

THE LANCET

Public Health

Supplementary appendix

This appendix formed part of the original submission and has been peer reviewed.
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Contents

PRISMA-ScR Checklist	1
Table 1: Full search strategy	3
Table 4: Summary of study characteristics and findings	8
Reasons for exclusion at full text review	48
Figure 1: PRISMA flowchart of selection procedure	53
Figure 2: Map of global distribution of included studies	54

PRISMA-ScR Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	3
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	4
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	4
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	4-5, Table 2
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	5
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Table 1
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	5, Figure 1, Table 2
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether	5

		data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	4-5
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	n/a
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	5
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	6, Figure 1, Appendix 2
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Appendix 3
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	n/a
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Appendix 3
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	Appendix 3
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	6-9
Limitations	20	Discuss the limitations of the scoping review process.	14
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	16
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	18

Table 1: Full search strategy
Searches from November 2021

Ovid MEDLINE(R) and In-Process, In-Data-Review & Other Non-Indexed Citations <1946 to November 08, 2021>

Embase <1996 to 2021 Week 44>

APA PsycInfo <2002 to November Week 1 2021>

#	Query	Results from 9 Nov 2021
1	(SARS-Cov-2 or 2019-nCOv or COVID-19 or coronavirus or exp COVID-19/) and (fatalit* or Death* or Mortalit* or exp Death/ or exp Mortality/) and (socioeconomic or SES or education* or employment or income or occupation* or poverty or class or depriv* or disadvantage* or social class or social factors or economic or unemployment or ethnic* or rac* or minorit* or exp Socioeconomic Factors/) and (area* or geo* or place* or neighbourhood* or region* or count* or ward* or cit* or district* or municipal* or province* or state* or communit* or count* or town* or district* or census or post* or zip or spatial or metropolitan or depriv* or environ*).ti,ab	8,572
2	limit 1 to yr="2020 -Current"	8,361

Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Index (SSCI) (Web of Science)

Timespan: 2020-01-01 to 2021-11-10 (Index Date)

#	Query	Results from 9 Nov 2021
1	(SARS-Cov-2 or 2019-nCOv or COVID-19 or coronavirus or exp COVID-19/) and (fatalit* or Death* or Mortalit* or exp Death/ or exp Mortality/) and (socioeconomic or SES or education* or employment or income or occupation* or poverty or class or depriv* or disadvantage* or social class or social factors or economic or unemployment or ethnic* or rac* or minorit* or exp Socioeconomic Factors/) and (area* or geo* or place* or neighbourhood* or region* or count* or ward* or cit* or district* or	3326

	municipal* or province* or state* or communit* or count* or town* or district* or census or post* or zip or spatial or metropolitan or depriv* or environ*).ti,ab	
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Searches from January 2022

Ovid MEDLINE(R) and In-Process, In-Data-Review & Other Non-Indexed Citations <1946 to January 10 2022>

Embase <1996 to 2022 Week 1>

APA PsycInfo <2002 to January Week 1 2022>

#	Query	Results from 10 Jan 2022
1	(SARS-Cov-2 or 2019-nCOv or COVID-19 or coronavirus or exp COVID-19/) and (fatalit* or Death* or Mortalit* or exp Death/ or exp Mortality/) and (socioeconomic or SES or education* or employment or income or occupation* or poverty or class or depriv* or disadvantage* or social class or social factors or economic or unemployment or ethnic* or rac* or minorit* or exp Socioeconomic Factors/) and (area* or geo* or place* or neighbourhood* or region* or count* or ward* or cit* or district* or municipal* or province* or state* or communit* or count* or town* or district* or census or post* or zip or spatial or metropolitan or depriv* or environ*).ti,ab	7,763
2	limit 1 to yr="2021 -2022"	5,107
3	Remove duplicates from 2	3,273

Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Index (SSCI) (Web of Science)

Timespan: 2021-11-09 to 2022-01-10 (Index Date)

#	Query	Results from 10 Jan 2022
1	(SARS-Cov-2 or 2019-nCOv or COVID-19 or coronavirus or exp COVID-19/) and (fatalit* or Death* or Mortalit* or exp Death/ or exp Mortality/) and	625

	(socioeconomic or SES or education* or employment or income or occupation* or poverty or class or depriv* or disadvantage* or social class or social factors or economic or unemployment or ethnic* or rac* or minorit* or exp Socioeconomic Factors/) and (area* or geo* or place* or neighbourhood* or region* or count* or ward* or cit* or district* or municipal* or province* or state* or communit* or count* or town* or district* or census or post* or zip or spatial or metropolitan or depriv* or environ*).ti,ab	
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Searches from May 2022

Ovid MEDLINE(R) In-Process & In-Data-Review Citations <1946 to May 13, 2022>

Embase <1996 to 2022 Week 19>

APA PsycInfo <2002 to May Week 2 2022>

Timespan: 2022-01-01 to 2022-05-16

#	Query	Results from 16 May 2022
1	(SARS-Cov-2 or 2019-nCoV or COVID-19 or coronavirus or exp COVID-19/) and (fatalit* or Death* or Mortalit* or exp Death/ or exp Mortality/) and (socioeconomic or SES or education* or employment or income or occupation* or poverty or class or depriv* or disadvantage* or social class or social factors or economic or unemployment or ethnic* or rac* or minorit* or exp Socioeconomic Factors/) and (area* or geo* or place* or neighbourhood* or region* or count* or ward* or cit* or district* or municipal* or province* or state* or communit* or count* or town* or district* or census or post* or zip or spatial or metropolitan or depriv* or environ*).ti,ab	7164
2	limit 1 to yr="2022 -Current"	1141
3	remove duplicates from 2	1116

Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Index (SSCI) (Web of Science)

Timespan: 2022-01-01 to 2022-05-16 (Index Date)

#	Query	Results from 16 May 2022
1	(SARS-Cov-2 or 2019-nCOv or COVID-19 or coronavirus or exp COVID-19/) and (fatalit* or Death* or Mortalit* or exp Death/ or exp Mortality/) and (socioeconomic or SES or education* or employment or income or occupation* or poverty or class or depriv* or disadvantage* or social class or social factors or economic or unemployment or ethnic* or rac* or minorit* or exp Socioeconomic Factors/) and (area* or geo* or place* or neighbourhood* or region* or count* or ward* or cit* or district* or municipal* or province* or state* or communit* or count* or town* or district* or census or post* or zip or spatial or metropolitan or depriv* or environ*).ti,ab	1140

Searches from July 2022

Ovid MEDLINE(R) In-Process & In-Data-Review Citations <1946 to July 11, 2022>

Embase <1996 to 2022 Week 27>

APA PsycInfo <2002 to July Week 1 2022>

Timespan: 2022-01-01 to 2022-07-11

#	Query	Results from 12 July 2022
1	(SARS-Cov-2 or 2019-nCOv or COVID-19 or coronavirus or exp COVID-19/) and (fatalit* or Death* or Mortalit* or exp Death/ or exp Mortality/) and (socioeconomic or SES or education* or employment or income or occupation* or poverty or class or depriv* or disadvantage* or social class or social factors or economic or unemployment or ethnic* or rac* or minorit* or exp Socioeconomic Factors/) and (area* or geo* or place* or neighbourhood* or region* or count* or ward* or cit* or district* or municipal* or province* or state* or communit* or count* or town* or	9602

	district* or census or post* or zip or spatial or metropolitan or depriv* or environ*).ti,ab	
2	limit 1 to yr="2022 -Current"	2196
3	remove duplicates from 2	2140

Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Index (SSCI) (Web of Science)

Timespan: 2022-01-01 to 2022-07-12 (Index Date)

#	Query	Results from 12 July 2022
1	(SARS-Cov-2 or 2019-nCoV or COVID-19 or coronavirus or exp COVID-19/) and (fatalit* or Death* or Mortalit* or exp Death/ or exp Mortality/) and (socioeconomic or SES or education* or employment or income or occupation* or poverty or class or depriv* or disadvantage* or social class or social factors or economic or unemployment or ethnic* or rac* or minorit* or exp Socioeconomic Factors/) and (area* or geo* or place* or neighbourhood* or region* or count* or ward* or cit* or district* or municipal* or province* or state* or communit* or count* or town* or district* or census or post* or zip or spatial or metropolitan or depriv* or environ*).ti,ab	319

Table 4: Summary of study characteristics and findings
Americas Region (n=72)

Author(s)	Country	Scale	Time period	Outcome	Measure of Socioeconomic disadvantage	Summary of how socioeconomic disadvantage affects COVID-19 deaths (significance included where reported) ↑ = Increases deaths ↓ = Decreases deaths ↔ = No difference in deaths between areas of high or low socioeconomic disadvantage
Almeida Andrade et al (2021) ⁹⁵	Brazil	Municipalities (n=1,794 municipalities of North East Brazil)	27 th March 2020 to 27 th March 2021	COVID-19 mortality – absolute deaths and mortality rate (COVID-19 deaths/population)	Social vulnerability index: urban infrastructure, human capital, income and work	↑ Increasing trend in mortality rates in the municipalities classified as high and very high social vulnerability. Analyses highlights that municipalities with high social vulnerability were the most severely affected.
Baggio et al (2021) ¹²⁸	Brazil	Municipalities (n=102 within Alagoas north east region of Brazil)	March and August 2020	COVID-19 mortality rate per 100,000 inhabitants	Municipal Human Development Index (MHDI) and Social Vulnerability Index	↑ Highest mortality rates were observed in municipalities with higher human development overall, MHDI education, and MHDI income, and in those with higher overall social vulnerability and the social capital indicator of social vulnerability. Relationship between incidence and mortality associated with both better human development and social vulnerability.
Bermudi et al (2021) ⁹⁶	Brazil	Neighbourhood (n=310 geocoded areas created from zip codes of COVID-19 death)	15 th March to 13 th June 2020	COVID-19 confirmed and suspected deaths	Socioeconomic index includes 7 factors: education, mobility, poverty, wealth, income, segregation, and	↑ High socioeconomic level protected against the risk of COVID-19 mortality. An increase of one unit in the socioeconomic indicator represented a 25% reduction in the risk of mortality. The risk of mortality with the best socioeconomic conditions

		registrations within City of São Paulo within State of São Paulo)			deprivation of resources and services	compared with that in the worst was 50% lower for confirmed deaths, and 66% lower for total deaths. There was a shift in the pattern of the relationship between COVID-19 mortality and socioeconomic status (SES) over time. The best SES level was a risk factor for COVID-19 in the first two epidemiological weeks (EW) in the city of São Paulo. From the 15 th EW, for total deaths, and 16 th EW for confirmed and total deaths, the worst socioeconomic condition became a risk factor.
Castro et al (2021) ⁹⁷	Brazil	Municipalities (n=5570)	26 th February to 31 st July 2020	COVID-19 mortality (Deaths per 100,000 population)	Illiteracy in people over 18, Gini index, average income per capita, % population living in households with a density greater than two people per bedroom, proportion of population in households with running water and bathroom, social vulnerability index (SVI), municipality human development index (MHDI)	↑There is a large geospatial correlation of COVID-19 in large urban centres and regions with the lowest human development index. In the geographic weighted regression, it was possible to identify that the percentage of people living in residences with density higher than 2 per dormitory, the MHDI and the SVI were the indicators that most contributed to explaining incidence. MHDI and the SVI contributed most to the mortality model.
Demenech et al (2020) ⁹⁸	Brazil	Federative Units	21st April to 7 th July	COVID-19 deaths per 1 million inhabitants	Gini coefficient	↑The Gini coefficient was correlated with both death and incidence rates in all recorded periods. The mortality rate was correlated with the Gini coefficient evolving from a weak positive correlation on 21st April ($\rho=+0.4760$, $p=0.012$) to a

						<p>moderate correlation on 7th July ($\rho = +0,6564$, $p = 0.001$). The results of this study indicate a possible negative reflection of income inequality on facing the COVID-19 pandemic in Brazil. Among the most unequal states the progression in incidence and mortality rates due to COVID-19 was more prominent, whereas among the less equal states there were modest increases. Even considering population density and spatial autocorrelation aspects, the Gini coefficient was associated with an increase in the incidence and mortality rates of COVID-19.</p>
de Souza et al (2020) ⁹⁹	Brazil	Municipalities (n=821 with reported deaths)	Up to 6 th May 2020	COVID-19 mortality per 1 million inhabitants	MHDI and SVI	<p>↑ All municipalities with very high MDHI had the highest COVID-19 mortality rate (73.12/1million), in municipalities with very low MHDI the mortality rate was 36.75/1million. Municipalities with average SVI had 68.48 deaths per 1million. The spread of the disease started in the most developed municipalities in the country and spread throughout the Brazilian territory reaching smaller and more vulnerable areas whose populations are exposed to a chronic and historical context of social deprivation. We observed that 56.2% of municipalities with confirmed cases had very low human development (COVID-19 incidence rate: 59.00/100 000; mortality rate: 36.75/1 000 000), and 52.8% had very high vulnerability (COVID-</p>

						19 incidence rate:41.68/100 000; mortality rate: 27.46/1 000 000).
de Souza et al (2022) ¹⁰⁰	Brazil	City (City of São Paulo)	26 th February 2020 to 21 st July 2021	COVID-19 mortality	Demographic density, Gini index, Human Development Index (HDI)of longevity and income.	↑ In multivariable analysis demographic density (p-value = 0.000), Gini index (p=0.000), HDI income (p=0.000), and HDI longevity (p=0.045) were positively associated with COVID-19 mortality. Demographic density was most associated with mortality from COVID-19, the Gini index was also a relevant factor, municipalities with lower income per capita had higher mortality rates from COVID-19, and lower life expectancy at birth was also associated with higher municipal mortality from COVID-19.
Ribeiro et al (2021) ¹⁰¹	Brazil	City (City of São Paulo)	March to September 2020	COVID-19 mortality	Socioeconomic indicators: household crowding, education attainment, income level, % of households located in subnormal areas (favelas)	↑A positive gradient was found for all indicators of socio-economic status, i.e. Increases in disparities denoted by less education, more household crowding, lower income, and a higher concentration of subnormal areas were associated with higher mortality rates. However, a 'dose-response' effect was only observed for education and household density. Among all indicators, the educational level was the one showing the most substantial disparity between the categories. In the young/adult population, among those living in areas with the lowest percentage of the population with a university degree, mortality was four times higher compared with that in the most educated group (RR¼4.02, 95% CI 3.42–4.72); in the elderly

						population, the same comparison denoted a 96% increased risk of death.
Sanhueza-Sanzana et al (2020) ¹⁰²	Brazil	Neighbourhood (n=119 within the municipality of Foraleza, in the state of Ceará	1 st January to 8 th June 2020	COVID-19 deaths	Socioeconomic status and sanitation conditions in the neighbourhoods, household income, human development index	↑ Among the neighbourhoods that recorded higher mortality, there was a trend of concentration in those in the northern zone of the city, a region of high social vulnerability such as poverty, illiteracy and low income. Lower mortality rates - below 6.7 per 10,000 inhabitants - were found in areas of the city where the population presented the highest income and most favourable sanitation conditions.
Silva & Ribeiro-Alves (2021) ¹⁰³	Brazil	Neighbourhood (within municipality of Rio de Janeiro)	27 th February to 23 rd May (year not provided)	COVID-19 deaths	Socioeconomic measures: crowding (average no. of bathrooms), education (% of illiteracy of neighbourhood residents aged 1- to 14), income (annual household per capita as minimum wage fraction 2010 R\$510 current)	↑All socioeconomic factors (crowding, education, income, and race/ethnicity) were correlated with a higher age-standardised mortality rate, although the age-standards incidence rate showed the opposing or mixed trend depending on which socioeconomic factors were considered. Although cases were proportionately more concentrated in wealthy neighbourhoods, the deaths were more frequently observed in deprived areas. People living in high-income neighbourhoods (highest quartile) had 37% more risk to be infected than low-income ones (lowest quartile), even though in low-income areas they had 56% more risk to die. There was a strong gradient overall using COVID-19 death risk measures.
Viezzer & Biondi (2021) ¹⁰⁴	Brazil	Municipalities (n=2482 within	up to 9th August 2020	COVID-19 confirmed deaths	Socioeconomic parameters: average per	↑Some correlation was found between health parameters and the socioeconomic

		the Atlantic Forest - municipalities with confirmed deaths)		per 100,00 inhabitants	capita income, number of people vulnerable to poverty in relation to total municipality inhabitants, illiteracy rate of the population aged 18 or over, and human development index.	index, that represent positive socioeconomic conditions, considering both all municipalities and those above 100,000 inhabitants. The strongest one was found considering the mortality rate for municipalities > 100,000 inhabitants possibly indicating a smaller mortality rate in big cities with better socioeconomic conditions. Strong correlations were found between COVID-19 and urbanization. Socioeconomic and eco-environmental aspects, although weaker predictors of COVID-19, presented meaningful relations with the health parameters.
Figueiredo et al (2020) ¹⁰⁵	Brazil	Federative Units	Up to 23 rd August 2020	COVID-19 mortality rate per 100,000 population	Socioeconomic: Gini index of household income per capita, unemployment rate, % of uneducated population, % of people living with household income per capita below poverty line, access to water and sewage systems, overcrowding.	↑Regarding the dependent variable “mortality”, the final model also included the independent variables Gini Index and overcrowding, and lethality rate. With this model, it is suggested that 57.9% of the mortality variation can be explained by these variables. In the Brazilian states, 59.8% of variation in the incidence of COVID-19 was justified by income inequality, significant home densification, and higher mortality. Those same variables explained 57.9% of the country’s variations in federal units. Our results indicate that socioeconomic factors influenced the evolution and impact of COVID-19 in Brazil.
Villalobos Dintrans et al (2021) ¹⁰⁶	Chile	Municipalities (n=52 administrative units in the	3rd March to 30th July 2020	COVID-19 deaths	Health-related indicators: health insurance, distance to health centre (access to healthcare);	↑For deaths, for level-type variables the share of people over 65 years old, population density, multidimensional poverty, and the prevalence of cases have

		Metropolitan Region of Chile)			socioeconomic: water access, poverty, income poverty, overcrowding, education, job status, health insurance coverage.	significant and positive coefficients; overcrowding and distance to a health centre also contribute to explain whether a municipality reaches the peak of cases faster or slower. Just like in the case of infection models, multidimensional poverty captures an effect that is not explained by a broad set of socioeconomic factors.
Rodriguez-Villamizar et al (2021) ¹⁰⁷	Columbia	Municipalities (n=772)	Up to 17 th July (no year, paper published 26.11.2020)	COVID-19 mortality	Multidimensional poverty index	↑Once the municipality reaches at least one COVID-19 death, the main factors associated with the mortality rate are the percentage of urban population and the poverty index, which increases the mortality rate in 2% and 3%, respectively. Demographics, health system capacity, and social conditions did have evidence of an ecological effect on COVID-19 mortality.
Benita et al (2021) ¹⁰⁸	Mexico	Municipalities (n=2459)	1 st June to 22 nd August 2020	COVID-19 deaths	Socioeconomic variables: Gini of income inequality, proportion of people in poverty	↑Income inequality observed as main factor associated with the spread of the virus and deaths. Municipalities with disproportionately social inequalities suffered from a larger incident rate ratio of COVID-19 deaths. Areas with the highest numbers of COVID-19 cases and deaths are the vulnerable geographical areas in terms of large social disadvantages.
Chávez-Almazán et al (2022) ¹⁰⁹	Mexico	Municipalities	Up to 10 th March 2021	COVID-19 mortality (deaths/population size) x100,000	Human Development Index (HDI) plus 16 socioeconomic indicators	↑Positive correlations were observed between morbidity and mortality and the human development index; COVID-19 fatality increased as the values of said index decreased. There was a significantly higher risk of elevated mortality in

						localities with moderate and low development, and in those with less than 49,999 inhabitants. The main factors associated with fatality were lack of access to health services, income vulnerability and social deprivation.
Dorregaray-Farge et al (2021) ¹³³	Peru	Districts within Metropolitan Lima	18 th March to 30 th September 2020	COVID-19 mortality and fatality	Human development index (HDI) and district poverty rate	<p>↑ There was a statistically significant correlation between fatality due to COVID-19 and poverty rate. No significant correlation was found between mortality and poverty rate. COVID-19 mortality was significantly correlated with population density and HDI. The results from this study show that mortality due to COVID-19 in the districts of Lima were greater mostly in older adults over 60 years of age and of masculine gender. In addition to this, we were able to determine that from the beginning of the pandemic until the month of September there was a positive correlation (at district level) between fatality due to COVID-19 and poverty rate at the district level. Population density was the factor associated more consistently to mortality and fatality due to COVID-19. For every increase in population density (in one thousand inhabitants), the fatality and mortality from district COVID-19 infection would increase 6%. Poverty was associated with greater fatality, but not with greater mortality.</p>

Al Rifat & Liu (2021) ⁴⁴	USA	County level (n=3107 counties)	20 th January 2020 to 20 th January 2021	COVID-19 mortality rates (deaths per 100,000 people)	Social vulnerability index	↑ Statistically significant +ve correlation was found between SVI and COVID-19 mortality rates (Spearman's Rho =0.205; $p < 0.01$). Study also found overlaps of hotspots in case and mortality rates and SVI suggesting that counties with high case and mortality rates are also the places where socially vulnerable people reside.
Abedi et al (2020) ⁴⁵	USA	County level (n=369 counties within Michigan, New York, New Jersey, Pennsylvania, California, Louisiana, Massachusetts)	Up to 9 th April 2020	Total COVID-19 deaths	Race, poverty level, median income, education, disability, and rate of the insured population	↑ Factors significantly associated with higher mortality include a higher % of people under the poverty level, a higher % of people on Medicaid, and a higher rate of people with disability in the county. A comparative analysis found that counties with more population diversity, higher income and education, lower rate of disability, and higher rate of insured people having a significantly lower median death rate. Counties with higher total population, more diverse demographics, higher education, and income levels are at higher risk of COVID-19 infection, however, counties with a smaller population, higher disability rates and higher poverty levels have a higher rate of mortality.
Adjei-Fremah et al (2022) ⁴⁶	USA	County level (Washington D.C and adjacent counties in Virginia and Maryland)	31 st March to 4 th July 2020	COVID-19 deaths	Area deprivation index (ADI) ranking 1-100. 1-10 is least disadvantaged, 90-100 is most disadvantaged	↔ There was statistically significant positive association between ADI and COVID-19 early transmission rate (E_1 ; 95% CI = 0.55, 0.98, $p = 0.0019$). Generally, a higher ADI score was associated with higher COVID-19 transmission rate E_1 . The early transmission rate (E_1) was higher in more socially disadvantaged wards (i.e.,

						wards with high ADI scores). In terms of segment load of mortality there was no association with ADI.
Akinwumiju et al (2022) ⁴⁷	USA	County level (n=3143)	21 st January to 16 th September 2020	COVID-19 mortality	Household income, community vulnerability index, population density, % (un)insured, poverty	↑ Preliminary results showed that only five out of the examined variables (case fatality rate, vulnerable population, poverty, percentage of adults that report no leisure-time physical activity, and percentage of the population with access to places for physical activity) can explain the variability of COVID-19 mortality across the Counties of contiguous USA within the study period. COVID-19 mortality exhibited positive and significant association with black race (0.51), minority (0.48) and poverty (0.34). Whereas, the percentage of persons that attended college was negatively associated with poverty (0.51), obesity (0.50) and diabetes (0.45).
Backer et al (2022) ⁴⁸	USA	County level (all counties within Florida)	23 rd January 2020 to 13 th January 2022	COVID-19 deaths	Poverty level, household size, social vulnerability index (SVI), and health insurance status	↑ Florida counties with the highest percentage of poverty (>17.3% below the federal poverty line) had the highest rate of cumulative COVID-19 cases and deaths per 100,000 people. Overall, high poverty Florida counties had a mortality rate that was 13.82% higher than the Florida average and 31.64% higher than the national average. Counties with moderate house sizes had an 18.09% increased mortality rate than the Florida average and a 36.58% higher value than the national average. Counties with a high SVI had death rates that were 3.21% higher than

						the Florida average and 19.36% higher than the national average. In counties with low-uninsured populations (<7.1% uninsured) the mortality rate was 21.85% higher than the Florida average and 40.93% higher than the national average. Overall, higher poverty counties exhibited higher rates of deaths when compared to the state and national averages.
Baltrus et al (2021) ⁴⁹	USA	County level (n=135 Counties within the State of Georgia)	Up to 23 rd April 2020	COVID-19 deaths	% of crowded households, % of uninsured people, % living under the federal poverty level	↑COVID-19 death rates were significantly and positively associated with % black population, % of crowded households, % of uninsured, % living in poverty.
Bilal et al (2021) ⁵⁰	USA	Neighbourhood (zip-code tabulation area) in Chicago, New York, and Philadelphia	Up to 1 st October 2020 for New York and Philadelphia, up to 3 rd October for Chicago	COVID-19 mortality rates (deaths per 1000 people)	Social vulnerability index	↑More vulnerable neighbourhoods in Chicago, New York, and Philadelphia had higher rates of COVID-19 positivity, confirmed cases, and mortality. Very strong inequities in mortality observed with mortality rates increasing by about 50% for each 1-SD increase in the SVI.
Bryan et al (2021) ⁵¹	USA	Neighbourhood (census-tract level within Chicago)	16 th March to 22 nd July 2020	COVID-19 deaths	Neighbourhood characteristics (n=33) including: crowded living conditions, access to health care, indicators of poverty, welfare (SNAP use), educational attainment, unemployment rate, historical redlining of the neighbourhood, internet at home	↑Higher death rates were seen in neighbourhoods with heightened barriers to social distancing (SNAP recipients, fewer households with internet, lower education, fewer workers able to work from home), crowded living conditions, worse access to health care, more comorbid conditions, older age, higher rates of poverty, and neighbourhoods that had historically been redlined.

Carrión et al (2021) ⁵²	USA	Neighbourhood (n=177 New York City zip code tabulation areas (ZCTA))	Up to 23 rd May 2020	COVID-19 deaths	Socioeconomic data on neighbourhood characteristics used to create a COVID-19 inequality index as a composite measure of neighbourhood level disadvantage	↑Results from the negative binomial model show a strong association between the ZCTA COVID-19 inequity index and cumulative mortality incidence. Each unit increase in the COVID-19 inequity index is associated with a 20% increased risk of COVID-19 related mortality when accounting for spatial dependence.
Chen & Krieger (2021) ²⁰	USA	County level (n=3142)	Up to 5 th May 2020	COVID-19 death rates per 100,000 population	Area-based socioeconomic measures (ABSMs): % persons below poverty, % household crowding, % population of colour, measure of racialised economic segregation, index of concentration at the extremes (ICE)	↑Highest COVID-19 death rates were consistently observed among those living in the most disadvantaged versus the most advantaged counties in relation to % poverty, ICE, % crowding, and % population of colour. Socioeconomic gradients were not always monotonic, most notably for ICE for which residents in the most advantaged quintile experience a death rate only slightly lower than residents of counties in the most disadvantaged quintile. In contrast, residents of counties in the middle quintile of ICE experienced the lowest COVID-19 death rates.
Clouston et al (2021) ⁵³	USA	County level (n=3141)	22 nd January to 28 th May	COVID-19 mortality	Socioeconomic status: integrated information on income, education, and wealth into a county-level index	↑Higher SES was associated with reduced risk of mortality. Counties with higher % of minority residents, older people, males, and people living in higher-density communities had higher mortality rates. Residents of higher SES counties were at much lower risk of COVID-19 mortality compared to those living in lower SES counties. In an initial period SES was positively associated with the emergence of COVID-19 but as public health response

						emerged that higher SES individuals were more able to engage in, the SES association with incidence and mortality became inverse.
Dalsania et al (2020) ⁵⁴	USA	County level (n=2026)	22 nd January to 28 th October 2020	COVID-19 deaths	20 variables related to the social determinants of health categorised as socioeconomic, health status, educational, and socio-demographic factors. Socioeconomic variables included the Index of concentration at the extremes (ICE) income, % uninsured. ICE income defined as households living above and below the 80 th income percentile	↑Counties in the highest quartiles of death rates had greater levels of adverse social determinants of health as compared to counties in the lowest quartile of death rates. Counties in the highest quartile of death rates had significantly lower socioeconomic status, educational attainment, and internet access, and significantly higher rates of low birthweight and incarceration. Each % increase in uninsured adults, % low birth weight, % adults without high school diploma, incarceration rate, and % households without internet in a county increased the rate of COVID-19 deaths by 1.9%, 7.6%, 3.5%, 5.4%, and 3.4% respectively. The lowest and second lowest quintiles of the ICE income (less privileged counties) are associated with increase COVID-19 death rates by 67.5% and 36% respectively.
De & Price (2021) ⁵⁵	USA	Neighbourhood level (zip codes from New York City)	Data extracted 2 nd May 2020	COVID-19 crude mortality rate or number of deaths per 100,000 people	Education, high risk occupation, overcrowding, median household income, no health insurance	↑Zip codes with higher proportions of residents living in overcrowded homes show significantly higher death rates. Income and education were highly correlated so only used education in the analysis which did not affect the results.
De Jesus et al (2021) ⁵⁶	USA	Neighbourhood (zip code from give New York	Data downloaded 2 nd July 2020	COVID-19 deaths per 100,000 residents	Median household income, % on food stamps, % without high	↑Overall environmental and social determinants of health drive a disproportionate burden of COVID-19

		city boroughs – the Bronx, Brooklyn, Manhattan, Queens, and Staten Island			school diploma, % overcrowding, % in poverty, % without health insurance	morbidity and mortality. COVID-19 death predictors for each borough; Manhattan, % 65+, % non-US citizen, and adult asthma ER visits; Staten Island, % obese; The Bronx model was not significant; Queens, %65+, % non-US citizen, % on food stamps, ozone level, and adult asthma ER visits were all significant predictors; Brooklyn, % 65+, % on food stamps, and % overcrowding, overall model significant. The Bronx which has the highest proportion of members of racial/ethnic groups, the highest number of people living in poverty, and the lowest levels of educational attainment, had higher rates of COVID-19 case and death rates than the other four boroughs. COVID-19 case and death rates were lowest among residents of the most affluent borough, Manhattan which is predominately White population.
Do and Frank (2020) ⁵⁷	USA	Neighbourhood level (zip code tabulation areas (ZCTA) within New York City)	11 th March to 19 th July 2020	COVID-19 deaths	% poor (proportion of residents below the federal poverty line), % affluent (proportion of households with incomes above \$200,000)	↑Neighbourhood poverty is associated with elevated death rates and neighbourhood affluence is protective.
Doti (2021) ⁵⁸	USA	State level	1 st January to 12 th January 2020 and first and second halves of 2020	COVID-19 death rates per 100,000	Income; poverty rate	↑Per capita personal income is not significant but poverty rate is in explaining COVID-19 death rates. Poverty rate at the state level is a more important variable than personal income in explaining COVID-19 death rates. Study findings suggest that higher poverty rates are significantly

						associated with COVID-19 death rates. A 1% increase in a state's poverty rate leads on average to a 0.76 increase during 1/1/2020 to 7/1/2020 period and a 0.87% increase during the 7/1/2020 to 12/1/2020 period.
Dukhovnov & Barbieri (2022) ⁵⁹	USA	County level (all US counties grouped into five SES quintiles)	1 st March to 31 st December 2020	COVID-19 mortality	Counties were grouped into five SES quintiles using 11 input variables to reflect the population composition: % ≥25 years with <9 years of education; % ≥4 years college education; % households below federal poverty line; median household income including case benefits; ratio of average income of wealthiest quintile of households to the poorest quintile within each county; unemployment rate; % labour in white-collar occupations; median housing price; median gross rent; % of households with no telephone; % of households with no or incomplete plumbing.	↑During March–May 2020, COVID-19 mortality was highest in the most socio-economically advantaged quintile of counties and lowest in the two most-disadvantaged quintiles. The pattern reversed during June–August and widened by September–December, such that COVID-19 mortality rates were 2.58 times higher in the bottom than in the top quintile of counties. Diverging trajectories of COVID-19 mortality among the poor and affluent counties indicated a progressively higher rate of loss of life among socio-economically disadvantaged communities. The most socio-economically disadvantaged areas in the USA appear to have experienced a 31% heavier mortality burden from the pandemic than the most socio-economically advantaged ones.

DuPre et al (2021) ¹³¹	USA	County (n=3141)	21 st January to 30 th June 2020	COVID-19 deaths per 100,00	Education level of adult population, poverty, health insurance coverage	↓Counties with higher poverty rates, less health insurance coverage, and living in non-family households were associated with better COVID-19 trajectories, perhaps reflecting populations with less mobility and/or fewer social contacts early in the pandemic. During the first wave counties that were younger and have more people who were female or Black had high odds of being in worse COVID-19 trajectories.
Fielding-Miller et al (2020) ⁶⁰	USA	County (n=3024)	Up to 12 th July	COVID-19 deaths and mortality per 100,000	Poverty, uninsured residents	↑% of farm workers in a county, % of residents living at or below the federal poverty line, population density, and % of residents over age of 65 were all significantly associated with a higher number of reported COVID-19 deaths. Each additional % point of individuals living in poverty was associated with 4.41 additional deaths (4.20 directly, 0.22 indirect p<0.001). In urban counties (n=115) a higher % of farmworkers, higher density, and larger population were all associated with a higher number of deaths, while lower rates on insurance coverage in a county was independently associated with fewer deaths. In non-urban counties (n=2909) these same patterns held true with higher % of residents living in poverty and senior residents also significantly associated with more deaths.
Figueroa et al (2021) ⁶¹	USA	County level	1 st January to 12 th September 2020	COVID-19 deaths per 100,000 residents	Average household size, median household income, proportion of	↑Higher household size, larger share of individuals with less than a high school diploma, were significantly associated with

					adults who completed less than high school degree	higher COVID-19 mortality rates. In multivariate analyses average household size was the strongest predictor of COVID-19 deaths 56.4 additional deaths per 10% increase in household size.
Finch et al (2021) ⁶²	USA	County level	21 st January 2020 to 1 st February 2021	COVID-19 deaths	Index of deep disadvantage	↑Results of a random intercept multilevel mixture model revealed that the pandemic followed four distinct paths in the country. The least ethnically diverse (85.1% white population) and most rural (82.8% rural residents) counties had the lowest death rates (0.06/1000) and the weakest link between deaths due to COVID-19 and poverty ($b=0.03$). In contrast, counties with the highest proportion of urban residents (100%), greatest ethnic diversity (48.2% non-white), and highest population density (751.4 people per square mile) had the highest COVID-19 death rates (0.33/1000), and strongest relationship between the COVID-19 death rate and poverty ($b=46.21$).
Finch & Finch (2020) ⁶³	USA	County level (n=2853)	21 st January to 1 st April 2020	COVID-19 deaths	Index of deep disadvantage	↑At the earlier date, there was not a statistically significant relationship between poverty index value and the number of deaths. By April 1 st 2020 there was a negative association between the two variables indicating that for counties with higher index value (more prosperous counties) there were fewer deaths than was the case for counties with lower index scores. The death rate was higher for relatively poorer counties. In Poisson

						<p>regression models the coefficients demonstrate that there was a statistically significant interaction between % of residents living in poverty, % living in deep poverty, urban location, and % low birth weight with date, indicating that their relationships with the number of deaths attributed to COVID-19 changed over time. Results of this study revealed that during the early weeks of the pandemic more disadvantaged counties in the US had a larger number of confirmed COVID-19 cases, but that over time this trend changed so that by the beginning of April more affluent counties had more confirmed cases of the virus. The number of deaths due to COVID-19 were associated with poorer and more urban counties.</p>
<p>Grekousis et al (2021)⁶⁴</p>	<p>USA</p>	<p>County level (n=3108)</p>	<p>6th February 2020 to 5th February 2021</p>	<p>COVID-19 deaths per 100,000 inhabitants per county</p>	<p>Socioeconomic: education, occupation, income, poverty</p>	<p>↑Living in a county which has households with lower income, people with a lack of health insurance, a high African American %, and lower education level, leads to 27.12% higher COVID-19 death rates than the national median, and 72.56% higher compared to the least vulnerable communities. Compared to counties with a high COVID-19 death rate, counties with a low COVID-19 death rate have 44.90% higher annual median household income and nearly double the house worth (89.51% more). Results show that the effects of the COVID-19 pandemic are not</p>

						universal and that the minoritized and impoverished populations suffer more.
Hawkins et al (2020) ⁶⁵	USA	County level (n=3127)	Data extracted 2 nd May 2020	COVID-19 mortality	Distressed Communities Index (DCI): unemployment, education level, poverty rate, median income, business growth, and housing vacancies	↑ Severely distressed communities account for a disproportionately higher number of deaths per 100,000 person. Counties with lower socioeconomic status (higher DCI score) have higher COVID-19 death rates per 100,000 persons compared with non-distressed counties.
Huang & Li (2022) ⁶⁶	USA	Neighbourhood (Census tracts within New York City)	23 rd March to 16 th August 2020	COVID-19 deaths	Household size, poverty rate, % of people with college+ education, % of people with no health insurance	↑ Census tracts with larger average household size, a larger share of people 60+ years old and people with no insurance, and higher poverty rate have higher infection and death rate. In other words, census tracts with more disadvantaged and vulnerable populations tend to have higher infection and death rates.
Islam et al (2021) ⁶⁷	USA	County level (n=3141)	Up to 10 th August 2020	COVID-19 deaths	Social Vulnerability Index	↑ The rate of COVID-19 cases and deaths increased in a dose-response manner with increasing levels of SVI. Compared with the lowest SVI quintile the rate of COVID-19 deaths in the second, third, fourth, and fifth quintile was 19%, 22%, 77% and 142% higher, respectively. Geographical clustering of counties with high COVID-19 mortality, high chronic disease prevalence and high social vulnerability was found, especially in southern USA.
Itzhak et al (2022) ⁶⁸	USA	County level (n=3071 of 3243 for which all	1 st April to 28 th November 2020	COVID-19 mortality	Socio-economic factors: educational level, median	↑ COVID-19 disease is highly correlated with socio-economic status. Wealthier counties with fewer minorities, a higher

		data were available)			household income, poverty rate	educated population, and lower overall poverty rates had lower morbidity and especially mortality rates. Several socio-economic features, such as total poverty rates or percentage of African Americans in the population, seem to have an essentially similar impact on the model's predictions over time, in this case, a high and positive impact on the morbidity and mortality predictions, respectively.
Jackson et al (2021) ⁶⁹	USA	County level (n=3140)	21 st January 2020 to 31 st January 2021	COVID-19 total deaths per 100,000	Social Vulnerability Index	↑ Pre-existing social vulnerability of counties moderately positively correlated with standardised fatalities. In general, as the level of social vulnerability increased within a county, so did cases and fatalities. Social vulnerability was more associated with fatalities than cases.
Karmakar et al (2021) ⁷⁰	USA	County level (n=3137)	20 th January to 29 th July 2020	COVID-19 mortality per 100,000	Social Vulnerability Index	↑ Significant association between SVI and COVID-19 incidence and mortality. 0.1 point increase in the overall SVI score was associated with a 13.7% increase in mortality rate. Counties with greater SVI scores, or greater sociodemographic disadvantage, had higher COVID-19 incidence and mortality rates. Increases in excess cases and deaths increase exponentially over time in higher vs lower SVI counties. The higher the SVI, the steeper the slope of the growth curves for COVID-19 cases and deaths.
Khan et al (2022) ⁷¹	USA	County level (n=2701)	21 st January 2020 to 17 th February 2021	COVID-19 deaths per 100,00 population	Socioeconomic factors included: education levels, poverty, and	↑ A significant association was observed between county-level risk groups and COVID-19 deaths and cases per 100,000,

					housing. Health status – quality of life, morbidity and mortality rates, health care access, insurance rates, hospital beds per capita, physician density.	even after adjusting for time since first death and case, respectively, within each county. Highest rates of COVID-19 cases (9557 [2520]) and deaths (210 [97]) per 100,000 population occurred in the cluster comprised of rural disadvantaged counties (p<0.05). Rates of COVID-19 deaths were nearly 2-fold higher in the rural disadvantaged cluster compared with the diverse urban counties with greater social assets.
Khanijahani (2021) ⁷²	USA	County level (n=3142)	Up to 2 nd November 2020	COVID-19 deaths in 100,000 population	socioeconomic and demographic variables: Financial hardship was measured in absolute and relative terms. Median household income; household size; proportion of households with selected monthly owner costs as a % of the household income of 35% or more (SMOCAPI), % pop. >25 years old with less than high school diploma, % civilian noninstitutionalised pop. with no health insurance, civilian labour force unemployment rate.	↑ % of people 25 and older with less than high school diploma was strongly, and significantly (p<0.01), correlated with COVID-19 deaths. More substantial disparities were observed in counties regarding the SMOCAPI 35%+, concentration curves with median household income on the x-axis show a higher concentration of proportion population cases and deaths of COVID-19 in counties with significantly lower median household income. Study shows how vulnerable ethnic and racial minorities and financially disadvantaged populations can disproportionately be impacted by COVID-19 cases and deaths.
Khanijahani et al (2021) ⁷³	USA	County level (n=3142)	Up to 21 st July 2020	COVID-19 mortality per	% in concentrated disadvantage: % of population below	↑ For every 10% increase in the proportion of county population residing in concentrated disadvantage, the ratio of

				100,000 population	poverty line, % of households receiving public assistance, % of female-headed households, % unemployment rate, % of people >25 years with less than high school diploma, % uninsured	COVID-19 deaths increases by about 14%. Other county-level characteristics such as population density and percentage of uninsured county population were also positively associated with confirmed COVID-19 deaths. Even after adjusting the model for multiple covariates and accounting for factors that may impact the outcome, this county-level analysis shows that counties with a higher proportion of the population resided in concentrated disadvantage or Black concentration experience disproportionately higher mortality rates due to COVID-19.
Kim & Bostwick (2020) ⁷⁴	USA	Neighbourhood (n=77 community areas in Chicago)	Not reported	COVID-19 mortality	Social vulnerability index	↑Community areas with higher levels of SVI and risk factor score had a significantly higher COVID death rate.
Kandula & Shaman (2021) ⁷⁵	USA	County level	Up to 31 st December 2020	COVID-19 mortality per 1,000 residents	Social vulnerability index: median per capita income (US\$100,000)	↑Mortality rates estimated to decrease by 1.5 (05% CI:1.02 to 1.87; p<0.001) for every thousand dollar increase in per capita income.
Liao & De Maio (2021) ⁷⁶	USA	County level (n=3141)	22 nd January to 8 th August 2020	COVID-19 deaths per 100,000 population	Gini index	↑1.0% rise in a county's income inequality corresponded to a 3.0% rise in mortality (RR, 1.030; 95% CI, 1.012-1.047).
Luo et al (2020) ⁷⁷	USA	County level (n=3108)	22 nd January to 26 th June 2020	COVID-19 death rate	Socioeconomic factors: % without health insurance, % of households with mortgage, % with income below poverty level, %>16 unemployed, %without internet,	↑The risk factors referring to socioeconomic are most correlated with COVID-19 death rate, followed by risk factors referring to demographic, commuting to work, atmosphere, health status, land cover, disaster and climate.

					median household income, mean household retirement income, mean household cash public assistance income, mean household supplemental security income	
McLaughlin et al (2020) ⁷⁸	USA	County level (n=3142)	22 nd January to 31 st December 2020	COVID-19 deaths per 100,000 county residents	Sociodemographic and economic variables included: gender, age, ethnicity/race, residential household segregation index, high school education status, unemployment status, state-adjusted median household income, and income inequality (ratio of household incomes at the 80th vs the 20th percentile); health insurance.	↑ In addition to age, other county-level predictors strongly related to mortality were increasing proportions of females, crowded housing, uninsured adults, higher population density, and more travel outside the home during the pandemic. Rates of COVID-19 cases and deaths were higher in counties with more racial/ethnic minorities, residential housing segregation, income inequality, uninsured persons, air pollution, and adults with diabetes.
Neelon et al (2021) ¹²⁹	USA	County level (n=3142)	15 th March to 31 st December 2020	COVID-19 deaths	Social vulnerability index	↑ Overall SVI: The death rates for both quartiles (most and least vulnerable) increased until mid-April before levelling off through the end of June. Beginning in early July, however, the mean death rate for the upper, most vulnerable quartile increased steadily until August 7. The trend for the upper quartile levelled off in early autumn before a final upswing through December 31. The daily death rates for the lower (least vulnerable) quartile hovered

						<p>between 2 and 3 deaths per million for most of the summer. However, beginning in late September, there was a rapid uptick in the death rate, and by December 31, there was an estimated 13.07 deaths per million on average in the least vulnerable counties. From mid-March to mid-May, the upper, most vulnerable quartile had lower death rates than the lower, least vulnerable quartile. However, on May 21, the trend reversed and the upper quartile had higher death rates compared to the lower quartile. The RRs increased until achieving a maximum value on August 14. On October 9, however, we observed a second crossover in which the most vulnerable counties had, on average, lower death rates than the least vulnerable counties. The impact of COVID-19 is not static but can migrate from less vulnerable counties to more vulnerable counties and back again over time.</p>
Nguyen et al (2021) ⁷⁹	USA	County level (n=159 counties within Georgia)	Up to 30 th September 2020	COVID-19 deaths per 100,000	Socioeconomic conditions	<p>↑The percentages of children in poverty, severe housing problems, and people not proficient in English were significant predictors associated with increases in case, hospitalization, and death rates. The order of magnitudes of association from highest to lowest in death rate was the percentages of people with excessive drinking, people reported fair or poor health, children in poverty, people not proficient in English, severe housing</p>

						problems, American Indian/Alaska Native, female, and adults with diabetes.
Oishi et al (2021) ⁸⁰	USA	Neighbourhood (n=177 zip-codes in New York City)	Up to 22 nd May 2020	COVID-19 deaths	Median income	↑COVID-19 cases and deaths per 100,000 residents were substantially higher in lower median income zip codes in New York City than higher median income zip codes. Wealthier zip codes and zip codes with longer pre-pandemic life expectancy had fewer deaths.
Oronce et al (2020) ⁸¹	USA	State level (n=50)	22 nd January to 13 th April 2020	COVID-19 deaths per 100,000 population	Gini index	↑States with a higher Gini index experienced a larger number of deaths (adjusted percent change for one unit increase in Gini index, + 27.2%; 95%CI, + 3.5% to + 56.3%; P = 0.02). States with higher income inequality experienced a higher number of deaths due to COVID-19. These findings suggest that social factors such as income inequality may explain why some parts of the USA are hit harder by the COVID-19 pandemic than others.
Ossimetha et al (2021) ⁸²	USA	County level (n=2664)	1 st April to 15 th May 2020	COVID-19 deaths per capita	Social deprivation index: includes % adults without high school degree, % of households with a single parent, % living in overcrowded housing, % living in rental units, % households without a car, unemployment rate, and poverty rate (ranges from 1 to 100 with higher values representing greater deprivation -	↑The adjusted difference in SARS-CoV-2 cases per 1000 persons reported in May 2020 between high- and low-SDI counties was 2.56 (95% CI, 1.77 to 3.34;P<.001), and the difference in deaths per 100,000 was 5.09 (95% CI, 3.25 to 6.94;P<.001). The adjusted difference in SARS-CoV-2 cases per 1000 persons between medium- and low-SDI counties was 1.39 (95% CI, 0.85to 1.93;P<.001), and the difference in deaths per 100,000 was 1.63 (95% CI,0.20to 3.06;P%.03). In analyses stratified by metropolitan, micropolitan, and rural

					counties divided according to tertile of SDI (33rd and 67th percentiles) and classified as having low-, medium-, and high-SDI levels.	location, higher SDI level was also associated with more SARS-CoV-2 cases and related deaths in May 2020. However, in rural areas, there was no association between SDI and SARS-CoV-2-related deaths. US counties with higher SDI scores experienced greater growth in the number of SARS-CoV-2 cases and related deaths. Deaths per capita were also significantly higher for higher-SDI counties.
Pan et al (2020) ⁸³	USA	County level (n=3141)	Up to 31 st May 2020	COVID-19 deaths per 100,000 populations	Socioeconomic: education, employment, income, family and social support, community safety. Physical environment: air and water quality, housing and transit. General health: length of life, quality of life. Clinical care: access to, and quality of, care.	↑Long commute driving alone (transit), severe housing problems, and juvenile arrests rate (community safety) were statistically significant health factors of COVID-19 mortality (P<0.05); and the rates of suicide (community safety) and uninsured (health care access) were marginally statistically significant (P<0.10). Study identified some county-level health factors that are significantly associated with COVID-19 mortality. For example, counties with a higher rate of uninsured population, more housing problems such as over-crowding, and longer commute driving alone are more likely to have significantly higher COVID-19 mortality; whereas counties with higher rates of suicides and juvenile arrests may have lower COVID-19 mortality.
Paul et al (2021) ⁸⁴	USA	County level (n=3104)	Up to 23 rd October 2020	COVID-19 mortality rates per 100,000 population	% of population under severe housing cost burden, residential segregation,	↑For every 5% increase in residential segregation among Whites and Blacks, the COVID-19 mortality rates increased by 3.4% and for every 5% increase in

					unemployment rates, income inequality ration, % population with college or associate degree, age 65+	unemployment rates, the mortality increased by 47.9% in urban counties, when adjusted for other variables. Unemployment rates were significantly associated with mortality from COVID-19 in rural counties in the unadjusted analysis; however, this effect was not (Bayesian) significant in the adjusted model. Under the adjusted regression, for every 5% increase in income disparity in rural counties, the mortality increased by 0.03%. Counties with a high percent of the population with college or associate degrees had lower mortality rates, whereas counties with a higher percentage of Blacks and the female population significantly increased the mortality rates in rural and urban counties.
Pekmezaris et al (2021) ¹³²	USA	State level (n=47 plus Washington DC); County level (n=62 counties in New York City)	1 st March to 19 th August 2020	COVID-19 mortality rate	Social vulnerability index	↑State level: Overall SVI was not associated with mortality; however, higher minority status and language rankings were significantly associated with higher COVID-19 mortality rates. Additional variables that were found not to be associated with mortality included: mean age, states' SES rankings, state's Household Composition and Disability rankings. County level: Counties with higher populations were associated with higher COVID-19 mortality rates, and so is population density. Moreover, total tests were associated with higher COVID-19 mortality rates as were counties with

						higher Minority Status and Language rankings. SVI variables that were found not to be associated with mortality included: housing and transportation type, socio-economic ranking and SVI ranking.
Pierce et al (2021) ⁸⁵	USA	Neighbourhood level (census-tract, Chicago)	16 th March to 1 st June 2020	COVID-19 deaths	Sociodemographic: below poverty, unemployed, less than high school diploma	↑Geomapping using residential address data at the individual-level identifies hot-spots of COVID-19 mortality in neighbourhoods on the Northeast, West, and South areas of Chicago that reflect a legacy of residential segregation and persistence of inequality in education, income, and access to healthcare. Hot spots were characterized as having higher proportions of minority and socioeconomically disadvantaged neighbourhoods compared with cold spots that had a higher proportion of NH white and affluent residents when examining census-tract level characteristics.
Robertson (2021) ⁸⁶	USA	County level (n=883)	Up to 31 st May 2020	COVID-19 deaths	% unemployed, median household income, persons per household, high school graduates, economic inequality	↑Counties with greater population density, crowding in housing (cases not deaths), workplaces, and religious congregations as well as self-reported social contacts per person had more cases and deaths. Cases and deaths were associated with higher median incomes and higher pre-pandemic unemployment. Income inequality was associated with cases but reversed in the death model. Cases and deaths occurred more frequently in counties with a larger proportion of African Americans in the

						population but were less frequent in counties with a larger proportion of Hispanics.
Russette et al (2021) ⁸⁷	USA	County level (n=3049)	21 st January to 29 th July 2020	COVID-19 deaths	% with low education attainment, % overcrowding in home, % on Medicaid as proxy for low socioeconomic status.	↑ Counties with an increasing prevalence of Medicaid coverage among populations 18-64 had significant reduced risk of COVID-19 mortality. Counties with increasing prevalence of Black American, Native Americans, low education attainment, overcrowding, and aged 65 and over, were found to have significant increased risk of COVID-19 mortality.
Samuel et al (2021) ⁸⁸	USA	County level (n=3142)	22 nd January to 19 th July 2020	COVID-19 mortality per 100,000	Socioeconomic measure: % living below the poverty threshold. Economic and transit characteristics: % unemployed, % lacking high school diploma, % households with housing cost burden, % single parent household, % crowded households, % households in multi-unit buildings, % households without a vehicle, without health insurance	↑ In adjusted models, each 1 % more Black or Native American residents were both associated with a 2% higher risk of additional coronavirus-related deaths over 6 months. The poverty rate was not associated with six-month cumulative mortality. Economic and transit characteristics were associated with higher mortality burden, but accounting for them did not attenuate racial disparities in mortality. Counties with higher percentages of lacking a high school diploma, households with limited English proficiency, and households without a vehicle, had more coronavirus-related deaths.
Sung (2021) ⁸⁹	USA	County level (n=3141)	Up to 14 th November 2020	COVID-19 deaths per 100,000 residents	Social Vulnerability Index	↑ There is a strong health gradient for COVID-19 death risk during the early stages of the pandemic. Counties in the 90 th percentile or higher with regards to the following parameters had higher COVID-19

						<p>mortality rates than counties below the 90th percentile for the corresponding indicator: % of persons in poverty; % of unemployed persons; per capita income; % of persons with no high school diploma; % of persons aged 65+; % of persons aged <17; % persons with a disability; % of single parent households; % of minorities; % of those with limited English proficiency; % of households in multiunit housing complexes; % of mobile home residents; % of crowded households; % of households with no vehicles; % of persons in institutionalised group quarters.</p> <p>Unstandardised coefficients from the spatial autoregression models indicated that counties in the 90th percentile or above for the following parameters showed significant associations with COVID-19 deaths rates compared to their counterparts: per capita income; the percentage of persons with no high school diploma; the percentage of persons aged 65 and older; the percentage of persons aged 17 and younger.</p>
Tan et al (2021) ⁹⁰	USA	County level (n=3220)	1 st March 2020 to 28 th February 2021	COVID-19 deaths	Gini coefficient; (confounders: poverty, age, race/ethnicity, urbanicity and rurality, crowding, educational level, no. of physicians per 100,000 individuals, and mask use)	<p>↑Study suggests that income inequality within US counties was associated with more cases and deaths due to COVID-19 in the summer months of 2020. There was a weak positive correlation between Gini coefficients and total deaths per 100,000 individuals. The association of inequality and COVID-19 cases and deaths varied over</p>

						time. For each 0.05-unit higher Gini coefficient, the adjusted relative risk of COVID-19 deaths was 1.25 in March and April 2020, 1.20, in May and June 2020, 1.46, in July and August 2020, 1.04, in September and October 2020, 0.76, in November and December 2020, and 1.02, in January and February 2021.
Unruh et al (2022) ⁹¹	USA	Neighbourhood (Zip code tabulation areas in Cook County, Illinois)	March 2020 to September 2021	COVID-19 mortality	Social deprivation index (SDI): % living in poverty, % with less than 12 years education, % single parent households, % living in rented housing units, % living in overcrowded housing units, % households without a car, % non-employed under age 65.	↑ Living in poverty alone was not associated with an increased number of deaths, but the interaction of living in poverty and in a non-white ZCTA increased the risk 2 to 3 times [IRR 2.99, 95% CI (0.71, 12.57)]. For every one-point increase in SDI score the number of deaths, number of tests, and number that tested positive all increased one unit.
Wrigley-Field et al (2021) ⁹²	USA	Neighbourhood (Census-tract level, Minnesota)	up to 31st December 2020	COVID-19 deaths	Area deprivation index (no further details provided)	↑The 2020 COVID-19 mortality rate was 75 deaths per 100,000 people in the most disadvantaged neighbourhoods compared to 23 deaths per 100,000 in the most advantaged neighbourhoods. In 2020 COVID-19 mortality and excess mortality in Minnesota were concentrated in disadvantaged neighbourhoods.
Zhang & Schwartz (2020) ⁹³	USA	County level (n=2814)	Up to 1 st May 2020	COVID-19 deaths	Social vulnerability index: % population in poverty, % minority, % over 65, % uninsured.	↑Population density was the strongest predictor of COVID-19 mortality rates. The variables, percent older population and poverty, both showed expected significant and positive associations with COVID-19 deaths. This is consistent with the

						hypothesis that the elderly and the poor are at greater risks of COVID-19 deaths.
Zhong et al (2022) ⁹⁴	USA	Neighbourhood (n=177 modified ZIP code tabulation areas in New York City)	1 st March 2020 to 30 th April 2021	COVID-19 deaths	Household size, education (with and without high school diploma) health insurance (with and without), median household income.	<p>↑ a 10% increase in health insurance coverage was associated with 29% reduction in death rate per capita in wave 1 but not in wave 2. Every \$10,000 increase in the median household income was associated with 3% reduction in death rate per capita in wave 1 and 7% reduction in wave 2. For a 10% increase in high school education the death rate was associated with a 29% reduction in wave 1 and a 21% reduction in wave 2.</p>

European Region (n=20)

Author(s)	Country	Scale	Time period	Outcome	Measure of Socioeconomic disadvantage	Summary of how socioeconomic disadvantage affects COVID-19 deaths (significance included where reported) ↑ = Increases deaths ↓ = Decreases deaths ↔ = No difference in deaths between areas of high or low socioeconomic disadvantage
Sun et al (2021) ¹¹⁰	England	Local authority districts (n=317)	March to May 2020	COVID-19 mortality	Unemployment rate, % of households in poverty, Gini coefficient, location of hospitals	↑ Spatial inequalities in COVID-19 mortality are around 3 times higher than non-COVID-19 mortality. Unemployment rate makes significant contribution to spatial variation in COVID-19 mortality rate.
Bray et al (2020) ¹¹¹	England	Local authority (n=310)	1 st March to 17 th April 2020	COVID-19 mortality rate	Median Index of multiple deprivation (IMD)	↑ Weak positive association between IMD and COVID-19 mortality, significant relationship mediated by ethnicity, overweight/obesity, population density, and pollution.
Breen & Ermisch (2021) ¹¹²	England	Local authority (n=306)	1 st March to 31 st July 2020	COVID-19 mortality	Area deprivation	↑ Areas with higher social deprivation have higher COVID-19 mortality rate but weaker than between social deprivation and mortality rates more generally.
Brown et al (2021) ¹¹³	England	Country	March to December 2020	Total COVID-19 deaths and mortality rate per 100,000 population	IMD	↑ Residents in deprived areas experienced higher mortality rates compared to people living in less deprived areas.
Chaudhuri et al (2021) ¹¹⁴	England	Local authority districts (LADs) (n=315)	1 st March to 16 th April 2020	Age-standardised COVID-19 mortality per	IMD; educational attainment	↑ Most deprived LADs significantly larger COVID-19 mortality compared to affluent areas. COVID-19 mortality disproportionately affects the local areas

				100,000 population		with an over-representation of individuals who are relatively socio-economically deprived.
Daras et al (2021) ²¹	England	Middle super output areas (MSOA) (n=6789)	1 st March to 31 st May 2020	Age-adjusted COVID-19 mortality	IMD as measure of income deprivation	↑ Association between income deprivation and COVID-19 mortality was largely explained by increase prevalence of long-term conditions and overcrowded housing.
Harris (2020) ¹¹⁵	England	MSOAs in London	1 st March to 17 th April 2020	COVID-19 deaths	Socio-economic indicators of neighbourhood wealth or deprivation including: health deprivation, housing stock, household size and residential overcrowding	↑ Wealth/deprivation, and ethnicity are key risk factors associated with higher mortality rates from COVID-19. Despite some spatial diffusion of COVID-19, a greater number of deaths continue to be associated with socio-economic disadvantage.
Griffith et al (2021) ¹¹⁶	England and Wales	MSOAs	1 st March to 31 st July 2020	COVID-19 mortality (adjusted for age and number of care homes)	IMD	↑ Higher relative deprivation is associated with increased COVID-19 mortality at all stages of the pandemic.
Griffith et al (2022) ¹¹⁷	England and Wales	MSOAs (n=7201)	March 2020 to April 2021	COVID-19 mortality	UK-wide Index of Multiple Deprivation.	↑ The association between deprivation and COVID-19 mortality increased between July and October 2021. This was true for all three geographic scales, however the increase was much more dramatic at the region level. A standard deviation increase in regional UKIMD was associated with 1.01 times higher COVID-19 mortality in July (95% CI, 0.83 to 1.16), which by October had reached 1.20 (95% CI, 1.10 to 1.30). The association between region level deprivation and Covid-19 mortality, then declines just as dramatically in the following months and by January 2021 the association between

						region level deprivation and mortality becomes negative. Deprivation remains associated with increased COVID-19 mortality at MSOA level at all time points.
Hoebel et al (2021) ¹¹⁸	Germany	District (n=401)	Late September 2020 to March 2021	COVID-19 mortality (no. of deaths per 100,000 population)	German index of socio-economic deprivation; area and socioeconomic indicators of deprivation in following domains: education, employment, income	↑COVID-19 mortality increased faster among people in more deprived districts widening socio-economic disparities over the course of the second wave of the pandemic. Mortality risk for men and women from the most deprived districts were 1.52 and 1.44 times higher than those living in the most affluent areas.
Doblhammer et al (2021) ¹¹⁹	Germany	Counties (n=401)	1 st October to 15 th December 2020	COVID-19 deaths	Socio-economic status (SES); urbanity/density, health, care need, regional connectedness, norms and values, special geographic location, population composition, ageing, age structure of population	↑While both social gradients were present in SARS-CoV-2 infections in October, the negative SES gradient began to dominate over time and was always the dominant one in mortality. Counties with low SES had higher infection and death rates.
Plumper & Neumayer (2020) ¹²⁰	Germany	Districts	Phase 1 up to 13 th April; Phase 2 14 th April to 19 th May	COVID-19 deaths	Average income, controlling for the share of the population that is university educated. Social deprivation measured by unemployment rate	↑Districts with higher unemployment rate reported lower cases in phase 1 and higher deaths in phase 2. In phase 1 poorer districts are less likely to be infected than the more affluent population but in phase 2 the probability of dying for people in the poorer more socially deprived districts is statistically significantly higher.
Zaldo-Aubanell et al (2021) ¹³⁵	Spain	Territory (basic health area n=372)	Up to 18 th May 2020	COVID-19 deaths	Composed Socioeconomic Index (CSI): resources for primary health, professional occupation, life expectancy, premature	↑BHAs with greater % of people aged over 65, of very high and high SES showed a positive association with COVID-19 mortality. BHAs of low and very low SES were associated with decreased levels of

					death rate, and preventable hospitalisations	COVID-19 incidence and mortality. CSI may be a weak measurement to detect individual-based characteristics.
Garcia (2021) ¹³⁶	Spain	Region (all 17 autonomous communities across Spain)	Up to 23 rd May 2020	COVID-19 mortality rate per 1 million inhabitants	Gini index, GDP	↑1% increase in the GDP per capita is associated with a 3.21% increase in mortality rate. Number of air passengers received by each region during Feb 2020 is statistically significant for both dependent variables, there is an association between mobility of people and both incidence and mortality.
Amate-Fortes & Guarnido-Rueda (2022) ¹³⁴	Spain	Municipalities (n=574 reporting COVID-19 mortality)	Up to 15 th June 2020	COVID-19 mortality per 100,000 inhabitants	Average relative gross income of the municipality, five measure of inequality (Gini index, Atkinson index, 80/20 index, top 1%, top 0.1%), number of primary care centres and hospitals, unemployment, population density.	↑ (for infections but not deaths) For the incidence rate the five estimates present a positive estimated parameter, although only significant in three of the cases, the Gini index, the Atkinson index and the concentration of income in the top 1% of the population. Greater income inequality within municipalities leads to higher level of infection. However, although the sign remains positive the significance is zero when estimating the effect that inequality has on the mortality rate. A higher level of income inequality generates a higher rate of infections but not deaths.
Ginsburgh et al (2020) ¹²¹	France	Departément (n=94)	1 st March to 3 rd September 2020	Cumulative COVID-19 deaths	Gini coefficient; median disposable income	↑ Départements with higher income inequality have more deaths. A 1% increase in the Gini coefficient corresponds to a 0.08% increase in the number of deaths.
Oroszi et al (2021) ¹²²	Hungary	Municipalities (n=3155)	Up to 13 th April 2021	COVID-19 deaths	Deprivation index (7 municipality-level socioeconomic indicators: income, level of education, rate of unemployment,	↑ strong positive association between mortality and deprivation. Residents in more deprived municipalities had a lower risk of being identified as a COVID-19 case but a higher risk of death during the second wave

					proportion of one-parent families, and of large families, density of housing, and car ownership	of the pandemic. Compared to the national average, the relative incidence of cases was 30%-36% lower in the most deprived areas but the relative mortality and case fatality were 27%-32% higher.
Di Girolamo et al (2020) ¹²³	Italy	Region (Census block level in Emilia-Romagna region in Northern Italy	March and April 2020	COVID-19 deaths	Index of deprivation: low level of education, unemployment, non-home ownership, single parent family, household crowding	↑Age-standardised mortality rates were greater among those living in the most disadvantaged versus the most advantaged census blocks. Percentage differences in age-standardised mortality rates between the least and most deprived census blocks were greater for COVID-19 mortality than for overall mortality, suggesting the pandemic has had a stronger impact on the most socio-economically deprived areas. People living in the most disadvantaged census blocks had the highest absolute and relative risk of dying.
Fonseca-Roderiguez et al (2021) ¹²⁵	Sweden	Municipalities (n=290)	February to 5 th October 2020	COVID-19 deaths (adjusted for age and sex)	Gini index, mean income, proportion of adults with only compulsory education.	↔ Univariate models showed a protective effect of mean income per municipality to mortality ratios, but this was not significant when adjusted for other variables. Proportion of residents with only compulsory education showed significant positive effect in the univariable mortality spatial regression models, this was not significant in the multivariable models.
Riou et al (2021) ¹²⁴	Switzerland	Neighbourhood	Up to 14 th April 2021	COVID-19 deaths	Swiss neighbourhood index of socioeconomic position (Swiss-SEP): median rent per m ² , proportion of households headed by a person with primary	↑COVID-19 mortality declined with increasing SEP of neighbourhoods. People living in areas of high SEP were more likely to get tested but less likely to die, compared with those in areas of lower SEP. People living in neighbourhoods of low SEP were

					education or less, proportion headed by person in manual or unskilled occupation, mean number of people per room (crowding)	less likely to be tested but more likely to test positive, be admitted to hospital, or die, compared to those in areas of high SEP.
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African Region (n=1)

Author(s)	Country	Scale	Time period	Outcome	Measure of Socioeconomic disadvantage	Summary of how socioeconomic disadvantage affects COVID-19 deaths (significance included where reported) ↑ = Increases deaths ↓ = Decreases deaths ↔ = No difference in deaths between areas of high or low socioeconomic disadvantage
Hussey et al (2021) ¹²⁶	South Africa	Sub-districts (n=8 within Cape Town)	1 st March 2020 to February 2021	COVID-19 standardised by age and sex.	Economic indicators for each sub-district: unemployment, households with a monthly income ≤ ZAR3200, private testing for deceased COVID-19 case	↑ Scatter plots show a linear positive relationship between increasing COVID-19 standardised death rate (SDR) in a sub-district and % of unemployment and % of low income households. More private laboratory testing was done in the higher income sub-districts. Study suggests that low-income sub-districts had higher COVID-19 SDRs. There was a strong socio-economic gradient in COVID-19 mortality.

South-East Asia Region (n=1)

Author(s)	Country	Scale	Time period	Outcome	Measure of Socioeconomic disadvantage	Summary of how socioeconomic disadvantage affects COVID-19 deaths (significance included where reported) ↑ = Increases deaths ↓ = Decreases deaths ↔ = No difference in deaths between areas of high or low socioeconomic disadvantage
Middya & Roy (2021) ¹³⁰	India	District level (n=400)	Up to 24 th February 2021	COVID-19 deaths	Socioeconomic factors (obtained from Census): number of households with at least 9 persons, number of households with TV, computer, mobile phone and car, number of persons with higher education	↑ Study finds five factors that are significantly related with district level COVID-19 deaths: population, pollution level, households having a TV, computer, mobile phones, and a car, persons aged over 50, number of persons having higher education.

Western Pacific Region (n=1)

Author(s)	Country	Scale	Time period	Outcome	Measure of Socioeconomic disadvantage	Summary of how socioeconomic disadvantage affects COVID-19 deaths (significance included where reported) ↑ = Increases deaths ↓ = Decreases deaths ↔ = No difference in deaths between areas of high or low socioeconomic disadvantage
Yoshikawa & Kawachi (2021) ¹²⁷	Japan	Prefecture (n=47)	Up to February 2021	COVID-19 deaths per 100,000 residents	Socioeconomic: mean household income, Gini coefficient, proportion receiving public assistance, education attainment, unemployment rate, employment in industries with close contact with the public, household crowding	↑ Higher mortality rate ratios in prefectures with the most socioeconomic disadvantage in terms of Gini coefficient proportion of the population receiving public assistance, unemployment rate, % of workers in transportation, postal industries and restaurant industry, and household crowding. Inverse or null association for prefecture-level educational attainment, % of workers in health care industry and retail industry. Study suggests the burden of COVID-19 was higher in socially disadvantaged regions.

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Does not include whole population (n=16)

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Figure 1: PRISMA flowchart of selection procedure

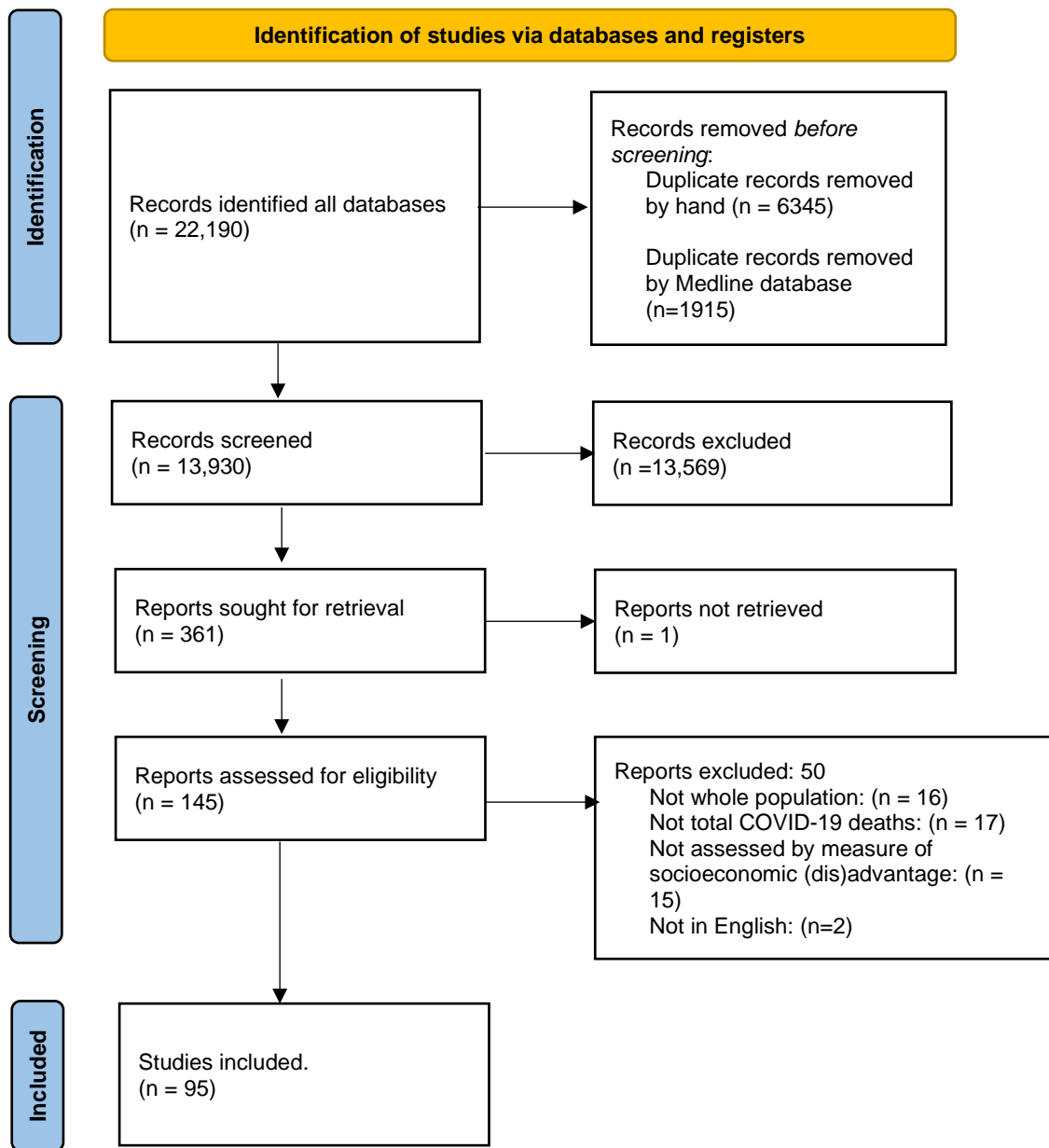
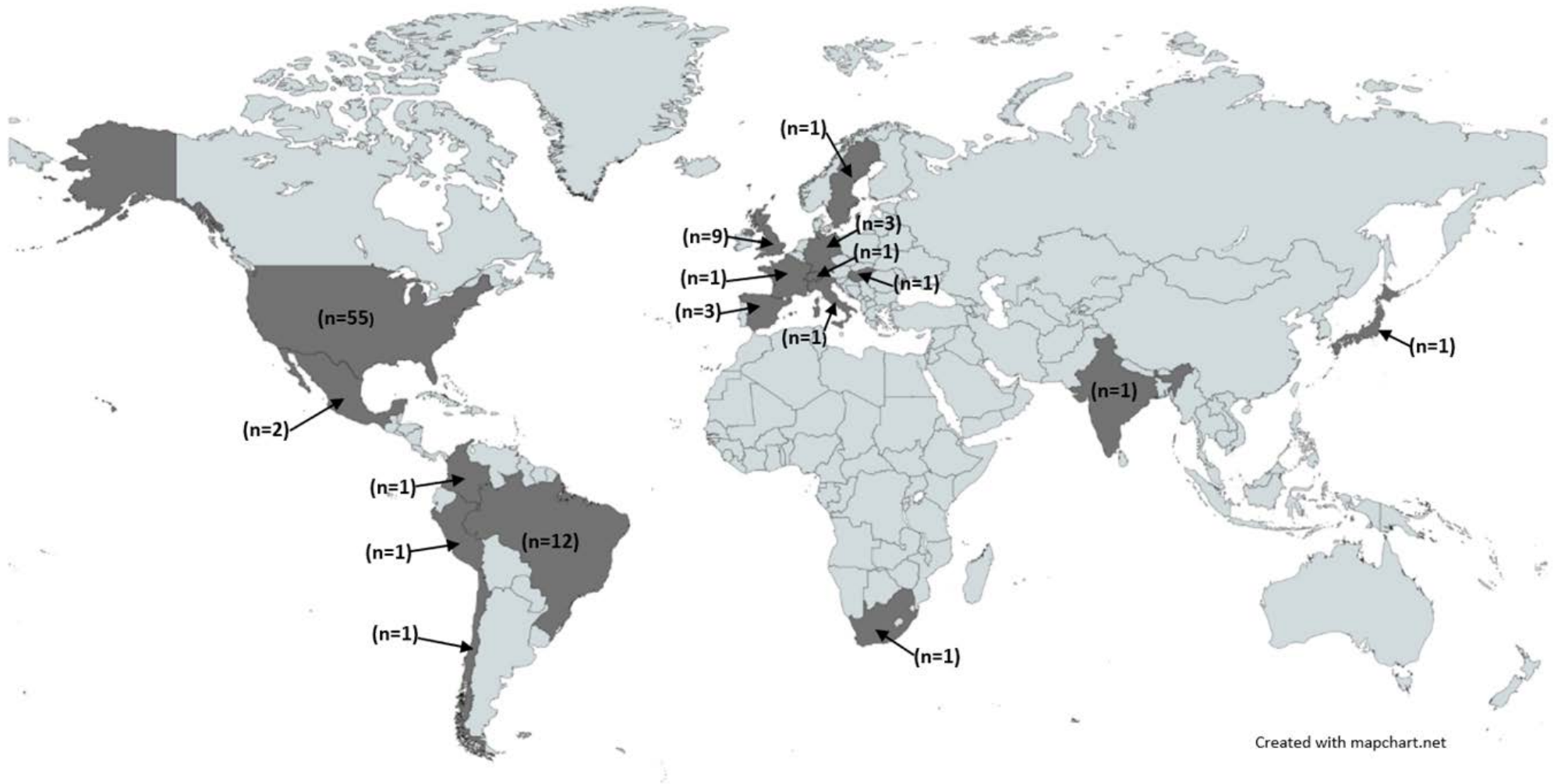


Figure 2: Map of global distribution of included studies



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