

Supplemental Online Content

Tsampasian V, Elghazaly H, Chattopadhyay R, et al. Risk factors associated with post-COVID-19 condition: a systematic review and meta-analysis. *JAMA Intern Med*. Published online March 23, 2023. doi:10.1001/jamainternmed.2023.0750

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This supplemental material has been provided by the authors to give readers additional information about their work.

eMethods. Search Strategy in PubMed

1. Long COVID.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
2. Post COVID.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
3. Chronic COVID.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
4. 1 or 2 or 3
5. Risk*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
6. Variable*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
7. Predictor*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
8. Factor*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
9. 5 or 6 or 7 or 8
10. 4 and 9

eTable 1. Newcastle-Ottawa Quality Assessment table for included cohort studies

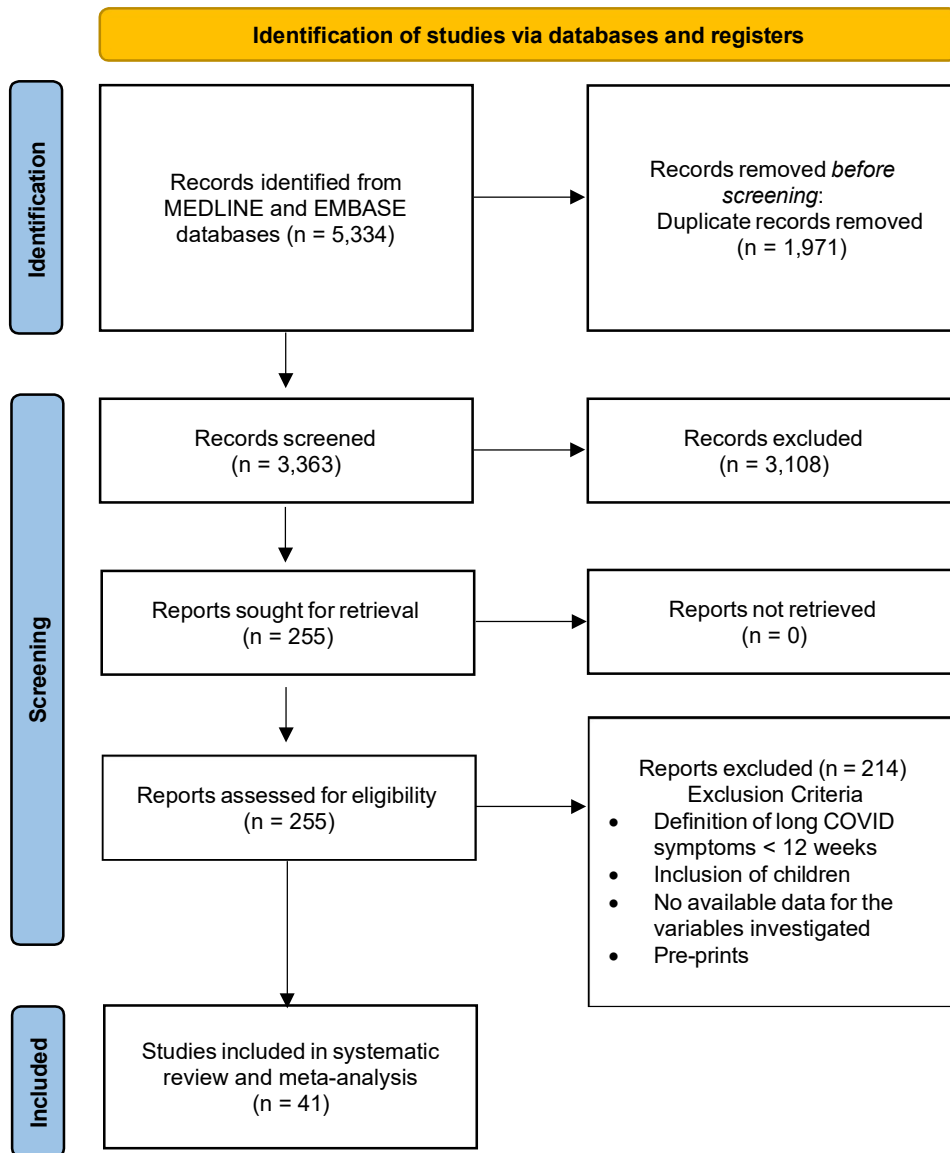
Study	Selection	Comparability	Outcome	Total	Quality of Study
Abdelrahman et al. ³⁸	***	**	**	7	High
Aranda et al. ³⁹	***	**	***	8	High
Asadi-Pooya et al. ⁴⁰	***	*	**	6	Moderate
Augustin et al. ⁴¹	***	**	**	7	High
Ayoubkhani et al. ⁴²	***	**	**	7	High
Baruch et al. ⁴³	***	**	***	8	High
Bellan et al. ⁴⁴	***	**	**	7	High
Blomberg et al. ⁴⁵	***	**	***	8	High
Chudzik et al. ⁴⁶	***	**	**	7	High
Daitch et al. ⁴⁷	***	**	***	8	High
Debski et al. ⁴⁸	***	**	**	7	High
Dias et al. ⁵⁰	***	**	**	7	High
Emecen et al. ⁵¹	***	**	**	7	High
Estrada-Codecido et al. ⁵²	***	**	**	7	High
Fernández-de-las-Peñas et al. ⁵³	***	*	***	7	High
Fernández-de-las-Peñas et al. ⁵⁴	***	**	***	8	High
Fernández-de-las-Peñas et al. ⁵⁵	***	**	***	8	High
Fernández-de-las-Peñas et al. ⁵⁶	***	**	***	8	High
Fernández-de-las-Peñas et al. ⁵⁷	***	**	***	8	High
Fernández-de-las-Peñas et al. ⁵⁸	***	**	***	8	High
Fernández-de-las-Peñas et al. ⁵⁹	***	*	***	7	High
Ioannou et al. ⁶⁰	***	**	***	8	High
Jones et al. ¹³	***	**	***	8	High
Kisiel et al. ⁶¹	**	**	**	6	Moderate
Kostev et al. ⁶²	***	**	**	7	High
Menezes et al. ⁶³	**	**	**	6	Moderate
Munblit et al. ⁶⁴	***	**	**	7	High
Pazukhina et al. ⁶⁵	**	**	**	6	Moderate
Peghin et al. ⁶⁶	***	**	***	8	High
Peters et al. ⁶⁷	**	**	**	6	Moderate
Petersen et al. ⁶⁸	**	**	**	6	Moderate
Righi et al. ⁶⁹	***	**	**	7	High
Silverberg et al. ⁷⁰	**	**	**	6	Moderate
Štěpánek et al. ⁷¹	**	**	**	6	Moderate
Subramanian et al. ⁷²	***	**	***	8	High
Thompson et al. ²⁴	***	**	***	8	High
Tleyjeh et al. ⁷³	**	**	**	6	Moderate
Whitaker et al. ⁷⁴	***	**	**	7	High
Wu et al. ⁷⁵	***	**	**	7	High
Zhang et al. ⁷⁶	**	**	***	7	High
Zisis et al. ⁷⁷	***	**	***	8	High

*Each star indicates a point for each component. Any study can obtain a maximum of four, two and three stars for each component (selection, comparability, outcomes) respectively. Trials with a total score of 7 or higher are considered to be high-quality studies, and those lower than 5 are considered as low-quality studies. These scores indicate at least moderate quality of the included trials.

eTable 2. Meta-regression analysis by geographic location

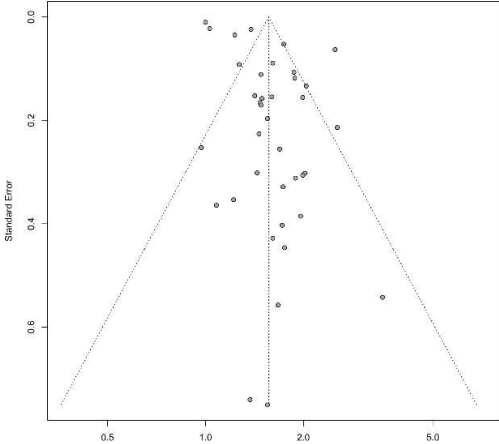
Risk factor	Geographic location	Significance (p value)
Female Sex	America	0.49
	Asia	0.74
	Europe	0.85
	International	0.84
Age	Asia	0.97
	Europe	0.19
Obesity	Europe	0.76
	International	0.12
Smoking	America	0.82
	Asia	0.54
	Europe	0.48
Diabetes	Europe	0.02
Asthma	Europe	<0.001
IHD	Europe	0.54
CKD	Europe	0.12
COPD	Europe	0.49
	International	0.59
Immunosuppression	Europe	0.75
Anxiety/Depression	Europe	0.84
Hospitalisations	America	0.88
	Asia	0.56
	Europe	0.75
ICU admissions	Asia	0.35
	Europe	0.36
Vaccination status	Asia	0.89
	Europe	0.97

eFigure 1. PRISMA flow diagram of the study selection process

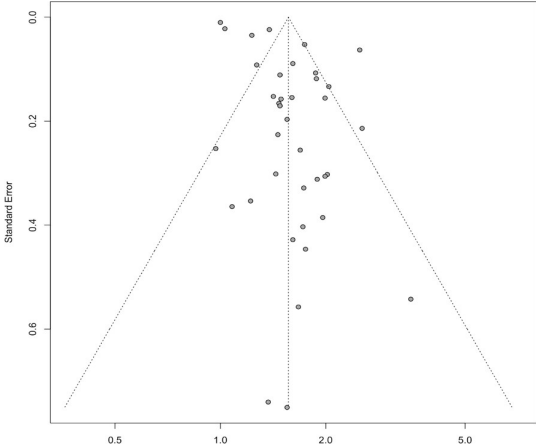


eFigure 2. Funnel plots assessing publication bias for each group meta-analysis: A) Sex, B) Age, C) Obesity, D) Smoking, E) Asthma, F) COPD, G) DM, H) CKD, I) IHD, J) Immunosuppression, K) Anxiety/Depression, L) Hospitalisation, M) ICU admission, N) Vaccination status

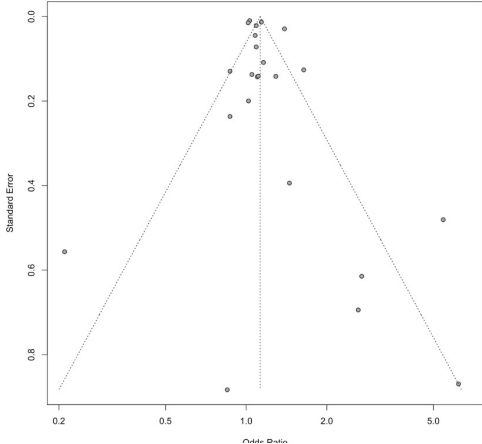
A) Female Sex



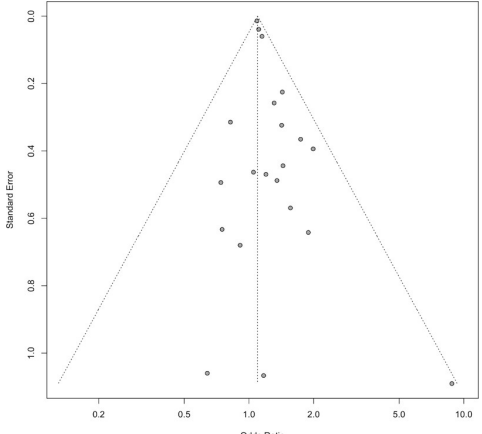
B) Age



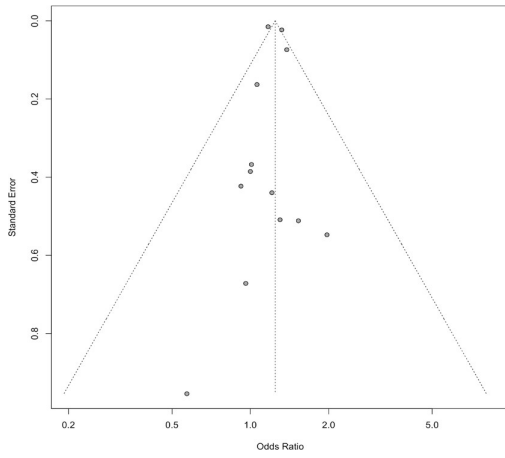
C) Obesity



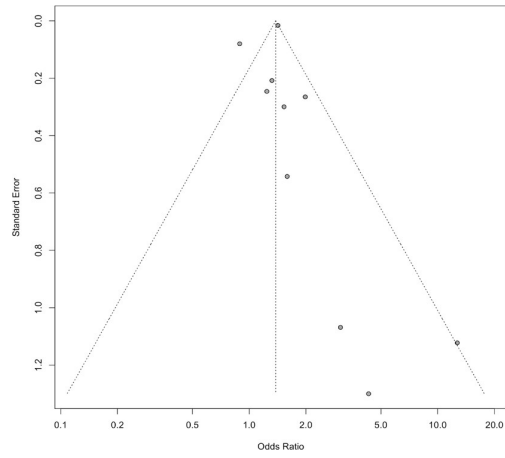
D) Smoking



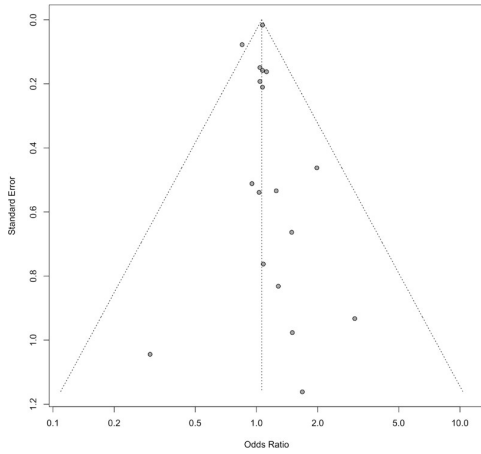
E) Asthma



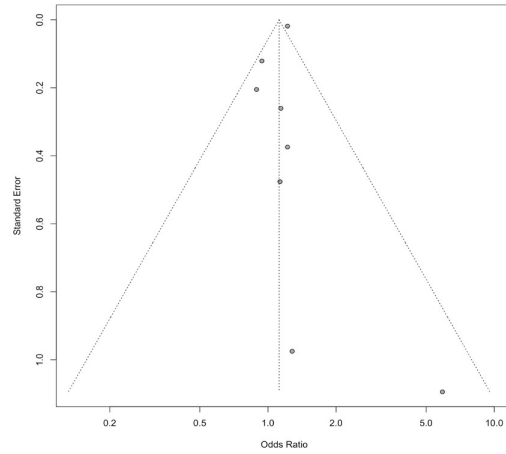
F) COPD



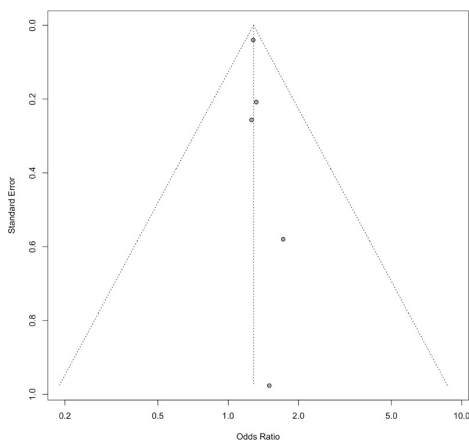
G) DM



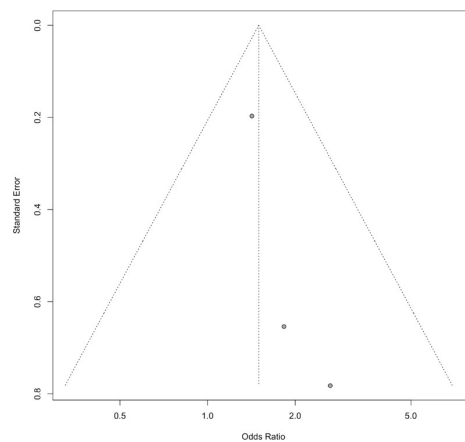
H) CKD



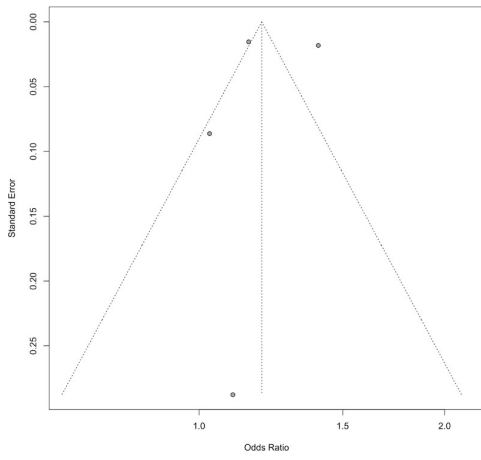
I) IHD



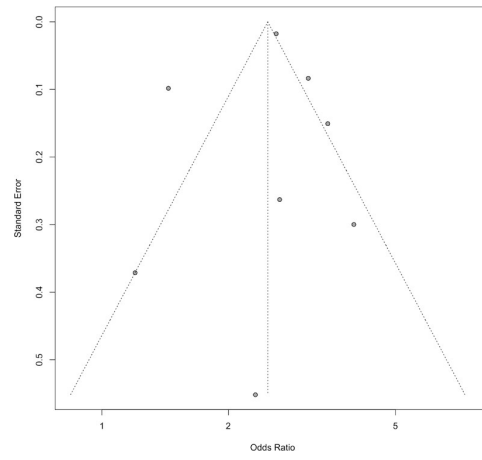
J) Immunosuppression



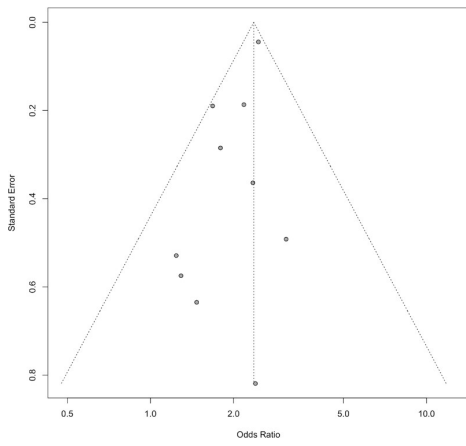
K) Anxiety/Depression



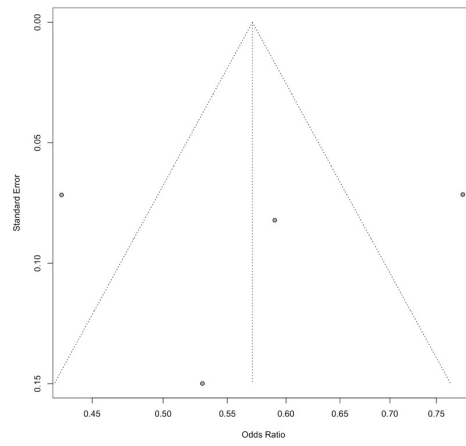
L) Hospitalisation



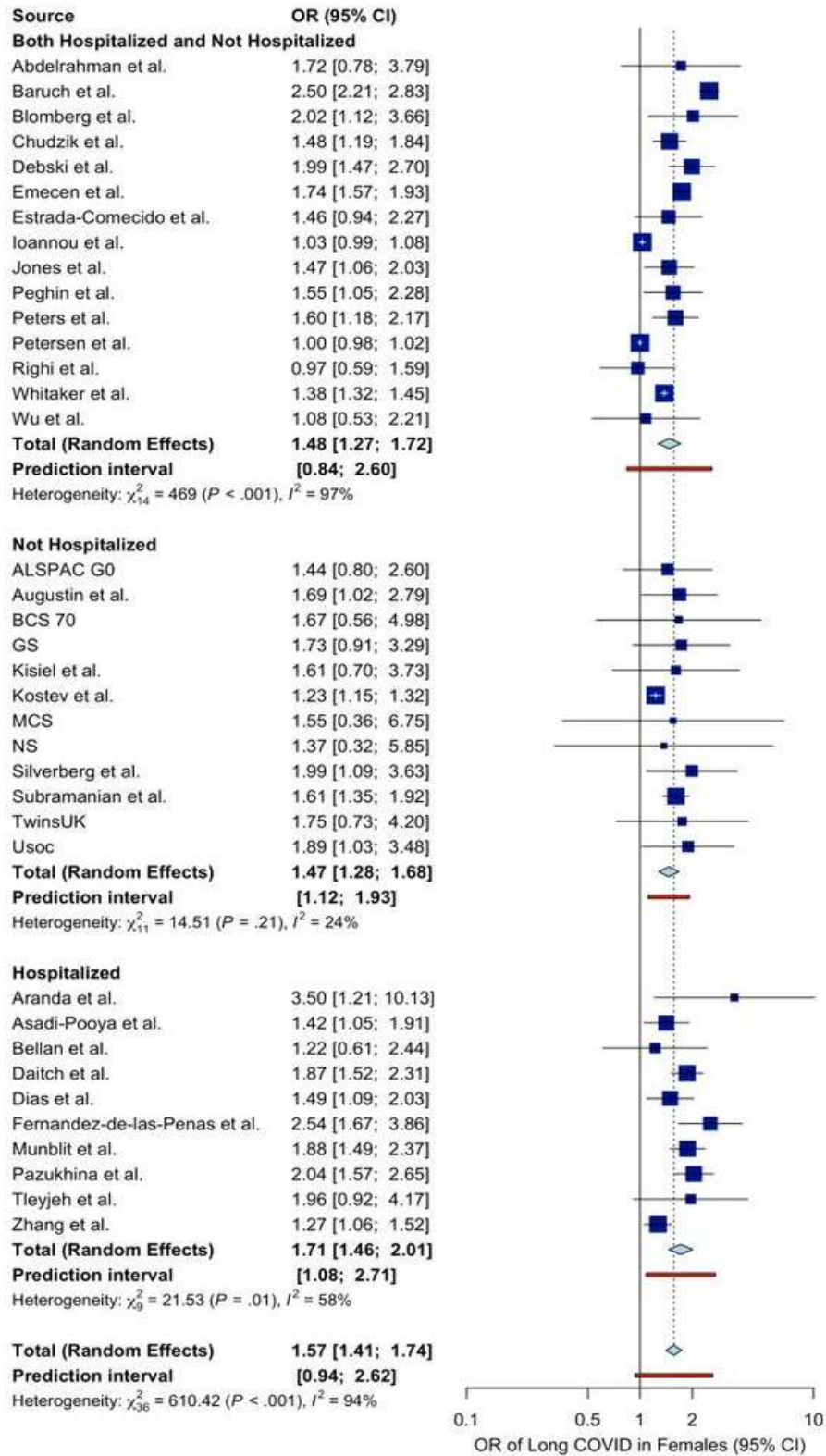
M) ICU admission



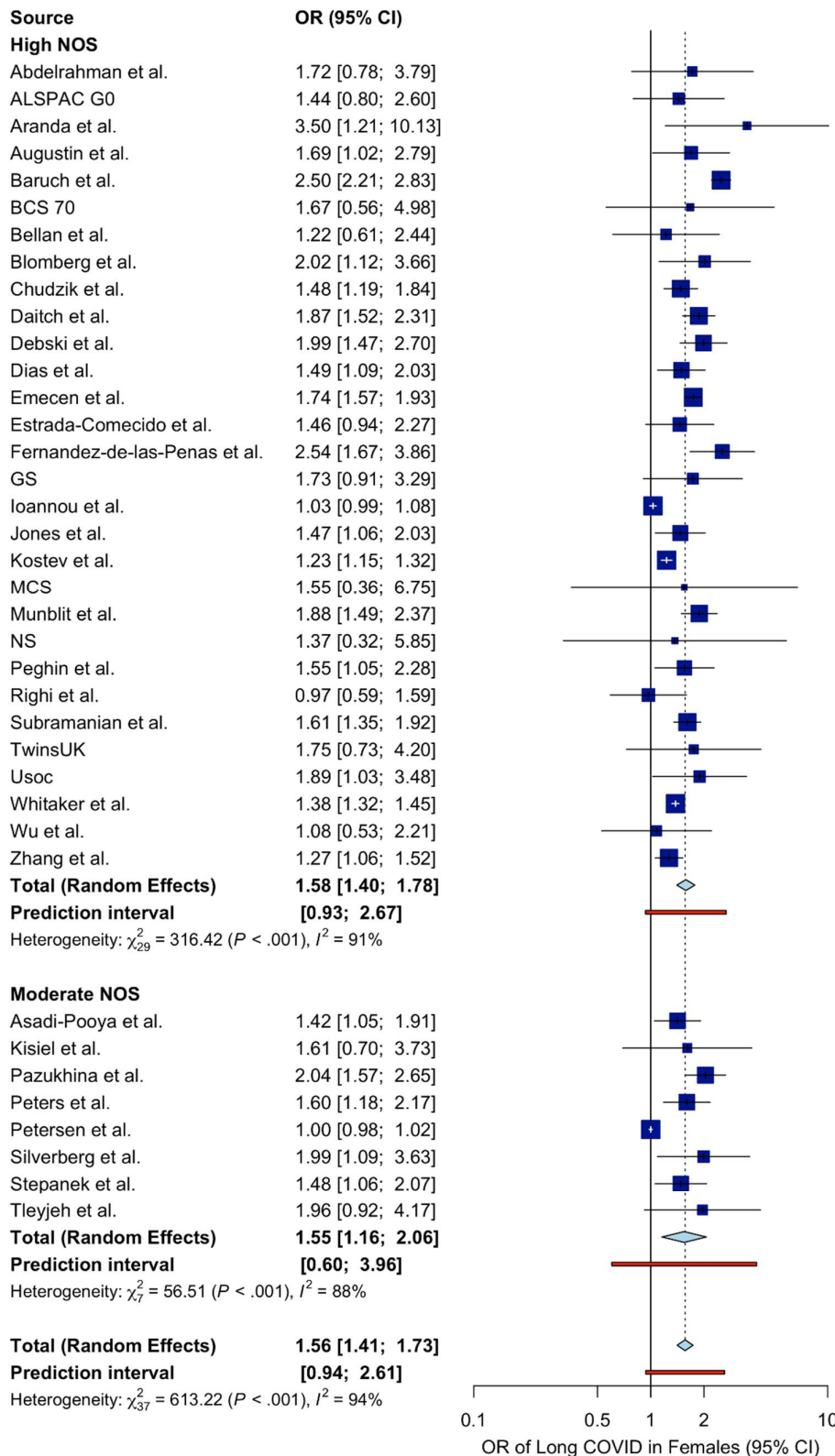
N) Vaccination status



eFigure 3. Subgroup analysis of studies investigating the correlation of female sex and development of post-COVID-19 condition according to study population

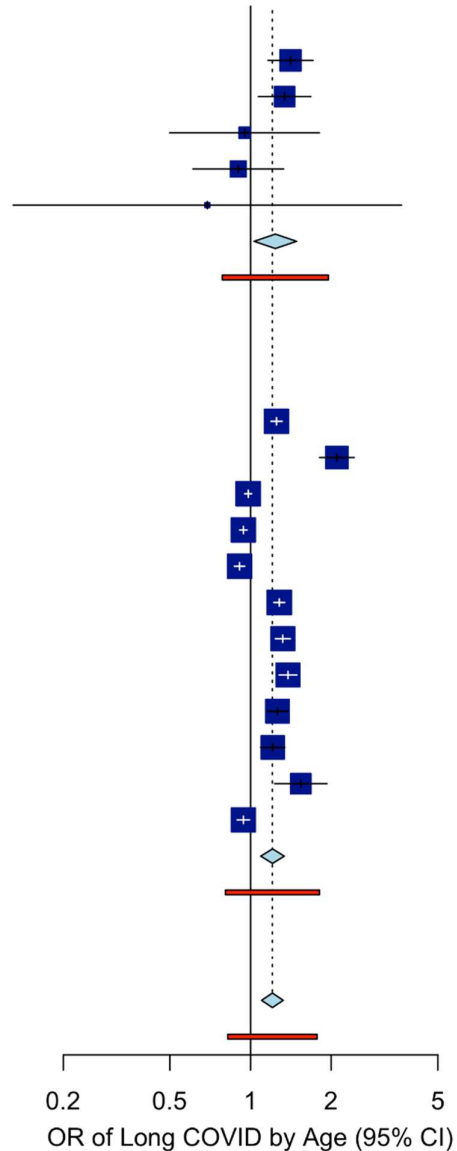


eFigure 4. Subgroup analysis of studies investigating the correlation of female sex and development of post-COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)

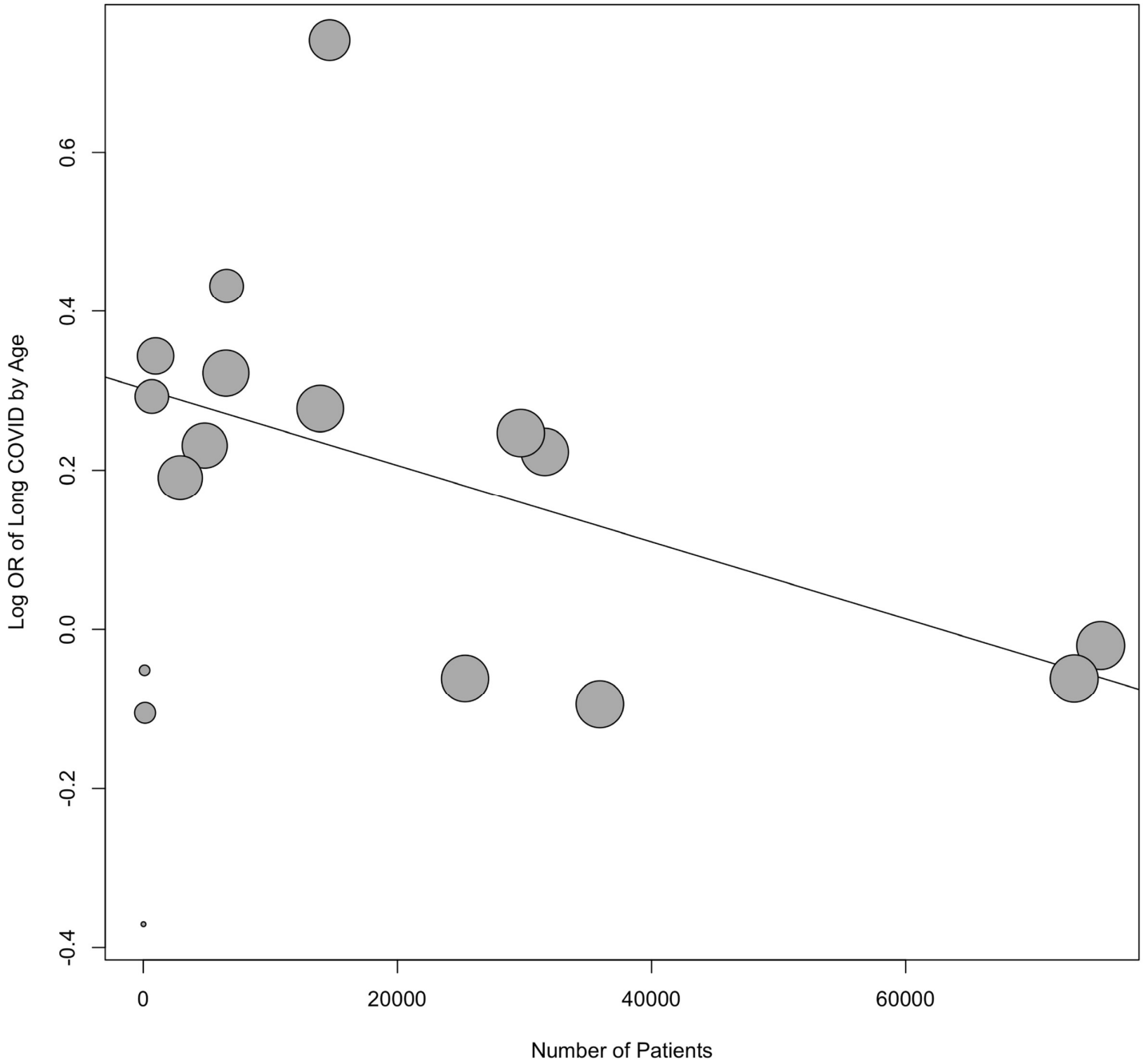


eFigure 5. Subgroup analysis of studies investigating the correlation of age and development of post-COVID-19 condition according to study size

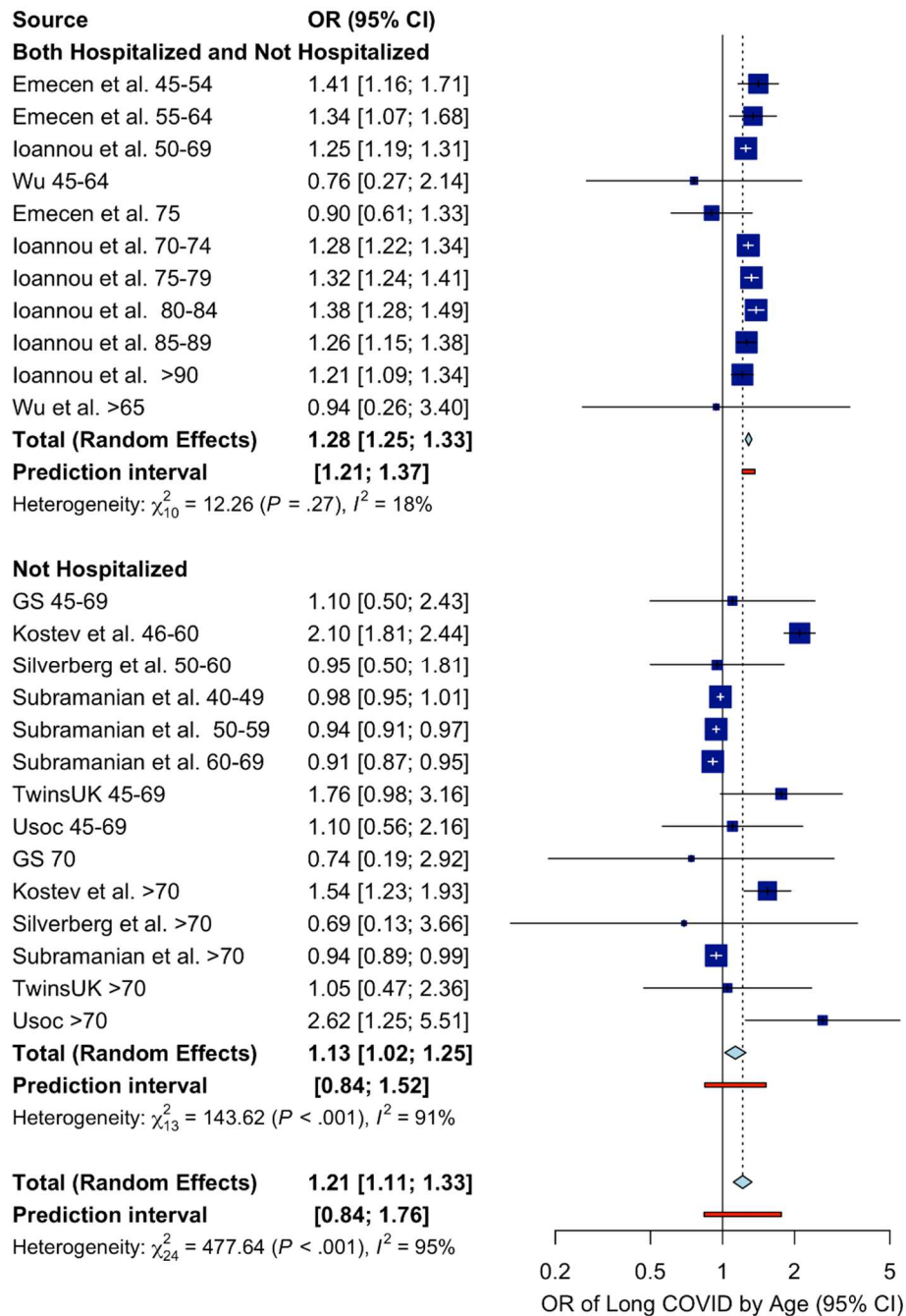
Source	OR (95% CI)
Fewer than 1000 Patients	
Emecen et al. 45-54	1.41 [1.16; 1.71]
Emecen et al. 55-64	1.34 [1.07; 1.68]
Silverberg et al. 50-60	0.95 [0.50; 1.81]
Emecen et al. 75	0.90 [0.61; 1.33]
Silverberg et al. >70	0.69 [0.13; 3.66]
Total (Random Effects)	1.24 [1.03; 1.49]
Prediction interval	[0.78; 1.95]
Heterogeneity: $\chi^2_4 = 5.6$ ($P = .23$), $I^2 = 29\%$	
More than 1000 Patients	
Ioannou et al. 50-69	1.25 [1.19; 1.31]
Kostev et al. 46-60	2.10 [1.81; 2.44]
Subramanian et al. 40-49	0.98 [0.95; 1.01]
Subramanian et al. 50-59	0.94 [0.91; 0.97]
Subramanian et al. 60-69	0.91 [0.87; 0.95]
Ioannou et al. 70-74	1.28 [1.22; 1.34]
Ioannou et al. 75-79	1.32 [1.24; 1.41]
Ioannou et al. 80-84	1.38 [1.28; 1.49]
Ioannou et al. 85-89	1.26 [1.15; 1.38]
Ioannou et al. >90	1.21 [1.09; 1.34]
Kostev et al. >70	1.54 [1.23; 1.93]
Subramanian et al. >70	0.94 [0.89; 0.99]
Total (Random Effects)	1.21 [1.09; 1.34]
Prediction interval	[0.81; 1.81]
Heterogeneity: $\chi^2_{11} = 455.09$ ($P < .001$), $I^2 = 98\%$	
Total (Random Effects)	1.21 [1.10; 1.32]
Prediction interval	[0.82; 1.77]
Heterogeneity: $\chi^2_{16} = 468.41$ ($P < .001$), $I^2 = 97\%$	



eFigure 6. Meta-regression analysis bubble plot of studies investigating age as risk factor for post-COVID-19 condition



eFigure 7. Subgroup analysis of studies investigating the correlation of age and development of post-COVID-19 condition according to study population



eFigure 8. Subgroup analysis of studies investigating the correlation of age and development of post-COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)

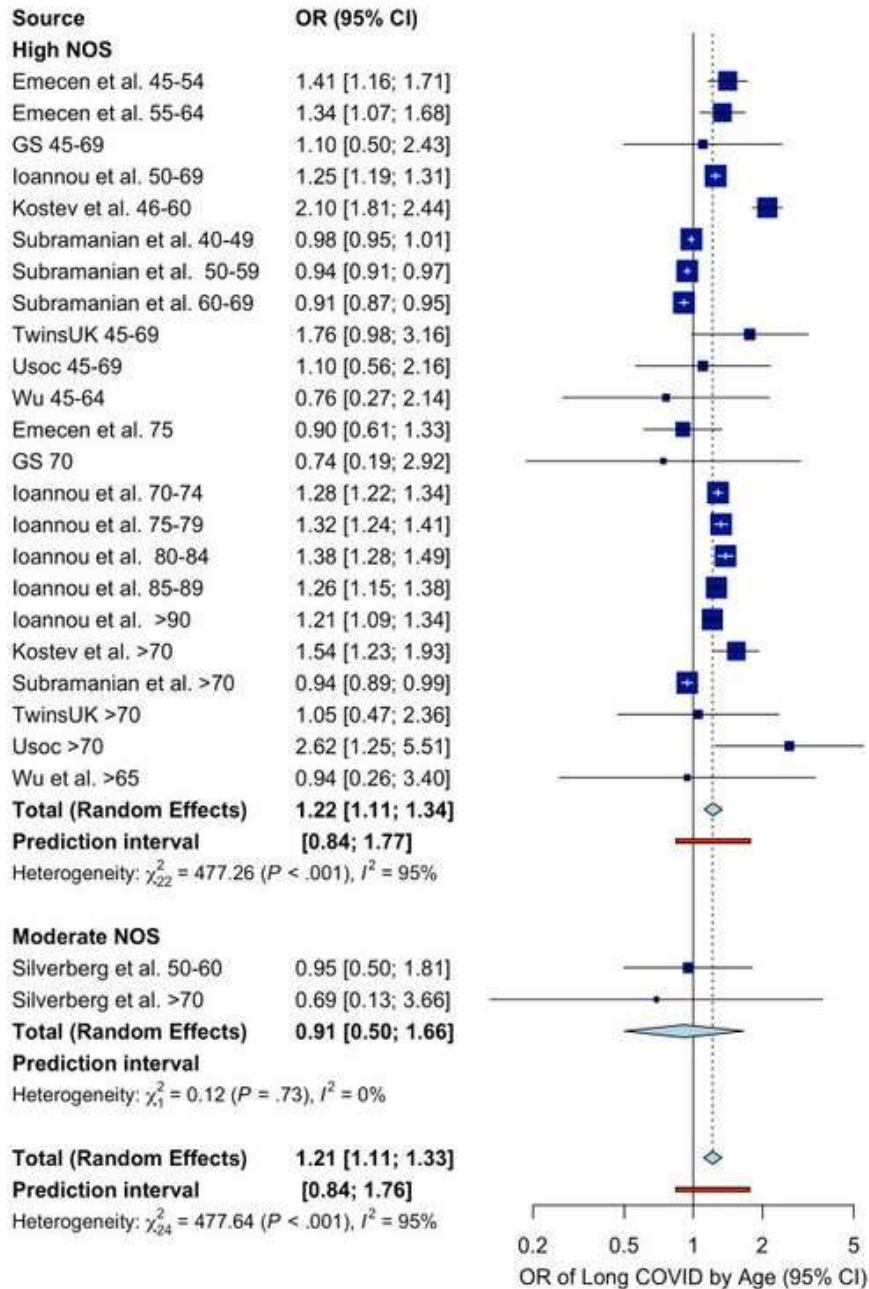
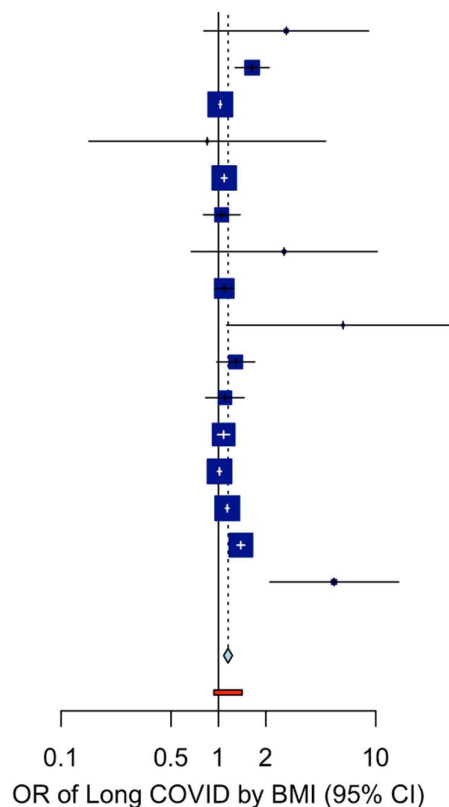
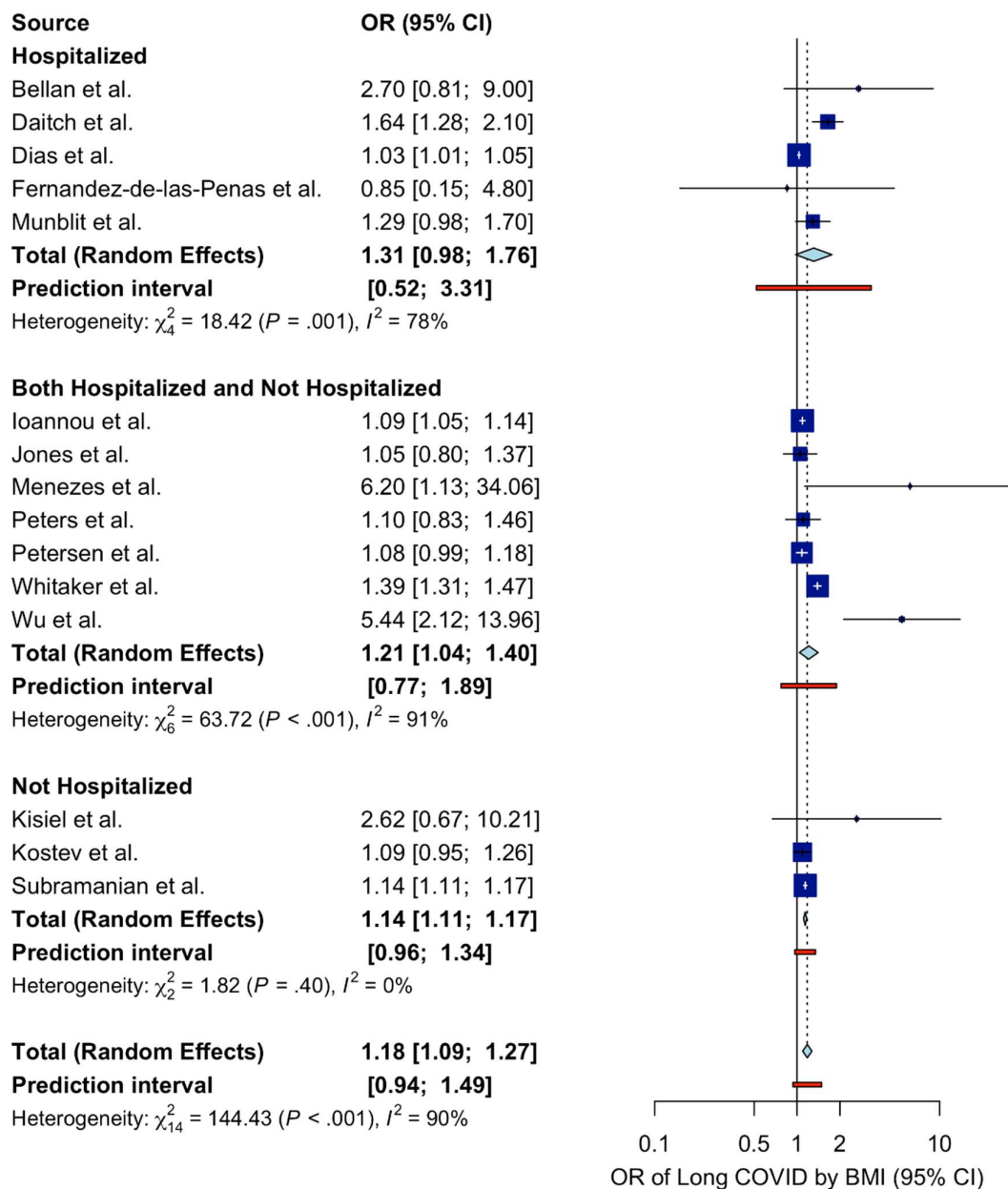


Figure 9. Forest plot showing the effect of BMI on post-COVID-19 condition. Individuals with obesity have an increased risk of developing post-COVID-19 condition.

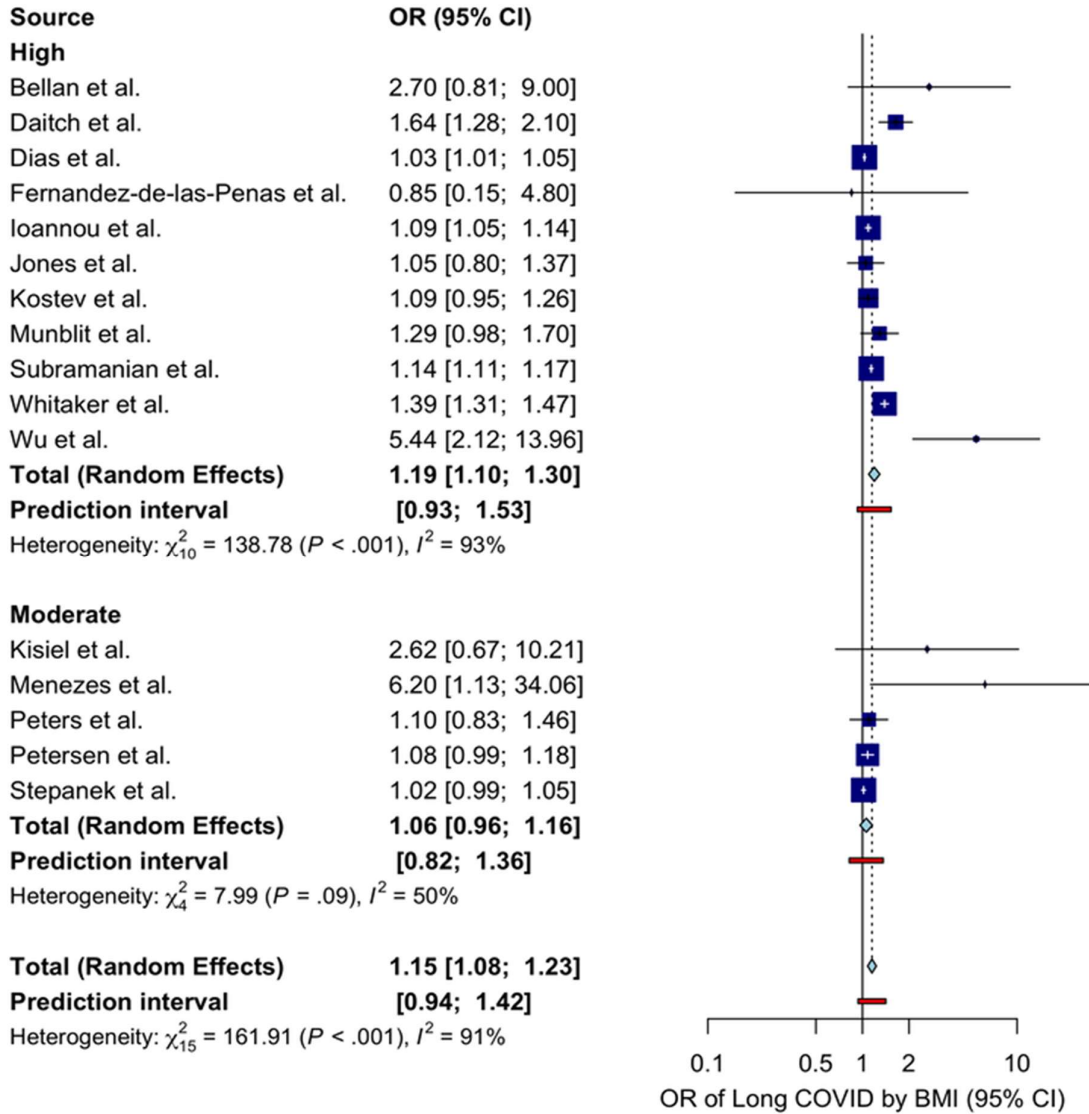
Source	OR (95% CI)
Bellan et al.	2.70 [0.81; 9.00]
Daitch et al.	1.64 [1.28; 2.10]
Dias et al.	1.03 [1.01; 1.05]
Fernandez-de-las-Penas et al.	0.85 [0.15; 4.80]
Ioannou et al.	1.09 [1.05; 1.14]
Jones et al.	1.05 [0.80; 1.37]
Kisiel et al.	2.62 [0.67; 10.21]
Kostev et al.	1.09 [0.95; 1.26]
Menezes et al.	6.20 [1.13; 34.06]
Munblit et al.	1.29 [0.98; 1.70]
Peters et al.	1.10 [0.83; 1.46]
Petersen et al.	1.08 [0.99; 1.18]
Stepanek et al.	1.02 [0.99; 1.05]
Subramanian et al.	1.14 [1.11; 1.17]
Whitaker et al.	1.39 [1.31; 1.47]
Wu et al.	5.44 [2.12; 13.96]
Total (Random Effects)	1.15 [1.08; 1.23]
Prediction interval	[0.94; 1.42]
Heterogeneity: $\chi^2_{15} = 161.91$ ($P < .001$), $I^2 = 91\%$	



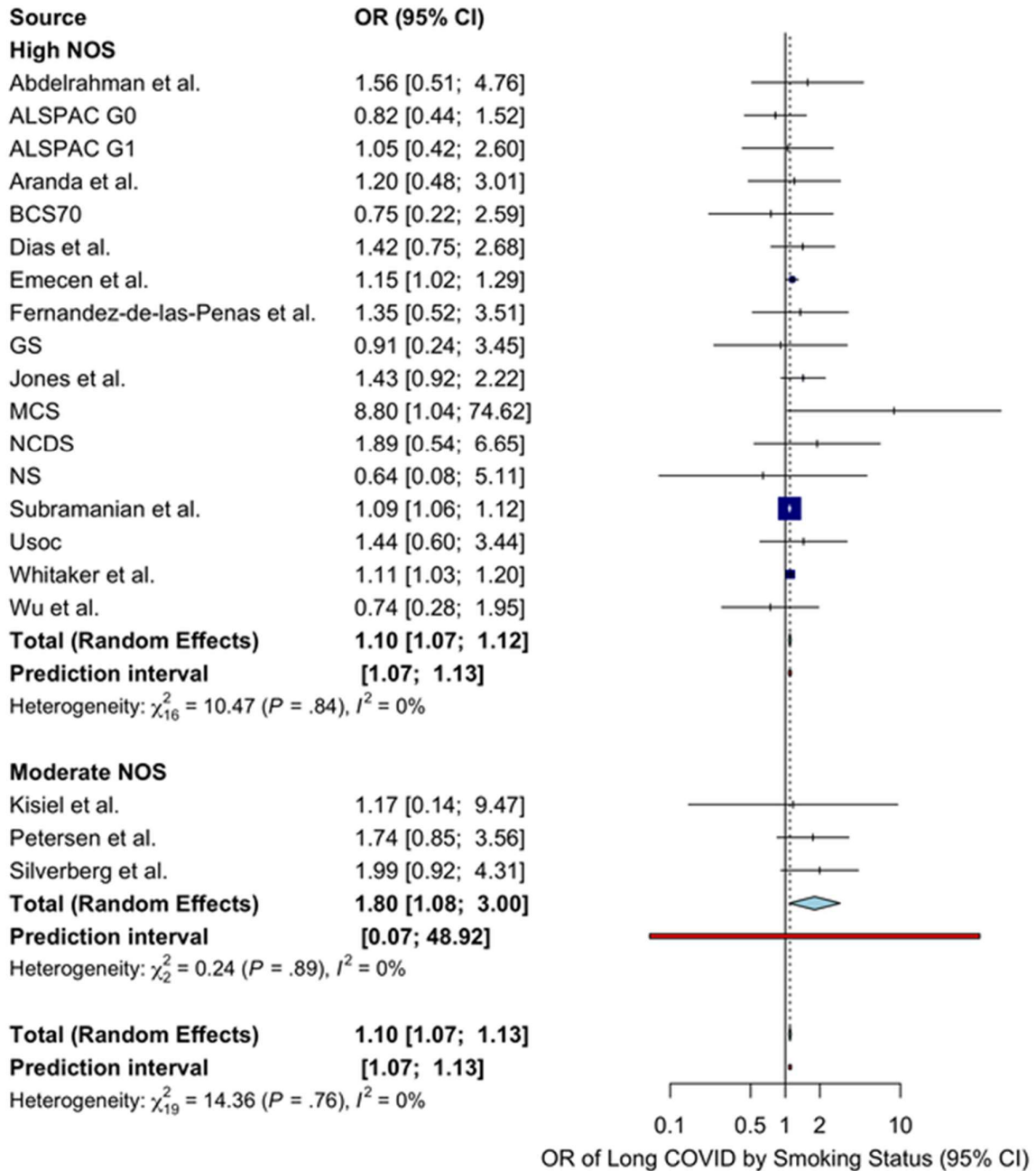
eFigure 10. Subgroup analysis of studies investigating the correlation of obesity and development of post-COVID-19 condition according to study population



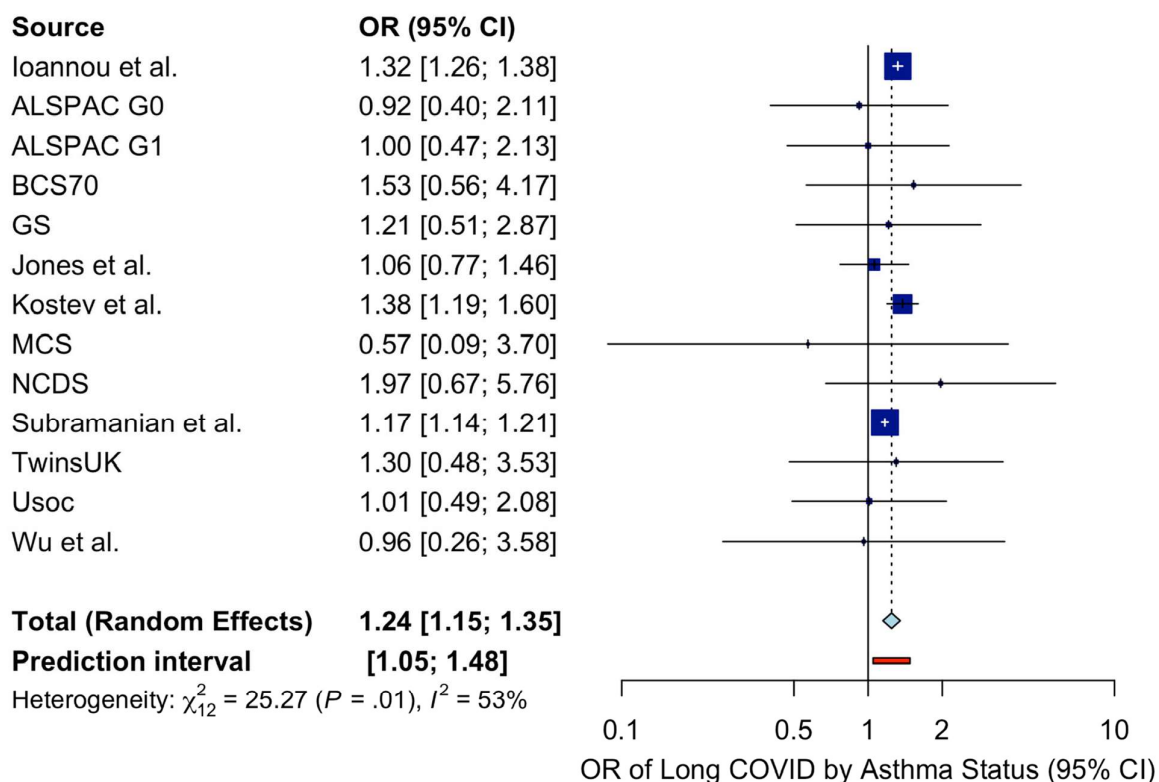
eFigure 11. Subgroup analysis of studies investigating the correlation of obesity and development of post-COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)



eFigure 12. Subgroup analysis of studies investigating the correlation of smoking and development of post-COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)



eFigure 13. Forest plot showing the effect of asthma on post-COVID-19 condition. Individuals with asthma have an increased risk of developing post-COVID-19 condition.

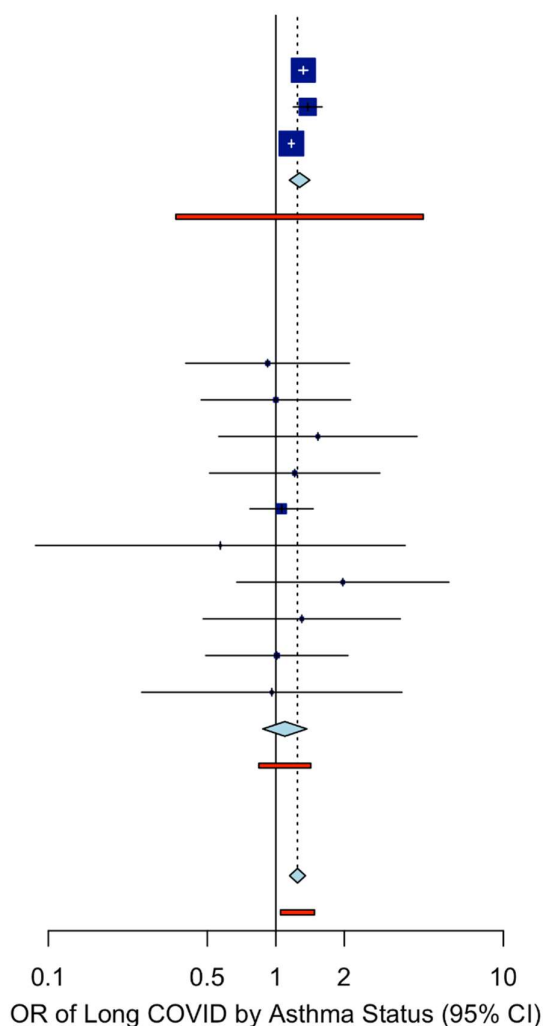


eFigure 14. Subgroup analysis of studies investigating the correlation of asthma and development of post-COVID-19 condition according to study size

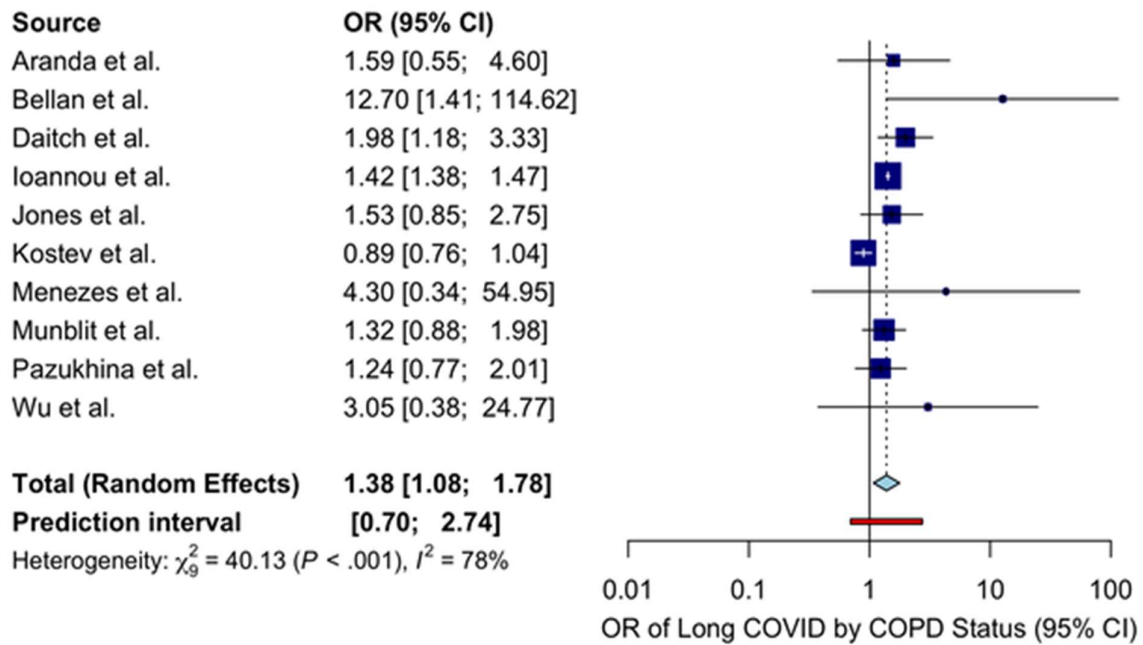
Source	OR (95% CI)
More than 1000 Patients	
Ioannou et al.	1.32 [1.26; 1.38]
Kostev et al.	1.38 [1.19; 1.60]
Subramanian et al.	1.17 [1.14; 1.21]
Total (Random Effects)	1.27 [1.15; 1.41]
Prediction interval	[0.36; 4.45]
Heterogeneity: $\chi^2_2 = 21.86$ ($P < .001$), $I^2 = 91\%$	

Fewer than 1000 Patients	
ALSPAC G0	0.92 [0.40; 2.11]
ALSPAC G1	1.00 [0.47; 2.13]
BCS70	1.53 [0.56; 4.17]
GS	1.21 [0.51; 2.87]
Jones et al.	1.06 [0.77; 1.46]
MCS	0.57 [0.09; 3.70]
NCDS	1.97 [0.67; 5.76]
TwinsUK	1.30 [0.48; 3.53]
Usoc	1.01 [0.49; 2.08]
Wu et al.	0.96 [0.26; 3.58]
Total (Random Effects)	1.10 [0.88; 1.37]
Prediction interval	[0.84; 1.42]
Heterogeneity: $\chi^2_9 = 2.56$ ($P = .98$), $I^2 = 0\%$	

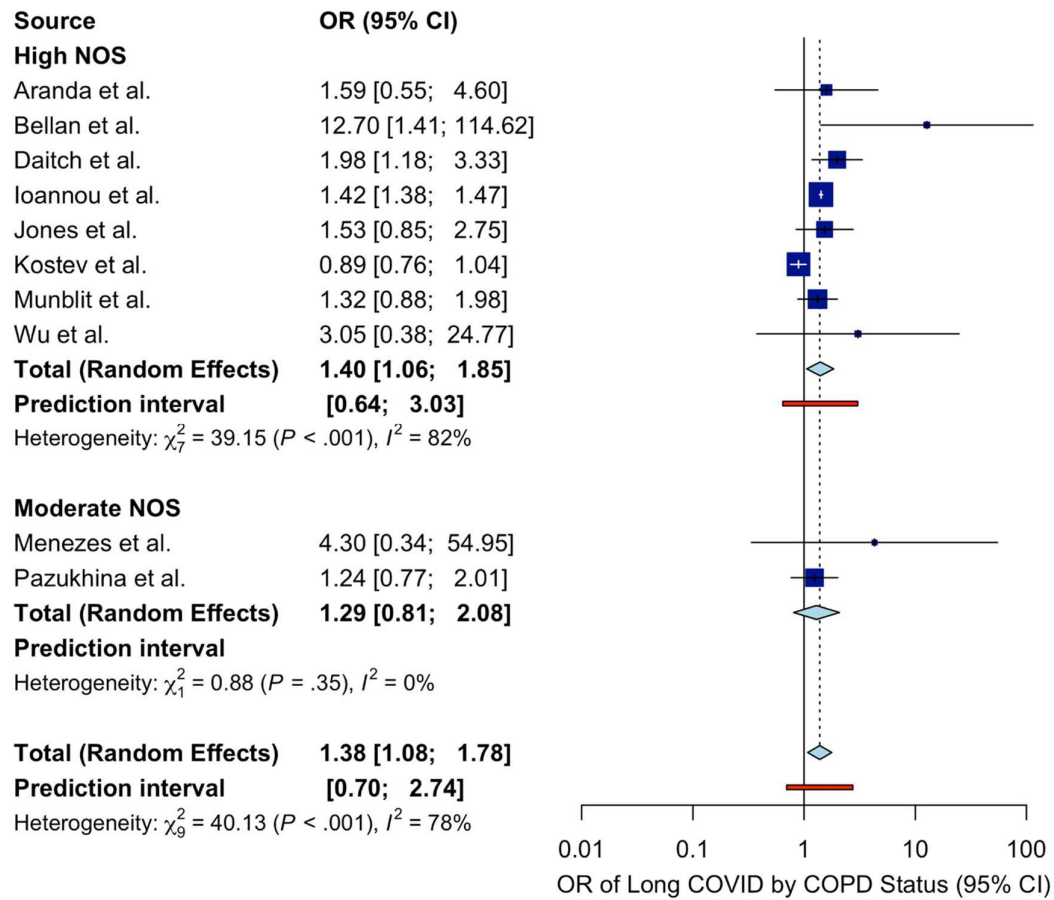
Total (Random Effects)	1.24 [1.15; 1.35]
Prediction interval	[1.05; 1.48]
Heterogeneity: $\chi^2_{12} = 25.27$ ($P = .01$), $I^2 = 53\%$	



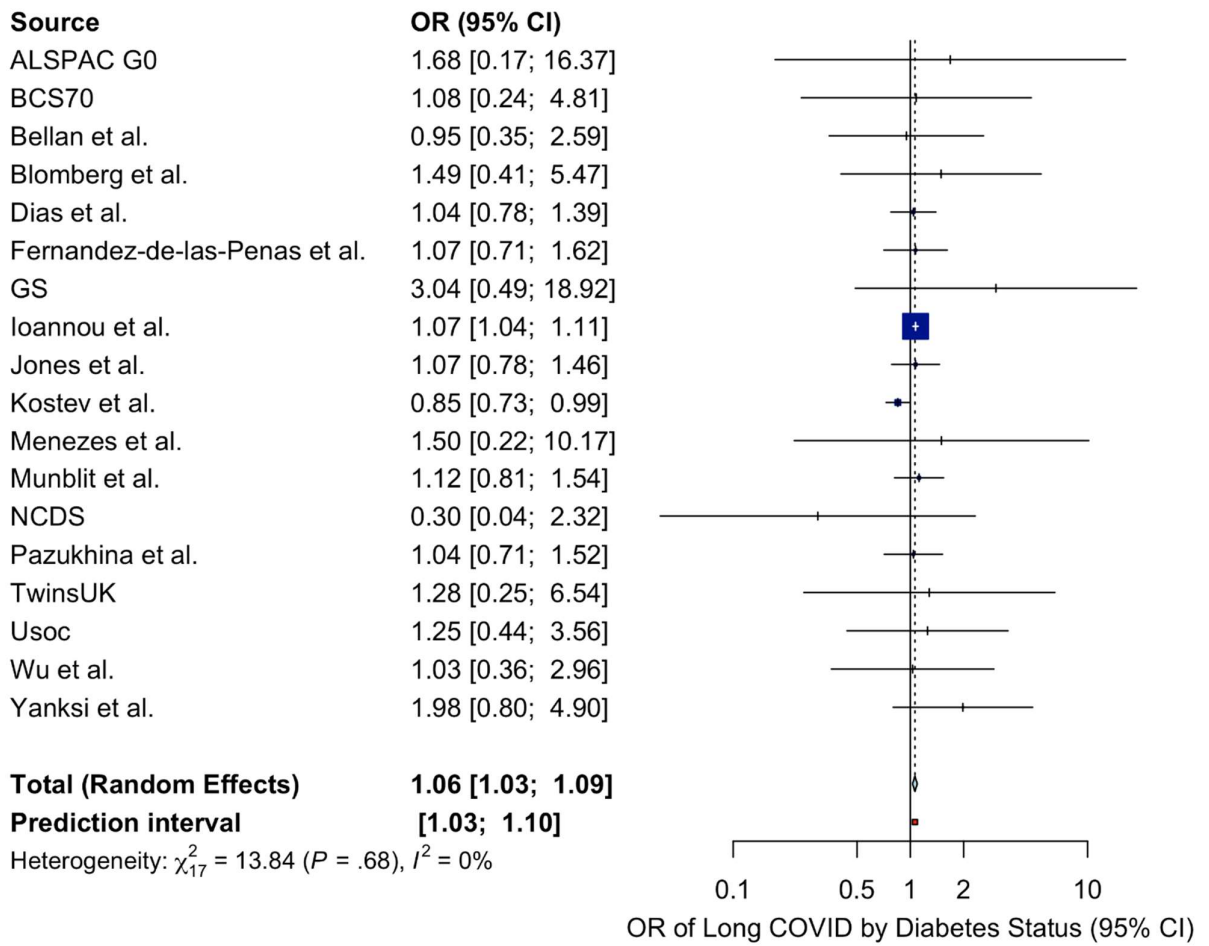
eFigure 15. Forest plot showing the effect of COPD on post-COVID-19 condition. Individuals with COPD have an increased risk of developing post-COVID-19 condition.



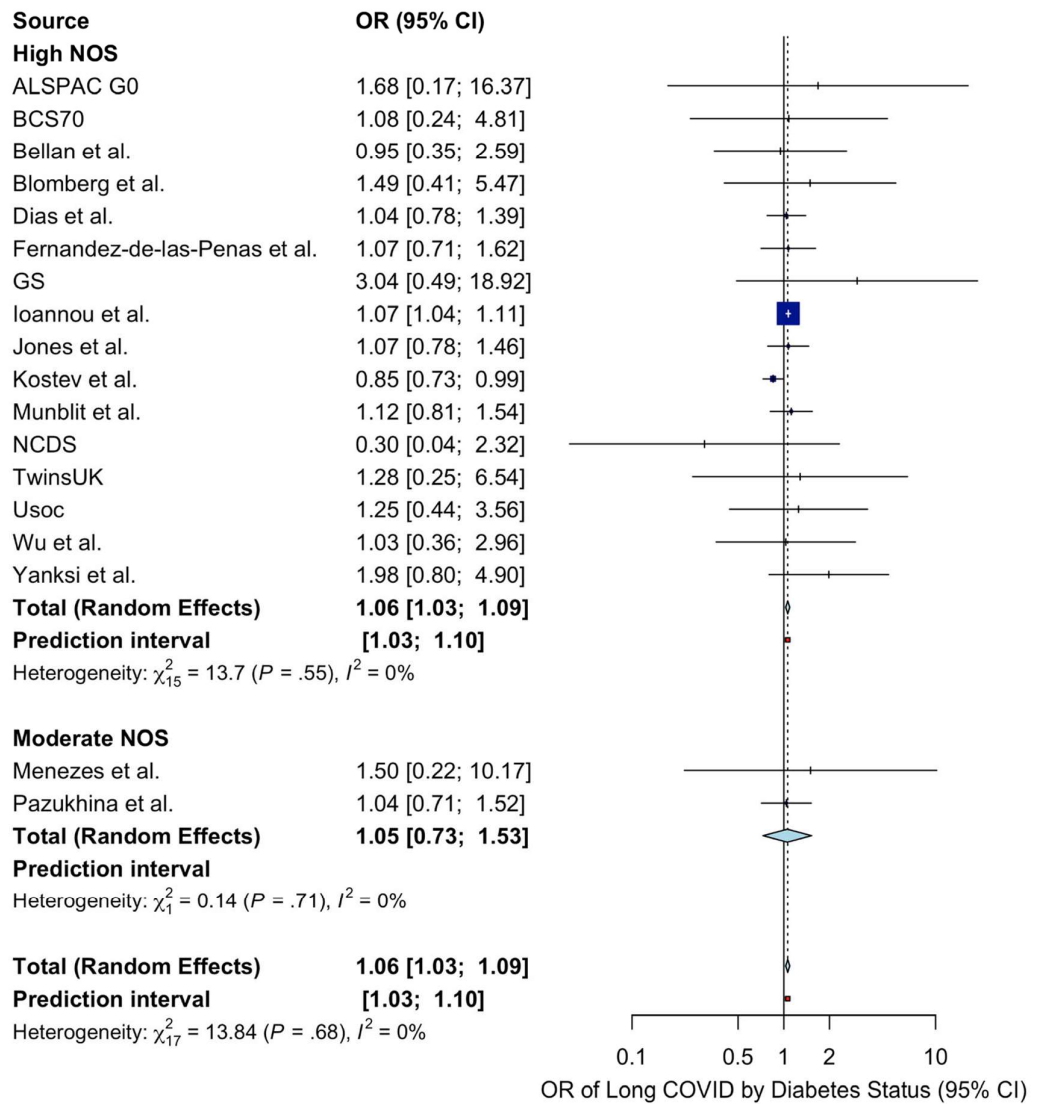
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eFigure 17. Forest plot showing the effect of diabetes on post-COVID-19 condition. Individuals with diabetes have an increased risk of developing post-COVID-19 condition.

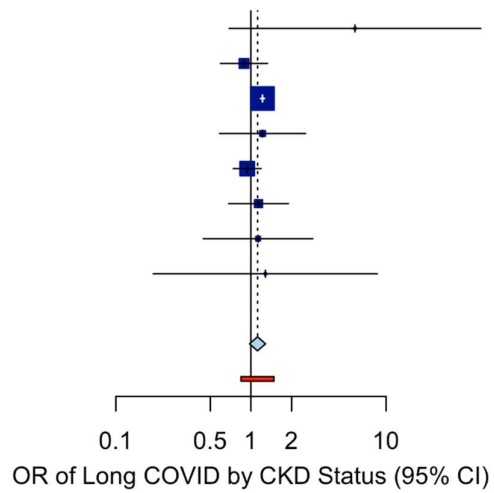


eFigure 18. Subgroup analysis of studies investigating the correlation of diabetes and development of post-COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)



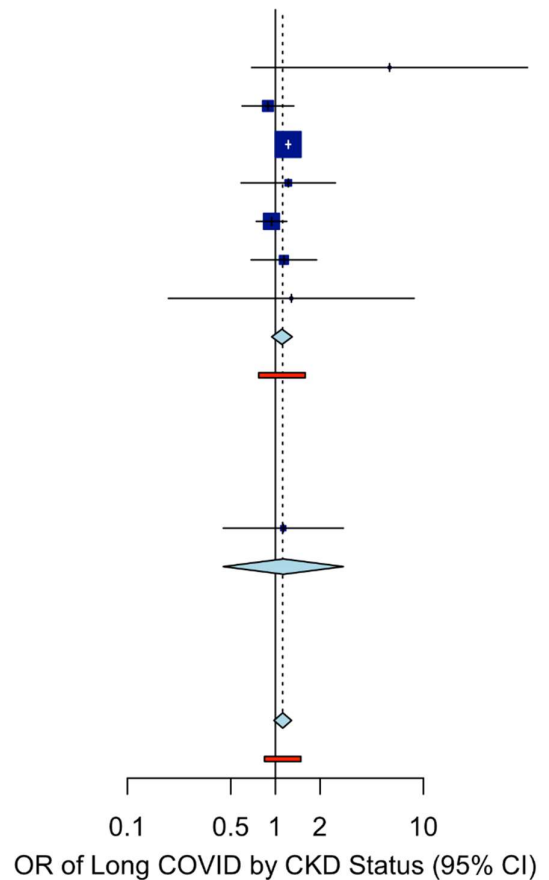
eFigure 19. Forest plot showing the effect of CKD on post-COVID-19 condition. CKD was not significantly associated with post-COVID-19 condition.

Source	OR (95% CI)
Bellan et al., 2021	5.90 [0.69; 50.40]
Dias	0.89 [0.60; 1.33]
Ioannou	1.22 [1.18; 1.27]
Jones	1.22 [0.59; 2.54]
Kostev	0.94 [0.74; 1.19]
Munblit et al., 2021	1.14 [0.68; 1.90]
Pazukhina	1.13 [0.44; 2.87]
Wu	1.28 [0.19; 8.65]
Total (Random Effects)	1.12 [0.98; 1.28]
Prediction interval	[0.85; 1.48]
Heterogeneity: $\chi^2_7 = 8.95$ ($P = .26$), $I^2 = 22\%$	



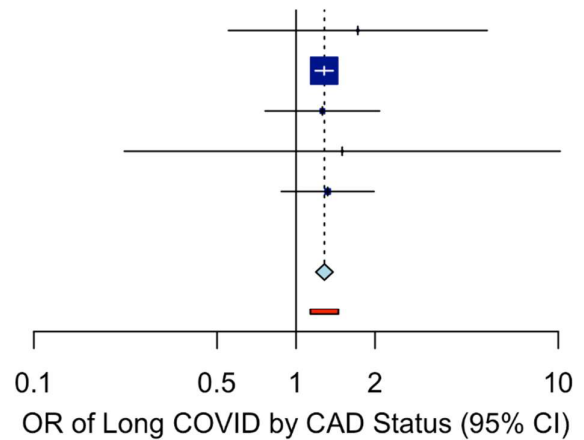
eFigure 20. Subgroup analysis of studies investigating the correlation of CKD and development of post-COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)

Source	OR (95% CI)
High NOS	
Bellan et al., 2021	5.90 [0.69; 50.40]
Dias	0.89 [0.60; 1.33]
Ioannou	1.22 [1.18; 1.27]
Jones	1.22 [0.59; 2.54]
Kostev	0.94 [0.74; 1.19]
Munblit et al., 2021	1.14 [0.68; 1.90]
Wu	1.28 [0.19; 8.65]
Total (Random Effects)	1.11 [0.94; 1.30]
Prediction interval	[0.77; 1.59]
Heterogeneity: $\chi^2_6 = 8.93$ ($P = .18$), $I^2 = 33\%$	
Moderate NOS	
Pazukhina	1.13 [0.44; 2.87]
Total (Random Effects)	1.13 [0.44; 2.87]
Prediction interval	
Heterogeneity: not applicable	
Total (Random Effects)	1.12 [0.98; 1.28]
Prediction interval	[0.85; 1.48]
Heterogeneity: $\chi^2_7 = 8.95$ ($P = .26$), $I^2 = 22\%$	



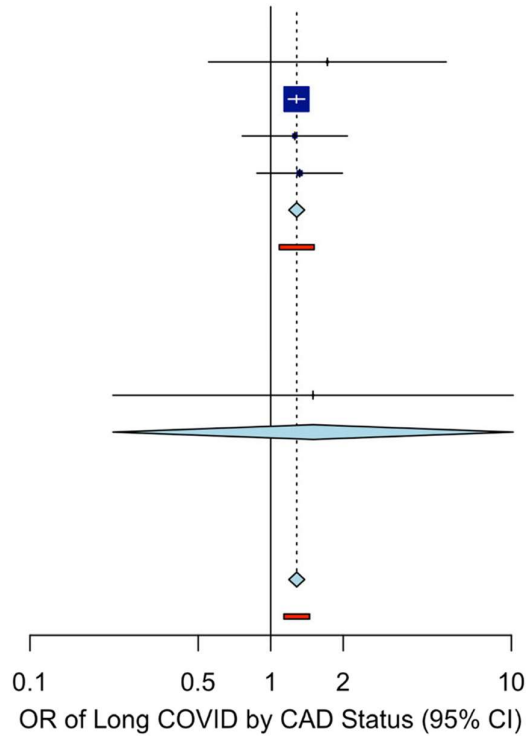
eFigure 21. Forest plot showing the association of IHD with post-COVID-19 condition. Individuals with IHD have an increased risk of developing post-COVID-19 condition.

Source	OR (95% CI)
Bellan et al.	1.72 [0.55; 5.36]
Ioannou et al.	1.28 [1.18; 1.38]
Jones et al.	1.26 [0.76; 2.08]
Menezes et al.	1.50 [0.22; 10.17]
Munblit et al.	1.32 [0.88; 1.98]
Total (Random Effects)	1.28 [1.19; 1.38]
Prediction interval	[1.13; 1.45]
Heterogeneity: $\chi^2_4 = 0.31$ ($P = .99$), $I^2 = 0\%$	



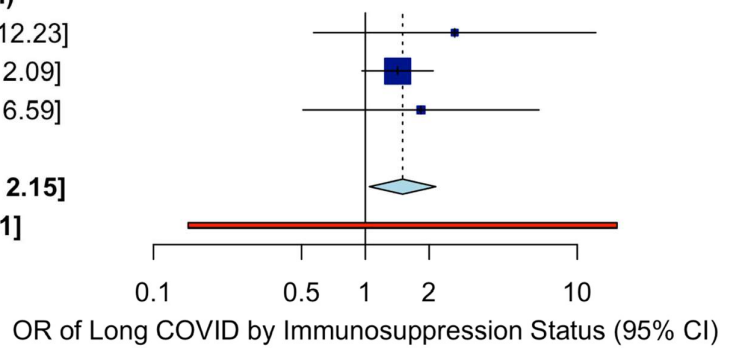
eFigure 22. Subgroup analysis of studies investigating the correlation of IHD and development of post-COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)

Source	OR (95% CI)
High NOS	
Bellan et al.	1.72 [0.55; 5.36]
Ioannou et al.	1.28 [1.18; 1.38]
Jones et al.	1.26 [0.76; 2.08]
Munblit et al.	1.32 [0.88; 1.98]
Total (Random Effects)	1.28 [1.19; 1.38]
Prediction interval	[1.09; 1.51]
Heterogeneity: $\chi^2_3 = 0.28$ ($P = .96$), $I^2 = 0\%$	
Moderate NOS	
Menezes et al.	1.50 [0.22; 10.17]
Total (Random Effects)	1.50 [0.22; 10.17]
Prediction interval	
Heterogeneity: not applicable	
Total (Random Effects)	1.28 [1.19; 1.38]
Prediction interval	[1.13; 1.45]
Heterogeneity: $\chi^2_4 = 0.31$ ($P = .99$), $I^2 = 0\%$	

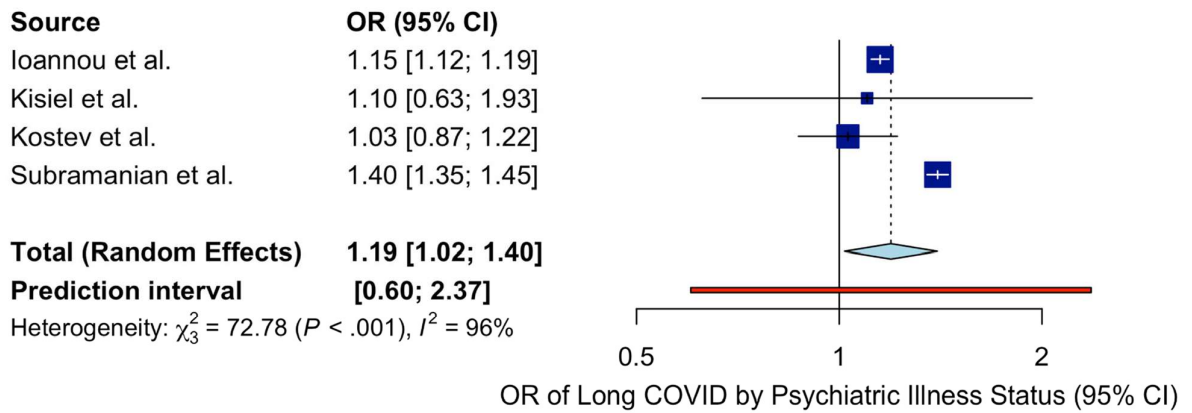


eFigure 23. Forest plot showing the association of immunosuppression with post-COVID-19 condition. Individuals with immunosuppression have an increased risk of developing post-COVID-19 condition.

Source	OR (95% CI)
Blomberg et al.	2.64 [0.57; 12.23]
Kisiel et al.	1.42 [0.97; 2.09]
Wu et al.	1.83 [0.51; 6.59]
Total (Random Effects)	1.50 [1.05; 2.15]
Prediction interval	[0.15; 15.41]
Heterogeneity: $\chi^2 = 0.69$ ($P = .71$), $I^2 = 0\%$	

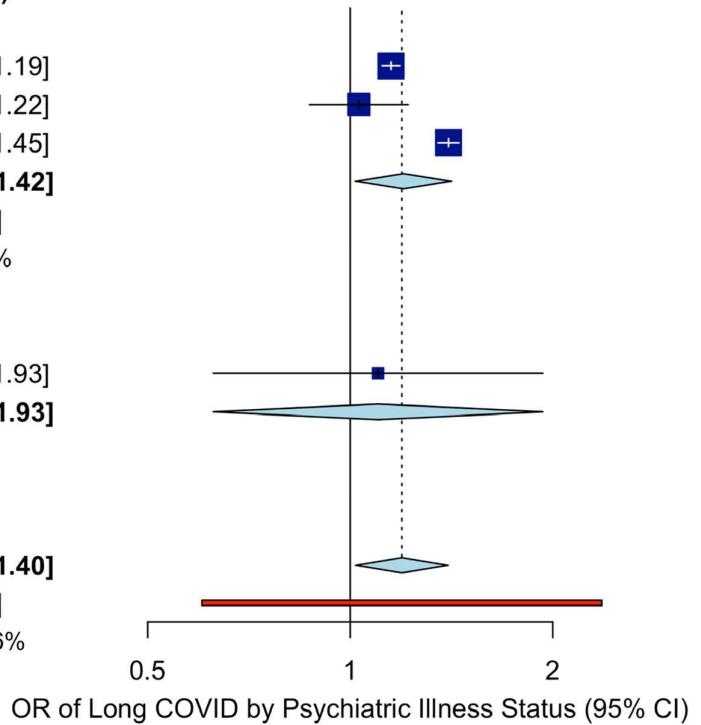


eFigure 24. Forest plot showing the association of anxiety/depression with post-COVID-19 condition. Individuals with anxiety/depression have an increased risk of developing post-COVID-19 condition.



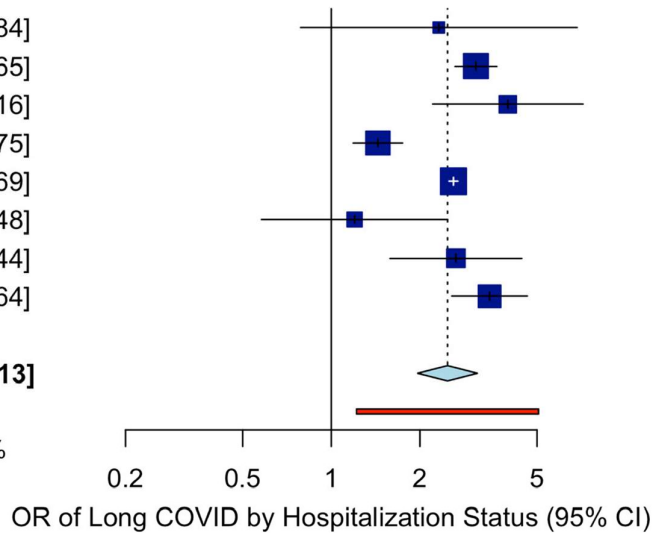
eFigure 25. Subgroup analysis of studies investigating the correlation of anxiety/depression and development of post-COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)

Source	OR (95% CI)
High NOS	
Ioannou et al.	1.15 [1.12; 1.19]
Kostev et al.	1.03 [0.87; 1.22]
Subramanian et al.	1.40 [1.35; 1.45]
Total (Random Effects)	1.20 [1.02; 1.42]
Prediction interval	[0.15; 9.37]
Heterogeneity: $\chi^2_2 = 72.6$ ($P < .001$), $I^2 = 97\%$	
Moderate NOS	
Kisiel et al.	1.10 [0.63; 1.93]
Total (Random Effects)	1.10 [0.63; 1.93]
Prediction interval	
Heterogeneity: not applicable	
Total (Random Effects)	1.19 [1.02; 1.40]
Prediction interval	[0.60; 2.37]
Heterogeneity: $\chi^2_3 = 72.78$ ($P < .001$), $I^2 = 96\%$	



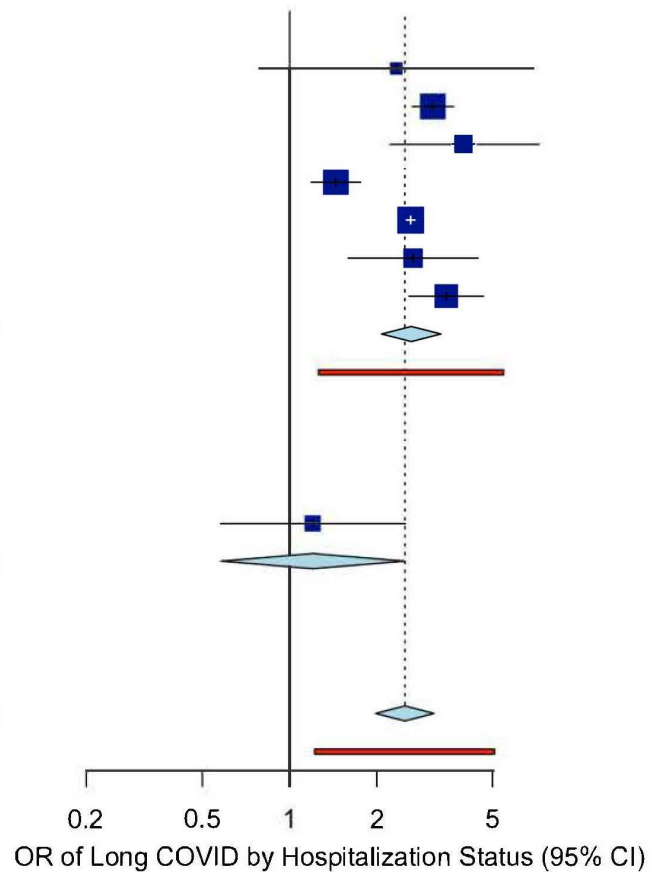
eFigure 26. Forest plot showing the association of hospitalisation with post-COVID-19 condition. Individuals that were hospitalized during the acute infection had an increased risk of developing post-COVID-19 condition.

Source	OR (95% CI)
Abdelrahman et al.	2.32 [0.79; 6.84]
Baruch et al.	3.10 [2.63; 3.65]
Blomberg et al.	3.98 [2.21; 7.16]
Emecen et al.	1.44 [1.19; 1.75]
Ioannou et al.	2.60 [2.51; 2.69]
Peters et al.	1.20 [0.58; 2.48]
Righi et al.	2.65 [1.58; 4.44]
Whitaker et al.	3.45 [2.57; 4.64]
Total (Random Effects)	2.48 [1.97; 3.13]
Prediction interval	[1.22; 5.06]
Heterogeneity: $\chi^2_7 = 50.25$ ($P < .001$), $I^2 = 86\%$	



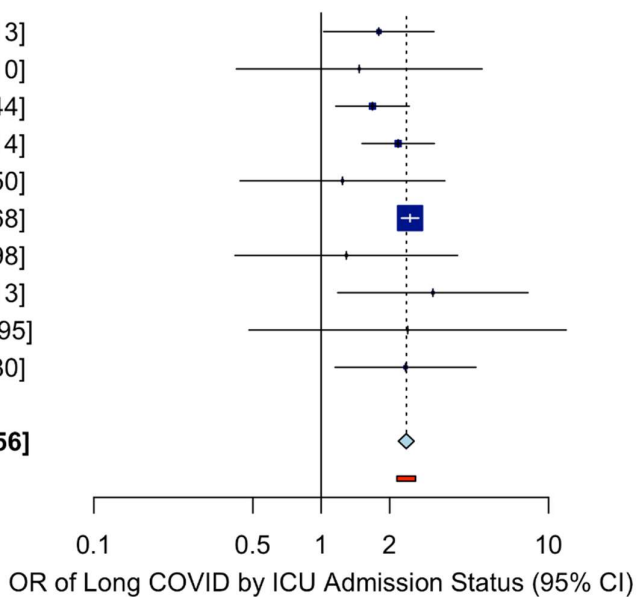
eFigure 27. Subgroup analysis of studies investigating the correlation of hospitalization and development of post-COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)

Source	OR (95% CI)
High NOS	
Abdelrahman et al.	2.32 [0.79; 6.84]
Baruch et al.	3.10 [2.63; 3.65]
Blomberg et al.	3.98 [2.21; 7.16]
Emecen et al.	1.44 [1.19; 1.75]
Ioannou et al.	2.60 [2.51; 2.69]
Righi et al.	2.65 [1.58; 4.44]
Whitaker et al.	3.45 [2.57; 4.64]
Total (Random Effects)	2.61 [2.07; 3.31]
Prediction interval	[1.26; 5.43]
Heterogeneity: $\chi^2_6 = 45.98$ ($P < .001$), $I^2 = 87\%$	
Moderate NOS	
Peters et al.	1.20 [0.58; 2.48]
Total (Random Effects)	1.20 [0.58; 2.48]
Prediction interval	
Heterogeneity: not applicable	
Total (Random Effects)	2.48 [1.97; 3.13]
Prediction interval	[1.22; 5.06]
Heterogeneity: $\chi^2_7 = 50.25$ ($P < .001$), $I^2 = 86\%$	



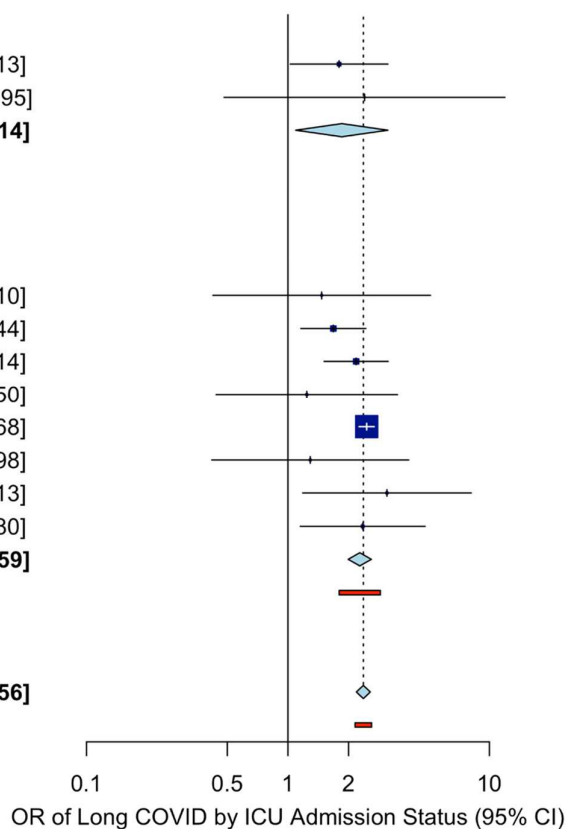
eFigure 28. Forest plot showing the association of ICU admission with post-COVID-19 condition. Individuals that required ICU admission during the acute infection had an increased risk of developing post-COVID-19 condition.

Source	OR (95% CI)
Asadi-Pooya	1.79 [1.03; 3.13]
Bellan et al., 2021	1.47 [0.42; 5.10]
Dias	1.68 [1.16; 2.44]
Emecen	2.18 [1.51; 3.14]
Fernandez-de-las-Penas et al. 1	1.24 [0.44; 3.50]
Ioannou	2.46 [2.25; 2.68]
Jones	1.29 [0.42; 3.98]
Peghin	3.10 [1.18; 8.13]
Peters	2.40 [0.48; 11.95]
Righi	2.35 [1.15; 4.80]
Total (Random Effects)	2.37 [2.18; 2.56]
Prediction interval	[2.15; 2.60]
Heterogeneity: $\chi^2_9 = 8.64$ ($P = .47$), $I^2 = 0\%$	

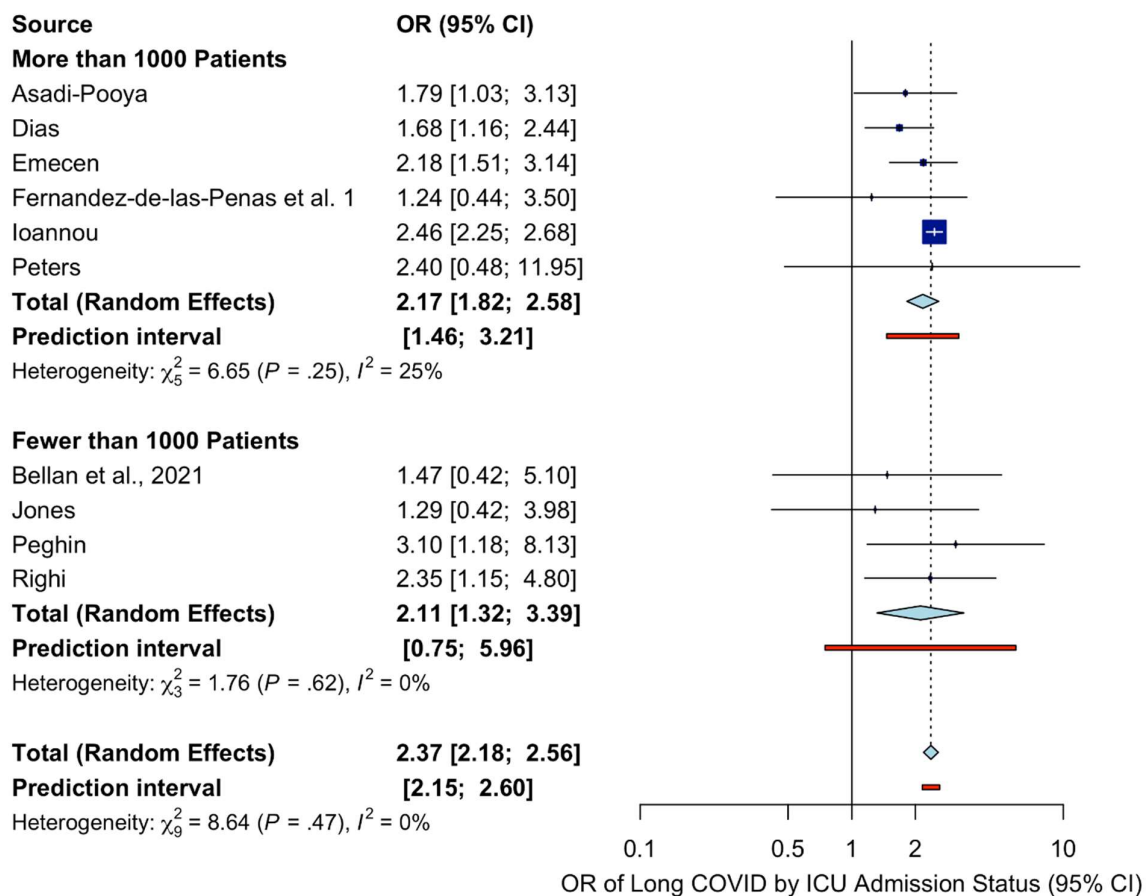


eFigure 29. Subgroup analysis of studies investigating the correlation of ICU admission and development of post-COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)

Source	OR (95% CI)
Moderate NOS	
Asadi-Pooya	1.79 [1.03; 3.13]
Peters	2.40 [0.48; 11.95]
Total (Random Effects)	1.85 [1.09; 3.14]
Prediction interval	
Heterogeneity: $\chi^2_1 = 0.11$ ($P = .74$), $I^2 = 0\%$	
High NOS	
Bellan et al., 2021	1.47 [0.42; 5.10]
Dias	1.68 [1.16; 2.44]
Emecen	2.18 [1.51; 3.14]
Fernandez-de-las-Penas et al. 1	1.24 [0.44; 3.50]
Ioannou	2.46 [2.25; 2.68]
Jones	1.29 [0.42; 3.98]
Peghin	3.10 [1.18; 8.13]
Righi	2.35 [1.15; 4.80]
Total (Random Effects)	2.27 [1.99; 2.59]
Prediction interval	
[1.80; 2.88]	
Heterogeneity: $\chi^2_7 = 7.67$ ($P = .36$), $I^2 = 9\%$	
Total (Random Effects)	2.37 [2.18; 2.56]
Prediction interval	
[2.15; 2.60]	
Heterogeneity: $\chi^2_9 = 8.64$ ($P = .47$), $I^2 = 0\%$	



eFigure 30. Subgroup analysis of studies investigating the correlation of ICU admission and development of post-COVID-19 condition according to study size

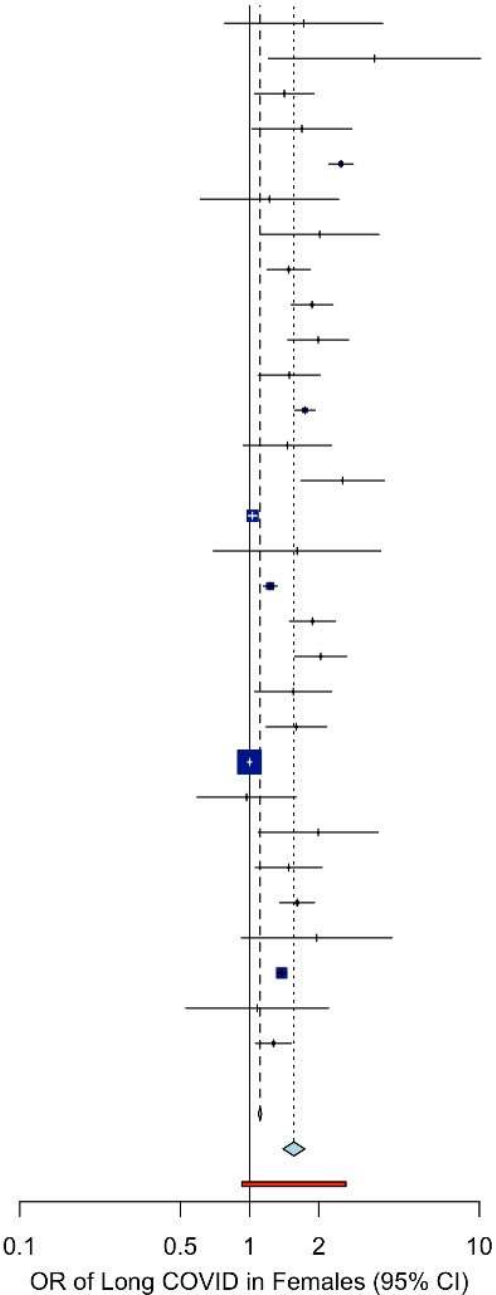


eFigure 31. Sensitivity analysis of all the risk factors examined using only the studies that included patients with laboratory confirmed COVID-19 infection

a. Female Sex

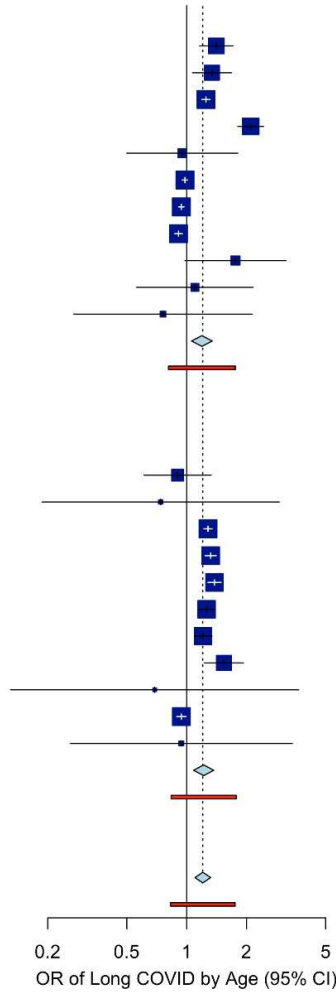
Source	OR (95% CI)
Abdelrahman et al.	1.72 [0.78; 3.79]
Aranda et al.	3.50 [1.21; 10.13]
Asadi-Pooya et al.	1.42 [1.05; 1.91]
Augustin et al.	1.69 [1.02; 2.79]
Baruch et al.	2.50 [2.21; 2.83]
Bellan et al.	1.22 [0.61; 2.44]
Blomberg et al.	2.02 [1.12; 3.66]
Chudzik et al.	1.48 [1.19; 1.84]
Daitch et al.	1.87 [1.52; 2.31]
Debski et al.	1.99 [1.47; 2.70]
Dias et al.	1.49 [1.09; 2.03]
Emecen et al.	1.74 [1.57; 1.93]
Estrada-Comecido et al.	1.46 [0.94; 2.27]
Fernandez-de-las-Penas et al.	2.54 [1.67; 3.86]
Ioannou et al.	1.03 [0.99; 1.08]
Kisiel et al.	1.61 [0.70; 3.73]
Kostev et al.	1.23 [1.15; 1.32]
Munblit et al.	1.88 [1.49; 2.37]
Pazukhina et al.	2.04 [1.57; 2.65]
Peghin et al.	1.55 [1.05; 2.28]
Peters et al.	1.60 [1.18; 2.17]
Petersen et al.	1.00 [0.98; 1.02]
Righi et al.	0.97 [0.59; 1.59]
Silverberg et al.	1.99 [1.09; 3.63]
Stepanek et al.	1.48 [1.06; 2.07]
Subramanian et al.	1.61 [1.35; 1.92]
Tleyjeh et al.	1.96 [0.92; 4.17]
Whitaker et al.	1.38 [1.32; 1.45]
Wu et al.	1.08 [0.53; 2.21]
Zhang et al.	1.27 [1.06; 1.52]

Total (fixed effect) 1.11 [1.09; 1.13]
Total (random effects) 1.56 [1.40; 1.74]
Prediction interval [0.93; 2.63]
 Heterogeneity: $\chi^2_{29} = 603.11$ ($P < .001$), $I^2 = 95\%$



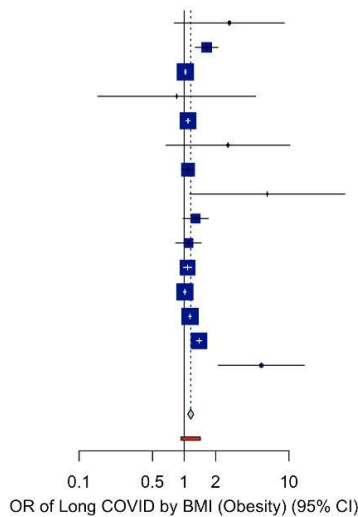
b. age

Source	OR (95% CI)
Patients between 40-69 years old	
Emecen et al. 45-54	1.41 [1.16; 1.71]
Emecen et al. 55-64	1.34 [1.07; 1.68]
Ioannou et al. 50-69	1.25 [1.19; 1.31]
Kostev et al. 46-60	2.10 [1.81; 2.44]
Silverberg et al. 50-60	0.95 [0.50; 1.81]
Subramanian et al. 40-49	0.98 [0.95; 1.01]
Subramanian et al. 50-59	0.94 [0.91; 0.97]
Subramanian et al. 60-69	0.91 [0.87; 0.95]
TwinsUK 45-69	1.76 [0.98; 3.16]
Usoc 45-69	1.10 [0.56; 2.16]
Wu 45-64	0.76 [0.27; 2.14]
Total (Random Effects)	1.19 [1.06; 1.35]
Prediction interval	[0.81; 1.76]
Heterogeneity: $\chi^2_{10} = 233.66$ ($P < .001$), $I^2 = 96\%$	
Patients 70 years old or older	
Emecen et al. 75	0.90 [0.61; 1.33]
GS 70	0.74 [0.19; 2.92]
Ioannou et al. 70-74	1.28 [1.22; 1.34]
Ioannou et al. 75-79	1.32 [1.24; 1.41]
Ioannou et al. 80-84	1.38 [1.28; 1.49]
Ioannou et al. 85-89	1.26 [1.15; 1.38]
Ioannou et al. >90	1.21 [1.09; 1.34]
Kostev et al. >70	1.54 [1.23; 1.93]
Silverberg et al. >70	0.69 [0.13; 3.66]
Subramanian et al. >70	0.94 [0.89; 0.99]
Wu et al. >65	0.94 [0.26; 3.40]
Total (Random Effects)	1.22 [1.08; 1.37]
Prediction interval	[0.83; 1.78]
Heterogeneity: $\chi^2_{10} = 118.51$ ($P < .001$), $I^2 = 92\%$	
Total (Random Effects)	1.21 [1.10; 1.32]
Prediction interval	[0.83; 1.75]
Heterogeneity: $\chi^2_{21} = 471.97$ ($P < .001$), $I^2 = 96\%$	



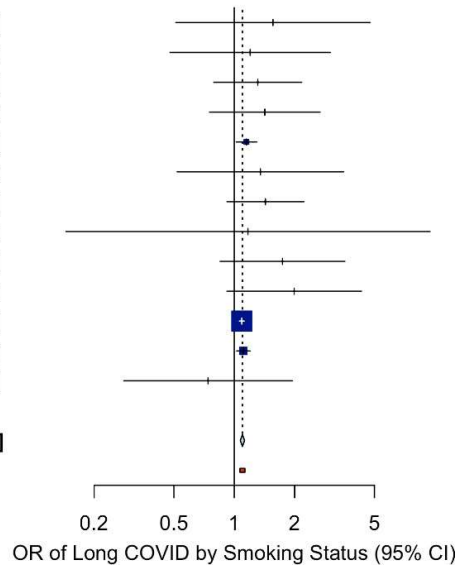
c. Obesity

Source	OR (95% CI)
Bellan et al.	2.70 [0.81; 9.00]
Daitch et al.	1.64 [1.28; 2.10]
Dias et al.	1.03 [1.01; 1.05]
Fernandez-de-las-Penas et al.	0.85 [0.15; 4.80]
Ioannou et al.	1.09 [1.05; 1.14]
Kisiel et al.	2.62 [0.67; 10.21]
Kostev et al.	1.09 [0.95; 1.26]
Menezes et al.	6.20 [1.13; 34.06]
Munblit et al.	1.29 [0.98; 1.70]
Peters et al.	1.10 [0.83; 1.46]
Petersen et al.	1.08 [0.99; 1.18]
Stepanek et al.	1.02 [0.99; 1.05]
Subramanian et al.	1.14 [1.11; 1.17]
Whitaker et al.	1.39 [1.31; 1.47]
Wu et al.	5.44 [2.12; 13.96]
Total (Random Effects)	1.16 [1.08; 1.24]
Prediction interval	[0.94; 1.43]
Heterogeneity: $\chi^2_{14} = 161.88$ ($P < .001$), $I^2 = 91\%$	



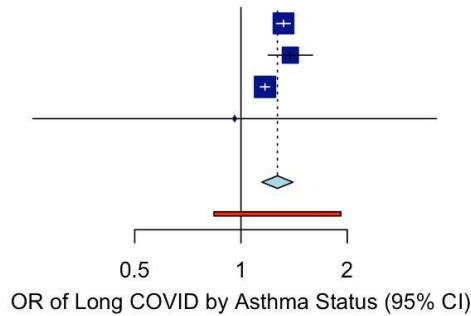
d. Smoking

Source	OR (95% CI)
Abdelrahman et al.	1.56 [0.51; 4.76]
Aranda et al.	1.20 [0.48; 3.01]
Blomberg et al.	1.31 [0.79; 2.17]
Dias et al.	1.42 [0.75; 2.68]
Emecen et al.	1.15 [1.02; 1.29]
Fernandez-de-las-Penas et al.	1.35 [0.52; 3.51]
Jones et al.	1.43 [0.92; 2.22]
Kisiel et al.	1.17 [0.14; 9.47]
Petersen et al.	1.74 [0.85; 3.56]
Silverberg et al.	1.99 [0.92; 4.31]
Subramanian et al.	1.09 [1.06; 1.12]
Whitaker et al.	1.11 [1.03; 1.20]
Wu et al.	0.74 [0.28; 1.95]
Total (Random Effects)	1.10 [1.07; 1.13]
Prediction interval	[1.07; 1.13]
Heterogeneity: $\chi^2_{12} = 8.53$ ($P = .74$), $I^2 = 0\%$	



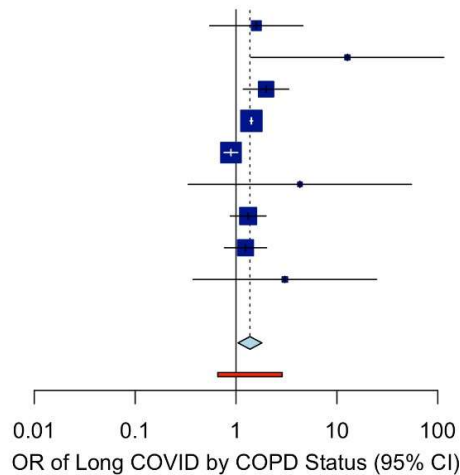
e. Asthma

Source	OR (95% CI)
Ioannou et al.	1.32 [1.26; 1.38]
Kostev et al.	1.38 [1.19; 1.60]
Subramanian et al.	1.17 [1.14; 1.21]
Wu et al.	0.96 [0.26; 3.58]
Total (Random Effects)	1.27 [1.15; 1.40]
Prediction interval	[0.84; 1.92]
Heterogeneity: $\chi^2_3 = 21.98$ ($P < .001$), $I^2 = 86\%$	



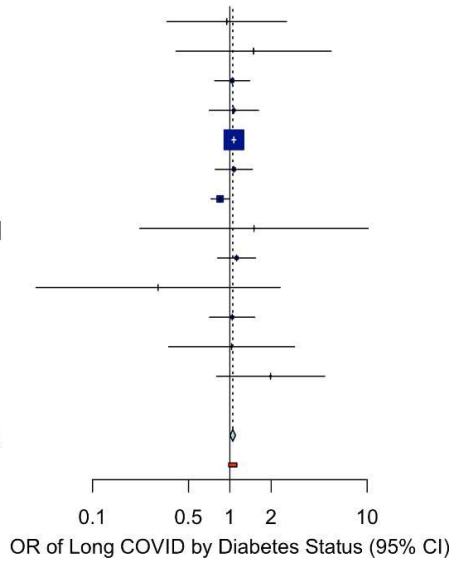
f. COPD

Source	OR (95% CI)
Aranda et al.	1.59 [0.55; 4.60]
Bellan et al.	12.70 [1.41; 114.62]
Daitch et al.	1.98 [1.18; 3.33]
Ioannou et al.	1.42 [1.38; 1.47]
Kostev et al.	0.89 [0.76; 1.04]
Menezes et al.	4.30 [0.34; 54.95]
Munblit et al.	1.32 [0.88; 1.98]
Pazukhina et al.	1.24 [0.77; 2.01]
Wu et al.	3.05 [0.38; 24.77]
Total (Random Effects)	1.37 [1.05; 1.80]
Prediction interval	[0.66; 2.87]
Heterogeneity: $\chi^2_8 = 40.03$ ($P < .001$), $I^2 = 80\%$	



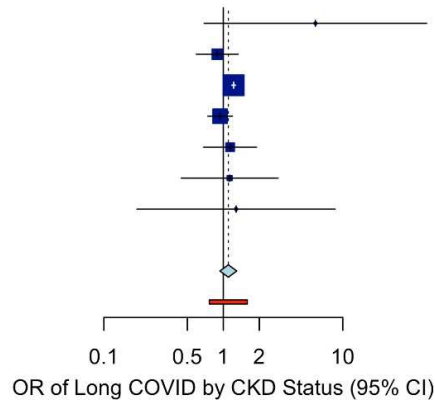
g. Diabetes

Source	OR (95% CI)
Bellan et al.	0.95 [0.35; 2.59]
Blomberg et al.	1.49 [0.41; 5.47]
Dias et al.	1.04 [0.78; 1.39]
Fernandez-de-las-Penas et al.	1.07 [0.71; 1.62]
Ioannou et al.	1.07 [1.04; 1.11]
Jones et al.	1.07 [0.78; 1.46]
Kostev et al.	0.85 [0.73; 0.99]
Menezes et al.	1.50 [0.22; 10.17]
Munblit et al.	1.12 [0.81; 1.54]
NCDS	0.30 [0.04; 2.32]
Pazukhina et al.	1.04 [0.71; 1.52]
Wu et al.	1.03 [0.36; 2.96]
Yanksi et al.	1.98 [0.80; 4.90]
Total (Random Effects)	1.05 [1.00; 1.10]
Prediction interval	[0.98; 1.12]
Heterogeneity: $\chi^2_{12} = 12.26$ ($P = .42$), $I^2 = 2\%$	



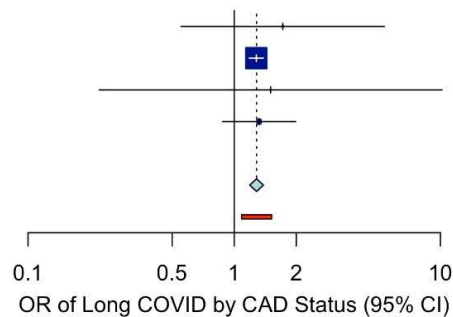
h. CKD

Source	OR (95% CI)
Bellan et al., 2021	5.90 [0.69; 50.40]
Dias	0.89 [0.60; 1.33]
Ioannou	1.22 [1.18; 1.27]
Kostev	0.94 [0.74; 1.19]
Munblit et al., 2021	1.14 [0.68; 1.90]
Pazukhina	1.13 [0.44; 2.87]
Wu	1.28 [0.19; 8.65]
Total (Random Effects)	1.10 [0.94; 1.30]
Prediction interval	[0.76; 1.59]
Heterogeneity: $\chi^2_6 = 8.95$ ($P = .18$), $I^2 = 33\%$	



i. IHD

Source	OR (95% CI)
Bellan et al.	1.72 [0.55; 5.36]
Ioannou et al.	1.28 [1.18; 1.38]
Menezes et al.	1.50 [0.22; 10.17]
Munblit et al.	1.32 [0.88; 1.98]
Total (Random Effects)	1.28 [1.19; 1.39]
Prediction interval	[1.08; 1.52]
Heterogeneity: $\chi^2_3 = 0.30$ ($P = .96$), $I^2 = 0\%$	

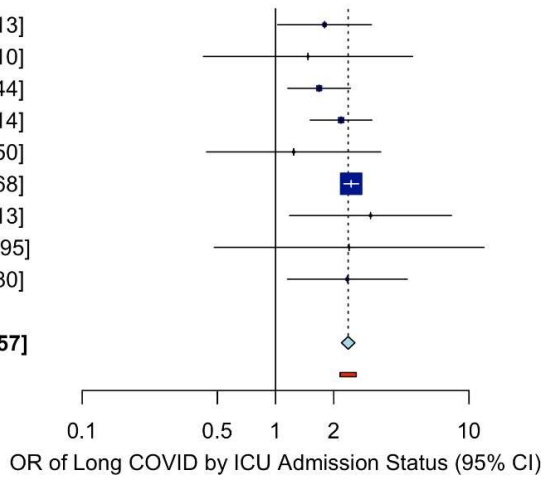


j. ICU admission

Source	OR (95% CI)
Asadi-Pooya	1.79 [1.03; 3.13]
Bellan et al., 2021	1.47 [0.42; 5.10]
Dias	1.68 [1.16; 2.44]
Emecen	2.18 [1.51; 3.14]
Fernandez-de-las-Penas et al. 1	1.24 [0.44; 3.50]
Ioannou	2.46 [2.25; 2.68]
Peghin	3.10 [1.18; 8.13]
Peters	2.40 [0.48; 11.95]
Righi	2.35 [1.15; 4.80]

Total (Random Effects) **2.37 [2.19; 2.57]**
Prediction interval **[2.15; 2.62]**

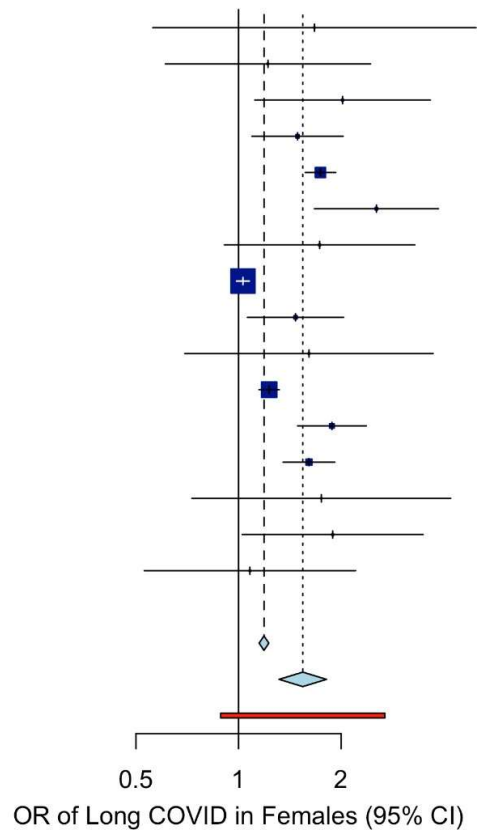
Heterogeneity: $\chi^2_8 = 7.52$ ($P = .48$), $I^2 = 0\%$



eFigure 32. Sensitivity analysis of all the risk factors excluding studies with many variables in each study (A study was defined as having many variables when they included ≥ 5 variables in their analysis)

a. Female Sex

Source	OR (95% CI)
BCS 70	1.67 [0.56; 4.98]
Bellan et al.	1.22 [0.61; 2.44]
Blomberg et al.	2.02 [1.12; 3.66]
Dias et al.	1.49 [1.09; 2.03]
Emecen et al.	1.74 [1.57; 1.93]
Fernandez-de-las-Penas et al.	2.54 [1.67; 3.86]
GS	1.73 [0.91; 3.29]
Ioannou et al.	1.03 [0.99; 1.08]
Jones et al.	1.47 [1.06; 2.03]
Kisiel et al.	1.61 [0.70; 3.73]
Kostev et al.	1.23 [1.15; 1.32]
Munblit et al.	1.88 [1.49; 2.37]
Subramanian et al.	1.61 [1.35; 1.92]
TwinsUK	1.75 [0.73; 4.20]
Usoc	1.89 [1.03; 3.48]
Wu et al.	1.08 [0.53; 2.21]
Total (fixed effect)	1.19 [1.15; 1.23]
Total (random effects)	1.54 [1.32; 1.81]
Prediction interval	[0.89; 2.69]
Heterogeneity: $\chi^2_{15} = 146.11$ ($P < .001$), $I^2 = 90\%$	

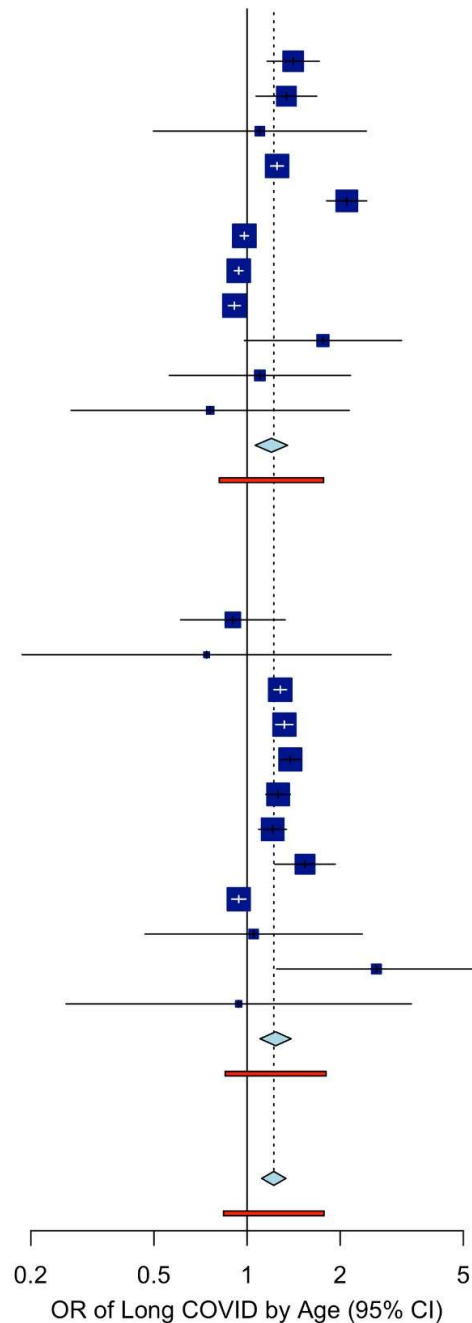


b. Age

Source	OR (95% CI)
Patients between 40-69 years old	
Emecen et al. 45-54	1.41 [1.16; 1.71]
Emecen et al. 55-64	1.34 [1.07; 1.68]
GS 45-69	1.10 [0.50; 2.43]
Ioannou et al. 50-69	1.25 [1.19; 1.31]
Kostev et al. 46-60	2.10 [1.81; 2.44]
Subramanian et al. 40-49	0.98 [0.95; 1.01]
Subramanian et al. 50-59	0.94 [0.91; 0.97]
Subramanian et al. 60-69	0.91 [0.87; 0.95]
TwinsUK 45-69	1.76 [0.98; 3.16]
Usoc 45-69	1.10 [0.56; 2.16]
Wu 45-64	0.76 [0.27; 2.14]
Total (Random Effects)	1.20 [1.06; 1.35]
Prediction interval	[0.81; 1.77]
Heterogeneity: $\chi^2_{10} = 233.68$ ($P < .001$), $I^2 = 96\%$	

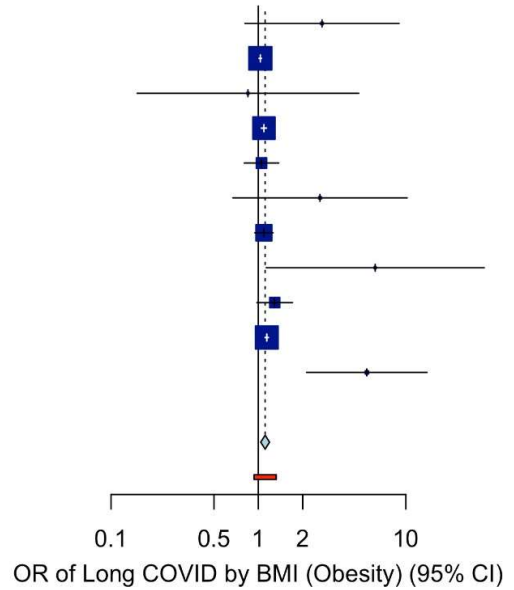
Patients 70 years old or older	
Emecen et al. 75	0.90 [0.61; 1.33]
GS 70	0.74 [0.19; 2.92]
Ioannou et al. 70-74	1.28 [1.22; 1.34]
Ioannou et al. 75-79	1.32 [1.24; 1.41]
Ioannou et al. 80-84	1.38 [1.28; 1.49]
Ioannou et al. 85-89	1.26 [1.15; 1.38]
Ioannou et al. >90	1.21 [1.09; 1.34]
Kostev et al. >70	1.54 [1.23; 1.93]
Subramanian et al. >70	0.94 [0.89; 0.99]
TwinsUK >70	1.05 [0.47; 2.36]
Usoc >70	2.62 [1.25; 5.51]
Wu et al. >65	0.94 [0.26; 3.40]
Total (Random Effects)	1.24 [1.10; 1.39]
Prediction interval	[0.85; 1.80]
Heterogeneity: $\chi^2_{11} = 122.44$ ($P < .001$), $I^2 = 91\%$	

Total (Random Effects)	1.22 [1.11; 1.34]
Prediction interval	[0.84; 1.77]
Heterogeneity: $\chi^2_{22} = 477.26$ ($P < .001$), $I^2 = 95\%$	



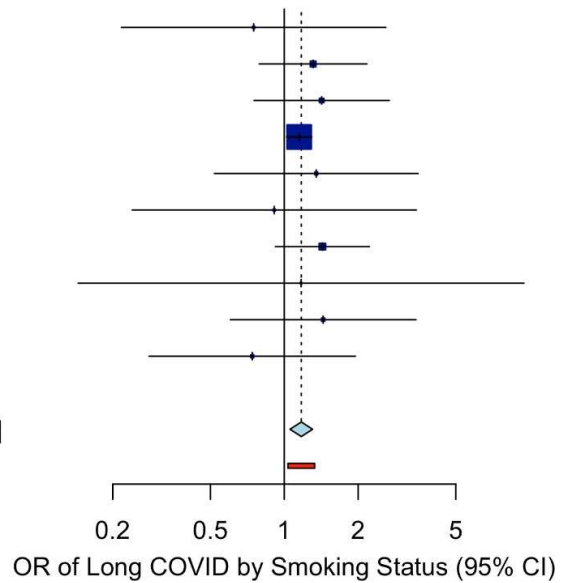
c. Obesity

Source	OR (95% CI)
Bellan et al.	2.70 [0.81; 9.00]
Dias et al.	1.03 [1.01; 1.05]
Fernandez-de-las-Penas et al.	0.85 [0.15; 4.80]
Ioannou et al.	1.09 [1.05; 1.14]
Jones et al.	1.05 [0.80; 1.37]
Kisiel et al.	2.62 [0.67; 10.21]
Kostev et al.	1.09 [0.95; 1.26]
Menezes et al.	6.20 [1.13; 34.06]
Munblit et al.	1.29 [0.98; 1.70]
Subramanian et al.	1.14 [1.11; 1.17]
Wu et al.	5.44 [2.12; 13.96]
Total (Random Effects)	1.11 [1.04; 1.19]
Prediction interval	[0.93; 1.32]
Heterogeneity: $\chi^2_{10} = 59.48$ ($P < .001$), $I^2 = 83\%$	



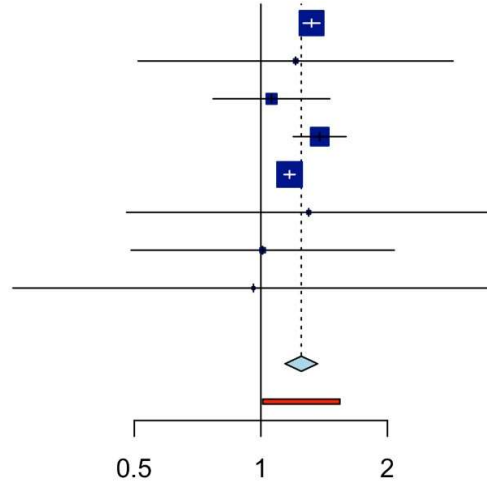
d. Smoking

Source	OR (95% CI)
BCS70	0.75 [0.22; 2.59]
Blomberg et al.	1.31 [0.79; 2.17]
Dias et al.	1.42 [0.75; 2.68]
Emecen et al.	1.15 [1.02; 1.29]
Fernandez-de-las-Penas et al.	1.35 [0.52; 3.51]
GS	0.91 [0.24; 3.45]
Jones et al.	1.43 [0.92; 2.22]
Kisiel et al.	1.17 [0.14; 9.47]
Usoc	1.44 [0.60; 3.44]
Wu et al.	0.74 [0.28; 1.95]
Total (Random Effects)	1.17 [1.05; 1.30]
Prediction interval	[1.04; 1.33]
Heterogeneity: $\chi^2_9 = 3.22$ ($P = .95$), $I^2 = 0\%$	



e. Asthma

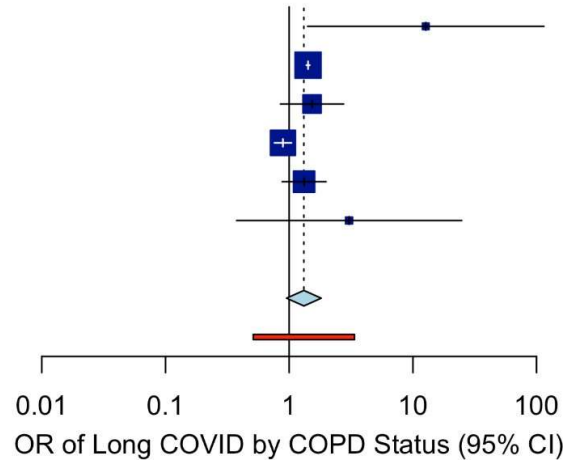
Source	OR (95% CI)
Ioannou et al.	1.32 [1.26; 1.38]
GS	1.21 [0.51; 2.87]
Jones et al.	1.06 [0.77; 1.46]
Kostev et al.	1.38 [1.19; 1.60]
Subramanian et al.	1.17 [1.14; 1.21]
TwinsUK	1.30 [0.48; 3.53]
Usoc	1.01 [0.49; 2.08]
Wu et al.	0.96 [0.26; 3.58]
Total (Random Effects)	1.25 [1.14; 1.36]
Prediction interval	[1.01; 1.54]
Heterogeneity: $\chi^2_7 = 22.97$ ($P = .002$), $I^2 = 70\%$	



OR of Long COVID by Asthma Status (95% CI)

f. COPD

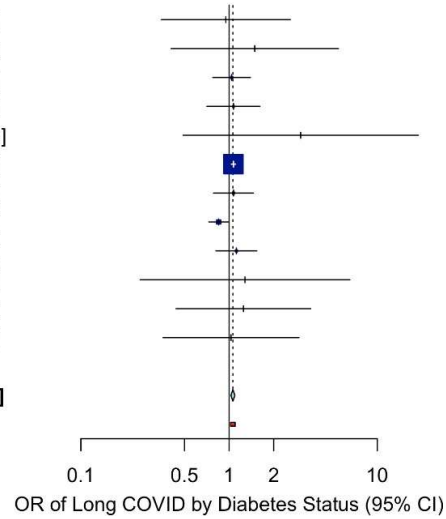
Source	OR (95% CI)
Bellan et al.	12.70 [1.41; 114.62]
Ioannou et al.	1.42 [1.38; 1.47]
Jones et al.	1.53 [0.85; 2.75]
Kostev et al.	0.89 [0.76; 1.04]
Munblit et al.	1.32 [0.88; 1.98]
Wu et al.	3.05 [0.38; 24.77]
Total (Random Effects)	1.31 [0.95; 1.82]
Prediction interval	[0.51; 3.37]
Heterogeneity: $\chi^2_5 = 37.34$ ($P < .001$), $I^2 = 87\%$	



OR of Long COVID by COPD Status (95% CI)

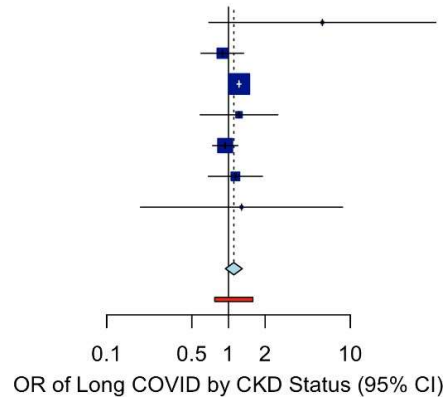
g. Diabetes

Source	OR (95% CI)
Bellan et al.	0.95 [0.35; 2.59]
Blomberg et al.	1.49 [0.41; 5.47]
Dias et al.	1.04 [0.78; 1.39]
Fernandez-de-las-Penas et al.	1.07 [0.71; 1.62]
GS	3.04 [0.49; 18.92]
Ioannou et al.	1.07 [1.04; 1.11]
Jones et al.	1.07 [0.78; 1.46]
Kostev et al.	0.85 [0.73; 0.99]
Munblit et al.	1.12 [0.81; 1.54]
TwinsUK	1.28 [0.25; 6.54]
Usoc	1.25 [0.44; 3.56]
Wu et al.	1.03 [0.36; 2.96]
Total (Random Effects)	1.06 [1.03; 1.09]
Prediction interval	[1.02; 1.10]
Heterogeneity: $\chi^2_{11} = 10.26$ ($P = .51$), $I^2 = 0\%$	



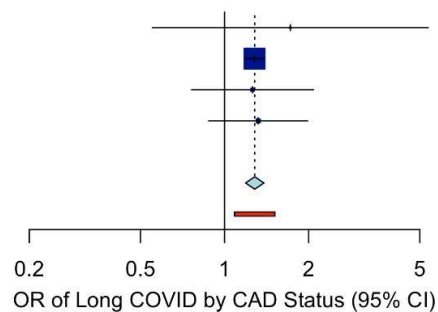
h. CKD

Source	OR (95% CI)
Bellan et al., 2021	5.90 [0.69; 50.40]
Dias	0.89 [0.60; 1.33]
Ioannou	1.22 [1.18; 1.27]
Jones	1.22 [0.59; 2.54]
Kostev	0.94 [0.74; 1.19]
Munblit et al., 2021	1.14 [0.68; 1.90]
Wu	1.28 [0.19; 8.65]
Total (Random Effects)	1.11 [0.94; 1.30]
Prediction interval	[0.77; 1.59]
Heterogeneity: $\chi^2_6 = 8.93$ ($P = .18$), $I^2 = 33\%$	



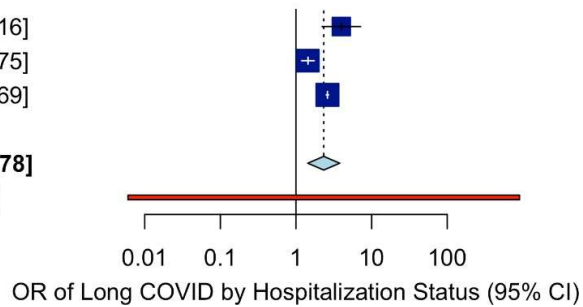
i. IHD

Source	OR (95% CI)
Bellan et al.	1.72 [0.55; 5.36]
Ioannou et al.	1.28 [1.18; 1.38]
Jones et al.	1.26 [0.76; 2.08]
Munblit et al.	1.32 [0.88; 1.98]
Total (Random Effects)	1.28 [1.19; 1.38]
Prediction interval	[1.09; 1.51]
Heterogeneity: $\chi^2_3 = 0.28$ ($P = .96$), $I^2 = 0\%$	



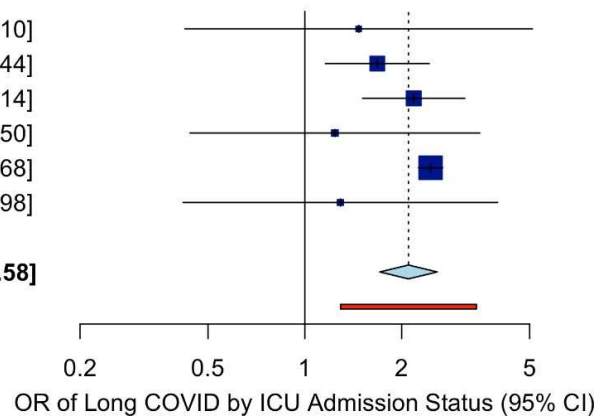
j. Hospitalisation

Source	OR (95% CI)
Blomberg et al.	3.98 [2.21; 7.16]
Emecen et al.	1.44 [1.19; 1.75]
Ioannou et al.	2.60 [2.51; 2.69]
Total (Random Effects)	2.33 [1.43; 3.78]
Prediction interval	[0.01; 901.31]
Heterogeneity: $\chi^2_2 = 37.13$ ($P < .001$), $I^2 = 95\%$	



k. ICU admission

Source	OR (95% CI)
Bellan et al., 2021	1.47 [0.42; 5.10]
Dias	1.68 [1.16; 2.44]
Emecen	2.18 [1.51; 3.14]
Fernandez-de-las-Penas et al. 1	1.24 [0.44; 3.50]
Ioannou	2.46 [2.25; 2.68]
Jones	1.29 [0.42; 3.98]
Total (Random Effects)	2.10 [1.71; 2.58]
Prediction interval	[1.29; 3.41]
Heterogeneity: $\chi^2_5 = 7.38$ ($P = .19$), $I^2 = 32\%$	



l. vaccination status

Source	OR (95% CI)
Ioannou	0.78 [0.68; 0.90]
Emecen	0.53 [0.40; 0.71]
Total (Random Effects)	0.66 [0.45; 0.96]
Heterogeneity: $\chi^2_1 = 5.41$ ($P = .02$), $I^2 = 82\%$	

