**Supplemental Data Table S1.** Positive rates of T-cell response assays and S antibody assays according to subgroups

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Assay** | **ChAdOx1/BNT162b2 group (N = 29)** | **BNT162b2 group (N = 27)** | **BI group\*****(N = 33)** | **Total****(N = 89)** | ***P*†** |
| In-house ELISPOT  | SW | 48.0% | 80.8% | 93.8% | 75.9% | 0.014 |
|  | SO | 84.0% | 84.6% | 100% | 90.4% | NS |
|  | NW | 0.0% | 7.7% | 75.0% | 29.9% | NS |
|  | NO | 0.0% | 7.7% | 62.5% | 25.3% | NS |
| T-SPOT.COVID  | Panel A | 62.1% | 59.3% | 87.9% | 70.8% | NS |
|  | Panel B | 0.0% | 0.0% | 51.5% | 19.1% | NS |
| QuantiFERON IGRA | Ag1 | 64.3% | 42.3% | 84.8% | 65.5% | NS |
|  | Ag2 | 71.4% | 65.4% | 97.0% | 79.3% | NS |
|  | Total (Ag1 and Ag2) | 71.4% | 65.4% | 97.0% | 79.3% | NS |
| Euroimmun IGRA |  | 96.3% | 96.2% | 100% | 97.7% | NS |
| Abbott IgG II Quant |  | 100% | 100% | 100% | 100% | NA |
| Elecsys Anti-S |  | 100% | 100% | 100% | 100% | NA |

\*Significantly higher positive rates in the BI group than in the noninfected group except for Euroimmun IGRA (*P* value not shown).

†Chi-square or Fisher’s exact test (ChAdOx1/BNT162b2 group vs. BNT162b2 group).

Abbreviations: S, spike; BI, breakthrough infection; NS, not significant; NA, not applicable; SW, S protein of wild-type virus; SO, S protein of the Omicron variant; NW, nucleocapsid protein of wild-type virus; NO, nucleocapsid protein of the Omicron variant; IGRA, interferon-gamma release assay.

**Supplemental Data Table S2.** Correlations among T-cell response assays and S antibody assays in the BI and noninfected groups

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Assay**  | **In-house ELISPOT** |  | **T-SPOT.COVID** |  | **QuantiFERON IGRA** | **Euroimmun IGRA** | **Abbott IgG II Quant** |
| **SW** | **SO** | **NW** | **NO** |  | **A** | **B** |  | **Ag1** | **Ag2** |
| In-house ELISPOT | SO | 0.46\*\* |  |  |  |  |  |  |  |  |  |  |  |
|  | 0.51\*\*\* |  |  |  |  |  |  |  |  |  |  |  |
|  | NW | 0.52\*\* | 0.54\*\* |  |  |  |  |  |  |  |  |  |  |
|  |  | –0.09 | 0.07 |  |  |  |  |  |  |  |  |  |  |
|  | NO | 0.45\*\* | 0.50\*\* | **0.84\*\*\*** |  |  |  |  |  |  |  |  |  |
|  |  | –0.05 | 0.11 | 0.53\*\*\* |  |  |  |  |  |  |  |  |  |
| T-SPOT.COVID | A | 0.52\*\* | **0.76\*\*\*** | **0.61\*\*\*** | 0.50\*\* |  |  |  |  |  |  |  |  |
|  |  | 0.34\* | 0.46\*\* | –0.16 | 0.02 |  |  |  |  |  |  |  |  |
|  | B | 0.49\*\* | 0.34 | **0.78\*\*\*** | **0.69\*\*\*** |  | 0.45\*\* |  |  |  |  |  |  |
|  |  | 0.02 | –0.02 | –0.04 | 0.18 |  | 0.06 |  |  |  |  |  |  |
| QuantiFERON IGRA | Ag1 | 0.06 | 0.28 | 0.06 | 0.07 |  | 0.27 | –0.06 |  |  |  |  |  |
|  | 0.32\* | 0.31\* | 0.09 | 0.16 |  | 0.46\*\*\* | –0.09 |  |  |  |  |  |
|  | Ag2 | 0.08 | 0.20 | –0.07 | –0.08 |  | 0.24 | –0.12 |  | **0.91\*\*\*** |  |  |  |
|  |  | 0.24 | 0.23 | 0.06 | 0.05 |  | 0.34\* | –0.16 |  | **0.85\*\*\*** |  |  |  |
| Euroimmun IGRA | S1 | 0.28 | 0.32 | 0.36\* | 0.27 |  | 0.45\*\* | 0.16 |  | **0.72\*\*** | **0.62\*\*\*** |  |  |
|  | 0.27 | 0.23 | 0.01 | 0.14 |  | 0.47\*\*\* | -0.16 |  | **0.75\*\*\*** | **0.60\*\*\*** |  |  |
| Abbott IgG II Quant |  | 0.16 | 0.15 | 0.34 | 0.20 |  | 0.32 | 0.47\*\* |  | 0.04 | 0.02 | 0.17 |  |
|  | 0.36\*\* | 0.08 | –0.07 | –0.02 |  | 0.12 | –0.12 |  | 0.13 | 0.17 | 0.18 |  |
| Elecsys Anti-S |  | 0.23 | 0.08 | 0.17 | 0.25 |  | 0.15 | 0.33 |  | –0.03 | –0.03 | 0.14 | **0.73\*\*\*** |
|  |  | 0.38\*\* | 0.12 | –0.09 | 0.04 |  | 0.34\* | –0.07 |  | 0.31\* | 0.18 | 0.30\* | **0.79\*\*\*** |

Each cell presents the correlation coefficient (ρ) and associated *P* value obtained using Spearman’s correlation test. \**P* < 0.05; \*\**P* < 0.01; \*\*\**P* < 0.001. 1st line: BI group (N = 33), 2nd line: noninfected group (N = 56). Significantly strong correlation (ρ ≥ 0.6) is shown in bold.

Abbreviations: S, spike; NS, not significant; NA, not applicable; SW, S protein of wild-type virus; SO, S protein of the Omicron variant; NW, nucleocapsid protein of wild-type virus; NO, nucleocapsid protein of the Omicron variant; IGRA, interferon-gamma release assay.

****

**Supplemental Data Figure S1.** Differences in T-cell responses and S antibody titers between the BI and noninfected groups (A) In-house ELISPOT, SW, (B) SO, (C) NW, (D) NO, (E) T-SPOT.COVID panel A, (F) T-SPOT.COVID panel B, (G) QuantiFERON IGRA Ag1, (H) QuantiFERON IGRA Ag2, (I) Euroimmun IGRA, (J) Abbott IgG II Quant, and (K) Elecsys Anti-S. The median value is shown above each box-and-whisker plot. For differences between the ChAdOx1/BNT162b2 and BNT162b2 groups, *P-*values obtained using the Mann–Whitney *U* test below 0.05 are presented. The T-cell responses obtained using in-house ELISPOT targeting SW and the antibody titers obtained using Abbott IgG II Quant were significantly higher in the BNT162b2 group than in the ChAdOx1/BNT162b2 group (*P* = 0.004 and 0.006, respectively), and the T-cell responses or the antibody titers obtained using the other assays did not significantly differ between the two groups.

Abbreviations: S, spike; SFCs, spot-forming cells; PBMCs, peripheral blood mononuclear cells; SW, S protein of wild-type virus; SO, S protein of the Omicron variant; NW, nucleocapsid protein of wild-type virus; NO, nucleocapsid protein of the Omicron variant.

 

**Supplemental Data Figure S2.** Comparison of T-cell responses to each stimulating peptide pool (SW; SO; NW; NO) of the in-house ELISPOT assay. (A) BI group (N = 33), (B) ChAdOx1/BNT162b2 group (N = 29), (C) and BNT162b2 group (N = 27). The median value is shown above each box-and-whisker plot. P-values obtained using the Wilcoxon signed-rank test below 0.05 are presented. The IFN-γ ELISPOT response to SW was lower than that to SO (P = 0.001) in the ChAdOx1/BNT162b2 group, but this difference was not observed in the BI or BNT162b2 groups.

Abbreviations: SFCs, spot-forming cells; PBMCs, peripheral blood mononuclear cells; SW, spike protein of wild-type virus; SO, spike protein of the Omicron variant; NW, nucleocapsid protein of wild-type virus; NO, nucleocapsid protein of the Omicron variant; NS, not significant.