Table 8: Full-dose Vaccine Efficacy or Effectiveness Against Asymptomatic Infection

Vaccine	Author	Country	Strain targeted by PCR	Baseline Serology	Dosing Schedule	Follow-up days*	Outcomes	Vaccine Efficacy or Effectiveness (95%CI)+
AstraZeneca (ChAdOx1 nCoV-19)	Voysey et al.[7] (RCT)	UK	Wild type	Negative	LD or SD and SD	>14	Asymptomatic or unknown	27.3% (-17-54.9)
	Voysey et al.[7] (RCT)	UK	Wild type	Negative	LD and SD	>14	Asymptomatic or unknown	58.9% (1-82.9)
	Voysey et al.[7] (RCT)	UK	Wild type	Negative	SD and SD	>14	Asymptomatic or unknown	3.8% (-72.4-46.3)
	Voysey et al.[7] (RCT)	UK	Wild type	Negative	LD or SD and SD	>14	Any PCR+	55.7% (41.1-66.7)
	Voysey et al.[6] (RCT)	UK	Wild type	Negative	LD or SD and SD	>14	Any PCR+	54.1% (44.7%, 61.9%)
	Voysey et al.[6] (RCT)	UK	Wild type	Negative	LD or SD and SD	>14	Asymptomatic or unknown	22.2% (-9.9-45)
	Voysey et al.[6] (RCT)	UK	Wild type	Negative	SD and SD	>14	Asymptomatic or unknown	2.0% (-50.7-36.2)
	Voysey et al.[6] (RCT)	UK	Wild type	Negative	LD and SD	>14	Asymptomatic or unknown	49.3% (7.4-72.2)
	Emary et al.[16] (RCT)	UK	Wild type, B.1.1.7, Other	Negative	LD or SD and SD	>14	Asymptomatic	15.7% (-10.7-35.8)
	Emary et al.[16]	UK	B.1.1.7	Negative	LD or SD and SD	>14	Asymptomatic	26.5% (-112-74.5)
	Emary et al.[16]	UK	Variants not B.1.1.7	Negative	LD or SD and SD	>14	Asymptomatic	75.4% (39.9-89.9)
Janssen Biotech (Ad26.COV2.S)	Janssen Biotech[33] (RCT)	Multiple	Wild type	Negative	NA	1-29	Asymptomatic	20% (-7-40.4)
	Janssen Biotech[33] (RCT)	Multiple	Wild type	Negative	NA	≥ 29	Asymptomatic	74% (46.8-88.4)
Pfizer BioNTech (BNT162b2)	Dagan et al.[13]	Israel	Wild type and B.1.1.7	Unknown	NA	>7	Asymptomatic	90% (83-94)
	Hall et al.[56]	UK	Wild type	Unknown	NA	21 days after 1st dose and 7 days after 2nd	Asymptomatic or unknown	NR
	Haas et al.[14]	Israel	Wild type and B.1.1.7	Unknown	NA	≥7	Asymptomatic	91·5% (90·7–92·2)
	Haas et al.[14]	Israel	Wild type and B.1.1.7	Unknown	NA	≥14	Asymptomatic	93·8% (93·3–94·2)
	Regev-Yochay et al.[25]	Israel	Wild	Both	NA	>10	Asymptomatic at first testing	65% (45 to 79)
	Regev-Yochay et al.[25]	Israel	Wild	Both	NA	>10	Asymptomatic (who never	72%(48-86%)

Vaccine	Author	Country	Strain targeted by PCR	Baseline Serology	Dosing Schedule	Follow-up days*	Outcomes	Vaccine Efficacy or Effectiveness (95%CI)+
							became symptomatic)	
	Pritchard et al.[17]	UK	Wild type and B.117	Both	NA	NR	Asymptomatic	OR 0.48(0.35 to 0.66)
	Pfizer [Press Release][50]	Israel	Wild type and B.1.1.7	Unknown	NA	>14	Asymptomatic	94%
	Tang et al.[12]	Qatar	VOC Delta	NR	NA	≥14	Asymptomatic	35.9 (11.1-53.9)
	Sansone et al.[62]	Italy	Wild type and VOC B.1.1.7 (Alpha/UK), B1.525	NR	NA	>14	Asymptomatic	OR: 0.38 (0.16-0.88)
	McEllistrem et al.[24]	USA	Wild type	Unclear	NA	7	Asymptomatic	NR
	Bailly et al.[27]	France	VOC 501Y.V2	Both	NA	NR	Asymptomatic	NR
	Andrejko et al.[10]	USA	Wild type	Seronegative	NA	>15	Asymptomatic	68.3% (27.9-85.7%)
	Tang et al.[9]	USA	Wild type	Seronegative	NA	0-6	Asymptomatic	IRR: 0.35 (0.11-1.09)
	Tang et al.[8]	USA	Wild type	Seronegative	NA	>7	Asymptomatic	IRR: 0.10 (0.04-0.22)
	Angel et al.[9]	Israel	Wild type	Seronegative	NA	>7	Asymptomatic	adjusted IRR: Vax 0.09(0.03-0.25); p<0.001
	Angel et al.[9]	Israel	Wild type	Seronegative	NA	>21	Asymptomatic	adjusted IRR: Vax 0.09(0.01-0.35); p=0.002
Moderna (mRNA-1273)	Ali et al.[51] (RCT)	USA	Wild type	Seronegative	NA	>14	Asymptomatic	39.2% (-24.7 to 69.7)
	Chemaitelly et al.[11]	Qatar	Wild type and VOC B.1.1.7; B.1.351; B.1.617	NR	NA	>14	Asymptomatic	92.5%(84.8-96.9%)
	Tang et al.[12]	Qatar	VOC Delta	NR	NA	≥14	Asymptomatic	80.2 (54.2-92.6)
BNT162b2 and ChAdOx1 nCoV-19	Shah et al.[53]	UK	Wild type	Unknown	NA	>14	HCW Transmission to household	HR=0.46 (95% CI: 0.30-0.70)
	Tang et al.[12]	Qatar	VOC Delta	NR	NA	≥14	Asymptomatic	40.0 (18.2-56.1)

* Time PCR was conducted after first or second dose; LD: Low dose, SD: Standard dose, #Calculated from raw values.+ Efficacy reported for RCTs and Effectiveness for observational studies. Hall et al. was the only full-dose study healthcare workers' data. Studies are observational, except otherwise state

Table 9: Ct Values

Vaccine	Author	Country	Virus type	Baseline Serology	1st or 2nd dose	Follow-up days	Sub-population	Ct Values (Vaccinated), Median (IQR), unless otherwise specified	Ct Values (Unvaccinated), Median (IQR), unless otherwise specified	Effect size/p-values
BNT162b2	Abu-Raddad[26]	Qatar	Wild type and B.1.1.7, B.1.351, B.1.617.2	Unknown	2	≥14	Breakthrough infection vs primary infection in unvaccinated	27.8 (21.1-32.7)	25.8 (19.5-31.4)	p <0.001
								Mean=26.8 (95% CI: 26.5-27.2)	Mean=25.5 (95% CI: 25.2-25.8)	Mean difference (95% CI): 1.3 (0.9-1.8), p<0.001
					2	≥14	Breakthrough infection vs reinfection in unvaccinated	28.2 (21.1-33.1)	31.2 (24.3-33.9)	p <0.001
								Mean=27 (95% CI: 26.3-27.6)	Mean=28.9 (95% CI: 28.3-29.5)	Mean difference (95% CI): 2.0 (1.1-2.8), p <0.001
	Bailly[27]	France	501Y.V2	Both	2	NR		21 (13-32)	15 (12-17)	p=0.05
	Ioannou[28]	Greece	B.1.1.7		2	>14		18 (15.5-25.5)	18.5 (13.5-24)	ns
	Jones[23]	UK	Wild-type and B.1.1.7	Unknown	1	≥12		30.3 (25.5-35.1)	23.3 (13.5-33)	ns
	Levine-Tiefenbrun[22]	Israel	Wild type	Unknown	1	<12		NR	NR	no significant differences in the Ct values for any of the 3 genes (RdRp, N and E)
					1	12-28		NR	NR	the Ct values for the 3 genes were significantly higher among infected vaccinated persons than controls ($p<10^{-8}$)
	McEllistrem[24]	USA	Wild type	Unknown	1	NR	Asymptomatic COVID-19	19.4 (18.9-22.5)	12.8 (12.4-14.9)	p=0.009
	Muhsen[58]	Israel	Wild type	Seronegative	2	>14		32 (14.5)	26.7 (8.8)	p=0.008
	Regev-Yochay[25]	Israel	Wild type	Both	2	≥11		Mean=27.3 (SD=2.2)	Mean=22.2 (SD=1.0)	Mean difference (95% CI): 5.09 (2.8-7.4), p<0.001

Vaccine	Author	Country	Virus type	Baseline Serology	1st or 2nd dose	Follow-up days	Sub-population	Ct Values (Vaccinated), Median (IQR), unless otherwise specified	Ct Values (Unvaccinated), Median (IQR), unless otherwise specified	Effect size/p-values
BNT162b2 or ChAdOx1	Baltas[20]	UK	Wild type and B.1.1.7	Unknown	1	9-24		30.8 (25.9-35.4)	28.8 (25.3-33.7)	P=0.053
	Lumley[21]	England	Wild type and B.1.1.7 (35% of unvaccinated seronegative; 65% vaccinated)	Seronegative	NR	NR		Change in median: 2.7 (-0.5 to 6.7)		NR
		England	Wild type and VOC	Seronegative	NR	NR		Mean=19.66 (95% CI: 15.01-27.53)	Mean=18.39 (95% CI: 14.00-25.57)	p=0.19
	Mostafa[19]	USA	Wild type, P.1, B.1.1.7 (61%), B.1.351, B.1.526 (9%), and B.1.526.1 (4.5%)	Unknown	2	2 to 100		19.26 (Q1, Q3: 16.56 to 21.96)	19.6 (Q1, Q3: 16.28 to 22.66)	ns
	Pritchard[17]	UK	Wild type	Both	1	0-7		31.2 (20.6-33.7)	28.4 (20.1-32.9)	p<0.001
					1	8-20		31 (23.5 to 33.8)	28.4 (20.1 to 32.9)	p<0.001
					1	≥21		31.7 (26.9 to 33.7)	28.4 (20.1 to 32.9)	p<0.001
					2	NR		33.1 (30.5 to 34.2)	28.4 (20.1 to 32.9)	p<0.001
	Shrotri[18]	UK	Wild type	Determined (adjusted for in analysis)	1	0-27		26.9 (25.19-26.62)	26.6 (26-27.1)	0.158
BNT162b2, ChAdOx1, or Moderna mRNA-1273	Pouwels[59]	UK	Alpha, Delta	Both	1	0 to 20	Alpha (1 Dec 2020 to 16 May 2021)	30.93 (Q1, Q3: 22.93 to 33.71)	28.7 (Q1, Q3: 20.4, 32.9) for not previously PCR positive; 32.8 (Q1, Q3: 30.9-34.2) for previously PCR positive	ns from unvaccinated but previously PCR/antibody-positive (age/sex-adjusted p=0.72), but significantly higher than in those unvaccinated and not previously PCR/antibody-positive, age/sex-adjusted p=0.02)
					1 or 2	>21 for dose 1 or 0-13 for dose 2		31.71(Q1, Q3: 26.64 to 33.57)		
					2	>14		33.3 (Q1, Q3: 31.6 to 34.0)		

Vaccine	Author	Country	Virus type	Baseline Serology	1st or 2nd dose	Follow-up days	Sub-population	Ct Values (Vaccinated), Median (IQR), unless otherwise specified	Ct Values (Unvaccinated), Median (IQR), unless otherwise specified	Effect size/p-values
					1	0 to 20	Delta (17 May 2021 to 13 Jun 2021)	29.93 (Q1, Q3: 22 to 34.21)	21.5 (Q1, Q3: 16.5 to 31.64) for not previously PCR positive; 30.86 (Q1, Q3: 29.5 to 34.28) for previously PCR positive	NR
					1 or 2	>21 for dose 1 or 0-13 for dose 2		30.07 (Q1, Q3: 18.64 to 33.64)		
					2	>14		32.29 (Q1, Q3: 26.07 to 33.93)		
					1	0 to 20	Delta (14 Jun 2021 to 1 Aug 2021)	25.64 (Q1, Q3: 21.64 to 30.79)	25.71 (Q1, Q3: 19.07 to 30.71) for not previously PCR positive; 22.29 (Q1, Q3: 16.57 to 30.29) for previously PCR positive	NR
					1 or 2	>21 for dose 1 or 0-13 for dose 2		24.64 (Q1, Q3: 18.86 to 31.29		
					2	>14		25.29 (Q1, Q3: 19.21 to 31.29)		
BNT162b2 or Moderna mRNA-1273	Jacobson[29]	USA	Wild type and B.1.427/B.1.429 (34.3%)	Both	1	≤ 14	Early post vaccination vs. unvaccinated	Mean=22.6 (SD=7)	Mean=23 (SD=7.4)	NR
					1 or 2	up to 14 after 2nd dose	Partially vaccinated vs unvaccinated	Mean=27.7 (SD=8.7)	Mean=23 (SD=7.4)	NR
					2	>14	Fully vaccinated vs unvaccinated	Mean=28.5 (SD=7.4)	Mean=23 (SD=7.4)	NR
BNT162b2, Moderna, or Janssen	Duerr[30]	USA	Wild type, B.1.1.7, B.1.526, P1, and others	Unknown	1 or 2	≥14	Vaccination breakthrough infections	27 (13-42)	≤30	NR
					1 or 2	≥14	Vaccination breakthrough infections that passed quality control	24 (13-36)	≤30	NR
ChAdOx1	Emary[16]	UK	Wild type and B.1.1.7	Unknown	2	≥14	Asymptomatic	30.25 (24.81-34.20)	28.15 (19.51-32.35)	p=0.0040

Vaccine	Author	Country	Virus type	Baseline Serology	1st or 2nd dose	Follow-up days	Sub-population	Ct Values (Vaccinated), Median (IQR), unless otherwise specified	Ct Values (Unvaccinated), Median (IQR), unless otherwise specified	Effect size/p-values
					2	≥14	Symptomatic	20.49 (15.43-24.44)	17.9 (15.06-25.06)	p=0.1534
					2	≥14	Symptomatic and asymptomatic B1.1.7	19.34 (15.39-21.62)	15.03 (12.51-16.59)	p=0.0113
					2	≥14	Symptomatic and asymptomatic not sequenced	29.52 (23.29-33.59)	25.57 (19.22-31.44)	p=0.0164
					2	≥14	Symptomatic and asymptomatic non-B.1.1.7 only	22.93 (17.54-29.4)	18.26 (15.15-25.57)	p=0.0201
Moderna (mRNA-1273)	Abu-Raddad[26]	Qatar	Wild type and B.1.1.7, B.1.351, B.1.617.2	Unknown	2	≥14	Breakthrough infection vs primary infection in unvaccinated	33.3 (29.6-34.8)	30.5 (23.5-33.7)	p<0.001
								Mean=31.2 (95% CI: 30.4-32.1)	Mean=28 (95% CI: 27-29.1)	Mean difference (95% CI): 3.2 (1.8-4.5), p<0.001
					2	≥14	Breakthrough infection vs reinfection in unvaccinated	33.1 (26.5-34.8)	33.1 (31.1-34.6)	p=0.104
								Mean=30 (95% CI: 28.3-31.7)	Mean=31.7 (95% CI: 30.5-32.9)	Mean difference (95% CI): 1.7 (-0.4-3.8), p=0.104
NR	Riemersma[35]	USA	Wild type and B.1.617.2	NR	2	≥14		NR	NR	p=0.84
					2	≥14		NR	NR	p=0.99
					2	≥14		NR	NR	p=0.85
					2	≥14		NR	NR	p=0.61

Newly identified observational studies shaded in blue.

Cycle Threshold (Ct) Values

Twenty studies reported on Ct values, which is an inverse proxy for viral load. Eleven of these are new to the updated version of this report (Table 9).

Results from Phase 2/3 vaccine efficacy studies of AZ vaccine compared with a comparator meningococcal vaccine in the United Kingdom, showed that the Ct values in infected vaccinated participants were statistically significantly higher than the comparator ($p<0.0001$), after 14 days of the second dose in baseline seronegative efficacy cohorts.[16] Furthermore, the vaccine recipients were PCR-positive for a significantly shorter period of time ($p<0.0001$). The Ct values in asymptomatic cases were also significantly higher among vaccine recipients than control ($p=0.0040$); however, this difference was not significant for primary symptomatic cases ($p=0.1534$). Vaccine recipients infected with the B.1.1.7 variant also showed significantly higher Ct values than control ($p=0.0113$).[16]

A longitudinal UK household survey by Pritchard el al. found statistically significant increase in the median Ct values of PfBnT or AZ single or full dose vaccinated individuals compared with unvaccinated individuals at any time point before or after 21 days post-vaccination ($p<0.001$).[17] Similarly, in another UK study by Shrotri et al., the mean Ct value of unvaccinated individuals within 27 days of vaccination was 26.6 (95% CI: 26-27.1) compared with 26·6 (95% CI: 25.19-26.62) with one dose of PfBnT or AZ, which was not significantly different ($p=0.158$).[18] However, after 28 days, there was a statistically significant decrease in the mean Ct between vaccinated and unvaccinated persons (mean Ct 26.6 (95% CI: 26-27.1) vs 31·3 (95% CI: 29.6-32.9), $p<0·001$).[18] Monthly routine PCR testing was conducted in these patients; however, the baseline serology was not reported.[18] In a longitudinal cohort study of HCWs who were offered voluntary nasal and oropharyngeal swab PCR testing every two weeks as well as serological testing, a small study of 49 people vaccinated with either PfBNT or AZ and 96 unvaccinated people in the USA by Mostafa et al. demonstrated non-significant differences in median Ct values (19.26 [Q1, Q3: 16.56-21.96] vs 19.6 [Q1, Q3: 16.28-22.66], respectively).[19] Similar non-significance in the median Ct values of PfBNT or AerZ-vaccinated people vs unvaccinated was found in a UK study by Baltas et al. (Median=30.8 [IQR: 25.9-35.4] vs. Median=28.8 [IQR: 25.3-33.7], $p=0.053$).[20] Lumley et al., found vaccination with either PfBnT or AZ to non-significantly increase Ct value by a mean of 2.7.[21]

A retrospective study of PfBnT mRNA vaccine recipients compared with demographically matched control group of unvaccinated individuals in Israel, found no significant differences in the Ct values for any of the three genes (RdRp, N and E) measured less than 12 days after the first dose in infected persons. However, between 12 and 28 days after the first dose, the Ct values for the three genes were significantly higher among infected vaccinated persons than controls ($p<10^{-8}$).[22] In another UK study of one dose of BNT162b2 vaccine, the median Ct values of infected HCWs were reported to have shown a non-significant trend towards increase between unvaccinated (median=20.3) and vaccinated HCWs after 12 days post-vaccination (median=30.3), suggesting that samples from infected vaccinated individuals had lower viral loads.[23] A study by McEllistrem et al. among community living centre residents reported five cases of asymptomatic infections (determined by surveillance nasal swabs every 2-5 days) among baseline PCR negative PfBnT vaccinated and unvaccinated residents. The

median Ct values among unvaccinated residents (12.8, IQR: 12.4-14.9) were significantly lower (p=0.009) than vaccinated residents (19.4, IQR: 18.9-25.5).[24] Furthermore, viral load was -2.4 mean log10 lower among the vaccinated cohort (p=0.004).[24] In another large cohort study of HCWs at a large medical centre in Israel by Regev-Yochay et al, the mean Ct values among PfBNT fully vaccinated HCWs (27.3±2.2) was significantly higher (mean difference 5.09, 95% CI: 2.8-7.4, p<0.001) than unvaccinated HCWs (22.2±1.0).[25] A matched case-control study by Abu-Raddad et al. from Qatar, evaluating the Ct values of people with two doses of PfBNT with breakthrough infections compared to Ct values of infections in unvaccinated individuals, found statistically significant higher median Ct values in vaccinated individuals (27.8; IQR: 21.1-32.7) than the median Ct value of unvaccinated individuals (25.8 (IQR: 19.5-31.4; p<0.001).[26] However, studies in France[27] and Greece[28] found no statistically significant differences between PfBNT vaccinated individuals' Ct values and the Ct values of those who were unvaccinated. Bailly et al. found that the Ct values of PfBNT fully vaccinated long-term care residents did not differ from the Ct values of unvaccinated residents (Median=21 [IQR:13-32] vs 15 [IQR: 12-17]; p=0.05).[27] Similarly, Ioannou et al.'s study of fully vaccinated healthcare workers in a Greek hospital amidst an outbreak found no significant differences between the median Ct values of those vaccinated and unvaccinated (18 [15.5-25.5] vs 18.5 [13.5-24]).[28]

A USA study investigating the Ct values of mRNA-based vaccinated healthcare workers (PfBNT or Moderna) compared to unvaccinated healthcare workers found that there was no statistically significant difference in mean Ct values in the early post-vaccination period defined as less than 14 days post vaccination (22.6±7 vs. 23±7.4) for partially-vaccinated healthcare workers more than 14 days past first dose but before the second dose (27.7±8.7 vs. 23±7.4) or for fully vaccinated healthcare workers at least 14 days past vaccination (28.5±7.4 vs. 23±7.4).[29] Another similar study by Duerr et al. reported Ct values for vaccinated individuals in the community but lumped all unvaccinated comparators as under a Ct value equal or less than 30 therefore, no effect size was presented[30] (Table 9).

A longitudinal UK study from December 2020 to August 2021 found significant differences in Ct values in individuals vaccinated with either one or two doses of PfBNT, AZ, or Moderna[59]. From 1st December 2020 to 16th May 2021, Pouwels et al. assessed Ct values of people vaccinated with either PfBNT, Moderna, or AZ against the B.1.1.7 (Alpha) variant compared to their unvaccinated counterparts. Individuals with at least one dose of a vaccine had significantly higher Ct values (median=31.71) compared to the seronegative unvaccinated (median=28.7; p=0.02) or seropositive unvaccinated individuals (median=32.8, p=0.72) (Table 9).[59] From the 17th of May 2021 to 1st August 2021, Ct values of vaccinated individuals were assessed for the B.1.617.2 (Delta) variant compared to unvaccinated individuals and on average found that there appeared to be a higher cycle threshold among vaccinated people. However, there were no reported effect sizes or p-values for these periods.[59]

The study by Abu-Raddad et al. from Qatar also evaluated the median Ct values of people with breakthrough infections those with two doses of Moderna and found that there was statistically significantly higher median Ct values in the vaccinated (33.3; IQR: 29.6-34.8) than the median Ct value of unvaccinated individuals (30.5 (IQR: 23.5-33.7; p<0.001).[26]

In a pre-print by Riemersma et al., the authors included the Ct values of RT-PCR SARS-CoV-2 positive people from a single Wisconsin commercial laboratory with self-reported vaccination status between June 28 through July 24, 2021.[36] There were 291 specimens positive for SARS-CoV-2, with 79 people indicating that they were fully vaccinated and 212 unvaccinated individuals. The authors reported no significant differences in Ct values of vaccinated and unvaccinated people (p=0.85); the mean or median values or the previous serology of the sample were not reported. Of the 42 people identified with a Delta infection it was reported that there was no difference in Ct values (p=0.61).[36]

Viral Load

Two USA studies reported on viral load; one study is new to this updated version of the report. A prospective cohort study of baseline seronegative vaccinated and unvaccinated healthcare workers across Arizona had their mid-turbinate nasal swabs assessed for viral load.[31] Thompson et al. found that the mean viral RNA load for partially and fully vaccinated healthcare workers, with a mRNA-based vaccine, who were at least 14 days past the date of vaccination had lower presence of virus compared to their unvaccinated counterparts (2.3 ± 1.7 Log_{10} copies/mL vs. 3.8 ± 1.7 Log_{10} copies/mL).[31] This represented at least 40.2% lower viral RNA load after at least partial vaccination.[31]

A second retrospective cohort study of five vaccinated and five unvaccinated asymptomatic nursing home residents in a single nursing home evaluated the effectiveness of at least one dose of the PfBNT vaccine on attenuating viral load.[24] Viral load was -2.4 mean log10 lower among the vaccinated cohort (p=0.004).[24]

Discussion

In this update, 25 additional studies were included. Therefore, this review has a total of 45 included studies. Four new studies from the Netherlands, Finland, and Israel evaluating household transmission following vaccination found that PfBNT, Moderna, AZ, and J&J vaccines significantly reduce the risk of household transmission.[2-5] The majority of the vaccines included in this review demonstrated efficacy and effectiveness against asymptomatic wild-type COVID-19 infections. There is some limited evidence that there is moderate efficacy and effectiveness of vaccines against the B.1.617.2 (Delta) strain of the virus.

The AZ, PfBnT, and Moderna vaccines were found to be significantly associated with higher Ct values than their respective comparators, suggesting that these vaccines may potentially reduce viral load and consequently lower the risk of transmission. It is however noteworthy that the relationship between viral load, viral shedding, infectivity, and the duration of infectivity are not well understood. Ct values are also subject to error.[65] Furthermore, although there were statistically significant differences in median Ct values between vaccinated and unvaccinated individuals, most of the Ct values for both the vaccinated and unvaccinated individuals were $\leq$29, which clinically both indicate that the cycle thresholds were strongly positive indicative of an abundance of target viral nucleic acid in the samples.[66,67] A couple of studies found that vaccination with an mRNA-based vaccine reduced the viral load.[31,55]

There were significant limitations to many of the included studies. It was not possible to directly compare findings across studies owing to variations in the assessment of asymptomatic status, the testing used, and timing of these assessments. Also, the possibility of persistent PCR positivity after COVID-19 infection[68] could not be excluded in some of the studies without baseline PCR assessment. Few studies included surveillance nasal swabs for PCR positivity. Most of the current data were around viral detection, rather than evidence of cultivatable virus. Therefore, there was limited data to evaluate the efficacy or effectiveness of COVID-19 vaccines in decreasing viral loads. In addition, there are only a limited number of epidemiologic data addressing evidence of forward transmission after vaccination.

Emerging Evidence

Variants of SARS-CoV-2 continue to surface, and the B.617.2 (Delta) variant is currently the one of most concern.[34,35] There has been emerging evidence that indicates that although a full vaccination series might reduce an individual's overall risk of becoming infected, there seems to be a limited difference in the Ct values between those vaccinated and unvaccinated.[34,36] Furthermore, certain outbreaks amongst vaccinated individuals in the USA have led to expanded prevention strategies, such as universal masking in indoor spaces.[35]

Comparisons of the proxy viral load measurement, Ct value, have found that, regardless of vaccination status, there was no difference in Ct values once an individual was infected with the B.1.617.2 (Delta) variant.[34,36] Public Health England (PHE) released a technical report on the NHS Test and Trace case data of the median and mean Ct values for all cases in the country. They reported that since May 2021 to July 2021, the median Ct value for unvaccinated individuals was 17.8 compared to the median of 18.0 in those who were vaccinated.[34] PHE suggested that there was limited difference in infectiousness due to the similarity in Ct values; the case data was not age stratified.[34]

The CDC reported in the Morbidity and Mortality Weekly Report on an outbreak of SARS-CoV-2 infections in vaccinated individuals in Barnstable County, Massachusetts.[35] During July 2021, 469 cases were associated with multiple summer and large public gathering events, with 74% (n=346) of cases occurring in fully vaccinated persons who had completed a 2-dose course of an mRNA vaccine (PfBNT or Moderna) or received the single-dose J&J vaccine. Genomic sequencing of specimens from 133 patients identified the B.1.617.2 (Delta) variant in 90% of cases. Of the 346 identified breakthrough infections, 274 (79%) had symptoms, and among the five who were hospitalized, four were fully vaccinated.[35] Ct values in specimens from 127 vaccinated persons with breakthrough cases were similar to those from 84 persons who were unvaccinated, not fully vaccinated, or whose vaccination status was unknown (median = 22.77 vs median=21.54, respectively).[35] Persons with COVID-19 reported attending densely packed indoor and outdoor events at venues that included bars, restaurants, guest houses, and rental homes. After the events of Barnstable County, the CDC recommended that all persons, including fully vaccinated individuals wear masks indoors in public settings especially in attendance of large public gatherings.

This emerging evidence suggests that the B.1.617.2 (Delta) variant is highly transmissible and that there may not be a difference between the viral load of those vaccinated compared

to those unvaccinated. However, more studies need to be conducted to fully understand the protection gleaned from vaccination. Until then, expanded prevention strategies, such as universal indoor masking, may help prevent the spread of the Delta variant.

Recommendations

Based on the current evidence, we suggest the following:

1) All vaccinees should self-isolate and seek testing after the development of COVID-19 compatible symptoms.

2) Following exposure, the risk of contracting COVID-19 and subsequent forward transmission from asymptomatic or pauci-symptomatic viral carriage should be considered in light of whether the exposed individual was vaccinated, the time elapsed since immunization, and the consequent expected degree of protection on a case-by-case basis for those in vulnerable setting. When possible, a case-by-case consideration for whether exposed persons are immunized, is necessary. Low-moderate risk exposures could potentially be managed with careful use of personal protective equipment (PPE), and self-monitoring.

3) If a vaccinated HCW is assessed as having a significant exposure before the period of expected robust immunity, high risk exposures may be managed as for unvaccinated persons.

4) All vaccinated persons should continue to use recommended PPE when in close contact with unvaccinated persons.

5) Population and public health data being collected on positive COVID-19 tests occurring after vaccination should be combined with laboratory data on Ct values, identification of variant strain infections, and epidemiologic contact tracing data to prospectively monitor for evidence of forward transmission of infection from vaccinated persons.

Conclusion

Four months since the publication of the previous version of this report, 24 additional relevant studies have been conducted. Four of these were large household surveillance studies from the Netherlands, Finland, and Israel suggesting that a full dose of PfBNT, Moderna, AZ, or J&J vaccines may prevent household transmission after 14 days of vaccination. Twelve additional studies found that vaccines significantly reduce the risk of asymptomatic infection, with multiple studies finding that vaccines decreased the viral RNA load or increased the cycle threshold, suggestive of reduced viral load. Some studies, such as the AZ vaccine RCTs, included data on cross sectional prevalence of positive SARS-CoV-2 RT-PCR from routine swabbing, which suggested efficacy against asymptomatic infection, although this was not routinely assessed in a comparable way across studies. Evidence regarding the Ct values for the AZ, PfBnT, and Moderna vaccine suggest their potential to reduce viral load and possibly transmission. Further research is needed to evaluate post-vaccination infectivity and transmission of variants of concern especially the B.1.617.2 (Delta) strain from other jurisdictions.

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Appendix 1: Search Strategy

Ovid Multifile

Database: EBM Reviews - Cochrane Central Register of Controlled Trials <July 2021>, Embase <1974 to 2021 August 20> , Ovid MEDLINE(R) and Epub Ahead of Print, In-

Process, In-Data-Review & Other Non-Indexed Citations and Daily <1946 to August 20, 2021>
Search Strategy:

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1 exp COVID-19 Vaccines/ (4322)
2 ((COVID-19 or COVID19) adj5 (immun* or inoculat* or vaccin*)).tw,kf. (19693)
3 ((coronavirus* or corona virus*) adj5 (immun* or inoculat* or vaccin*)).tw,kf. (4818)
4 ((2019-nCoV or nCoV or n-CoV or SARS-CoV-2 or SARS-CoV2 or SARSCoV-2 or SARSCoV2 or SARS2) adj5 (immun* or inoculat* or vaccin*)).tw,kf. (11949)
5 (((BNT162 or BNT162-01 or BNT162a1 or BNT162b1 or BNT162b2 or BNT162c2) and vaccin*) or N38TVC63NU).tw,kf. (1144)
6 (((AZD1222 or ChAdOx1) and vaccin*) or Covishield$2 or B5S3K2V0G8).tw,kf. (766)
7 ((Moderna and vaccin*) or EPK39PL4R4).tw,kf. (454)
8 ((mRNA adj3 vaccin*) and (COVID-19 or COVID19 or coronavirus* or corona virus* or 2019-nCoV or nCoV or n-CoV or SARS-CoV-2 or SARS-CoV2 or SARSCoV-2 or SARSCoV2 or SARS2)).tw,kf. (1795)
9 ((messenger RNA adj3 vaccin*) and (COVID-19 or COVID19 or coronavirus* or corona virus* or 2019-nCoV or nCoV or n-CoV or SARS-CoV-2 or SARS-CoV2 or SARSCoV-2 or SARSCoV2 or SARS2)).tw,kf. (158)
10 (LV-SMENP-DC and vaccin*).tw,kf. (5)
11 ((Ad5-nCoV and vaccin*) or hAdOx1 nCoV-19).tw,kf. (37)
12 (("Ad26.COV2.S" or Ad26COVS1 or JNJ 78436735 or JNJ-78436735 or JT2NS6183B) and vaccin*).tw,kf. (158)
13 Viral Vaccines/ and (Coronavirus/ or Betacoronavirus/ or Coronavirus Infections/) (1906)
14 or/1-13 [COVID-19 VACCINES] (33065)
15 COVID-19/pc [prevention & control] (8859)
16 Coronavirus Infections/pc [prevention & control] (10743)
17 Pandemics/pc [prevention & control] (14512)
18 ((control* or decreas* or halt* or prevent* or reduc* or stop*) adj5 (COVID-19 or COVID19)).tw,kf. (27144)
19 ((control* or decreas* or halt* or prevent* or reduc* or stop*) adj5 (coronavirus* or corona virus*)).tw,kf. (3792)
20 ((control* or decreas* or halt* or prevent* or reduc* or stop*) adj5 (2019-nCoV or nCoV or n-CoV or SARS-CoV-2 or SARS-CoV2 or SARSCoV-2 or SARSCoV2 or SARS2)).tw,kf. (6889)
21 ((control* or decreas* or halt* or prevent* or reduc* or stop*) adj5 spread*).tw,kf. (52770)
22 COVID-19/ep [Epidemiology] (17717)
23 COVID-19/tm [Transmission] (3563)
24 COVID-19/vi [Virology] (6344)
25 Coronavirus Infections/ep [Epidemiology] (23509)
26 Coronavirus Infections/tm [Transmission] (4703)
27 Coronavirus Infections/vi [Virology] (7690)
28 exp Disease Transmission, Infectious/ (352747)
29 (transmit* or transmissi* or infectiousness* or infectivit*).tw,kf. (1235632)
30 ((COVID-19 or COVID19) adj5 (caus* or pass or passed or passes or passing or spread*)).tw,kf. (32763)
31 ((coronavirus* or corona virus*) adj5 (caus* or pass or passed or passes or passing or spread*)).tw,kf. (17810)
32 ((virus* or infection*) adj5 (caus* or pass or passed or passes or passing or spread*)).tw,kf. (386113)

82 exp Animals/ not Humans/ (16123202)
83 81 not 82 [ANIMAL-ONLY REMOVED] (3982)
84 (202105* or 202106* or 202107* or 202108*).dt. (478611)
85 83 and 84 [UPDATE PERIOD] (576)
86 85 use ppez [MEDLINE RECORDS] (576)
87 SARS-CoV-2 vaccine/ (8936)
88 ((COVID-19 or COVID19) adj5 (immun* or inoculat* or vaccin*)).tw,kw. (22548)
89 ((coronavirus* or corona virus*) adj5 (immun* or inoculat* or vaccin*)).tw,kw. (5596)
90 ((2019-nCoV or nCoV or n-CoV or SARS-CoV-2 or SARS-CoV2 or SARSCoV-2 or SARSCoV2 or SARS2) adj5 (immun* or inoculat* or vaccin*)).tw,kw. (13897)
91 (((BNT162 or BNT162-01 or BNT162a1 or BNT162b1 or BNT162b2 or BNT162c2) and vaccin*) or N38TVC63NU).tw,kw. (1157)
92 (((AZD1222 or ChAdOx1) and vaccin*) or Covishield$2 or B5S3K2V0G8).tw,kw. (772)
93 ((Moderna and vaccin*) or EPK39PL4R4).tw,kw. (459)
94 ((mRNA adj3 vaccin*) and (COVID-19 or COVID19 or coronavirus* or corona virus* or 2019-nCoV or nCoV or n-CoV or SARS-CoV-2 or SARS-CoV2 or SARSCoV-2 or SARSCoV2 or SARS2)).tw,kw. (1814)
95 ((messenger RNA adj3 vaccin*) and (COVID-19 or COVID19 or coronavirus* or corona virus* or 2019-nCoV or nCoV or n-CoV or SARS-CoV-2 or SARS-CoV2 or SARSCoV-2 or SARSCoV2 or SARS2)).tw,kw. (161)
96 (LV-SMENP-DC and vaccin*).tw,kw. (5)
97 ((Ad5-nCoV and vaccin*) or hAdOx1 nCoV-19).tw,kw. (37)
98 (("Ad26.COV2.S" or Ad26COVS1 or JNJ 78436735 or JNJ-78436735 or JT2NS6183B) and vaccin*).tw,kw. (158)
99 (severe acute respiratory syndrome vaccine/ or virus vaccine/) and (coronavirinae/ or betacoronavirus/ or exp SARS-related coronavirus/ or coronavirus infection/) (1111)
100 or/87-99 [COVID-19 VACCINES] (36579)
101 coronavirus disease 2019/pc [prevention] (16383)
102 coronavirus infection/pc [prevention] (10779)
103 pandemic/pc [prevention] (14596)
104 ((control* or decreas* or halt* or prevent* or reduc* or stop*) adj5 (COVID-19 or COVID19)).tw,kw. (27702)
105 ((control* or decreas* or halt* or prevent* or reduc* or stop*) adj5 (coronavirus* or corona virus*)).tw,kw. (5416)
106 ((control* or decreas* or halt* or prevent* or reduc* or stop*) adj5 (2019-nCoV or nCoV or n-CoV or SARS-CoV-2 or SARS-CoV2 or SARSCoV-2 or SARSCoV2 or SARS2)).tw,kw. (7180)
107 ((control* or decreas* or halt* or prevent* or reduc* or stop*) adj5 spread*).tw,kw. (52807)
108 coronavirus disease 2019/ep [epidemiology] (29877)
109 coronavirus infection/ep [epidemiology] (23549)
110 virus transmission/ (72848)
111 (transmit* or transmissi* or infectiousness* or infectivit*).tw,kw. (1241266)
112 ((COVID-19 or COVID19) adj5 (caus* or pass or passed or passes or passing or spread*)).tw,kw. (32798)
113 ((coronavirus* or corona virus*) adj5 (caus* or pass or passed or passes or passing or spread*)).tw,kw. (17833)
114 ((virus* or infection*) adj5 (caus* or pass or passed or passes or passing or spread*)).tw,kw. (386369)
115 ((2019-nCoV or nCoV or n-CoV or SARS-CoV-2 or SARS-CoV2 or SARSCoV-2 or SARSCoV2 or SARS2) adj5 spread*).tw,kw. (5298)
116 (unvaccinat* or nonvaccinat* or non-vaccinat* or "not vaccinat*").tw,kw. (42646)

33 ((2019-nCoV or nCoV or n-CoV or SARS-CoV-2 or SARS-CoV2 or SARSCoV-2 or SARSCoV2 or SARS2) adj5 spread*).tw,kf. (5291)
34 (unvaccinat* or nonvaccinat* or non-vaccinat* or "not vaccinat*").tw,kf. (42643)
35 or/15-34 [TRANSMISSION] (1923307)
36 14 and 35 [COVID-19 VACCINES - DISEASE TRANSMISSION] (16076)
37 (controlled clinical trial or randomized controlled trial or pragmatic clinical trial or equivalence trial).pt. (1248935)
38 "Clinical Trials as Topic"/ (314700)
39 exp "Controlled Clinical Trials as Topic"/ (382216)
40 (randomi#ed or randomi#ation? or randomly or RCT or placebo*).tw,kf. (3721675)
41 ((singl* or doubl* or trebl* or tripl*) adj (mask* or blind* or dumm*)).tw,kf. (731366)
42 trial.ti. (939819)
43 or/37-42 [RCT FILTER] (4670500)
44 36 and 43 [RCTs] (1647)
45 controlled clinical trial.pt. (186646)
46 Controlled Clinical Trial/ or Controlled Clinical Trials as Topic/ (573850)
47 (control* adj2 trial).tw,kf. (691363)
48 Non-Randomized Controlled Trials as Topic/ (12839)
49 (nonrandom* or non-random* or quasi-random* or quasi-experiment*).tw,kf. (157674)
50 (nRCT or non-RCT).tw,kf. (1028)
51 Controlled Before-After Studies/ (210357)
52 (control* adj3 ("before and after" or "before after")).tw,kf. (825048)
53 Interrupted Time Series Analysis/ (203342)
54 time series.tw,kf. (77728)
55 (pre- adj3 post-).tw,kf. (294878)
56 (pretest adj3 posttest).tw,kf. (16682)
57 Historically Controlled Study/ (220764)
58 (control* adj2 study).tw,kf. (556350)
59 Control Groups/ (111904)
60 (control* adj2 group?).tw,kf. (1573730)
61 trial.ti. (939819)
62 or/45-61 [nRCT FILTER] (4350878)
63 36 and 62 [nRCTs] (1075)
64 exp Cohort Studies/ (3093661)
65 cohort?.tw,kf. (1911901)
66 Retrospective Studies/ (1784445)
67 (longitudinal or prospective or retrospective).tw,kf. (3831913)
68 ((followup or follow-up) adj (study or studies)).tw,kf. (130616)
69 Observational study.pt. (107979)
70 (observation$2 adj (study or studies)).tw,kf. (341258)
71 ((population or population-based) adj (study or studies or analys#s)).tw,kf. (47080)
72 ((multidimensional or multi-dimensional) adj (study or studies)).tw,kf. (276)
73 Comparative Study.pt. (2066781)
74 ((comparative or comparison) adj (study or studies)).tw,kf. (285012)
75 exp Case-Control Studies/ (1423752)
76 ((case-control* or case-based or case-comparison) adj (study or studies)).tw,kf. (272319)
77 Cross-Sectional Studies/ (690149)
78 (crosssection* or cross-section*).tw,kf. (1054262)
79 or/64-78 [OBSERVATIONAL STUDY FILTER] (9827573)
80 36 and 79 [OBSERVATIONAL STUDIES] (2568)
81 44 or 63 or 80 [ALL STUDY DESIGNS] (4117)

117 or/101-116 [TRANSMISSION] (1771114)
118 100 and 117 [COVID-19 VACCINES - DISEASE TRANSMISSION] (18078)
119 exp randomized controlled trial/ or controlled clinical trial/ (1492681)
120 clinical trial/ (1541965)
121 exp "controlled clinical trial (topic)"/ (217360)
122 (randomi#ed or randomi#ation? or randomly or RCT or placebo*).tw,kw. (3785088)
123 ((singl* or doubl* or trebl* or tripl*) adj (mask* or blind* or dumm*)).tw,kw. (760770)
124 trial.ti. (939819)
125 or/119-124 [RCT FILTER] (5250210)
126 118 and 125 [RCTs] (1545)
127 controlled clinical trial/ (558033)
128 "controlled clinical trial (topic)"/ (11831)
129 (control* adj2 trial).tw,kw. (1058875)
130 (nonrandom* or non-random* or quasi-random* or quasi-experiment*).tw,kw. (158708)
131 (nRCT or non-RCT).tw,kw. (1030)
132 (control* adj3 ("before and after" or "before after")).tw,kw. (825052)
133 time series analysis/ (29877)
134 time series.tw,kw. (78764)
135 pretest posttest control group design/ (564)
136 (pre- adj3 post-).tw,kw. (294927)
137 (pretest adj3 posttest).tw,kw. (20506)
138 controlled study/ (8321938)
139 (control* adj2 study).tw,kw. (985693)
140 control group/ (111799)
141 (control* adj2 group?).tw,kw. (1574940)
142 trial.ti. (939819)
143 or/127-142 [nRCT FILTER] (11387363)
144 118 and 143 [nRCTs] (2998)
145 cohort analysis/ (1033210)
146 cohort?.tw,kw. (1917721)
147 retrospective study/ (2052657)
148 longitudinal study/ (308271)
149 prospective study/ (1296159)
150 (longitudinal or prospective or retrospective).tw,kw. (3853020)
151 follow up/ (1723966)
152 ((followup or follow-up) adj (study or studies)).tw,kw. (132434)
153 observational study/ (349424)
154 (observation$2 adj (study or studies)).tw,kw. (343991)
155 population research/ (116549)
156 ((population or population-based) adj (study or studies or analys#s)).tw,kw. (55167)
157 ((multidimensional or multi-dimensional) adj (study or studies)).tw,kw. (277)
158 exp comparative study/ (3392659)
159 ((comparative or comparison) adj (study or studies)).tw,kw. (302872)
160 exp case control study/ (1423752)
161 ((case-control* or case-based or case-comparison) adj (study or studies)).tw,kw. (275780)
162 cross-sectional study/ (817603)
163 (crosssection* or cross-section*).tw,kw. (1058104)
164 major clinical study/ (4204970)
165 or/145-164 [OBSERVATIONAL STUDY FILTER] (13849196)
166 118 and 165 [OBSERVATIONAL STUDIES] (3519)

167 126 or 144 or 166 [ALL STUDY DESIGNS] (5730)
168 exp animal/ or exp animal experimentation/ or exp animal model/ or exp animal experiment/ or nonhuman/ or exp vertebrate/ (54468436)
169 exp human/ or exp human experimentation/ or exp human experiment/ (42855732)
170 168 not 169 (11614435)
171 167 not 170 [ANIMAL-ONLY REMOVED] (5365)
172 (202105* or 202106* or 202107* or 202108*).dc. (933210)
173 171 and 172 [UPDATE PERIOD] (1560)
174 173 use oemezd [EMBASE RECORDS] (1560)
175 exp COVID-19 Vaccines/ (4322)
176 ((COVID-19 or COVID19) adj5 (immun* or inoculat* or vaccin*)).ti,ab,kw. (22546)
177 ((coronavirus* or corona virus*) adj5 (immun* or inoculat* or vaccin*)).ti,ab,kw. (5595)
178 ((2019-nCoV or nCoV or n-CoV or SARS-CoV-2 or SARS-CoV2 or SARSCoV-2 or SARSCoV2 or SARS2) adj5 (immun* or inoculat* or vaccin*)).ti,ab,kw. (13896)
179 (((BNT162 or BNT162-01 or BNT162a1 or BNT162b1 or BNT162b2 or BNT162c2) and vaccin*) or N38TVC63NU).ti,ab,kw. (1123)
180 (((AZD1222 or ChAdOx1) and vaccin*) or Covishield$2 or B5S3K2V0G8).ti,ab,kw. (741)
181 ((Moderna and vaccin*) or EPK39PL4R4).ti,ab,kw. (392)
182 ((mRNA adj3 vaccin*) and (COVID-19 or COVID19 or coronavirus* or corona virus* or 2019-nCoV or nCoV or n-CoV or SARS-CoV-2 or SARS-CoV2 or SARSCoV-2 or SARSCoV2 or SARS2)).ti,ab,kw. (1813)
183 ((messenger RNA adj3 vaccin*) and (COVID-19 or COVID19 or coronavirus* or corona virus* or 2019-nCoV or nCoV or n-CoV or SARS-CoV-2 or SARS-CoV2 or SARSCoV-2 or SARSCoV2 or SARS2)).ti,ab,kw. (161)
184 (LV-SMENP-DC and vaccin*).ti,ab,kw. (1)
185 ((Ad5-nCoV and vaccin*) or hAdOx1 nCoV-19).ti,ab,kw. (26)
186 (("Ad26.COV2.S" or Ad26COVS1 or JNJ 78436735 or JNJ-78436735 or JT2NS6183B) and vaccin*).ti,ab,kw. (145)
187 Viral Vaccines/ and (Coronavirus/ or Betacoronavirus/ or Coronavirus Infections/) (1906)
188 or/175-187 [COVID-19 VACCINES] (35531)
189 COVID-19/pc [prevention & control] (8859)
190 Coronavirus Infections/pc [prevention & control] (10743)
191 Pandemics/pc [prevention & control] (14512)
192 ((control* or decreas* or halt* or prevent* or reduc* or stop*) adj5 (COVID-19 or COVID19)).ti,ab,kw. (27702)
193 ((control* or decreas* or halt* or prevent* or reduc* or stop*) adj5 (coronavirus* or corona virus*)).ti,ab,kw. (5416)
194 ((control* or decreas* or halt* or prevent* or reduc* or stop*) adj5 (2019-nCoV or nCoV or n-CoV or SARS-CoV-2 or SARS-CoV2 or SARSCoV-2 or SARSCoV2 or SARS2)).ti,ab,kw. (7180)
195 ((control* or decreas* or halt* or prevent* or reduc* or stop*) adj5 spread*).ti,ab,kw. (52807)
196 COVID-19/ep [Epidemiology] (17717)
197 COVID-19/tm [Transmission] (3563)
198 COVID-19/vi [Virology] (6344)
199 Coronavirus Infections/ep [Epidemiology] (23509)
200 Coronavirus Infections/tm [Transmission] (4703)
201 Coronavirus Infections/vi [Virology] (7690)
202 exp Disease Transmission, Infectious/ (352747)
203 (transmit* or transmissi* or infectiousness* or infectivit*).ti,ab,kw. (1241265)

204 ((COVID-19 or COVID19) adj5 (caus* or pass or passed or passes or passing or spread*)).ti,ab,kw. (32798)
205 ((coronavirus* or corona virus*) adj5 (caus* or pass or passed or passes or passing or spread*)).ti,ab,kw. (17833)
206 ((virus* or infection*) adj5 (caus* or pass or passed or passes or passing or spread*)).ti,ab,kw. (386369)
207 ((2019-nCoV or nCoV or n-CoV or SARS-CoV-2 or SARS-CoV2 or SARSCoV-2 or SARSCoV2 or SARS2) adj5 spread*).ti,ab,kw. (5298)
208 (unvaccinat* or nonvaccinat* or non-vaccinat* or "not vaccinat*").ti,ab,kw. (42646)
209 or/189-208 [TRANSMISSION] (1929116)
210 188 and 209 [COVID-19 VACCINES - DISEASE TRANSMISSION] (17254)
211 (202105* or 202106* or 202107* or 202108*).up. (1733210)
212 210 and 211 [UPDATE PERIOD] (4802)
213 212 use cctr [CENTRAL RECORDS] (233)
214 86 or 174 or 213 [ALL DATABASES] (2369)
215 remove duplicates from 214 (1983) [TOTAL UNIQUE RECORDS]
216 215 use ppez [MEDLINE UNIQUE RECORDS] (569)
217 215 use oemezd [EMBASE UNIQUE RECORDS] (1206)
218 215 use cctr [CENTRAL UNIQUE RECORDS] (208)
219 202104*.up. (277685)
220 210 and 219 [APRIL UPDATE] (917)
221 220 use cctr [CENTRAL APRIL UPDATE] (25)
222 214 or 221 [ALL UPDATE PERIODS - ALL DATABASES] (2394)
223 remove duplicates from 222 (2007)
224 223 use ppez [MEDLINE UNIQUE RECORDS] (569)
225 223 use oemezd [EMBASE UNIQUE RECORDS] (1206)
226 223 use cctr [CENTRAL UNIQUE RECORDS] (232)
227 226 and 219 [CENTRAL UNIQUE RECORDS - APRIL ONLY] (24)

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PICO - Prevention>SARS-CoV-2 Vaccines-Primary Studies
3819 records