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

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)

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

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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)

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

eFigure 32. Sensitivity analysis of all the risk factors with studies that investigated ≥5 variables

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]
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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

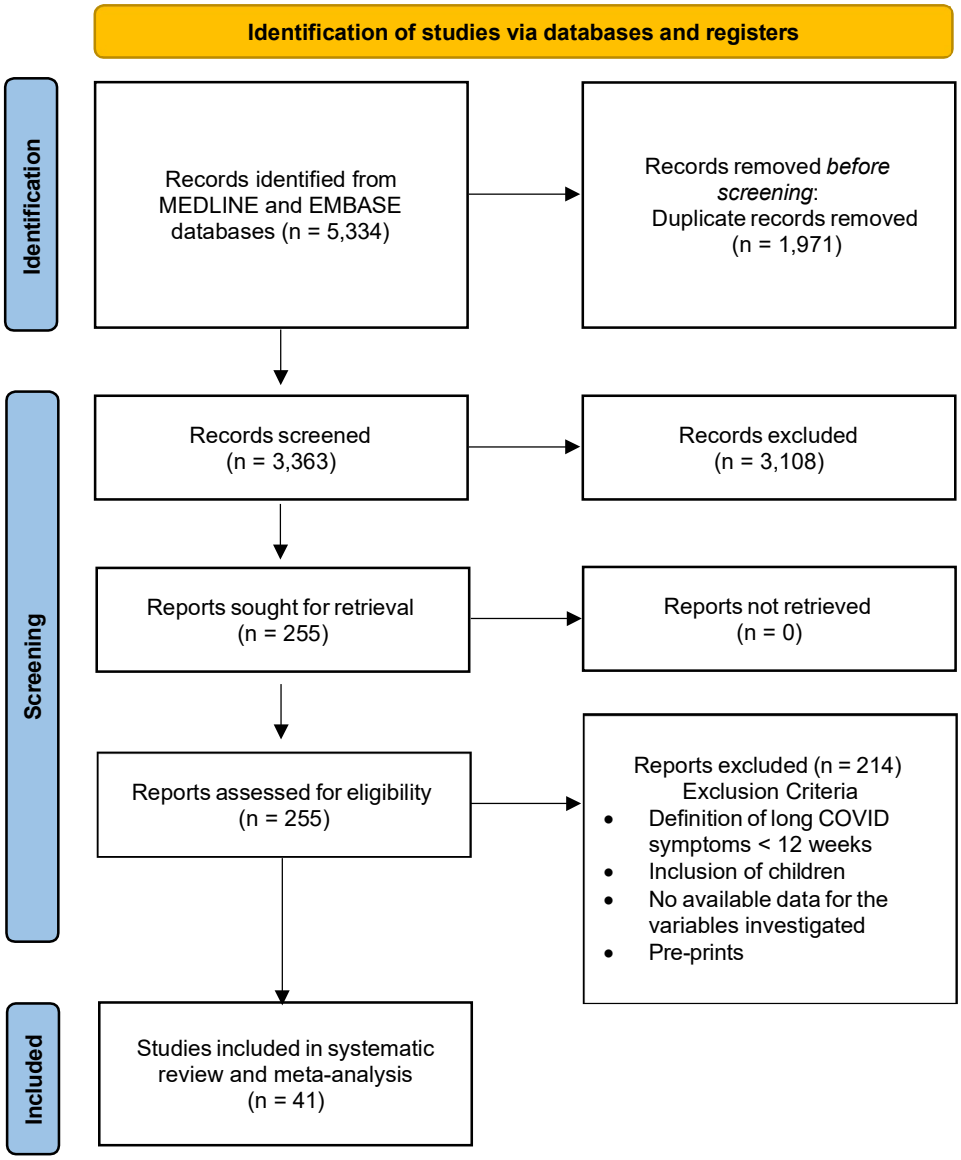
Study	Selection	Comparability	Outcome	Total	Quality of Study
Abdelrahman et al.[38]	***	**	**	7	High
Aranda et al.[39]	***	**	***	8	High
Asadi-Pooya et al.[40]	***	*	**	6	Moderate
Augustin et al. [41]	***	**	**	7	High
Ayoubkhani et al. [42]	***	**	**	7	High
Baruch et al. [43]	***	**	***	8	High
Bellan 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

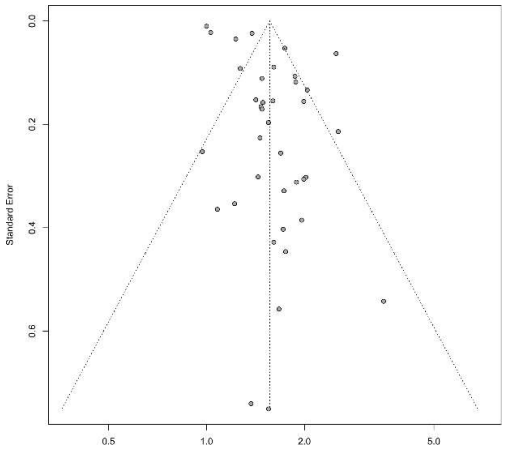
Risk factor	Geographic location	Significance (p value)
Female Sex	America	0.49
	Asia	0.74
	Europe	0.85
	International	0.84
Age	Asia	0.97
	Europe	0.19
Obesity	Europe	0.76
	International	0.12
Smoking	America	0.82
	Asia	0.54
	Europe	0.48
Diabetes	Europe	**0.02**
Asthma	Europe	**<0.001**
IHD	Europe	0.54
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

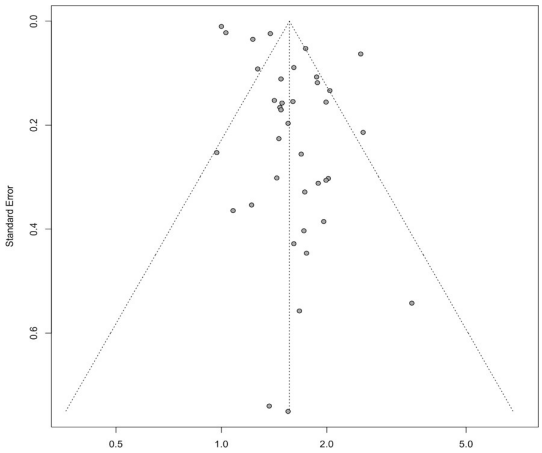


eFigure 2. Funnel plots assessing publication bias for each group meta-analysis: A) Sex, B) Age, C) Obesity, D) Smoking, E) Asthma, F) COPD, G) DM, H) CKD, I) IHD, J) Immunosuppression, K) Anxiety/Depression, L) Hospitalisation, M) ICU admission, N) Vaccination status

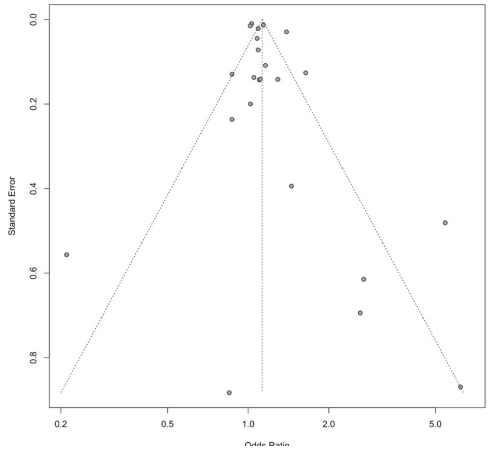
A) Female Sex



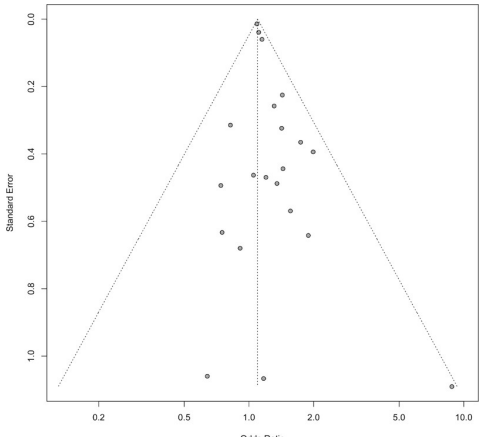
B) Age



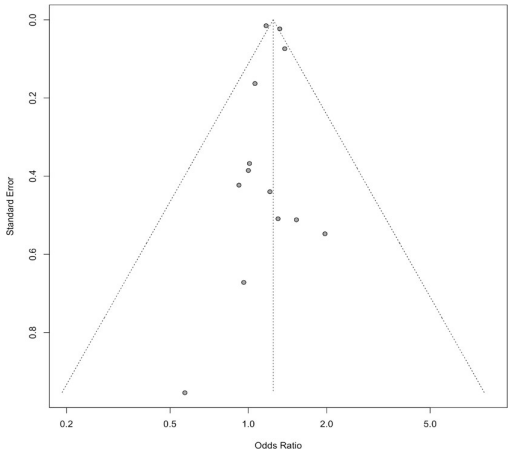
C) Obesity



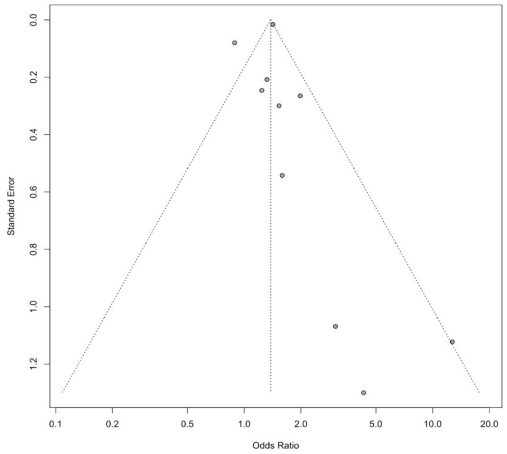
D) Smoking



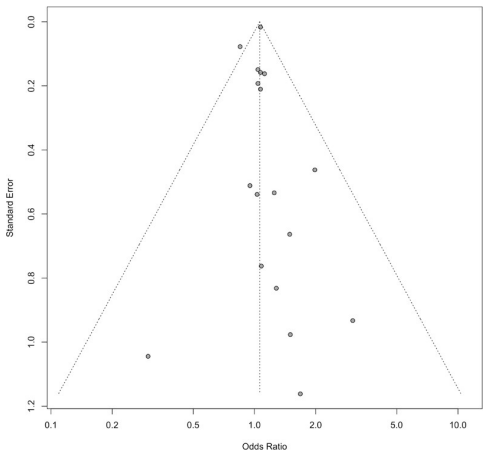
E) Asthma



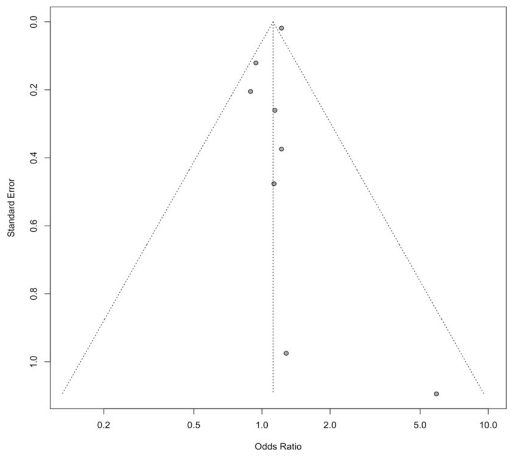
F) COPD



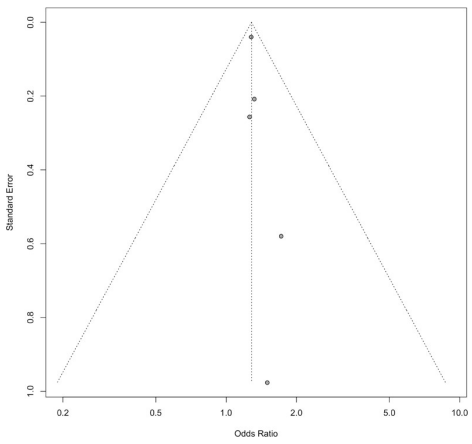
G) DM



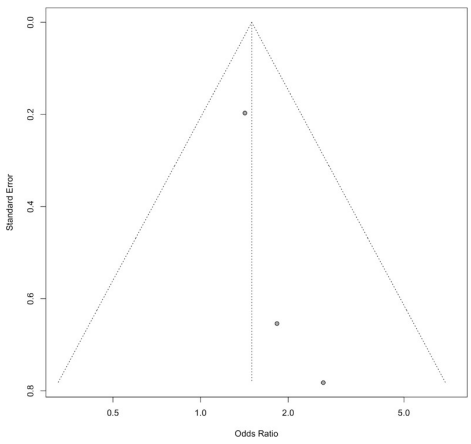
H) CKD



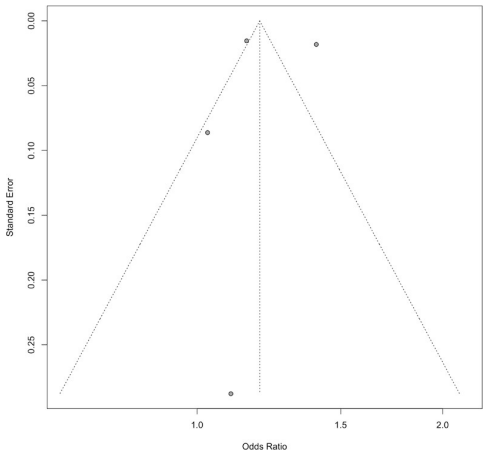
I)IHD



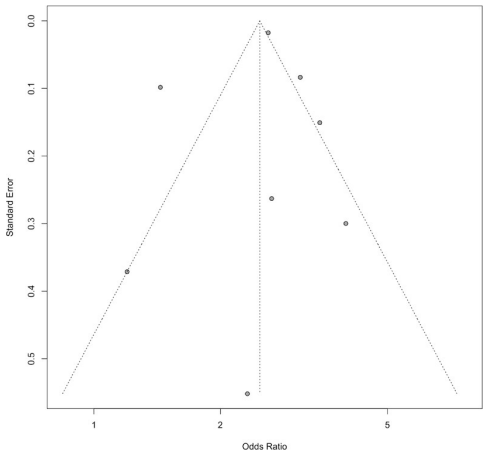
J) Immunosuppression



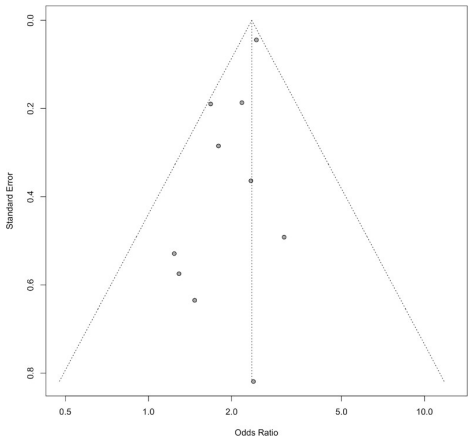
K) Anxiety/Depression



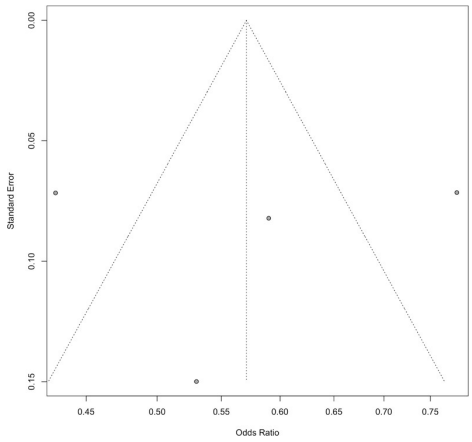
L) Hospitalisation



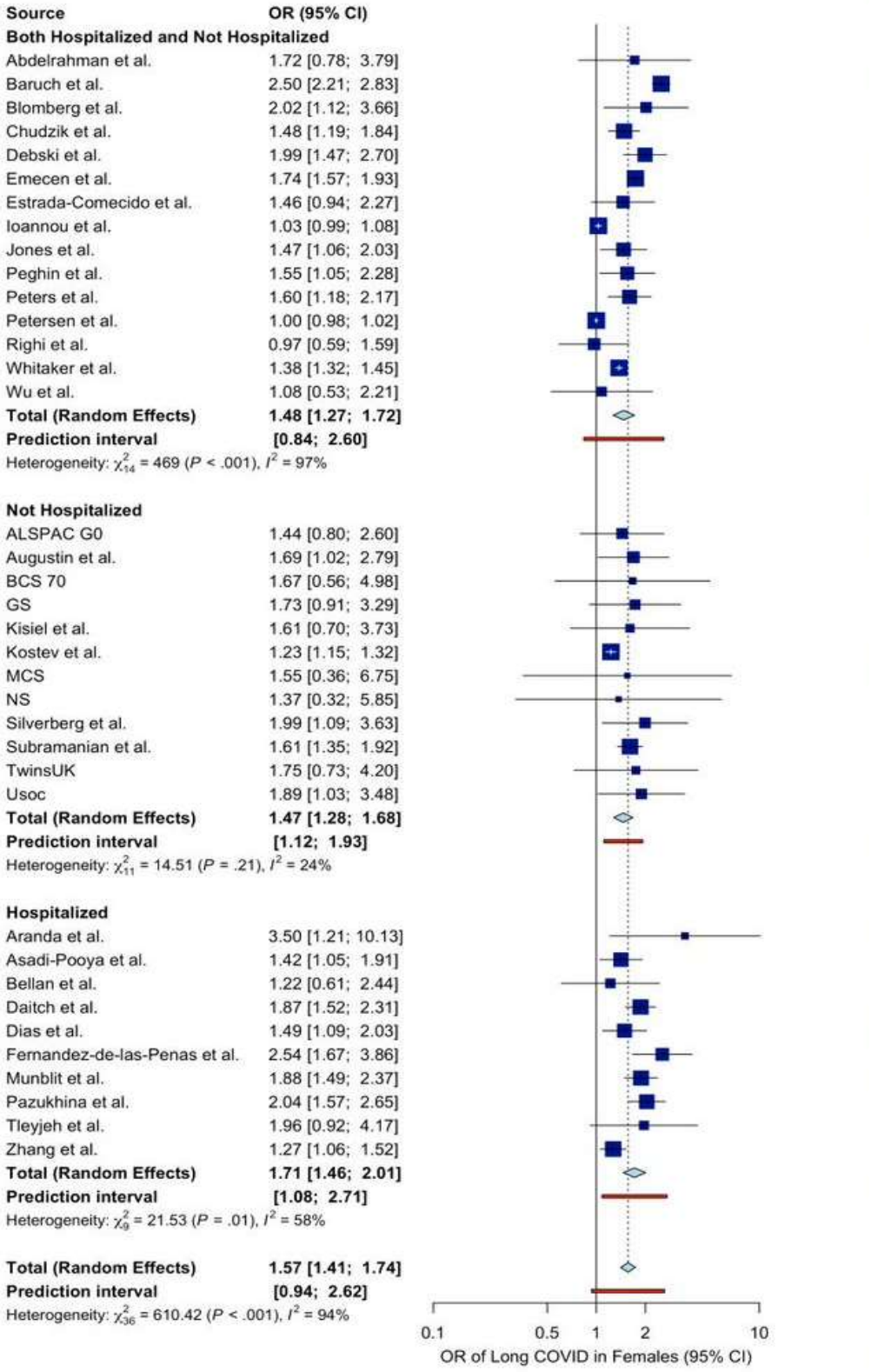
M) ICU admission



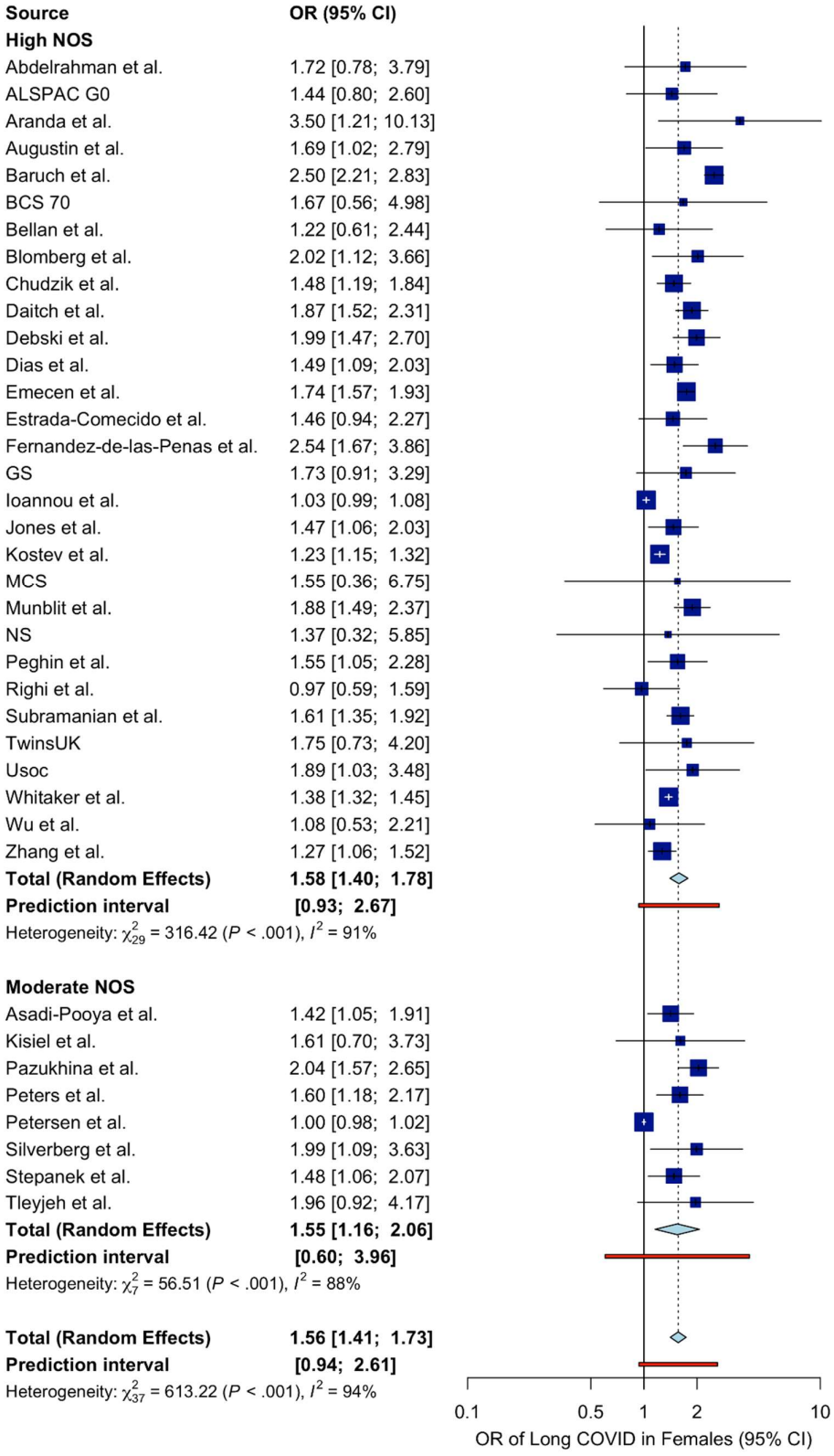
N) Vaccination status



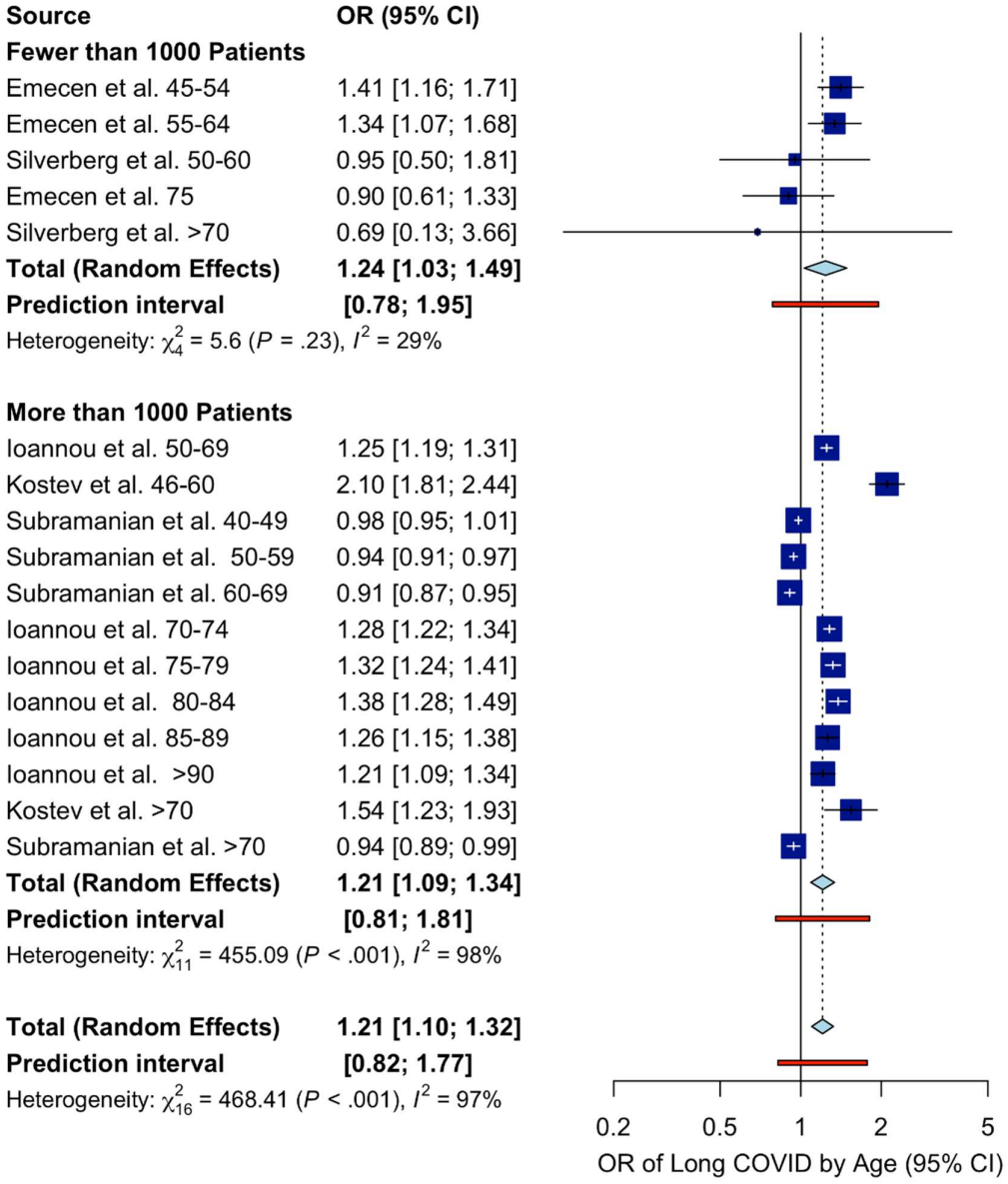
eFigure 3. Subgroup analysis of studies investigating the correlation of female sex and development of post−COVID-19 condition according to study population



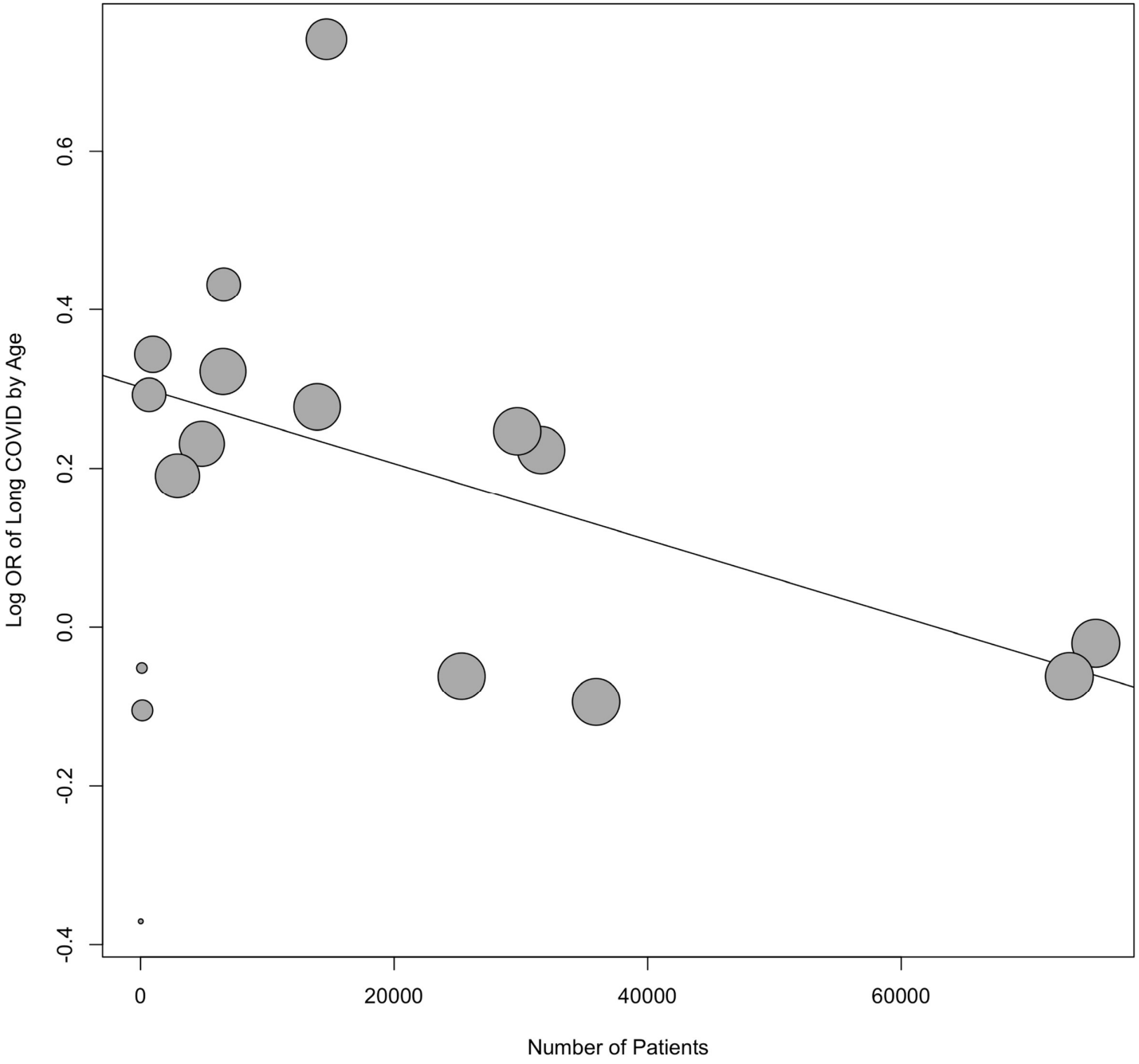
eFigure 4. Subgroup analysis of studies investigating the correlation of female sex and development of post−COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)



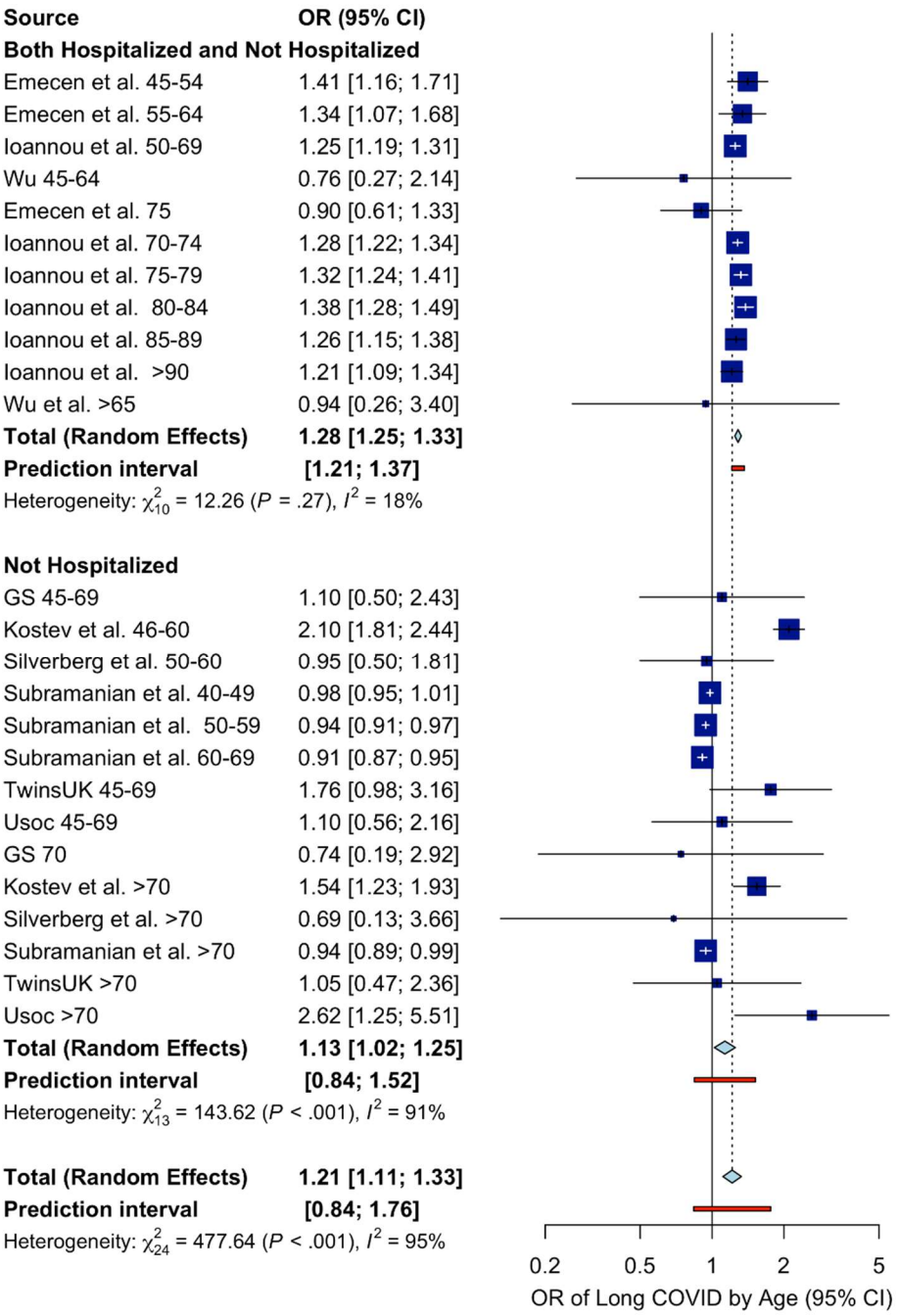
eFigure 5. Subgroup analysis of studies investigating the correlation of age and development of post−COVID-19 condition according to study size



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)

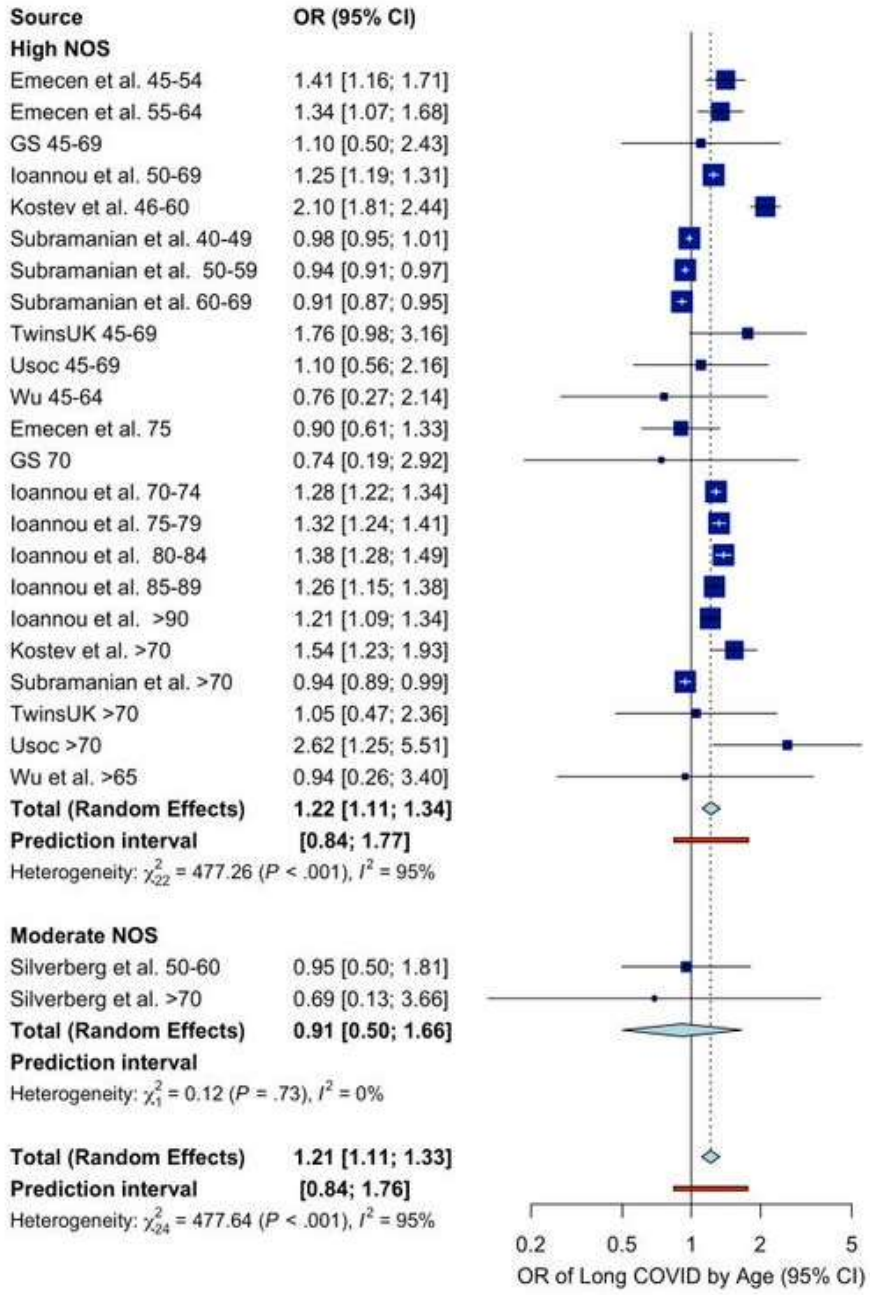
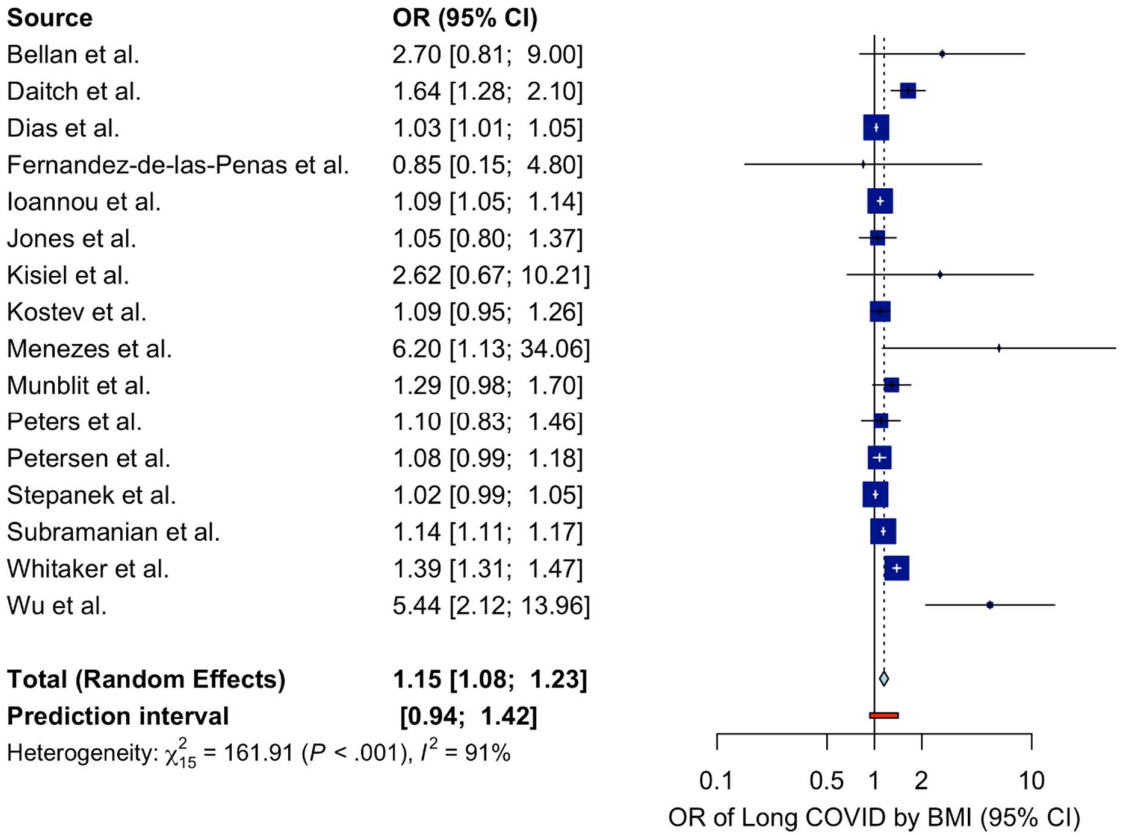
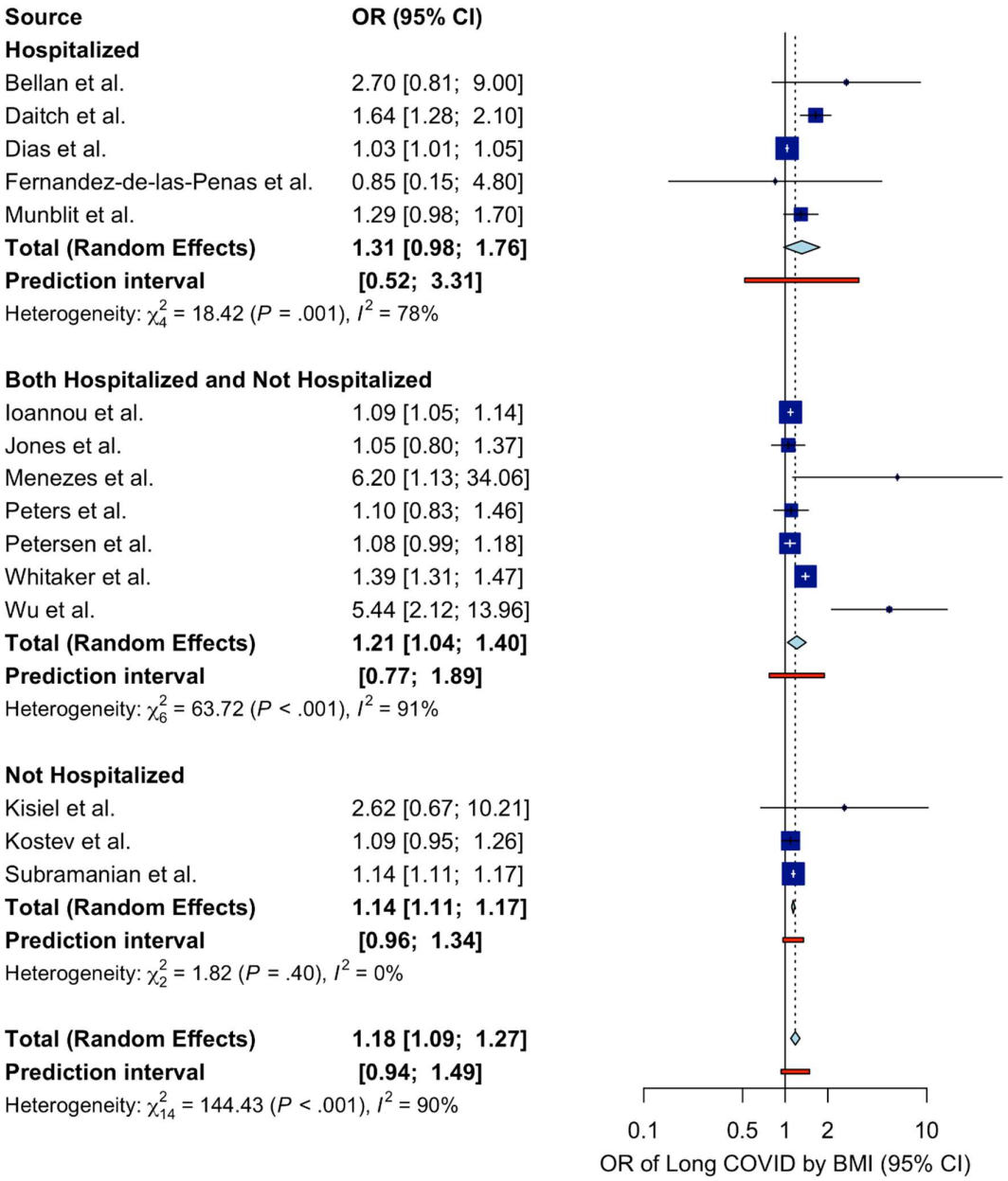


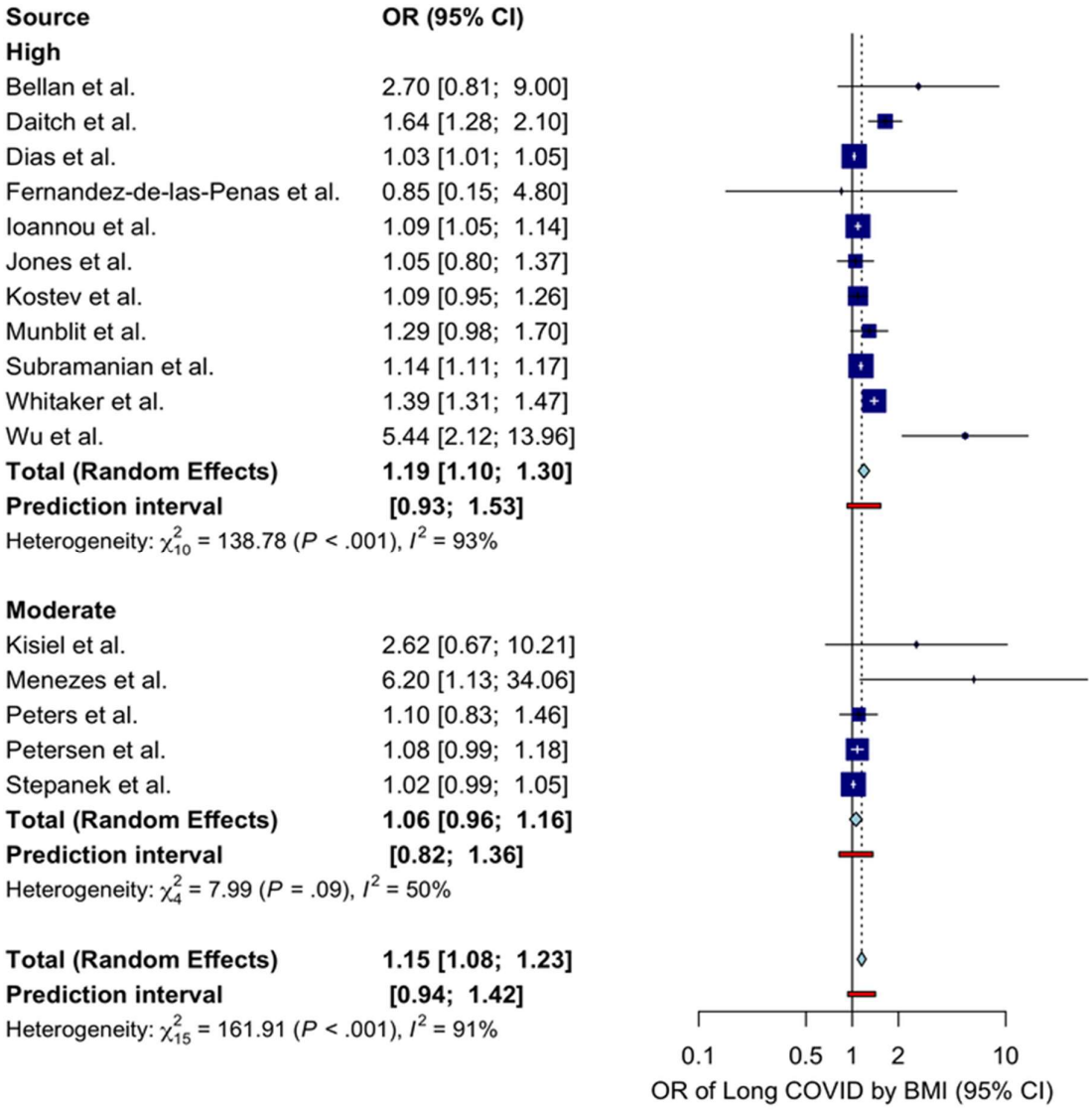
Figure 9. Forest plot showing the effect of BMI on post−COVID-19 condition. Individuals with obesity have an increased risk of developing post−COVID-19 condition.



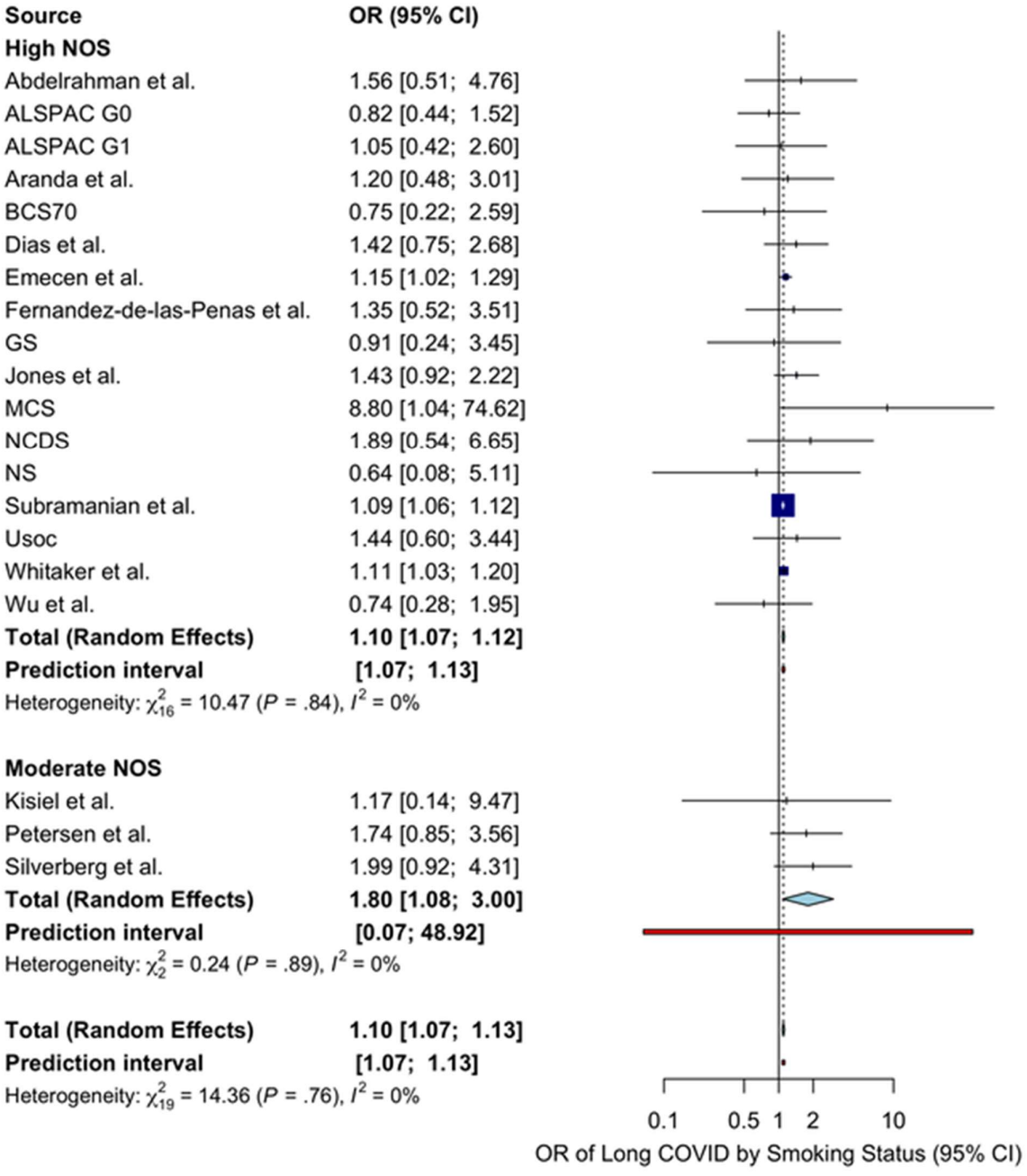
eFigure 10. Subgroup analysis of studies investigating the correlation of obesity and development of post−COVID-19 condition according to study population



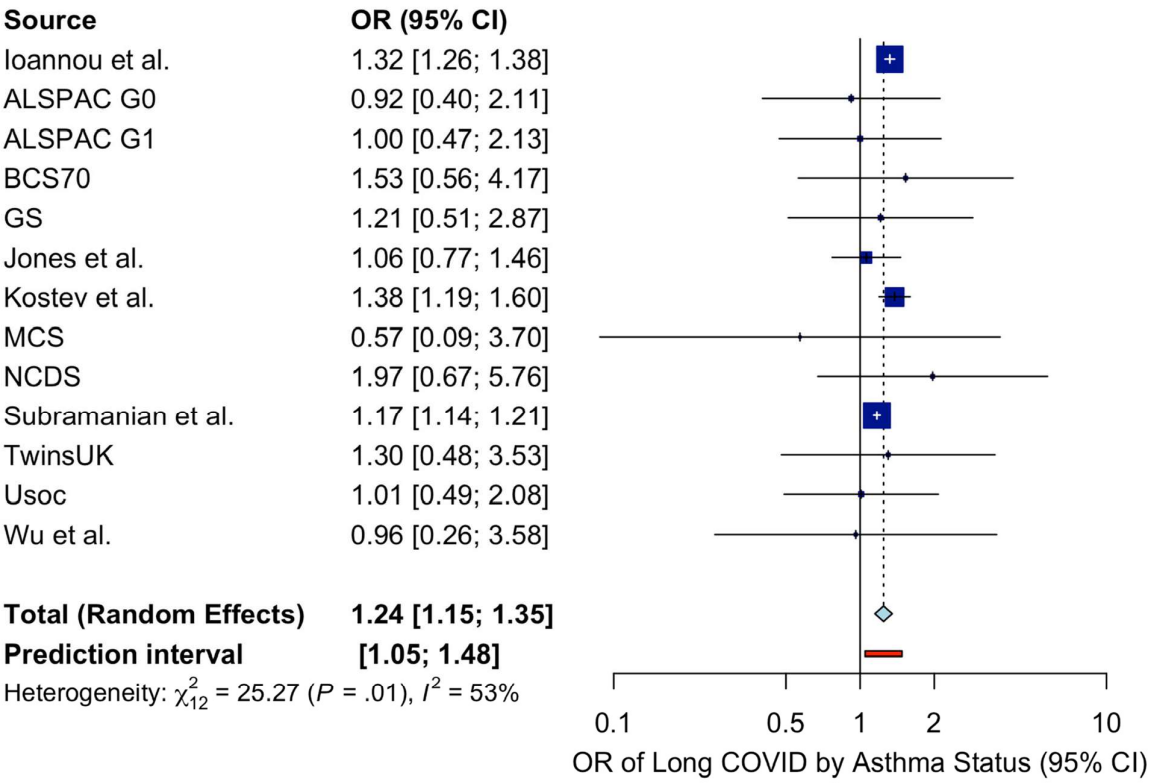
eFigure 11. Subgroup analysis of studies investigating the correlation of obesity and development of post−COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)



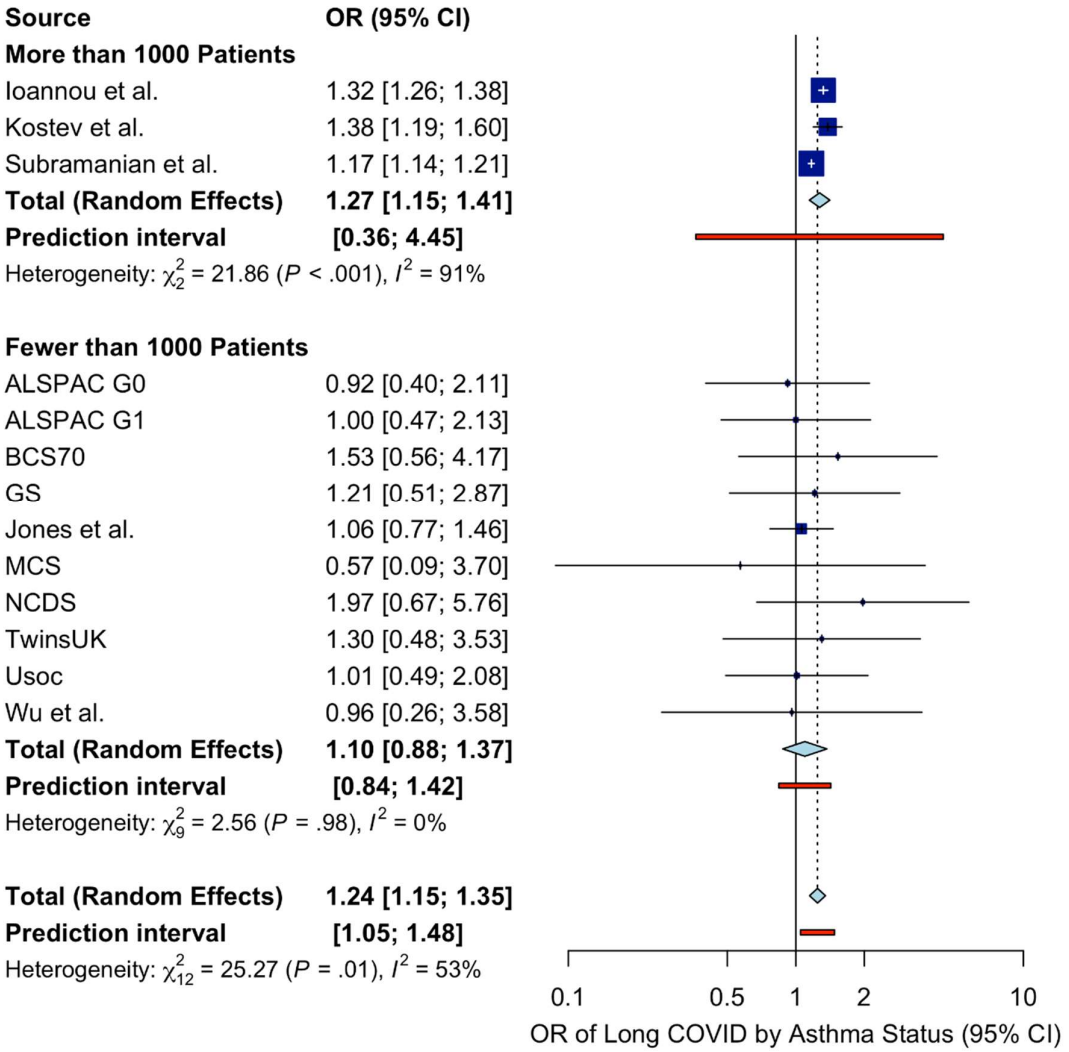
eFigure 12. Subgroup analysis of studies investigating the correlation of smoking and development of post−COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)



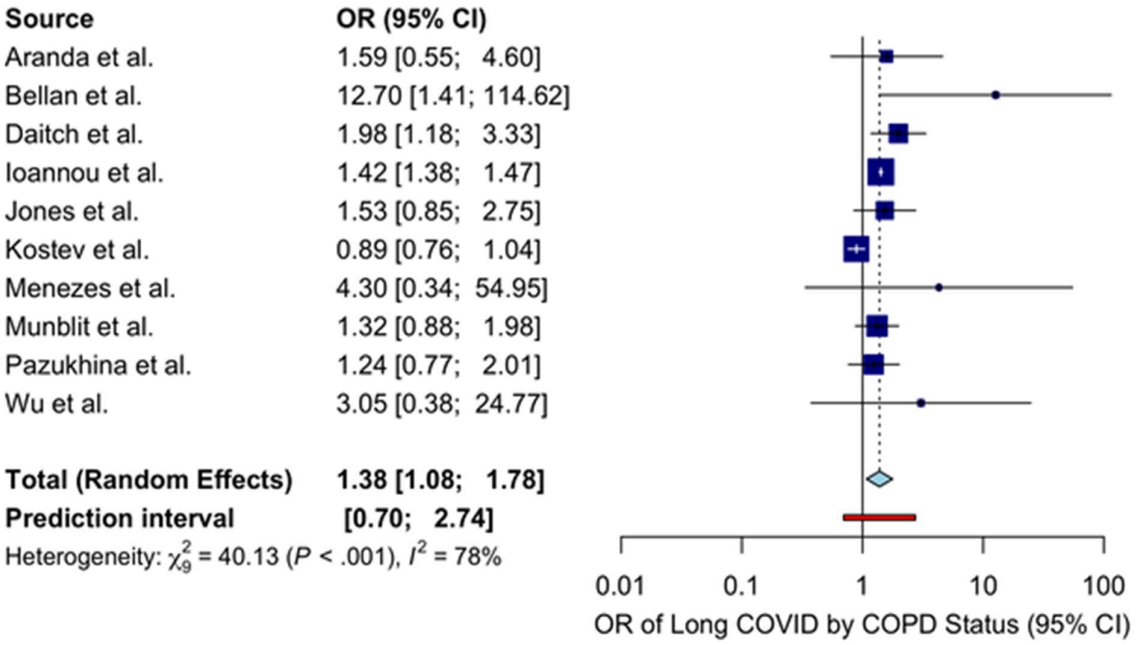
eFigure 13. Forest plot showing the effect of asthma on post−COVID-19 condition. Individuals with asthma have an increased risk of developing post−COVID-19 condition.



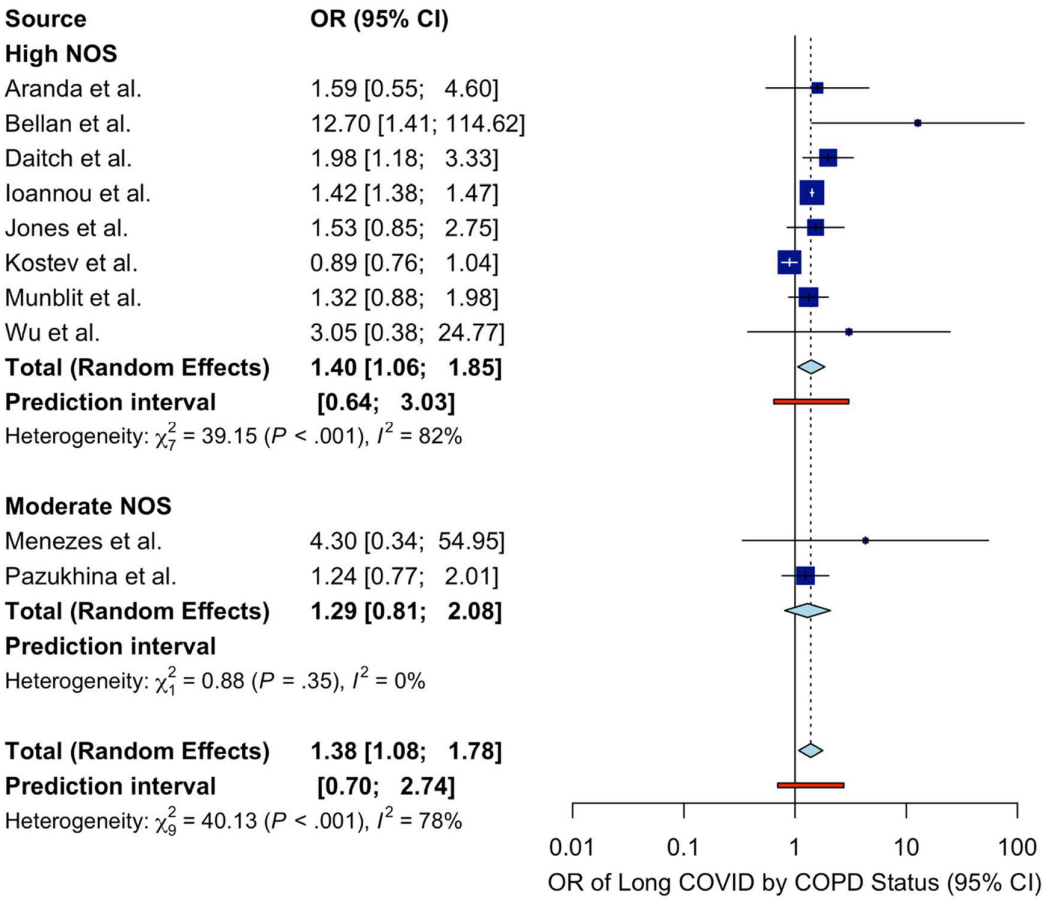
eFigure 14. Subgroup analysis of studies investigating the correlation of asthma and development of post−COVID-19 condition according to study size



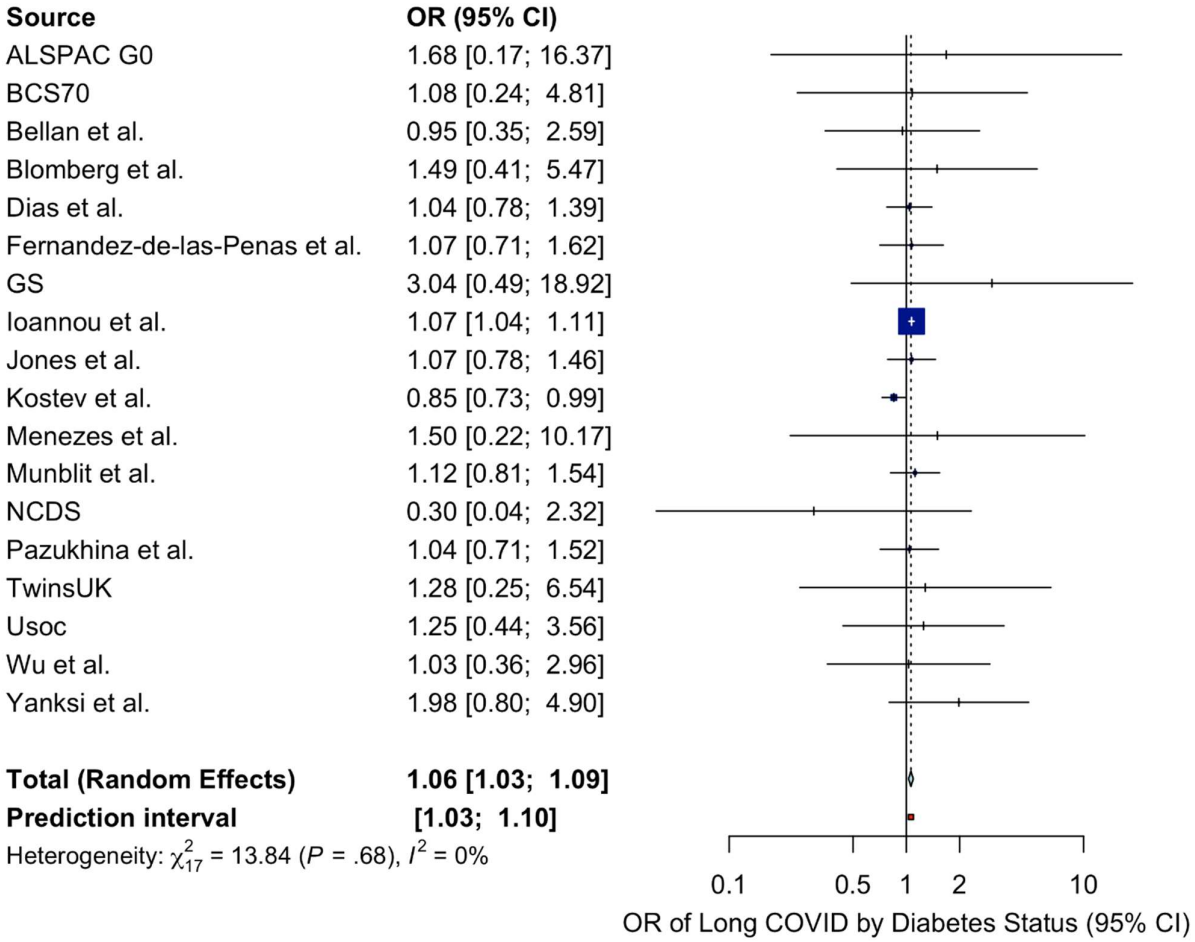
eFigure 15. Forest plot showing the effect of COPD on post−COVID-19 condition. Individuals with COPD have an increased risk of developing post−COVID-19 condition.



eFigure 16. Subgroup analysis of studies investigating the correlation of COPD and development of post−COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)



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.



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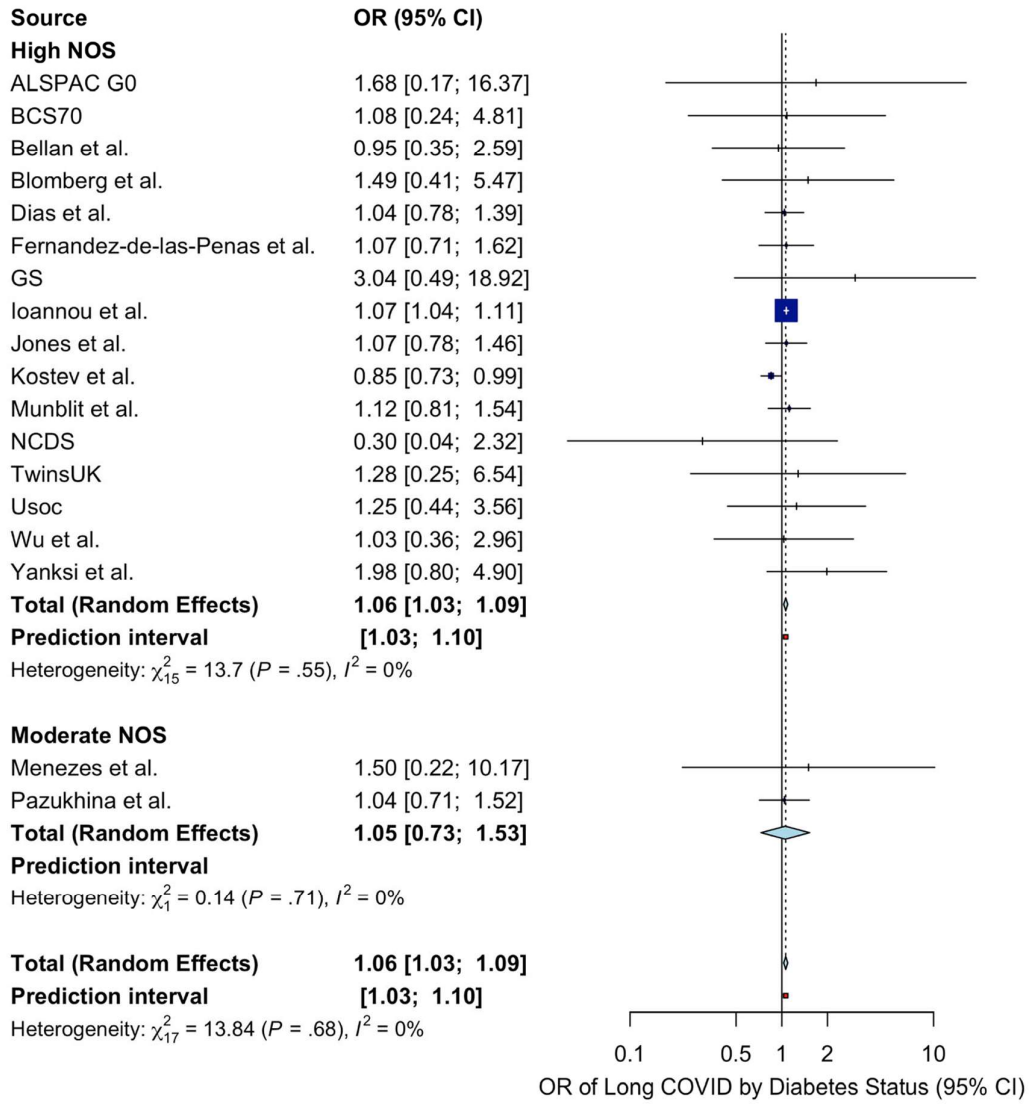
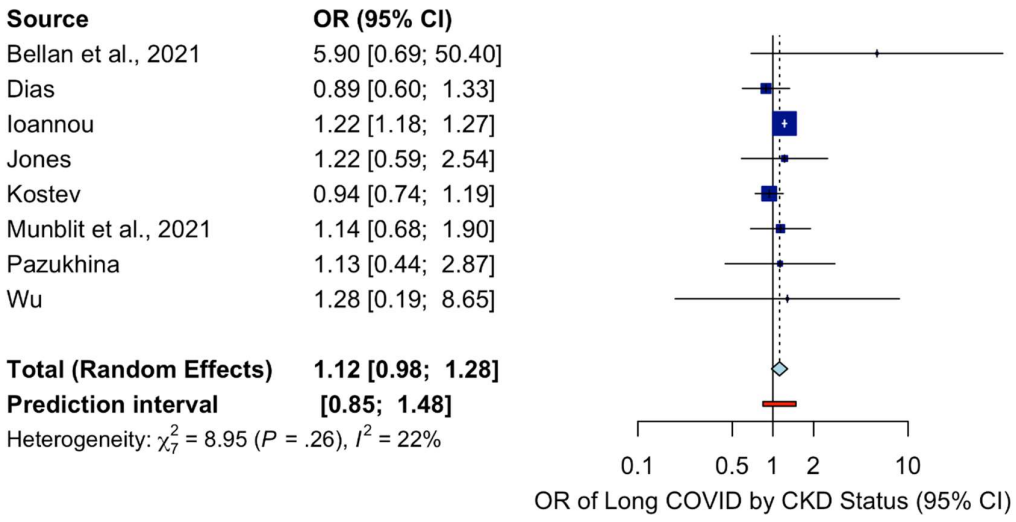
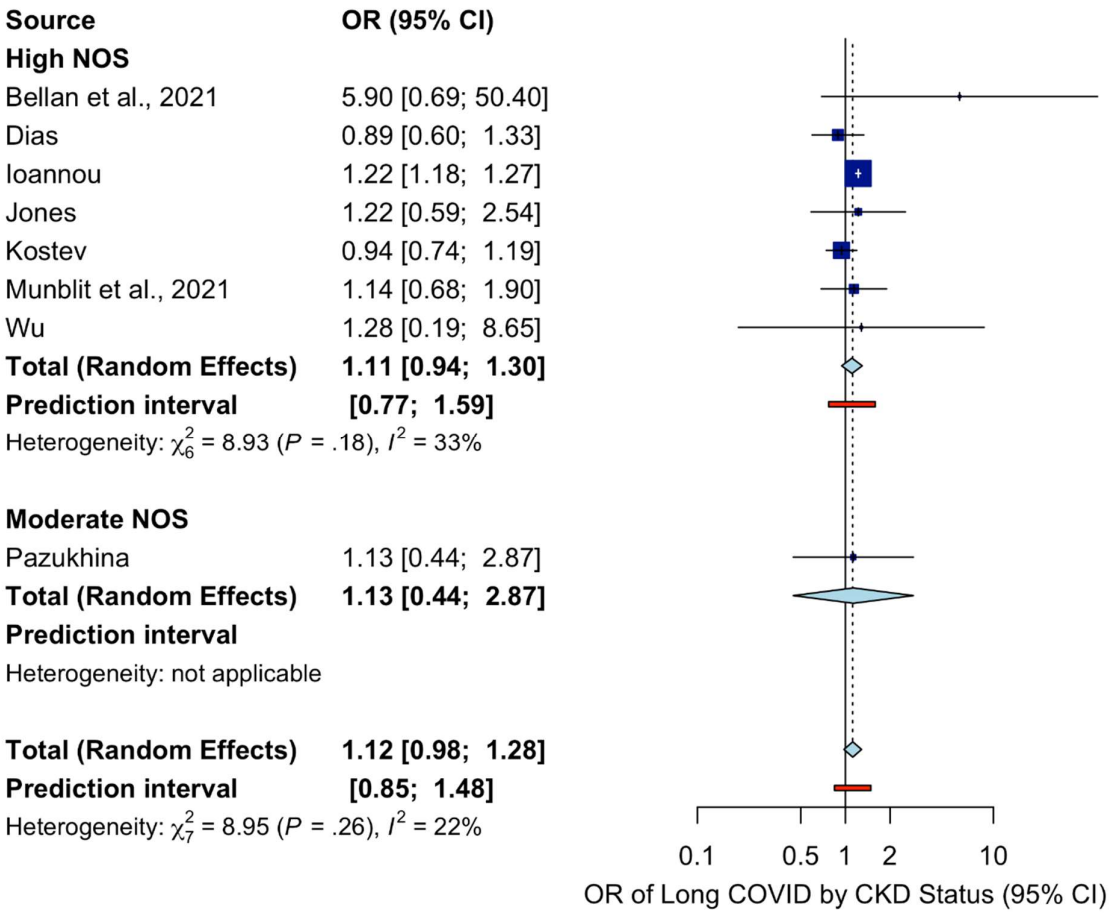


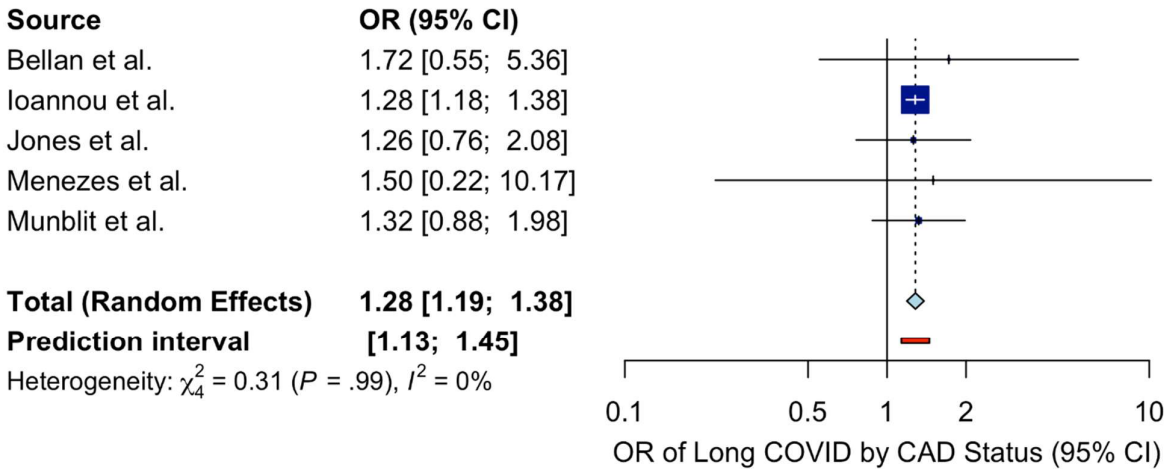
eFigure 19. Forest plot showing the effect of CKD on post−COVID-19 condition. CKD was not significantly associated with post−COVID-19 condition.



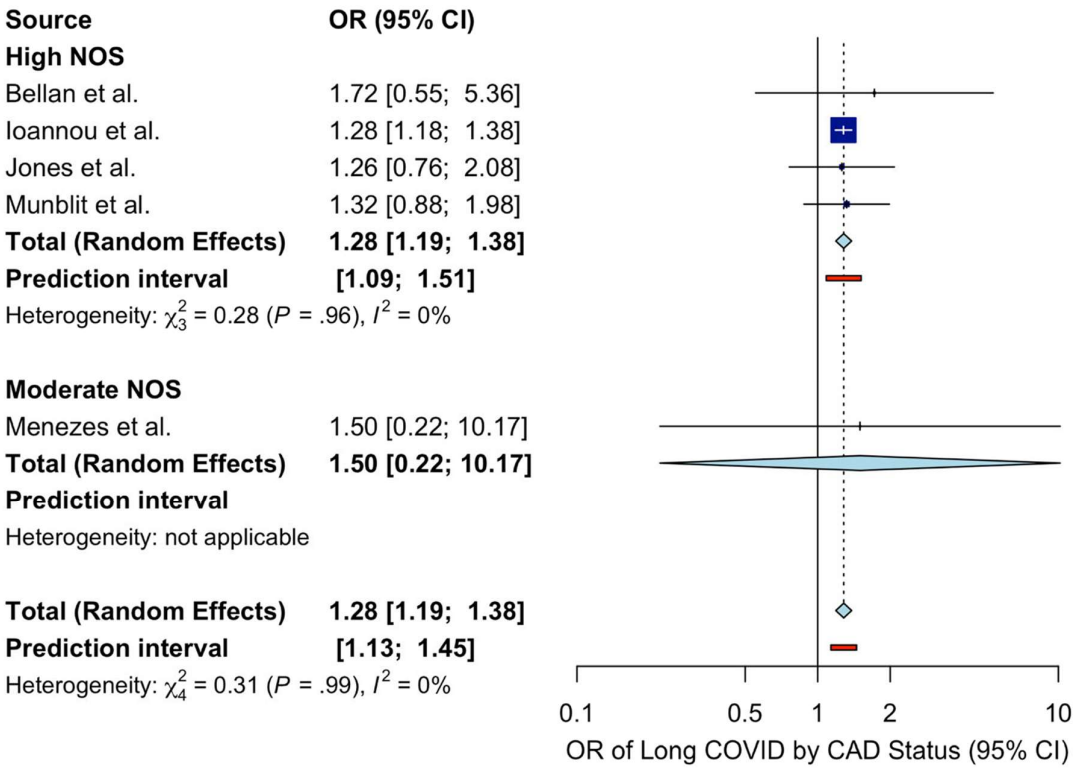
eFigure 20. Subgroup analysis of studies investigating the correlation of CKD and development of post−COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)



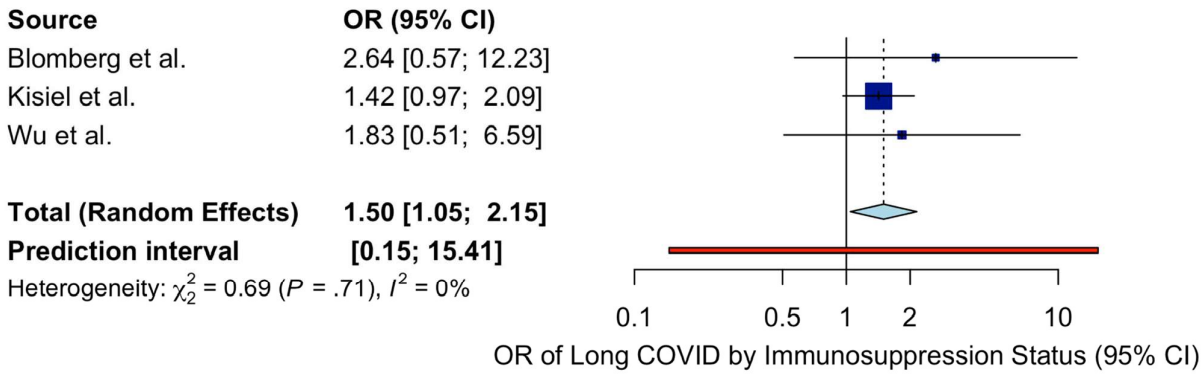
eFigure 21. Forest plot showing the association of IHD with post−COVID-19 condition. Individuals with IHD have an increased risk of developing post−COVID-19 condition.



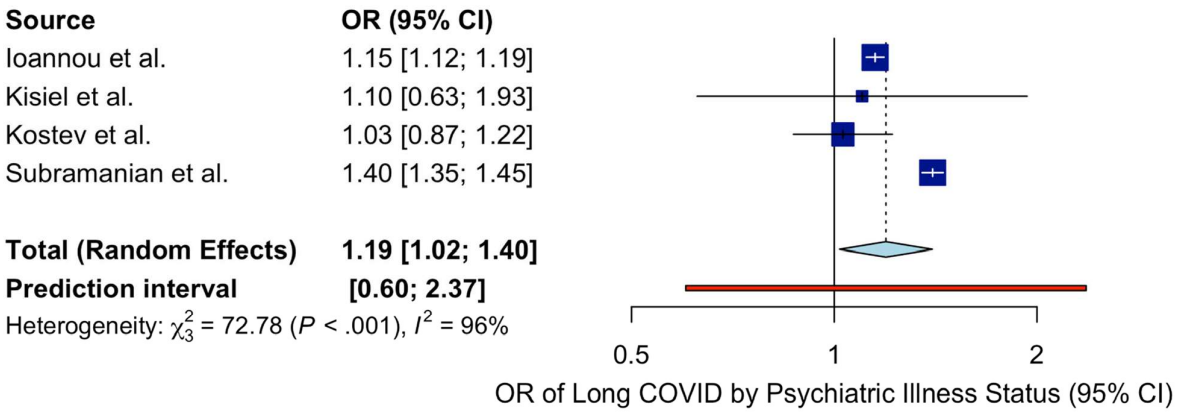
eFigure 22. Subgroup analysis of studies investigating the correlation of IHD and development of post−COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)



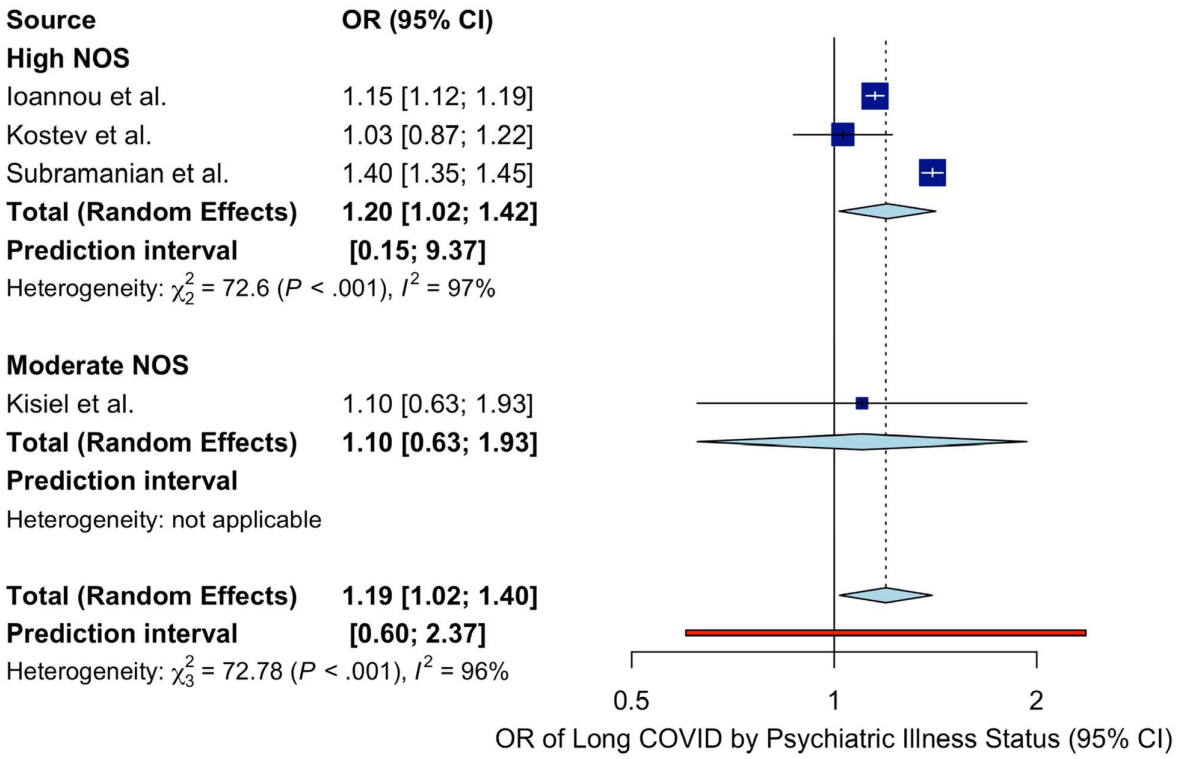
eFigure 23. Forest plot showing the association of immunosuppression with post−COVID-19 condition. Individuals with immunosuppression have an increased risk of developing post−COVID-19 condition.



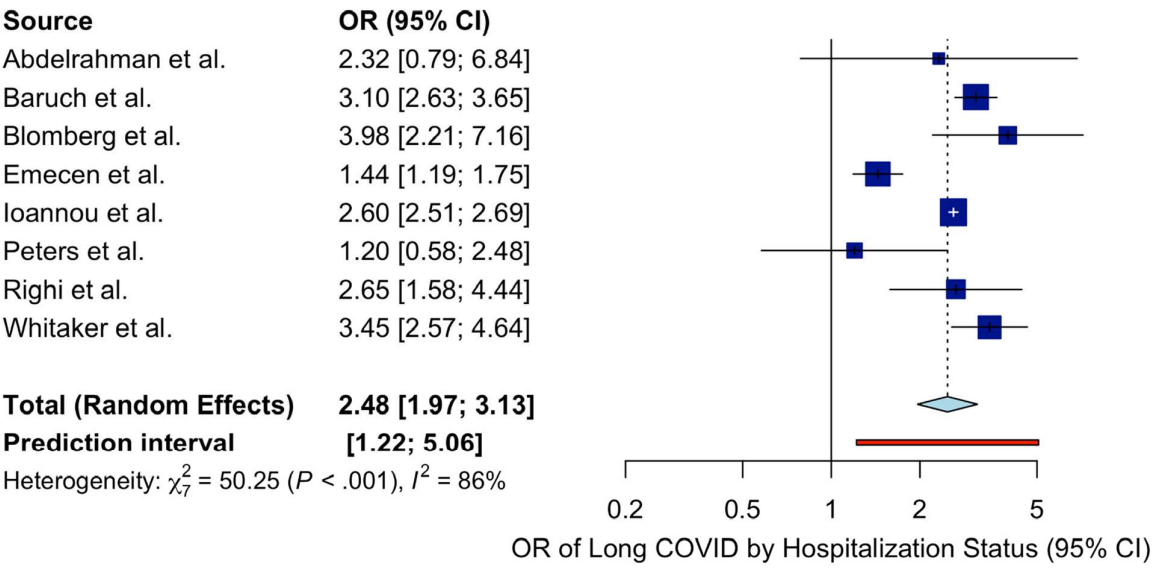
eFigure 24. Forest plot showing the association of anxiety/depression with post−COVID-19 condition. Individuals with anxiety/depression have an increased risk of developing post−COVID-19 condition.



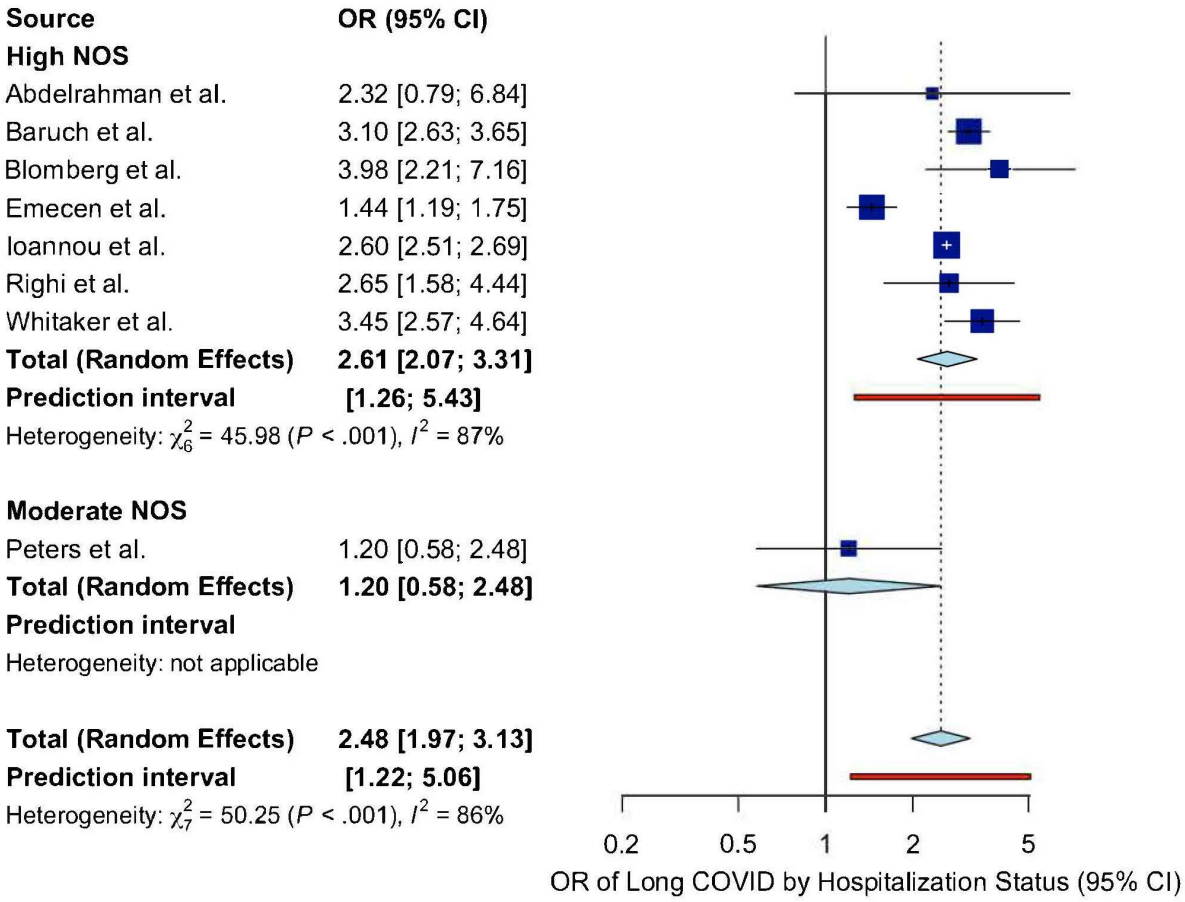
eFigure 25. Subgroup analysis of studies investigating the correlation of anxiety/ depression and development of post−COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)



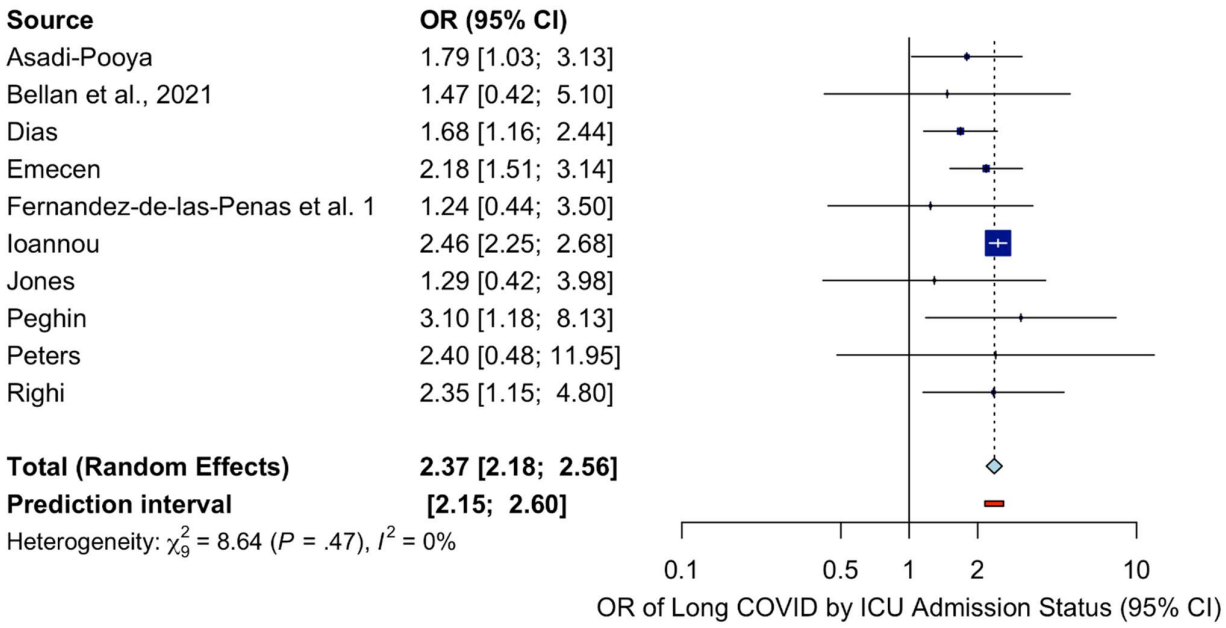
eFigure 26. Forest plot showing the association of hospitalisation with post−COVID-19 condition. Individuals that were hospitalized during the acute infection had an increased risk of developing post−COVID-19 condition.



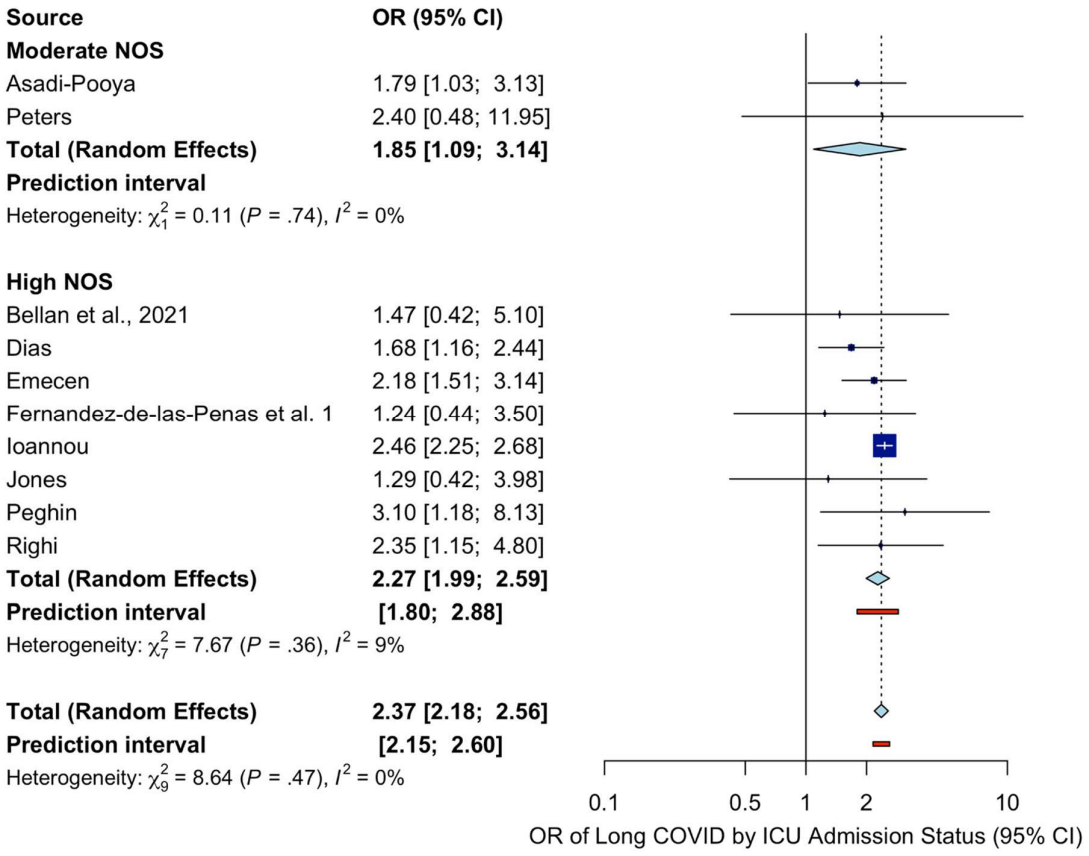
eFigure 27. Subgroup analysis of studies investigating the correlation of hospitalization and development of post−COVID-19 condition according to study quality (as per the Newcastle-Ottawa Scale)



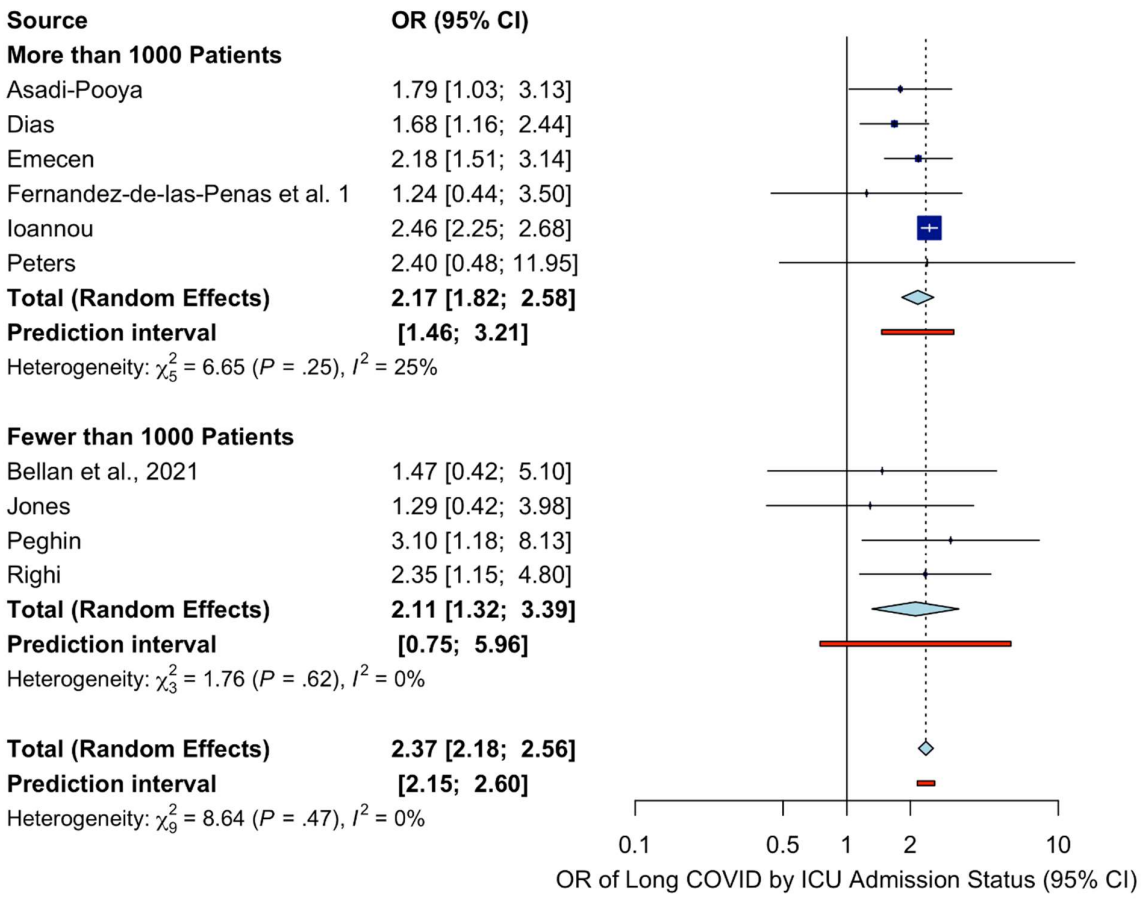
eFigure 28. Forest plot showing the association of ICU admission with post−COVID-19 condition. Individuals that required ICU admission during the acute infection had an increased risk of developing post−COVID-19 condition.



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)

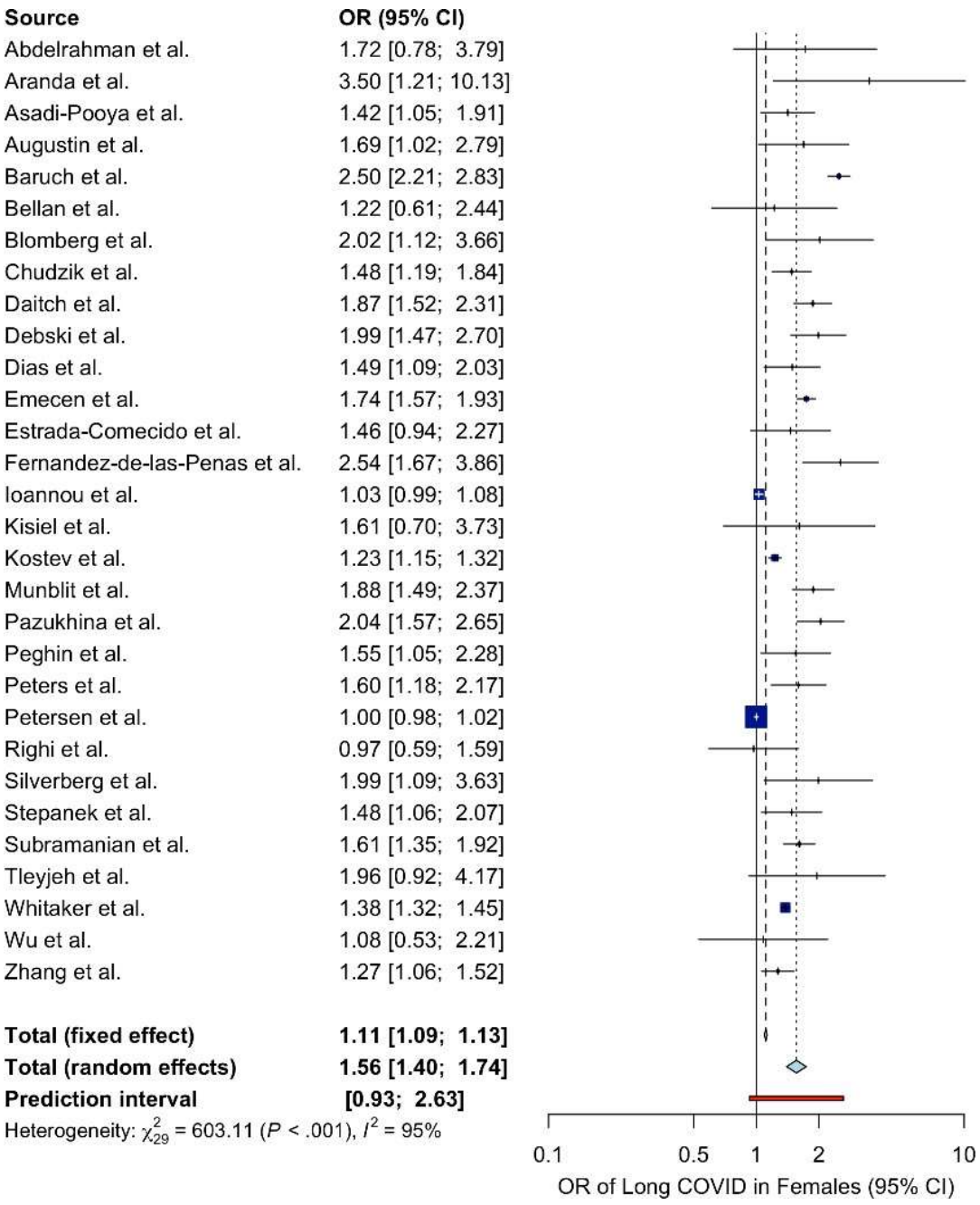


eFigure 30. Subgroup analysis of studies investigating the correlation of ICU admission and development of post−COVID-19 condition according to study size

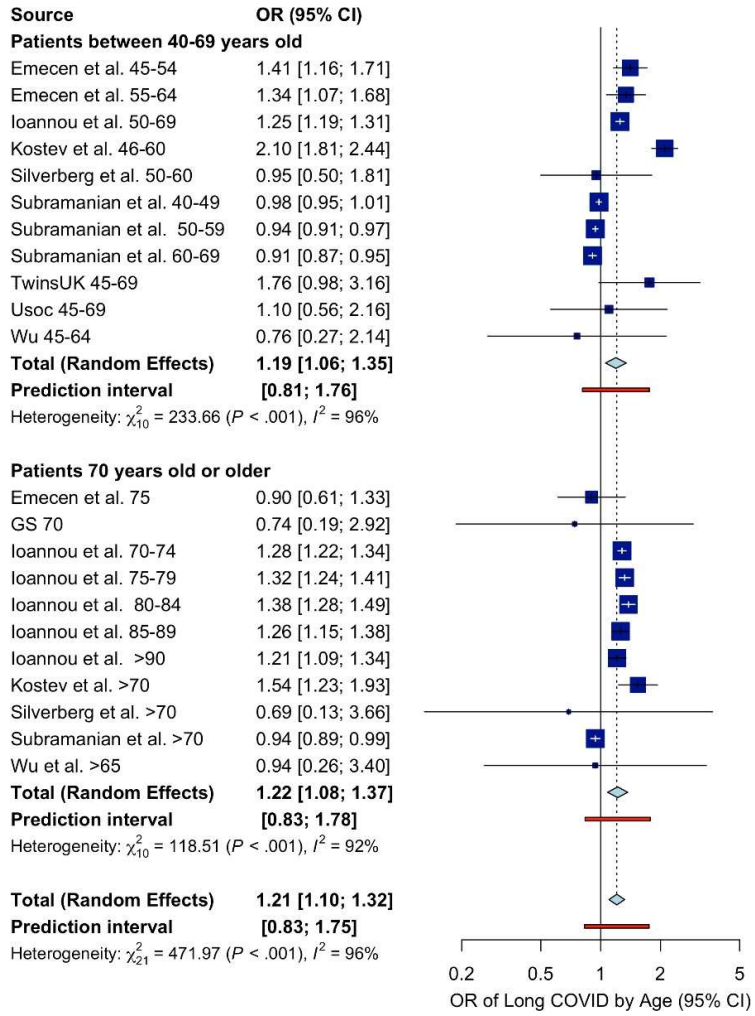


eFigure 31. Sensitivity analysis of all the risk factors examined using only the studies that included patients with laboratory confirmed COVID-19 infection

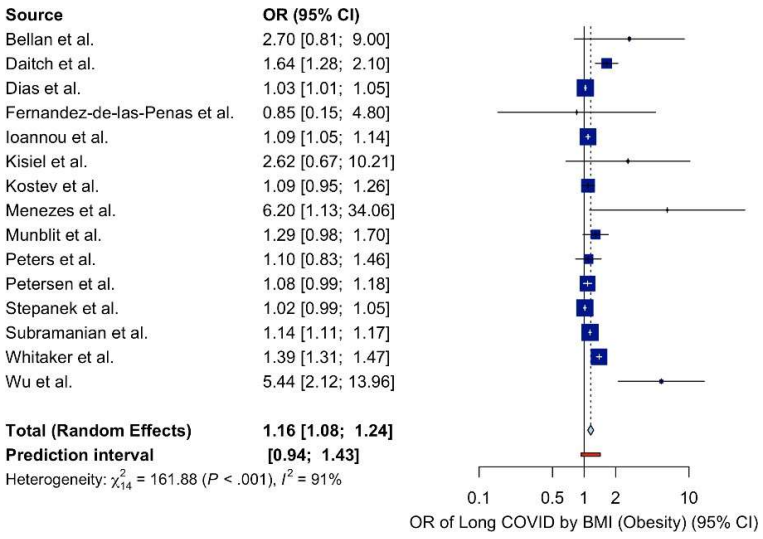
a. Female Sex



b. age



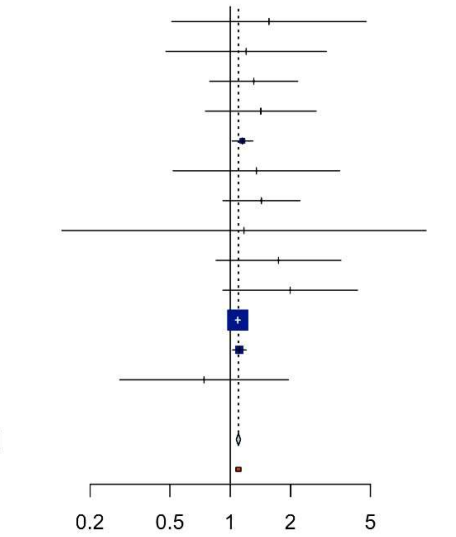
c. Obesity



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]**

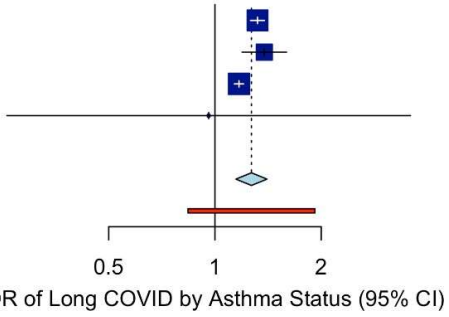
Heterogeneity: $\chi^2_{12} = 8.53$ ($P = .74$), $I^2 = 0\%$



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]**

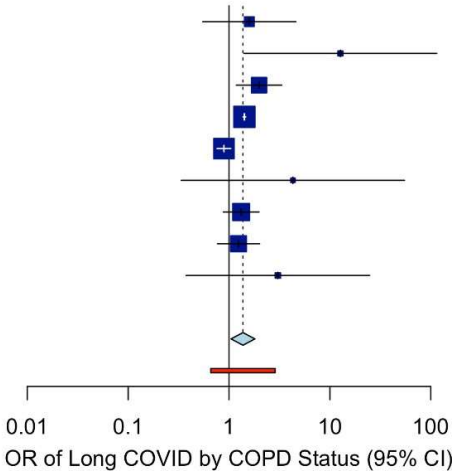
Heterogeneity: $\chi^2_3 = 21.98$ ($P < .001$), $I^2 = 86\%$



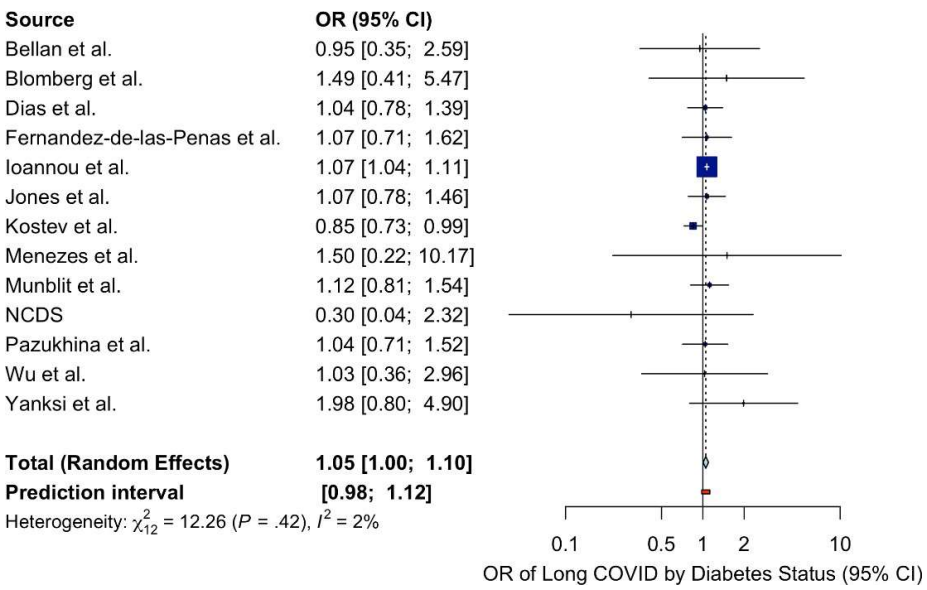
f. COPD

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]**

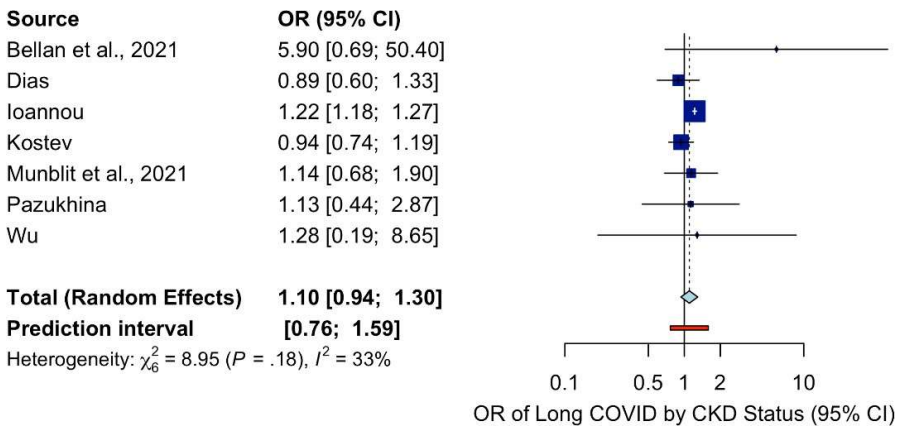
Heterogeneity: $\chi^2_8 = 40.03$ ($P < .001$), $I^2 = 80\%$



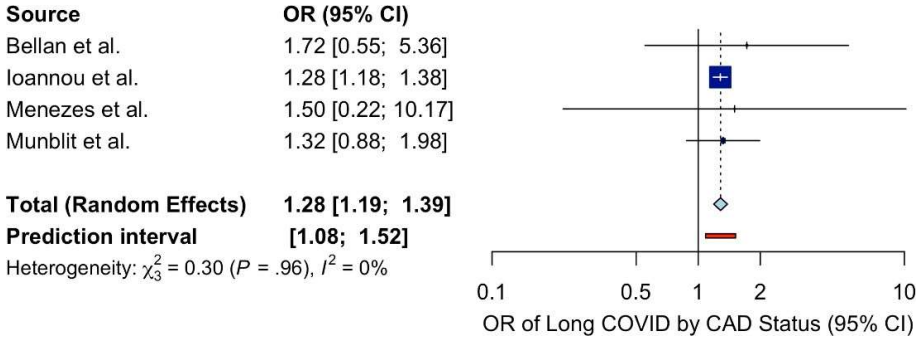
g. Diabetes



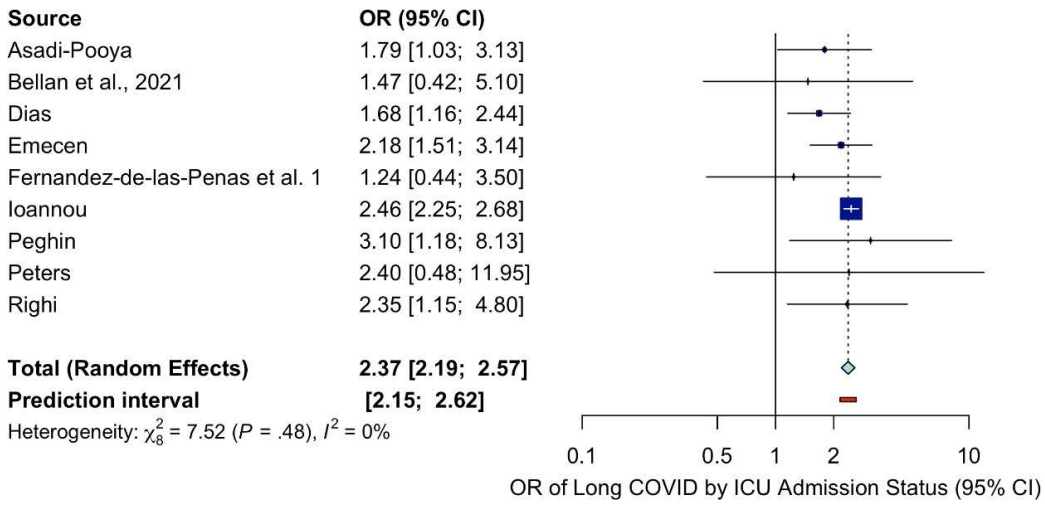
h. CKD



i. IHD

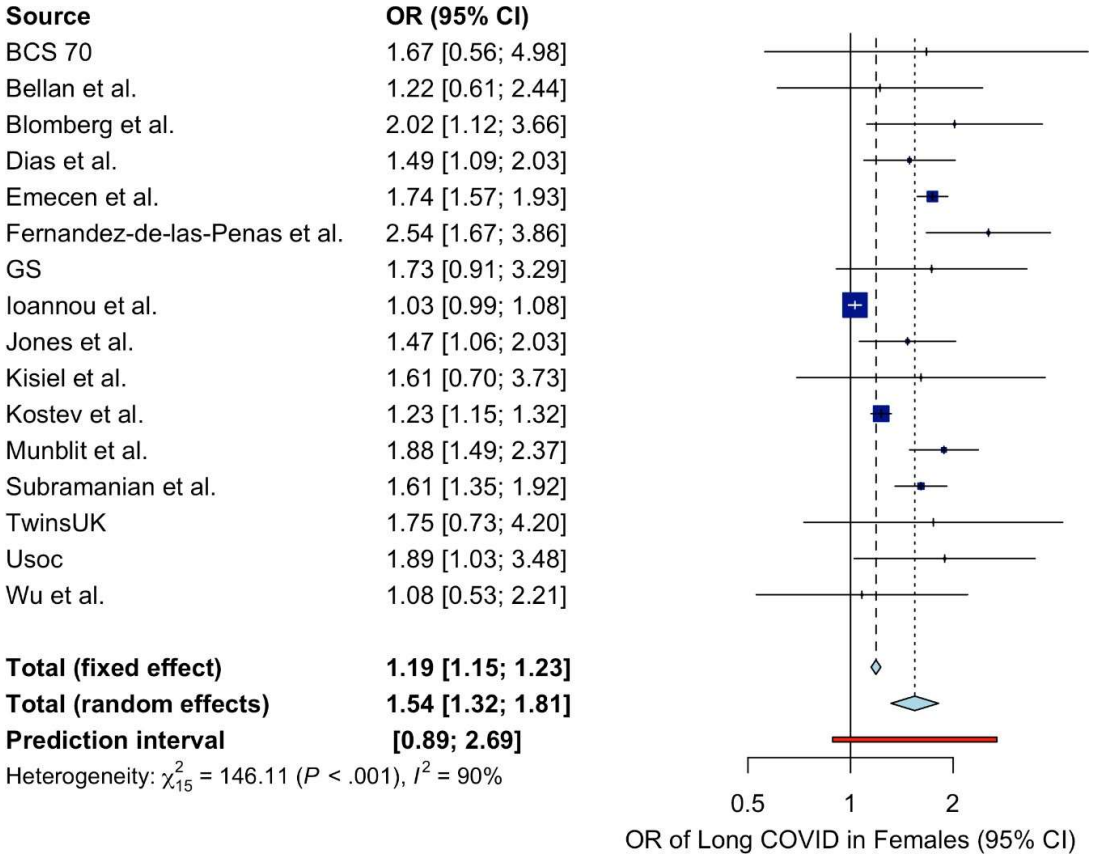


j. ICU admission

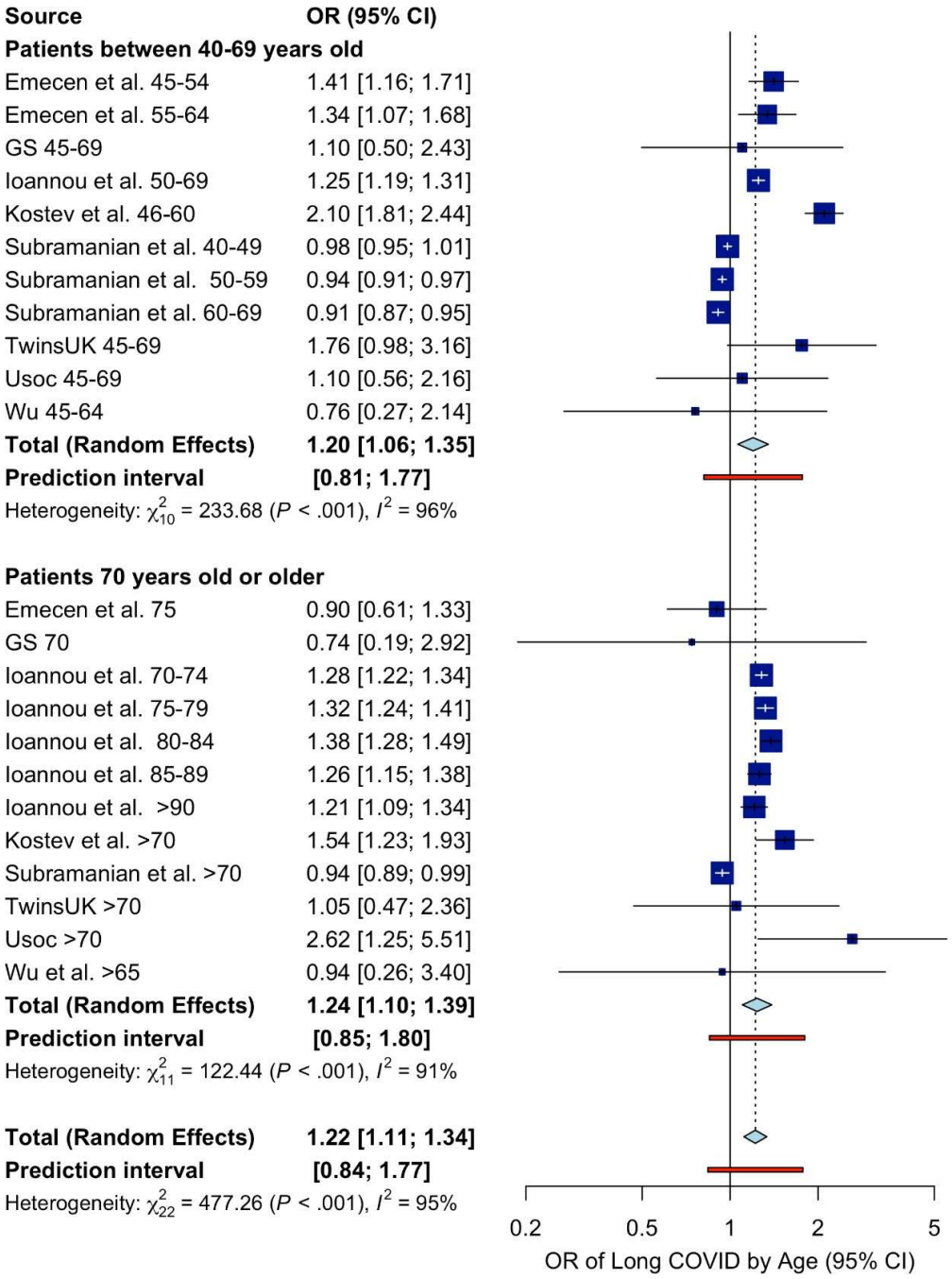


eFigure 32. Sensitivity analysis of all the risk factors excluding studies with many variables in each study (A study was defined as having many variables when they included ≥5 variables in their analysis)

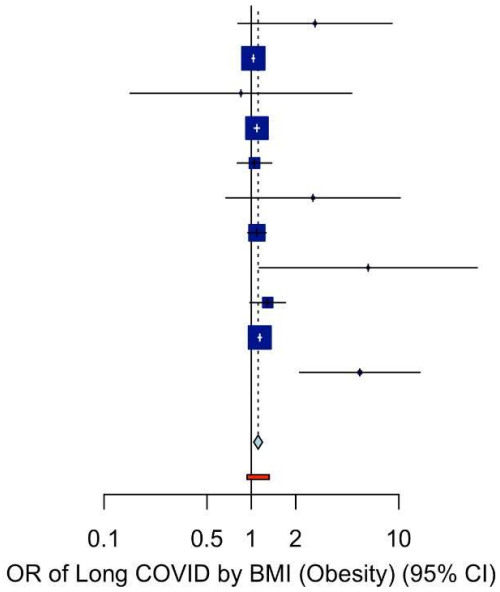
a. Female Sex



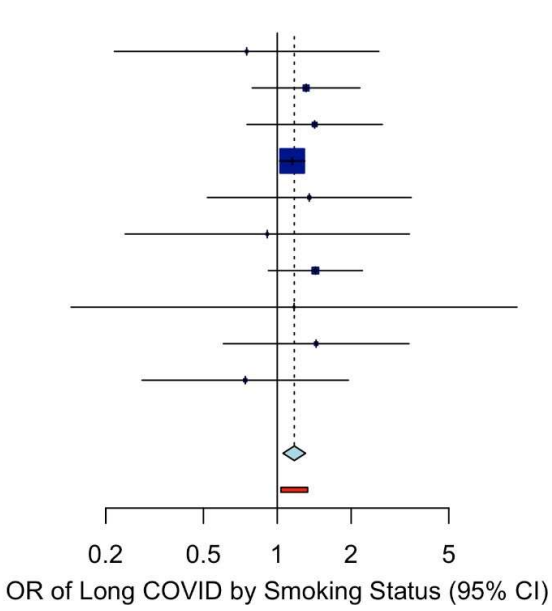
b. Age



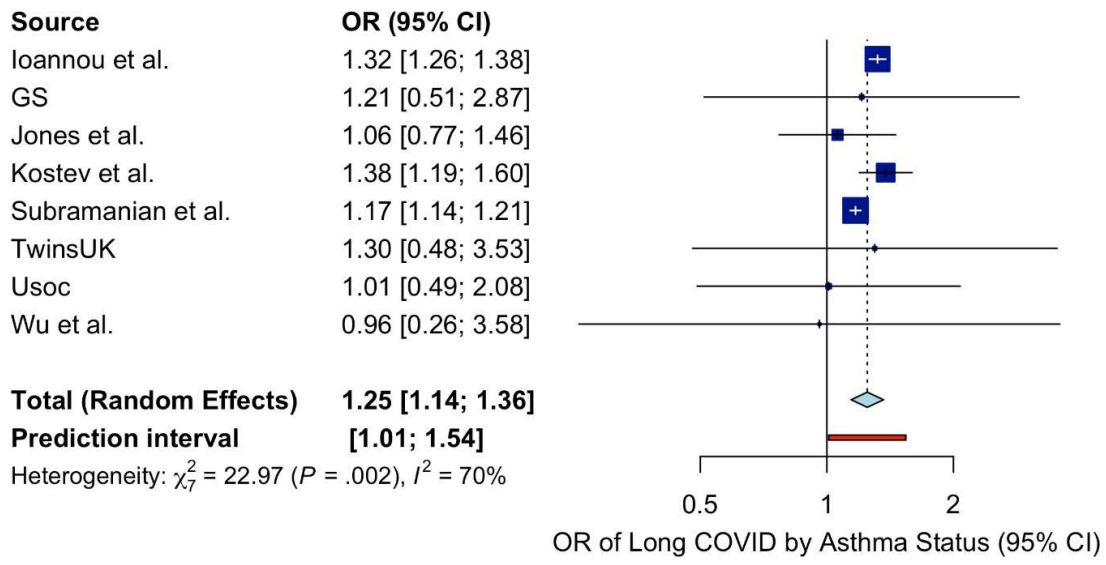
c. Obesity



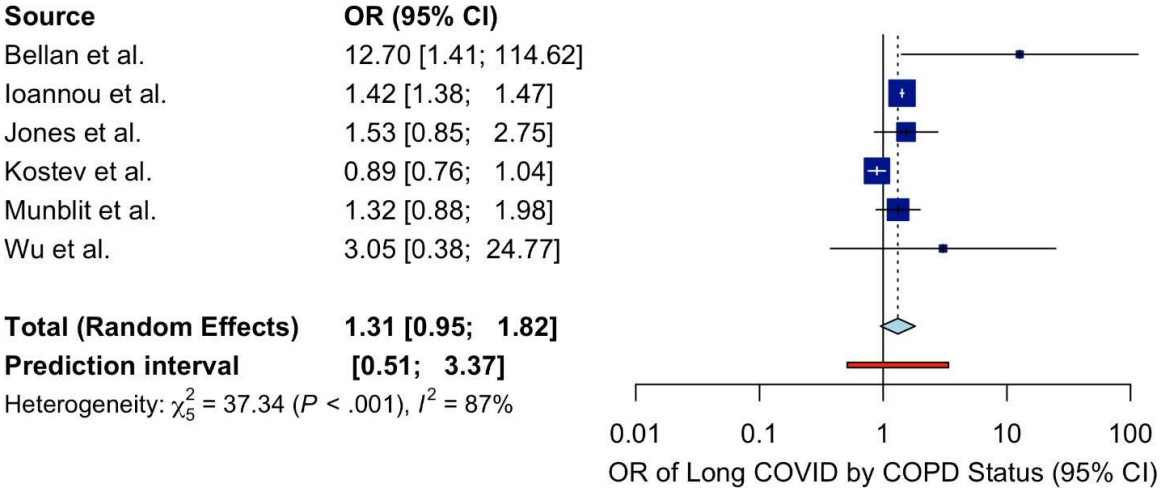
d. Smoking



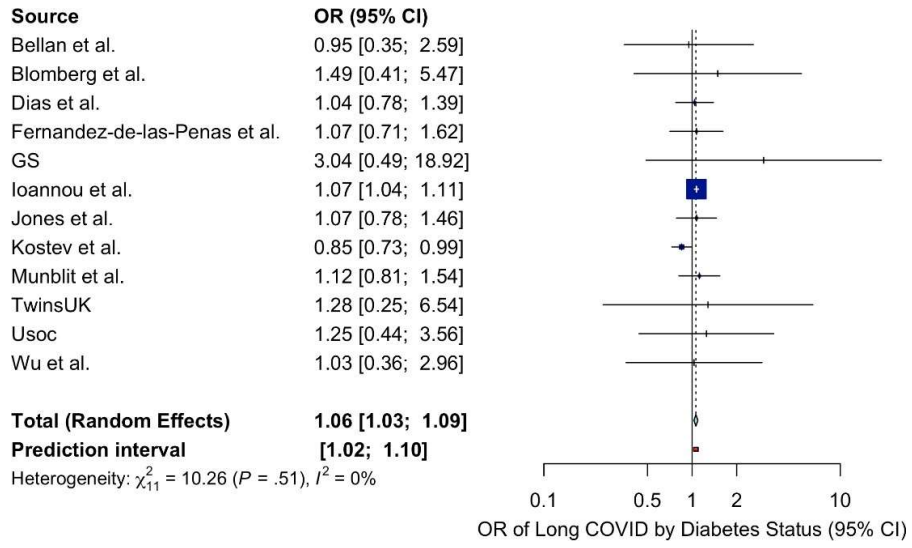
e. Asthma



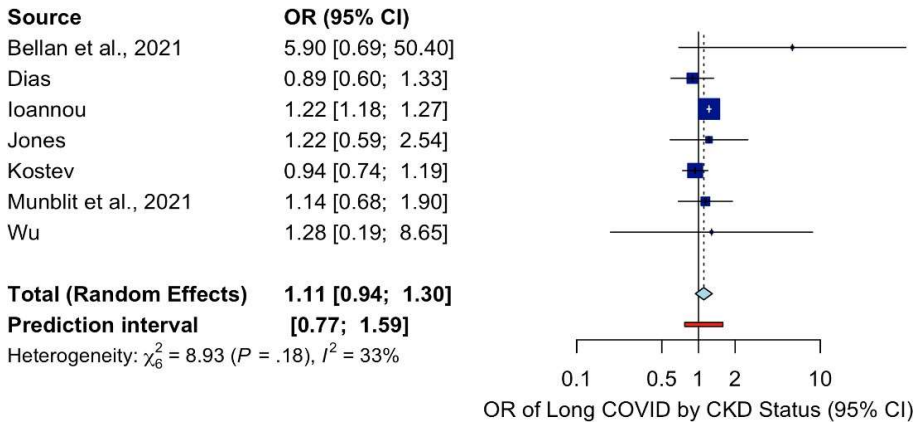
f. COPD



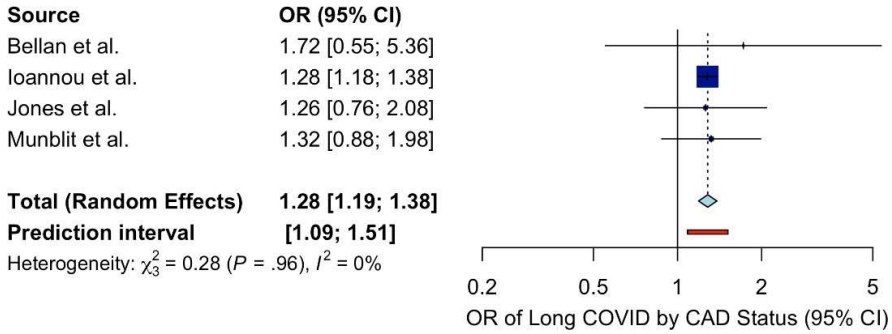
g. Diabetes



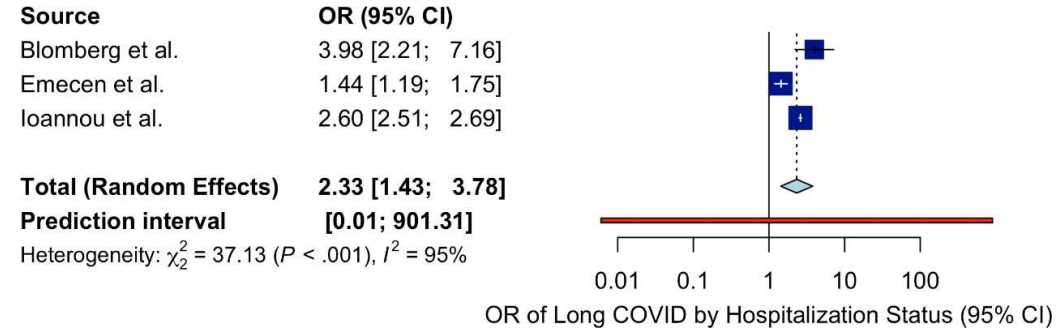
h. CKD



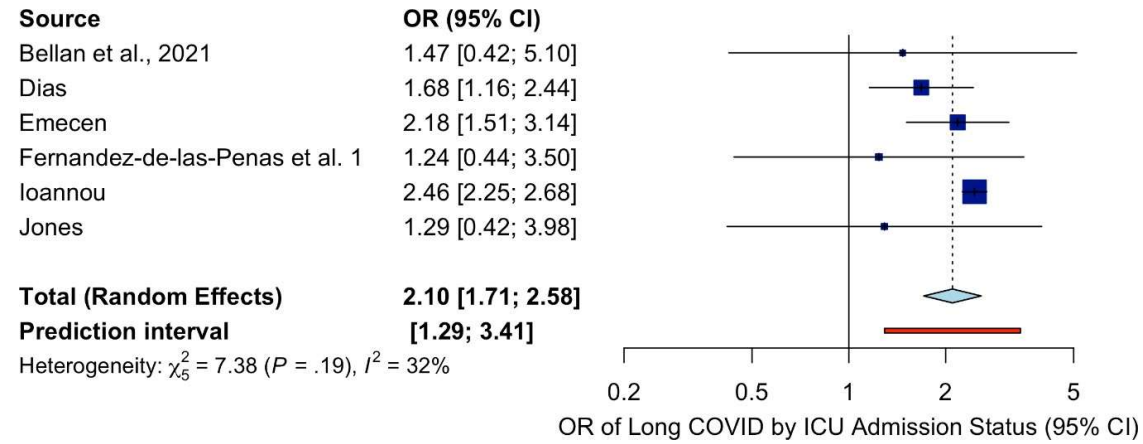
i. IHD



j. Hospitalisation



k. ICU admission



l. vaccination status