



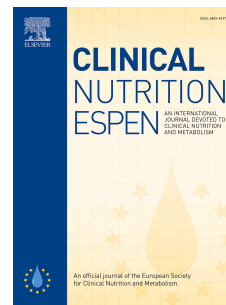
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Journal Pre-proof

Risk of bias and certainty of evidence on the association between obesity and mortality in patients with SARS-COV-2: an umbrella review of meta-analyses

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Title: Risk of bias and certainty of evidence on association between obesity and mortality in patients with SARS-COV-2: an umbrella review of metaanalyses

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Supporting Information

Table S1. Literature search in the other database than Pubmed

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Table S3. Accuracy of statistical analyses performed by SR-MAs on association between obesity and mortality in patients with COVID-19.

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Table S5. Support for AMSTAR-2 classification of methodological quality of the SR-MAs included in the current umbrella review.

List of References of Primary studies included in the SR-MAs of the current umbrella review

Primary studies included in the SR-MAs of the current umbrella review - Overlap analysis

Table S1. Literature search in the other database than Pubmed

Database	Search strategy
Embase	((obese:ab,ti OR obesity:ab,ti OR overweight:ab,ti OR body:ab,ti) AND mass:ab,ti AND index:ab,ti OR waist:ab,ti) AND circumference:ab,ti AND [embase]/lim OR ('body mass'/exp OR 'body mass') AND [embase]/lim OR ('abdominal obesity'/exp OR 'abdominal obesity') AND [embase]/lim OR ('waist circumference'/exp OR 'waist circumference') AND [embase]/lim OR ('obesity'/exp OR 'obesity') AND [embase]/lim) AND (('coronavirus disease 2019'/exp OR 'coronavirus disease 2019') AND [embase]/lim OR (((((((((((2019 AND novel AND coronavirus AND disease OR 2019) AND novel AND coronavirus AND infection OR '2019 ncov') AND disease OR '2019 ncov') AND infection OR covid) AND 19 OR covid) AND 2019 OR 'covid 19' OR covid19 OR ncov) AND 2019 AND disease OR ncov) AND 2019 AND infection OR novel) AND coronavirus AND 2019 AND disease OR novel) AND coronavirus AND 2019 AND infection OR novel) AND coronavirus AND disease AND 2019 OR novel) AND coronavirus AND infection AND 2019 OR sars) AND coronavirus AND 2 AND infection OR 'sars cov 2') AND disease OR 'sars cov 2') AND infection OR 'sars cov2') AND [embase]/lim OR ('severe acute respiratory syndrome coronavirus 2'/exp OR 'severe acute respiratory syndrome coronavirus 2') AND [embase]/lim) AND ('meta analysis'/de OR 'systematic review'/de)
Cochrane Library	<p>#1 MeSH descriptor: [Obesity] explode all trees</p> <p>#2 MeSH descriptor: [Overweight] explode all trees</p> <p>#3 MeSH descriptor: [Waist Circumference] explode all trees</p> <p>#4 MeSH descriptor: [Obesity, Abdominal] explode all trees</p> <p>#5 MeSH descriptor: [Body Mass Index] explode all trees</p> <p>#6 (Obesity OR Obese OR Obesity OR Overweight OR Body Mass Index OR Waist Circumference OR Abdominal Obesity):ti,ab,kw</p> <p>#7 MeSH descriptor: [COVID-19] explode all trees</p> <p>#8 MeSH descriptor: [SARS-CoV-2] explode all trees</p> <p>#9 (COVID-19 Virus Infection OR COVID 19 Virus Infection OR COVID-19 Virus Infections OR COVID-19):ti,ab,kw</p> <p>#10 (Coronavirus Disease 2019 Virus OR 2019 Novel Coronavirus OR 2019 Novel Coronaviruses):ti,ab,kw</p> <p>#11 (SARS-CoV-2 Virus OR SARS CoV 2 Virus OR SARS-CoV-2 Viruses):ti,ab,kw</p>

	#12 {OR #1-#6}
	#13 {OR #7-#11}
	#14 #12 and #13
EPISTEMONIKOS	(title:(Obesity OR Obese OR Obesity OR Overweight OR Body Mass Index OR Waist Circumference OR Abdominal Obesity) OR abstract:(Obesity OR Obese OR Obesity OR Overweight OR Body Mass Index OR Waist Circumference OR Abdominal Obesity)) AND (title:(covid-19 OR coronavirus OR SARS-CoV-2) OR abstract:(covid-19 OR coronavirus OR SARS-CoV-2))
LITCOVID	(obesity OR overweight OR obese) AND ("systematic review" OR "meta-analysis")
LOVE	(obesity OR overweight OR obese OR Waist Circumference OR Abdominal Obesity OR Visceral Obesity)
MEDRXIV	"(Obesity OR Obese OR Obesity OR Overweight) AND (COVID-19 OR Coronavirus) AND (Systematic review OR Meta-analysis) "
BVS	(obesidade OR obesidad OR obesity)(covid-19 OR infecções por coronavirus OR coronavirus infections OR infecciones por coronavirus) AND (type_of_study:("systematic_reviews"))
PROSPERO	#1 MeSH DESCRIPTOR Obesity EXPLODE ALL TREES #2 MeSH DESCRIPTOR COVID-19 EXPLODE ALL TREES #3 #1 AND #2

Table S2. References and reasons for exclusion of articles during the full-text reading phase of eligibility confirmation

Reference	Reason for exclusion
1. Singh AK. Prevalence of comorbidities and their association with mortality in patients with COVID -19: A Systematic Review and Meta-analysis. <i>Diabetes Obes Metab.</i> 2020 Oct;22(10):1915-1924	Did not assess obesity as an exposition factor.
2. Bansal V. Obesity Is a Risk Factor for Increased COVID-19 Severity: A Systemic Review and Meta-Regression. <i>Critical Care Medicine.</i> 2021 Jan; 49 (1): 43	Abstract publication.
3. Abbasi J. Large Meta-analysis Digs Into Obesity's COVID-19 Risks. <i>JAMA.</i> 2020 Nov; 324 (17): 1709-1711	News and Analysis publication.
4. Moazzami B. Metabolic risk factors and risk of Covid-19: A systematic review and meta-analysis. <i>PLoS One.</i> 2020 Dec;15(12):e0243600	Did not assess association between obesity and mortality.
5. Sales-Peres SHC. Coronavirus (SARS-CoV-2) and the risk of obesity for critically illness and ICU admitted: Meta-analysis of the epidemiological evidence. <i>Obes Res Clin Pract.</i> Sep-Oct 2020;14(5):389-397	Did not assess mortality as outcome.
6. Booth A. Population risk factors for severe disease and mortality in COVID-19: A global systematic review and meta-analysis. <i>PLoS One.</i> 2021 Mar;16(3):e0247461	Assessed mortality as part of a composite outcome.
7. Huang HK. The J-shaped relationship between body mass index and mortality in patients with COVID-19: A dose-response meta-analysis. <i>Diabetes Obes Metab.</i> 2021 Jul; 23(7):1701-1709	Letter to the Editor publication.
8. Liu M. Is there an exposure-effect relationship between body mass index and invasive mechanical ventilation, severity, and death in patients with COVID-19? Evidence from an updated meta-analysis. <i>Obes Rev.</i> 2020 Nov; 21(11): e13149	Letter to the Editor publication.
9. Zhoe Y. Comorbidities and the risk of severe or fatal outcomes associated with coronavirus disease 2019: A systematic review and meta-analysis. <i>Int J Infect Dis.</i> 2020 Oct; 99:47-56	Did not perform metanalysis about obesity and mortality since just one primary study included assessed it.
10. Chowdhury AI. Does higher BMI increase COVID-19 severity?: a systematic review and metaanalysis. <i>Obes Med.</i> 2021 May; 23:100340.	Did not assess mortality as outcome.
11. Das P. Obesity as a Predictor for Adverse Outcomes Among COVID-19 Patients: A Meta-Analysis. <i>medRxiv.</i> 2020	Assessed mortality as part of a composite

Nov;2020.11.27.20239616.	outcome.
12. Xinya Zhang, 2021. A systematic review and meta-analysis of the prevalence of obesity and/or obesity-related diseases in patients with coronavirus disease 2019 (COVID-19).	Full-text was not found.
13. Hussain A. Obesity and mortality of COVID-19. Meta-analysis. <i>Obes Res Clin Pract.</i> Jul-Aug 2020;14(4):295-300	Retracted article.
14. Hussain A. Retraction notice to Obesity and Mortality of COVID-19. Meta-analysis. <i>Obesity Research & Clinical Practice</i> 14/4 (2020) 295-300]. <i>Obes Res Clin Pract.</i> Jan-Feb 2021;15(1):100.	Retraction of publication.
15. McPartlan E. A systematic review and meta analysis of obesity as a risk factor for poor outcomes associated with COVID-19. PROSPERO 2021 CRD42021247838	Protocol publication (Review Ongoing - status in 27 April 2022)
16. Fang C. Body mass index associated with severity and mortality of patients with coronavirus disease 2019: A systematic review and meta-analysis. doi: 10.21203/rs.3.rs-79456/v1. https://www.researchsquare.com/article/rs-79456/v1	Presented the difference of BMI between survivors and non-survivors and not the HR/OR/RR for its association.
17. Ao G. The relationship between COVID-19 and obesity: a systematic review and meta-analysis. PROSPERO 2020 CRD42020203744	Protocol publication (Review Ongoing - status in 27 April 2022)
18. Mozaffari H. Obesity and poor prognosis of coronavirus disease 2019 (COVID-19): a systematic review and meta-analysis. PROSPERO 2020 CRD42020203386	Protocol publication (Review Ongoing - status in 27 April 2022)
19. Puzanian H. The association and the predictors of mortality in obese patients with COVID-19 infection: A Systematic Review and Meta-analysis. PROSPERO 2020 CRD42020220140	Protocol publication (Review Ongoing - status in 27 April 2022)
20. Yang J. Obesity aggravates COVID-19: A systematic review and meta-analysis. <i>J Med Virol.</i> 2021 Jan;93(1):257-261	Did not assess mortality as outcome.
21. Saragih ID. Obesity and comorbidity in the prognosis of survival among older people with COVID-19: a systematic review	Protocol publication

and meta-analysis. PROSPERO 2020 CRD42020212730	(Review completed not published - status in 27 April 2022)
22. Zhen J. Obesity as an independent risk factor for COVID-19 severity and mortality. PROSPERO 2020 CRD42020190687	Protocol publication (Review Ongoing - status in 27 April 2022)
23. Oliveira JD. Obesity and diabetes and complications of COVID-19: a systematic review. PROSPERO 2020 CRD42020202626	Protocol publication (Review Ongoing - status in 27 April 2022)
24. Yang J, Zheng Y, Gou X, et al. Prevalence of comorbidities and its effects in patients infected with Sars-Cov-2: A Systematic Review And Meta-Analysis. Int J Infect Dis. 2020 May; 94:91-95. doi: 10.1016/j.ijid.2020.03.017.	Did not assess mortality as outcome.
25. Borges LD. Prevalence of excess body weight in adults and the elderly diagnosed with COVID-19: systematic review and meta-analysis. PROSPERO 2020 CRD42020183602	Protocol publication (Review Ongoing - status in 27 April 2022)
26. Malik P. Obesity a predictor of outcomes of COVID-19 hospitalized patients-A systematic review and meta-analysis. J Med Virol. 2021 Feb;93(2):1188-1193	Assessed mortality as part of a composite outcome.
27. Maolin Ma. Severe Coronavirus Disease 2019 (COVID-19) Cases Associated with Obesity: A Meta Analysis. PROSPERO 2020 CRD42020183314	Protocol publication (Review completed not published - status in 27 April 2022)
28. Foldi M. Obesity as a risk factor for mechanical ventilation and ICU admission among SARS-CoV-2 infected individuals: a meta-analysis and systematic review. PROSPERO 2020 CRD42020185980	Protocol publication (Review Ongoing - status in 27 April 2022)
29. Chen M. The association between BMI and progression to severe outcomes in patients with COVID-19: a systematic review and meta-analysis. PROSPERO 2020 CRD42020191114	Protocol publication (Review Ongoing - status in 27 April 2022)

30. Dualib P. A systematic review and meta-analysis of the association of diabetes mellitus, obesity and cardiovascular disease with poorer progression in patients with COVID-19. PROSPERO 2020 CRD42020184254	Protocol publication (Review Ongoing - status in 27 April 2022)
31. Raeisi T. The Negative Impact of Obesity on the Occurrence and Prognosis of the 2019 Novel Coronavirus (COVID-19) Disease: A Systematic Review and Meta-Analysis. https://doi.org/10.21203/rs.3.rs-86237/v1	The authors have requested that this preprint be withdrawn due to erroneous posting.
32. Pranata R. Visceral Adiposity and Severe Coronavirus Disease-2019 (COVID-19): Systematic Review and Meta-Analysis. PROSPERO 2020 CRD42020215876	Protocol publication (Review completed not published - status in 27 April 2022)
33. Sahu AK. Clinical determinants of severe COVID-19 disease - A systematic review and meta-analysis. J Glob Infect Dis. 2021 Jan;13(1):13-19.	Did not assess mortality as outcome.
34. Seidu S. Association of obesity with outcomes in patients with COVID-19: a systematic review and meta-analysis. PROSPERO 2020 CRD42020179783	Protocol publication (Review Ongoing - status in 27 April 2022)
35. Sharma A. Association of Obesity With More Critical Illness in COVID-19. Mayo Clin Proc . 2020 Sep;95(9):2040-2042	Assessed mortality as part of a composite outcome.
36. Soeroto AY. Association of BMI and Obesity with Composite poor outcome in COVID-19 adult patients: A Systematic Review and Meta-Analysis. Diabetes Metab Syndr. Nov-Dec 2020;14(6):1897-1904	Assessed mortality as part of a composite outcome.
37. Chang TH. Effect of obesity and body mass index on coronavirus disease 2019 severity: A systematic review and meta-analysis. Obes Rev. 2020 Nov;21(11):e13089.	Did not assess mortality as outcome.
38. Malik VS. Higher body mass index is an important risk factor in COVID-19 patients: a systematic review and meta-analysis. Environ Sci Pollut Res Int. 2020 Nov;27(33):42115-42123/	Did not assess mortality as outcome.
39. Sawadogo W. The association of obesity and COVID-19 severity: a systematic review and meta-analysis. PROSPERO	Protocol publication

2020 CRD42020198718	(Review Ongoing - status in 27 April 2022)
40. Xu L. Risk factors for 2019 novel coronavirus disease (COVID-19) patients progressing to critical illness: a systematic review and meta-analysis. <i>Aging (Albany NY)</i> . 2020 Jun 23;12(12):12410-12421	Did not investigate the association between obesity and mortality.
41. Zhao X. Obesity as a risk factor for the severity and mortality of influenza and COVID-19: a systematic review and meta-analysis. PROSPERO 2020 CRD42020201461	Protocol publication (Review Ongoing - status in 27 April 2022)
42. Soeroto AY. Effect of increased BMI and obesity on the outcome of COVID-19 adult patients: A systematic review and meta-analysis. <i>Diabetes Metab Syndr</i> . Nov-Dec 2020;14(6):1897-1904.	Assessed mortality as part of a composite outcome.
43. Foldi M. Obesity is a risk factor for developing critical condition in COVID-19 patients: A systematic review and meta-analysis. <i>Obes Rev</i> . 2020 Oct;21(10):e13095	Did not assess mortality.
44. Ho JSY. Increased COVID-19 Infection Susceptibility and Adverse Outcomes Due to Obesity: A Systematic Review and Meta-analysis. <i>Ann Acad Med Singap</i> . 2020 Dec; 49(12):996-1008.	Did not assess mortality.
45. Sales-Peres S. Coronavirus (COVID-19) and the risk of overweight or obesity for complications and death: a systematic review with meta-analysis of the epidemiological evidence. PROSPERO 2020 CRD42020183216	Protocol publication (Review completed and published - status in 27 April 2022) - number 5 of this list also excluded.
46. Chowdhury AI. Does higher body mass index increase COVID-19 severity? A systematic review and meta-analysis. <i>Obes Med</i> . 2021 May;23:100340.	Did not assess mortality.
47. Singh R. Association of Obesity with COVID-19 Severity and Mortality: A Systemic Review and Meta-Regression. medRxiv preprint doi: https://doi.org/10.1101/2021.05.08.21256845 ; this version posted May 10, 2021	Pre-print (not peer review)
48. Mahamat-Saleh Y. Diabetes, Hypertension, Body Mass Index, Smoking and COVID-19-Related Mortality: A Systematic Review and Meta-Analysis of Observational Studies. <i>SSRN Electronic Journal</i> . 2021.	Pre-print (not peer review)

DOI:10.2139/ssrn.3773509	
49. Sun X. Increased COVID-19 Infection Susceptibility and Adverse Outcomes Due to Obesity: A Systematic Review and Meta-analysis. Research Square. 2020. DOI: https://doi.org/10.21203/rs.3.rs-244649/v1 .	Pre-print (not peer review)
50. Shraim LOM. The relationship between body weight and COVID-19 health outcomes in adults admitted to hospital for COVID-19. PROSPERO 2021 CRD42021273827	Protocol publication (Review Ongoing - status in 27 April 2022)
51. Park, R. Prognostic impact of obesity in cancer patients with COVID-19 infection: A systematic review and meta-analysis	Abstract publication.
52. Tobias, D. Body mass index and COVID-19 mortality: a systematic review and meta-analysis	Full-text was not found.
53. Ibarra, MMO. Prevalence and clinical implications of abnormal body composition phenotypes in patients with COVID-19: a systematic review	Full-text was not found.
54. Ashraf, M. Effect of body mass index on cardiac injury/cardiovascular outcomes in coronavirus disease 2019: A systematic review and meta-analysis	Abstract
55. Bunn, S. Obesity as a risk factor for the admission of COVID-19 patients into ICU: A systematic review and meta-analysis	Abstract
56. Buscemi, S. Risk Factors for COVID-19: Diabetes, Hypertension, and Obesity	Published on Advances in Experimental Medicine and Biology (peer-reviewed book series)
57. LI, X. Clinical determinants of the severity of COVID-19: A systematic review and meta-analysis	Assessed mortality as part of a composite outcome.
58. Ferreira, MER. COVID-19 and obesity: a systematic review and meta-analysis on the pre-existing clinical conditions, covid-19 symptoms, laboratory findings and clinical outcomes	Letter to editor
59. Singh, R. The association of obesity with COVID-19 severity and mortality: Systemic review and meta-regression	Pre-print (not peer review)
60. Srivastava, S. Obesity: A Risk Factor for COVID-19	Published on Advances in Experimental Medicine and Biology (peer-

reviewed book series

61. Vardavas, CI. Prognostic factors for mortality, ICU and hospital admission due to SARS-CoV-2: A systematic review and meta-analysis of cohort studies in Europe Pre-print (not peer review)

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Table S3. Accuracy of statistical analyses performed by SR-MAs on association between obesity and mortality in patients with COVID-19.

First Author, year (REF)	Metanalysis Model	Pooled data	Effect size	Heterogeneity assessment and exploring	Subgroup analysis conducted	Publication bias assessment	Other analysis	Software
Seidu S, 2020 (1)	Inverse variance weighted method (DerSimonian and Laird) Random effects model.	Multivariable-adjusted risk estimates were used for pooling if available, otherwise crude RRs were used as reported.	RR (95% CI). The reported HRs was assumed to approximate the same measure of RR.	Cochrane χ^2 statistic and the I^2 statistic Explored by subgroup and meta-regression analysis.	Prespecified study-level characteristics such as geographical location, average age at baseline and study quality	Visual inspection of Begg's funnel plots and Egger's regression symmetry tests.	None.	STATA 16.0 (StataCorp LP)
Yang J, 2021 (4)	Random effects model.	Not reported.	OR (95% CIs)	I^2 statistic Explored by sensitivity, subgroup and meta-regression analysis.	Region, caseload, age, study type, type of value and BMI range.	Funnel plot and Egger's test.	None.	STATA 16.0
Popkin BM, 2020 (9)	Random effects model.	Not reported.	OR (95% CIs).	Not reported.	Not performed.	Not reported.		STATA 16.0 (College Station, TX)
Huang Y, 2020 (12)	Fixed or random effects model if heterogeneity <50% and >50%, respectively.	Unclear reporting (OR and 95% CI was estimated when it was not provided by authors, but it is not clear if adjusted or crude OR was	OR (95% CIs)	I^2 statistic. Heterogeneity was not explored.	Not performed.	Funnel plot and Egger's test.		STATA/SE 12.0

		pooled when it was provided by authors)					
Yang J, 2020 (25)	Generic inverse variance approach. If $I^2 > 50\%$ or $p < 0.10$, indicating heterogeneity, the random-effects model was utilized. Otherwise, the fixed-effects model was used.	Not reported	OR (95% CIs)	I^2 statistic.	BMI range.	Visual inspections of funnel plots.	RveMan 5.3 (Cochrane Collaboration)
Mesas AE, 2020 (26)	DerSimonian and Laird method. Random effects model.	Unclear reporting (The OR and 95% CIs were calculated for no survivors and survivors among exposed and nonexposed individuals).	OR (95% CIs)	I^2 statistic Explored by sensitivity, subgroup and meta-regression analysis.	Elderly, men and in poor health condition.	Funnel plot and Egger's test.	STATA SE 15.0 (StataCorp, College Station, TX, USA)
Aghili SMM, 2021 (27)	Random effects model, regardless of heterogeneity.	Adjusted ORs (aORs) were pooled.	OR (95% CIs).	I^2 statistic.	NR	NR	STATA Direct 3.1.22
Hoong CWS, 2021	DerSimonian and	Unclear reporting	Adjusted OR	Cochran's Q	Study region, quality of study, type of study,	Funnel plot, Egger's test,	Comprehensive Meta-analysis

(28)	Laird method. Random effects model.	(For each study, the data for the outcomes was reported as the Odds Ratio)	(95% CIs).	statistic I^2 statistic Explored by sensitivity analysis (Using the Remove-One index)	number of centers, sample size of obese population and possible confounding patients' demographics and comorbidities	and the trim-and-fill method.	(CMA) 3.0
Li Y, 2021 (29)	Random effects model.	Not reported.	OR (95% CIs).	I^2 statistic. Explored by sensitivity analysis.	Not performed.	Funnel plot and Egger's test.	R 3.6.1 (Foundation for Statistical Computing, Vienna, Austria).
Zhang X, 2021 (30)	Random effects model.	Unclear reporting. (7 studies reported unadjusted likelihood of mortality)	OR (95% CIs)	Q test. Explored by sensitivity and subgroup analysis.	Geographic region.	Funnel plot.	Comprehensive Meta-Analysis (CMA) Professional v3 (Englewood, New Jersey, USA)
Ng WH, 2021 (31)	Random effects model.	Unclear reporting (Meta-analysis was conducted using pooled studies, which reported bivariate analysis)	Logarithm of HR (95% CIs) and HR.	I^2 statistic. Heterogeneity was not explored.	Not performed.	Not reported.	R, 4.0.2 (R Foundation for Statistical Computing, Vienna, Austria)
Deng L, 2021 (32)	Random effects model.	Not reported.	OR (95% CIs).	I^2 statistic. Explored by	Country and obesity definitions.	Funnel plot.	Dose response analysis using STATA MP version 16.0

				subgroup analysis.			the fixed-effect model and based on the generalized least square method.	
Ho JSY, 2020 (33)	DerSimonian and Laird method. Random effects model.	Unclear reporting (Pooled odds ratio and 95% CIs)	OR (95% CIs).	Cochran's Q and I ² statistic. Explored by subgroup analysis.	Setting (inpatients or outpatients)	Not reported.	None.	OpenMeta-Analyst software
Chu Y, 2020 (34)	Mantel-Haenszel method. Fixed or random effects model if heterogeneity >50%.	Not reported.	OR (95% CI).	I ² statistics. Explored by sensitivity, subgroup and meta regression analyses.	Mean age (60 years).	Funnel plot, Egger's test, and the trim-and-fill method.	Meta regression by age, hypertension, diabetes, CV disease, and COPD at baseline.	Review Manager (RevMan) Version 5.3 and Stata 15.0 software
Du Y, 2020 (35)	Fixed or random effects model depending on the heterogeneity.	Unclear reporting (ORs and 95% CIs were considered to determine the association between BMI and the risk of critical COVID-19 and mortality)	Pooled OR (95% CI).	Cochran's Q test and I ² statistic Explored by sensitivity, subgroup and meta-regression analysis.	Subgroup analysis by geography, age, study type, sample size, BMI category. Meta regression by age, sex and comorbidities at baseline.	Funnel plots and Egger's test.	A dose-response analysis using a generalized least squares (GLS) regression	STATA 15.0 (Stata Corp, Texas, USA)

Noor FM, 2020 (36)	Random effects model.	Not reported	Pooled risk ratio (RR) and 95% CI.	Chi-square (Q) test and I ² statistics. Explored by subgroup and sensitivity analysis.	Continent.	Funnel plot.	None.	STATA version 16 and Microsoft Excel
Zhao X, 2020 (37)	Random-effect model if I ² >50%.	Unclear reporting (the HRs or ORs of primary studies were extracted)	OR/RR and 95% CI.	Q test and I ² statistic. Explored by sensitivity analysis.	Not performed.	The Begg's test.	None	STATA 15.1 (StataCorp, College Station, TX, USA).
Helvacı N, 2021 (38)	DerSimonian-Laird. Random-effects method.	Not reported	OR (95% CI).	I ² statistics. Heterogeneity was not explored.	Not performed.	Not reported.	None	Meta package version 4.13 in R software version 3.6.3.
Poly TN, 2021 (39)	Random-effects model.	Unclear reporting (Risk ratio were calculated from the HRs or ORs)	Risk ratios (RR) with 95% CIs	Cochran Q test and I ² statistics. Explored by subgroup analysis.	Comorbidities, age, gender.	Funnel plot.	None	Not reported
Pranata R, 2021 (40)	Random-effects model.	Adjusted ORs (aORs) were pooled. Dichotomous variables were converted into OR.	Pooled OR and 95% CI analysis.	Cochran's Q test and I ² statistic Explored by sensitivity and subgroup analysis.	Individual components of the composite poor outcome.	Funnel-plot analysis and Begg's test.	Dose response analysis by restricted maximum likelihood method.	STATA 16.0 (StataCorp LLC, Texas, US)
Cai Z, 2021 (41)	Random (DerSimonian-Laird or fixed	Unclear reporting (Pooled the data and calculated the	OR and 95% CI.	I ² statistic Explored by sensitivity analysis	Not performed.	Funnel plots.	None.	STATA software (version 12.0,

	effects (inverse variance) models.	odds ratios for dichotomous outcomes)		excluding each study.				STATA Corp, College Station, TX, USA).
Dessie Z, 2021 (42)	Mixed effects model.	Not reported	ORs or HRs (95% CI).	Cochran's Q test and I ² statistics. Heterogeneity was not explored.	Not performed.	Funnel plots with Egger weighted regression test	None.	R-4.0.2 and STATA version 16 softwares
Geng J, 2021 (43)	Generic inverse variance (fixed effects model) or random-effects model by DerSimonian and Laird if high heterogeneity.	Not reported	Pooled odds ratio (OR) and 95% CI.	I ² statistic. Heterogeneity was not explored.	Not performed.	Not reported.	None.	STATA 14.2 (STATA Corporation, College Station, TX, USA) and R 4.0.3 (The R Foundation for Statistical Computing, Vienna, Austria)
Saleh Y, 2021 (44)	Random effects models.	Not reported.	Summary RRs (95% CIs).	Cochrane Q test and the I ² statistic. Explored by sensitivity analysis.	Not performed.	Not reported.	Dose response analysis using fractional polynomial model and population attributable fraction of mortality due to obesity was calculated..	Not reported

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Table S4. Methodological quality of SR-MAs: answers for each question of AMSTAR-2.

First Author, year (REF)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Classification
Seidu S, 2020 (1)	Y	PY	Y	PY	N	N	N	PY	PY	N	N	Y	N	N	N	N	Critically Low quality
Yang J, 2021 (4)	Y	N	N	N	N	Y	N	PY	PY	N	Y	N	N	N	N	Y	Critically Low quality
Popkin BM, 2020 (9)	N	N	N	PY	N	N	N	PY	N	N	N	N	N	N	N	N	Low quality
Huang Y, 2020 (12)	N	N	N	N	Y	Y	N	N	PY	N	N	N	Y	N	Y	Y	Critically Low quality
Yang J, 2020 (25)	Y	N	N	PY	N	Y	PY	N	PY	N	Y	N	N	N	Y	Y	Low Quality
Mesas AE, 2020 (26)	Y	Y	N	Y	Y	Y	N	N	PY	N	Y	Y	Y	Y	Y	N	Moderate quality
Aghili SMM, 2021 (27)	Y	N	N	N	Y	Y	N	N	N	N	Y	N	N	N	N	N	Critically Low quality
Hoong CWS, 2021 (28)	Y	N	N	N	Y	Y	N	PY	PY	N	Y	N	N	Y	Y	N	Low quality
Li Y, 2021 (29)	Y	N	N	N	Y	N	N	N	PY	N	Y	Y	Y	N	Y	N	Low quality
Zhang X, 2021 (30)	N	N	N	PY	Y	Y	N	N	PY	N	N	N	N	N	Y	N	Critically Low quality

Ng WH, 2021 (31)	Y	N	Y	N	Y	N	N	N	N	N	N	N	N	Y	N	N	Critically Low quality
Deng L, 2021 (32)	Y	N	N	N	N	N	N	N	PY	N	Y	N	N	N	Y	N	Critically Low quality
Ho JSY, 2020 (33)	Y	N	Y	PY	Y	Y	N	PY	PY	N	N	N	N	N	Y	N	Critically Low quality
Chu Y, 2020 (34)	Y	N	N	N	Y	N	N	PY	PY	N	Y	N	N	Y	Y	N	Critically Low quality
Du Y, 2020 (35)	Y	N	Y	PY	Y	Y	N	N	PY	N	Y	N	N	N	Y	Y	Low quality
Noor FM, 2020 (36)	Y	N	N	PY	Y	Y	N	N	PY	N	Y	N	N	N	N	Y	Low quality
Zhao X, 2020 (37)	Y	N	Y	N	Y	Y	N	N	PY	N	N	N	N	N	Y	Y	Critically Low quality
Helvaci N, 2021 (38)	Y	N	N	N	Y	Y	N	PY	PY	N	N	N	N	N	N	Y	Critically Low quality
Poly TN, 2021 (39)	Y	PY	N	N	Y	Y	N	N	PY	N	N	N	Y	Y	Y	Y	Critically Low quality
Pranata R, 2021 (40)	Y	N	N	PY	Y	Y	N	PY	PY	N	Y	N	N	Y	N	Y	Low Quality
Cai Z, 2021 (41)	Y	N	N	N	Y	Y	N	N	N	N	N	N	N	N	N	Y	Critically Low quality
Dessie Z, 2021 (42)	Y	N	N	Y	Y	Y	N	N	PY	N	Y	N	N	N	Y	Y	Critically Low quality
Geng J, 2021	Y	N	N	N	Y	Y	N	N	N	N	Y	N	N	N	N	Y	Critically Low

(43)																		quality
Saleh Y, 2021	Y	N	N	N	N	Y	N	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Critically Low quality
(44)																		

Abbreviations: N = no; Y = yes; PY = partial yes, SR-MA = systematic review with meta-analysis.

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Table S5. Support for AMSTAR-2 classification of methodological quality of the SR-MAs included in the current meta-review.

First Author, year (REF)	AMSTAR Classification	Reasons for classification
Seidu S, 2020 (1)	Critically Low quality	The search strategy was not presented and there was not a grey literature search; a list of studies exclusion was not available; it is not clear if data selection and extraction was performed in duplicate; results regarding the outcome in primary studies were not well described; authors did not report on the sources of funding for the studies included in the review, did not assess the potential impact of RoB in individual studies on the results of the meta-analysis and did not account it in the interpretation of results. The heterogeneity was not explored by subgroup analysis and discussed. Review authors did not carry out an adequate investigation of publication bias.
Yang J, 2021 (4)	Critically Low quality	The review did not contain a protocol; authors did not explain their selection of the study designs; the search strategy was not presented; it is not clear if studies selection was performed in duplicate; a list of studies exclusion was not available; results regarding the outcome in primary studies were not described; authors did not report on the sources of funding for the studies included in the review, did not assess the potential impact of RoB in individual studies on the results of the meta-analysis and did not account it in the interpretation of results. The heterogeneity was not explored and discussed. Review authors did not carry out an adequate investigation of publication bias.
Popkin BM, 2020 (9)	Low quality	The review did not contain a protocol; authors did not explain their selection of the study designs; it is not clear if studies selection and data extraction was performed in duplicate; a list of studies exclusion was not available; results regarding the exposition and outcome (not specified if in-hospital, in the ICU or post discharge mortality) in primary studies were not described; authors did not use a satisfactory technique for assessing the RoB in individual studies that were included in the review and did not report on the sources of funding for the studies included in the review. The heterogeneity was not explored and discussed. Review authors did not carry out an adequate investigation of publication bias.
Huang Y, 2020 (12)	Critically Low quality	The review did not contain a protocol; authors did not explain their selection of the study designs; it is not clear if studies selection was performed in duplicate; the reasons why studies were excluded were not available; results regarding the outcome in primary studies were not described; authors did not report on the sources of funding for the studies included in the review, did not assess the potential impact of RoB in individual studies on the results of the meta-analysis and did not account it in the interpretation of results. The heterogeneity was not explored and discussed.
Yang J, 2020 (25)	Critically Low quality	Authors did not explain their selection of the study designs and the research question is not clear; the search strategy was not presented and there is no mention to grey literature; a list of studies exclusion was not available; results regarding the outcome in primary studies were not well described; authors did not report on the sources of funding for the studies included in the review and did not assess the

		potential impact of RoB in individual studies on the results of the meta-analysis. The heterogeneity was not explored and discussed.
Mesas AE, 2020 (26)	Moderate quality	Authors did not explain their selection of the study designs; a list of studies exclusion was not available; results regarding the exposition definition in primary studies were not described and authors did not report on the sources of funding for the studies included in the review.
Aghili SMM, 2021 (27)	Critically Low quality	The review did not contain a protocol; authors did not explain their selection of the study designs; the search strategy was not presented; a list of studies exclusion was not available; authors did not report on the sources of funding for the studies included in the review, did not assess the potential impact of RoB in individual studies on the results of the meta-analysis and did not account it in the interpretation of results. The heterogeneity was not explored and discussed. The authors did not provide a justification for not performing an investigation of publication bias.
Hoong CWS, 2021 (28)	Low quality	The review did not contain a protocol; authors did not explain their selection of the study designs; the search strategy was not presented; a list of studies exclusion was not available; authors did not report on the sources of funding for the studies included in the review and did not assess the potential impact of RoB in individual studies on the results of the meta-analysis.
Li Y, 2021 (29)	Low Quality	The authors did not explain their selection of the study designs and did not justify the reason that only papers in English were considered for inclusion; data extraction was not performed in duplicate; a list of studies exclusion was not available; results regarding the exposition in primary studies were not described; authors did not report on the sources of funding for the studies included in the review. The heterogeneity was not explored and discussed.
Zhang X, 2021 (30)	Critically Low quality	The review did not contain a protocol; authors did not explain their selection of the study designs; the authors did not searched trial/study registries, included/consulted content experts in the fie and searched for grey literature; a list of studies exclusion was not available; insufficient description of the exposition in primary studies; authors did not report on the sources of funding for the studies included in the review, did not assess the potential impact of RoB in individual studies on the results of the meta-analysis and did not account it in the interpretation of results. The heterogeneity was not explored and discussed.
Ng WH, 2021 (31)	Critically Low quality	The review did not contain a protocol; the authors did not justify the reason that only papers in English were considered for inclusion; data extraction was not performed in duplicate; a list of studies exclusion was not available; results regarding the exposure and design of primary studies were not described properly; authors did not use a satisfactory technique for assessing the RoB in individual studies and did not report on the sources of funding for the studies included in the review. Review authors did not carry out an adequate investigation of publication bias. Although it is not recommend investigating publication bias in a meta-analysis with fewer than 10 studies, the authors did not discuss this.

Deng L, 2021 (32)	Critically Low quality	The review did not contain a protocol; authors did not explain their selection of the study designs; the search strategy was not presented; the authors did not justify the reason that only papers in English were considered for inclusion and did not describe if studies selection and data extraction were performed in duplicate; a list of studies exclusion was not available; the description of design of the studies should be not provided; authors did not report on the sources of funding for the studies included in the review and did not consider RoB in individual studies when interpreting /discussing review results. The heterogeneity was not explored and discussed.
Ho JSY, 2020 (33)	Critically Low quality	The search strategy was not presented; studies exclusion was not available; results regarding the outcome in primary studies were not described; authors did not report on the sources of funding for the studies included in the review, insufficient description of methods for statistical combination of results, did not assess the potential impact of RoB in individual studies on the results of the meta-analysis and did not account it in the interpretation of results. The heterogeneity was not explored and discussed.
Chu Y, 2020 (34)	Critically Low quality	The review did not contain a protocol; authors did not explain their selection of the study designs and did not justified the data restriction; it is not clear if data extraction was performed in duplicate; a list of studies exclusion was not available; authors did not report on the sources of funding for the studies included in the review; did not assess the potential impact of RoB in individual studies on the results of the meta-analysis and did not account it in the interpretation of results.
Du Y, 2020 (35)	Low Quality	The review did not contain a protocol; the search strategy was not presented and there was not a grey literature search; the authors did not justify the language restriction; a list of studies exclusion was not available; Results regarding the outcome in primary studies were not well described; authors did not report on the sources of funding of the studies included in the review, did not assess the potential impact of RoB in individual studies on the results of the meta-analysis and did not account it in the interpretation of results. Heterogeneity was not discussed and interpreted.
Noor FM, 2020 (36)	Low quality	Authors did not explain their selection of the study designs; the full search strategy was not presented and they did not mention grey literature search; a list of studies exclusion was not available; results regarding the outcome in primary studies were not described; authors did not report on the sources of funding for the studies included in the review, did not assess the potential impact of RoB in individual studies on the results of the meta-analysis and did not account it in the interpretation of results. The heterogeneity was not explored and discussed.
Zhao X, 2020 (37)	Critically Low quality	The search strategy was not presented; a list of studies exclusion was not available; results regarding the outcome in primary studies were not well described; authors did not report on the sources of funding for the studies included in the review, did not assess the potential impact of RoB in individual studies on the results of the meta-analysis and did not account it in the interpretation of results. The heterogeneity was not explored and discussed.
Helvacı N,	Critically Low	Authors did not explain their selection of the study designs; the search strategy was not presented, there is language and time

2021 (38)	quality	restriction, there is no mention to grey literature; a list of studies exclusion was not available; results regarding the outcome in primary studies were not well described; authors did not report on the sources of fuNRing of the studies included in the review, did not assess the potential impact of RoB in individual studies on the results of the meta-analysis and did not account it in the interpretation of results. The heterogeneity was not explored and discussed. Review authors did not carry out an adequate investigation of publication bias.
Poly TN, 2021 (39)	Critically Low quality	The review did not contain a protocol; authors did not explain their selection of the study designs; the search strategy was not presented, there is language and time restriction, there was not a grey literature search; a list of studies exclusion was not available; results regarding the outcome in primary studies were not well described; authors did not report on the sources of funding for the studies included in the review, did not assess the potential impact of RoB in individual studies on the results of the meta-analysis and did not account it in the interpretation of results.
Pranata R, 2021 (40)	Low Quality	The review did not contain a protocol; authors did not explain their selection of the study designs; the search strategy was not presented and there is no mention to grey literature search; a list of studies exclusion was not available; results regarding the outcome in primary studies were not well described; authors did not report on the sources of funding for the studies included in the review, did not assess the potential impact of RoB in individual studies on the results of the meta-analysis and did not account it in the interpretation of results. The heterogeneity was not explored and discussed. Review authors did not carry out an adequate investigation of publication bias.
Cai Z, 2021 (41)	Critically Low Quality	The review did not contain a protocol; authors did not explain their selection of the study designs; the search strategy was not presented; a list of studies exclusion was not available; results regarding the outcome in primary studies were not described; authors did not report on the sources of funding for the studies included in the review, did not assess the potential impact of RoB in individual studies on the results of the meta-analysis and did not account it in the interpretation of results. The heterogeneity was not explored and discussed. Review authors did not carry out an adequate investigation of publication bias.
Dessie Z, 2021 (42)	Critically Low Quality	The review did not contain a protocol; authors did not explain their selection of the study designs; a list of studies exclusion was not available; results regarding the outcome in primary studies were not described; authors did not report on the sources of funding for the studies included in the review, did not assess the potential impact of RoB in individual studies on the results of the meta-analysis and did not account it in the interpretation of results. The heterogeneity was not explored and discussed.
Geng J, 2021 (43)	Critically Low Quality	The review did not contain a protocol; the search strategy was not presented; a list of studies exclusion was not available; results regarding the outcome in primary studies were not described; authors did not report on the sources of funding for the studies included in the review, did not assess the potential impact of RoB in individual studies on the results of the meta-analysis and did not account it

		in the interpretation of results. The heterogeneity was not explored and discussed. Review authors did not carry out an adequate investigation of publication bias.
Saleh Y, 2021 (44)	Critically Low Quality	The review did not contain a protocol; authors did not explain their selection of the study designs; the search strategy was not presented; a list of studies exclusion was not available; results regarding the outcome in primary studies were not described; authors did not report on the sources of funding for the studies included in the review.

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Supplementary Material: List of References of Primary studies included in the SR-MAs of the current umbrella review

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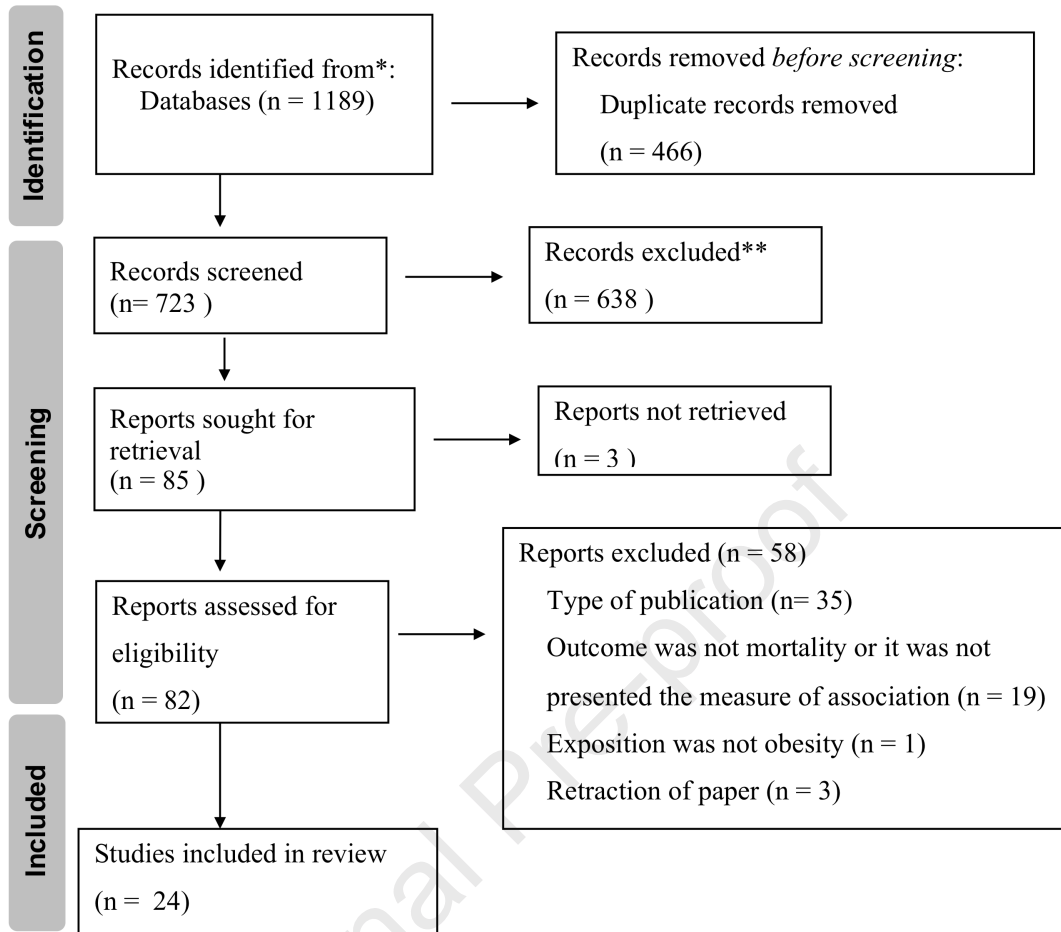
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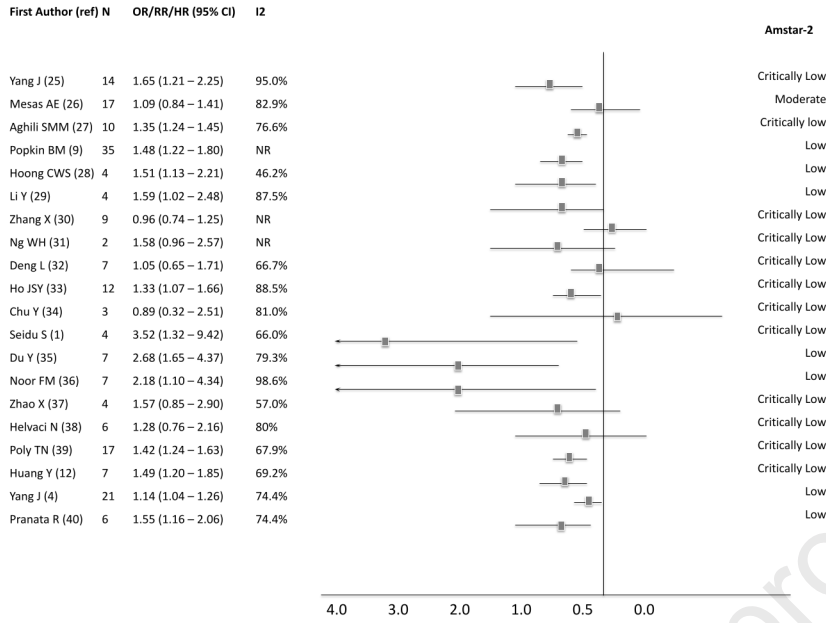
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