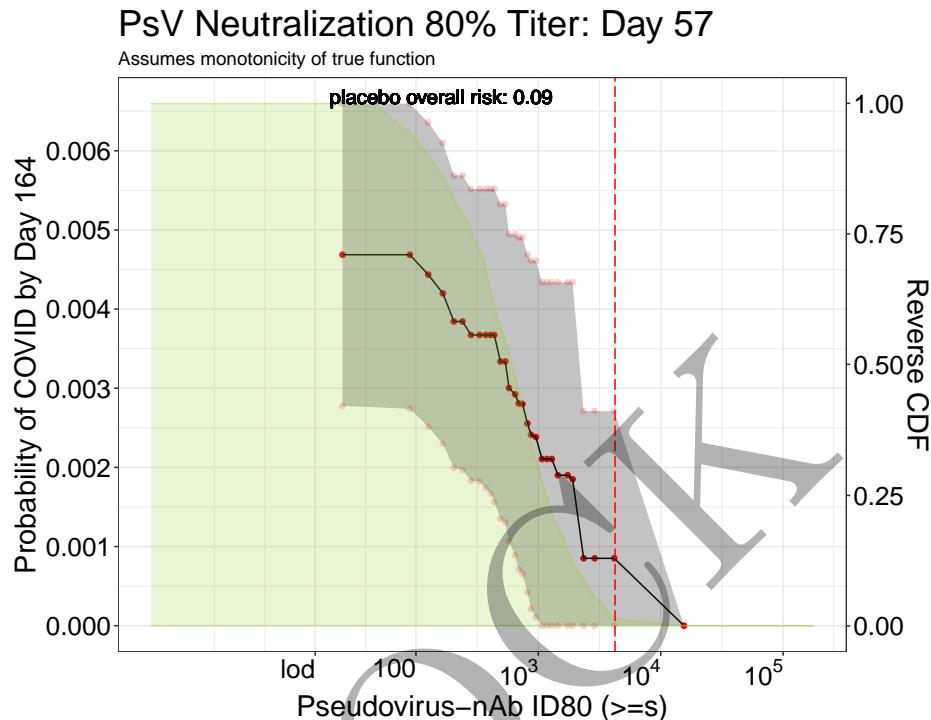


Figure 6.28: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 6.28: 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
1.403	2.53×10^1	0.00469	0.00278	0.00660
2.220	1.66×10^2	0.00420	0.00230	0.00610
2.455	2.85×10^2	0.00367	0.00183	0.00552
2.644	4.41×10^2	0.00367	0.00156	0.00578
2.764	5.81×10^2	0.00300	0.00106	0.00495
2.874	7.48×10^2	0.00280	0.00066	0.00495
2.981	9.57×10^2	0.00238	0.00011	0.00466
3.162	1.45×10^3	0.00190	0.00000	0.00439
3.371	2.35×10^3	0.00085	0.00000	0.00271
4.187	1.54×10^4	0.00000	0.00000	NA

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

MOCK

6.8.1 Day 29 Spike protein antibody

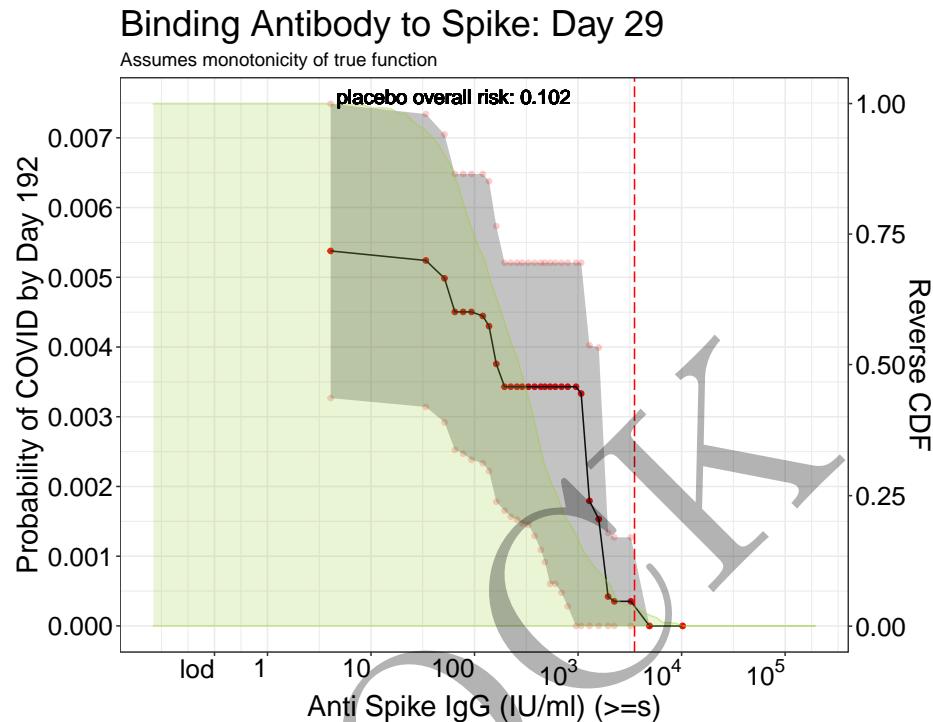


Figure 6.29: Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 6.29: Table of monotone-corrected risk estimates for a range of thresholds of Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.613	4.10×10^0	0.00538	0.00327	0.00749
1.805	6.38×10^1	0.00450	0.00253	0.00648
2.081	1.21×10^2	0.00445	0.00233	0.00656
2.351	2.24×10^2	0.00343	0.00157	0.00529
2.522	3.33×10^2	0.00343	0.00145	0.00541
2.677	4.75×10^2	0.00343	0.00091	0.00595
2.841	6.93×10^2	0.00343	0.00048	0.00638
3.112	1.29×10^3	0.00179	0.00000	0.00403
3.348	2.23×10^3	0.00035	0.00000	0.00127
4.007	1.02×10^4	0.00000	0.00000	NA

6.8.2 Day 29 RBD binding antibody

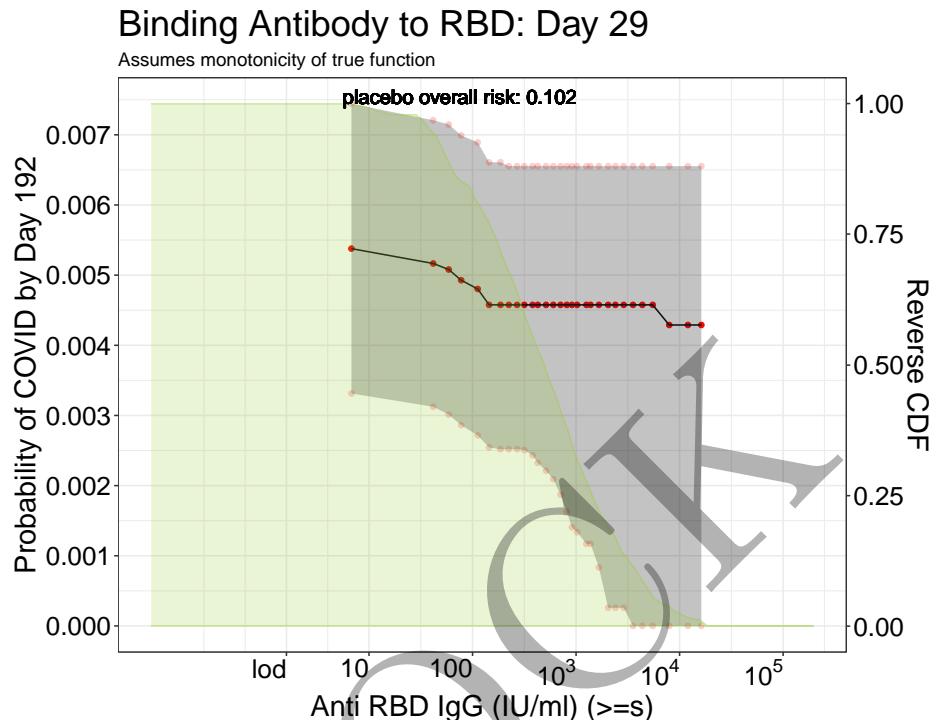


Figure 6.30: Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 6.30: Table of monotone-corrected risk estimates for a range of thresholds of Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals.

\log_{10} -Threshold	Threshold	Risk estimate	CI left	CI right
0.834	$6.82 * 10^0$	0.00538	0.00331	0.00744
1.892	$7.80 * 10^1$	0.00493	0.00286	0.00699
2.273	$1.87 * 10^2$	0.00458	0.00252	0.00663
2.575	$3.76 * 10^2$	0.00458	0.00243	0.00672
2.780	$6.03 * 10^2$	0.00458	0.00209	0.00706
2.960	$9.12 * 10^2$	0.00458	0.00141	0.00775
3.144	$1.39 * 10^3$	0.00458	0.00122	0.00793
3.461	$2.89 * 10^3$	0.00458	0.00037	0.00879
3.736	$5.45 * 10^3$	0.00458	0.00000	0.01497
4.211	$1.63 * 10^4$	0.00429	0.00000	0.01875

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

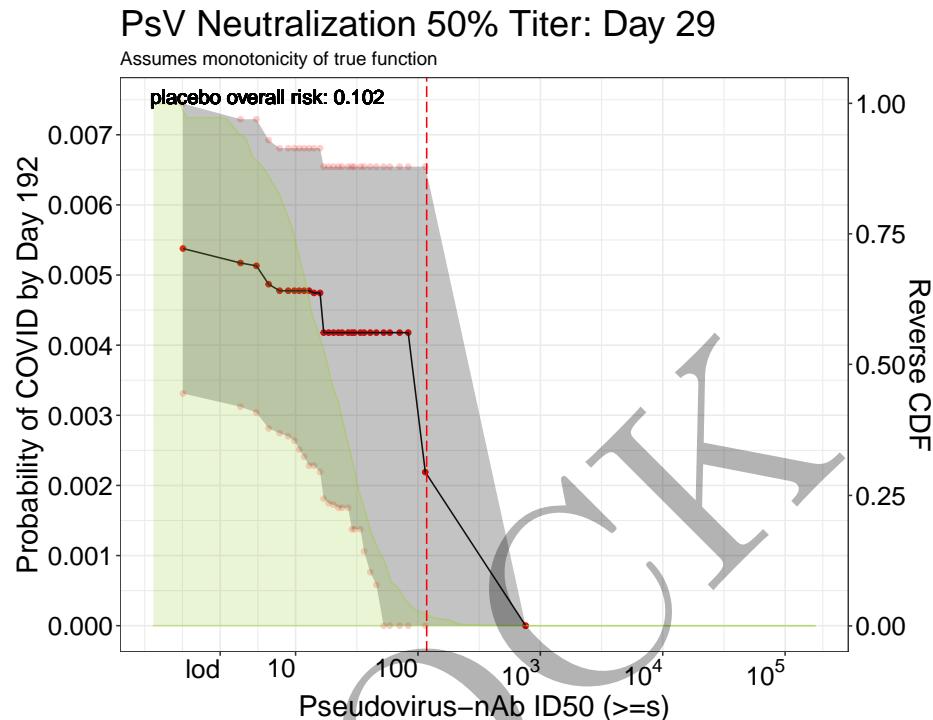


Figure 6.31: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 6.31: 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
0.083	$1.21 * 10^0$	0.00538	0.00331	0.00744
0.779	$6.01 * 10^0$	0.00487	0.00281	0.00692
0.988	$9.73 * 10^0$	0.00478	0.00264	0.00691
1.147	$1.40 * 10^1$	0.00474	0.00229	0.00720
1.271	$1.87 * 10^1$	0.00418	0.00175	0.00661
1.382	$2.41 * 10^1$	0.00418	0.00178	0.00658
1.481	$3.03 * 10^1$	0.00418	0.00172	0.00664
1.656	$4.53 * 10^1$	0.00418	0.00058	0.00778
1.852	$7.11 * 10^1$	0.00418	0.00000	0.01174
2.879	$7.57 * 10^2$	0.00000	0.00000	NA

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

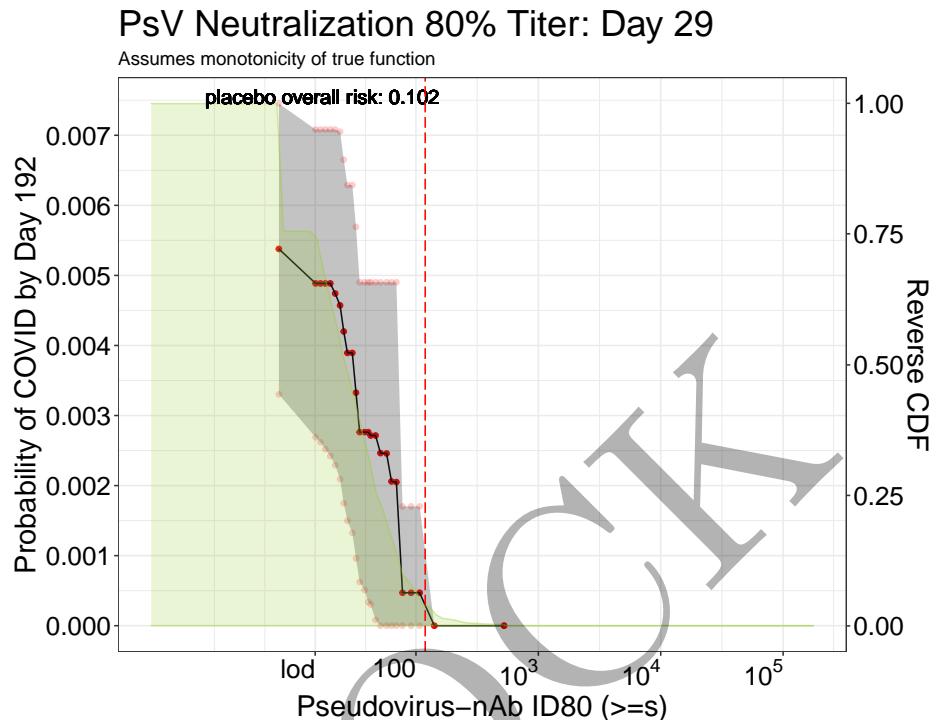


Figure 6.32: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals. The dashed red line marks the threshold after which no more COVID events are observed. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 6.32: 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
0.876	$7.52 * 10^0$	0.00538	0.00330	0.00745
1.260	$1.82 * 10^1$	0.00489	0.00252	0.00725
1.339	$2.18 * 10^1$	0.00474	0.00229	0.00719
1.440	$2.75 * 10^1$	0.00389	0.00150	0.00629
1.541	$3.48 * 10^1$	0.00276	0.00062	0.00490
1.610	$4.07 * 10^1$	0.00276	0.00034	0.00519
1.707	$5.09 * 10^1$	0.00246	0.00000	0.00511
1.839	$6.90 * 10^1$	0.00205	0.00000	0.00527
1.956	$9.04 * 10^1$	0.00047	0.00000	0.00195
2.719	$5.24 * 10^2$	0.00000	0.00000	NA

MOCK

Chapter 7

Univariate CoR: Nonparametric Threshold Modeling ($\leq s$)

The same methodology as the previous section is apply to estimate the “below” threshold-response function $E_{W|A=1}[Y = 1 | A = 1, X, S \leq s]$.

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

7.1.1 Day 57 Spike protein binding antibody

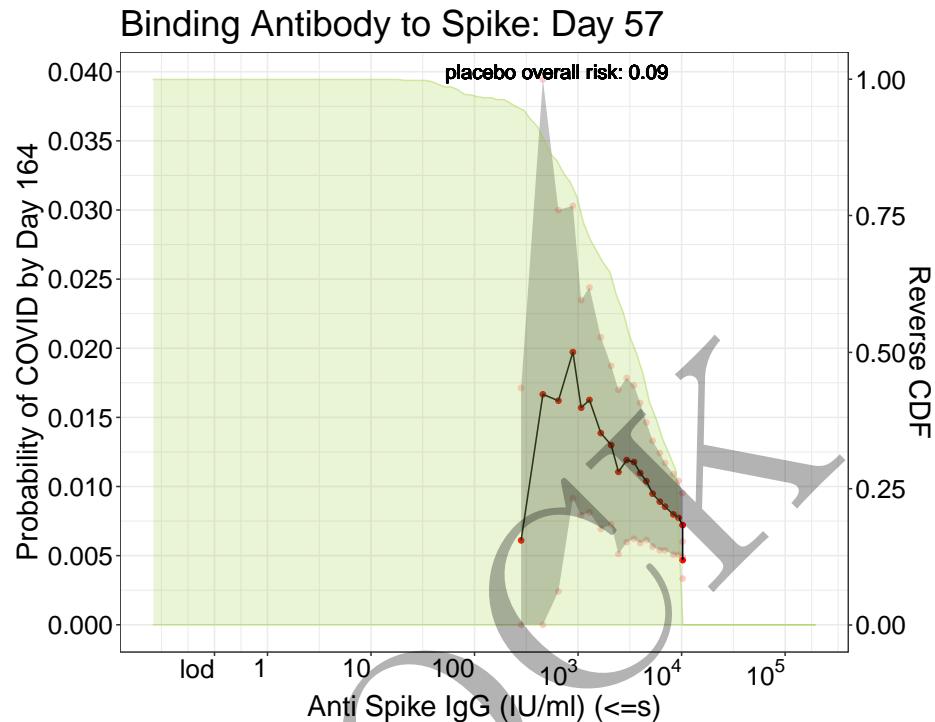


Figure 7.1: Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals.

Table 7.1: 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
2.450	$2.82 * 10^2$	0.00610	0.00000	0.01713
2.815	$6.53 * 10^2$	0.01621	0.00241	0.03000
3.033	$1.08 * 10^3$	0.01570	0.00791	0.02348
3.221	$1.66 * 10^3$	0.01386	0.00693	0.02080
3.394	$2.48 * 10^3$	0.01106	0.00512	0.01699
3.603	$4.01 * 10^3$	0.01097	0.00591	0.01604
3.716	$5.20 * 10^3$	0.00948	0.00566	0.01330
3.841	$6.93 * 10^3$	0.00854	0.00538	0.01170
3.973	$9.40 * 10^3$	0.00774	0.00506	0.01041
4.007	$1.02 * 10^4$	0.00468	0.00334	0.00602

7.1.2 Day 57 RBD binding antibody

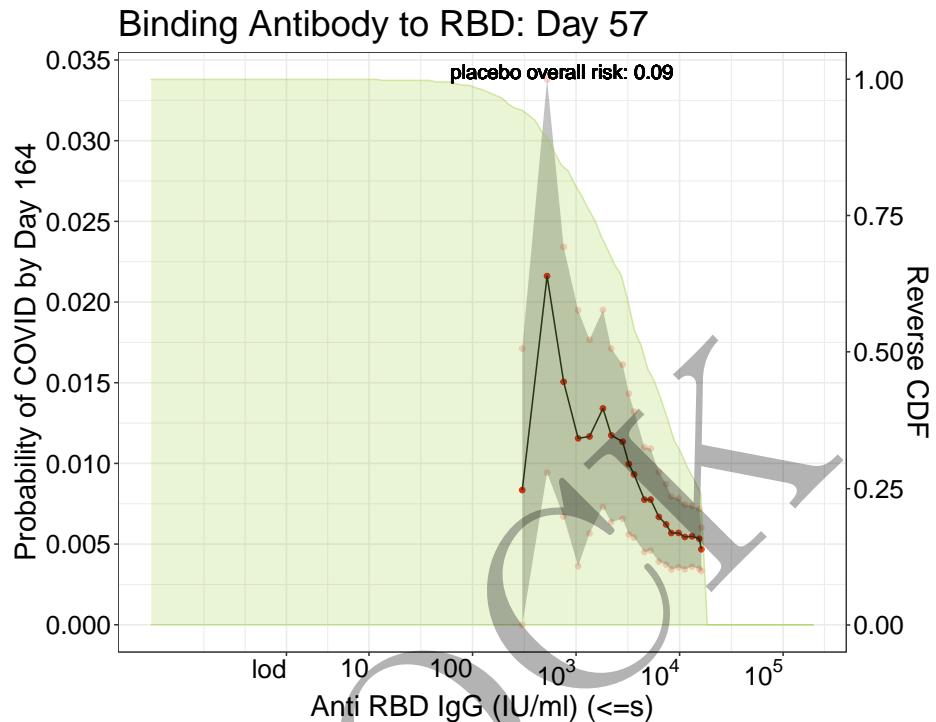


Figure 7.2: Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with pointwise 95% confidence intervals.

Table 7.2: 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
2.478	$3.01 * 10^2$	0.00835	0.00000	0.01712
2.882	$7.62 * 10^2$	0.01506	0.00670	0.02341
3.132	$1.36 * 10^3$	0.01167	0.00567	0.01767
3.338	$2.18 * 10^3$	0.01174	0.00637	0.01712
3.514	$3.27 * 10^3$	0.00996	0.00560	0.01432
3.722	$5.27 * 10^3$	0.00776	0.00460	0.01092
3.866	$7.35 * 10^3$	0.00622	0.00373	0.00871
3.986	$9.68 * 10^3$	0.00569	0.00356	0.00782
4.125	$1.33 * 10^4$	0.00548	0.00360	0.00737
4.211	$1.63 * 10^4$	0.00468	0.00334	0.00602

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

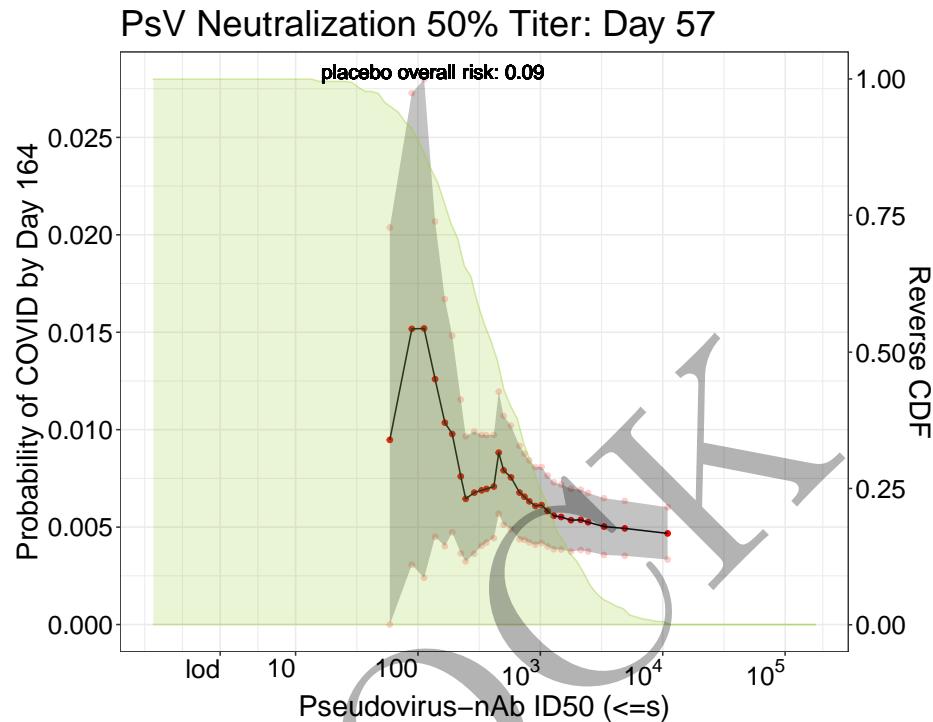


Figure 7.3: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals.

Table 7.3: 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
1.765	$5.82 * 10^1$	0.00948	0.00000	0.02037
2.143	$1.39 * 10^2$	0.01259	0.00450	0.02068
2.345	$2.21 * 10^2$	0.00760	0.00365	0.01155
2.519	$3.30 * 10^2$	0.00689	0.00404	0.00973
2.657	$4.54 * 10^2$	0.00882	0.00569	0.01195
2.867	$7.36 * 10^2$	0.00656	0.00434	0.00877
3.005	$1.01 * 10^3$	0.00613	0.00418	0.00808
3.174	$1.49 * 10^3$	0.00552	0.00385	0.00719
3.387	$2.44 * 10^3$	0.00525	0.00375	0.00675
4.038	$1.09 * 10^4$	0.00468	0.00334	0.00602

7.1. PLOTS AND TABLES WITH ESTIMATES AND POINTWISE CONFIDENCE INTERVAL FOR DAY 57403

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

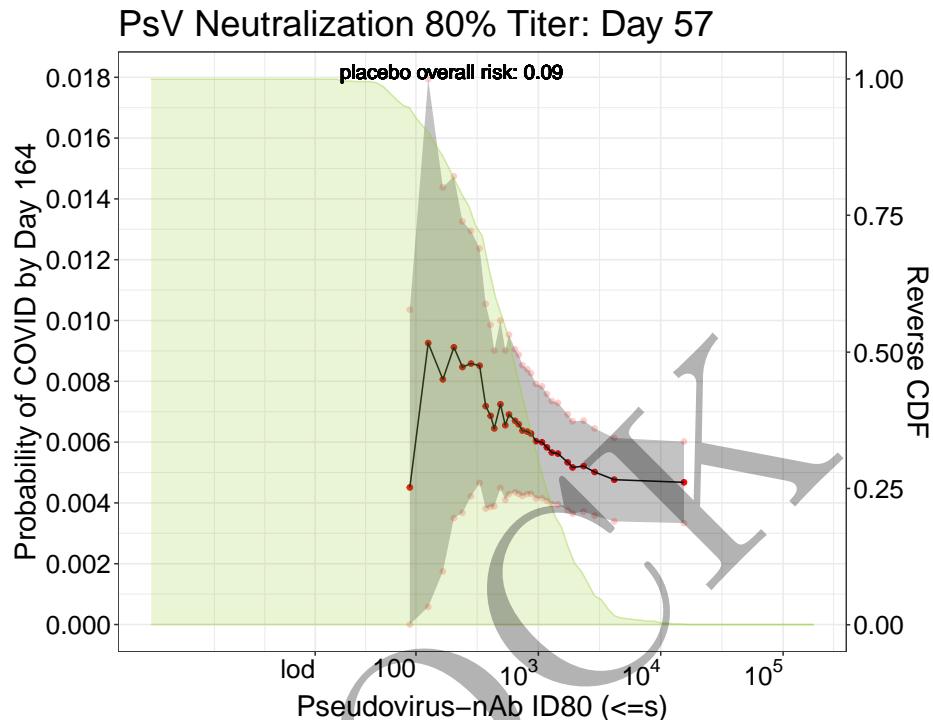


Figure 7.4: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals.

Table 7.4: 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
1.954	$8.99 * 10^1$	0.00451	0.00000	0.01036
2.309	$2.04 * 10^2$	0.00912	0.00350	0.01474
2.516	$3.28 * 10^2$	0.00851	0.00466	0.01237
2.644	$4.41 * 10^2$	0.00645	0.00389	0.00901
2.764	$5.81 * 10^2$	0.00691	0.00429	0.00953
2.909	$8.11 * 10^2$	0.00635	0.00429	0.00840
3.031	$1.07 * 10^3$	0.00599	0.00415	0.00784
3.162	$1.45 * 10^3$	0.00562	0.00395	0.00729
3.371	$2.35 * 10^3$	0.00521	0.00371	0.00671
4.187	$1.54 * 10^4$	0.00468	0.00334	0.00602

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

MOCK

7.2.1 Day 29 Spike protein antibody

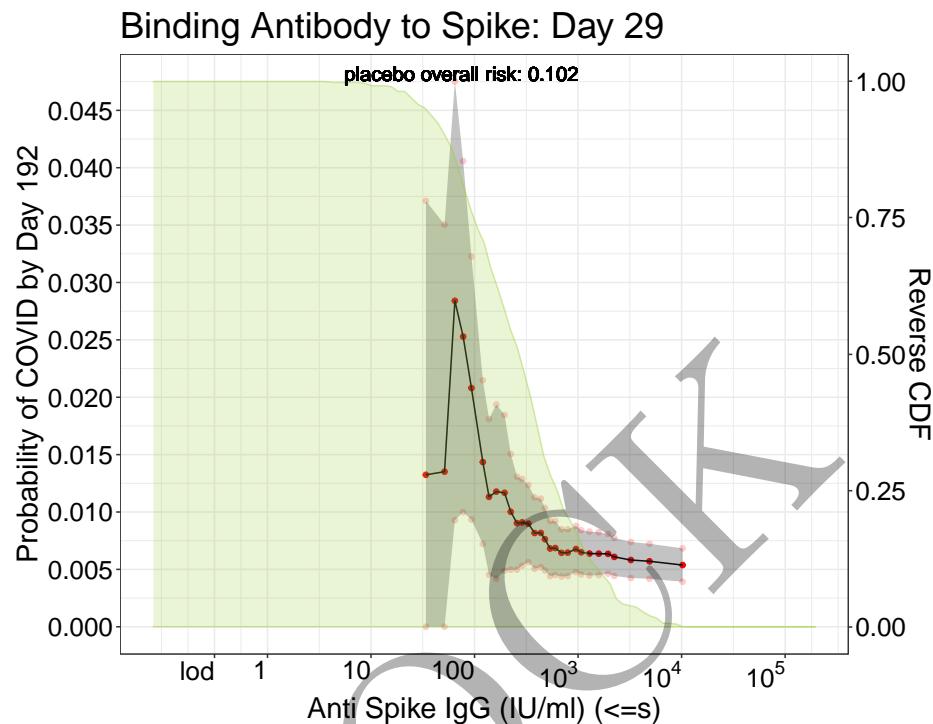


Figure 7.5: Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with pointwise 95% confidence intervals.

Table 7.5: 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
1.532	$3.40 * 10^1$	0.01324	0.00000	0.03712
1.886	$7.69 * 10^1$	0.02528	0.00999	0.04058
2.138	$1.37 * 10^2$	0.01132	0.00453	0.01811
2.351	$2.24 * 10^2$	0.01002	0.00498	0.01506
2.522	$3.33 * 10^2$	0.00899	0.00562	0.01235
2.733	$5.41 * 10^2$	0.00682	0.00442	0.00922
2.903	$8.00 * 10^2$	0.00646	0.00442	0.00850
3.112	$1.29 * 10^3$	0.00638	0.00446	0.00829
3.348	$2.23 * 10^3$	0.00609	0.00443	0.00775
4.007	$1.02 * 10^4$	0.00538	0.00392	0.00683

7.2.2 Day 29 RBD binding antibody

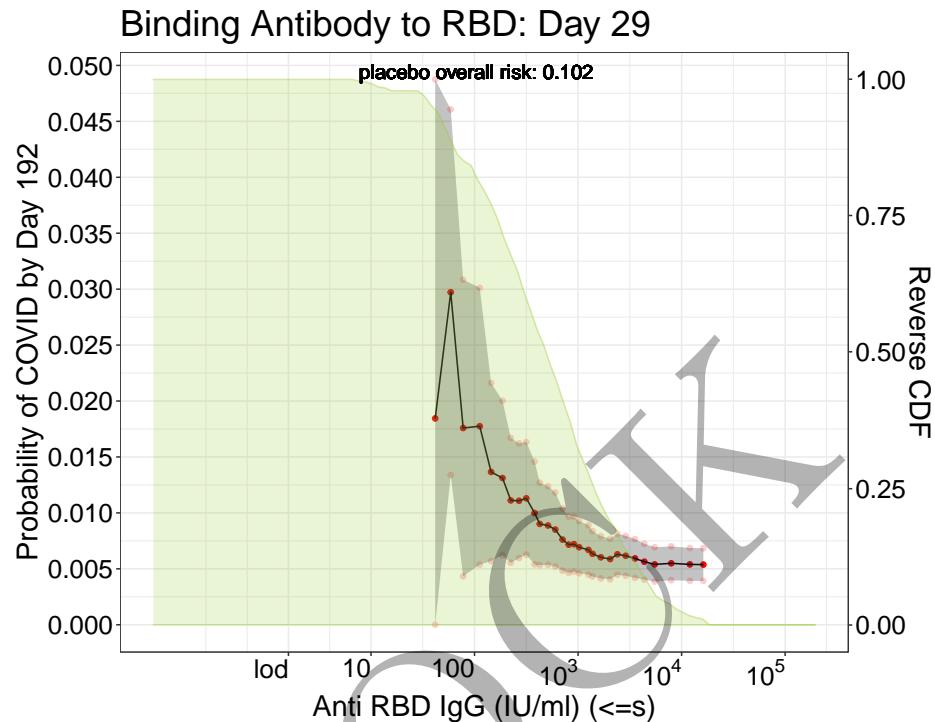


Figure 7.6: Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with pointwise 95% confidence intervals.

Table 7.6: 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
1.620	$4.17 * 10^1$	0.01845	0.00000	0.04875
2.052	$1.13 * 10^2$	0.01775	0.00537	0.03012
2.345	$2.21 * 10^2$	0.01112	0.00554	0.01670
2.575	$3.76 * 10^2$	0.01000	0.00540	0.01459
2.780	$6.03 * 10^2$	0.00851	0.00520	0.01182
3.010	$1.02 * 10^3$	0.00693	0.00460	0.00927
3.217	$1.65 * 10^3$	0.00603	0.00414	0.00792
3.461	$2.89 * 10^3$	0.00617	0.00438	0.00795
3.736	$5.45 * 10^3$	0.00540	0.00386	0.00693
4.211	$1.63 * 10^4$	0.00538	0.00392	0.00683

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

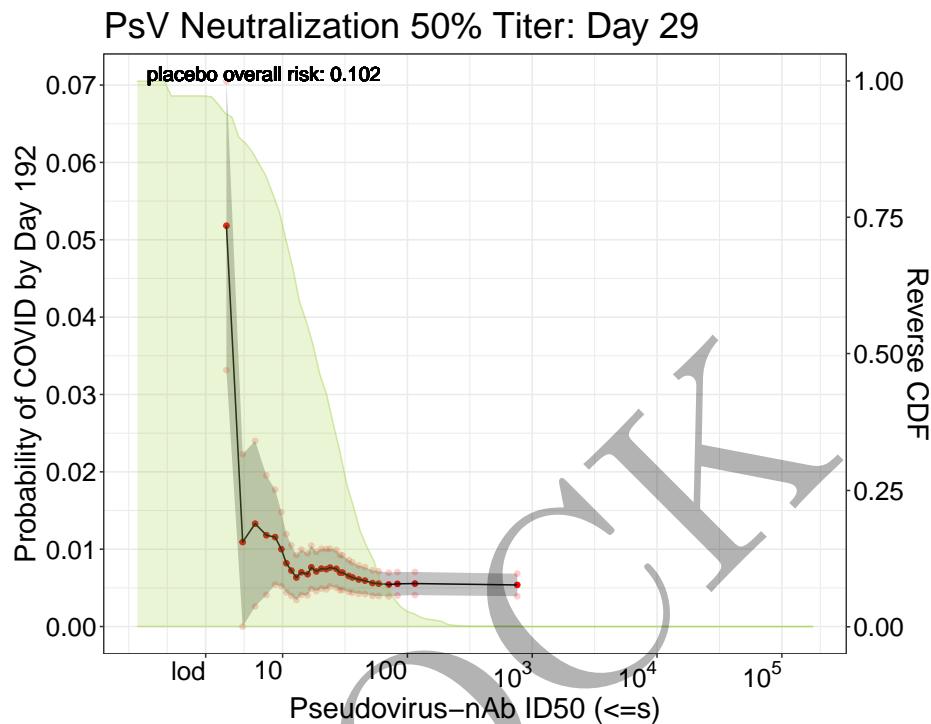


Figure 7.7: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals.

Table 7.7: 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
0.548	$3.53 * 10^0$	0.05182	0.03313	0.07050
0.873	$7.46 * 10^0$	0.01181	0.00408	0.01953
1.032	$1.08 * 10^1$	0.00819	0.00441	0.01196
1.147	$1.40 * 10^1$	0.00702	0.00408	0.00996
1.271	$1.87 * 10^1$	0.00713	0.00459	0.00967
1.427	$2.67 * 10^1$	0.00747	0.00502	0.00991
1.526	$3.36 * 10^1$	0.00653	0.00447	0.00860
1.656	$4.53 * 10^1$	0.00594	0.00419	0.00768
1.852	$7.11 * 10^1$	0.00543	0.00389	0.00696
2.879	$7.57 * 10^2$	0.00538	0.00392	0.00683

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

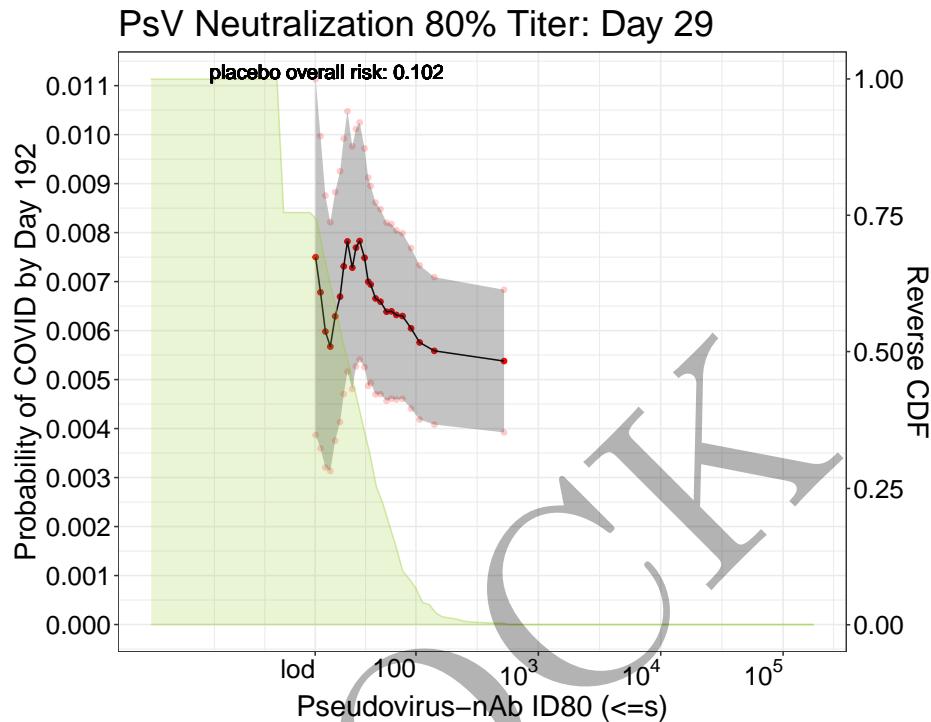


Figure 7.8: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals.

Table 7.8: 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
1.183	$1.52 * 10^1$	0.00750	0.00387	0.01113
1.300	$2.00 * 10^1$	0.00567	0.00313	0.00821
1.385	$2.43 * 10^1$	0.00669	0.00413	0.00925
1.477	$3.00 * 10^1$	0.00728	0.00481	0.00976
1.541	$3.48 * 10^1$	0.00783	0.00541	0.01025
1.632	$4.29 * 10^1$	0.00694	0.00493	0.00895
1.707	$5.09 * 10^1$	0.00659	0.00470	0.00848
1.839	$6.90 * 10^1$	0.00632	0.00459	0.00805
1.956	$9.04 * 10^1$	0.00605	0.00441	0.00769
2.719	$5.24 * 10^2$	0.00538	0.00392	0.00683

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

MOCK

7.3.1 Day 57 Spike protein binding antibody

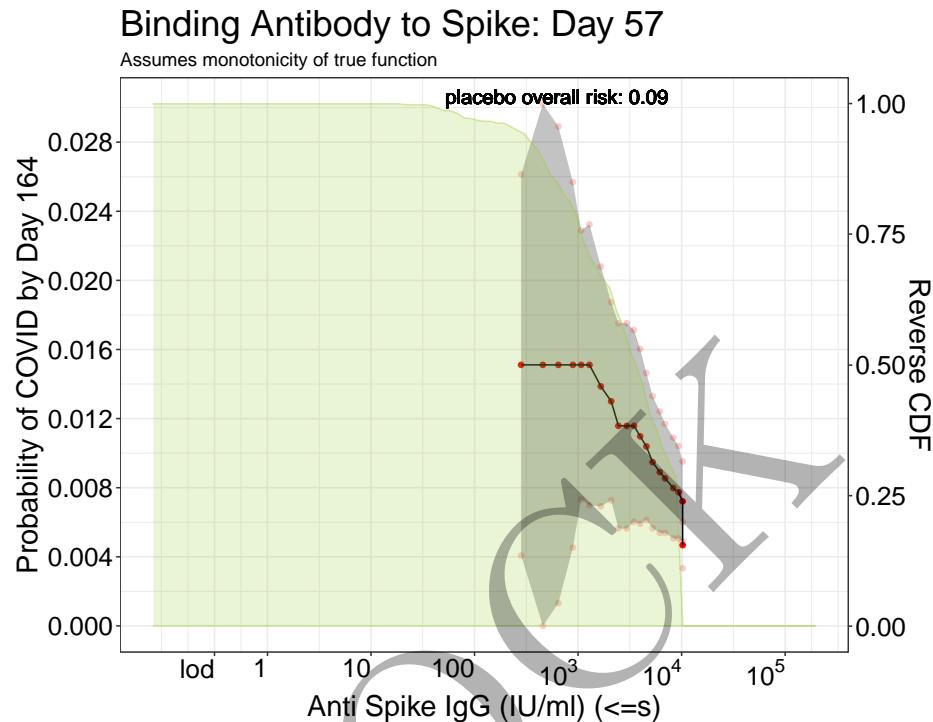


Figure 7.9: Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with pointwise 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 7.9: 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
2.450	$2.82 * 10^2$	0.01511	0.00408	0.02614
2.815	$6.53 * 10^2$	0.01511	0.00132	0.02890
3.033	$1.08 * 10^3$	0.01511	0.00732	0.02289
3.221	$1.66 * 10^3$	0.01386	0.00693	0.02080
3.394	$2.48 * 10^3$	0.01158	0.00564	0.01751
3.603	$4.01 * 10^3$	0.01097	0.00591	0.01604
3.716	$5.20 * 10^3$	0.00948	0.00566	0.01330
3.841	$6.93 * 10^3$	0.00854	0.00538	0.01170
3.973	$9.40 * 10^3$	0.00774	0.00506	0.01041
4.007	$1.02 * 10^4$	0.00468	0.00334	0.00602

7.3.2 Day 57 RBD binding antibody

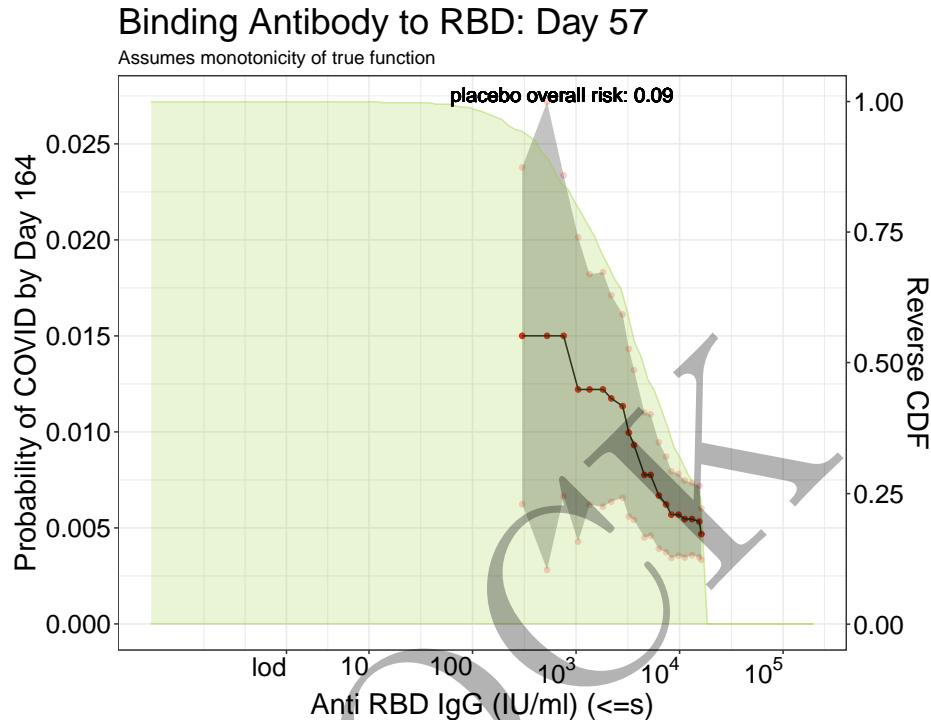


Figure 7.10: Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with pointwise 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 7.10: 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
2.478	$3.01 * 10^2$	0.01500	0.00624	0.02377
2.882	$7.62 * 10^2$	0.01500	0.00665	0.02336
3.132	$1.36 * 10^3$	0.01221	0.00621	0.01821
3.338	$2.18 * 10^3$	0.01174	0.00637	0.01712
3.514	$3.27 * 10^3$	0.00996	0.00560	0.01432
3.722	$5.27 * 10^3$	0.00776	0.00460	0.01092
3.866	$7.35 * 10^3$	0.00622	0.00373	0.00871
3.986	$9.68 * 10^3$	0.00569	0.00356	0.00782
4.125	$1.33 * 10^4$	0.00546	0.00358	0.00735
4.211	$1.63 * 10^4$	0.00468	0.00334	0.00602

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

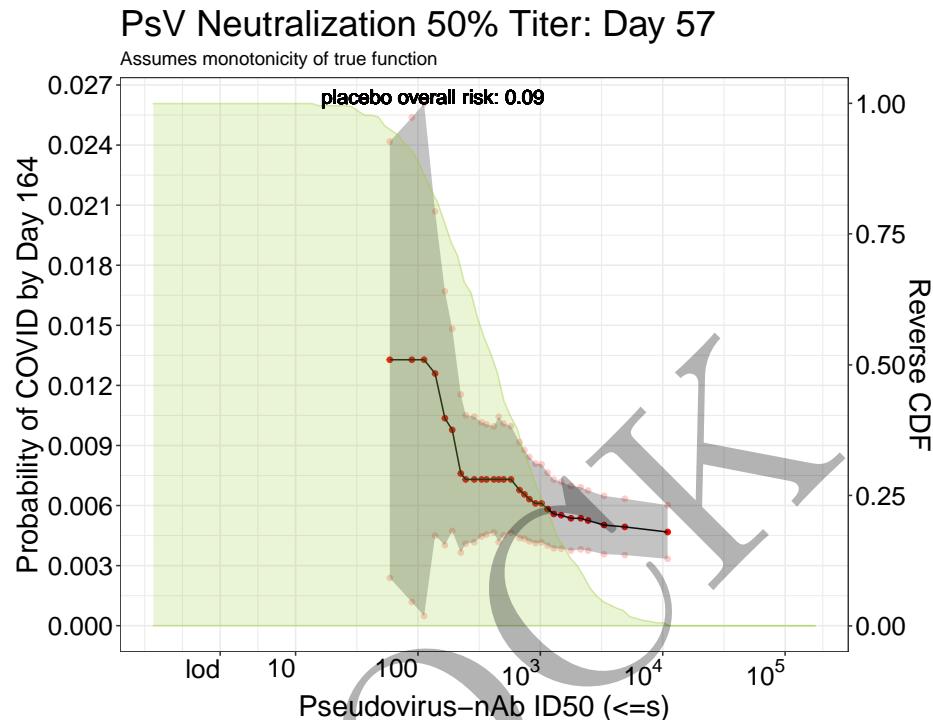


Figure 7.11: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 7.11: 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
1.765	$5.82 * 10^1$	0.01328	0.00238	0.02418
2.143	$1.39 * 10^2$	0.01259	0.00450	0.02068
2.345	$2.21 * 10^2$	0.00760	0.00365	0.01155
2.519	$3.30 * 10^2$	0.00730	0.00446	0.01015
2.657	$4.54 * 10^2$	0.00730	0.00417	0.01043
2.867	$7.36 * 10^2$	0.00656	0.00434	0.00877
3.005	$1.01 * 10^3$	0.00611	0.00416	0.00806
3.174	$1.49 * 10^3$	0.00552	0.00385	0.00719
3.387	$2.44 * 10^3$	0.00525	0.00375	0.00675
4.038	$1.09 * 10^4$	0.00468	0.00334	0.00602

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

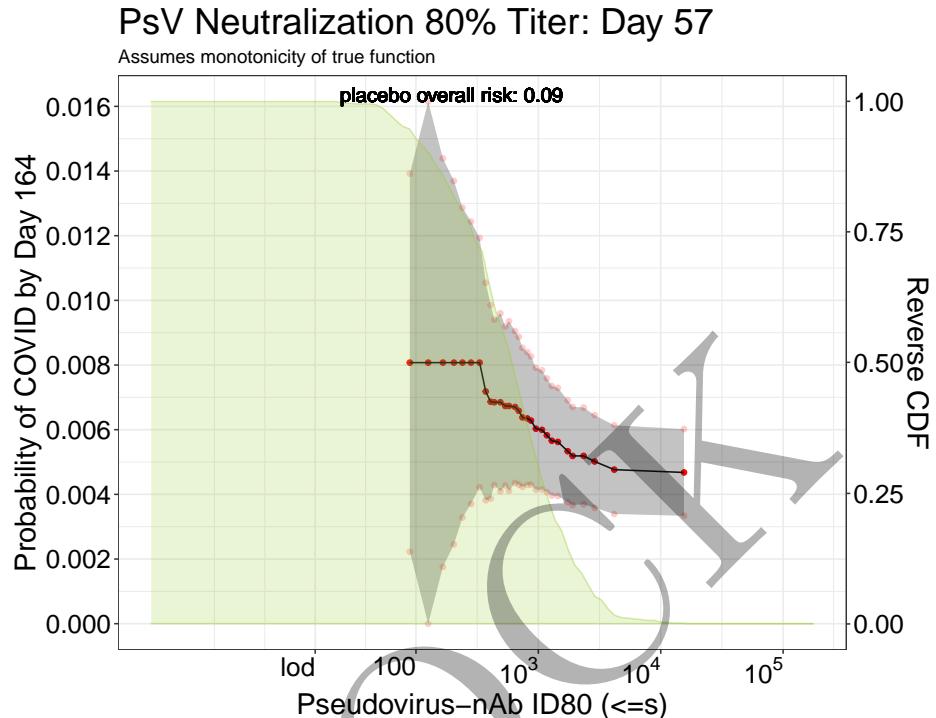


Figure 7.12: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 7.12: 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
1.954	$8.99 * 10^1$	0.00807	0.00223	0.01392
2.309	$2.04 * 10^2$	0.00807	0.00245	0.01369
2.516	$3.28 * 10^2$	0.00807	0.00422	0.01193
2.644	$4.41 * 10^2$	0.00685	0.00429	0.00941
2.764	$5.81 * 10^2$	0.00673	0.00411	0.00935
2.909	$8.11 * 10^2$	0.00635	0.00429	0.00840
3.031	$1.07 * 10^3$	0.00599	0.00415	0.00784
3.162	$1.45 * 10^3$	0.00562	0.00395	0.00729
3.371	$2.35 * 10^3$	0.00519	0.00369	0.00669
4.187	$1.54 * 10^4$	0.00468	0.00334	0.00602

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

MOCK

7.4.1 Day 29 Spike protein antibody

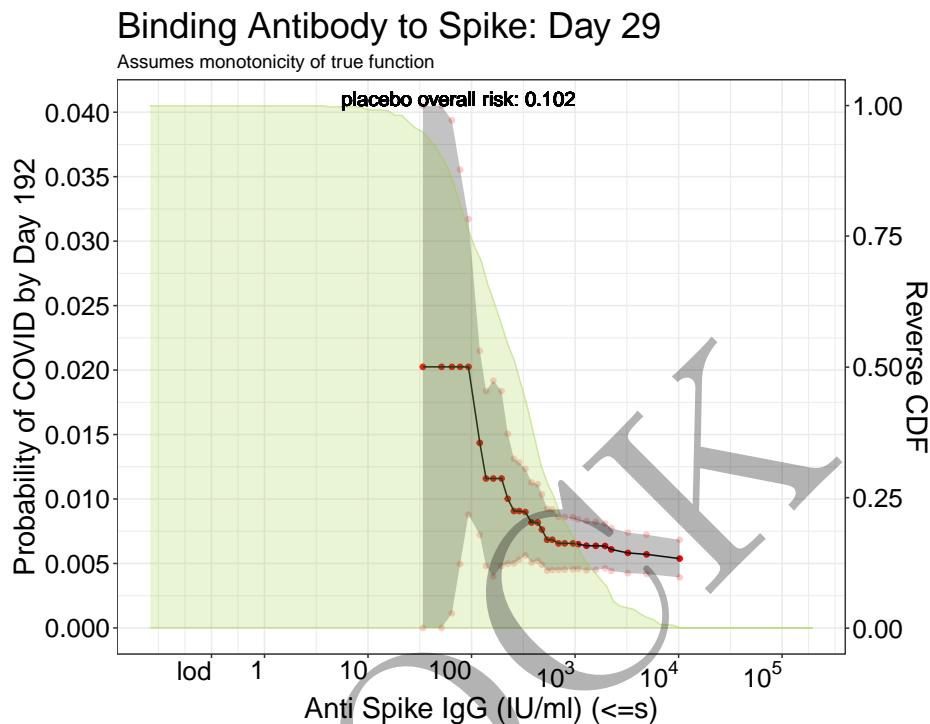


Figure 7.13: Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with pointwise 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 7.13: 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
1.532	$3.40 * 10^1$	0.02025	0.00000	0.04412
1.886	$7.69 * 10^1$	0.02025	0.00496	0.03554
2.138	$1.37 * 10^2$	0.01159	0.00480	0.01838
2.351	$2.24 * 10^2$	0.01002	0.00498	0.01506
2.522	$3.33 * 10^2$	0.00899	0.00562	0.01235
2.733	$5.41 * 10^2$	0.00684	0.00444	0.00924
2.903	$8.00 * 10^2$	0.00656	0.00452	0.00860
3.112	$1.29 * 10^3$	0.00638	0.00446	0.00829
3.348	$2.23 * 10^3$	0.00609	0.00443	0.00775
4.007	$1.02 * 10^4$	0.00538	0.00392	0.00683

7.4.2 Day 29 RBD binding antibody

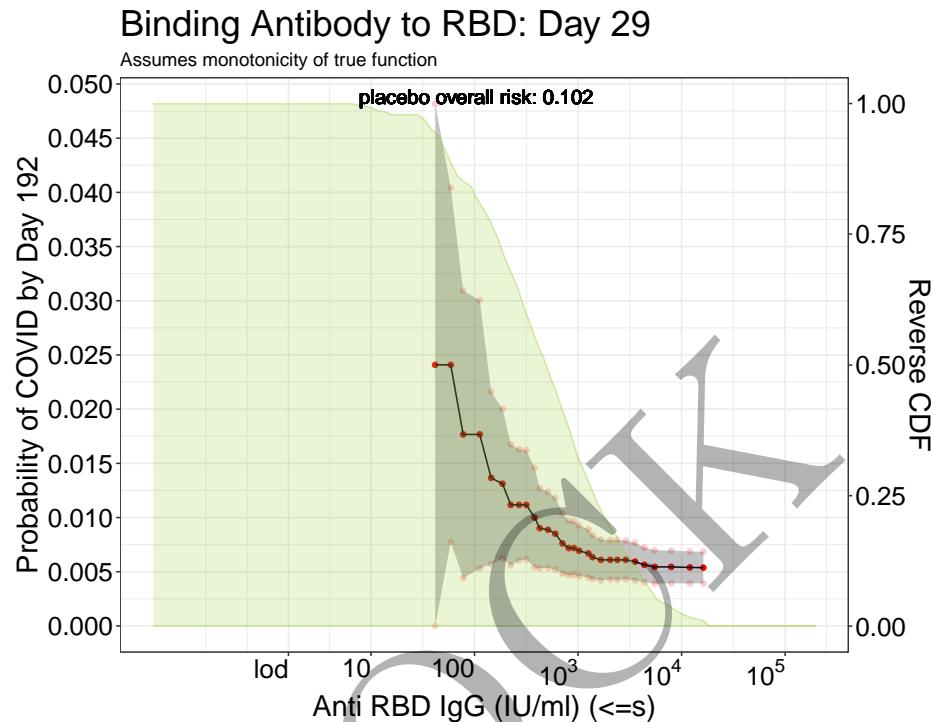


Figure 7.14: Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with pointwise 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 7.14: 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
1.620	$4.17 * 10^1$	0.02409	0.00000	0.05439
2.052	$1.13 * 10^2$	0.01767	0.00529	0.03004
2.345	$2.21 * 10^2$	0.01117	0.00559	0.01675
2.575	$3.76 * 10^2$	0.01000	0.00540	0.01459
2.780	$6.03 * 10^2$	0.00851	0.00520	0.01182
3.010	$1.02 * 10^3$	0.00693	0.00460	0.00927
3.217	$1.65 * 10^3$	0.00609	0.00420	0.00798
3.461	$2.89 * 10^3$	0.00609	0.00431	0.00788
3.736	$5.45 * 10^3$	0.00544	0.00391	0.00698
4.211	$1.63 * 10^4$	0.00538	0.00392	0.00683

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

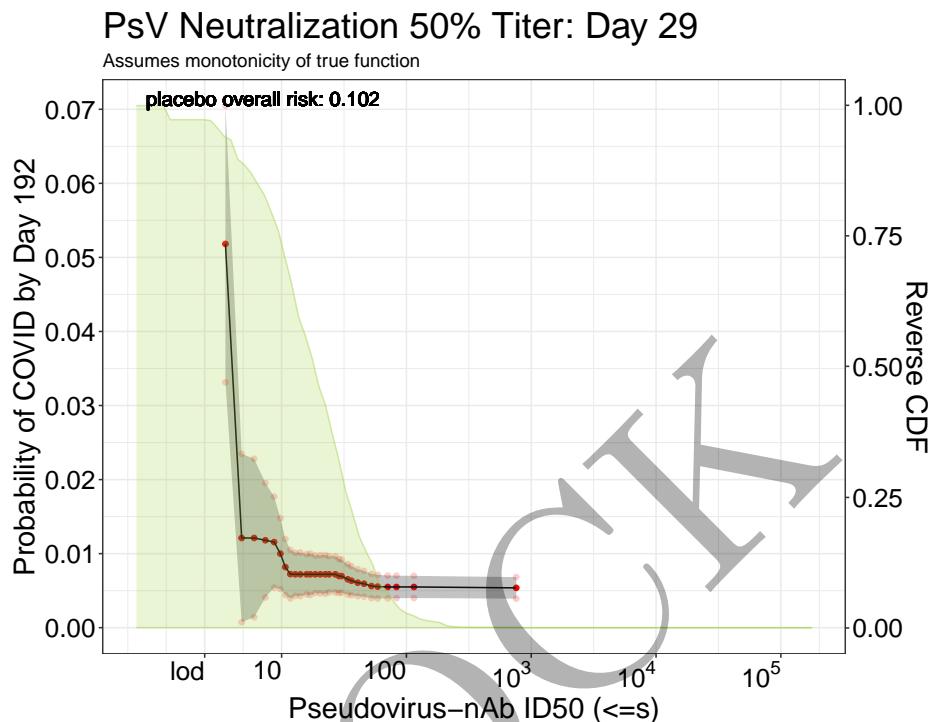


Figure 7.15: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with pointwise 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 7.15: 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
0.548	$3.53 * 10^0$	0.05182	0.03313	0.07050
0.873	$7.46 * 10^0$	0.01181	0.00408	0.01953
1.032	$1.08 * 10^1$	0.00819	0.00441	0.01196
1.147	$1.40 * 10^1$	0.00721	0.00427	0.01015
1.271	$1.87 * 10^1$	0.00721	0.00467	0.00975
1.427	$2.67 * 10^1$	0.00721	0.00477	0.00965
1.526	$3.36 * 10^1$	0.00653	0.00447	0.00860
1.656	$4.53 * 10^1$	0.00594	0.00419	0.00768
1.852	$7.11 * 10^1$	0.00550	0.00396	0.00704
2.879	$7.57 * 10^2$	0.00538	0.00392	0.00683

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

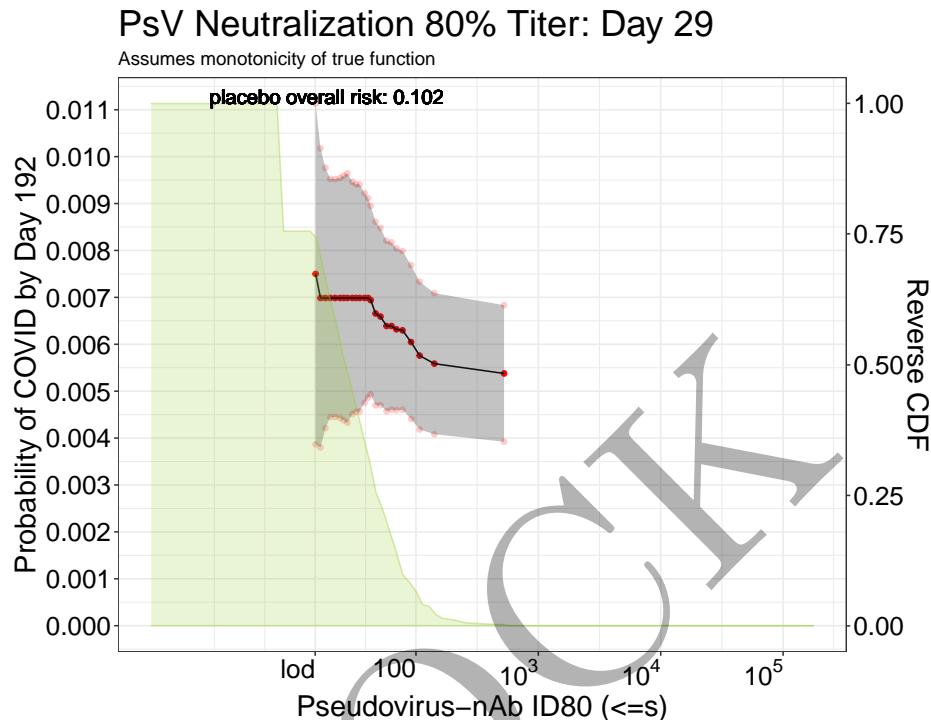


Figure 7.16: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with pointwise 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 7.16: 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
1.183	$1.52 * 10^1$	0.00750	0.00387	0.01113
1.300	$2.00 * 10^1$	0.00699	0.00445	0.00953
1.385	$2.43 * 10^1$	0.00699	0.00443	0.00955
1.477	$3.00 * 10^1$	0.00699	0.00451	0.00946
1.541	$3.48 * 10^1$	0.00699	0.00457	0.00941
1.632	$4.29 * 10^1$	0.00694	0.00493	0.00895
1.707	$5.09 * 10^1$	0.00659	0.00470	0.00848
1.839	$6.90 * 10^1$	0.00632	0.00459	0.00805
1.956	$9.04 * 10^1$	0.00605	0.00441	0.00769
2.719	$5.24 * 10^2$	0.00538	0.00392	0.00683

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

MOCK

7.5.1 Day 57 Spike protein binding antibody

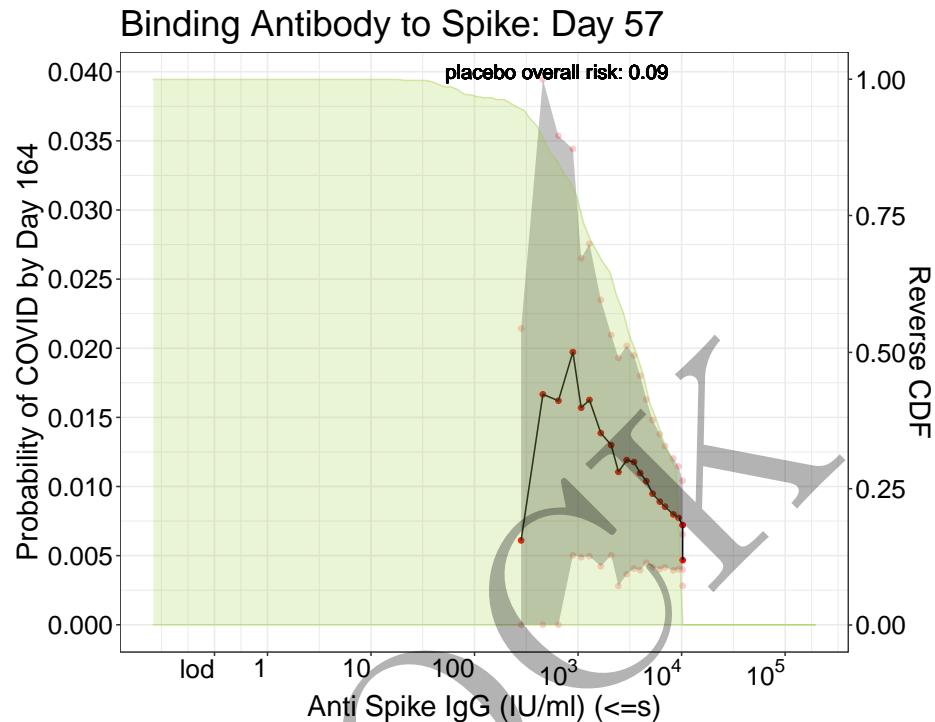


Figure 7.17: Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals.

Table 7.17: 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
2.450	$2.82 * 10^2$	0.00610	0.00000	0.02142
2.815	$6.53 * 10^2$	0.01621	0.00000	0.03537
3.033	$1.08 * 10^3$	0.01570	0.00488	0.02651
3.221	$1.66 * 10^3$	0.01386	0.00423	0.02350
3.394	$2.48 * 10^3$	0.01106	0.00281	0.01930
3.603	$4.01 * 10^3$	0.01097	0.00394	0.01801
3.716	$5.20 * 10^3$	0.00948	0.00417	0.01479
3.841	$6.93 * 10^3$	0.00854	0.00416	0.01293
3.973	$9.40 * 10^3$	0.00774	0.00402	0.01146
4.007	$1.02 * 10^4$	0.00468	0.00281	0.00654

7.5.2 Day 57 RBD binding antibody

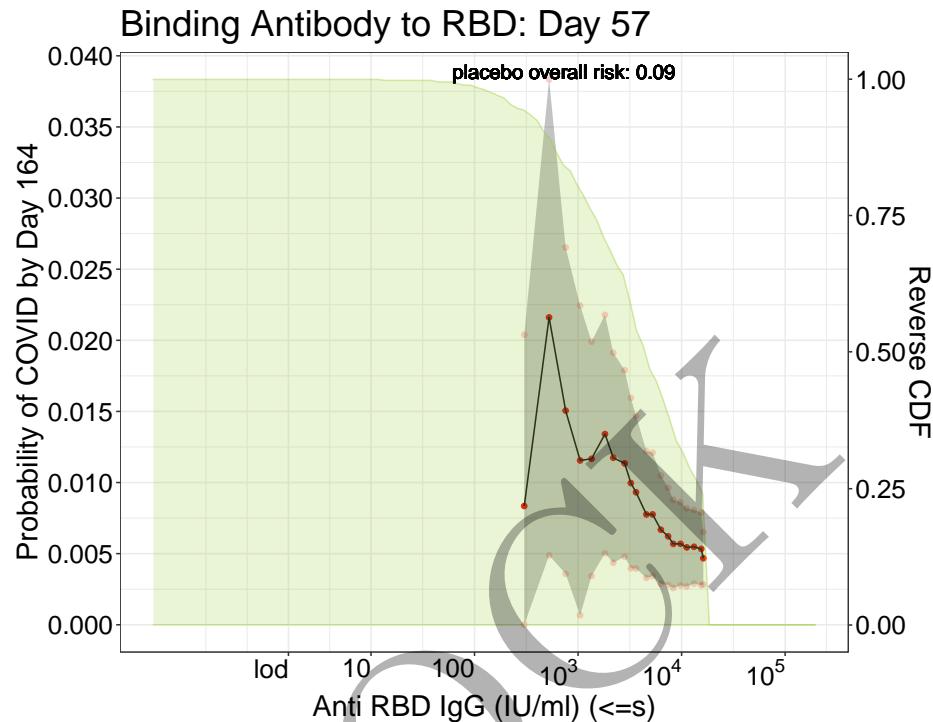


Figure 7.18: Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals.

Table 7.18: 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
2.478	$3.01 * 10^2$	0.00835	0.00000	0.02039
2.882	$7.62 * 10^2$	0.01506	0.00359	0.02653
3.132	$1.36 * 10^3$	0.01167	0.00343	0.01991
3.338	$2.18 * 10^3$	0.01174	0.00436	0.01913
3.514	$3.27 * 10^3$	0.00996	0.00397	0.01595
3.722	$5.27 * 10^3$	0.00776	0.00342	0.01210
3.866	$7.35 * 10^3$	0.00622	0.00280	0.00964
3.986	$9.68 * 10^3$	0.00569	0.00276	0.00862
4.125	$1.33 * 10^4$	0.00548	0.00290	0.00807
4.211	$1.63 * 10^4$	0.00468	0.00284	0.00652

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

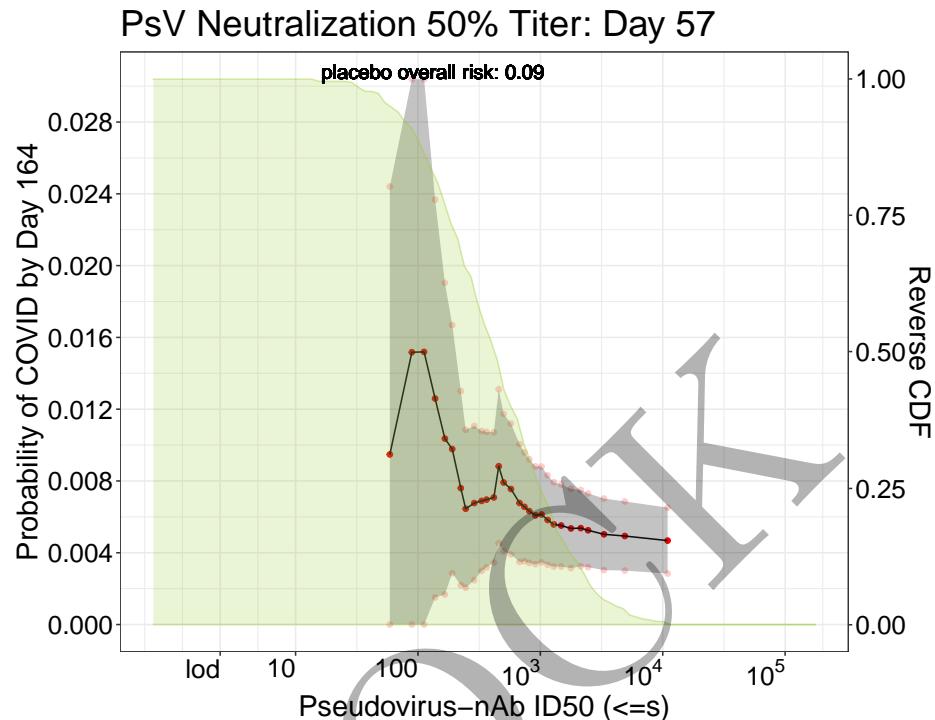


Figure 7.19: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals.

Table 7.19: 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
1.765	$5.82 * 10^1$	0.00948	0.00000	0.02441
2.143	$1.39 * 10^2$	0.01259	0.00151	0.02368
2.345	$2.21 * 10^2$	0.00760	0.00219	0.01301
2.519	$3.30 * 10^2$	0.00689	0.00299	0.01079
2.657	$4.54 * 10^2$	0.00882	0.00453	0.01311
2.867	$7.36 * 10^2$	0.00656	0.00353	0.00959
3.005	$1.01 * 10^3$	0.00613	0.00346	0.00880
3.174	$1.49 * 10^3$	0.00552	0.00323	0.00781
3.387	$2.44 * 10^3$	0.00525	0.00320	0.00731
4.038	$1.09 * 10^4$	0.00468	0.00284	0.00651

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

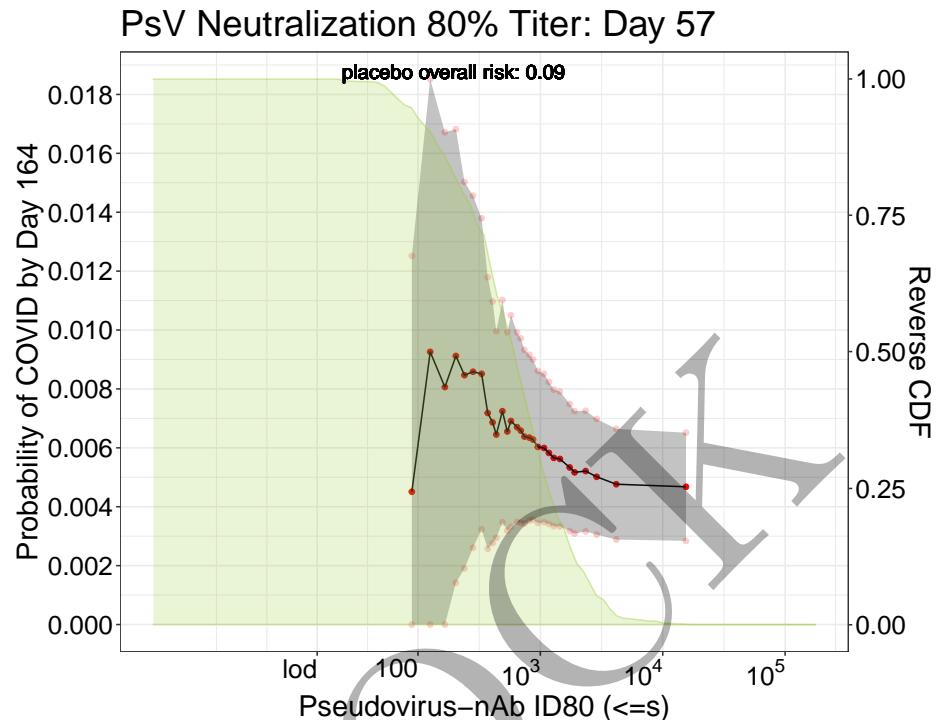


Figure 7.20: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals.

Table 7.20: 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
1.954	$8.99 * 10^1$	0.00451	0.00000	0.01252
2.309	$2.04 * 10^2$	0.00912	0.00142	0.01682
2.516	$3.28 * 10^2$	0.00851	0.00323	0.01380
2.644	$4.41 * 10^2$	0.00645	0.00295	0.00996
2.764	$5.81 * 10^2$	0.00691	0.00332	0.01050
2.909	$8.11 * 10^2$	0.00635	0.00353	0.00916
3.031	$1.07 * 10^3$	0.00599	0.00347	0.00852
3.162	$1.45 * 10^3$	0.00562	0.00333	0.00791
3.371	$2.35 * 10^3$	0.00521	0.00316	0.00726
4.187	$1.54 * 10^4$	0.00468	0.00284	0.00651

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

MOCK

7.6.1 Day 29 Spike protein antibody

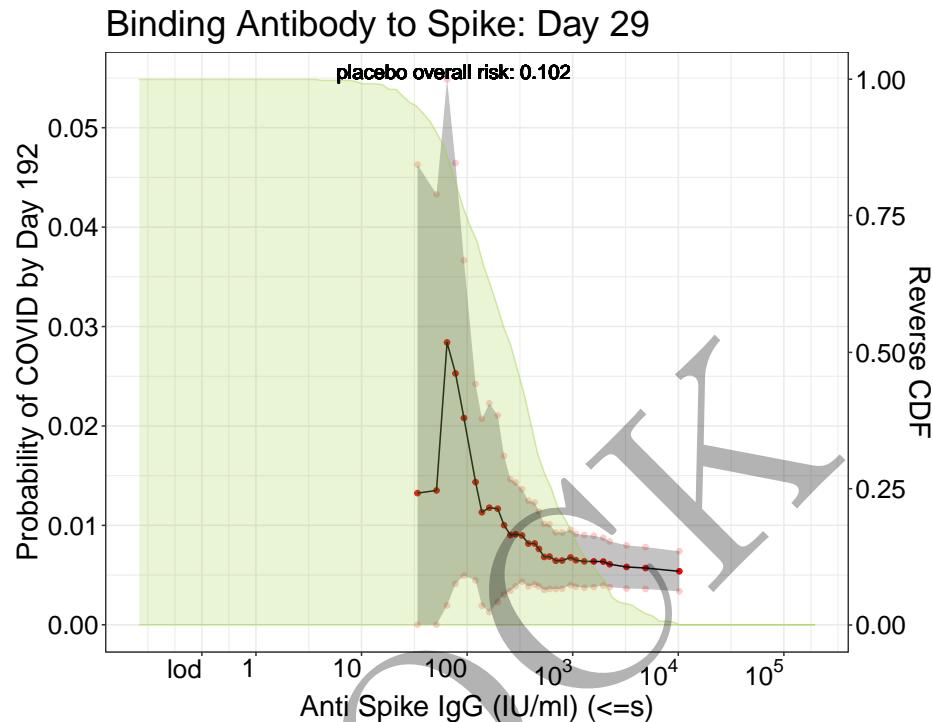


Figure 7.21: Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals.

Table 7.21: 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
1.532	$3.40 * 10^1$	0.01324	0.00000	0.04628
1.886	$7.69 * 10^1$	0.02528	0.00412	0.04645
2.138	$1.37 * 10^2$	0.01132	0.00192	0.02071
2.351	$2.24 * 10^2$	0.01002	0.00304	0.01699
2.522	$3.33 * 10^2$	0.00899	0.00433	0.01364
2.733	$5.41 * 10^2$	0.00682	0.00350	0.01014
2.903	$8.00 * 10^2$	0.00646	0.00364	0.00928
3.112	$1.29 * 10^3$	0.00638	0.00373	0.00903
3.348	$2.23 * 10^3$	0.00609	0.00379	0.00839
4.007	$1.02 * 10^4$	0.00538	0.00336	0.00739

7.6.2 Day 29 RBD binding antibody

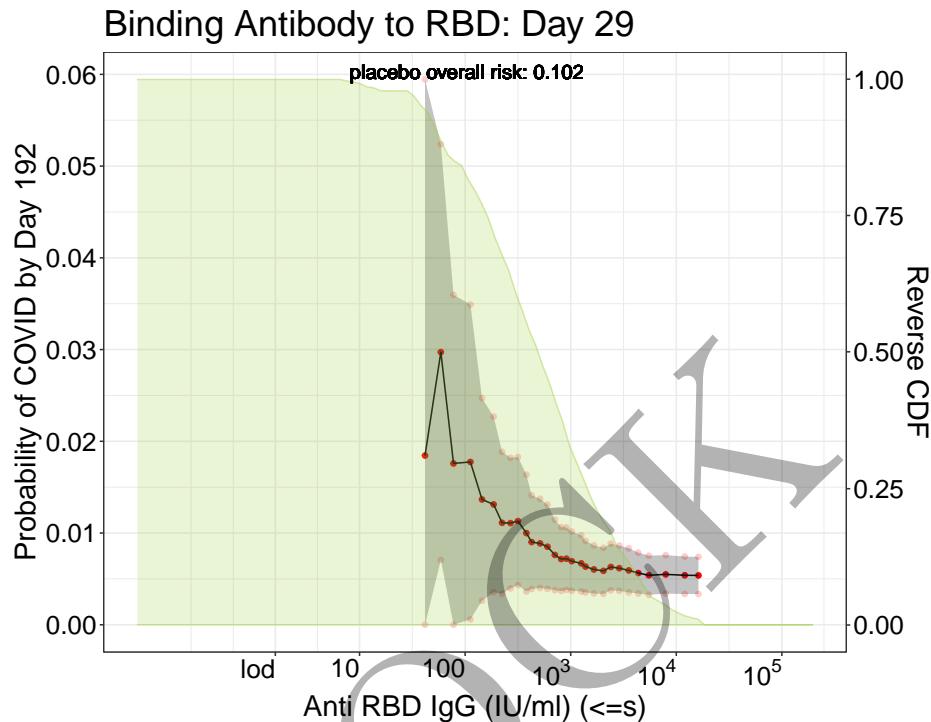


Figure 7.22: Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals.

Table 7.22: 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
1.620	$4.17 * 10^1$	0.01845	0.00000	0.06045
2.052	$1.13 * 10^2$	0.01775	0.00059	0.03491
2.345	$2.21 * 10^2$	0.01112	0.00338	0.01885
2.575	$3.76 * 10^2$	0.01000	0.00363	0.01636
2.780	$6.03 * 10^2$	0.00851	0.00392	0.01310
3.010	$1.02 * 10^3$	0.00693	0.00370	0.01017
3.217	$1.65 * 10^3$	0.00603	0.00341	0.00865
3.461	$2.89 * 10^3$	0.00617	0.00369	0.00864
3.736	$5.45 * 10^3$	0.00540	0.00326	0.00753
4.211	$1.63 * 10^4$	0.00538	0.00336	0.00740

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

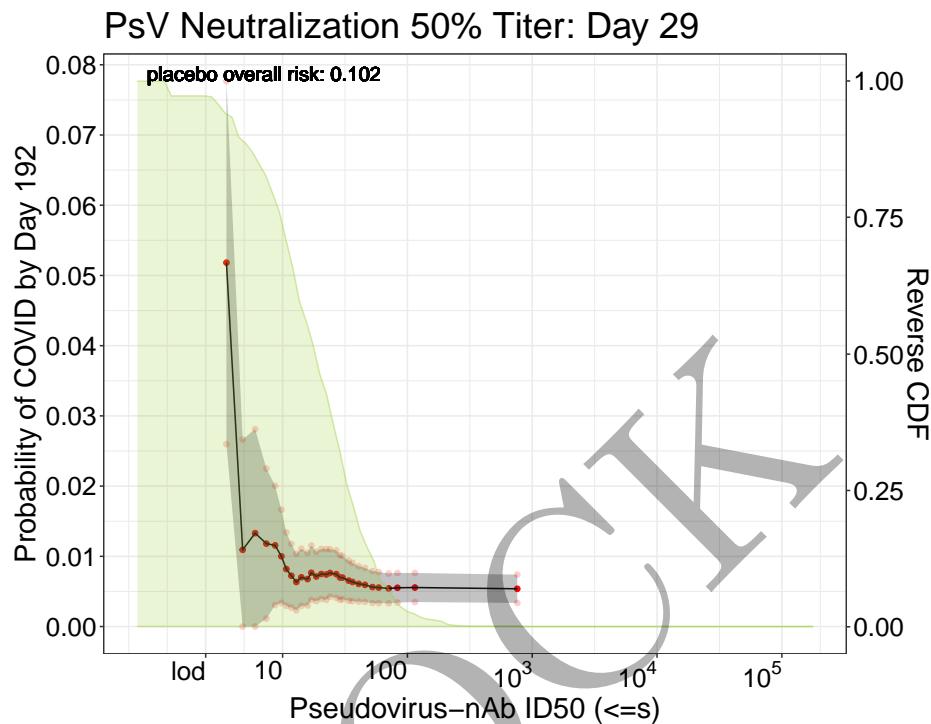


Figure 7.23: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals.

Table 7.23: 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
0.548	3.53 * 10 ⁰	0.05182	0.02597	0.07766
0.873	7.46 * 10 ⁰	0.01181	0.00112	0.02249
1.032	1.08 * 10 ¹	0.00819	0.00296	0.01341
1.147	1.40 * 10 ¹	0.00702	0.00295	0.01108
1.271	1.87 * 10 ¹	0.00713	0.00362	0.01064
1.427	2.67 * 10 ¹	0.00747	0.00409	0.01084
1.526	3.36 * 10 ¹	0.00653	0.00367	0.00939
1.656	4.53 * 10 ¹	0.00594	0.00353	0.00835
1.852	7.11 * 10 ¹	0.00543	0.00330	0.00755
2.879	7.57 * 10 ²	0.00538	0.00336	0.00739

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

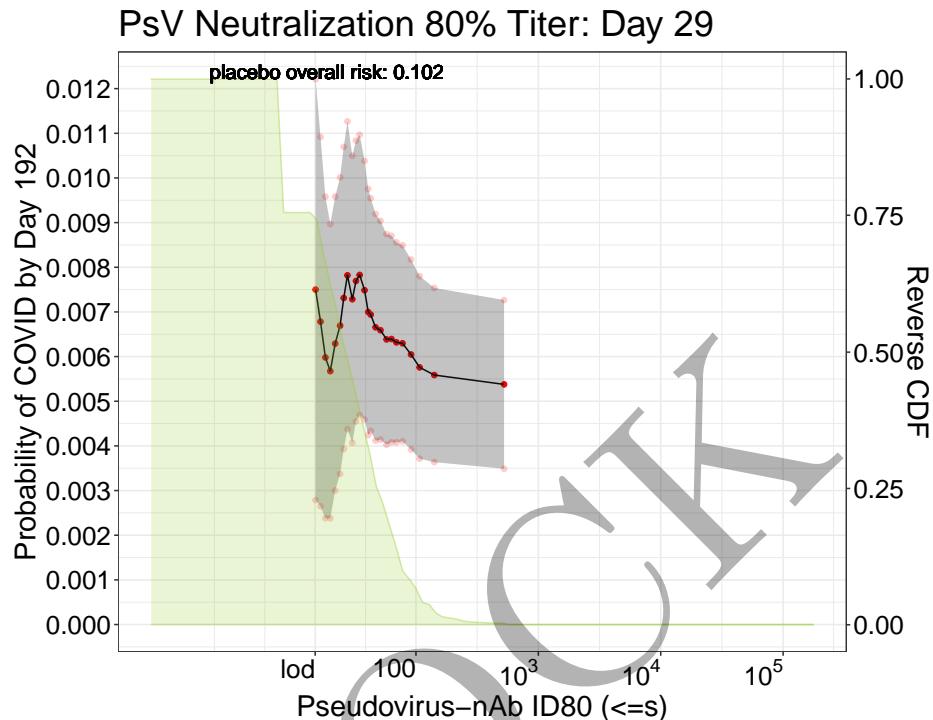


Figure 7.24: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals.

Table 7.24: 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
1.183	$1.52 * 10^1$	0.00750	0.00279	0.01221
1.300	$2.00 * 10^1$	0.00567	0.00238	0.00897
1.385	$2.43 * 10^1$	0.00669	0.00337	0.01001
1.477	$3.00 * 10^1$	0.00728	0.00407	0.01050
1.541	$3.48 * 10^1$	0.00783	0.00469	0.01097
1.632	$4.29 * 10^1$	0.00694	0.00434	0.00955
1.707	$5.09 * 10^1$	0.00659	0.00414	0.00904
1.839	$6.90 * 10^1$	0.00632	0.00408	0.00856
1.956	$9.04 * 10^1$	0.00605	0.00392	0.00817
2.719	$5.24 * 10^2$	0.00538	0.00349	0.00727

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

MOCK

7.7.1 Day 57 Spike protein binding antibody

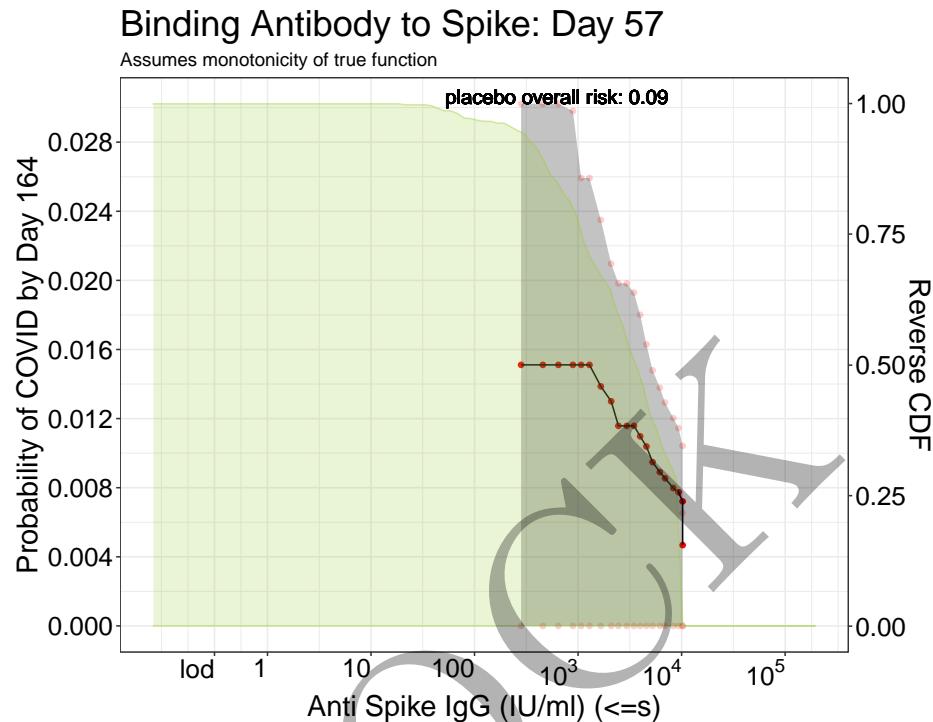


Figure 7.25: Adjusted threshold-response function for a range of thresholds of the Day 57 Spike protein binding antibody levels with simultaneous 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 7.25: 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
2.450	$2.82 * 10^2$	0.01511	0.00000	0.03043
2.815	$6.53 * 10^2$	0.01511	0.00000	0.03427
3.033	$1.08 * 10^3$	0.01511	0.00429	0.02593
3.221	$1.66 * 10^3$	0.01386	0.00423	0.02350
3.394	$2.48 * 10^3$	0.01158	0.00333	0.01983
3.603	$4.01 * 10^3$	0.01097	0.00394	0.01801
3.716	$5.20 * 10^3$	0.00948	0.00417	0.01479
3.841	$6.93 * 10^3$	0.00854	0.00416	0.01293
3.973	$9.40 * 10^3$	0.00774	0.00402	0.01146
4.007	$1.02 * 10^4$	0.00468	0.00281	0.00654

7.7.2 Day 57 RBD binding antibody

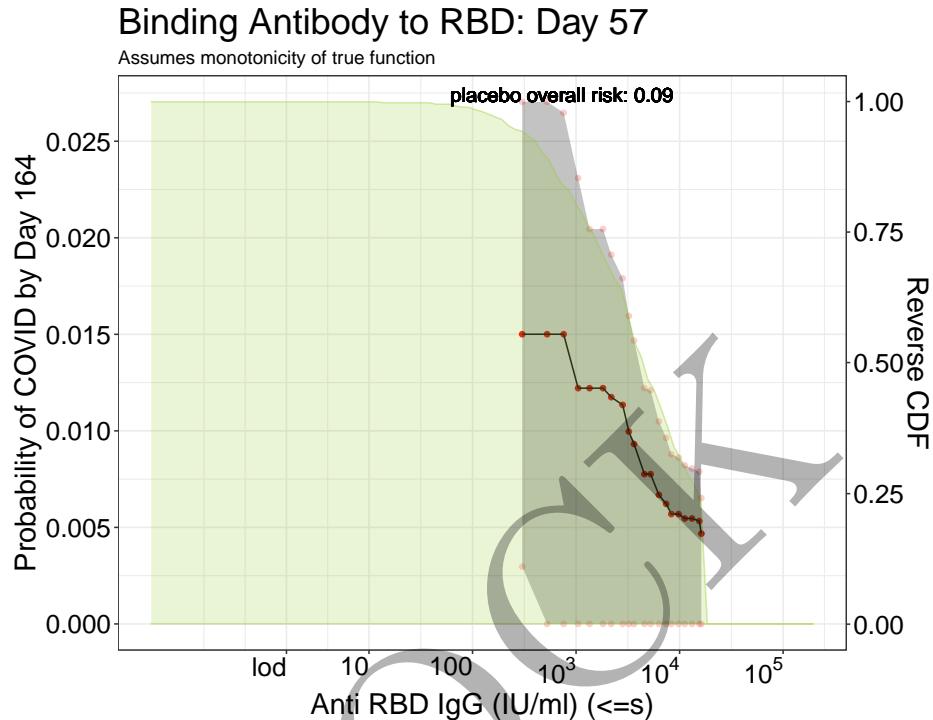


Figure 7.26: Adjusted threshold-response function for a range of thresholds of the Day 57 RBD binding antibody levels with simultaneous 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 7.26: 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
2.478	$3.01 * 10^2$	0.01500	0.00297	0.02704
2.882	$7.62 * 10^2$	0.01500	0.00353	0.02647
3.132	$1.36 * 10^3$	0.01221	0.00397	0.02045
3.338	$2.18 * 10^3$	0.01174	0.00436	0.01913
3.514	$3.27 * 10^3$	0.00996	0.00397	0.01595
3.722	$5.27 * 10^3$	0.00776	0.00342	0.01210
3.866	$7.35 * 10^3$	0.00622	0.00280	0.00964
3.986	$9.68 * 10^3$	0.00569	0.00276	0.00862
4.125	$1.33 * 10^4$	0.00546	0.00288	0.00805
4.211	$1.63 * 10^4$	0.00468	0.00284	0.00652

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

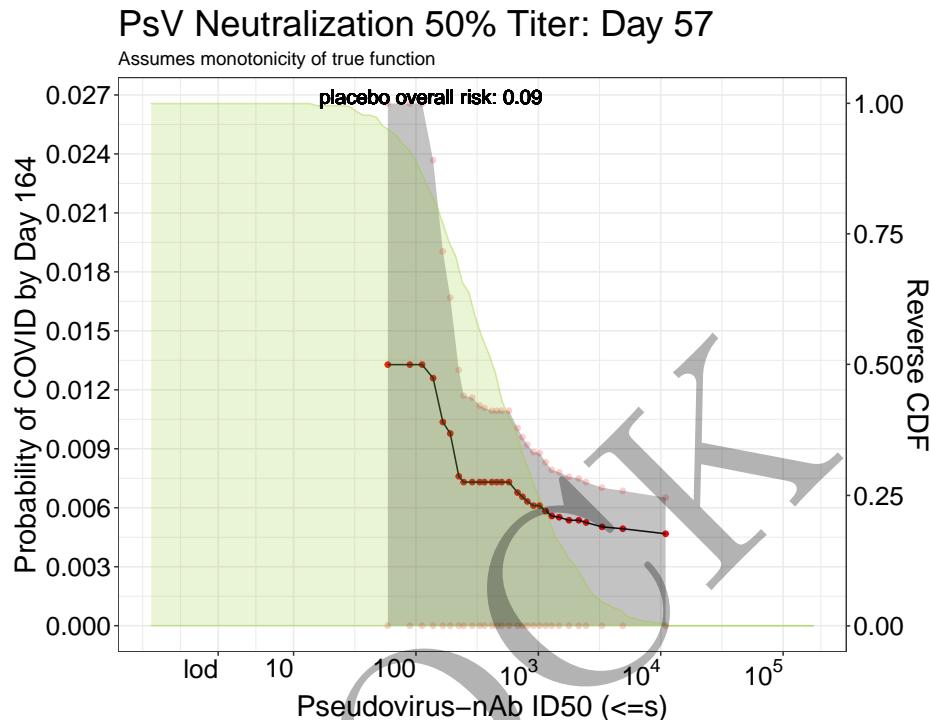


Figure 7.27: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 7.27: 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
1.765	$5.82 * 10^1$	0.01328	0.00000	0.02821
2.143	$1.39 * 10^2$	0.01259	0.00151	0.02368
2.345	$2.21 * 10^2$	0.00760	0.00219	0.01301
2.519	$3.30 * 10^2$	0.00730	0.00340	0.01120
2.657	$4.54 * 10^2$	0.00730	0.00302	0.01159
2.867	$7.36 * 10^2$	0.00656	0.00353	0.00959
3.005	$1.01 * 10^3$	0.00611	0.00344	0.00878
3.174	$1.49 * 10^3$	0.00552	0.00323	0.00781
3.387	$2.44 * 10^3$	0.00525	0.00320	0.00731
4.038	$1.09 * 10^4$	0.00468	0.00284	0.00651

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

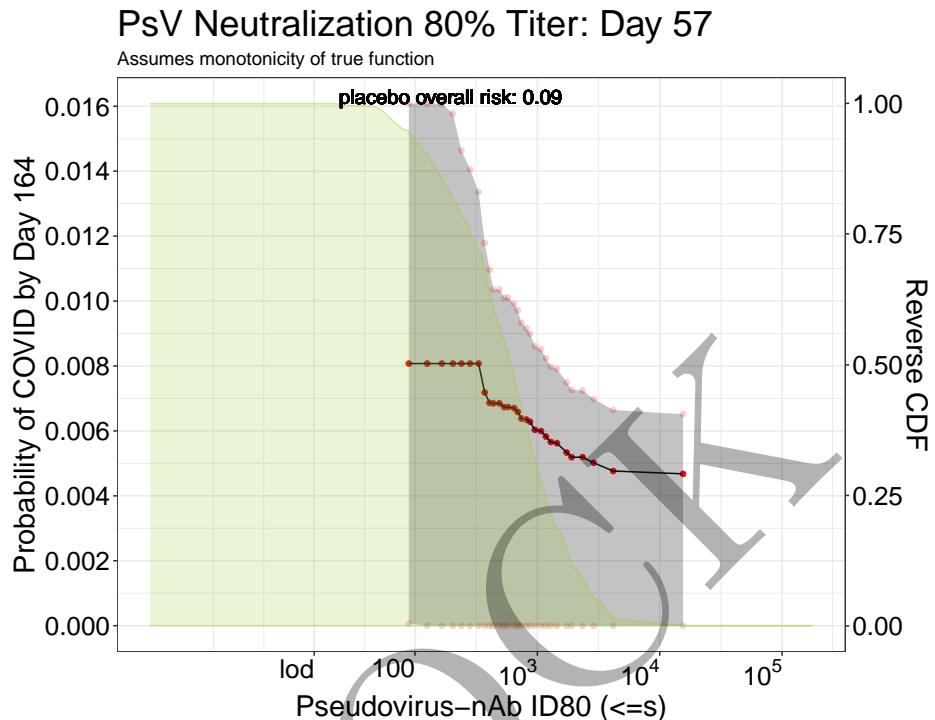


Figure 7.28: Adjusted threshold-response function for a range of thresholds of the Day 57 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 7.28: 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
1.954	$8.99 * 10^1$	0.00807	0.00007	0.01608
2.309	$2.04 * 10^2$	0.00807	0.00038	0.01577
2.516	$3.28 * 10^2$	0.00807	0.00279	0.01336
2.644	$4.41 * 10^2$	0.00685	0.00334	0.01035
2.764	$5.81 * 10^2$	0.00673	0.00314	0.01032
2.909	$8.11 * 10^2$	0.00635	0.00353	0.00916
3.031	$1.07 * 10^3$	0.00599	0.00347	0.00852
3.162	$1.45 * 10^3$	0.00562	0.00333	0.00791
3.371	$2.35 * 10^3$	0.00519	0.00314	0.00724
4.187	$1.54 * 10^4$	0.00468	0.00284	0.00651

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

MOCK

7.8.1 Day 29 Spike protein antibody

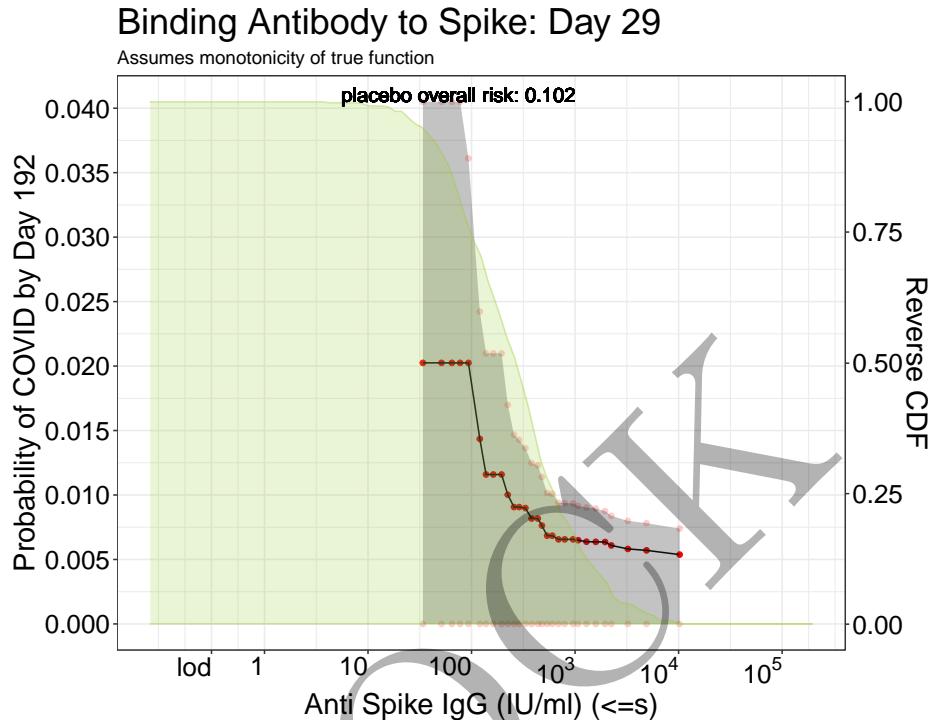


Figure 7.29: Adjusted threshold-response function for a range of thresholds of the Day 29 Spike protein antibody levels with simultaneous 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 7.29: 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
1.532	$3.40 * 10^1$	0.02025	0.00000	0.05329
1.886	$7.69 * 10^1$	0.02025	0.00000	0.04141
2.138	$1.37 * 10^2$	0.01159	0.00219	0.02099
2.351	$2.24 * 10^2$	0.01002	0.00304	0.01699
2.522	$3.33 * 10^2$	0.00899	0.00433	0.01364
2.733	$5.41 * 10^2$	0.00684	0.00352	0.01016
2.903	$8.00 * 10^2$	0.00656	0.00374	0.00938
3.112	$1.29 * 10^3$	0.00638	0.00373	0.00903
3.348	$2.23 * 10^3$	0.00609	0.00379	0.00839
4.007	$1.02 * 10^4$	0.00538	0.00336	0.00739

7.8.2 Day 29 RBD binding antibody

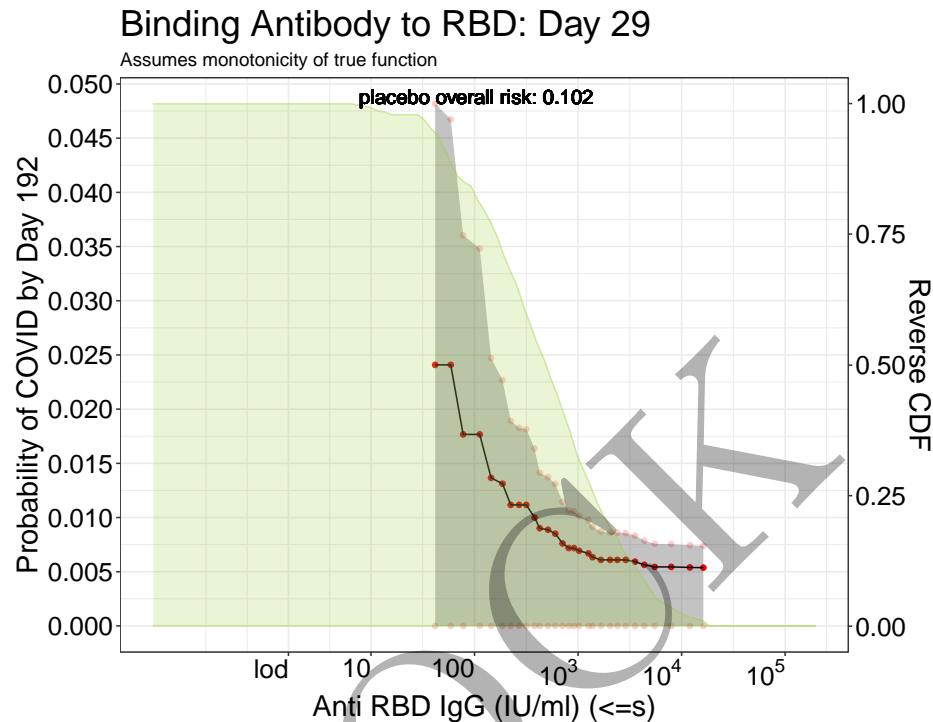


Figure 7.30: Adjusted threshold-response function for a range of thresholds of the Day 29 RBD binding antibody levels with simultaneous 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 7.30: 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
1.620	$4.17 * 10^1$	0.02409	0.00000	0.06609
2.052	$1.13 * 10^2$	0.01767	0.00051	0.03483
2.345	$2.21 * 10^2$	0.01117	0.00343	0.01890
2.575	$3.76 * 10^2$	0.01000	0.00363	0.01636
2.780	$6.03 * 10^2$	0.00851	0.00392	0.01310
3.010	$1.02 * 10^3$	0.00693	0.00370	0.01017
3.217	$1.65 * 10^3$	0.00609	0.00347	0.00871
3.461	$2.89 * 10^3$	0.00609	0.00362	0.00857
3.736	$5.45 * 10^3$	0.00544	0.00331	0.00758
4.211	$1.63 * 10^4$	0.00538	0.00336	0.00740

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

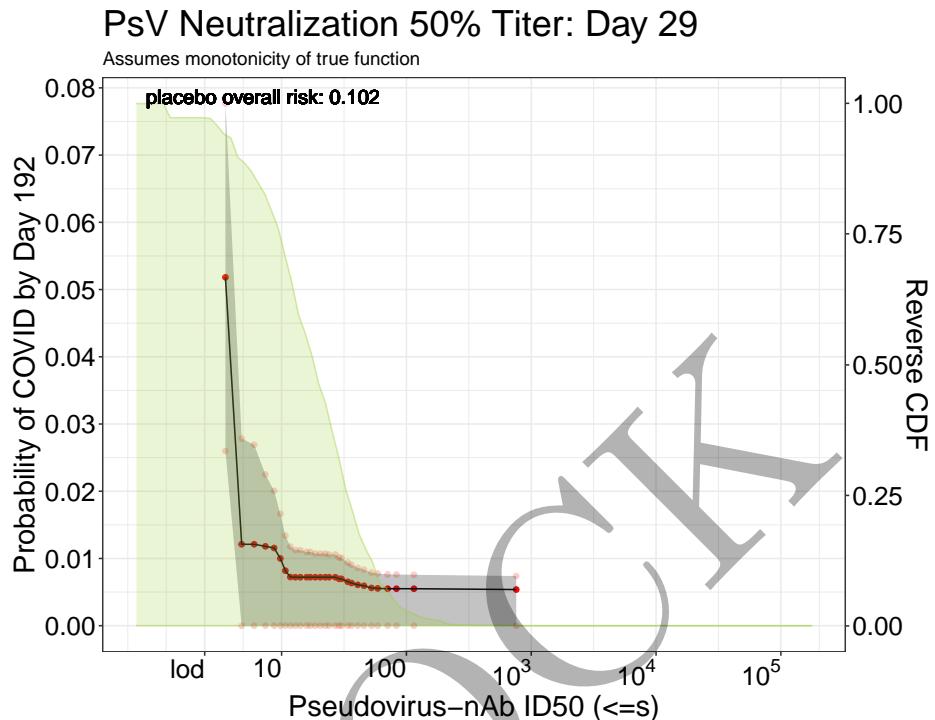


Figure 7.31: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (50% titer) levels with simultaneous 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 7.31: 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
0.548	$3.53 * 10^0$	0.05182	0.02597	0.07766
0.873	$7.46 * 10^0$	0.01181	0.00112	0.02249
1.032	$1.08 * 10^1$	0.00819	0.00296	0.01341
1.147	$1.40 * 10^1$	0.00721	0.00314	0.01128
1.271	$1.87 * 10^1$	0.00721	0.00370	0.01072
1.427	$2.67 * 10^1$	0.00721	0.00383	0.01059
1.526	$3.36 * 10^1$	0.00653	0.00367	0.00939
1.656	$4.53 * 10^1$	0.00594	0.00353	0.00835
1.852	$7.11 * 10^1$	0.00550	0.00337	0.00763
2.879	$7.57 * 10^2$	0.00538	0.00336	0.00739

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

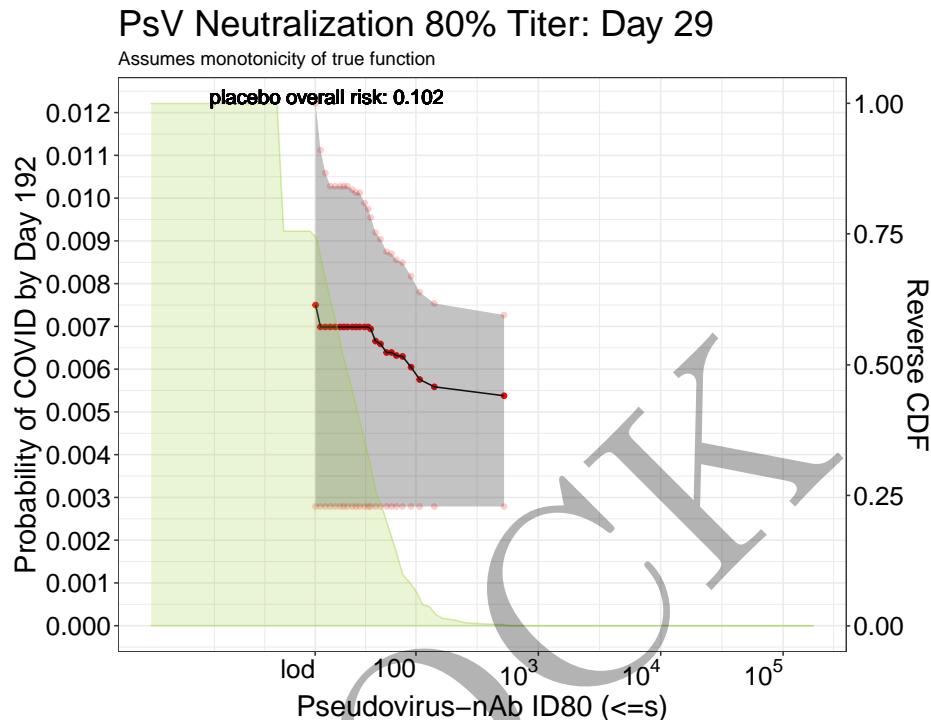


Figure 7.32: Adjusted threshold-response function for a range of thresholds of the Day 29 Pseudo virus-neutralizing antibody (80% titer) levels with simultaneous 95% confidence intervals. The estimates and confidence intervals are adjusted using the assumption that the true threshold-response is nonincreasing.

Table 7.32: 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
1.183	1.52×10^1	0.00750	0.00279	0.01221
1.300	2.00×10^1	0.00699	0.00369	0.01028
1.385	2.43×10^1	0.00699	0.00367	0.01031
1.477	3.00×10^1	0.00699	0.00377	0.01020
1.541	3.48×10^1	0.00699	0.00385	0.01013
1.632	4.29×10^1	0.00694	0.00434	0.00955
1.707	5.09×10^1	0.00659	0.00414	0.00904
1.839	6.90×10^1	0.00632	0.00408	0.00856
1.956	9.04×10^1	0.00605	0.00392	0.00817
2.719	5.24×10^2	0.00538	0.00349	0.00727

Chapter 8

Day 57 Univariate CoR: Nonlinear modeling

To explore nonlinear association and threshold modeling, we fit smoothing spline models using the mgcv R package and two-phase models using the chngpt R package.

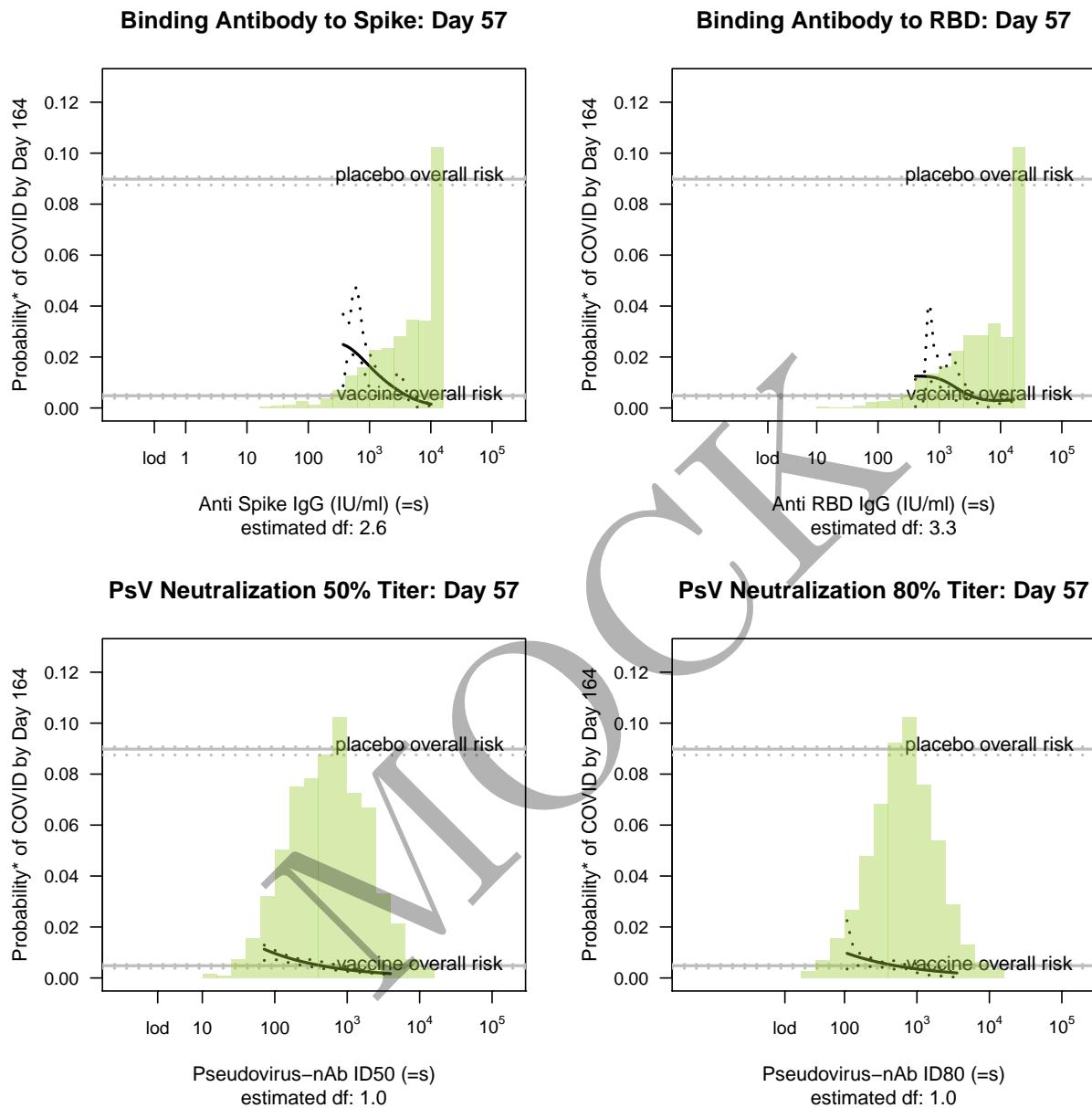


Figure 8.1: Marginalized risk as functions of Day 57 markers ($=s$) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates) as modeled by GAM with automatic smoothness estimation. The horizontal lines indicate the overall cumulative risk of the vaccine and placebo arms by Day 164 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. $\text{lod} = 0.3, 1.6, 2.4, 15$ for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.

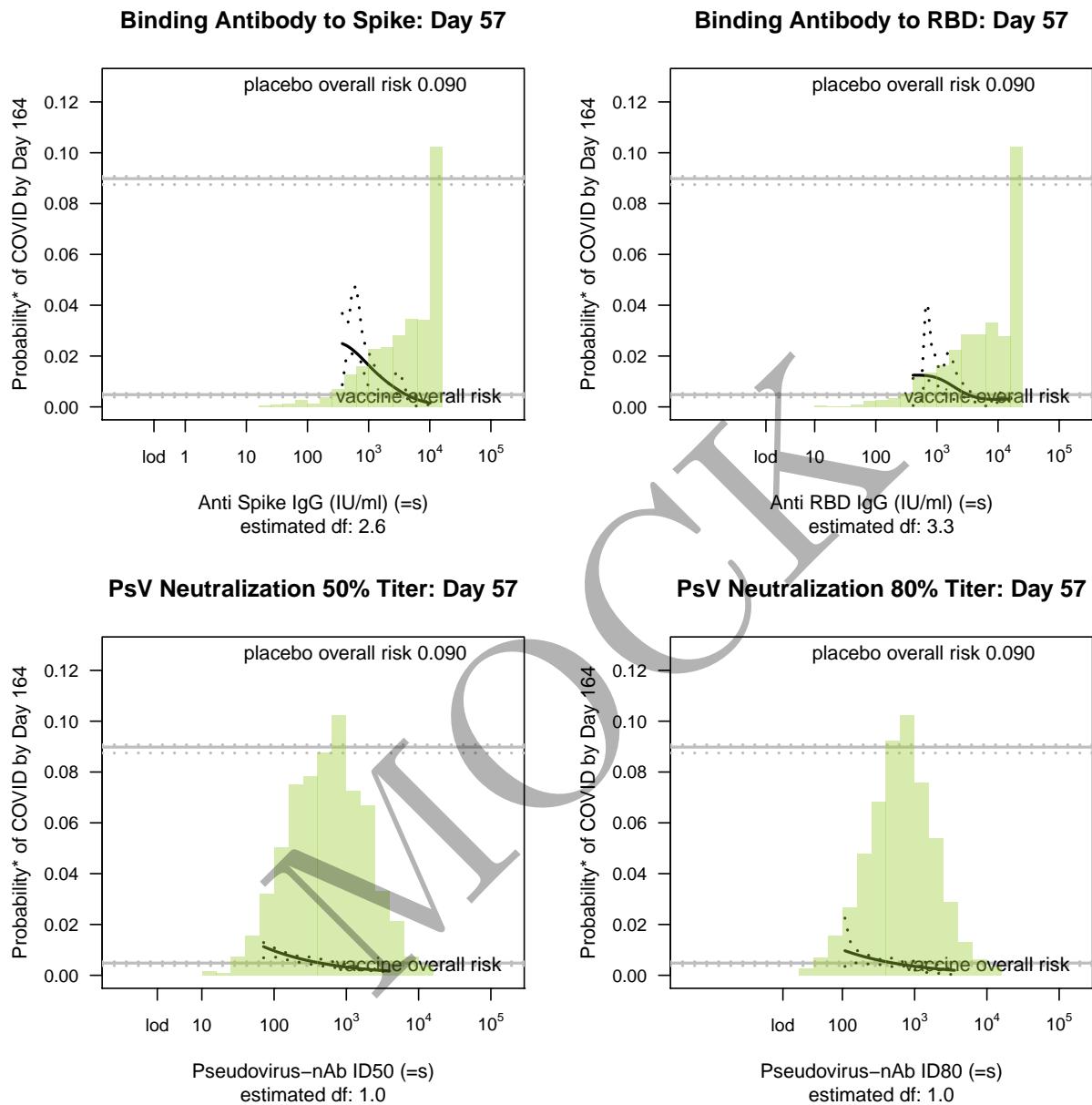


Figure 8.2: Marginalized risk as functions of Day 57 markers (=s) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates) as modeled by GAM with automatic smoothness estimation. The horizontal lines indicate the overall cumulative risk of the vaccine arm by Day 164 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4, 15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.

MOCK

Chapter 9

Day 29 Univariate CoR: Nonlinear modeling

To explore nonlinear association and threshold modeling, we fit smoothing spline models using the mgcv R package and two-phase models using the chngpt R package.

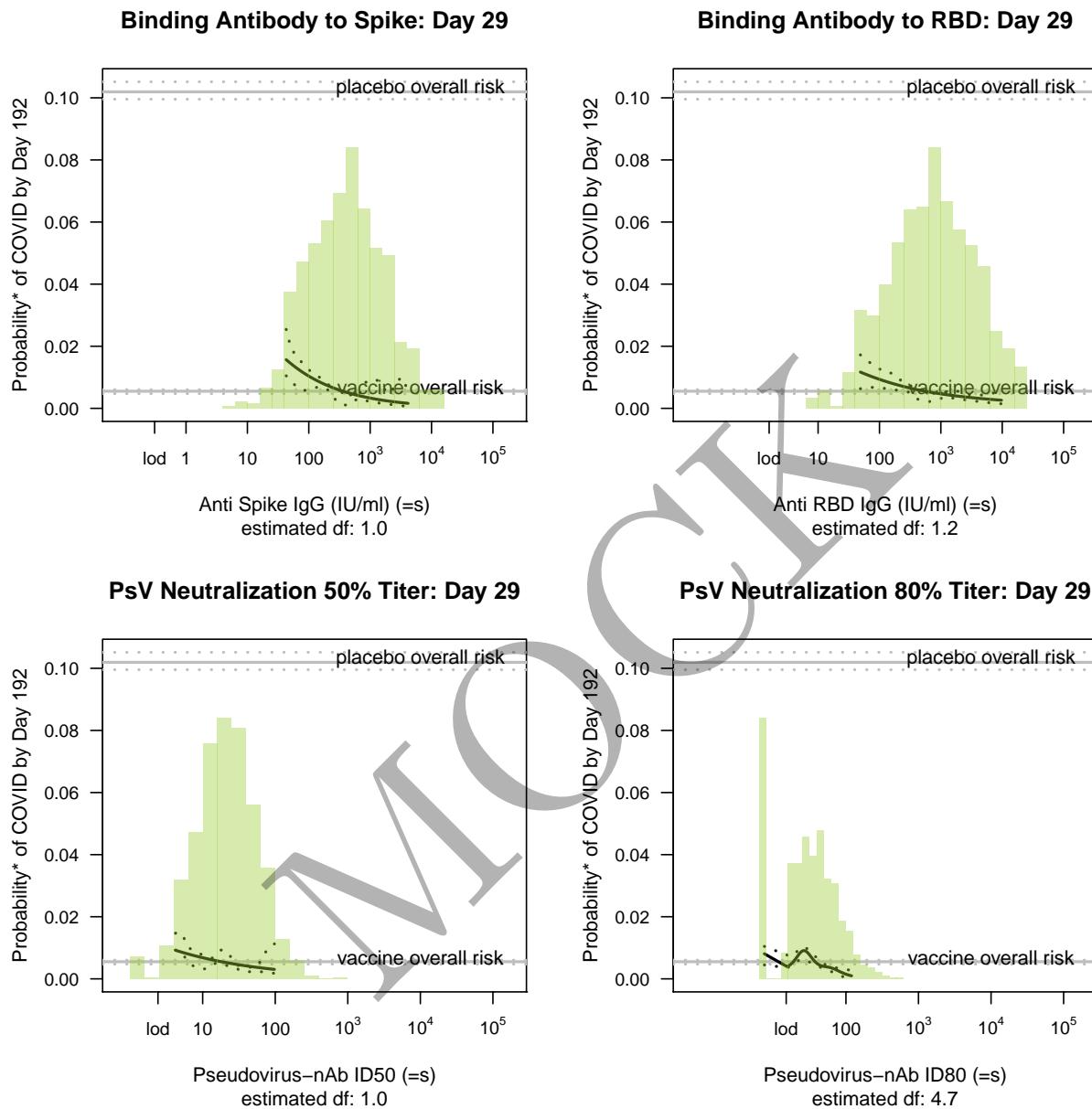


Figure 9.1: Marginalized risk as functions of Day 29 markers ($=s$) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates) as modeled by GAM with automatic smoothness estimation. The horizontal lines indicate the overall cumulative risk of the vaccine and placebo arms by Day 192 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. $lod = 0.3, 1.6, 2.4, 15$ for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.

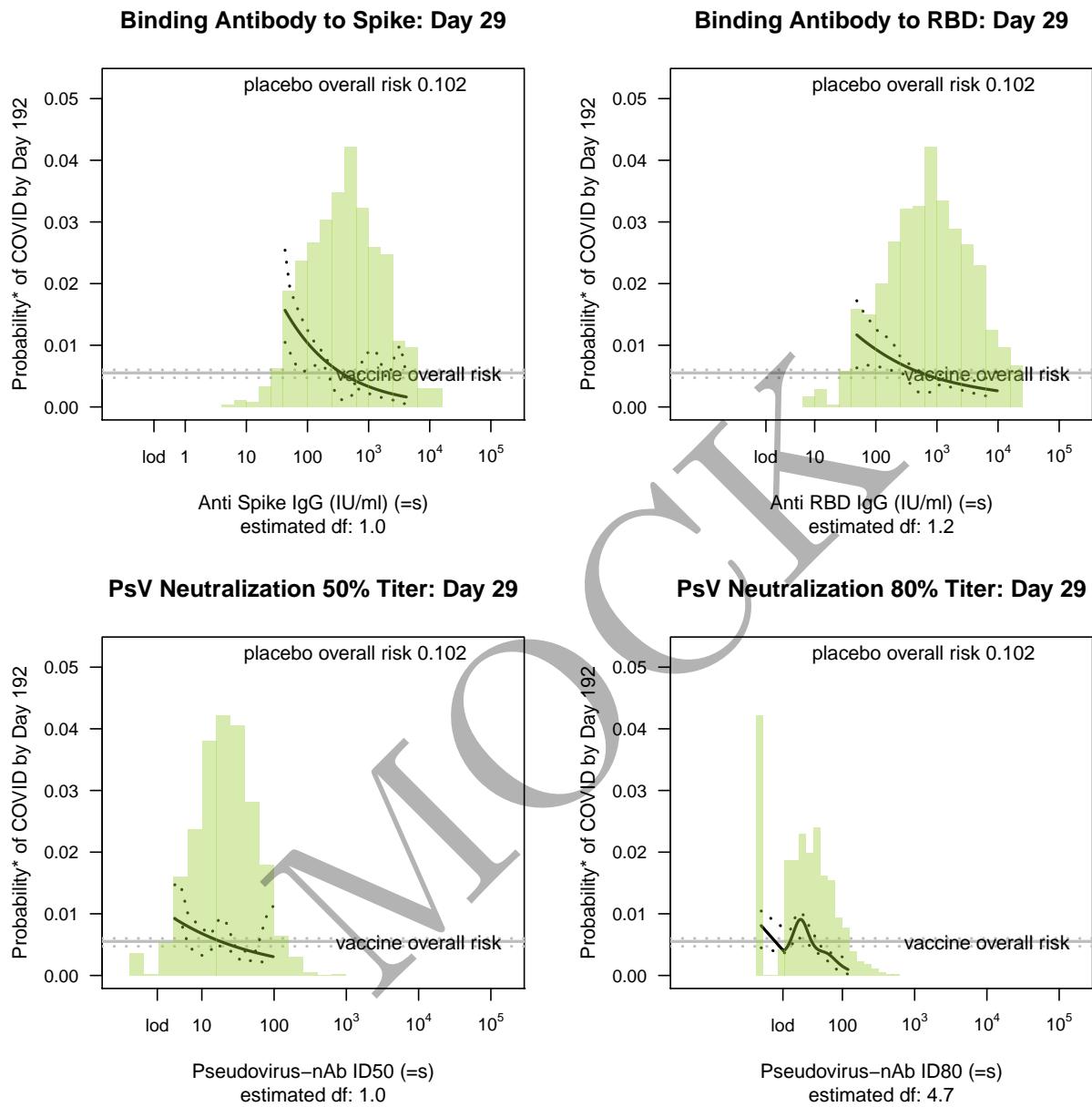


Figure 9.2: Marginalized risk as functions of Day 29markers (=s) among baseline seronegative vaccine recipients with 95% bootstrap point-wise confidence bands (5 replicates) as modeled by GAM with automatic smoothness estimation. The horizontal lines indicate the overall cumulative risk of the vaccine arm by Day 192 and its 95% point-wise confidence interval. Histograms of the immunological markers in the vaccine arm are overlaid. lod = 0.3, 1.6, 2.4, 15 for bAb Spike, bAb RBD, PsV nAb ID50, PsV nAb ID80, respectively.

MOCK

Chapter 10

Appendix

- This report was built from the [CoVPN/correlates_reporting](#) repository with commit hash 24ed61884c57033177845492cccb7a2820196bd2. A diff of the changes introduced by that commit may be viewed at https://github.com/CoVPN/correlates_reporting/commit/24ed61884c57033177845492cccb7a2820196bd2
- The sha256 hash sum of the raw input file, “COVID_VEtiral_practicedata_primarystage1.csv”: 83d0f55d1745ffd42be124d8f9ec9a9903abcc13cd22f95e537542a08b41300a
- The sha256 hash sum of the processed file, “moderna_mock_data_processed.csv”: 28964ce20cfcd70a621aff9df412c42b11