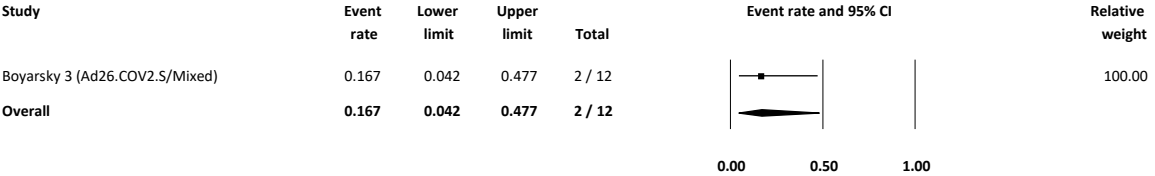


Supplementary Figure S1.

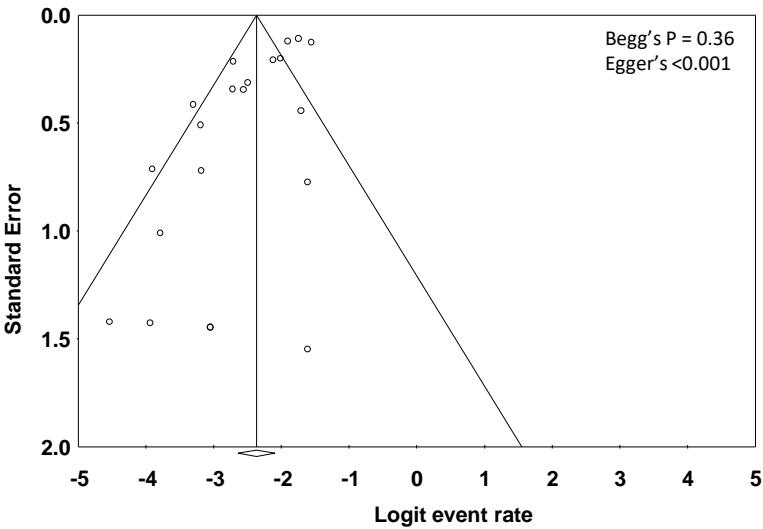
A. Serologic response after one dose of vaccine: Ad26.COV2.S vaccine



Overall: Heterogeneity: $I^2 = 0\%$, $Q = 0$, $P = 1.00$

Supplementary Figure S2.

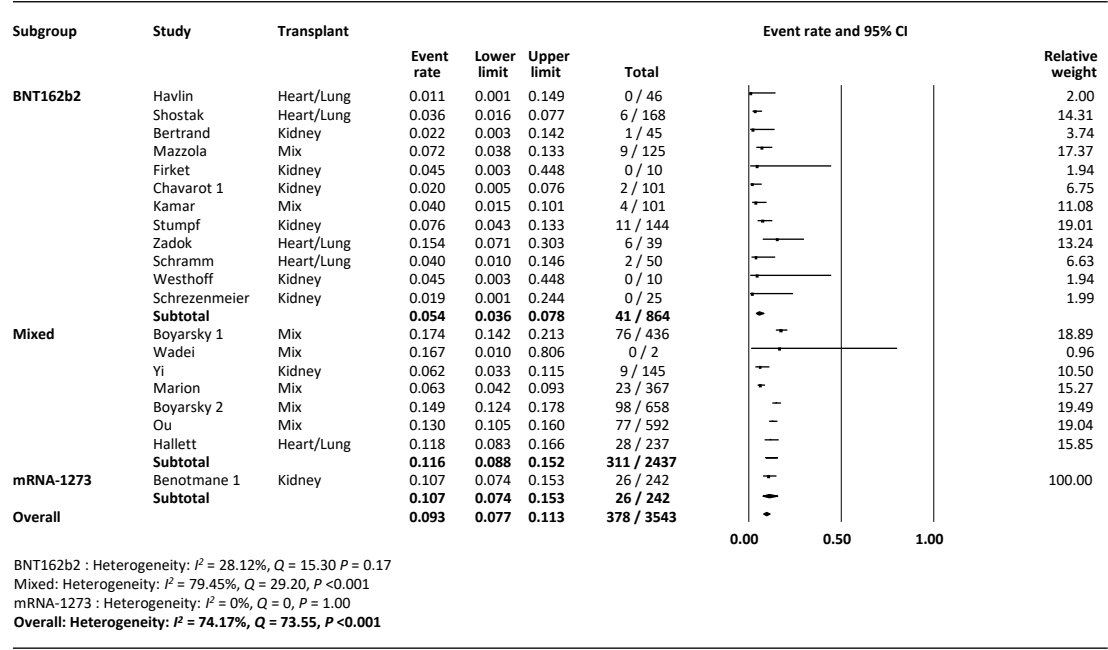
A. Funnel plot of studies included in meta-analysis of serologic response after one dose of vaccine



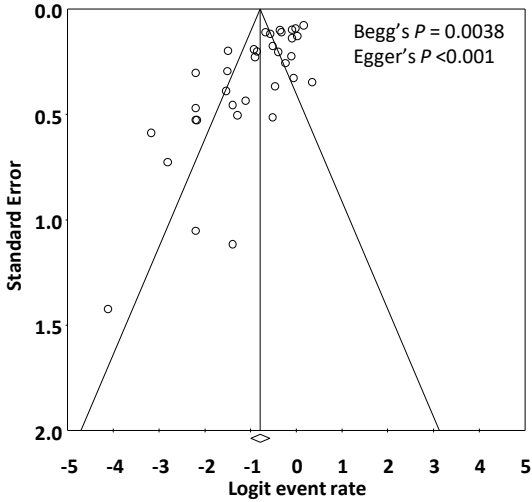
B. Sensitivity analysis excluding one study at a time for serologic response after one dose of vaccine

Removed study	Point	Lower limit	Upper limit	Event rate (95% CI) with study removed
Boyarsky 1	0.078	0.060	0.101	•
Wadei	0.084	0.064	0.108	•
Benotmane 1	0.081	0.061	0.107	•
Yi	0.086	0.066	0.111	•
Marion	0.088	0.068	0.113	•
Havlin	0.086	0.067	0.110	•
Shostak	0.090	0.070	0.115	•
Bertrand	0.086	0.067	0.111	•
Boyarsky 2	0.077	0.058	0.103	•
Mazzola	0.085	0.065	0.110	•
Firket	0.085	0.065	0.109	•
Chavarot 1	0.089	0.069	0.113	•
Ou	0.078	0.058	0.104	•
Kamar	0.088	0.068	0.113	•
Hallett	0.080	0.061	0.106	•
Stumpf	0.085	0.065	0.110	•
Zadok	0.081	0.062	0.105	•
Schramm	0.086	0.067	0.111	•
Westhoff	0.085	0.065	0.109	•
Schrezenmeier	0.085	0.066	0.110	•
Overall	0.084	0.065	0.108	•

C. Sensitivity analysis according to type of mRNA vaccine for serologic response after one dose of vaccine



A. Funnel plot of studies included in meta-analysis of serologic response after two doses of vaccine

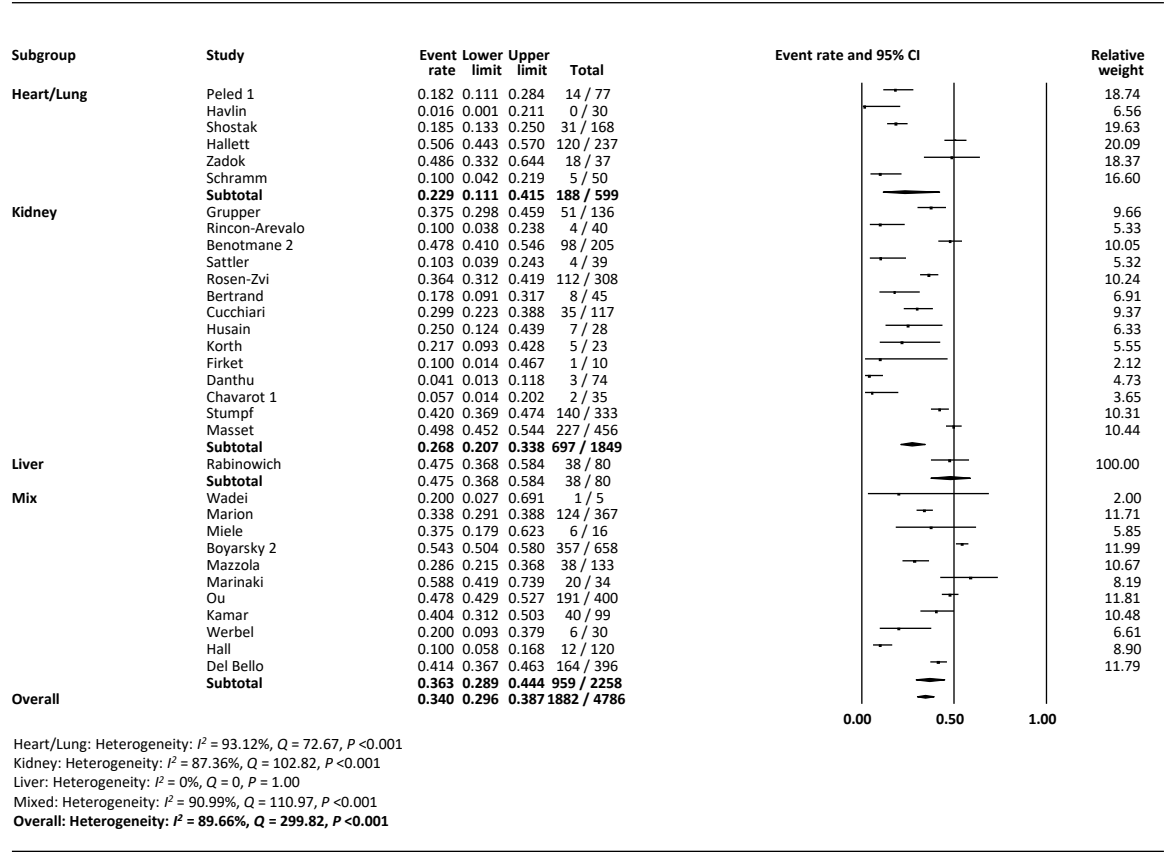


B. Sensitivity analysis excluding one study at a time for serologic response after two doses of vaccine

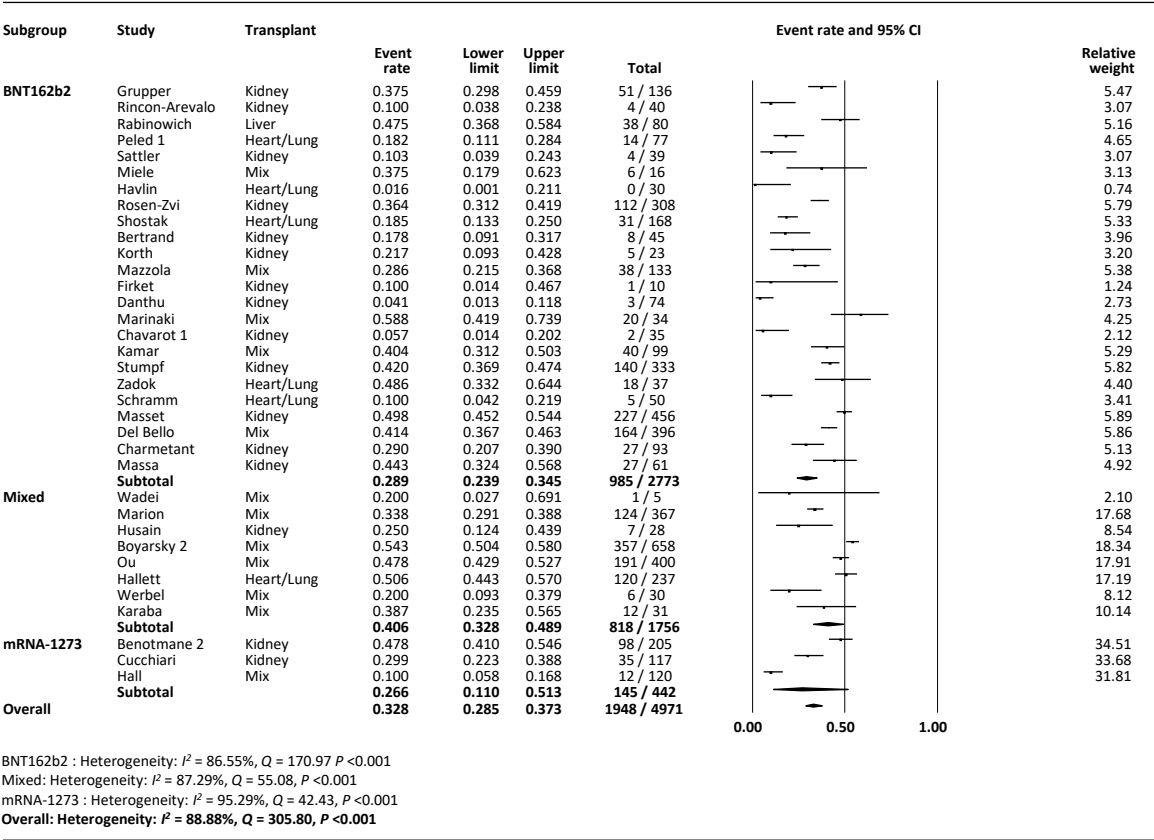
Removed study name				Event rate (95% CI) with study removed		
	Point	Lower limit	Upper limit			
Grupper	0.309	0.266	0.356		—	
Wadei	0.313	0.271	0.359		—	
Rincon-Arevalo	0.319	0.277	0.365		—	
Benotmane 2	0.305	0.262	0.352		—	
Rabinowich	0.306	0.264	0.353		—	
Peled 1	0.318	0.276	0.364		—	
Sattler	0.319	0.277	0.365		—	
Marion	0.310	0.266	0.357		—	
Miele	0.311	0.268	0.357		—	
Havlin	0.316	0.274	0.362		—	
Rosen-Zvi	0.309	0.265	0.356		—	
Shostak	0.320	0.278	0.365		—	
Bertrand	0.317	0.274	0.363		—	
Cucchiari	0.313	0.269	0.359		—	
Husain	0.314	0.271	0.360		—	
Korth	0.315	0.272	0.361		—	
Boyarsky 2	0.305	0.263	0.350		—	
Mazzola	0.313	0.270	0.360		—	
Firket	0.315	0.272	0.360		—	
Danthu	0.323	0.281	0.368		—	
Marinaki	0.305	0.263	0.351		—	
Chavarot 1	0.319	0.277	0.365		—	
Ou	0.304	0.261	0.352		—	
Kamar	0.308	0.265	0.355		—	
Hallett	0.305	0.262	0.351		—	
Stumpf	0.306	0.262	0.354		—	
Zadok	0.307	0.265	0.353		—	
Schramm	0.320	0.278	0.366		—	
Werbel	0.315	0.273	0.362		—	
Hall	0.325	0.283	0.370		—	
Karaba	0.310	0.267	0.356		—	
Masset	0.304	0.261	0.351		—	
Del Bello	0.306	0.262	0.354		—	
Charmetant	0.313	0.270	0.359		—	
Massa	0.308	0.265	0.354		—	
Overall	0.312	0.270	0.358		—	
				0.00	0.50	1.00

Supplementary Figure S3.

C. Sensitivity analysis excluding preprint studies for serologic response after two dose of vaccine

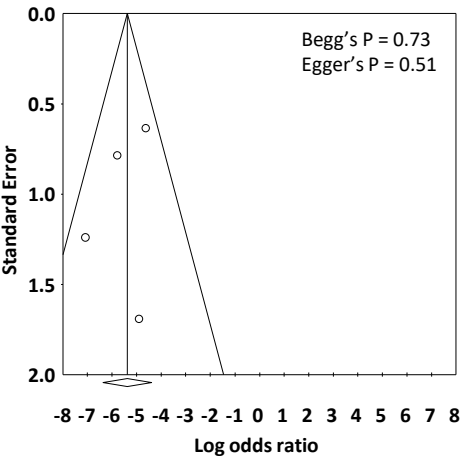


D. Sensitivity analysis according to type of mRNA vaccine for serologic response after two doses of vaccine

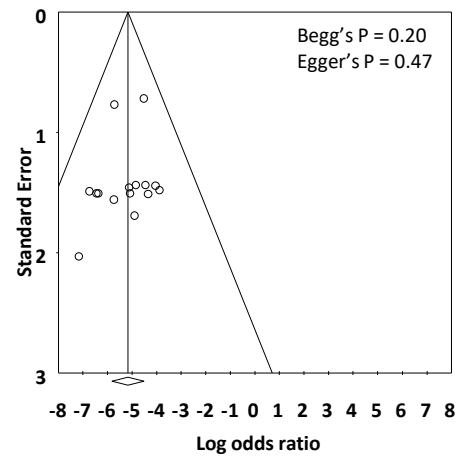


Supplementary Figure S4.

A. Funnel plot of studies included in meta-analysis of comparison of serologic response after one dose of vaccine compared to controls

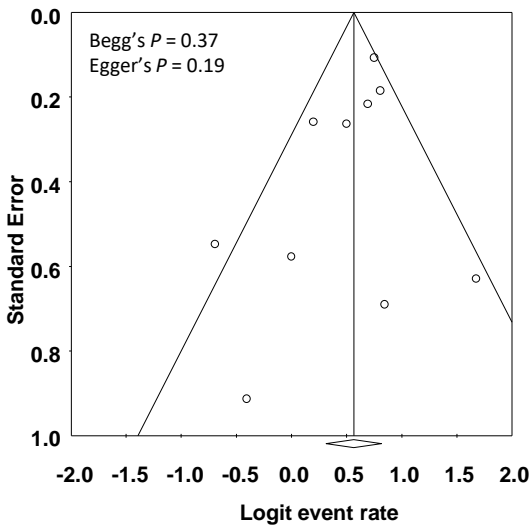


B. Funnel plot of studies included in meta-analysis of comparison of serologic response after two doses of vaccine compared to controls

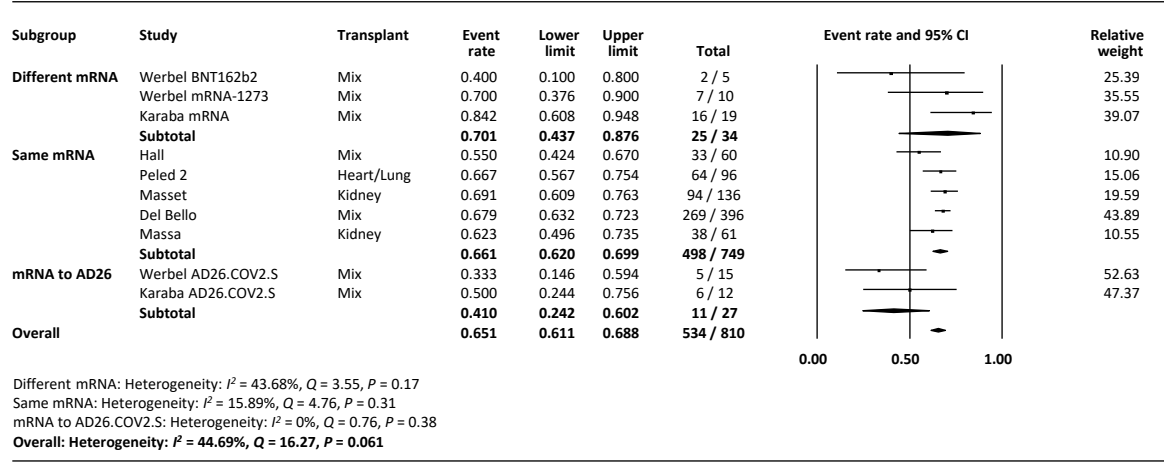


Supplementary Figure S5.

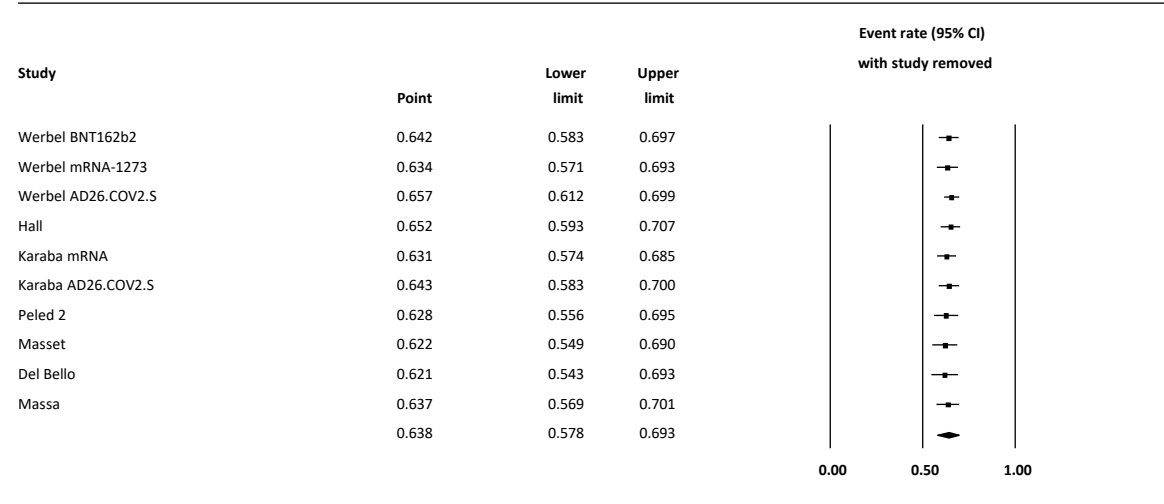
A. Funnel plot of studies included in meta-analysis of serologic response after three doses of vaccine



B. Sensitivity analysis according to type of vaccine for serologic response after three doses of vaccine

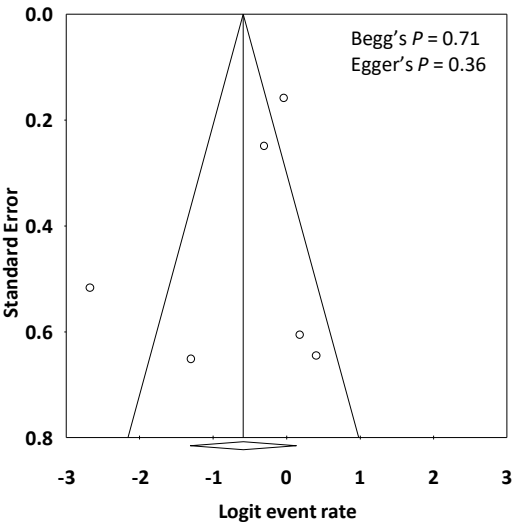


C. Sensitivity analysis excluding one study at a time for serologic response after three doses of vaccine



Supplementary Figure S6.

A. Funnel plot of studies included in meta-analysis of serologic response after three doses of vaccine among non-responders to two doses



B. Sensitivity analysis according to type of vaccine for serologic response after three doses of vaccine among non-responders to two doses

Subgroup	Study	Transplant	Event rate	Lower limit	Upper limit	Total	Event rate and 95% CI	Relative weight
Same mRNA	Benotmane 3	Kidney	0.491	0.414	0.568	78 / 159		29.75
	Charmetant	Kidney	0.424	0.311	0.546	28 / 66		28.35
	Chavarot 2	Kidney	0.065	0.024	0.160	4 / 62		22.49
	Schrezenmeier BNT 162b2	Kidney	0.214	0.071	0.494	3 / 14		19.41
	Subtotal		0.279	0.133	0.494	113 / 301		
BNT162b2 to AZD1222	Schrezenmeier AZD1222	Kidney	0.545	0.268	0.797	6 / 11		100.00
	Subtotal		0.545	0.268	0.797	6 / 11		
BNT162b2 to mRNA-1273	Westhoff	Kidney	0.600	0.297	0.842	6 / 10		100.00
	Subtotal		0.600	0.297	0.842	6 / 10		
Overall			0.428	0.284	0.585	125 / 322		

Same mRNA: Heterogeneity: $I^2 = 88.54\%$, $Q = 26.17$, $P < 0.001$
BNT162b2 to AZD1222 : Heterogeneity: $I^2 = 0\%$, $Q =$, $P = 1.00$
BNT162b2 to mRNA-1273: Heterogeneity: $I^2 = 0\%$, $Q =$, $P = 1.00$
Overall: Heterogeneity: $I^2 = 82.11\%$, $Q = 27.94$, $P < 0.001$

C. Sensitivity analysis excluding one study at a time for serologic response after three doses of vaccine among non-responders to two doses

Study	Point	Lower limit	Upper limit	Event rate (95% CI) with study removed
Benotmane 3	0.322	0.143	0.574	
Charmetant	0.337	0.147	0.599	
Chavarot 2	0.462	0.383	0.543	
Westhoff	0.321	0.175	0.513	
Schrezenmeier BNT 162b2	0.382	0.221	0.574	
Schrezenmeier AZD1222	0.326	0.176	0.523	
	0.357	0.212	0.533	

Supplementary Table S1. Risk of bias assessment by Joanna Briggs Institute Critical Appraisal Checklist

Author	Year	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
1. Grupper	2021	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
2. Boyarsky	2021	Yes	Yes	Yes	No	No	NA	No	Yes	Yes
3. Wadei	2021	Yes	Yes	Yes	No	No	Yes	No	Unclear	Yes
4. Rincon-Arevalo	2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5. Benotmane	2021	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
6. Benotmane	2021	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
7. Rabinowich	2021	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
8. Yi	2021	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes
9. Peled	2021	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
10. Sattler	2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
11. Marion	2021	Yes	Yes	Yes	No	Yes	No	No	Yes	Yes
12. Miele	2021	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
13. Havlin	2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14. Rosen-Zvi	2021	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
15. Shostak	2021	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
16. Bertrand	2021	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
17. Cucchiari	2021	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
18. Husain	2021	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes
19. Korth	2021	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
20. Boyarsky	2021	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes
21. Mazzola	2021	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
22. Firket	2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
23. Danthu	2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
24. Boyarsky	2021	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
25. Marinaki	2021	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
26. Chavarot	2021	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes
27. Ou	2021	Yes	Yes	Yes	No	No	No	No	Yes	Yes
28. Kamar	2021	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes
29. Hallett	2021	Yes	Yes	Yes	No	No	No	No	Yes	Yes
30. Stumpf	2021	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes
31. Zadok	2021	Yes	Yes	Yes	No	No	No	No	Yes	Yes
32. Schramm	2021	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes
33. Werbel	2021	Yes	Yes	Yes	No	Yes	No	No	Yes	Unclear
34. Hall	2021	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes
35. Karaba	2021	Yes	Yes	Yes	Unclear	No	Yes	Yes	Yes	Yes
36. Peled	2021	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
37. Benotmane	2021	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
38. Masset	2021	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Unclear
39. Del Bello	2021	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes
40. Charmetant	2021	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
41. Chavarot	2021	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes

42. Westhoff	2021	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
43. Massa	2021	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
44. Schrezenmeier	2021	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes

Q1: Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?; Q2: Were the participants included in any comparisons similar?; Q3: Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?; Q4: Was there a control group?; Q5: Were there multiple measurements of the outcome both pre and post the intervention/exposure?; Q6: Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?; Q7: Were the outcomes of participants included in any comparisons measured in the same way?; Q8: Were outcomes measured in a reliable way?; Q9: Was appropriate statistical analysis used?; NA not applicable.

Supplementary Table S2. Univariate and multivariate meta-regression models of variables associated with serologic response after one dose of mRNA vaccine

	Univariate meta-regression			Multivariate meta-regression		
	Coefficient	95% CI	P-value	Coefficient	95% CI	P-value
Age	-0.036	-0.16-0.084	0.56	-0.050	-0.18-0.079	0.45
Female	0.025	0.010-0.040	0.0010	-0.011	-0.042-0.021	0.51
Steroid	-0.025	-0.044-(-0.0050)	0.014	-0.029	-0.052-(-0.0061)	0.013
BNT162b2 vs. Mixed	0.84	0.33-1.34	0.0011	0.58	-0.41-1.57	0.25
BNT162b2 vs. mRNA-1273	0.75	-0.13-1.62	0.094	0.74	-0.15-1.62	0.10
Heart/lung vs. Kidney	-0.23	-0.98-0.52	0.55	-0.80	-1.81-0.22	0.12
Heart/lung vs. Mixed	0.35	-0.33-1.03	0.31	-0.13	-0.91-0.64	0.74

Supplementary Table S3. Univariate and multivariate meta-regression models of variables associated with serologic response after two doses of mRNA vaccine

	Univariate meta-regression			Multivariate meta-regression		
	Coefficient	95% CI	P-value	Coefficient	95% CI	P-value
Age	-0.047	-0.12-0.026	0.21	-0.10	-0.19-(-0.020)	0.016
Female	0.0013	-0.015-0.017	0.87	-0.019	-0.043-0.0046	0.12
Steroid	-0.0096	-0.018-(-0.0015)	0.021	-0.014	-0.025-(-0.0024)	0.017
BNT162b2 vs. Mixed	0.46	-0.030-0.95	0.066	0.52	0.25-1.29	0.19
BNT162b2 vs. mRNA-1273	-0.074	-0.76-0.61	0.83	0.23	-0.58-1.04	0.58
Heart/lung vs. Kidney	0.10	-0.52-0.73	0.75	-0.39	-1.23-0.46	0.37
Heart/lung vs. Liver	0.96	-0.32-2.24	0.14	-0.0008	-1.52-1.52	1.00
Heart/lung vs. Mixed	0.49	-0.15-1.14	.13	-0.18	-1.02-0.65	0.67

Supplementary Table S4. Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) criteria for studies included in the meta-analysis

(A) Meta-analysis of observational studies assessing serological response after one dose of vaccine

Number of participants	Starting Level of Evidence	Quality assessment					Reasons to increase level of evidence (Large magnitude of effect; Dose-response gradient; Potential confounding)	Overall quality of evidence
		Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication bias		
3543	Low	Not serious	Not serious	Serious	Not serious	Not serious	N/A	Low

(B) Meta-analysis of case control studies comparing serological response after one dose of vaccine to controls

Number of participants	Starting Level of Evidence	Quality assessment					Reasons to increase level of evidence (Large magnitude of effect; Dose-response gradient; Potential confounding)	Overall quality of evidence
		Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication bias		
349 (cases) and 146 (controls)	Low	Not serious	Serious	Serious	Not serious	Not serious	N/A	Low

(C) Meta-analysis of observational studies assessing serological response after two doses of vaccine

Number of participants	Starting Level of Evidence	Quality assessment					Reasons to increase level of evidence (Large magnitude of effect; Dose-response gradient; Potential confounding)	Overall quality of evidence
		Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication bias		
4971	Low	Not serious	Not serious	Serious	Not serious	Not serious	N/A	Low

(D) Meta-analysis of case control studies comparing serological response after two doses of vaccine to controls

Number of participants	Starting Level of Evidence	Quality assessment					Reasons to increase level of evidence (Large magnitude of effect; Dose-response gradient; Potential confounding)	Overall quality of evidence
		Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication bias		
1106 (cases) and 673 (controls)	Low	Not serious	Serious	Serious	Not serious	Not serious	N/A	Low

(E) Meta-analysis of observational studies assessing serological response after three doses of vaccine

Number of participants	Starting Level of Evidence	Quality assessment					Reasons to increase level of evidence (Large magnitude of effect; Dose-response gradient; Potential confounding)	Overall quality of evidence
		Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication bias		
810	Low	Not serious	Not serious	Serious	Not serious	Not serious	N/A	Low