Supplementary Materials

Search strategy

Database	Platform	No. of results
Medline	OVID	4718
Embase	OVID	7850
Emcare	OVID	2946
CINAHL	EBSCO	1007
Cochrane CENTRAL	Wiley	98

All searches undertaken on 13th October.

The search strategy was developed in MEDLINE and adapted to all other databases.

Ovid MEDLINE(R) ALL <1946 to October 13, 2021>

1 SARS-CoV-2/ or COVID-19/ 112819
2 (corona* adj1 (virus* or viral*)).ti,ab,kw,kf. 4216
3 (CoV not (Coefficien* or "co-efficien*" or covalent* or Covington* or covariant* or covarianc* or "cut-off value*" or "cutoff value*" or "cut-off volume*" or "cutoff volume*" or "combined optimi?ation value*" or "central vessel trunk*" or CoVR or CoVS)).ti,ab,kw,kf. 64155
4 (coronavirus* or 2019nCoV* or 19nCoV* or "2019 novel*" or Ncov* or "n-cov" or "SARS-CoV-2*" or "SARSCoV-2*" or SARSCoV2* or "SARS-CoV2*" or "severe acute respiratory syndrome*" or COVID*2).ti,ab,kw,kf. 196562
5 or/1-4 201960
6 limit 5 to dt=20191201-20211013 189003
7 6 not (letter or historical article or comment or editorial or news).pt. not (Animals/ not humans/) 151366
8 (ethnicity or ethnic).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] 187026
9 Minority Groups/ 15469
10 Population Groups/ 5186
11 continental population groups/ 23457
12 hispanic americans/ 30483
13 african continental ancestry group/ 38755
14 American Native Continental Ancestry Group/ 480
15 Asian Continental Ancestry Group/ 69899
16 European Continental Ancestry Group/ 69534
17 Oceanic Ancestry Group/ 11183
18 African Americans/ 58336
19 Arabs/ 4935
20 Asian Americans/ 8325
21 (multi?cultural or multi cultural or cross?cultural or cross cultural or trans?cultural or transcultural).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol

supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] 42403
22 (BAME or minority or minorities).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] 88772
23 "transients and migrants"/ 12779
24 migrant*.mp. 26157
25 expatriate.mp. 699
26 asylum.mp. 3960
27 foreign-born.mp. 3703
28 indigenous.mp. or Indigenous Peoples/ 38564
29 Ethnic Groups/ 66074
30 refugee*.mp. or Refugees/ 16000
31 aboriginal*.mp. 9622
32 "country of birth".mp. 2137
33 or/8-32 541151
34 7 and 33 4718

Table S1. Inclusion & exclusion criteria.

	Inclusion	Exclusion
Condition	1. Original clinical data on COVID-19 infection (lab confirmed PCR, serological evidence of previous SARS-CoV-2 infection, i.e., antibodies) 2. Original clinical data on severe COVID-19 disease (hospitalisation, ITU admission, mechanical ventilation) 3. Original clinical data on COVID-19 mortality (ICD10 cause of death, death from any cause within a time-period of positive PCR test for SARS-CoV-2 infection)	1. Longer-term COVID-19 outcomes 2. Mental health problems related to COVID-19 3. COVID-19 vaccines
Context	1. Quantitative studies (cohort studies, cross-sectional studies, case-control studies) 2. Non-population based (i.e., individuals with COVID-19) AND population-based studies (i.e., individuals with and without COVID-19)	1. Modelling studies (e.g., mathematical modelling, machine learning, computational) 2. Animal data 3. Qualitative data 4. Any type of review 5. Conference papers 6. Pre-prints 7. Retracted papers 8. Ecological studies 9. Commentaries or editorials 10. Not available in English
Population	1. Includes COVID-19 outcome disaggregated by ethnicity or race (include studies with closely related measures, i.e., Indigenous or Aboriginal groups, race, migrant status, country of birth). 2. Adult populations (16+)	1. COVID-19 outcomes that are not disaggregated by ethnicity 2. Children (under 16) 3. Religious groups 4. Sample recruited based on an existing physical or mental health problem, or healthcare utilisation

Criteria to minimise inclusion of duplicate data

To minimise the inclusion of duplicate data (i.e., participants from the same population assessing the same outcome), the following criteria were used to decide which dataset to include:

1. The largest sample and most representative sample (particularly for ethnic groups).

2. The most recent version up to the 3rd October 2022.

3. Data that would facilitate inclusion in a meta-analysis (prioritising age and sex adjusted models, versus over or under adjusted models).

4. Studies which provide more detailed categories (ethnic groups are not amalgamated) and relevant measures of ethnicity (prioritising self-defined ethnicity).

5. Longitudinal studies which cover a longer period.

Criteria were given equal weight.

JBI CRITICAL APPRAISAL CHECKLIST FOR ANALYTICAL CROSS SECTIONAL STUDIES

Reviewer_____
Date_____

Author_____Year_____ Record Number_____

	Yes (2)	No (0)	Unclear (1)	N/A Remove Item
1. Were the criteria for inclusion in the sample clearly defined?	☐	☐	☐	☐
2. Were the study subjects and the setting described in detail?	☐	☐	☐	☐
3. Was the exposure measured in a valid and reliable way?	☐	☐	☐	☐
4. Were objective, standard criteria used for measurement of the condition?	☐	☐	☐	☐
5. Were confounding factors identified?	☐	☐	☐	☐
6. Were strategies to deal with confounding factors stated?	☐	☐	☐	☐
7. Were the outcomes measured in a valid and reliable way?	☐	☐	☐	☐
8. Was appropriate statistical analysis used?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)

_____

_____

EXPLANATION OF ANALYTICAL CROSS SECTIONAL STUDIES CRITICAL APPRAISAL

How to cite: Moola S, Munn Z, Tufanaru C, Aromataris E, Sears K, Sfetcu R, Currie M, Qureshi R, Mattis P, Lisy K, Mu P-F. Chapter 7: Systematic reviews of etiology and risk . In: Aromataris E, Munn Z (Editors). *JBI Manual for Evidence Synthesis.* JBI, 2020. Available from https://synthesismanual.jbi.global

Analytical cross sectional studies Critical Appraisal Tool

Answers: Yes, No, Unclear or Not/Applicable (remove item if N/A)

1. Were the criteria for inclusion in the sample clearly defined?

The authors should provide clear inclusion and exclusion criteria that they developed prior to recruitment of the study participants. The inclusion/exclusion criteria should be specified (e.g., risk, stage of disease progression) with sufficient detail and all the necessary information critical to the study. Score 2 if very clear inclusion criteria for patients e.g., all patients in X hospital or community, all patients with confirmed covid-19. Score 1 is some detail but could be clearer. Score 0 if unclear.

2. Were the study subjects and the setting described in detail?

The study sample should be described in sufficient detail so that other researchers can determine if it is comparable to the population of interest to them. The authors should provide a clear description of the population from which the study participants were selected or recruited, including demographics, location, and time period. Score 2 if country, region (and name of hospital if hospital-based), and exact dates reported. Score 1 if most important details are reported but not all. Score 0 if unclear (especially if exact dates are not reported).

3. Was the exposure measured in a valid and reliable way?

The study should clearly describe the method of measurement of exposure. Assessing validity requires that a 'gold standard' is available to which the measure can be compared. The validity of exposure measurement usually relates to whether a current measure is appropriate or whether a measure of past exposure is needed. Reliability refers to the processes included in an epidemiological study to check repeatability of measurements of the exposures. These usually include intra-observer reliability and inter-observer reliability. Score 2 if ethnicity was measured and reported in a valid/reliable way (self-reported/self-defined) and groups were not aggregated. Score 1 if ethnicity reported in valid/reliable way but groups were aggregated or vice versa. Score 0 if unclear, not self-reported, aggregated groups.

4. Were objective, standard criteria used for measurement of the condition?

It is useful to determine if patients were included in the study based on either a specified diagnosis or definition. This is more likely to decrease the risk of bias. Characteristics are another useful approach to matching groups, and studies that did not use specified diagnostic methods or definitions should provide evidence on matching by key characteristics Score 2 for lab-confirmed PCR test/lab confirmed anti-bodies, clear definition of COVID-19 hospital admission/ICU admission/mortality. Score 0 if unclear.

5. Were confounding factors identified?

Confounding has occurred where the estimated intervention exposure effect is biased by the presence of some difference between the comparison groups (apart from the exposure investigated/of interest). Typical confounders include baseline characteristics, prognostic factors, or

concomitant exposures (e.g. smoking). A confounder is a difference between the comparison groups and it influences the direction of the study results. A high quality study at the level of cohort design will identify the potential confounders and measure them (where possible). This is difficult for studies where behavioral, attitudinal or lifestyle factors may impact on the results. Score 2 if at least age and sex identified as confounding factors. Score 1 if either age or sex identified as confounding. Score 0 if neither identified as confounders.

6. Were strategies to deal with confounding factors stated?

Strategies to deal with effects of confounding factors may be dealt within the study design or in data analysis. By matching or stratifying sampling of participants, effects of confounding factors can be adjusted for. When dealing with adjustment in data analysis, assess the statistics used in the study. Most will be some form of multivariate regression analysis to account for the confounding factors measured. Score 2 if study reports strategy to deal with confounding factors. Score 0 if does not report.

7. Were the outcomes measured in a valid and reliable way?

Read the methods section of the paper. If for e.g. lung cancer is assessed based on existing definitions or diagnostic criteria, then the answer to this question is likely to be yes. If lung cancer is assessed using observer reported, or self-reported scales, the risk of over- or under-reporting is increased, and objectivity is compromised. Importantly, determine if the measurement tools used were validated instruments as this has a significant impact on outcome assessment validity. Having established the objectivity of the outcome measurement (e.g. lung cancer) instrument, it's important to establish how the measurement was conducted. Were those involved in collecting data trained or educated in the use of the instrument/s? (e.g. radiographers). If there was more than one data collector, were they similar in terms of level of education, clinical or research experience, or level of responsibility in the piece of research being appraised? Similar to item 4: Score 2 for lab-confirmed PCR test/lab confirmed anti-bodies, clear definition of COVID-19 hospital admission/ICU admission/mortality. Score 0 if unclear.

8. Was appropriate statistical analysis used?

As with any consideration of statistical analysis, consideration should be given to whether there was a more appropriate alternate statistical method that could have been used. The methods section should be detailed enough for reviewers to identify which analytical techniques were used (in particular, regression or stratification) and how specific confounders were measured.

For studies utilizing regression analysis, it is useful to identify if the study identified which variables were included and how they related to the outcome. If stratification was the analytical approach used, were the strata of analysis defined by the specified variables? Additionally, it is also important to assess the appropriateness of the analytical strategy in terms of the assumptions associated with the approach as differing methods of analysis are based on differing assumptions about the data and how it will respond. Score 2 if age and sex adjusted for. Score 1 if age and sex were adjusted for and maybe one or two others, or if only age OR sex were adjusted for. Score 0 if over adjusted or under adjusted.

Data manipulation.

We extracted available crude data, unadjusted and adjusted odds/risk/hazard ratios, for each ethnic group. Where only crude numbers were available, unadjusted risk ratios (RR) were calculated. Crude numbers were used to calculate unadjusted RR for the ethnic majority group *versus* minoritised ethnic groups. Adjusted odds ratios (OR) were extracted and converted to adjusted RR using a validated conversion method (Zhang & Kai, 1998). Adjusted hazard ratios (HR) were extracted and assumed to approximate an adjusted RR. We contacted authors if the required data were not available. We specifically contacted authors of studies which reported effect sizes for aggregated Asian ethnic groups, to determine whether the study population mostly included East or South Asian people.

GRADE criteria

We assessed overall certainty in the pooled adjusted estimates using the Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) approach. The overall certainty estimates were categorised into one of four levels: high, moderate, low, very low. In keeping with GRADE guidance for prognostic studies, observational studies start as high certainty evidence.

Certainty was rated down based on the following criteria:

1. Risk of bias: rated down if most studies were moderate or high risk of bias.
2. Imprecision: rated down if confidence intervals were wide, relative to the clinical decision threshold (i.e., would the outcome differ depending on whether the upper or lower boundary of the confidence interval represented the truth).
3. Inconsistency: rated down if there was wide variation in point estimates within ethnic groups.
4. Indirectness: rated down if most studies did not record ethnicity through self-report.

We were unable to use publication bias as criteria when assessing the certainty of the adjusted analyses, as only the meta-analysis of the risk of seropositivity included a sufficient number of studies to test for publication bias.

Table S2. Characteristics of included studies (N = 77). Ethnic groups are presented as described in the original studies.

First author	Date published	Study design	Study setting	Study population	Sample size (N)	Ethnicity measure	Ethnic groups
High-income countries							
Song	13th May 21	Cohort	Population	Veteran Affairs Million Veteran Program	648,202	Self-reported, supplemented with administrative data	White*, Black or African American, AND Hispanic
Acosta	21st Oct 21	Cross-sectional	Hospital	COVID-NET	143,342	Medical records	Hispanic, American Indian or Alaska Native, Black, Asian or Pacific Islander, White*
Adjei	16th Sep 21	Mortality report	Hospital	Premier Healthcare Database	288,144	Medical records	Hispanic, White*, Black, Asian, Other
Lindsay	1st Oct 21	Cohort	Population	Optum COVID-19 HER dataset	771,278 (infection) 91,741 (sero)	Historic Environment Records (unclear if self-reported)	Non-Hispanic White*, Asian, Hispanic, Non-Hispanic Black, Unknown.
Luo	16th Dec 20	Cohort	Population	Veteran Health Administration	10,621,580	Electronic health records (unclear if self-reported)	White*, Black or African American, Asian, Pacific Islander, Asian, American Indian or Alaska Native
Metra	3rd Jul 21	Cohort	Population	TriNetX	346,953	Self-reported	White*, Black

Zerbo	25th Aug 21	Cohort	Population	Kaiser Permanente Northern California	4,579,858	Self-reported	White*, Black, Asian, Hawaiian/Pacific Islander, Native American or Alaska Native, Multiracial, Hispanic, Unknown
Bennett	13th Jul 21	Cohort	Population	National Cohort Collaborative	1,926,699	NR	White*, Black, Native Hawaiian or Pacific Islander, Asian, Other
Chang	5th Oct 21	Cohort	Population	Centres for Medicare and Medicaid	31,629,094	Administrative data	White*, Black, Hispanic, Asian or Pacific Islander, American Indian or Alaska Native, Other/Unknown
Egede	Nov 20	Cross-sectional	Population	Froedert Medical College	31,549	Self-reported	White*, Black, Hispanic
Feldman	23rd Nov 21	Cross-sectional	Population	US Centres for Disease Control and Prevention	219,100,000	US Centres for Disease Control and Prevention	American Indian or Alaska Native, Asian, Black, Hawaiian or Pacific Islander, Hispanic, White*
Ioannou	21st Oct 21	Cohort	Population	Veterans Affairs	9,127,673	Self-reported	White*, Black, Asian, American Indian or Alaska Native, Pacific Islander or Native Hawaiian
Jones	2nd Sep 21	Cross-sectional	Population	Blood donors	1,443,519	Self-reported	American Indian, Asian, Black, Hispanic, White*, Multiple Races, Other
Young	16th Aug 21	Cohort	Population	Armed Forces Health Surveillance Division	694,878	Self-reported	White*, Black, Hispanic, Other, Unknown
Thomas 1	18th Aug 21	Cohort	Population	Surveillance Data	77,555	Name-based classification	White British*, White Irish, White Other, Bangladeshi, Chinese, Indian,

							Pakistani, Other Asian, Black African, Black Caribbean, Other
Gray	24th Nov 21	Cohort	Hospital	Hospital episode statistics	374,244	Self-reported	White*, Bangladeshi, Pakistani, Other Asian, Black African, Black Caribbean, Other Black, Mixed, Other
Knight	19th Sep 22	Cohort	Population	CVD COVID UK Impact Consortium	44,964,486	Medical records	Asian, Black, Mixed, Other, White*
Thomas 2	10th May 22	Cohort	Community	Online questionnaire	2,820	Self-reported	White British or Irish*, White Other, any other background
Martin	26th May 22	Cross-sectional	Hospital	UK REACH (healthcare workers)	10,772	Self-reported	White*, Asian, Black, Mixed, Other
Talaei	22nd Feb 22	Cohort	Population	COVIDENCE UK	11,130	Self-reported	White*, Black, South Asian, Mixed/Multiple
Mathur	30th Apr 21	Cohort	Population	OpenSAFELY	17,288,532	Self-reported (primary care record)	White* (White British, White Irish, other White), South Asian (Indian, Pakistani, Bangladeshi, other South Asian), Black (African, Caribbean, other Black), Other (Chinese, all others), and Mixed (White and Asian, White and African, White and Caribbean, other mixed)
Hippisley Cox	13th Sep 21	Cohort	Population	QResearch Database (vaccinated)	6,952,440	NR	White*, Indian, Pakistani, Bangladeshi, Other Asian,

							Caribbean, Black African, Chinese, Other
Ward	10th Feb 21	Cross-sectional	Community	REACT-2 Study	105,651	Self-reported	White*, Asian (includes Asian, Asian British), Black (includes Black, African, Caribbean, Black British)
Farrell	3rd Nov 20	Cohort	Hospital	Hospital Microbiology Department, Ireland	382	Unclear if self-reported	White Irish*, White Other, Black Asian and Minority Ethnic Groups (BAME)
Allen	4th Feb 22	Cross-sectional	Hospital	Healthcare workers	5,085	Self-reported	Irish*, other White, Asian, Black, Other
Chu	24th Jun 21	Cohort	Population	Ontario Laboratory Information System Database	47,192	Surname-based algorithm to identify ethnicity	General*, Chinese, South Asian
Saeed	1st Feb 21	Cross-sectional	Population	Blood donors from all Canadian Blood Services	74,642	Self-reported	White*, Aboriginal, Asian, Other
Passos-Castilho	13th Apr 22	Cohort	Hospital	4 hospitals in Montreal	1,104	Self-reported	Asian, White*, Black, Latino, Middle Eastern/North African, Other/Mixed
Islamoska	27th Oct 21	Cohort	Population	National Patient Register	500,349	Country of birth (unclear if self-reported)	Danish*, Immigrant

Guijarro	27th Feb 21	Cohort	Population	Population-based study	152,018	City Council registry	Country of birth
Ramos-Rincon	31st Mar 22	Cohort	Hospital	SEMI-COVID-19 Registry	23,953	Medical records	Latin American, North American, Sub-Saharan African, Asian, European*
Rostila	12th Mar 21	Cohort	Population	Register-based study of all Stockholm residents aged 21 and over	1,778,670	Country of birth obtained from registers (unclear if self-reported)	Sweden*, other Nordic countries, Europe, Middle East, Africa, rest of the world
Nwaru	7th Jan 22	Cohort	Population	SCIFI-PEARL	326,052	LISA register	Swedish born*, foreign born
Stralin	26th Feb 21	Cohort	Population	Swedish national board of Health and Welfare	17,140	Personal identity number	Country of birth (Sweden*, other)
Gustafsson	6th Sep 21	Cohort	Population	All Swedish residents who tested positive	72,728	Statistics Sweden	Country of birth (Sweden*, high-income country, middle-income country, low-income country)
Consolazio	2nd Mar 21	Cohort	Population	All COVID-19 cases	3,325,675	Country of birth obtained through Census (unclear if self-reported)	Italy*, European Union, Eastern Europe, Other Europe, Centre-Southern Africa, West Africa, East Africa, North Africa, Centre-Southern Asia, Western Asia, East Asia, Centre-South America, North America, Oceania, Other

Lombardi	4th Feb 21	Cross-sectional	Hospital	Healthcare workers, Italian third-level University Hospital	4,055	Country of birth (unclear if self-reported)	Italy*, Other
Fabiani	8th Jan 21	Cohort	Population	Italian National case-base COVID-19 surveillance system	213,180	Self-reported Nationality	Italian nationals*, Non-Italian Nationals
Cacciani	Jul-Aug 22	Cohort	Hospital	Hospital discharges	275,525	Unclear	Italian born*, foreign born
DiGirolamo	Jul-Aug 22	Cohort	Population	Health services	38,376,849	Unclear	Italian born*, immigrant
Pagani	11th Oct 21	Cross-sectional	Community	San Siro Social Housing	2,044	Citizenship of parents	Italian*, non-Italian
Coyer 1	22nd Sep 21	Case series	Population	Surveillance data, all COVID-19 hospitalisations	2,326	Country of birth of individuals and their parents	Migration: Non-Ethnic Dutch*, Western (North American, European, Oceania, Indonesia, Japan), Non-Western (African, Latin-American, Asian, Turkey)
Collard	17th May 22	Cohort	Hospital	COVID Predict	1,178	Estimated using country of birth	Dutch*, South Asian, African, Ghanian, Turkish, Moroccan, Other
Coyer 2	8th Dec 21	Cross-sectional	Population	Health Life	2,497	Country of birth of individuals and their parents	Dutch*, South Asian, African, Ghanian, Turkish, Moroccan, Other
Vos	10th Nov 20	Cross-sectional	Population	PICO study	3,207	NR	Dutch*, non-dutch Western, Non-Western
Indseth	12th Aug 21	Cohort	Population	Norwegian Surveillance System	1,329,243	Country of birth, residence	Immigrants, Non-Immigrants*, AND Region AfAsSA, Region ENAO

Labberton	14th Feb 22	Cohort	Population	Beredt C19	5,490,000	Personal identifier	Country of birth
Jefferies	14th Oct 20	Cohort	Population	All confirmed COVID-19 cases	1,503	Self-reported	Māori, Pacific peoples, Asian, European*, Other, Unknown
Ishii	4th Feb 21	Cross-sectional	Community	Drive through PCR test	3,540	NR	Japanese*, Non-Native
Saidel Odes	30th Apr 21	Cohort	Hospital	Soroka University Medical Centre	8,518	NR	Jewish*, Bedouin Arab
Al Awaidy	4th Aug 21	Cohort	Hospital	All confirmed COVID-19 cases	69,382	NR	Omani nationals*, foreign-born individuals
Abu Ruz	2nd Mar 22	Cohort	Hospital	Hospital in UAE	3,296	Medical records	Middle Eastern*, other
Al Zahmi	16th Mar 22	Cohort	Hospital	Mediclinic Parkview Hospital	560	Medical records	Arab*, African
Hamadah	10th Sep 20	Cohort	Hospital	All confirmed COVID-19 cases	1,123	Passports and National Civil ID cards	Kuwaitis*, Non-Kuwaiti
Al Kuwari	8th Sep 20	Cohort	Population	All confirmed COVID-19 cases	5,685	State Identification Card	Indian, Bangladeshi, Nepalese, Qatari*, Pakistani, Filipino, Egyptian, Sri Lankan, Sudanese, Other
Shaikh	12th Aug 21	Cohort	Hospital	Prince Mohammed Bin Abdulaziz Hospital	565	NR	Saudi Nationals*, Non-Saudi Nationals
Nasif	26th Dec 21	Cohort	Hospital	Several hospitals in Makkah	2,617	NR	Saudi*, Arabic, South Asia, South East Asia, Africa
Low- and middle-income countries							

Horta	29th Oct 20	Cross-sectional	Population	Three household surveys	89,362	Self-reported	White*, Brown (Pardo), Black, Yellow (Asian), Indigenous
Da Silva	30th Dec 21	Cross-sectional	Population	Brazilian University Students	5,984	NR	Brown, White*, Yellow, Black, Indigenous, Unknown
Rodrigues	31st Mar 22	Cohort	Population	SIVEP-Gripe	840,201	Medical records	White*, Mixed, Black, Asian, Indigenous
Sansone	25th Jul 22	Cohort	Population	OpenDataSUS	585,655	Medical records	White*, Black, Asian, Pardos, Indigenous
Silva	28th Apr 21	Cohort	Population	SIVEP-Gripe	159,704	SIVEP-Gripe (unclear if self-reported)	Black, Mixed ethnicity, East Asian, Indigenous, White*
Ibarra-Nava	10th Mar 21	Cross-sectional	Population	Epidemiological Surveillance System for Viral Respiratory Diseases (SISVER)	416,546	Participants asked if they speak an Indigenous language	Indigenous, Non-Indigenous*
Servan-Mori	15th Jul 21	Cross-sectional	Population	General Directorate of Epidemiology of the Ministry of Health	795,878	Participants asked if they speak an Indigenous language	Indigenous, Non-Indigenous*
Bojorquez-Chapela	10th Feb 22	Cross-sectional	Community	Migrants living in shelters	481	Self-reported	Country of birth (Mexico*, other)
Dahal	7th Aug 22	Cohort	Population	Ministry of Health	2,173,036	Self-reported	Indigenous, non-Indigenous*
Ramli	24th Mar 22	Cross-sectional	Community	Healthcare facilities	690	NR	Malay, Non-Malay

Utulu	10th Apr 22	Cohort	Population	Nigeria Centre for Disease Control	1,494	NR	Igbo, Yoruba, Hausa, Others
Cifuentes	20th Feb 21	Cohort	Population	SIVIGILA	1,033,218	NR	White/Mestizo/Other*, African-Colombian descent, Indigenous, Gipsy/Roman, Raizal (refers to descendants of the original enslaved Africans and Gipsy-Romany)
Concha	1st Oct 21	Cross-sectional	Community	North Eastern Colombian territories	452	Unclear if self-reported	Colombian*, Indigenous
Sultanoglu	24th Jun 20	Cohort	Population	All confirmed COVID-19 cases	15,428	NR	Nationality: Northern Cyprus*, German, Turkmenistan
Sacoto	6th Sep 22	Cohort	Population	Ministry of Health	251,765	Unclear if self-reported	Black, White, Indigenous, Mestizo*, Montubio, Unknown
Kadyrova	27th Jul 22	Cross-sectional	Community	Public University employees	100	NR	Kazakh*, non-Kazakh
Ikram	29th Apr 22	Cohort	Hospital	King Edward VII Hospital	236	Medical records	Black, White*, Coloured, Asian
Jugwanth	4th Feb 22	Cross-sectional	Community	Unclear	530	NR	African, White*, Indian, Mixed Race
Stead	24th Feb 22	Cross-sectional	Hospital	Healthcare workers in Eastern Cape	1,295	Self-reported	Black, White*, Coloured, Others

Ethnic majority groups are highlighted with an asterisk *

Figure S1. Map displaying geographical distribution of included studies

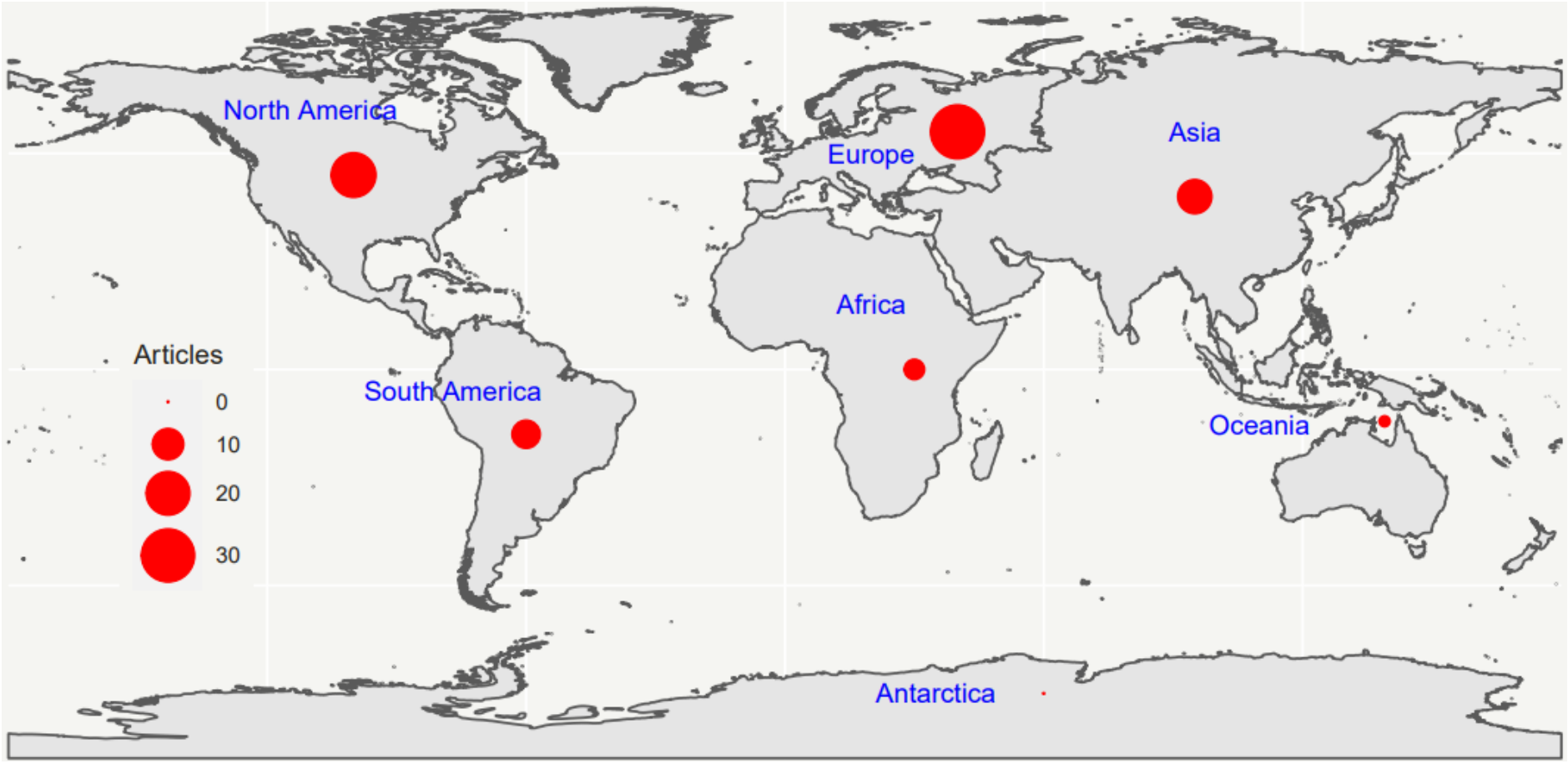
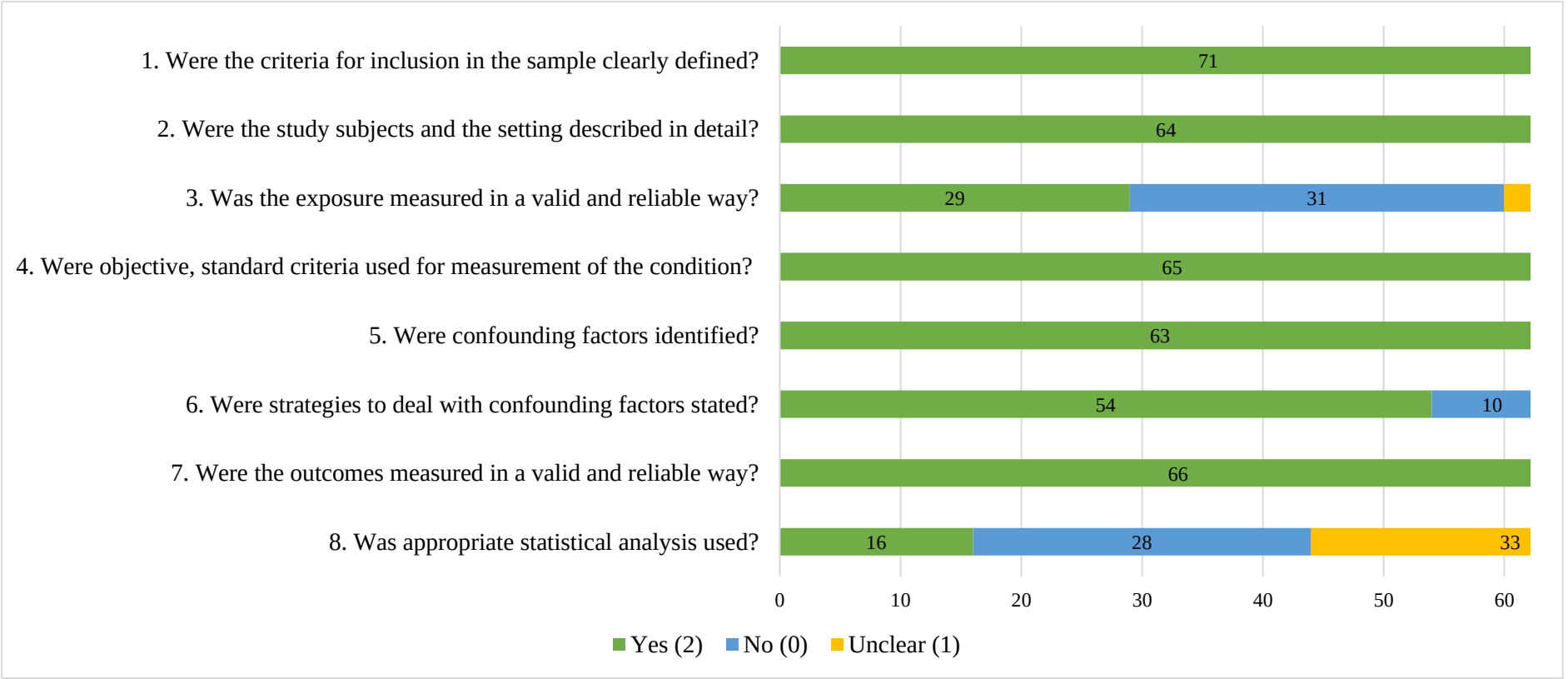


Figure S2. Summary of JBI critical appraisal scores.



Unadjusted meta-analyses of outcomes by ethnic majority group versus minoritised ethnic groups.

Fourteen studies (with approximately 52,500,000 participants) reported crude numbers to compare the risk of infection among minoritised ethnic groups to the ethnic majority group (Figure S3). Minoritised ethnic groups had 1.4 times the risk of infection (RR = 1.40, 95% CI: 1·04 to 1·89, I^2 = 100·0). Egger's test suggested no evidence of publication bias for the studies reporting infection (p=0·984, Figure S13).

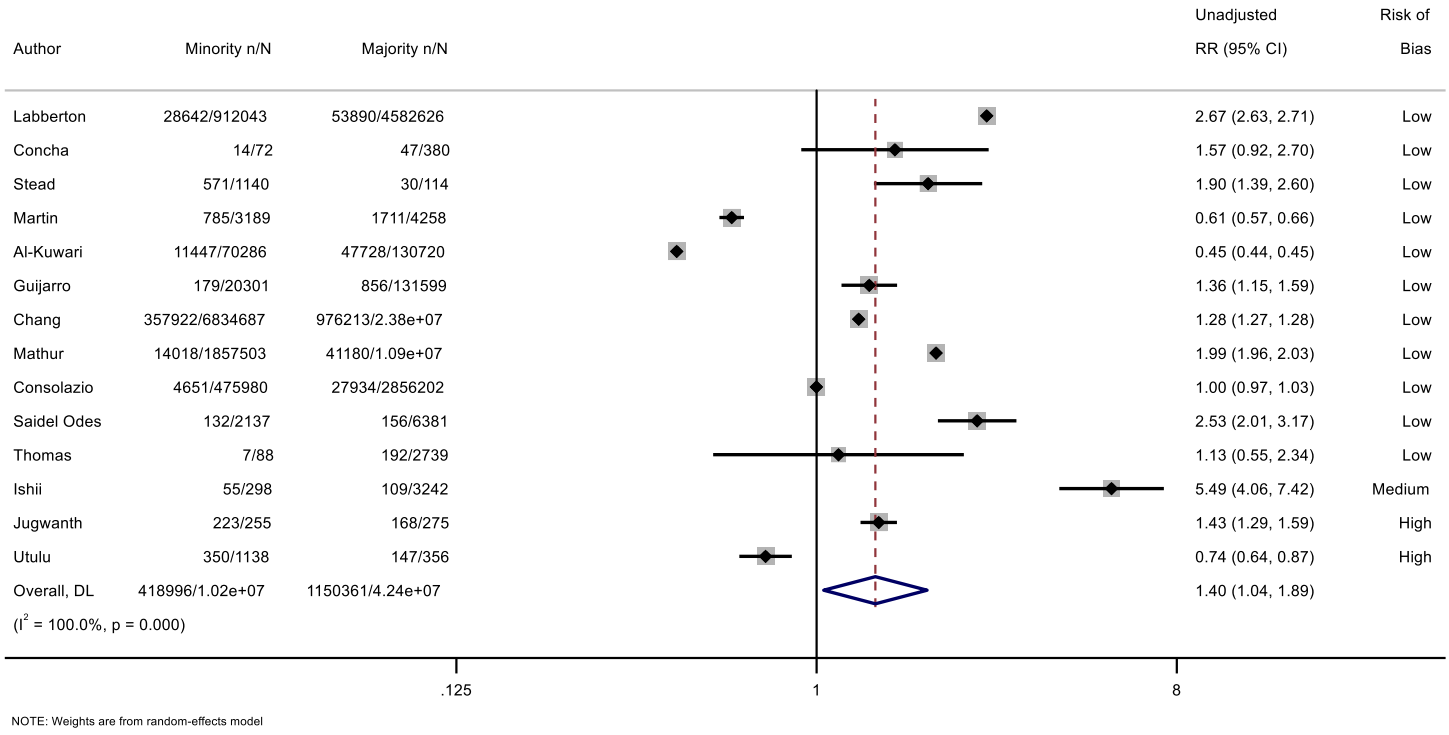


Figure S3. Forest plot showing the pooled effect size for the risk of infection in minoritised ethnic groups compared to the ethnic majority group.

Ten studies reported seropositivity (due to infection rather than vaccination), including 1,643,454 participants (Figure S4). Minoritised ethnic groups were more likely to be seropositive compared to the ethnic majority group (RR = 1·61, 95% CI: 1·22 to 2·13, I^2 = 99·1). Egger's test indicated no evidence of publication bias for studies reporting seropositivity (p=0·239, Figure S14).

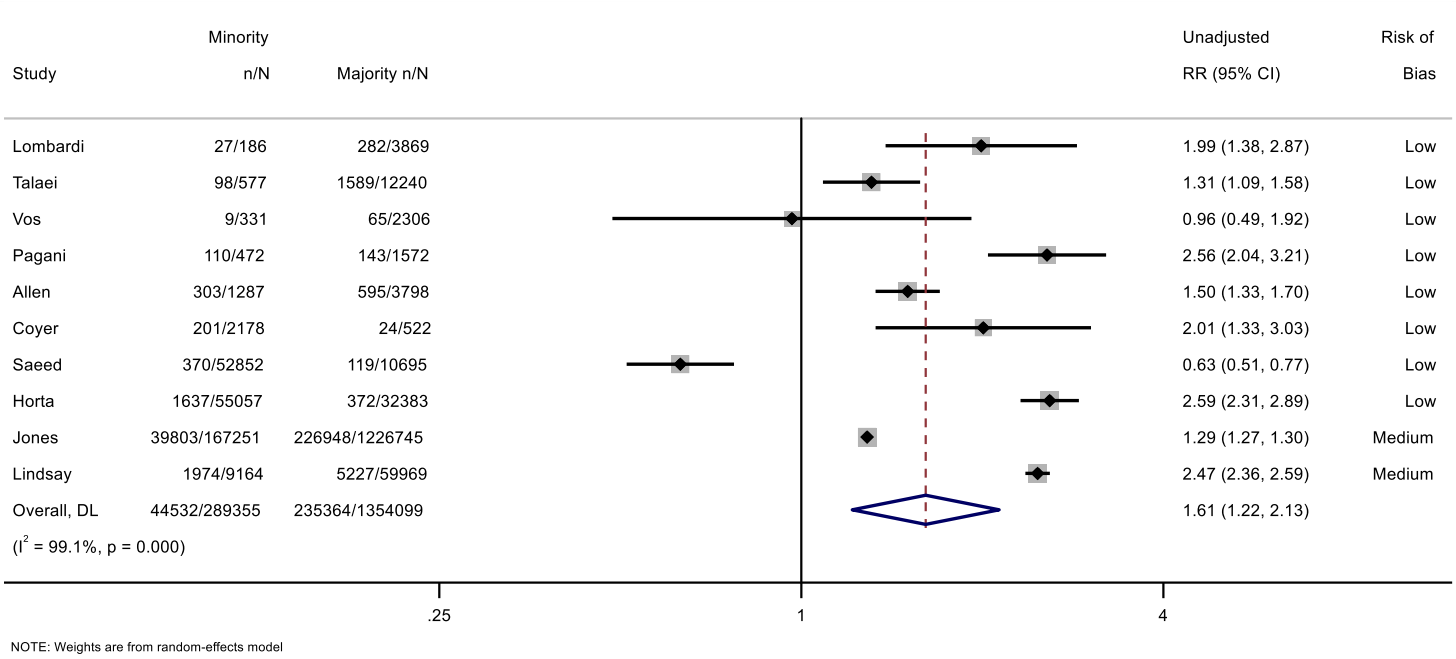


Figure S4. Forest plot showing the pooled effect size for the risk of seropositivity in minoritised ethnic groups compared to the ethnic majority group.

A total of 14 studies, including approximately 47,600,000 participants, reported crude numbers to determine the risk of hospital admission. Six studies reported the unadjusted risk of hospitalisation in the general population, showing an increased risk of hospitalisation for minoritised ethnic groups compared to the ethnic majority group (RR = 1·41, 95% CI: 1·01 to 1·98, I^2 = 99·9) (Figure S5). Eight studies investigated prognosis (hospital admission) among people infected with COVID-19. There was no difference in risk for minoritised ethnic groups compared to the ethnic majority group (RR = 1·19, 95% CI: 0·73 to 1·94, I^2 = 99·9) (Figure S5). Egger's test suggested no evidence of publication bias (p=0·350, Figure S18).

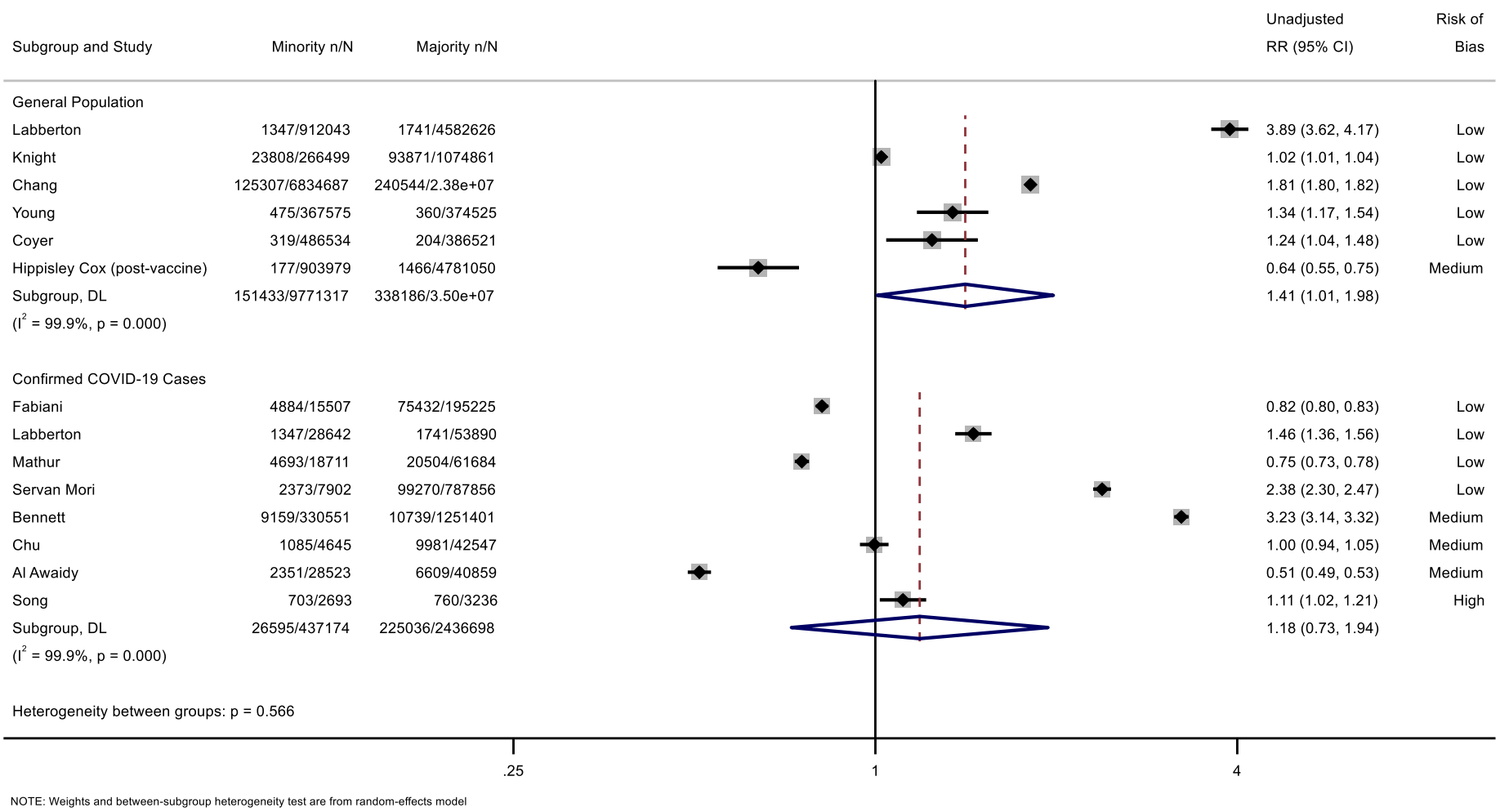


Figure S5. Forest plot showing the pooled effect size for the risk of hospital admission in minoritised ethnic groups compared to the ethnic majority group.

There were 21 studies (with approximately 15,000,000 participants) that included crude numbers to identify the risk of ICU admission. Three studies reported crude numbers to investigate the unadjusted risk of ICU admission among the general population. Minoritised ethnic groups were three times as likely to be admitted to ICU for COVID-19 compared to the ethnic majority group (RR = 3·03, 95% CI = 2·08 to 4·41, I^2 = 93·9) (Figure S6). Among eight studies which assessed prognosis following infection, there was no increased risk of ICU admission for minoritised ethnic groups (RR = 1·30, 95% CI = 0·97 to 1·74, I^2 = 99·2). However, there was an increased risk among 10 studies which assessed prognosis following hospitalisation for COVID-19 (RR = 1·58, 95% CI = 1·19 to 2·11, I^2 = 97·6) (Figure S6). Egger's test indicated possible publication bias for studies reporting ICU admission (p=0·007, Figure S19).

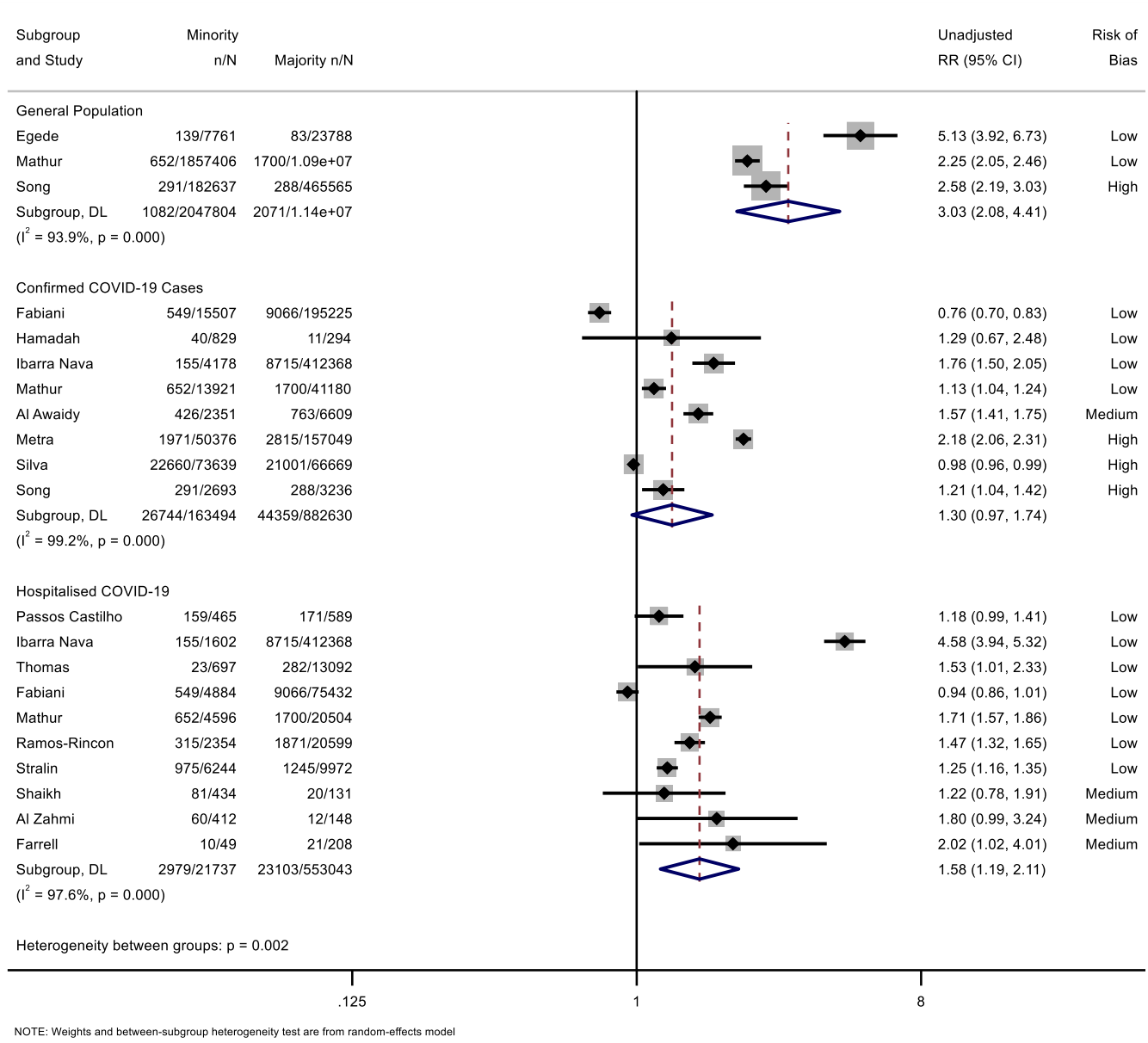


Figure S6. Forest plot showing the pooled effect size for the risk of ICU admission in minoritised ethnic groups compared to the ethnic majority group (studies are separated by denominator).

A total of 35 studies reported the risk of mortality, including approximately 283,000,000 participants. Seven studies reported the risk of mortality in the general population (Figure S7). The unadjusted analyses showed a reduced risk of mortality for minoritised ethnic groups compared to the ethnic majority group (RR = 0·63, 95% CI = 0·41 to 0·98, I^2 = 99·7). Of the ten studies which assessed prognosis (mortality) following COVID-19 infection, there was no difference in risk of mortality for minoritised ethnic groups (RR = 0·78, 95% CI = 0·51 to 1·20, I^2 = 99·7), and the risk was reduced in the 18 studies which reported prognosis following hospitalisation (RR = 0·67, 95% CI = 0·61 to 0·73, I^2 = 99·6) (Figure S7). Egger's test suggested evidence of publication bias for the studies reporting mortality (p=0·010, Figure S20).

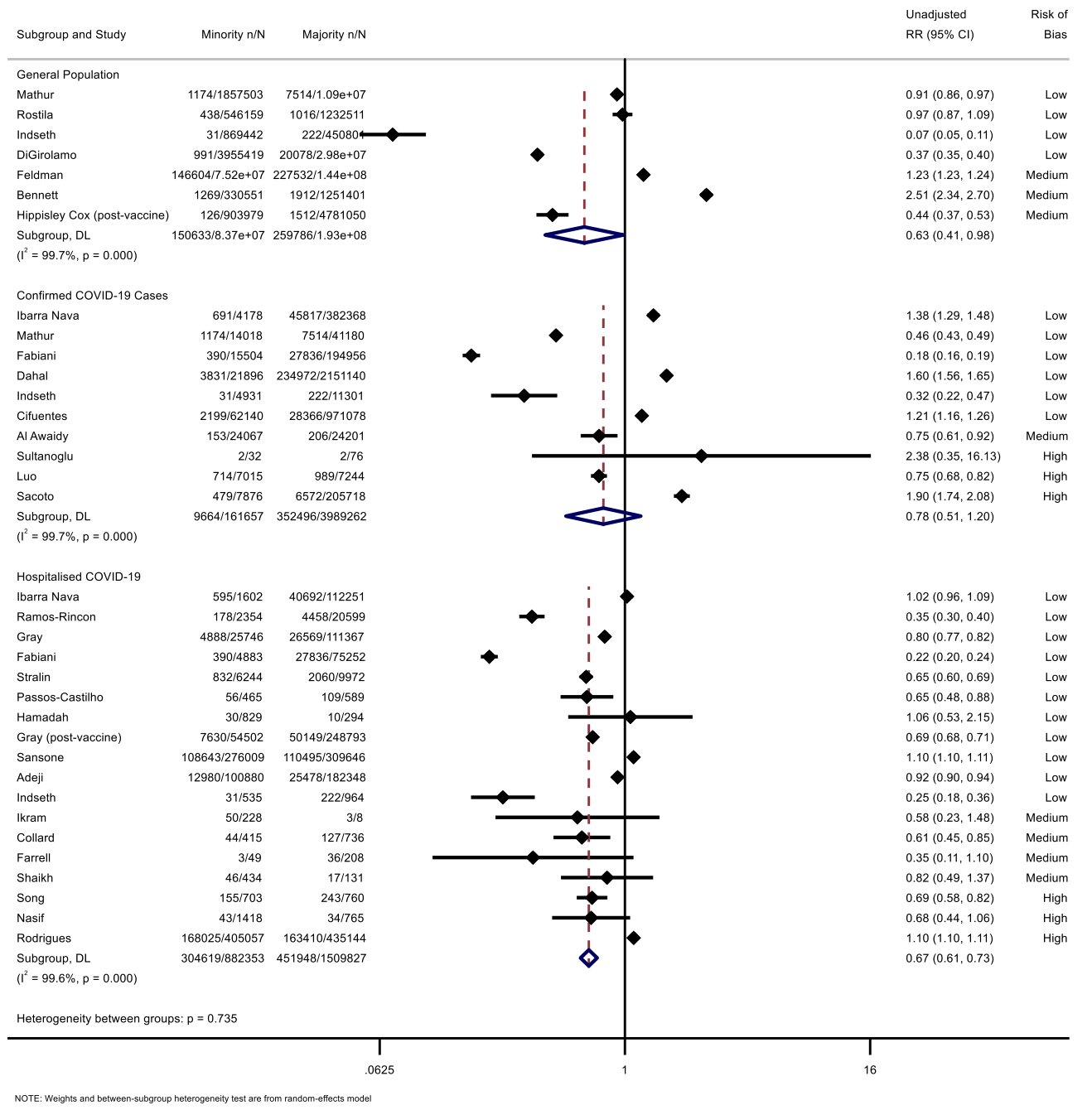


Figure S7. Forest plot showing the pooled effect size for the risk of mortality in minoritised ethnic groups compared to the ethnic majority group (studies are separated by denominator).

Sensitivity analyses: meta-analyses of outcomes by ethnic majority group versus minoritised ethnic groups (combined), excluding studies which reported country of birth or nationality.

After excluding six studies which reported country of birth or nationality, the meta-analysis of approximately 43,600,000 participants identified that minoritised ethnic groups were not more likely to become infected compared to the ethnic majority group (K = 10; RR = 1·19, 95% CI: 1·82 to 1·73, I^2 = 96·4) (Figure S8).

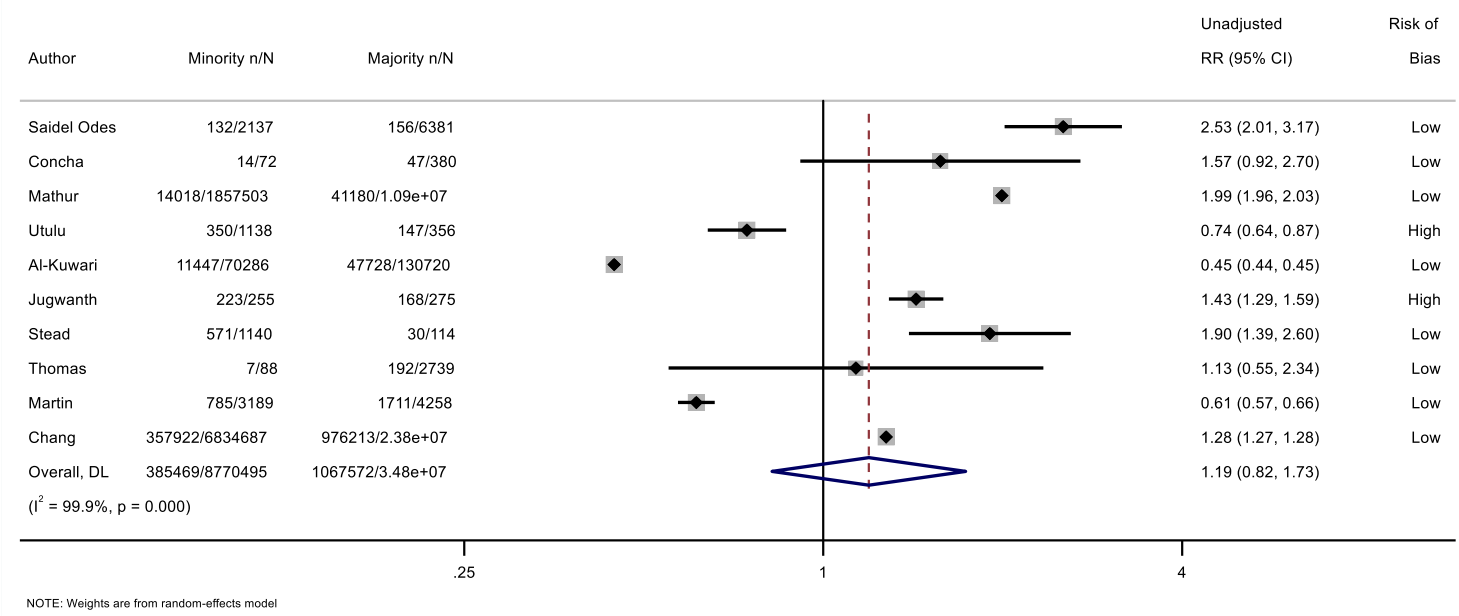


Figure S8. Forest plot showing the pooled risk of infection for minoritised ethnic groups compared to the ethnic majority group, excluding studies reporting country of birth or nationality.

After excluding three studies, seven studies reported the association between ethnicity and seropositivity, including 1,634,655 participants. Minoritised ethnic groups were 1·4 times more likely to be seropositive compared to the ethnic majority group (RR = 1·42, 95% CI: 1·02 to 1·99, I^2 = 99·3) (Figure S9).

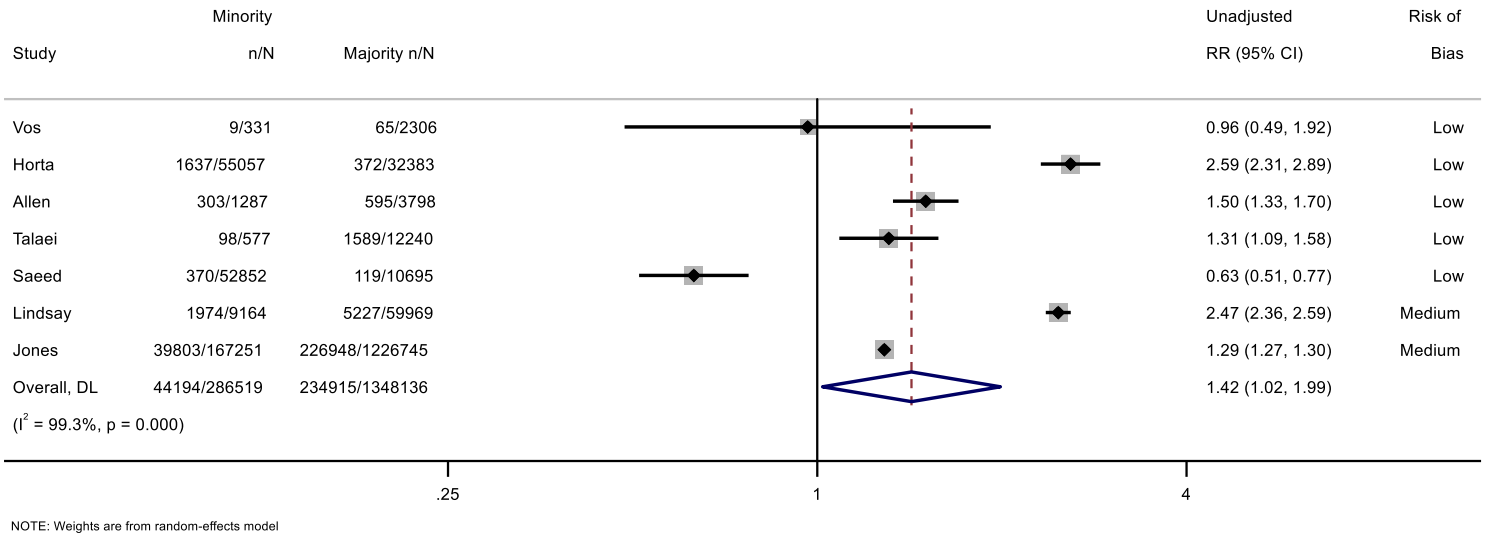


Figure S9. Forest plot showing the pooled risk of seropositivity for minoritised ethnic groups compared to the ethnic majority group, excluding studies reporting country of birth or nationality.

After excluding studies which reported country of birth or nationality, there was no difference in risk of hospital admission in general population studies (K = 4, RR = 1·13, 95% CI: 0·76 to 1·68, I^2 = 99·9), or for studies which assessed prognosis among confirmed COVID-19 cases (K = 5, RR = 1·45, 95% CI: 0·75 to 2·81, I^2 = 99·9) (Figure S10).

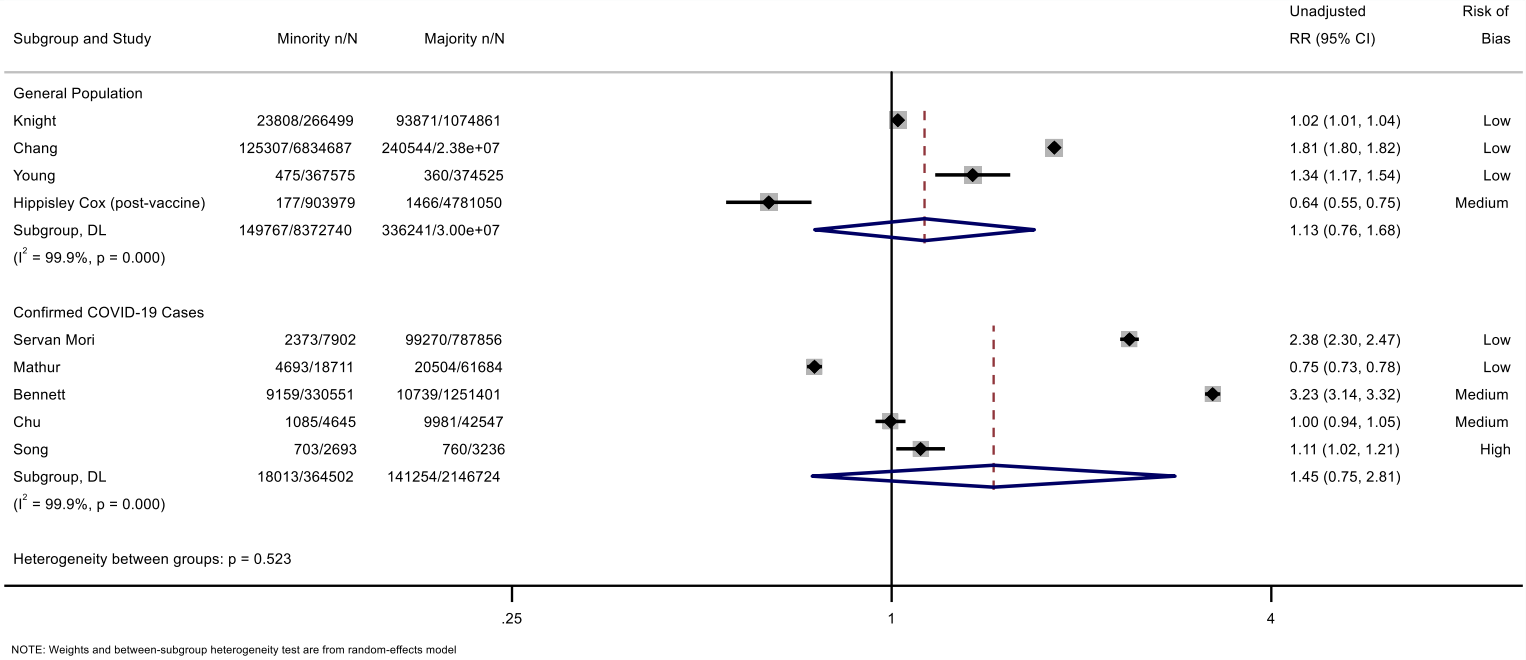


Figure S10. Forest plot showing the pooled risk of hospital admission for minoritised ethnic groups compared to the ethnic majority group (by denominator), excluding studies reporting country of birth or nationality.

After excluding studies which reported country of birth or nationality (Figure S11), population-based studies showed an increased risk of ICU admission (K = 3, RR = 3·03, 95% CI: 2·08 to 4·41, I^2 = 93·9)., as did studies which assessed prognosis among hospitalised COVID-19 cases (K = 7, RR = 1·86, 95% CI: 1·28 to 2·69, I^2 = 96·7). Studies which assessed prognosis in confirmed COVID-19 cases showed no difference in the risk of ICU admission (K = 5, RR = 1·39, 95% CI: 0·93 to 2.07, I^2 = 99·5).

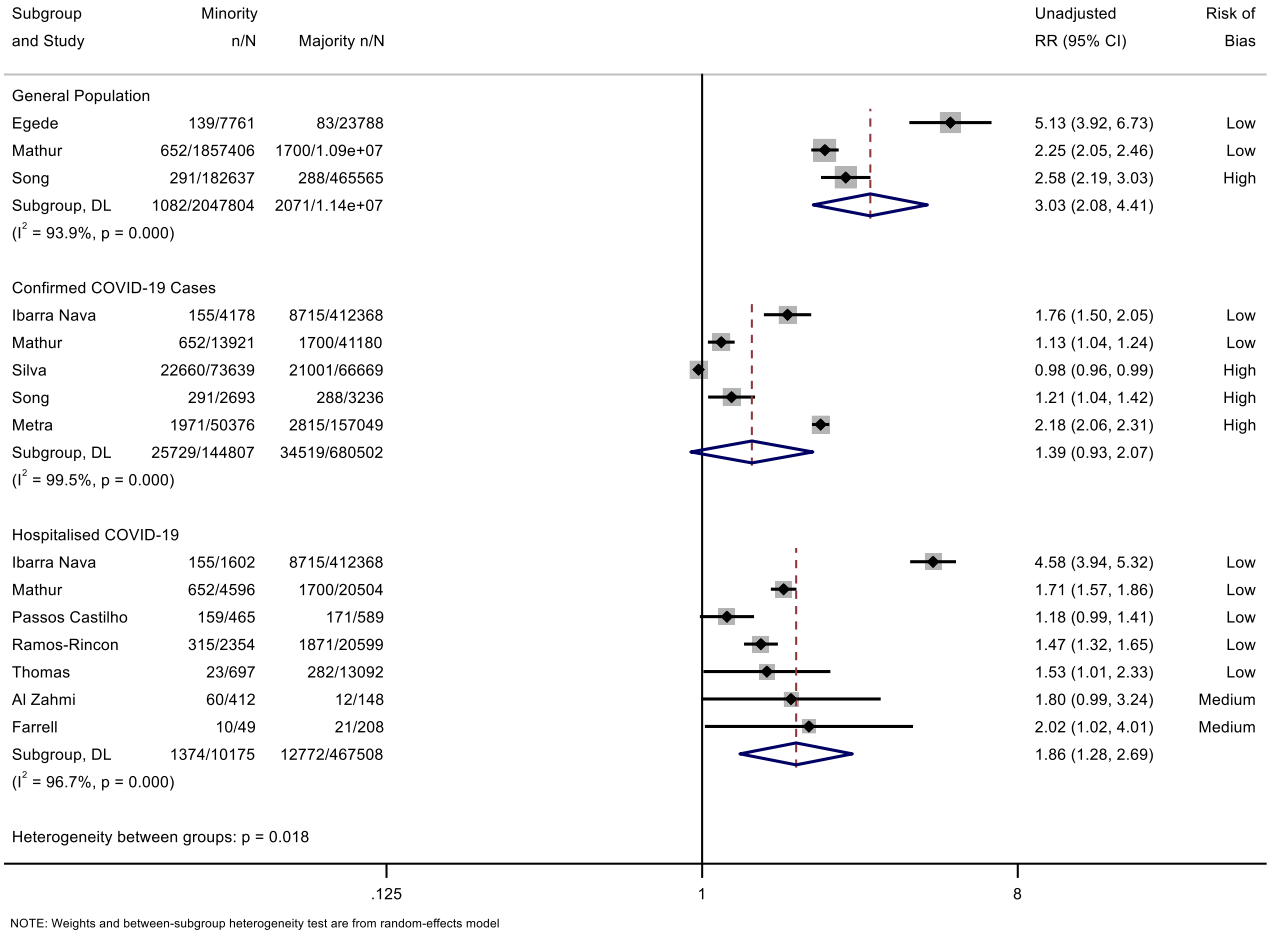


Figure S11. Forest plot showing the pooled risk of ICU admission for minoritised ethnic groups compared to the ethnic majority group (by denominator), excluding studies reporting country of birth or nationality.

After excluding studies which used closely related indicators of ethnicity (Figure S12), population-based studies showed no difference in risk of mortality (K = 4, RR = 1·07, 95% CI:

0·72 to 1·59, I^2 = 99·5). There was no difference in risk of mortality for studies assessing prognosis among confirmed COVID-19 cases (K = 6, RR = 1·10, 95% CI: 0·74 to 1·63, I^2 = 99·7), and a reduced risk among those hospitalised with COVID-19 (K = 10, RR = 0·87, 95% CI = 0·79 to 0·96, I^2 = 99·6).

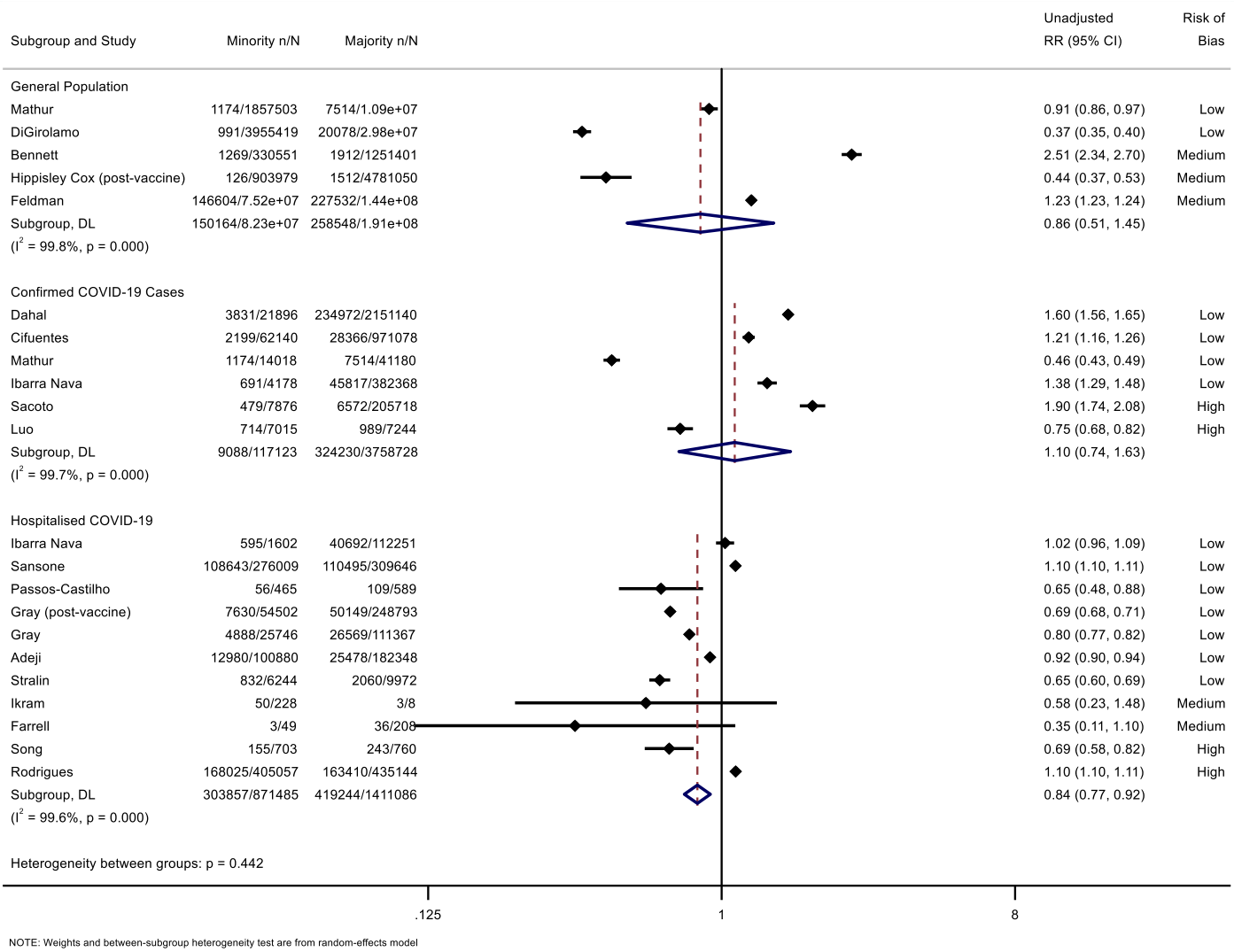


Figure S12. Forest plot showing the pooled risk of mortality for minoritised ethnic groups compared to the ethnic majority group (by denominator), excluding studies reporting country of birth or nationality.

Funnel Plots

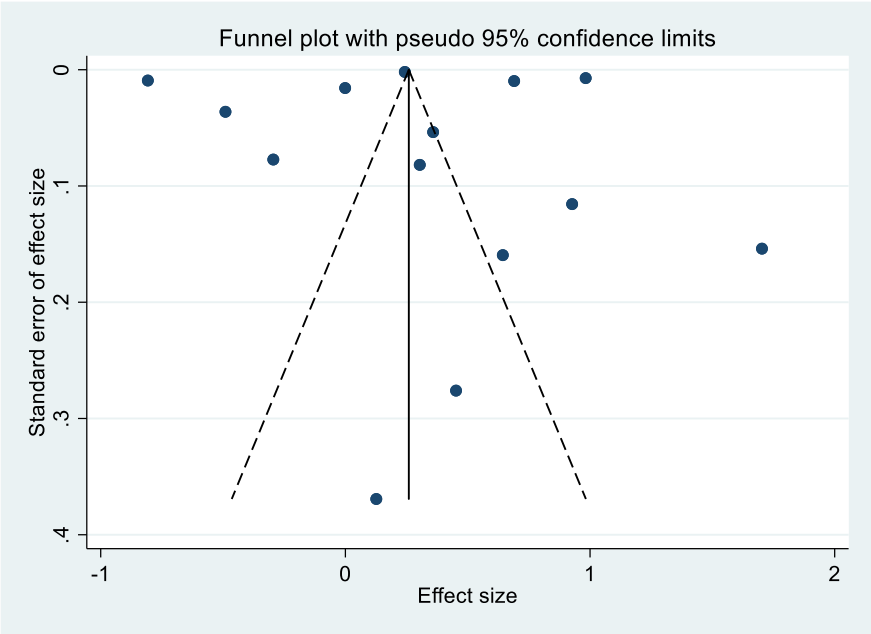


Figure S13. Funnel plot to assess publication bias for the unadjusted pooled risk of infection.

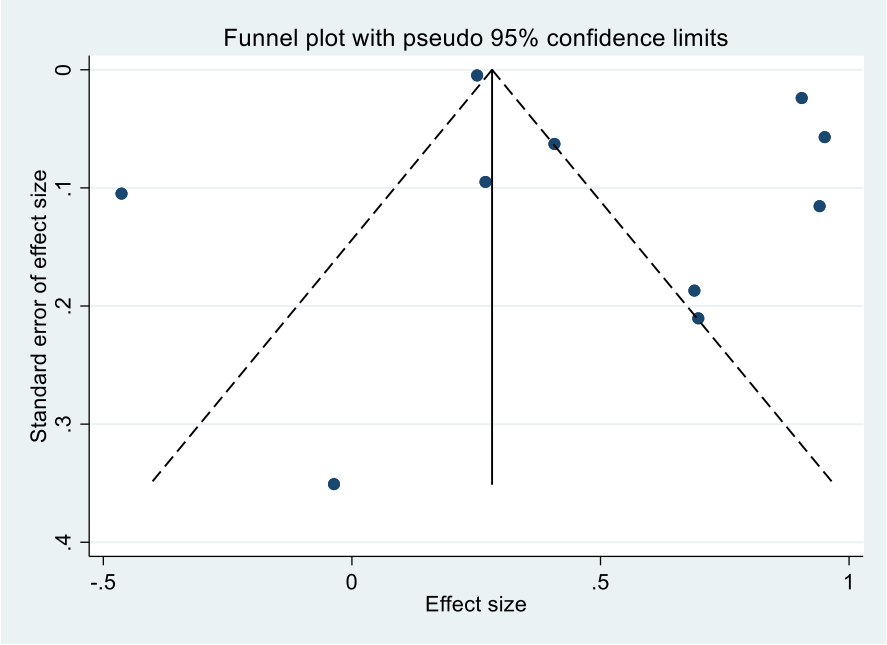


Figure S14. Funnel plot to assess publication bias for the unadjusted pooled risk of seropositivity.

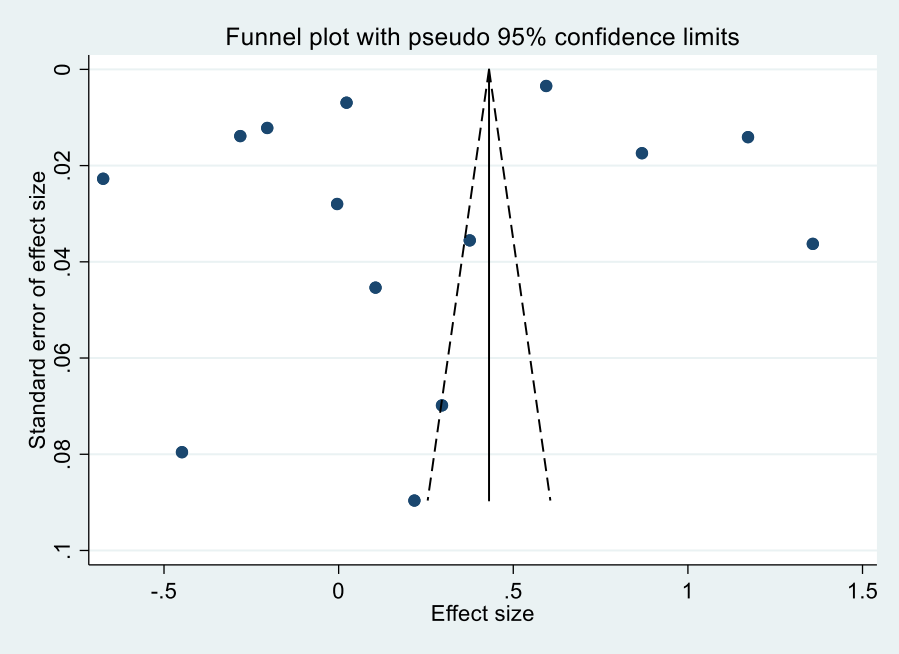


Figure S15. Funnel plot to assess publication bias for the unadjusted pooled risk of hospital admission.

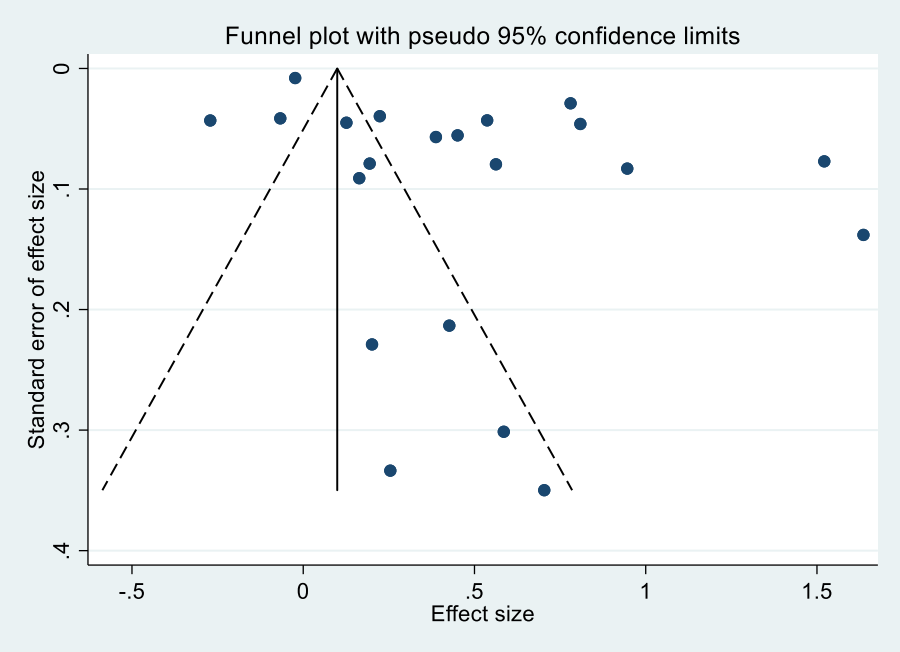


Figure S16. Funnel plot to assess publication bias for the unadjusted pooled risk of ICU admission.

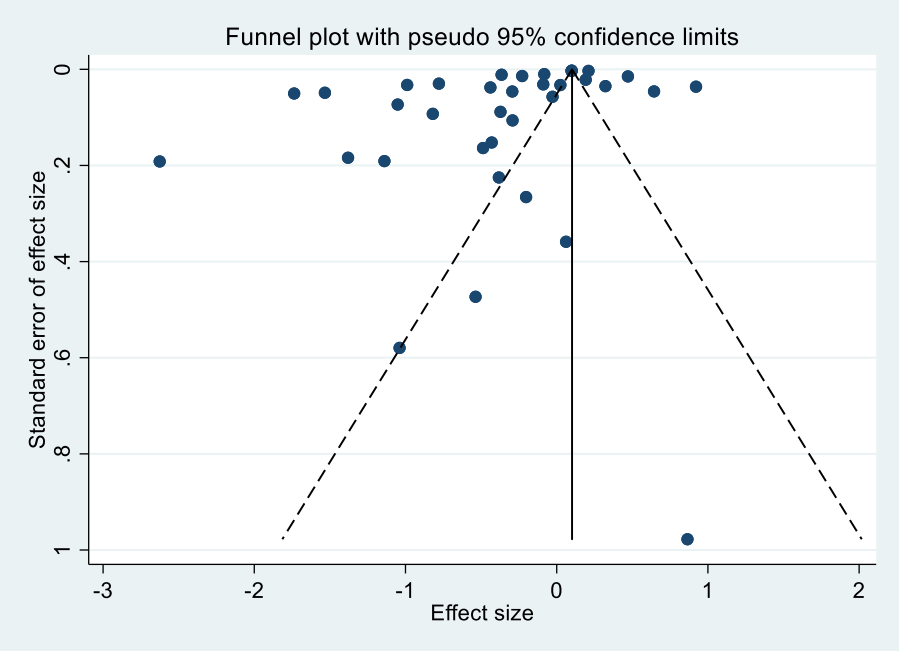


Figure S17. Funnel plot to assess publication bias for the unadjusted pooled risk of mortality.

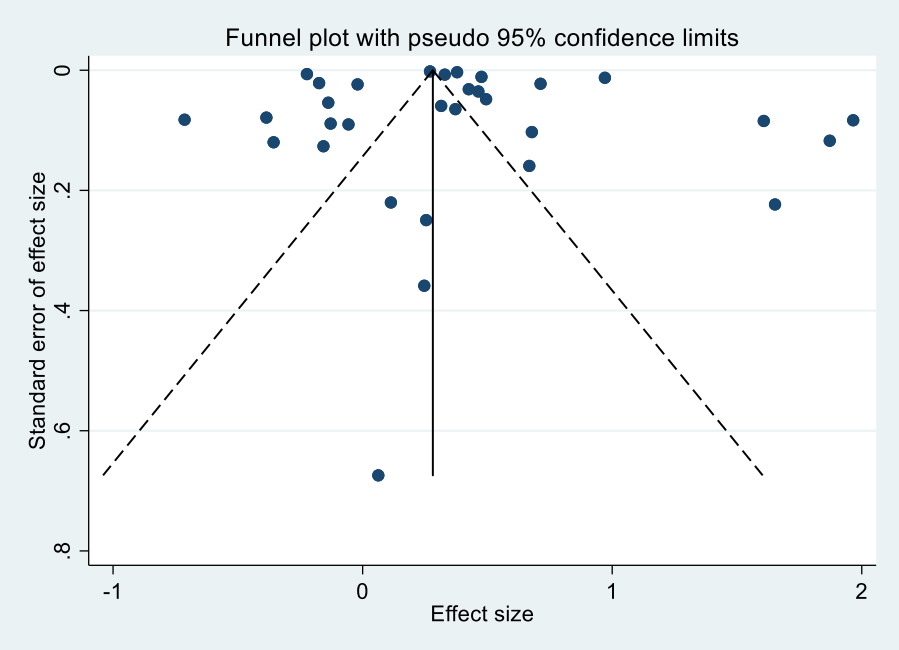


Figure S18. Funnel plot to assess publication bias for the adjusted pooled risk of infection.

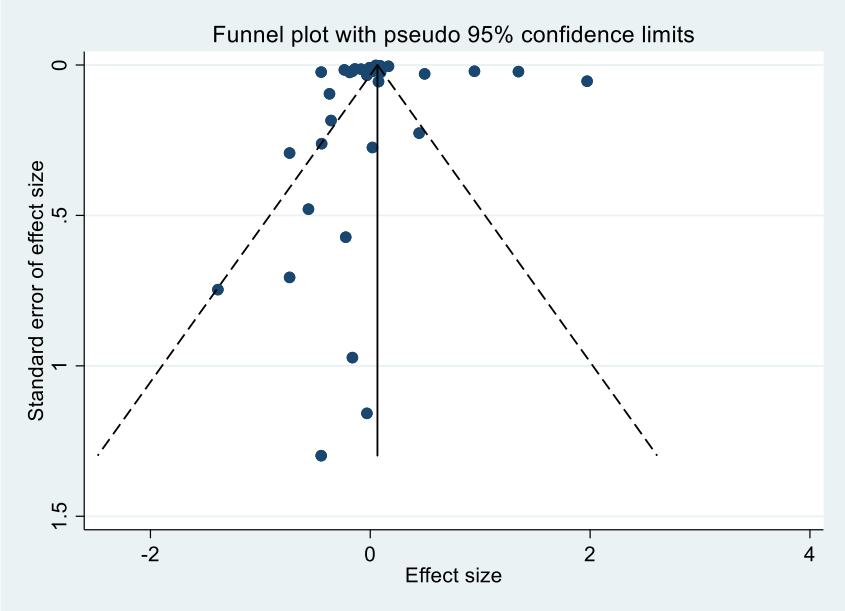


Figure S19. Funnel plot to assess publication bias for the adjusted pooled risk of mortality, among hospitalised cases.

Bubble Plot

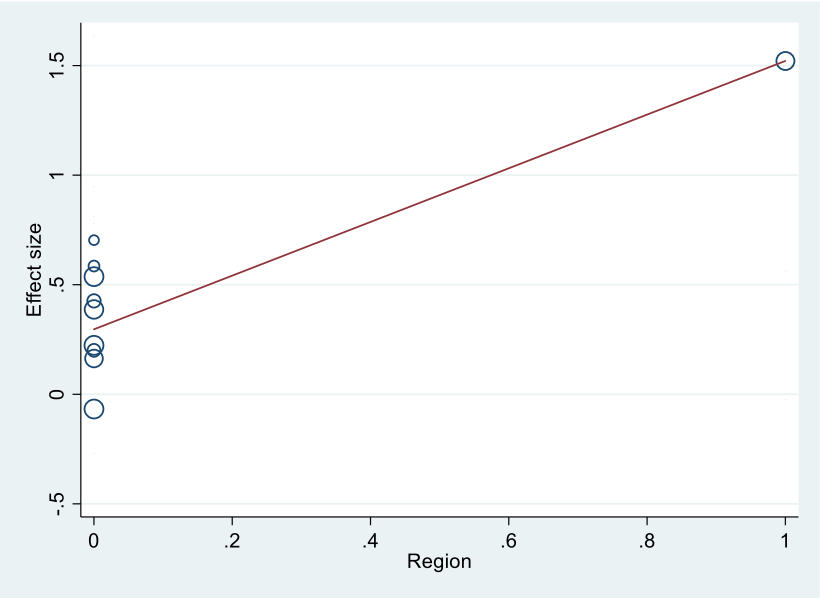


Figure S20. Bubble plot with fitted meta-regression to show the impact of region (HIC [0] versus LMIC [1]) on heterogeneity in the risk of ICU admission among hospitalised COVID-19 cases.

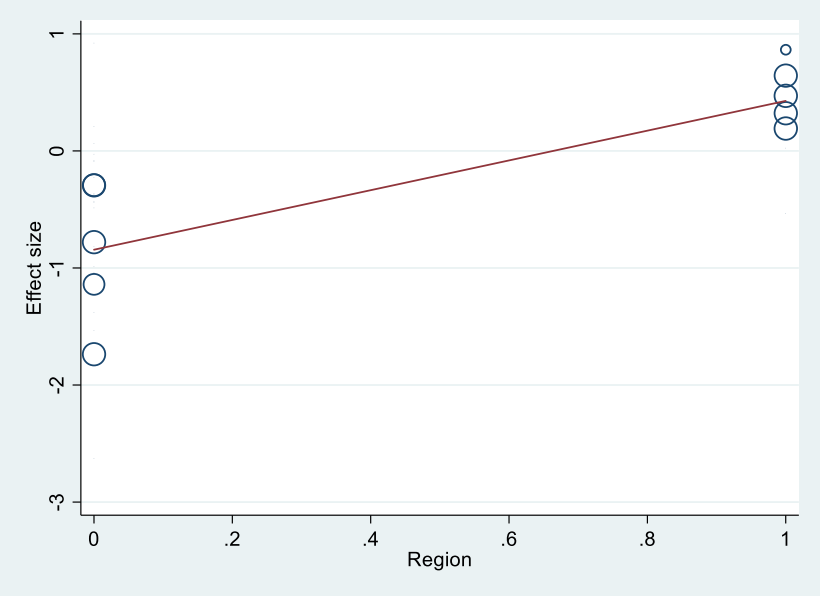


Figure S21. Bubble plot with fitted meta-regression to show the impact of region (HIC [0] versus LMIC [1]) on heterogeneity in the risk of mortality among confirmed COVID-19 cases.

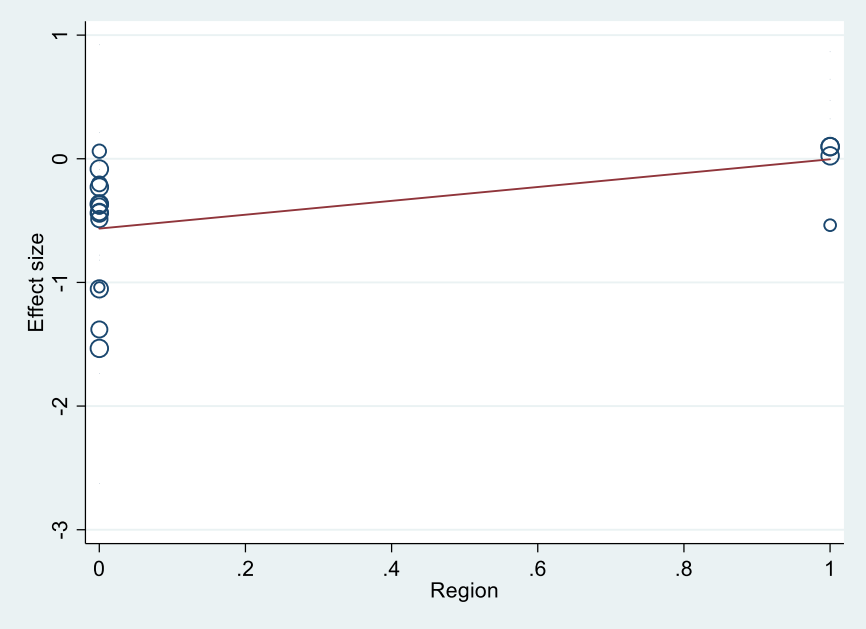


Figure S22. Bubble plot with fitted meta-regression to show the impact of region (HIC [0] versus LMIC [1]) on heterogeneity in the risk of mortality among hospitalised COVID-19 cases.

Sensitivity analyses: stratified meta-analyses by region for adjusted analyses with sufficient data.

To further explore the impact of region on the adjusted risk of outcomes, stratified meta-analyses were conducted, by region (LMIC *versus* HIC). In a synthesis of two studies from LMIC, the risk of infection was increased for Black, South Asian, and Mixed people (similar to the main analyses), but not those from Other ethnic groups (Figure S23). Among HIC, Black and South Asian ethnic groups had an increased risk of infection, compared to White people, and studies presenting an aggregated Asian group showed a reduced risk of infection (Figure S24). These findings are similar to the main analyses, except the risk of infection is no longer increased for Mixed or Other ethnic groups.

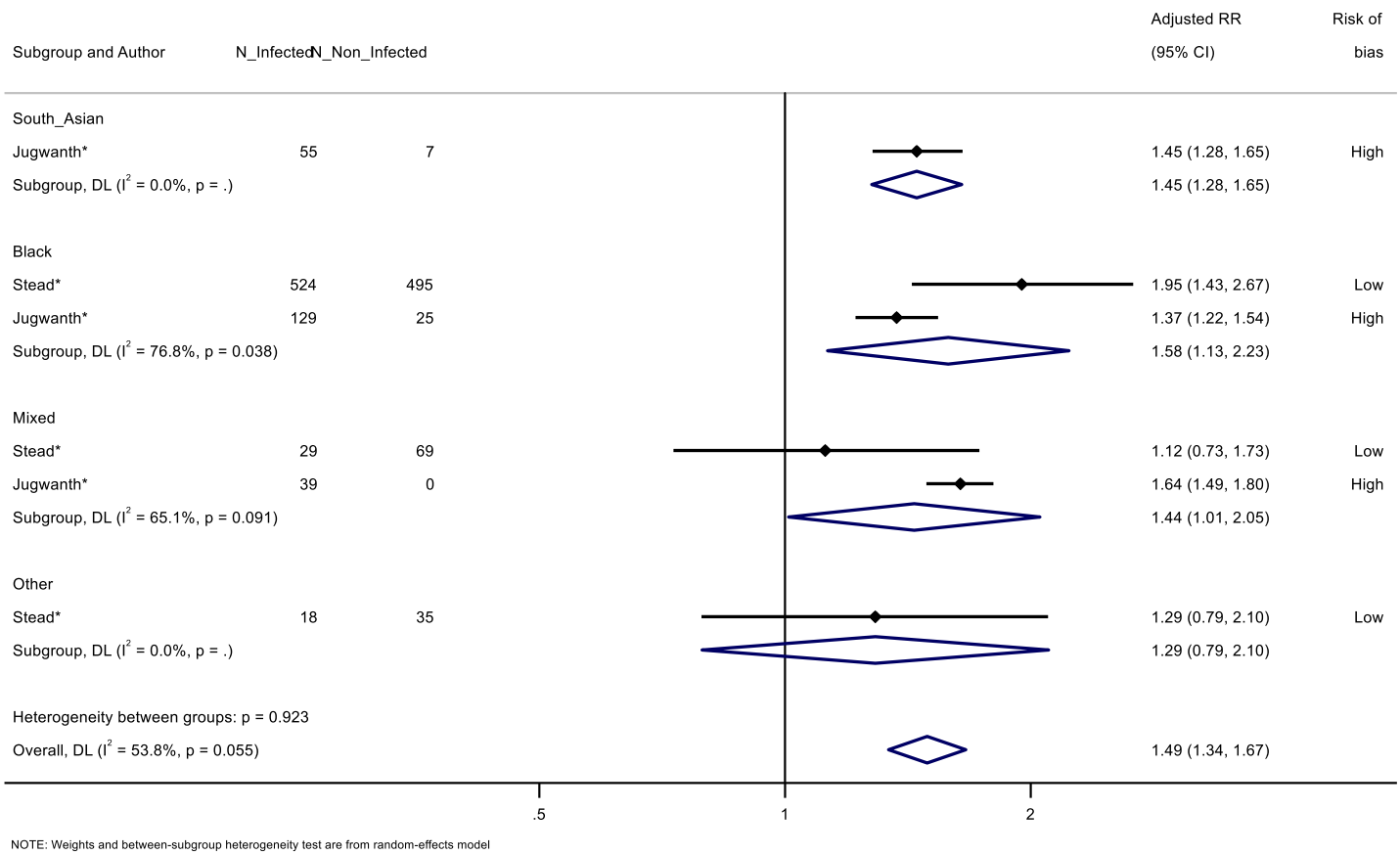


Figure S23. Forest plot showing the pooled adjusted risk of infection by ethnic group, for studies in LMIC.

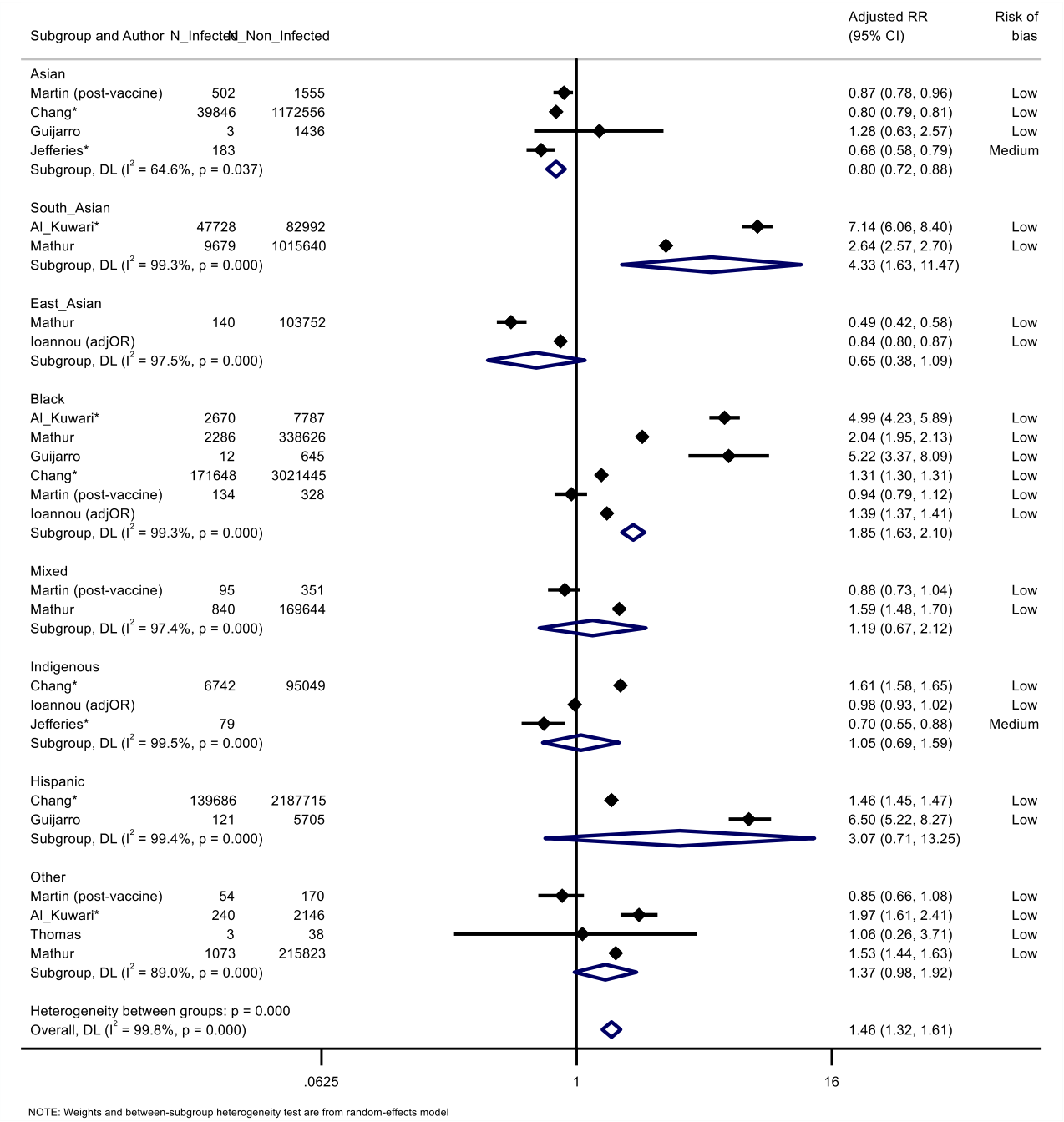


Figure S24. Forest plot showing the pooled adjusted risk of infection by ethnic group, for studies in HIC.

In a synthesis of three studies from LMIC, there was no increased risk of mortality once hospitalised with COVID-19, for any minoritised ethnic group, compared to White people (Figure S25). Among HIC, only Indigenous people had an increased risk of mortality once hospitalised with COVID-19, compared to White people (Figure S26). Comparing with the main analyses, these findings suggest that Indigenous people are only at an increased risk of mortality in HIC and not LMIC.

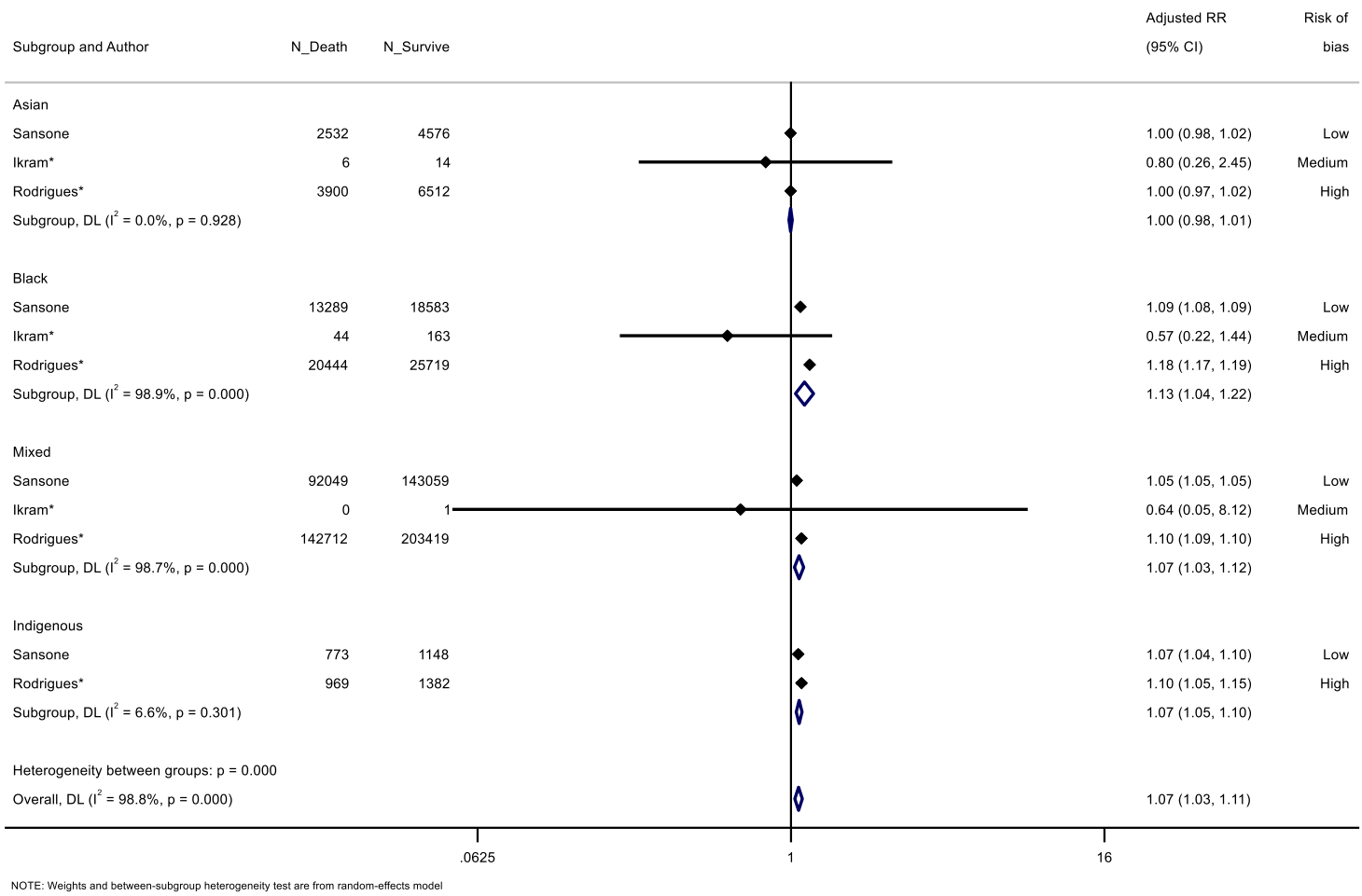


Figure S25. Forest plot showing the pooled adjusted risk of mortality among hospitalised COVID-19 cases by ethnic group, for studies in LMIC.

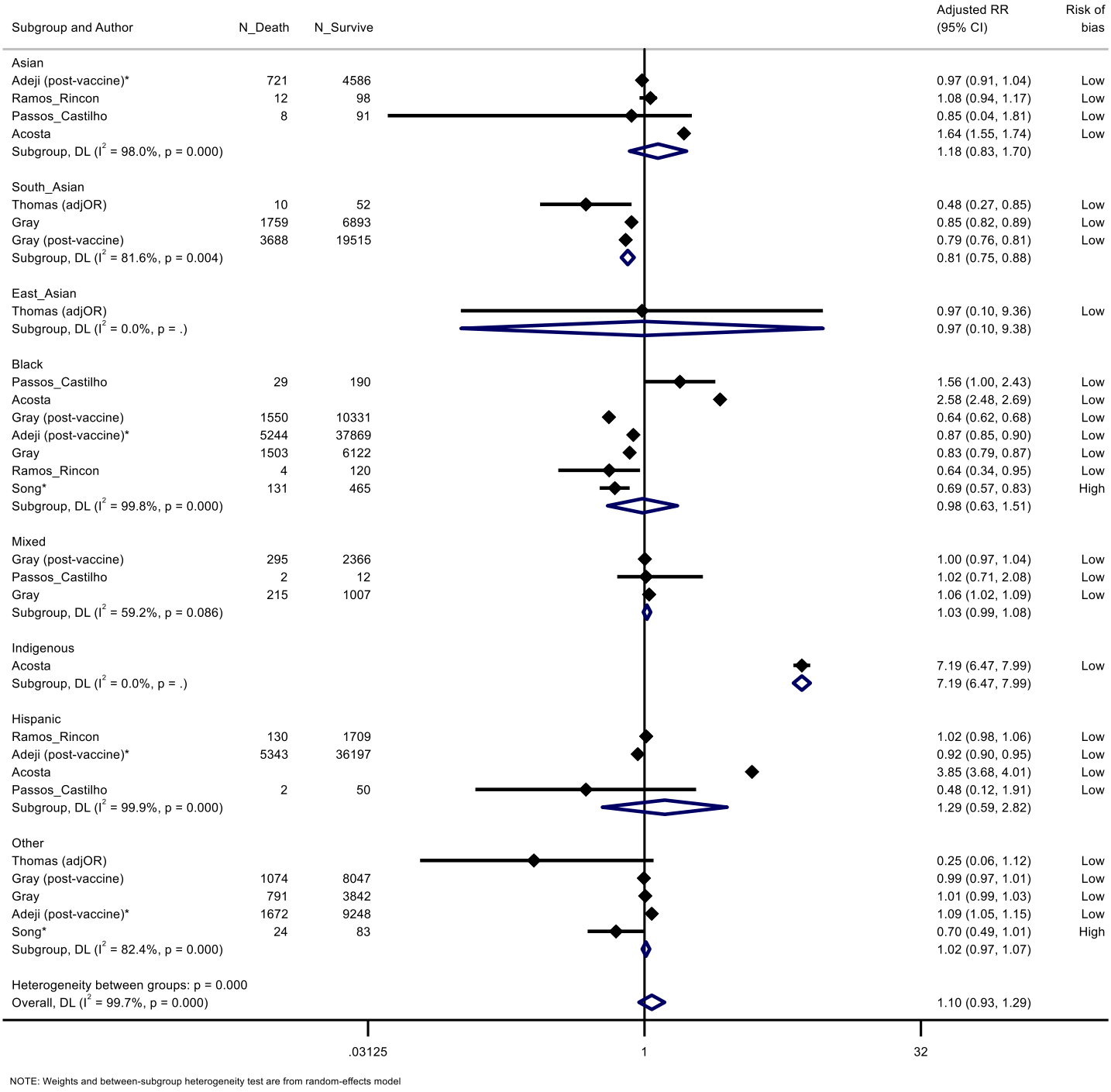


Figure S26. Forest plot showing the pooled adjusted risk of mortality among hospitalised COVID-19 cases by ethnic group, for studies in HIC.

Sensitivity analyses: adjusted meta-analyses excluding studies with a high risk of bias.

After removing one study with a high risk of bias, Mixed people were no longer at an increased risk of infection (Figure S27). There were no seroprevalence studies with a high risk of bias.

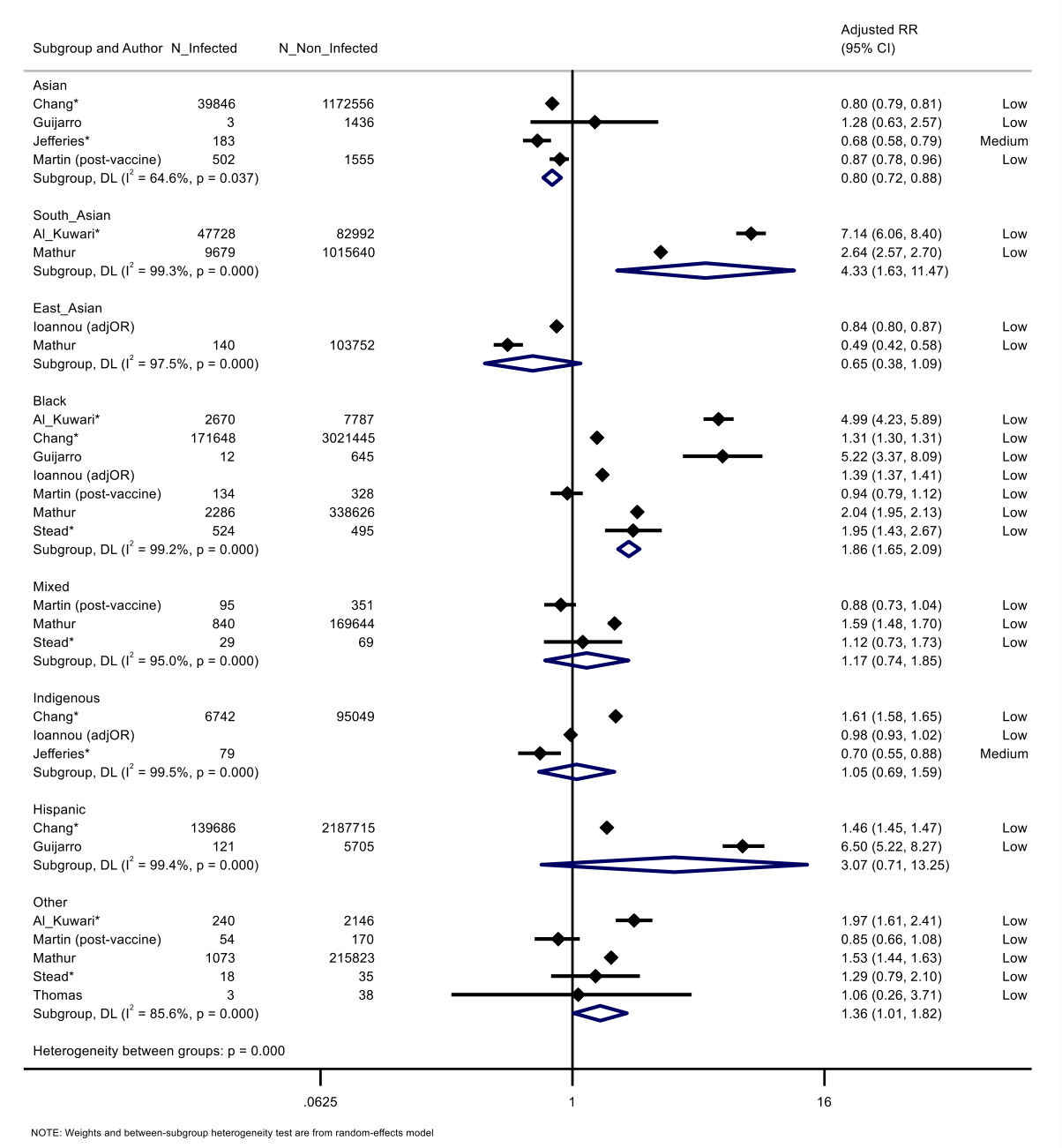


Figure S27. Forest plot showing the pooled adjusted risk of infection by ethnic group, removing one study with a high risk of bias.

For hospital admission, there were no population-based studies with a high risk of bias. One study of confirmed COVID-19 cases had a high risk of bias and removing this study did not alter the findings (Figure S28).

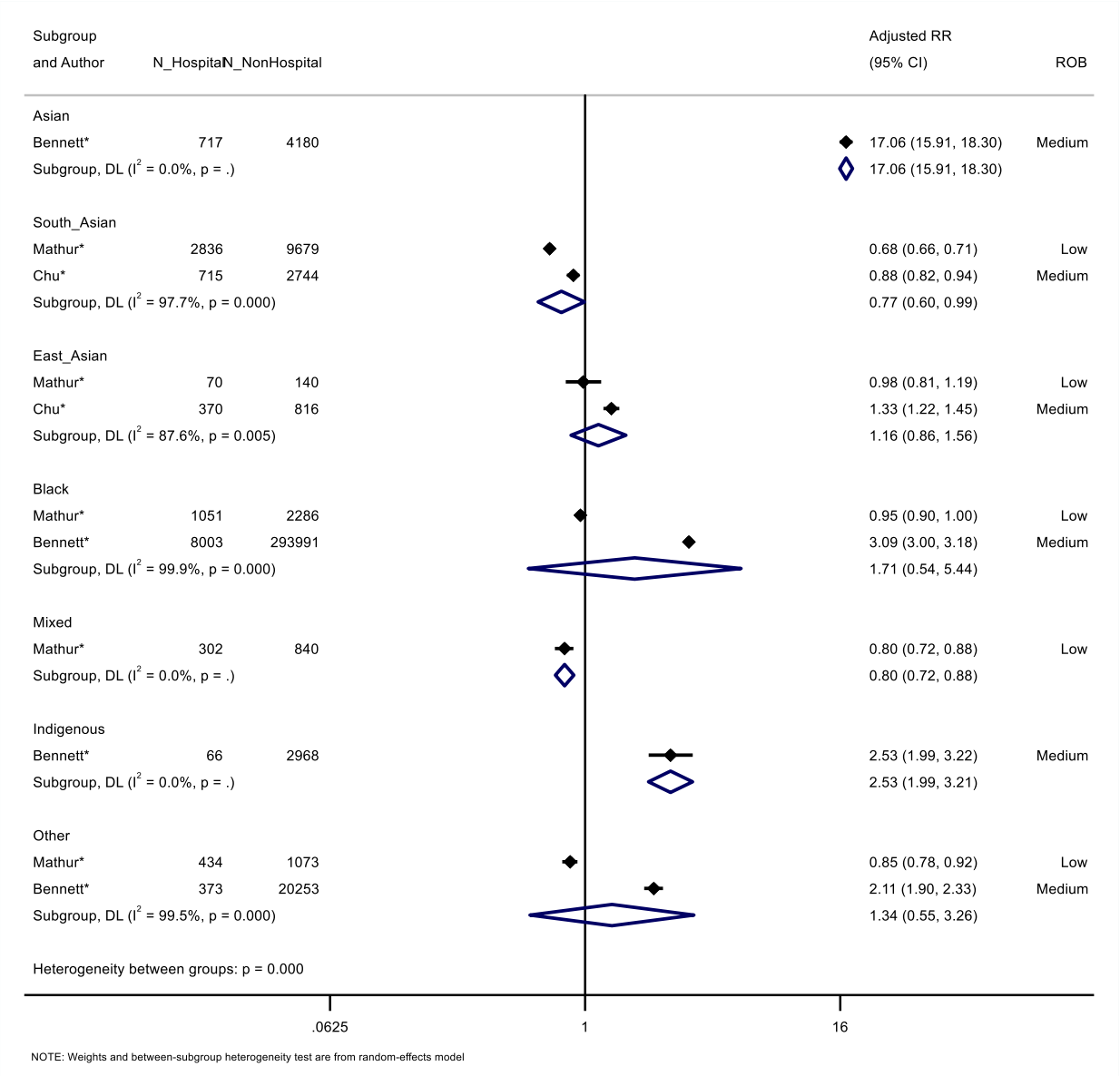


Figure S28. Forest plot showing the pooled adjusted risk of hospital admission among confirmed COVID-19 cases, by ethnic group, removing one study with a high risk of bias.

One population-based study investigating ICU admission as the outcome had a high risk of bias (Figure S29). After excluding this study, we now see that people from Other ethnic groups are at an increased risk of ICU admission. Three of the four studies which assessed the risk of ICU admission among confirmed COVID-19 cases had a high risk of bias, therefore, it was not possible to conduct a sensitivity analysis removing these studies. Among studies of hospitalised COVID-19 cases, there were no studies with a high risk of bias.

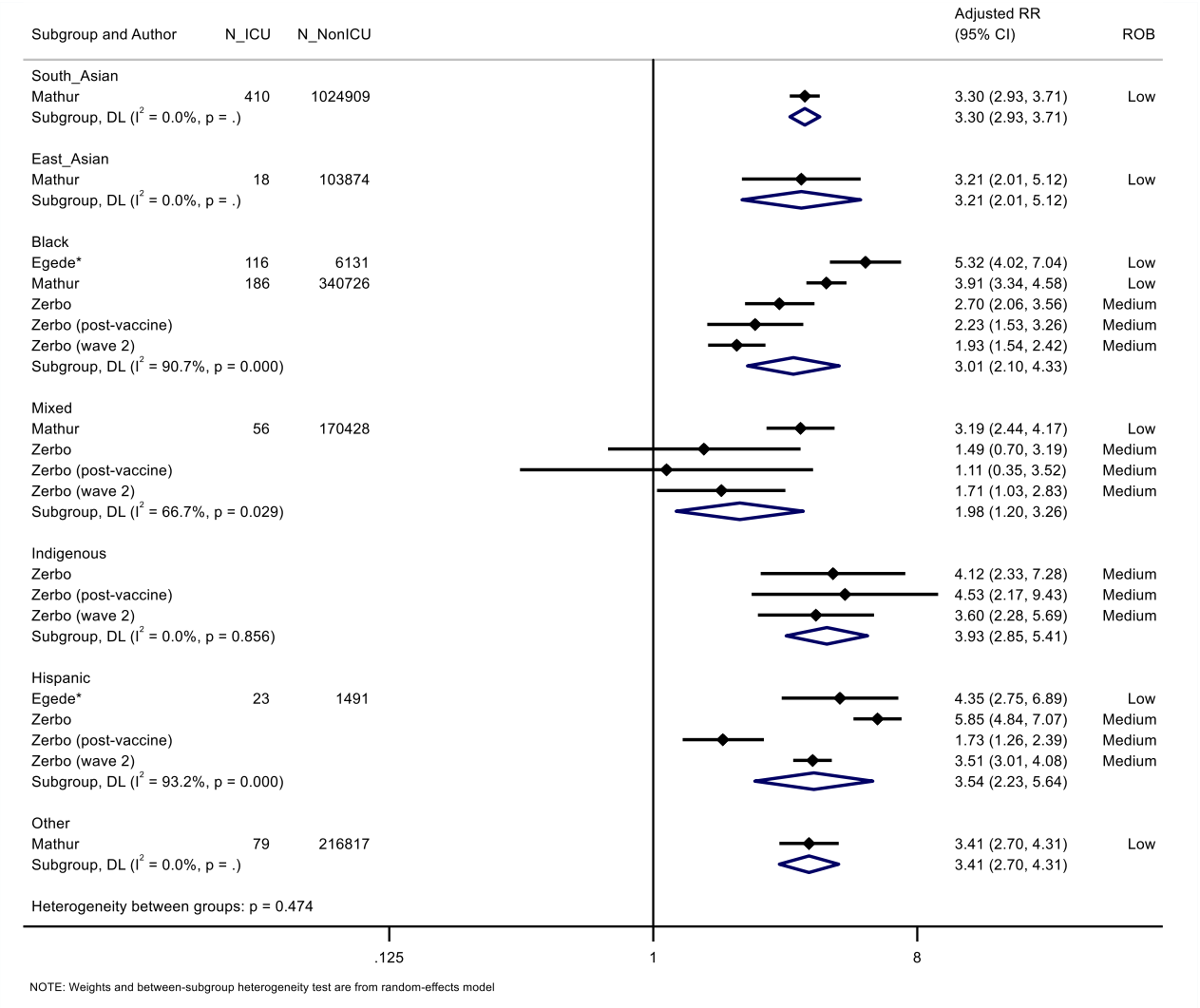


Figure S29. Forest plot showing the pooled adjusted risk of ICU admission among population-based studies, by ethnic group, removing one study with a high risk of bias.

There were no population-based studies of mortality with a high risk of bias. One study assessing the risk of mortality among confirmed COVID-19 cases had a high risk of bias and two studies among hospitalised COVID-19 cases had a high risk of bias. Excluding these studies did not alter the findings (Figure S30 & S31). However, we no longer observe a trend towards an increased risk of mortality for Indigenous peoples, among studies of hospitalised COVID-19 cases.

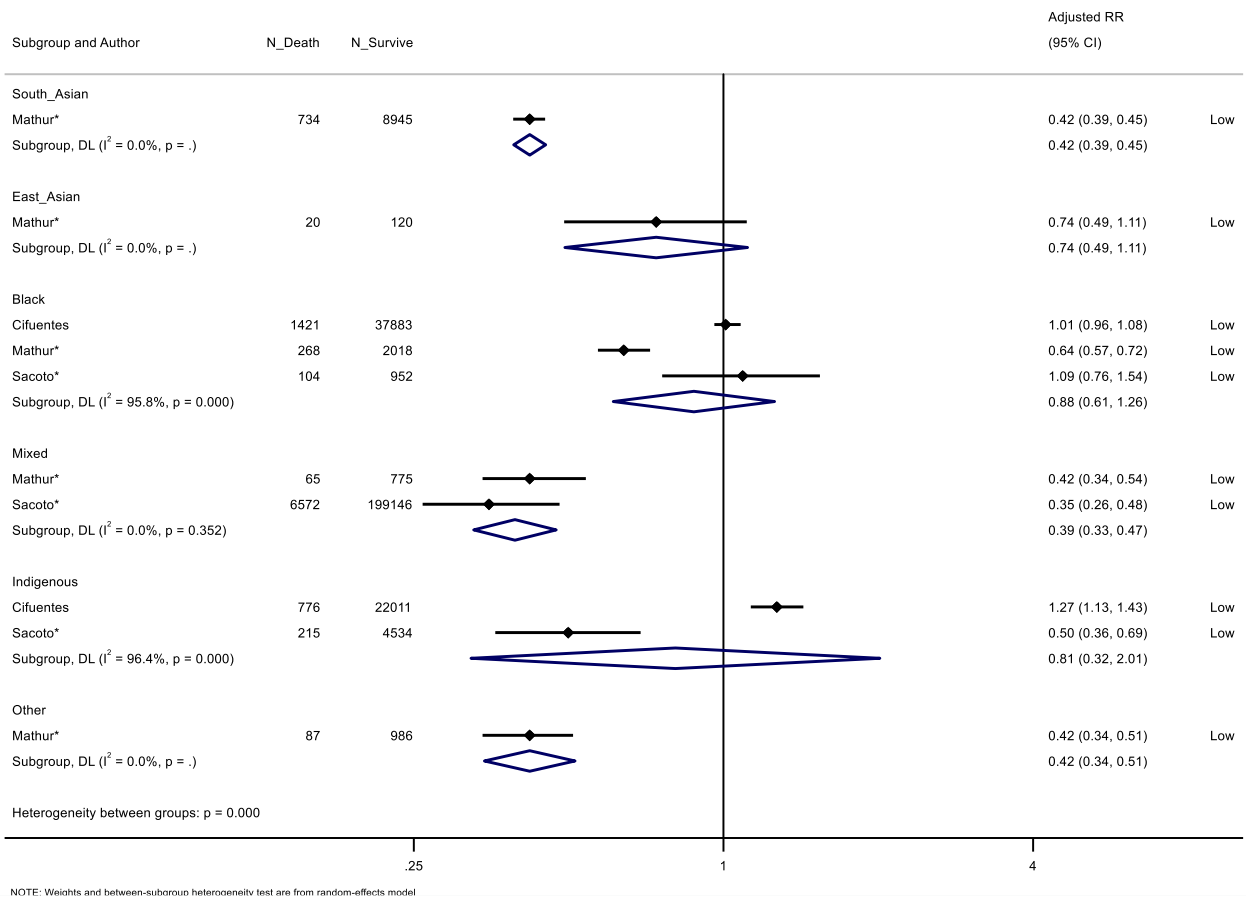


Figure S30. Forest plot showing the pooled adjusted risk of mortality among confirmed COVID-19 cases, by ethnic group, removing one study with a high risk of bias.

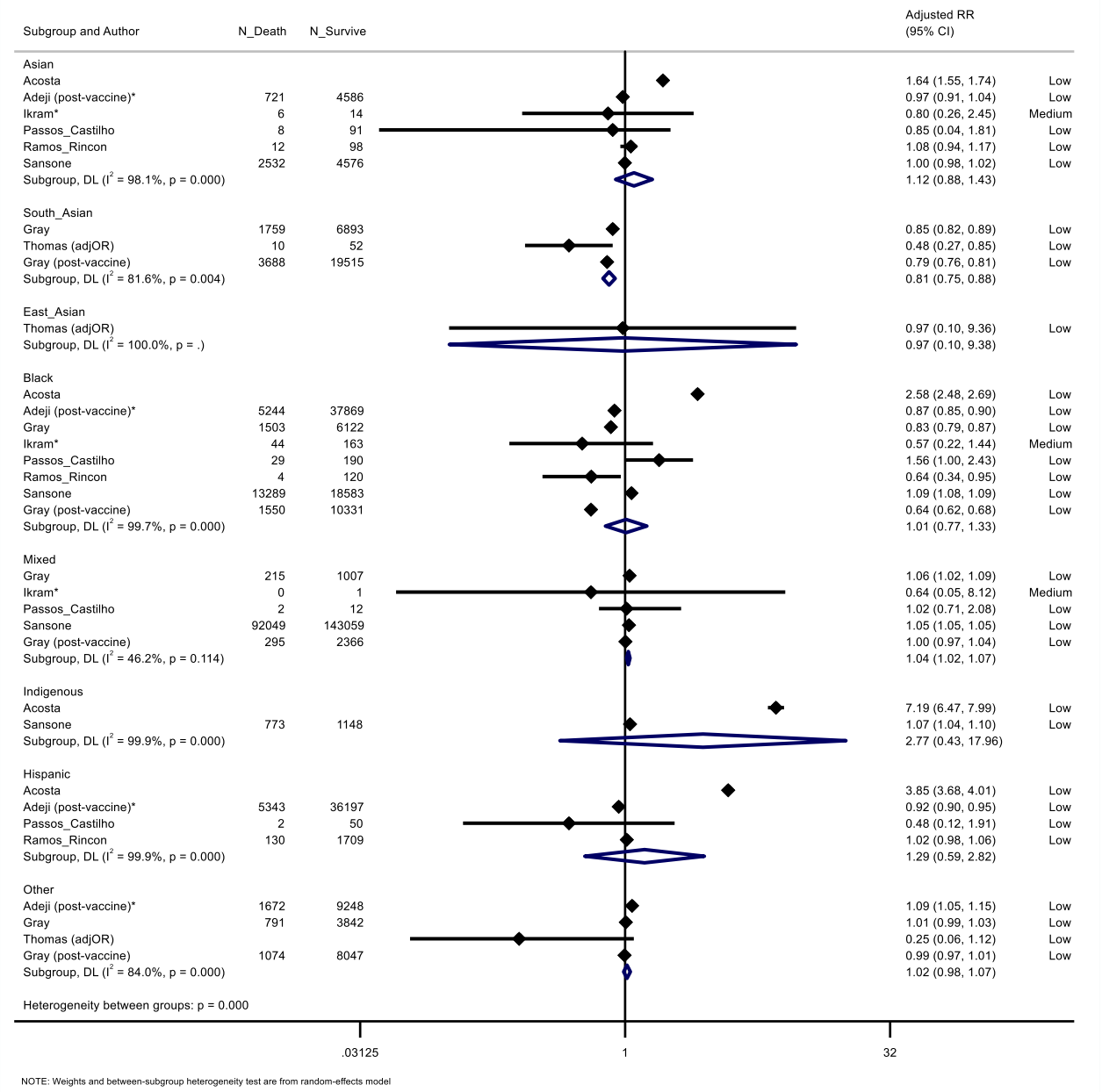


Figure S31. Forest plot showing the pooled adjusted risk of mortality among hospitalised COVID-19 cases, by ethnic group, removing two studie with a high risk of bias.

Table S3. GRADE Certainty.

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N Studies	Study design	Risk of Bias	Imprecision	Inconsistency	Indirectness	Certainty
Infection						
10	Observational	Not serious	Not serious	Serious	Not serious	◯ ◯ ⊕ ◯ Moderate
Seropositivity						
7	Observational	Not serious	Not serious	Serious	Not serious	◯ ◯ ⊕ ◯ Moderate
Hospital admission (general population)						
5	Observational	Not serious	Not serious	Serious	Not serious	◯ ◯ ⊕ ◯ Moderate
ICU admission (general population)						
6	Observational	Serious	Serious	Serious	Serious	⊕ ⊕ ⊕ ⊕ Very low
Mortality (general population)						
5	Observational	Not serious	Not serious	Serious	Serious	◯ ◯ ⊕ ⊕ Very low

Synthesis Without Meta-analysis (SWiM)

Methods

This narrative synthesis presents the findings of studies that were not amenable to meta-analysis, for each outcome (i.e., infection, seropositivity, hospital admission, ICU admission, mortality). The findings are first presented for the analysis of the ethnic majority group (varying by study) compared with minoritised ethnic groups (combined). Then, the findings are presented for the analysis of disaggregated ethnic groups compared to the reference group for that study.

For the analysis of the ethnic majority group compared to minoritised ethnic groups (combined), crude numbers were used to calculate unadjusted risk ratios (RR). For disaggregated ethnic groups compared to the reference group, age and sex adjusted RR were extracted where possible. As with the main analyses, adjusted odds ratios (OR) were extracted and converted to adjusted RR using a validated conversion method (Zhang & Kai, 1998). Adjusted hazard ratios (HR) were extracted and assumed to approximate an adjusted RR. Unadjusted or over-adjusted RR were included if age and sex adjusted RR were not available.

Effect direction plots, not taking account of statistical significance (as recommended by the Cochrane handbook), and sign tests were conducted to assess evidence of associations, by counting the number of effects showing an increased risk, a decreased risk, or no effect. The certainty of evidence was not assessed for the SWiM, as there were too few studies reporting effect sizes for each outcome or ethnic group.

Effect direction plots are used to present the effects. Separate plots are presented for the analysis of ethnic minority groups (combined) compared to the ethnic majority group, and for the analysis of disaggregated ethnic groups. Studies are grouped by risk of bias. To informally

investigate heterogeneity in the findings, the tables of studies for each outcome are ordered by region.

Ethnic majority group *versus* minoritised ethnic groups

In total, 16 studies were not included in the meta-analysis investigating the risk of COVID-19 health outcomes for minoritised ethnic groups (combined) compared with the ethnic majority group (varied across studies). These studies were excluded as crude numbers were not reported, meaning it was not possible to calculate the overall RR for minoritised ethnic groups combined. The number of studies reporting findings for each outcome are as follows: infection (N = 3), seropositivity (N = 3), hospital admission (N = 5), ICU admission (N = 3), mortality (N = 6). Table S3 presents the effect direction plot for these studies. Across all outcomes, there are only a small number of effect sizes, and the findings are mixed. Of the three studies reporting effects for infection, one identified an increased risk for minoritised ethnic groups, one identified a decreased risk, and one study found no difference or conflicting findings compared to the ethnic majority group. For seroprevalence, one UK study identified an increased risk, whereas the two other studies (conducted in Oman and Mexico) identified no difference. Most studies identified an increased risk of hospital admission for minoritised ethnic groups compared to the majority, though the findings for the risk of ICU admission were mixed, as were the findings for the risk of mortality.

Table S4. Effect direction plot for studies not included in the meta-analysis (ethnic majority group *versus* minoritised ethnic groups [a]).

[a] This includes closely related measures of ethnicity, such as Indigenous/Aboriginal groups, race, migrant status, and country of birth.

Study	Country	Ethnic Majority Group	Minoritised Ethnic Groups	Infection	Seropositivity	Hospital	ICU	Mortality
Thomas	UK	White	Irish, White Other, Bangladeshi, Chinese, Indian, Pakistani, Black, Other				◄►	◄►
Ioannou	USA	White	Black, Hispanic, Asian, American Indian/Alaska Native, Pacific Islander/Native Hawaiian	◄►				
Coyer	Netherlands	Dutch	Non-Dutch			◄►		
Cacciani	Italy	Italian	Foreign-born			▲		
Ward	UK	White	Asian, Black, Mixed, Other		▲			
Al Abri	Oman	Omani	Non-Omani		◄►			
Nwaru	Sweden	Swedish	Immigrant			▲	◄►	
Gustafsson	Sweden	Swedish	High-income country, middle income country, low-income country			▲		◄►
Acosta	USA	White	Hispanic, American Indian/Alaska Native, Black, Asian/Pacific Islander					▲
Zerbo	USA	White	Black, Asian/Indigenous/Unknown, Hawaiian/Pacific Islander, Native American/Alaska Native, Multiracial, Hispanic			▲	▲	◄►
Borjorquez-Chapela	Mexico	Mexican	Foreign-born		◄►			
Abu Ruz	United Arab Emirates	Middle Eastern	Other					▲
Jefferies	New Zealand	European	Māori, Pacific Peoples, Asian	▼				
Da Silva	Brazil	White	Non-White	▲				
Ramli	Malaysia	Malay	Non-Malay					
Sultanoglu	Cyprus	Northern Cyprus	German, Turkmenistan					◄►

Effect direction: upward arrow ▲= increased risk, downward arrow ▼= decreased risk, sideways arrow ◄►= no difference/mixed effects/conflicting findings

Study quality: denoted by row colour: green = low risk of bias; amber = some concerns; red = high risk of bias

Disaggregated ethnic groups

When investigating the risk of COVID-19 health outcomes for disaggregated ethnic groups, there were 37 studies which either (i) could not be included in the meta-analyses at all, or (ii) included some ethnic groups which could not be included in the meta-analysis. Studies could not be included in the meta-analyses if the reference group was not White, and an ethnic group could not be included in the meta-analysis if only one study reported an effect size for that group. Studies which used country of birth or nationality as an indicator of ethnicity could not be included in the meta-analysis of disaggregated ethnic groups due to inconsistencies across the studies (i.e., nationalities and reference groups were widely varied across studies).

Table S4 presents the synthesis of studies which reported ethnicity (N = 12). For infection, the risk was increased for all ethnic groups in Nigeria compared to the reference group, and for Bedouin Arab patients compared with Jewish, in Israel. Indigenous peoples had an increased risk of hospital admission and mortality (compared with Non-Indigenous), across two studies conducted in Mexico. All minoritised groups in Ecuador had an increased risk of mortality, compared with Mestizo people. For ICU admission, three effects showed an increased risk and four showed no difference in risk. For mortality, seven effects showed an increased risk (including four effects from the Ecuador study, previously described), one showed a decreased risk, and three showed no difference in risk.

Table S5 presents the synthesis of studies which reported migrant status, country of birth, or nationality (N = 25). Most studies were of low risk of bias. For infection, three effect sizes showed a decreased risk (all from a study in Qatar), two showed an increased risk, and two showed no difference or conflicting findings. For seropositivity, most effects showed no difference, with two showed an increased risk for foreign-born people compared with Italian-born. Seven effects suggest an increased risk of hospital admission for minoritised ethnic groups (two showed a decreased risk, two showed no difference). For mortality, five effects showed an increased risk, six effects showed a decreased risk, and five showed no difference or conflicting findings.

This synthesis is limited as the studies are highly heterogenous. The studies differ by country, which influences the included ethnic groups and the reporting of ethnicity (i.e., some studies report nationality or country of birth). In addition, this synthesis does not explore prognosis (i..e., hospital admission, ICU admission, mortality) following infection or hospitalisation.

Table S5. Effect direction plot for studies or ethnic groups not included in the meta-analyses of disaggregated ethnic groups (measures of ethnicity).

Study	Country	Reference Group	Minoritised Ethnic Group	Infection	Seropositivity	Hospital	ICI	Mortality	ROB
Saidel Odes	Isreal	Jewish	Bedouin Arab	▲					aLow
Concha	Colombia	Colombian	Indigenous	◄►					aLow
Passos Castilho	Canada	White	Middle Eastern/African				◄►	◄►	aLow
Cifuentes	Colombia	White	Gipsy-Roman					▲	aLow
Cifuentes	Colombia	White	Raizal					◄►	aLow
Dahal	Mexico	Non-Indigenous	Indigenous					▲	aLow
Ibarra Nava	Mexico	Non-Indigenous	Indigenous					▲	aLow
Jefferies	New Zeleand	European	Maori	▼					bSomeConcerns
Farrell	Ireland	White Irish	White Other				▲	◄►	bSomeConcerns
Farrell	Ireland	White Irish	BAME				▲	▼	bSomeConcerns
Utulu	Nigeria	Other	Igbu	▲					cHigh
Utulu	Nigeria	Other	Yoruba	▲					cHigh
Utulu	Nigeria	Other	Hausa	▲					cHigh
Servan Mori	Mexico	Non-Indigenous	Indigenous			▲			cHigh
Al Zahmi	United Arab Emirates	Middle Eastern	White				◄►		cHigh
Al Zahmi	United Arab Emirates	Middle Eastern	South Asian				▲		cHigh
Al Zahmi	United Arab Emirates	Middle Eastern	East Asian				◄►		cHigh
Al Zahmi	United Arab Emirates	Middle Eastern	Other				◄►		cHigh
Sacoto	Ecuador	Mestizo	White					▲	cHigh
Sacoto	Ecuador	Mestizo	Black					▲	cHigh
Sacoto	Ecuador	Mestizo	Indigenous					▲	cHigh
Sacoto	Ecuador	Mestizo	Montubio					▲	cHigh

Effect direction: upward arrow ▲= increased risk, downward arrow ▼= decreased risk, sideways arrow ◄►= no difference/mixed effects/conflicting findings

Study quality: denoted by row colour: green = low risk of bias; amber = some concerns; red = high risk of bias

Table S6. Effect direction plot for studies or ethnic groups not included in the meta-analyses of disaggregated ethnic groups (indicated by migrant status, country of birth, or nationality).

Study	Country	Reference Group	Country of Birth/Nationality	Infection	Seropositivity	Hospital	ICI	Mortality
Consolazio	Italy	Italian	European Union, Eastern Europe, Other Europe, Centre Southern Africa, West Africa, East Africa, North Africa, Centre Southern Asia, Western Asia, East Asia, Centre-South America, North America, Oceania, Other	◄►				
Labberton	Norway	Norweigen-born	Immigrant	▲		▲		
Guijarro	Spain	Spain	European Union, Eastern Europe, Asia, North Africa, Sub Saharan Africa, Caribbean, Latin America	◄►				
Lombardi	Italy	Italy	Other		▲			
Pagani	Italy	Italian	Non-Italian		▲			
Vos	Netherlands	Dutch	Non-Dutch Western		◄►			
Vos	Netherlands	Dutch	Non Western		◄►			
Al Abri	Oman	Omani	Non-Omani		◄►			
Coyer	Netherlands	Dutch	South Asian Surinamese, African Surinamese, Ghanaian, Turkish, Moroccan		◄►			
Coyer	Netherlands	Dutch	Western			◄►		
Coyer	Netherlands	Dutch	Non Western			▲		
Fabiani	Italy	Italian	Non-Italian			▼	◄►	▼
Islamoska	Denmark	Danish	Immigrant			▲		
Cacciani	Italy	Italian	Foreign-born			▲		
Nwaru	Sweden	Swedish	Immigrant			▲	◄►	▲
Gustafsson	Sweden	Swedish	High Income Country			▲		▼
Gustafsson	Sweden	Swedish	Middle Income Country			▲		▼
Gustafsson	Sweden	Swedish	Low Income Country			▲		◄►
Stralin	Sweden	Swedish	Foreign-born				▲	▲
Rostila	Sweden	Sweden	Other Nordic Countries					▲
Rostila	Sweden	Sweden	Middle East					▼

Rostila	Sweden	Sweden	Africa						▲
Rostila	Sweden	Sweden	Rest of the World						▼
Ishi	Japan	Japanese	Non-Native	▲					
Borjorquez-Chapela	Mexico	Mexican	Foreign-born		◄►				
Al Awaidy	Oman	Omani	Non-Omani			▼	▲		▼
Shaikh	Saudi Arabia	Saudi National	Non-Saudi National			◄►			
Collard	Netherlands	Dutch	South Asian Surinamese, African Surinamese, Ghanaian, Turkish, Moroccan						◄►
Abu Ruz	United Arab Emirates	Middle Eastern	Other						▲
Al Kuwari	Qatar	Europe	South East Asian	▼					
Al Kuwari	Qatar	Europe	Northern Africa	▼					
Al Kuwari	Qatar	Europe	South East Asia	▼					
Ishi	Japan	Japanese	Non-Native	▲					
Nasif	Saudi Arabia	Saudi National	Arabic, South Asia, Southest Asia, Africa						◄►
Sultanoglu	Cyprus	Cyprus	German						◄►
Sultanoglu	Cyprus	Cyprus	Turkmenistan						◄►

Effect direction: upward arrow ▲= increased risk, downward arrow ▼= decreased risk, sideways arrow ◄►= no difference/mixed effects/conflicting findings

Study quality: denoted by row colour: green = low risk of bias; amber = some concerns; red = high risk of bias

PRISMA Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Page 1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Page 4
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Page 6
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 6
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Page 6/7
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 6/7
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Supplementary material
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 7/8
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Page 7/8
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Page 7/8
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Page 7/8
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Page 8
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Page 9/10
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Page 9/10
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Page 9/10 & supplementary material

Section and Topic	Item #	Checklist item	Location where item is reported
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Page 9/10
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Page 10
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Page 10
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Page 10
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Page 10
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Page 9
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Figure 1 / Page 11
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Figure 1 / page 11
Study characteristics	17	Cite each included study and present its characteristics.	Table 1 / 2 / Page 11
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Table 2
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Figures 2-5
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Figures 2-5
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Figure 2-5 / Pages 11-15
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Page 14/15
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Supplementary materials
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Supplementary materials
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Pages 11-15
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Pages 15-18

Section and Topic	Item #	Checklist item	Location where item is reported
	23b	Discuss any limitations of the evidence included in the review.	Page 17/18
	23c	Discuss any limitations of the review processes used.	Page 17/18
	23d	Discuss implications of the results for practice, policy, and future research.	Page 18
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Page 6
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Page 6
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Page 11/19
Competing interests	26	Declare any competing interests of review authors.	Page 19
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Page 19

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71