Supplementary Material

Supplementary Figure 1. Sample selection flowchart — linked data from HealthVerity claims and Federal Retail Pharmacy Program for COVID-19 vaccination, United States, January 1, 2022–March 31, 2022

Inclusion Criteria:

**69,677,228** persons (49.5%) who received their primary vaccination series within the guidelinesa

Merged dataset

**140,738,610** persons with ≥1 dose

Inclusion Criteria:

**25,660,789** persons who satisfied one of the following vaccine schedule conditions:

* Ad26.COV2.S booster at least 60 days after Ad26.COV2.S primary series, OR
* Any mRNAb booster at least 60 days after Ad26.COV2.S primary series, OR
* Any mRNA booster at least 120 days after homologous mRNA primary series

Final Sample

**18,912,378** persons aged ≥18 years with known sex, without any diagnosis codes indicating immunocompromised status c, and who received a booster between September 23, 2021 and March 15, 2022

Excluded:

**6,748,411** unique persons with one or more of the following flags:

* Age at first vaccination date < 18 years   
   (n = **1,935,533**)
* Age at booster date was missing or unknown   
   (n = **7,761**)
* Missing or unknown sex   
   (n = **30,356**)
* Booster date before September 23, 2021 or after March 15, 2022   
   (n = **3,953,053**)
* Immunocompromised status3 (n = **2,817,955**)
* Recipients of two mRNA+ Ad26.COV2.S schedule (supplemental cohort, **n=12,259**)

HealthVerity medical and pharmacy claims December 1, 2020 – May 17, 2022

**71,270,067** persons with ≥1 dose

Federal Retail Pharmacy Program data December 1, 2020 – May 16, 2022

**111,465,857** persons with ≥1 dose

a For individuals who received an BNT162b2 Pfizer–BioNTech vaccine as their first dose, they were considered to have completed the primary series within guidelines if they received a second dose of BNT162b2 Pfizer–BioNTech 17 to 42 days after the first. For individuals who received an mRNA-1273 Moderna vaccine as their first dose, they were considered to have completed the primary series within guidelines if they received a second dose of mRNA-1273 Moderna 24 to 42 days after the first.

b BNT162b2 Pfizer–BioNTech or mRNA-1273 Moderna

c Individuals were classified as immunocompromised if they had, at any time in the available medical claims data, at least one ICD-10-CM code of solid malignancy (C00–C80, C7A, C7B, D3A, Z51.0, and Z51.1), hematologic malignancy (C81–C86, C88, C90–C96, D46, D61.0, D70.0, D61.2, D61.9, and D71), rheumatologic or inflammatory disorder (D86, E85 [except E85.0], G35, J67.9, L40.54, L40.59, L93.0, L93.2, L94, M05–M08, M30, M31.3, M31.5, M32–M34, M35.3, M35.8, M35.9, M46, and T78.40), other intrinsic immune condition or immunodeficiency (D27.9, D61.09, D72.89, D80, D81 [except D81.3], D82–D84, D89 [except D89.2], K70.3, K70.4, K72, K74.3–K74.6 [except K74.60 and K74.69], N04, and R18), or organ or stem cell transplant (T86 [except T86.82–T86.84, T86.89, and T86.9], D47.Z1, Z48.2, Z94, and Z98.85).

Supplementary Table 1. Underlying medical conditions — linked data from HealthVerity claims and Federal Retail Pharmacy Program for COVID-19 vaccination, United States, January 1, 2022 –March 31, 2022

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| --- | --- |
| **Condition** | **ICD Codes** |
| Asthma | J45, J45.2, J45.20, J45.21, J45.22, J45.3, J45.30, J45.31, J45.32, J45.4, J45.40, J45.41, J45.42, J45.5, J45.50, J45.51, J45.52, J45.9, J45.90, J45.901, J45.902, J45.909, J45.99, J45.990, J45.991, J45.998 |
| Cancer | C00, C00.0, C00.1, C00.2, C00.3, C00.4, C00.5, C00.6, C00.8, C00.9, C01, C02, C02.0, C02.1, C02.2, C02.3, C02.4, C02.8, C02.9, C03, C03.0, C03.1, C03.9, C04, C04.0, C04.1, C04.8, C04.9, C05, C05.0, C05.1, C05.2, C05.8, C05.9, C06, C06.0, C06.1, C06.2, C06.8, C06.80, C06.89, C06.9, C07, C08, C08.0, C08.1, C08.9, C09, C09.0, C09.1, C09.8, C09.9, C10, C10.0, C10.1, C10.2, C10.3, C10.4, C10.8, C10.9, C11, C11.0, C11.1, C11.2, C11.3, C11.8, C11.9, C12, C13, C13.0, C13.1, C13.2, C14, C14.0, C14.2, C14.8, C15, C15.3, C15.4, C15.5, C15.8, C15.9, C16, C16.0, C16.1, C16.2, C16.3, C16.4, C16.5, C16.6, C16.8, C16.9, C17, C17.0, C17.1, C17.2, C17.3, C17.8, C17.9, C18, C18.0, C18.1, C18.2, C18.3, C18.4, C18.5, C18.6, C18.7, C18.8, C18.9, C19, C20, C21, C21.0, C21.1, C21.2, C21.8, C22, C22.0, C22.1, C22.2, C22.3, C22.4, C22.7, C22.8, C22.9, C23, C24, C24.0, C24.1, C24.8, C24.9, C25, C25.0, C25.1, C25.2, C25.3, C25.4, C25.7, C25.8, C25.9, C26, C26.0, C26.1, C26.9, C30, C30.0, C30.1, C31, C31.0, C31.1, C31.2, C31.3, C31.8, C31.9, C32, C32.0, C32.1, C32.2, C32.3, C32.8, C32.9, C33, C34, C34.0, C34.00, C34.01, C34.02, C34.1, C34.10, C34.11, C34.12, C34.2, C34.3, C34.30, C34.31, C34.32, C34.8, C34.80, C34.81, C34.82, C34.9, C34.90, C34.91, C34.92, C37, C38, C38.0, C38.1, C38.2, C38.3, C38.4, C38.8, C39, C39.0, C39.9, C40, C40.0, C40.00, C40.01, C40.02, C40.1, C40.10, C40.11, C40.12, C40.2, C40.20, C40.21, C40.22, C40.3, C40.30, C40.31, C40.32, C40.8, C40.80, C40.81, C40.82, C40.9, C40.90, C40.91, C40.92, C41, C41.0, C41.1, C41.2, C41.3, C41.4, C41.9, C43, C43.0, C43.1, C43.10, C43.11, C43.111, C43.112, C43.12, C43.121, C43.122, C43.2, C43.20, C43.21, C43.22, C43.3, C43.30, C43.31, C43.39, C43.4, C43.5, C43.51, C43.52, C43.59, C43.6, C43.60, C43.61, C43.62, C43.7, C43.70, C43.71, C43.72, C43.8, C43.9, C45, C45.0, C45.1, C45.2, C45.7, C45.9, C46, C46.0, C46.1, C46.2, C46.3, C46.4, C46.5, C46.50, C46.51, C46.52, C46.7, C46.9, C47, C47.0, C47.1, C47.10, C47.11, C47.12, C47.2, C47.20, C47.21, C47.22, C47.3, C47.4, C47.5, C47.6, C47.8, C47.9, C48, C48.0, C48.1, C48.2, C48.8, C49, C49.0, C49.1, C49.10, C49.11, C49.12, C49.2, C49.20, C49.21, C49.22, C49.3, C49.4, C49.5, C49.6, C49.8, C49.9, C49.A, C49.A0, C49.A1, C49.A2, C49.A3, C49.A4, C49.A5, C49.A9, C50, C50.0, C50.01, C50.011, C50.012, C50.019, C50.02, C50.021, C50.022, C50.029, C50.1, C50.11, C50.111, C50.112, C50.119, C50.12, C50.121, C50.122, C50.129, C50.2, C50.21, C50.211, C50.212, C50.219, C50.22, C50.221, C50.222, C50.229, C50.3, C50.31, C50.311, C50.312, C50.319, C50.32, C50.321, C50.322, C50.329, C50.4, C50.41, C50.411, C50.412, C50.419, C50.42, C50.421, C50.422, C50.429, C50.5, C50.51, C50.511, C50.512, C50.519, C50.52, C50.521, C50.522, C50.529, C50.6, C50.61, C50.611, C50.612, C50.619, C50.62, C50.621, C50.622, C50.629, C50.8, C50.81, C50.811, C50.812, C50.819, C50.82, C50.821, C50.822, C50.829, C50.9, C50.91, C50.911, C50.912, C50.919, C50.92, C50.921, C50.922, C50.929, C51, C51.0, C51.1, C51.2, C51.8, C51.9, C52, C53, C53.0, C53.1, C53.8, C53.9, C54, C54.0, C54.1, C54.2, C54.3, C54.8, C54.9, C55, C56, C56.1, C56.2, C56.9, C57, C57.0, C57.00, C57.01, C57.02, C57.1, C57.10, C57.11, C57.12, C57.2, C57.20, C57.21, C57.22, C57.3, C57.4, C57.7, C57.8, C57.9, C58, C60, C60.0, C60.1, C60.2, C60.8, C60.9, C61, C62, C62.0, C62.00, C62.01, C62.02, C62.1, C62.10, C62.11, C62.12, C62.9, C62.90, C62.91, C62.92, C63, C63.0, C63.00, C63.01, C63.02, C63.1, C63.10, C63.11, C63.12, C63.2, C63.7, C63.8, C63.9, C64, C64.1, C64.2, C64.9, C65, C65.1, C65.2, C65.9, C66, C66.1, C66.2, C66.9, C67, C67.0, C67.1, C67.2, C67.3, C67.4, C67.5, C67.6, C67.7, C67.8, C67.9, C68, C68.0, C68.1, C68.2, C68.8, C68.9, C69, C69.0, C69.00, C69.01, C69.02, C69.1, C69.10, C69.11, C69.12, C69.2, C69.20, C69.21, C69.22, C69.3, C69.30, C69.31, C69.32, C69.4, C69.40, C69.41, C69.42, C69.5, C69.50, C69.51, C69.52, C69.6, C69.60, C69.61, C69.62, C69.8, C69.80, C69.81, C69.82, C69.9, C69.90, C69.91, C69.92, C70, C70.0, C70.1, C70.9, C71, C71.0, C71.1, C71.2, C71.3, C71.4, C71.5, C71.6, C71.7, C71.8, C71.9, C72, C72.0, C72.1, C72.2, C72.20, C72.21, C72.22, C72.3, C72.30, C72.31, C72.32, C72.4, C72.40, C72.41, C72.42, C72.5, C72.50, C72.59, C72.9, C73, C74, C74.0, C74.00, C74.01, C74.02, C74.1, C74.10, C74.11, C74.12, C74.9, C74.90, C74.91, C74.92, C75, C75.0, C75.1, C75.2, C75.3, C75.4, C75.5, C75.8, C75.9, C76, C76.0, C76.1, C76.2, C76.3, C76.4, C76.40, C76.41, C76.42, C76.5, C76.50, C76.51, C76.52, C76.8, C77, C77.0, C77.1, C77.2, C77.3, C77.4, C77.5, C77.8, C77.9, C78, C78.0, C78.00, C78.01, C78.02, C78.1, C78.2, C78.3, C78.30, C78.39, C78.4, C78.5, C78.6, C78.7, C78.8, C78.80, C78.89, C79, C79.0, C79.00, C79.01, C79.02, C79.1, C79.10, C79.11, C79.19, C79.2, C79.3, C79.31, C79.32, C79.4, C79.40, C79.49, C79.5, C79.51, C79.52, C79.6, C79.60, C79.61, C79.62, C79.7, C79.70, C79.71, C79.72, C79.8, C79.81, C79.82, C79.89, C79.9, C80, C80.0, C80.1, C80.2, C7A, C7A.0, C7A.00, C7A.01, C7A.010, 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C85.10, C85.11, C85.12, C85.13, C85.14, C85.15, C85.16, C85.17, C85.18, C85.19, C85.2, C85.20, C85.21, C85.22, C85.23, C85.24, C85.25, C85.26, C85.27, C85.28, C85.29, C85.8, C85.80, C85.81, C85.82, C85.83, C85.84, C85.85, C85.86, C85.87, C85.88, C85.89, C85.9, C85.90, C85.91, C85.92, C85.93, C85.94, C85.95, C85.96, C85.97, C85.98, C85.99, C86, C86.0, C86.1, C86.2, C86.3, C86.4, C86.5, C86.6, C88, C88.0, C88.2, C88.3, C88.4, C88.8, C88.9, C90, C90.0, C90.00, C90.01, C90.02, C90.1, C90.10, C90.11, C90.12, C90.2, C90.20, C90.21, C90.22, C90.3, C90.30, C90.31, C90.32, C91, C91.0, C91.00, C91.01, C91.02, C91.1, C91.10, C91.11, C91.12, C91.3, C91.30, C91.31, C91.32, C91.4, C91.40, C91.41, C91.42, C91.5, C91.50, C91.51, C91.52, C91.6, C91.60, C91.61, C91.62, C91.A, C91.A0, C91.A1, C91.A2, C91.Z, C91.Z0, C91.Z1, C91.Z2, C91.9, C91.90, C91.91, C91.92, C92, C92.0, C92.00, C92.01, C92.02, C92.1, C92.10, C92.11, C92.12, C92.2, C92.20, C92.21, C92.22, C92.3, C92.30, C92.31, C92.32, C92.4, C92.40, C92.41, C92.42, C92.5, C92.50, C92.51, C92.52, C92.6, C92.60, C92.61, C92.62, C92.A, C92.A0, C92.A1, C92.A2, C92.Z, C92.Z0, C92.Z1, C92.Z2, C92.9, C92.90, C92.91, C92.92, C93, C93.0, C93.00, C93.01, C93.02, C93.1, C93.10, C93.11, C93.12, C93.3, C93.30, C93.31, C93.32, C93.Z, C93.Z0, C93.Z1, C93.Z2, C93.9, C93.90, C93.91, C93.92, C94, C94.0, C94.00, C94.01, C94.02, C94.2, C94.20, C94.21, C94.22, C94.3, C94.30, C94.31, C94.32, C94.4, C94.40, C94.41, C94.42, C94.6, C94.8, C94.80, C94.81, C94.82, C95, C95.0, C95.00, C95.01, C95.02, C95.1, C95.10, C95.11, C95.12, C95.9, C95.90, C95.91, C95.92, C96, C96.0, C96.2, C96.20, C96.21, C96.22, C96.29, C96.4, C96.5, C96.6, C96.A, C96.Z, C96.9, D00, D00.0, D00.00, D00.01, D00.02, D00.03, D00.04, D00.05, D00.06, D00.07, D00.08, D00.1, D00.2, D01, D01.0, D01.1, D01.2, D01.3, D01.4, D01.40, D01.49, D01.5, D01.7, D01.9, D02, D02.0, D02.1, D02.2, D02.20, D02.21, D02.22, D02.3, D02.4, D03, D03.0, D03.1, D03.10, D03.11, D03.111, D03.112, D03.12, D03.121, D03.122, D03.2, D03.20, D03.21, D03.22, D03.3, D03.30, D03.39, D03.4, D03.5, D03.51, D03.52, D03.59, D03.6, D03.60, D03.61, D03.62, D03.7, D03.70, D03.71, D03.72, D03.8, D03.9, D04, D04.0, D04.1, D04.10, D04.11, D04.111, D04.112, D04.12, D04.121, D04.122, D04.2, D04.20, D04.21, D04.22, D04.3, D04.30, D04.39, D04.4, D04.5, D04.6, D04.60, D04.61, D04.62, D04.7, D04.70, D04.71, D04.72, D04.8, D04.9, D05, D05.0, D05.00, D05.01, D05.02, D05.1, D05.10, D05.11, D05.12, D05.8, D05.80, D05.81, D05.82, D05.9, D05.90, D05.91, D05.92, D06, D06.0, D06.1, D06.7, D06.9, D07, D07.0, D07.1, D07.2, D07.3, D07.30, D07.39, D07.4, D07.5, D07.6, D07.60, D07.61, D07.69, D09, D09.0, D09.1, D09.10, D09.19, D09.2, D09.20, D09.21, D09.22, D09.3, D09.8, D09.9 |
| Cardiac congenital malformations | Q20.0, Q20.1, Q20.2, Q20.3, Q20.4, Q20.5, Q20.6, Q20.8, Q20.9, Q21.0, Q21.1, Q21.2, Q21.3, Q21.4, Q21.8, Q21.9, Q22.0, Q22.1, Q22.2, Q22.3, Q22.4, Q22.5, Q22.6, Q22.8, Q22.9, Q23.0, Q23.1, Q23.2, Q23.3, Q23.4, Q23.8, Q23.9, Q24.0, Q24.1, Q24.2, Q24.3, Q24.4, Q24.5, Q24.6, Q24.8, Q24.9, Q25.0, Q25.1, Q25.2, Q25.21, Q25.29, Q25.3, Q25.4, Q25.40, Q25.41, Q25.42, Q25.43, Q25.44, Q25.45, Q25.46, Q25.47, Q25.48, Q25.49, Q25.5, Q25.6, Q25.71, Q25.72, Q25.79, Q25.8, Q25.9, Q26.0, Q26.1, Q26.2, Q26.3, Q26.4, Q26.5, Q26.6, Q26.8, Q26.9, Q27.0, Q27.1, Q27.2, Q27.30, Q27.31, Q27.32, Q27.33, Q27.34, Q27.39, Q27.4, Q27.8, Q27.9, Q28.0, Q28.1, Q28.2, Q28.3, Q28.8, Q28.9 |
| Cerebrovascular disease | I69, I69.01, I69.011, I69.012, I69.013, I69.014, I69.015, I69.018, I69.019, I69.02, I69.021, I69.022, I69.023, I69.028, I69.03, I69.031, I69.032, I69.033, I69.034, I69.039, I69.04, I69.041, I69.042, I69.043, I69.044, I69.049, I69.05, I69.051, I69.052, I69.053, I69.054, I69.059, I69.06, I69.061, I69.062, I69.063, I69.064, I69.065, I69.069, I69.09, I69.091, I69.092, I69.093, I69.098, I69.1, I69.11, I69.111, I69.112, I69.113, I69.114, I69.115, I69.118, I69.119, I69.12, I69.121, I69.122, I69.123, I69.128, I69.13, I69.131, I69.132, I69.133, I69.134, I69.139, I69.14, I69.141, I69.142, I69.143, I69.144, I69.149, I69.15, I69.151, I69.152, I69.153, I69.154, I69.159, I69.16, I69.161, I69.162, I69.163, I69.164, I69.165, I69.169, I69.19, I69.191, I69.192, I69.193, I69.198, I69.2, I69.21, I69.211, I69.212, I69.213, I69.214, I69.215, I69.218, I69.219, I69.22, I69.221, I69.222, I69.223, I69.228, I69.23, I69.231, I69.232, I69.233, I69.234, I69.239, I69.24, I69.241, I69.242, I69.243, I69.244, I69.249, I69.25, I69.251, I69.252, I69.253, I69.254, I69.259, I69.26, I69.261, I69.262, I69.263, I69.264, I69.265, I69.269, I69.29, I69.291, I69.292, I69.293, I69.298, I69.3, I69.31, I69.311, I69.312, I69.313, I69.314, I69.315, I69.318, I69.319, I69.32, I69.321, I69.322, I69.323, I69.328, I69.33, I69.331, I69.332, I69.333, I69.334, I69.339, I69.34, I69.341, I69.342, I69.343, I69.344, I69.349, I69.35, I69.351, I69.352, I69.353, I69.354, I69.359, I69.36, I69.361, I69.362, I69.363, I69.364, I69.365, I69.369, I69.39, I69.391, I69.392, I69.393, I69.398, I69.8, I69.81, I69.811, I69.812, I69.813, I69.814, I69.815, I69.818, I69.819, I69.82, I69.821, I69.822, I69.823, I69.828, I69.83, I69.831, I69.832, I69.833, I69.834, I69.839, I69.84, I69.841, I69.842, I69.843, I69.844, I69.849, I69.85, I69.851, I69.852, I69.853, I69.854, I69.859, I69.86, I69.861, I69.862, I69.863, I69.864, I69.865, I69.869, I69.89, I69.891, I69.892, I69.893, I69.898, I69.9, I69.91, I69.911, I69.912, I69.913, I69.914, I69.915, I69.918, I69.919, I69.92, I69.921, I69.922, I69.923, I69.928, I69.93, I69.931, I69.932, I69.933, I69.934, I69.939, I69.94, I69.941, I69.942, I69.943, I69.944, I69.949, I69.95, I69.951, I69.952, I69.953, I69.954, I69.959, I69.96, I69.961, I69.962, I69.963, I69.964, I69.965, I69.969, I69.99, I69.991, I69.992, I69.993, I69.998, I60, I60.0, I60.00, I60.01, I60.02, I60.1, I60.10, I60.11, I60.12, I60.2, I60.3, I60.30, I60.31, I60.32, I60.4, I60.5, I60.50, I60.51, I60.52, I60.6, I60.7, I60.8, I60.9, I61, I61.0, I61.1, I61.2, I61.3, I61.4, I61.5, I61.6, I61.8, I61.9, I62, I62.0, I62.00, I62.01, I62.02, I62.03, I62.1, I62.9, I63, I63.01, I63.011, I63.012, I63.013, I63.019, I63.02, I63.03, I63.031, I63.032, I63.033, I63.039, I63.09, I63.1, I63.11, I63.111, I63.112, I63.113, I63.119, I63.12, I63.13, I63.131, I63.132, I63.133, I63.139, I63.19, I63.2, I63.21, I63.211, I63.212, I63.213, I63.219, I63.22, I63.23, I63.231, I63.232, I63.233, I63.239, I63.29, I63.3, I63.31, I63.311, I63.312, I63.313, I63.319, I63.32, I63.321, I63.322, I63.323, I63.329, I63.33, I63.331, I63.332, I63.333, I63.339, I63.34, I63.341, I63.342, I63.343, I63.349, I63.39, I63.4, I63.41, I63.411, I63.412, I63.413, I63.419, I63.42, I63.421, I63.422, I63.423, I63.429, I63.43, I63.431, I63.432, I63.433, I63.439, I63.44, I63.441, I63.442, I63.443, I63.449, I63.49, I63.5, I63.51, I63.511, I63.512, I63.513, I63.519, I63.52, I63.521, I63.522, I63.523, I63.529, I63.53, I63.531, I63.532, I63.533, I63.539, I63.54, I63.541, I63.542, I63.543, I63.549, I63.59, I63.6, I63.8, I63.81, I63.89, I63.9, I65, I65.01, I65.02, I65.03, I65.09, I65.1, I65.2, I65.21, I65.22, I65.23, I65.29, I65.8, I65.9, I66, I66.0, I66.01, I66.02, I66.03, I66.09, I66.1, I66.11, I66.12, I66.13, I66.19, I66.2, I66.21, I66.22, I66.23, I66.29, I66.3, I66.8, I66.9, I67, I67.0, I67.1, I67.2, I67.3, I67.4, I67.5, I67.6, I67.7, I67.8, I67.81, I67.82, I67.83, I67.84, I67.841, I67.848, I67.85, I67.858, I67.89, I67.9, I68, I68.0, I68.2, I68.8 |
| Chromosomal abnormalities | Q91.0, Q91.1, Q91.2, Q91.3, Q91.4, Q91.5, Q91.6, Q91.7, Q92.0, Q92.1, Q92.2, Q92.5, Q92.61, Q92.62, Q92.7, Q92.8, Q92.9, Q93.0, Q93.1, Q93.2, Q93.3, Q93.4, Q93.5, Q93.51, Q93.59, Q93.7, Q93.81, Q93.82, Q93.88, Q93.89, Q93.9, Q95.0, Q95.1, Q95.2, Q95.3, Q95.5, Q95.8, Q95.9, Q96.0, Q96.1, Q96.2, Q96.3, Q96.4, Q96.8, Q96.9, Q97.0, Q97.1, Q97.2, Q97.3, Q97.8, Q97.9, Q98.0, Q98.1, Q98.3, Q98.4, Q98.5, Q98.6, Q98.7, Q98.8, Q98.9, Q99.0, Q99.1, Q99.2, Q99.8, Q99.9 |
| Chronic kidney disease | N03.A, N04, N04.0, N04.1, N04.2, N04.3, N04.4, N04.5, N04.6, N04.7, N04.8, N04.9, N04.A, N05, N05.0, N05.1, N05.2, N05.3, N05.4, N05.5, N05.6, N05.7, N05.8, N05.9, N05.A, N06, N06.0, N06.1, N06.2, N06.3, N06.4, N06.5, N06.6, N06.7, N06.8, N06.9, N06.A, N07, N07.0, N07.1, N07.2, N07.3, N07.4, N07.5, N07.6, N07.7, N07.8, N07.9, N07.A, N08, N11, N11.0, N11.1, N11.8, N11.9, N12, N14, N14.0, N14.1, N14.2, N14.3, N14.4, N15, N15.0, N15.1, N15.8, N15.9, N16, N17, N17.0, N17.1, N17.2, N17.8, N17.9, N18, N18.1, N18.2, N18.3, N18.30, N18.31, N18.32, N18.4, N18.5, N18.6, N18.9, N19, N25, N26.1, N26.9, O26.83, Q61, Q61.0, Q61.00, Q61.01, Q61.02, Q61.1, Q61.11, Q61.19, Q61.2, Q61.3, Q61.4, Q61.5, Q61.8, Q61.9 |
| Chronic obstructive pulmonary disease (COPD) | J44, J44.0, J44.1, J44.9 |
| Cystic fibrosis | E84, E84.0, E84.1, E84.11, E84.19, E84.8, E84.9 |
| Type 1 diabetes | E10, E10.1, E10.10, E10.11, E10.2, E10.21, E10.22, E10.29, E10.3, E10.31, E10.311, E10.319, E10.32, E10.321, E10.3211, E10.3212, E10.3213, E10.3219, E10.329, E10.3291, E10.3292, E10.3293, E10.3299, E10.33, E10.331, E10.3311, E10.3312, E10.3313, E10.3319, E10.339, E10.3391, E10.3392, E10.3393, E10.3399, E10.34, E10.341, E10.3411, E10.3412, E10.3413, E10.3419, E10.349, E10.3491, E10.3492, E10.3493, E10.3499, E10.35, E10.351, E10.3511, E10.3512, E10.3513, E10.3519, E10.352, E10.3521, E10.3522, E10.3523, E10.3529, E10.353, E10.3531, E10.3532, E10.3533, E10.3539, E10.354, E10.3541, E10.3542, E10.3543, E10.3549, E10.355, E10.3551, E10.3552, E10.3553, E10.3559, E10.359, E10.3591, E10.3592, E10.3593, E10.3599, E10.36, E10.37, E10.37X1, E10.37X2, E10.37X3, E10.37X9, E10.39, E10.4, E10.40, E10.41, E10.42, E10.43, E10.44, E10.49, E10.5, E10.51, E10.52, E10.59, E10.6, E10.61, E10.610, E10.618, E10.62, E10.620, E10.621, E10.622, E10.628, E10.63, E10.630, E10.638, E10.64, E10.641, E10.649, E10.65, E10.69, E10.8, E10.9 |
| Type 2 diabetes | E11.0, E11.00, E11.01, E11.1, E11.10, E11.11, E11.2, E11.21, E11.22, E11.29, E11.3, E11.31, E11.311, E11.319, E11.32, E11.321, E11.3211, E11.3212, E11.3213, E11.3219, E11.329, E11.3291, E11.3292, E11.3293, E11.3299, E11.33, E11.331, E11.3311, E11.3312, E11.3313, E11.3319, E11.339, E11.3391, E11.3392, E11.3393, E11.3399, E11.34, E11.341, E11.3411, E11.3412, E11.3413, E11.3419, E11.349, E11.3491, E11.3492, E11.3493, E11.3499, E11.35, E11.351, E11.3511, E11.3512, E11.3513, E11.3519, E11.352, E11.3521, E11.3522, E11.3523, E11.3529, E11.353, E11.3531, E11.3532, E11.3533, E11.3539, E11.354, E11.3541, E11.3542, E11.3543, E11.3549, E11.355, E11.3551, E11.3552, E11.3553, E11.3559, E11.359, E11.3591, E11.3592, E11.3593, E11.3599, E11.36, E11.37, E11.37X1, E11.37X2, E11.37X3, E11.38X9, E11.39, E11.4, E11.40, E11.41, E11.42, E11.43, E11.44, E11.49, E11.5, E11.51, E11.52, E11.59, E11.6, E11.61, E11.610, E11.618, E11.62, E11.620, E11.621, E11.622, E11.628, E11.63, E11.630, E11.638, E11.64, E11.641, E11.649, E11.65, E11.69, E11.8, E11.9 |
| Digestive congenital malformations | Q38.0, Q38.1, Q38.2, Q38.3, Q38.4, Q38.5, Q38.6, Q38.7, Q38.8, Q39.0, Q39.1, Q39.2, Q39.3, Q39.4, Q39.5, Q39.6, Q39.8, Q39.9, Q40.0, Q40.1, Q40.2, Q40.3, Q40.8, Q40.9, Q41.0, Q41.1, Q41.2, Q41.8, Q41.9, Q42.0, Q42.1, Q42.2, Q42.3, Q42.8, Q42.9, Q43.0, Q43.1, Q43.2, Q43.3, Q43.4, Q43.5, Q43.6, Q43.7, Q43.8, Q43.9, Q44.0, Q44.1, Q44.2, Q44.3, Q44.4, Q44.5, Q44.6, Q44.7, Q45.0, Q45.1, Q45.2, Q45.3, Q45.8, Q45.9 |
| Down syndrome | Q90, Q90.0, Q90.1, Q90.2, Q90.9 |
| Epilepsy | G40.001, G40.009, G40.011, G40.019, G40.101, G40.109, G40.111, G40.119, G40.201, G40.209, G40.211, G40.219, G40.301, G40.309, G40.311, G40.319, G40.401, G40.409, G40.411, G40.419, G40.42, G40.501, G40.509, G40.801, G40.802, G40.803, G40.804, G40.811, G40.812, G40.813, G40.814, G40.821, G40.822, G40.823, G40.824, G40.833, G40.834, G40.89, G40.901, G40.909, G40.911, G40.919, G40.A01, G40.A09, G40.A11, G40.A19, G40.B01, G40.B09, G40.B11, G40.B19, R56.00, R56.01, R56.1, R56.9 |
| Congenital malformations of eye, ear, face and neck | Q10.0, Q10.1, Q10.2, Q10.3, Q10.4, Q10.5, Q10.6, Q10.7, Q11.0, Q11.1, Q11.2, Q11.3, Q12.0, Q12.1, Q12.2, Q12.3, Q12.4, Q12.8, Q12.9, Q13.0, Q13.1, Q13.2, Q13.3, Q13.4, Q13.5, Q13.81, Q13.89, Q13.9, Q14.0, Q14.1, Q14.2, Q14.3, Q14.8, Q14.9, Q15.0, Q15.8, Q15.9, Q16.0, Q16.1, Q16.2, Q16.3, Q16.4, Q16.5, Q16.9, Q17.0, Q17.1, Q17.2, Q17.3, Q17.4, Q17.5, Q17.8, Q17.9, Q18.0, Q18.1, Q18.2, Q18.3, Q18.4, Q18.5, Q18.6, Q18.7, Q18.8, Q18.9, Q35.1, Q35.3, Q35.5, Q35.7, Q35.9, Q36.0, Q36.1, Q36.9, Q37.0, Q37.1, Q37.2, Q37.3, Q37.4, Q37.5, Q37.8, Q37.9 |
| Fibrosis | J84.10, J84.112 |
| Genitourinary congenital malformations | Q50.01, Q50.02, Q50.1, Q50.2, Q50.31, Q50.32, Q50.39, Q50.4, Q50.5, Q50.6, Q51.0, Q51.10, Q51.11, Q51.2, Q51.20, Q51.21, Q51.22, Q51.28, Q51.3, Q51.4, Q51.5, Q51.6, Q51.7, Q51.810, Q51.811, Q51.818, Q51.820, Q51.821, Q51.828, Q51.9, Q52.0, Q52.10, Q52.11, Q52.12, Q52.120, Q52.121, Q52.122, Q52.123, Q52.124, Q52.129, Q52.2, Q52.3, Q52.4, Q52.5, Q52.6, Q52.70, Q52.71, Q52.79, Q52.8, Q52.9, Q53.00, Q53.01, Q53.02, Q53.10, Q53.11, Q53.111, Q53.112, Q53.12, Q53.13, Q53.20, Q53.21, Q53.211, Q53.212, Q53.22, Q53.23, Q53.9, Q54.0, Q54.1, Q54.2, Q54.3, Q54.4, Q54.8, Q54.9, Q55.0, Q55.1, Q55.20, Q55.21, Q55.22, Q55.23, Q55.29, Q55.3, Q55.4, Q55.5, Q55.61, Q55.62, Q55.63, Q55.64, Q55.69, Q55.7, Q55.8, Q55.9, Q56.0, Q56.1, Q56.2, Q56.3, Q56.4, Q60.0, Q60.1, Q60.2, Q60.3, Q60.4, Q60.5, Q60.6, Q62.0, Q62.10, Q62.11, Q62.12, Q62.2, Q62.31, Q62.32, Q62.39, Q62.4, Q62.5, Q62.60, Q62.61, Q62.62, Q62.63, Q62.69, Q62.7, Q62.8, Q63.0, Q63.1, Q63.2, Q63.3, Q63.8, Q63.9, Q64.0, Q64.10, Q64.11, Q64.12, Q64.19, Q64.2, Q64.31, Q64.32, Q64.33, Q64.39, Q64.4, Q64.5, Q64.6, Q64.70, Q64.71, Q64.72, Q64.73, Q64.74, Q64.75, Q64.79, Q64.8, Q64.9 |
| Heart disease | I21, I21.0, I21.01, I21.02, I21.09, I21.1, I21.11, I21.19, I21.2, I21.21, I21.29, I21.3, I21.4, I21.9, I21.A, I21.A1, I21.A9, I22, I22.0, I22.1, I22.2, I22.8, I22.9, I23, I23.0, I23.1, I23.2, I23.3, I23.4, I23.5, I23.6, I23.7, I23.8, I24, I24.0, I24.1, I24.8, I24.9, I25, I25.1, I25.10, I25.11, I25.110, I25.111, I25.1108, I25.119, I25.2, I25.3, I25.4, I25.41, I25.42, I25.5, I25.6, I25.7, I25.70, I25.700, I25.701, I25.708, I25.709, I25.71, I25.710, I25.711, I25.718, I25.719, I25.72, I25.720, I25.721, I25.728, I25.729, I25.73, I25.730, I25.731, I25.738, I25.739, I25.75, I25.750, I25.751, I25.758, I25.759, I25.76, I25.760, I25.761, I25.768, I25.769, I25.79, I25.790, I25.791, I25.798, I25.799, I25.8, I25.81, I25.810, I25.811, I25.812, I25.82, I25.83, I25.84, I25.89, I25.9, I42, I42.0, I42.1, I42.2, I42.3, I42.4, I42.5, I42.6, I42.7, I42.8, I42.9, I43, I50, I50.1, I50.2, I50.20, I50.21, I50.22, I50.23, I50.3, I50.30, I50.31, I50.32, I50.33, I50.4, I50.40, I50.41, I50.42, I50.43, I50.8, I50.81, I50.810, I50.811, I50.812, I50.813, I50.814, I50.82, I50.83, I50.84, I50.89, I50.9 |
| Hypertension | I10, I11, I11.0, I11.9, I12, I12.0, I12.9, I13, I13.0, I13.1, I13.10, I13.11, I13.2, I15, I15.0, I15.1, I15.2, I15.8, I15.9, I16, I16.0, I16.1, I16.9 |
| Liver disease | B18, B18.0, B18.1, B18.2, B18.8, B18.9, K70, K70.0, K70.1, K70.10, K70.11, K70.2, K70.3, K70.30, K70.31, K70.4, K70.40, K70.41, K70.9, K71, K71.0, K71.1, K71.10, K71.11, K71.2, K71.3, K71.4, K71.5, K71.50, K71.51, K71.6, K71.7, K71.8, K71.9, K72, K72.0, K72.00, K72.01, K72.1, K72.10, K72.11, K72.9, K72.90, K72.91, K73, K73.0, K73.1, K73.2, K73.8, K73.9, K74, K74.0, K74.00, K74.01, K74.02, K74.1, K74.2, K74.3, K74.4, K74.5, K74.6, K74.60, K74.69, K75, K75.0, K75.1, K75.2, K75.3, K75.4, K75.8, K75.81, K75.89, K75.9, K76, K76.0, K76.1, K76.2, K76.3, K76.4, K76.5, K76.6, K76.7, K76.8, K76.81, K76.89, K76.9, K77, Z94.4 |
| Muscle congenital malformations | Q65.00, Q65.01, Q65.02, Q65.1, Q65.2, Q65.30, Q65.31, Q65.32, Q65.4, Q65.5, Q65.6, Q65.81, Q65.82, Q65.89, Q65.9, Q66.0, Q66.00, Q66.01, Q66.02, Q66.1, Q66.10, Q66.11, Q66.12, Q66.2, Q66.21, Q66.211, Q66.212, Q66.219, Q66.22, Q66.221, Q66.222, Q66.229, Q66.3, Q66.30, Q66.31, Q66.32, Q66.4, Q66.40, Q66.41, Q66.42, Q66.50, Q66.51, Q66.52, Q66.6, Q66.7, Q66.70, Q66.71, Q66.72, Q66.80, Q66.81, Q66.82, Q66.89, Q66.9, Q66.90, Q66.91, Q66.92, Q67.0, Q67.1, Q67.2, Q67.3, Q67.4, Q67.5, Q67.6, Q67.7, Q67.8, Q68.0, Q68.1, Q68.2, Q68.3, Q68.4, Q68.5, Q68.6, Q68.8, Q69.0, Q69.1, Q69.2, Q69.9, Q70.00, Q70.01, Q70.02, Q70.03, Q70.10, Q70.11, Q70.12, Q70.13, Q70.20, Q70.21, Q70.22, Q70.23, Q70.30, Q70.31, Q70.32, Q70.33, Q70.4, Q70.9, Q71.00, Q71.01, Q71.02, Q71.03, Q71.10, Q71.11, Q71.12, Q71.13, Q71.20, Q71.21, Q71.22, Q71.23, Q71.30, Q71.31, Q71.32, Q71.33, Q71.40, Q71.41, Q71.42, Q71.43, Q71.50, Q71.51, Q71.52, Q71.53, Q71.60, Q71.61, Q71.62, Q71.63, Q71.811, Q71.812, Q71.813, Q71.819, Q71.891, Q71.892, Q71.893, Q71.899, Q71.90, Q71.91, Q71.92, Q71.93, Q72.00, Q72.01, Q72.02, Q72.03, Q72.10, Q72.11, Q72.12, Q72.13, Q72.20, Q72.21, Q72.22, Q72.23, Q72.30, Q72.31, Q72.32, Q72.33, Q72.40, Q72.41, Q72.42, Q72.43, Q72.50, Q72.51, Q72.52, Q72.53, Q72.60, Q72.61, Q72.62, Q72.63, Q72.70, Q72.71, Q72.72, Q72.73, Q72.811, Q72.812, Q72.813, Q72.819, Q72.891, Q72.892, Q72.893, Q72.899, Q72.90, Q72.91, Q72.92, Q72.93, Q73.0, Q73.1, Q73.8, Q74.0, Q74.1, Q74.2, Q74.3, Q74.8, Q74.9, Q75.0, Q75.1, Q75.2, Q75.3, Q75.4, Q75.5, Q75.8, Q75.9, Q76.0, Q76.1, Q76.2, Q76.3, Q76.411, Q76.412, Q76.413, Q76.414, Q76.415, Q76.419, Q76.425, Q76.426, Q76.427, Q76.428, Q76.429, Q76.49, Q76.5, Q76.6, Q76.7, Q76.8, Q76.9, Q77.0, Q77.1, Q77.2, Q77.3, Q77.4, Q77.5, Q77.6, Q77.7, Q77.8, Q77.9, Q78.0, Q78.1, Q78.2, Q78.3, Q78.4, Q78.5, Q78.6, Q78.8, Q78.9, Q79.0, Q79.1, Q79.2, Q79.3, Q79.4, Q79.51, Q79.59, Q79.6, Q79.60, Q79.61, Q79.62, Q79.63, Q79.69, Q79.8, Q79.9 |
| Nervous system congenital malformations | Q00.0, Q00.1, Q00.2, Q01.0, Q01.1, Q01.2, Q01.8, Q01.9, Q02, Q03.0, Q03.1, Q03.8, Q03.9, Q04.0, Q04.1, Q04.2, Q04.3, Q04.4, Q04.5, Q04.6, Q04.8, Q04.9, Q05.0, Q05.1, Q05.2, Q05.3, Q05.4, Q05.5, Q05.6, Q05.7, Q05.8, Q05.9, Q06.0, Q06.1, Q06.2, Q06.3, Q06.4, Q06.8, Q06.9, Q07.00, Q07.01, Q07.02, Q07.03, Q07.8, Q07.9, Q85.00, Q85.01, Q85.02, Q85.03, Q85.09 |
| Neurodevelopmental disorders | F70, F71, F72, F73, F78, F79, F80.0, F80.1, F80.2, F80.4, F80.81, F80.82, F80.89, F80.9, F81.0, F81.2, F81.81, F81.89, F81.9, F82, F84.0, F84.2, F84.3, F84.5, F84.8, F84.9, F88, F89, F90.0, F90.1, F90.2, F90.8, F90.9, F94.8, F94.9, F95.0, F95.1, F95.2, F95.8, F95.9, F98.4, F98.5, F98.8 |
| Neurological disorders | F01, F01.5, F01.50, F01.51, F02, F02.8, F02.80, F02.81, F03, F03.9, F03.90, F03.91, G30, G30.0, G30.1, G30.8, G30.9 |
| Other congenital malformations | Q80.0, Q80.1, Q80.2, Q80.3, Q80.4, Q80.8, Q80.9, Q81.0, Q81.1, Q81.2, Q81.8, Q81.9, Q82.0, Q82.1, Q82.2, Q82.3, Q82.4, Q82.5, Q82.6, Q82.8, Q82.9, Q83.0, Q83.1, Q83.2, Q83.3, Q83.8, Q83.9, Q84.0, Q84.1, Q84.2, Q84.3, Q84.4, Q84.5, Q84.6, Q84.8, Q84.9, Q85.1, Q85.8, Q85.9, Q86.0, Q86.1, Q86.2, Q86.8, Q87.0, Q87.1, Q87.11, Q87.19, Q87.2, Q87.3, Q87.40, Q87.410, Q87.418, Q87.42, Q87.43, Q87.5, Q87.81, Q87.82, Q87.89, Q89.01, Q89.09, Q89.1, Q89.2, Q89.3, Q89.4, Q89.7, Q89.8, Q89.9 |
| Other status (eg. technology dependence) | Z93.0, Z93.1, Z93.2, Z93.3, Z93.4, Z93.50, Z93.51, Z93.52, Z93.59, Z93.6, Z93.8, Z93.9, Z99.0, Z99.11, Z99.2, Z99.3, Z99.81, Z99.89 |
| Respiratory congenital malformations | Q30.0, Q30.1, Q30.2, Q30.3, Q30.8, Q30.9, Q31.0, Q31.1, Q31.2, Q31.3, Q31.5, Q31.8, Q31.9, Q32.0, Q32.1, Q32.2, Q32.3, Q32.4, Q33.0, Q33.1, Q33.2, Q33.3, Q33.4, Q33.5, Q33.6, Q33.8, Q33.9, Q34.0, Q34.1, Q34.8, Q34.9 |
| Sickle cell disease | D57, D57.0, D57.00, D57.01, D57.02, D57.03, D57.09, D57.1, D57.2, D57.20, D57.21, D57.211, D57.212, D57.213, D57.218, D57.219, D57.4, D57.41, D57.411, D57.412, D57.413, D57.418, D57.419, D57.42, D57.43, D57.431, D57.432, D57.433, D57.438, D57.439, D57.44, D57.45, D57.451, D57.452, D57.453, D57.458, D57.459, D57.8, D57.80, D57.81, D57.811, D57.812, D57.813, D57.818, D57.819 |
| Thalassemia | D56, D56.0, D56.1, D56.2, D56.3, D56.4, D56.5, D56.8, D56.9 |

Supplemental Table 2. Supplemental analysis of relative vaccine effectivenessa against COVID-19 outcomes among three vaccine cohorts, without controlling for prior SARS-CoV-2 infection — linked data from HealthVerity open claims and Federal Retail Pharmacy Program for COVID-19 vaccination, United States, January 1, 2022 –March 31, 2022

|  |  |  |
| --- | --- | --- |
| **Outcome  (reference: 2 Ad26.COV2.S)** | **Ad26.COV2.S + mRNA** | **3 mRNA** |
| Any claim with COVID-19 | 38 (36–40) | 36 (35–38) |
| An outpatient claim with COVID-19 | 43 (41–46) | 43 (41–44) |
| An ED claim with COVID-19 | 59 (54–63) | 64 (60–66) |
| An inpatient claim with COVID-19 | 45 (35–53) | 55 (49–60) |
| An inpatient claim and ICU admission with COVID-19 | 49 (23–66) | 66 (54–75) |

Abbreviations: COVID-19 = Coronavirus disease 2019; ED = emergency department; ICU = intensive care unit

a The sample included three cohorts of individuals: (1) those with Ad26.COV2.S vaccine and Ad26.COV2.S booster (2 Ad26.COV2.S; reference); (2) those with an Ad26.COV2.S vaccine and an mRNA booster (Ad26.COV2.S+mRNA), and (3) those with two doses of an mRNA vaccine and an mRNA booster (3 mRNA). Vaccine effectiveness was measured as (1-adjusted hazard ratio)\*100. Each adjusted hazard ratio was obtained from a single Cox proportional hazards model, with the specific COVID-19 severity outcome as the dependent variable and the following covariates: cohort with Ad26.COV2.S+mRNA or cohort with 3 mRNA (reference: cohort with 2 Ad26.COV2.S), age (as a continuous variable), sex, and having at least one underlying condition during the 2 years prior to booster. The models were estimated in the full sample, as well as stratified by age group.

Supplemental Table 3. Characteristics of an additional cohort (2 mRNA + Ad26.COV2.S) — linked data from HealthVerity claims and Federal Retail Pharmacy Program for COVID-19 vaccination, United States, January 1, 2022 –March 31, 2022

|  |  |
| --- | --- |
|  | **N (%)** |
| Subtotal | 12,259 (100.0) |
| **Age (years)** |  |
| **Mean, median, IQR** | **48.5, 50 (36, 60)** |
| 18 - 49 | 6,076 (49.6) |
| 50 - 64 | 4,419 (36.0) |
| 65 and older | 1,764 (14.4) |
| **Sex** |  |
| Male | 6,923 (56.5) |
| Female | 5,336 (43.5) |
| **U.S. Census region** |  |
| Northeast | 2,470 (20.1) |
| Midwest | 2,503 (20.4) |
| South | 4,365 (35.6) |
| West | 2,407 (19.6) |
| Unknown | 514 (4.2) |
| **Any underlying medical conditions during 2 years prior to booster a** |  |
| Yes | 2,811 (22.9) |
| No | 9,448 (77.1) |
| **Prior SARS-CoV-2 infection b** |  |
| Yes | 1,102 (9.0) |
| No | 11,157 (91.0) |
| **Outcome c** |  |
| Any claim with COVID-19 | 260 (2.12) |
| An outpatient claim with COVID-19 | 180 (1.47) |
| An ED claim with COVID-19 | 29 (0.24) |
| An inpatient claim with COVID-19 | 13 (0.11) |
| An inpatient claim and ICU admission with COVID-19 | – |

Abbreviations: IQR=interquartile range, SARS-CoV-2=severe acute respiratory syndrome coronavirus 2

a Presence of at least one of the following conditions: asthma, cancer, congenital malformations, cerebrovascular disease, chromosomal abnormalities, chronic kidney disease, chronic obstructive pulmonary disease, cystic fibrosis, diabetes, Down syndrome, epilepsy, fibrosis, heart disease, hypertension, liver disease, neurodevelopmental disorders, neurological disorders, other status, sickle cell disease, thalassemia.

b Presence of a positive diagnostic lab test or the *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) code of U07.1 in the open medical claims

c The outcome of ICU admission was masked due to small cell size. Outcome incidence per 100,000 person-years was: 7,392 for any claim with COVID-19, 5,095 for an outpatient claim with COVID-19, 815 for an ED claim with COVID-19, and 365 for an inpatient claim with COVID-19.

Supplemental Table 4. Supplemental analysis of relative vaccine effectivenessa against COVID-19 outcomes among four vaccine cohorts — linked data from HealthVerity claims and Federal Retail Pharmacy Program for COVID-19 vaccination, United States, January 1, 2022 –March 31, 2022

|  |  |  |  |
| --- | --- | --- | --- |
| **Outcome  (reference: 2 Ad26.COV2.S)** | **Ad26.COV2.S + mRNA** | **3 mRNA** | **2 mRNA + Ad26.COV2.S** |
| Any claim with COVID-19 | 37 (35 – 39) | 34 (32 – 36) | 16 (5 – 26) |
| An outpatient claim with COVID-19 | 41 (39 – 44) | 40 (38 – 42) | 23 (10 – 34) |

Abbreviations: COVID-19 = Coronavirus disease 2019; ED = emergency department; ICU = intensive care unit

a The sample included four cohorts of individuals: (1) those with Ad26.COV2.S vaccine and Ad26.COV2.S booster (2 Ad26.COV2.S; reference); (2) those with an Ad26.COV2.S vaccine and an mRNA booster (Ad26.COV2.S+mRNA), (3) those with two doses of an mRNA vaccine and an mRNA booster (3 mRNA), and (4) those with two doses of an mRNA vaccine and an Ad26.COV2.S booster (2 mRNA+ Ad26.COV2.S). Vaccine effectiveness was measured as (1-adjusted hazard ratio)\*100. Each adjusted hazard ratio was obtained from a single Cox proportional hazards model, with the specific COVID-19 severity outcome as the dependent variable and the following covariates: cohort with Ad26.COV2.S+mRNA, cohort with 3 mRNA, or cohort with 2 mRNA+Ad26.COV2.S (reference: cohort with 2 Ad26.COV2.S), age (as a continuous variable), sex, prior SARS-CoV-2 infection, and having at least one underlying condition during the 2 years prior to booster.