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The impact and variability of social determinants of health on the transmission and outcomes of COVID-19 across the world: a systematic review protocol

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STRENGTHS AND LIMITATIONS OF THIS STUDY:

- This review will address the impact of a wide range of social determinants of health (SODH) and the geographical variations that affect the transmission and outcomes of COVID-19.
- A multidisciplinary team is involved in this review and the search strategy was undertaken with the involvement of a library information scientist.
- A standard scientific reporting format will be used to summarize the review findings to avoid the shortcoming and biases of narrative synthesis.
- The influx of journal articles that were published over the last year in response to the current pandemic, without a scientific track record of previous studies, were reviewed in this manuscript

ABSTRACT

Introduction:

The COVID-19 pandemic has exacerbated health inequalities across the globe, disproportionately affecting those with poor social determinants of health (SDOH). It is imperative to understand how SDOH influences the transmission and outcomes (positive case, hospitalization and mortality) of COVID-19. This systematic review will investigate the impact of a wide range of SDOH across the globe on the transmission and outcomes of COVID-19.

Methods and analysis:

This review will follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocol (PRISMA) guidelines. We searched articles published from January 1, 2019, to December 31, 2021, in three electronic bibliographic databases (MEDLINE via PubMed, Embase and Scopus), as well as the WHO COVID-19 Global Research on coronavirus disease database. We will consider observational studies that report statistical relationships between the social determinants of health (as listed in PROGRESS-Plus and Healthy People 2020) and COVID-19 transmission and outcomes. There will be no limitation on the geographical location of publications. The quality of included observational studies will be assessed using a modified version of the Newcastle Ottawa Scale (NOS). A narrative Synthesis without Meta-Analysis (SWiM) reporting standards will be used to report the review findings.

Ethics and dissemination:

This review will be based on published studies obtained from publicly available sources, and therefore, ethical approval is not required. We will publish the results of this review in a peer-reviewed journal, as well as present the study findings at a national conference.

PROSPERO registration number: CRD42021228818

Keywords:

Social determinants of health, COVID-19, transmission, outcomes, geographical variations

INTRODUCTION

In December 2019, a pneumonia case associated with SARS-CoV-2 was first identified in Wuhan, Hubei province, China. As of 24 April 2021, this emerging infection has caused 154,640,649 infections and 3,232,285 deaths globally.[1] The current experience of the COVID-19 pandemic has taken the world by surprise, despite the modern advances in health sciences. Outcomes of the disease include not only an increased death toll but has put a spotlight on health inequalities.[2] According to the World Health Organization (WHO), social determinants of health (SDOH) are the non-medical factors that influence the health outcome of humans. They broadly define it by the conditions in which people are born, grow, work, live, and age and the wider set of forces and systems shaping the conditions of daily life.[3] All these conditions have a major impact on the health, wellbeing and quality of life of an individual.[4] The transmission of any communicable disease is highly dependent on these SDOH. The vast dynamics of disease transmission may result in symptomatic or asymptomatic disease outcomes, which may lead to hospitalization and/or death. Generally, people residing in socioeconomically underdeveloped areas are at least three times more likely to die of preventable diseases compared to those in developed areas.[5] The socioeconomically disadvantaged population also has limited access to healthcare services. Studies show that even those who live above the poverty line are more prone to be affected by chronic health conditions.[6]

This pandemic has made it clear that social determinants of health differentially affect disease transmission and outcomes globally.[2] Reports and studies generated from countries with high infection rates suggest that geographic variations were signifying higher transmission rates, hospitalizations and mortality in marginalized, densely populated, low-income, and crowded households.[7–12]. Populations living in crowded neighborhoods are at a higher risk of becoming ill and transmitting the virus at an increased rate, as social distancing may not be feasible.[13–15]

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Access to health care services is described by the National Academies of Sciences, Engineering, and Medicine as the "timely use of personal health services to achieve the best possible health outcomes".[16] Access to healthcare is an influential SDOH that has gained attention during this COVID-19 pandemic.[17, 18] Accessibility to health care services may include geographic accessibility (within physical reach), economic accessibility (within financial reach) and cultural accessibility (acceptance and communication).[19–21] Health insurance is an important aspect of accessibility which is evident from several studies and reports. It has been demonstrated that there is unequal coverage of health insurance and access to services, leading to poorer health outcomes in marginalized groups. [22, 23] In a study by Gallup and West Health, it was found that 14% of adults in the U.S. do not seek healthcare when experiencing fever and dry cough due to the high cost of healthcare.[24] Given the fact that fever and dry cough are the most common symptoms of COVID-19, there is a high chance that many COVID-19 cases may go unnoticed or undiagnosed, which may result in unknowingly transmitting the disease.[25] Primary care visits may not be feasible, or people may hesitate to use health care resources without health insurance. This inability puts those without health insurance at risk of not being screened for chronic conditions, such as CVD (cardiovascular disease), hypertension, asthma, and diabetes. Therefore during this health emergency, access to health care may play a major role in whether an individual will test for COVID-19 and follow recommendations, such as social distancing and other preventive measures.[26]

In terms of racial disparities, the United States has experienced disproportionate outcomes of infection, hospitalization and mortality among historically marginalized groups, such as African American, Hispanic and Asian populations. [27, 28] studies show that mortality due to COVID-19 is associated with socioeconomic class.[29–31] Black, Asian and minority ethnic (BAME) backgrounds represented one-third of the ICU admission in UK hospitals, while Somali immigrants living in Norway had a ten times higher rate of infection compared to the non-immigrants.[32, 33] Those who are minorities may not be aware of their underlying conditions due to barriers in accessing primary care and might be at high risk of developing more severe symptoms during this pandemic situation.[34, 35]

It is imperative to focus on SDOH during the COVID-19 pandemic to better understand preventable health inequalities and to improve health outcomes. As such, there is an immediate need to comprehend the social determinants of COVID-19 transmission and outcomes to decrease human sufferings and save lives.[36] In addition to known clinical risk factors, knowledge of social risk factors will help policymakers and healthcare decision-makers to prioritize groups who are most at-risk during the COVID-19 pandemic and to formulate health messages according.

Objectives

1. To find the impact of social determinants of health (SDOH) on the transmission and outcomes of COVID-19.
2. To explore the geographic variations of SDOH on transmission and outcomes of COVID-19.

METHODS

This protocol is registered with the International Prospective Register of Systematic Reviews (PROSPERO) under the registration number CRD42021228818 and follows the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines,[37] as shown in **Figure 1**.

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Figure 1: PRISMA 2009 Flow Diagram

Eligibility criteria

A summary of eligibility criteria is shown in **Table 1**.

Types of studies:

The types of studies that will be considered in this systematic review will include empirical quantitative studies following prospective and retrospective cohort, case-control, cross-sectional, pre-post designs, and modeling studies that report statistical relationships between exposures of interest (i.e., social determinants of health) and COVID-19 transmission and outcomes. We will only include studies published in the English language. Qualitative studies, reviews, narrative reviews, systematic reviews, meta-analyses, pharmacological and biochemical studies, animal model studies, conference abstracts, conference proceedings, and theses/dissertations will not be included in this systematic review. Simulation modeling, which does not report new empirical data, opinion literature, including commentaries, editorials, and analyses that discuss COVID-19 regarding equity, social determinants, and/or vulnerable populations, will also be excluded from the review.

Types of study population:

Studies in this review will include populations of all ages, ethnicity, gender, and geographic location. We will consider any population that has been tested positive for COVID-19.

Types of outcome measures:

Studies will be included if they use a measure for social determinants of health that affect the transmission and outcomes (confirmed positive case, hospitalization, and mortality) of COVID-19. We will use Healthy People 2020 and PROGRESS-Plus to classify our definition of social determinants of health.[38, 39] Healthy People 2020 addresses five SDOH; economic stability, education, social and community context, health and health care, neighborhood, and built environment. PROGRESS-Plus refers to the place of residence, race/ethnicity/culture/language, occupation, gender, religion, education, socioeconomic status, and social capital. Plus refers to

personal characteristics associated with discrimination (e.g., age, disability), features of relationships (e.g., smoking parents, excluded from school), and time-dependent relationships (e.g., leaving the hospital, respite care, other instances where a person may be temporarily at a disadvantage).

Table 1: Inclusion and exclusion criteria for the review

Inclusion criteria	Exclusion criteria
▪ Empirical-based observational quantitative studies such as cross-sectional, case-control, prospective and retrospective cohort, pre-post designs, and modeling studies ▪ Studies covering all geographical locations ▪ Studies in the English language only ▪ Studies covering people of all age groups ▪ Studies that include SDOH listed in PROGRESS-Plus & Healthy People 2020 ▪ Studies that include any COVID-19 positive population ▪ Studies that include populations tested positive for COVID-19, with underlying co-morbidities ▪ Studies that include a population that required hospitalization or resulted in mortality due to COVID-19	▪ Studies in Non-English language ▪ Qualitative studies, simulation modeling studies (without new empirical data), review studies, systematic review, review of the systematic review, meta-analysis, narrative reviews, conference abstracts, proceedings, thesis ▪ Pharmacological and biochemical studies, animal model studies, ▪ Opinion literature, including commentaries, editorials, brief reports, perspectives, and analyses ▪ Studies that include COVID-19 disease outcome among special populations (such as patients with HIV, prisoners, cancer patients, etc.) ▪ Studies that include laboratory measures and radiologic findings of COVID-19 diagnosis. ▪ Articles with missing descriptions of findings and/or results

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Search strategy

We undertook a comprehensive literature search to locate both published and unpublished literature. We searched articles published from January 1, 2019, to December 31, 2021, in three electronic bibliographic databases (MEDLINE via PubMed, Embase and Scopus), as well as the WHO COVID-19 Global Research on coronavirus disease database, to ensure results focused on the novel COVID-19 pandemic and retrieve pre-print articles. Our search strategy was based on the published Ovid Embase COVID-19 search strategy translated for use in the searched databases.[40] The full, detailed search strategy is available in **Supplement 1**. Following the search, all identified citations were imported into EndNote X9 (Clarivate Analytics, PA, USA), and duplicates were removed. Deduplicated results were exported to an Excel spreadsheet for screening. The reference lists of all included studies will be then further reviewed for eligible studies.

Study records

Selection process:

Based on the title and abstract (where available), ten (10) researchers initially reviewed and assessed potential articles for eligibility that meet inclusion criteria, while maintaining a low threshold for consideration for further review. The same researchers will screen the full text of the potential articles for inclusion. We will resolve the disagreement or uncertainty regarding the eligibility of particular studies through discussion by two independent researchers.

Data management and collection:

Ten (10) researchers will work on data extraction using a piloted data extraction tool, and the extracted data will be reviewed by a supervisor for errors.

Data to be collected:

a. Study details (title, year of publication, author, abstract, study design, country, region)

b. Study population characteristics (age, sex…)

c. Sampling strategy and sample size

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d. SODH including participant demographics (place of residence, occupation, race/ethnicity/culture/language, education, religion, social capital, socioeconomic status, economic stability, education, social and community contexts, health and health care access, neighborhood and built environment).[38, 39]

e. Outcome severity of COVID-19

OUTCOMES

This systematic review will focus on SDOH that impact the transmission and outcomes of COVID-19. We will also look for the geographical variations of these outcomes from the selected articles for this review. The following outcomes will be examined:

a. Positive COVID-19 cases

b. Hospitalization due to COVID-19 that includes regular bed patients admission, High Dependency Unit (HDU) patient admission, Intensive Care Unit (ICU) patient admission

c. Mortality due to COVID-19

RISK OF BIAS

To assess the quality of included observational studies, we will use a modified version of the Newcastle Ottawa Scale.[41] Two reviewers will independently assess each study, with discrepancies resolved by agreement or a third independent assessor if such agreement cannot be achieved.

DATA SYNTHESIS & ANALYSIS

This review is broad and exploratory in nature, and therefore, a meta-analysis of the effect estimate is not planned, but data will be evaluated for the possibility of conducting a meta-analysis. To avoid the shortcomings in the reporting of narrative synthesis, we will follow the Synthesis without Meta-Analysis (SWiM) reporting standards.[42] We will tabulate the results and narrate the summary of findings for each SDOH identified in this review. Additionally, we will prepare at least three tables consisting of the study characteristics, participant characteristics, and a summary of findings that describes study setting, size, methodology, primary outcomes,

secondary outcomes, summary statistics, and/or statistical results (risk ratios, odds ratios, risk differences, mean differences, standardized mean differences, the ratio of means), and relationship to SDOH.

DISCUSSION

Our systematic review will focus on the role that social determinants of health play in the transmission and outcomes of COVID-19. We hope that the concluded review will provide evidence to determine the impact and variability of social determinants of health associated with SARS-CoV-2 infection and the dynamics of transmission and outcomes. This protocol will guide the review homogeneously and methodologically. Our systematic review will address a gap in the COVID-19 literature, by exploring not only the impact social determinants of health have on the transmission and outcomes of the disease but also by exploring the global geographical differences of SDOH and its impact on the COVID-19 pandemic. Through this review, we hope to provide an empirical understanding of the diverse social determinants of COVID-19, which could appraise the global pandemic response efforts as well as provide comprehensive evidence for future public health policy implications.

PATIENT/PUBLIC INVOLVEMENT

There will be no patient or public involvement in this study.

ETHICS AND DISSEMINATION

As the data included in this review have been published or obtained from publicly available sources, ethical approval is not required. We will submit the full systematic review manuscript to a peer-reviewed journal and will present the study results at a national conference.

AUTHOR CONTRIBUTIONS

All authors have contributed equally to the design and conceptualization of this review. MA, AW, FNR, FRO, SS, SR, CAM, and LI drafted the manuscript and protocol with UKS, FF, SRM, and LF as editors. LF developed the search strategy with input from UKS, FF, and SRM concerning keywords

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and databases. All review methods were planned and discussed with the authors, with LF acting as a methodological mentor.

FUNDING

All authors declare that they have not received any grant/fund for this research from any source.

COMPETING INTERESTS

Authors declare that they have no competing interests.

PATIENT CONSENT FOR PUBLICATION

Not required

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REFERENCES

1 WHO Coronavirus (COVID-19) Dashboard | WHO Coronavirus (COVID-19) Dashboard With Vaccination Data. https://covid19.who.int/ (accessed 6 May 2021).

2 Abrams EM, Szefler SJ. COVID-19 and the impact of social determinants of health. Lancet Respir. Med. 2020;8:659–61. doi:10.1016/S2213-2600(20)30234-4

3 WHO | Social determinants of health.

4 Marmot M, Allen JJ. Social determinants of health equity. Am. J. Public Health. 2014;104. doi:10.2105/AJPH.2014.302200

5 Preventable deaths and deprivation | The Health Foundation. https://www.health.org.uk/news-and-comment/charts-and-infographics/preventable-death-and-deprivation (accessed 14 Apr 2021).

6 WHO | Part Two. The urgent need for action. *WHO* Published Online First: 2015.http://www.who.int/chp/chronic_disease_report/part2_ch2/en/ (accessed 15 Apr 2021).

7 Deaths involving COVID-19 by local area and socioeconomic deprivation - Office for National Statistics. https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/deathsinvolvingcovid19bylocalareasanddeprivation/deathsoccurringbetween1marchand17april (accessed 25 Apr 2021).

8 Adhikari S, Pantaleo NP, Feldman JM, *et al.* Assessment of Community-Level Disparities in Coronavirus Disease 2019 (COVID-19) Infections and Deaths in Large US Metropolitan Areas. *JAMA Netw open* 2020;3:e2016938. doi:10.1001/jamanetworkopen.2020.16938

9 Lower income people, new immigrants at higher COVID-19 risk in Toronto, data suggests | CBC News. https://www.cbc.ca/news/canada/toronto/low-income-immigrants-covid-19-infection-1.5566384 (accessed 25 Apr 2021).

10 Millett GA, Jones AT, Benkeser D, *et al.* Assessing differential impacts of COVID-19 on black communities. *Ann Epidemiol* 2020;47:37–44. doi:10.1016/j.annepidem.2020.05.003

11 Baqui P, Bica I, Marra V, *et al.* Ethnic and regional variations in hospital mortality from

15

COVID-19 in Brazil: a cross-sectional observational study. *Lancet Glob Heal* 2020;8:e1018–26. doi:10.1016/S2214-109X(20)30285-0

12 Martins-Filho PR, Araújo BCL, Sposato KB, *et al.* Racial disparities in covid-19-related deaths in brazil: Black lives matter? J. Epidemiol. 2021;31:239–40. doi:10.2188/jea.JE20200589

13 Wong DWS, Li Y. Spreading of COVID-19: Density matters. *PLoS One* 2020;15:e0242398. doi:10.1371/journal.pone.0242398

14 Coronavirus: In dense Bangladesh, social distancing a tough task | Coronavirus pandemic News | Al Jazeera. https://www.aljazeera.com/news/2020/3/20/coronavirus-in-dense-bangladesh-social-distancing-a-tough-task (accessed 25 Apr 2021).

15 For India's slum dwellers, social distancing will be impossible during Covid-19 lockdown - CNN. https://edition.cnn.com/2020/03/30/india/india-coronavirus-social-distancing-intl-hnk/index.html (accessed 25 Apr 2021).

16 Kawachi I, Berkman LF. Social Capital, Social Cohesion, and Health. In: *Social Epidemiology*. Oxford University Press 2015. 290–319. doi:10.1093/med/9780195377903.003.0008

17 Ahmed SAKS, Ajisola M, Azeem K, *et al.* Impact of the societal response to COVID-19 on access to healthcare for non-COVID-19 health issues in slum communities of Bangladesh, Kenya, Nigeria and Pakistan: results of pre-COVID and COVID-19 lockdown stakeholder engagements. *BMJ Glob Heal* 2020;5:e003042. doi:10.1136/bmjgh-2020-003042

18 Shadmi E, Chen Y, Dourado I, *et al.* Health equity and COVID-19: Global perspectives. Int. J. Equity Health. 2020;19:104. doi:10.1186/s12939-020-01218-z

19 Oliver A, Mossialos E. Equity of access to health care: Outlining the foundations for action. J. Epidemiol. Community Health. 2004;58:655–8. doi:10.1136/jech.2003.017731

20 Bhatt J, Bathija P. Ensuring Access to Quality Health Care in Vulnerable Communities. *Acad Med* 2018;93:1271–5. doi:10.1097/ACM.0000000000002254

21 Access to Health Services | Healthy People 2020. https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-health/interventions-resources/access-to-health (accessed 15 Apr 2021).

16

22 Health Disparities by Race and Ethnicity - Center for American Progress. https://www.americanprogress.org/issues/race/reports/2020/05/07/484742/health-disparities-race-ethnicity/ (accessed 23 Apr 2021).

23 Buchmueller TC, Levinson ZM, Levy HG, *et al.* Effect of the affordable care act on racial and ethnic disparities in health insurance coverage. *Am J Public Health* 2016;106:1416–21. doi:10.2105/AJPH.2016.303155

24 In U.S., 14% With Likely COVID-19 to Avoid Care Due to Cost. https://news.gallup.com/poll/309224/avoid-care-likely-covid-due-cost.aspx (accessed 23 Apr 2021).

25 Transmission of SARS-CoV-2: implications for infection prevention precautions. https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions (accessed 23 Apr 2021).

26 Sohn H. Racial and Ethnic Disparities in Health Insurance Coverage: Dynamics of Gaining and Losing Coverage Over the Life-Course. *Popul Res Policy Rev* 2017;36:181–201. doi:10.1007/s11113-016-9416-y

27 COVID-19 Racial Disparities in Testing, Infection, Hospitalization, and Death: Analysis of Epic Patient Data | KFF. https://www.kff.org/coronavirus-covid-19/issue-brief/covid-19-racial-disparities-testing-infection-hospitalization-death-analysis-epic-patient-data/ (accessed 25 Apr 2021).

28 Risk for COVID-19 Infection, Hospitalization, and Death By Race/Ethnicity | CDC. https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/hospitalization-death-by-race-ethnicity.html (accessed 25 Apr 2021).

29 Shahbazi F, Khazaei S. Socio-economic inequality in global incidence and mortality rates from coronavirus disease 2019: an ecological study. *New Microbes New Infect* 2020;38:100762. doi:10.1016/j.nmni.2020.100762

30 Seligman B, Ferranna M, Bloom DE. Social determinants of mortality from COVID-19: A simulation study using NHANES. *PLOS Med* 2021;18:e1003490. doi:10.1371/journal.pmed.1003490

31 Karmakar M, Lantz PM, Tipirneni R. Association of Social and Demographic Factors with

17

COVID-19 Incidence and Death Rates in the US. *JAMA Netw Open* 2021;4:e2036462–e2036462. doi:10.1001/jamanetworkopen.2020.36462

32 Baumer T, Phillips E, Dhadda A, *et al.* Epidemiology of the First Wave of COVID-19 ICU Admissions in South Wales—The Interplay Between Ethnicity and Deprivation. *Front Med* 2020;7:569714. doi:10.3389/fmed.2020.569714

33 Indseth T, Grøsland M, Arnesen T, *et al.* COVID-19 among immigrants in Norway, notified infections, related hospitalizations and associated mortality: A register-based study. *Scand J Public Health* 2021;49:48–56. doi:10.1177/1403494820984026

34 Germain S, Yong A. COVID-19 Highlighting Inequalities in Access to Healthcare in England: A Case Study of Ethnic Minority and Migrant Women. Fem. Leg. Stud. 2020;28:301–10. doi:10.1007/s10691-020-09437-z

35 Szczepura A. Access to health care for ethnic minority populations. Postgrad. Med. J. 2005;81:141–7. doi:10.1136/pgmj.2004.026237

36 Paremoer L, Nandi S, Serag H, *et al.* Covid-19 pandemic and the social determinants of health. BMJ. 2021;372. doi:10.1136/bmj.n129

37 Page MJ, McKenzie JE, Bossuyt PM, *et al.* The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;:n71. doi:10.1136/bmj.n71

38 Social Determinants of Health | Healthy People 2020. https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-of-health (accessed 15 Apr 2021).

39 PROGRESS-Plus | Cochrane Equity. https://methods.cochrane.org/equity/projects/evidence-equity/progress-plus (accessed 9 May 2021).

40 Ovid Database Guide. https://ospguides.ovid.com/OSPguides/medline.htm (accessed 15 Apr 2021).

41 Ottawa Hospital Research Institute. http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp (accessed 3 Apr 2021).

42 Campbell M, McKenzie JE, Sowden A, *et al.* Synthesis without meta-analysis (SWiM) in systematic reviews: Reporting guideline. *BMJ* 2020;368. doi:10.1136/bmj.l6890

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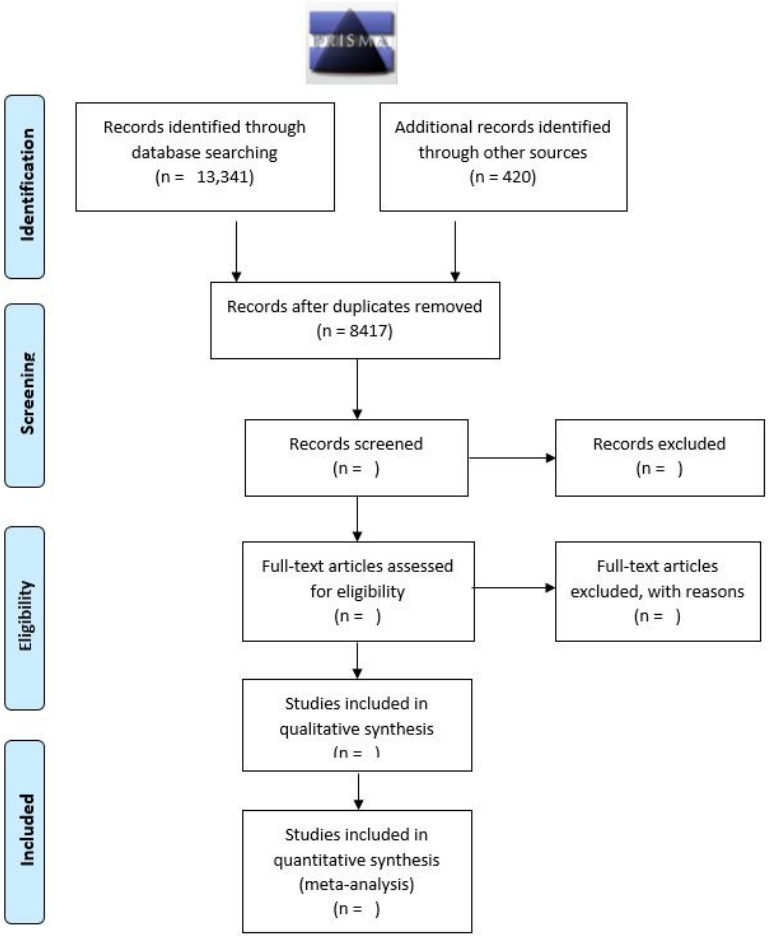

Figure 1: PRISMA 2009 Flow Diagram

Figure 1: PRISMA 2009 Flow Diagram

166x170mm (120 x 120 DPI)

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SUPPLEMENT 1

Embase

13	'health care access'/de
14	((acces* OR avail*) NEXT/2 (healthcare OR 'health care' OR 'health service*')):ti,ab,kw
15	'socioeconomics'/exp
16	('socioeconomic factors' OR 'health services accessibility'):ti,ab,kw,de
17	(education* achieve* OR education* status):ti,ab,kw,de
18	'health insurance'/de
19	'unemployment'/de
20	'social isolation'/exp
21	'social determinant of health'/de
22	'social environment'/de
23	'social exclusion'/de
24	('health insurance' (standard* NEXT/1 living) OR 'social determinant*' OR unemployment OR 'social isolation' OR 'psychosocial deprivation' OR 'social environment' OR 'social exclusion' OR 'social marginali*ation'):ti,ab,kw
25	('social determinant? of health' OR SDOH OR SDH OR 'social deprivation' OR 'social disadvantage' OR 'financial difficult*' OR 'financial problem?' OR 'income difference*' OR indigent* OR 'insurance status' OR jobless OR 'job insecurity*' OR 'low income' OR marginali* OR 'occupation* status'):ti,ab,kw
26	(Poverty OR SES OR 'social disparit*' OR 'social environment' OR 'social exclusion' OR 'social factor?' OR 'social gradient?' OR 'social position?' OR 'social variation?' OR 'socioeconomic status' OR 'socioeconomic circumstances' OR 'socioeconomic gradient'):ti,ab,kw
27	('socioeconomic health differences' OR 'socioeconomic position' OR 'socioeconomic variable' OR underprivilege* OR unemployed OR unemployment OR uninsur* OR 'vulnerable population' OR 'vulnerable group?' OR 'vulnerable communit*' OR 'vulnerable people' OR 'vulnerable person?'):ti,ab,kw
28	((socio* OR social*) NEXT/10 (predict* OR prognos* OR risk*)):ti,ab,kw

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29	#13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28
30	#12 AND #29

PubMed

1	"Coronavirus"[Mesh]
2	"Coronavirus Infections"[Mesh]
3	(coronavirus*[tw] OR corona virus*[tw] OR OC43[tw] OR NL63[tw] OR 22pE[tw] OR HKU1[tw] OR HCoV*[tw] OR ncov*[tw] OR covid*[tw] OR sars-cov*[tw] OR sarscov*[tw] OR Sars-coronavirus*[tw] OR Severe Acute Respiratory Syndrome Coronavirus*[tw])
4	#1 OR #2 OR #3
5	(MERS[tw] OR MERS-CoV[tw] OR Middle East respiratory syndrome[tw] OR camel*[tw] OR dromedary*[tw] OR equine[tw] OR coronary[tw] OR coronal[tw] OR covidence*[tw] OR covidien[tw] OR influenza virus[tw] OR HIV[tw] OR bovine[tw] OR calves[tw] OR TGEV[tw] OR feline[tw] OR porcine[tw] OR BCoV[tw] OR PEDV[tw] OR PDCoV[tw] OR FIPV[tw] OR FCoV[tw] OR SADS-CoV[tw] OR canine[tw] or CCov[tw] OR zoonotic[tw] OR avian influenza[tw] OR H1N1[tw] OR H5N1[tw] OR H5N6[tw] OR IBV[tw] OR murine corona*[tw])
6	#4 NOT #5
7	(((pneumonia[tw] OR covid*[tw] OR coronavirus*[tw] OR corona virus*[tw] OR ncov*[tw] OR 2019ncov[tw] OR sars*[tw]) OR "Pneumonia"[Mesh]) AND Wuhan[tw])
8	(coronavirus disease 2019[tw] OR 2019-ncov[tw] OR 2019nCoV[tw] OR ncov2019[tw] OR ncov19[tw] OR ncov-19[tw] OR HCoV-19[tw] OR 2019-novel CoV[tw] OR severe acute respiratory syndrome coronavirus 2[tw] OR sars2[tw] OR sars 2[tw] OR sars-cov2[tw] OR sars-cov-2[tw] OR sarscov2[tw] OR sarscov-2[tw] OR Sars-coronavirus2[tw] OR Sars-coronavirus-2[tw] OR SARS-CoV-19[tw] OR SARS-like coronavirus*[tw] OR coronavirus-19[tw] OR covid19[tw] OR covid-19[tw] OR covid 2019[tw] OR ((novel[tw] OR new[tw] OR nouveau[tw]) AND (CoV OR nCoV OR

3

	covid OR coronavirus*) OR ("corona virus" OR Pandemi*) OR coronavirus pandemic[tw] OR covid pandemic [tw] OR covid19 pandemic[tw] OR covid-19 pandemic[tw])
9	"COVID-19" [Supplementary Concept]
10	"severe acute respiratory syndrome coronavirus 2" [Supplementary Concept]
11	#7 OR #12 OR #9 OR #10
12	#6 OR #11
13	"Health Services Accessibility"[Mesh]
14	(acces* healthcare[tw] OR acces* heath care[tw] OR acces* health service*[tw] OR avail* healthcare[tw] OR avail* health care[tw] OR avail* health service*[tw])
15	“socioeconomic factors”[MeSH]
16	(socioeconomic factors[tw] OR socioeconomic[tw] OR health services accessibility[tw])
17	(education* achieve*[tw] OR education* status[tw])
18	“Insurance, Health”[MeSH:NoExp]
19	“Unemployment”[MeSH]
20	"Social Isolation"[Mesh]
21	“Social Determinants of Health”[MeSH]
22	"Social Environment"[Mesh:NoExp]
23	"Social Marginalization"[Mesh]
24	(health insurance[tw] OR “standard of living”[tw] OR social determinant*[tw] OR unemployment[tw] OR social isolation[tw] OR psychosocial deprivation[tw] OR social environment[tw] OR social exclusion[tw] OR social marginalization[tw] OR social marginalisation[tw])
25	(social determinant of health[tw] OR social determinants of health[tw] OR SDOH[tw] OR SDH[tw] OR social deprivation[tw] OR social disadvantage[tw] OR financial difficult*[tw] OR financial problem[tw] OR financial problems[tw] OR income differences[tw] OR indigent[tw] OR insurance status[tw] OR jobless[tw] OR job insecurit*[tw] OR low income[tw] OR marginali*[tw] OR occupation* status[tw])

4

26	(poverty[tw] OR SES[tw] OR social disparit*[tw] OR social factor[tw] OR social factors[tw] OR social gradient[tw] OR social gradients[tw] OR social position[tw] OR social positions[tw] OR social variation[tw] OR social variations[tw] OR socioeconomic status[tw] OR socioeconomic circumstance*[tw] OR socioeconomic gradient[tw])
27	(socioeconomic health differences[tw] OR socioeconomic position[tw] OR socioeconomic variable[tw] OR underprivilege*[tw] OR unemployed[tw] OR uninsur*[tw] OR vulnerable population[tw] OR vulnerable populations[tw] OR vulnerable group[tw] OR vulnerable groups[tw] OR vulnerable communit*[tw] OR vulnerable people[tw] OR vulnerable person[tw] OR vulnerable persons[tw])
28	(socio* predict*[tw] OR socio* prognos*[tw] OR socio* risk*[tw] OR social*predict*[tw] OR social* prognos*[tw] OR social* risk*[tw])
29	#13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28
30	#12 AND #29

Scopus

1	TITLE-ABS-KEY(coronavirus* OR “corona virus*” OR OC43 OR NL63 OR 22pE OR HKU1 OR HCoV* OR ncov* OR covid* OR sars-cov* OR sarscov* OR Sars-coronavirus* OR “Severe Acute Respiratory Syndrome Coronavirus*” OR coronavirnae OR “coronavirus infection”)
2	TITLE-ABS-KEY(SARS or SARS-CoV OR MERS OR MERS-CoV OR “Middle East respiratory syndrome” OR camel* OR dromedary* OR equine OR coronary OR coronal OR covidence* OR covidien OR influenza virus OR HIV or bovine OR calves OR TGEV OR feline OR porcine OR BCoV OR PEDV OR PDCoV OR FIPV OR FCoV OR SADS-CoV OR canine or CCov OR zoonotic OR avian influenza OR H1N1 OR H5N1 OR H5N6 OR IBV OR “murine corona*”)
3	#1 NOT #2
4	TITLE-ABS-KEY((pneumonia OR covid* OR coronavirus* OR “corona virus*” OR ncov* OR 2019-ncov OR sars*) AND Wuhan)

5

5	TITLE-ABS-KEY(“coronavirus disease 2019” OR 2019-ncov OR 2019nCoV OR ncov2019 OR ncov19 OR ncov-19 OR HCoV-19 OR "2019-novel CoV" OR “severe acute respiratory syndrome coronavirus 2” OR sars2 OR “sars 2” OR sars-cov2 OR sars-cov-2 OR sarscov2 OR sarscov-2 OR Sars-coronavirus2 OR Sars-coronavirus-2 OR SARS-CoV-19 OR "SARS-like coronavirus*" OR coronavirus-19 OR covid19 OR covid-19 OR “covid 2019” OR ((novel OR new OR nouveau) W/2 (CoV OR nCoV OR covid OR coronavirus* OR "corona virus" OR Pandemi*2)) OR ((covid OR covid19 OR covid-19) AND pandemic*2) OR (coronavirus* AND pneumonia))
6	#3 OR #4 OR #5
7	TITLE-ABS-KEY((acces* OR avail*) W/2 (healthcare OR “health care” OR “health service*”))
8	TITLE-ABS-KEY(“socioeconomic factors” OR “health services accessibility”)
9	TITLE-ABS-KEY (“education* achieve*” OR “education* status”)
10	TITLE-ABS-KEY(“health insurance” (standard* W/1 living) OR “social determinant*” OR unemployment OR “social isolation” OR “psychosocial deprivation” OR “rural health” OR “social environment” OR “social exclusion” OR “social marginali?ation”)
11	TITLE-ABS-KEY(“social deprivation” OR “social disadvantage” OR “financial difficult*” OR “social determinant* of health” OR SDOH OR SDH OR “financial problem?” OR “income difference*” OR indigent* OR “insurance status” OR jobless OR “job insecurity*” OR “low income” OR marginali* OR “occupation* status”)
12	TITLE-ABS-KEY(poverty OR SES OR “social disparit*” OR “social environment” OR “social exclusion” OR “social factor?” OR “social gradient?” OR “social position?” OR “social variation?” OR “socioeconomic status” OR “socioeconomic circumstances” OR “socioeconomic gradient”)
13	TITLE-ABS-KEY(“socioeconomic health differences” OR “socioeconomic position” OR “socioeconomic variable” OR underprivilege* OR unemployed OR unemployment OR uninsur* OR “vulnerable population” OR “vulnerable group?” OR “vulnerable communit*” OR “vulnerable people” OR “vulnerable person?”)
14	TITLE-ABS-KEY((socio* OR social*) W/10 (predict* OR prognos* OR risk*))

6

15	#7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14
16	#6 AND #15

WHO Database

1	(acces* healthcare OR acces* heath care OR acces* health service* OR avail* healthcare OR avail* health care OR avail* health service*)
2	("socioeconomic factors" OR "health services accessibility")
3	(education* achieve* OR education* status)
4	("health insurance" OR social determinant* OR unemployment OR "social isolation" OR "psychosocial deprivation" OR "social environment" OR "social exclusion" OR social marginali?ation)
5	("social deprivation" OR "social disadvantage" OR financial difficult* OR "social determinants of health" OR SDOH OR SDH OR "financial problem" OR "financial problems" OR "income difference" OR "income differences" OR indigent* OR "insurance status" OR jobless OR "job insecurity" OR "low income" OR marginali* OR occupation* status)
6	(poverty OR SES OR social disparit* OR "social environment" OR "social exclusion" OR "social factor" OR "social factors" OR "social gradient" OR "social position" OR "social positions" OR "social variation" OR "social variations" OR "socioeconomic status" OR "socioeconomic circumstances" OR "socioeconomic gradient")
7	("socioeconomic health differences" OR "socioeconomic position" OR "socioeconomic variable" OR underprivilege* OR unemployed OR unemployment OR uninsur* OR "vulnerable population" OR "vulnerable group" OR "vulnerable groups" OR "vulnerable community" OR "vulnerable communities" OR "vulnerable people" OR "vulnerable person")
8	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7

PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocol*

Section and topic	Item No	Checklist item
ADMINISTRATIVE INFORMATION		
Title:		
Identification	1a	Identify the report as a protocol of a systematic review (page 1)
Update	1b	If the protocol is for an update of a previous systematic review, identify as such (N/A)
Registration	2	If registered, provide the name of the registry (such as PROSPERO) and registration number (page 3)
Authors:		
Contact	3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author (page 1)
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review (page 12/13)
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments (N/A)
Support:		
Sources	5a	Indicate sources of financial or other support for the review (page 13)
Sponsor	5b	Provide name for the review funder and/or sponsor (page 13)
Role of sponsor or funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol (N/A)
INTRODUCTION		
Rationale	6	Describe the rationale for the review in the context of what is already known (page 4/5/6)
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO) (page 6)
METHODS		
Eligibility criteria	8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review (page 8/9)
Information sources	9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage (page 10)
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated (page 10, Supplement 1)
Study records:		
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review (page 10/11)

Selection process	11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis) (page 10)
Data collection process	11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators (page 10)
Data items	12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications (page 11)
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale (page 11)
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis (page 11)
Data synthesis	15a	Describe criteria under which study data will be quantitatively synthesised (page 11/12)
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I^2, Kendall's τ) (N/A)
	15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression) (N/A)
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned (page 11/12)
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies) (at page 8)
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (such as GRADE) (page 6/7)

*** It is strongly recommended that this checklist be read in conjunction with the PRISMA-P Explanation and Elaboration (cite when available) for important clarification on the items. Amendments to a review protocol should be tracked and dated. The copyright for PRISMA-P (including checklist) is held by the PRISMA-P Group and is distributed under a Creative Commons Attribution Licence 4.0.**

From: Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart L, PRISMA-P Group. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ. 2015 Jan 2;349(jan02 1):g7647.

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The impact and variability of social determinants of health on the transmission and outcomes of COVID-19 across the world: a systematic review protocol

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Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology, Infectious diseases, Sociology
Keywords:	Epidemiology < TROPICAL MEDICINE, Public health < INFECTIOUS DISEASES, PUBLIC HEALTH

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1

The impact and variability of social determinants of health on the transmission and outcomes of COVID-19 across the world: a systematic review protocol

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Word Count: ≈2250 Words

STRENGTHS AND LIMITATIONS OF THIS STUDY:

- This review will address the impact of a wide range of social determinants of health (SODH) and the geographical variations that affect the transmission and outcomes of COVID-19.
- A multidisciplinary team is involved in this review and the search strategy was undertaken with the involvement of a library information scientist.
- A standard scientific reporting format will be used to summarize the review findings to avoid the shortcoming and biases of narrative synthesis.
- The influx of journal articles that were published over the last year in response to the current pandemic, without a scientific track record of previous studies, will bereviewed in this manuscript

ABSTRACT

Introduction:

The COVID-19 pandemic has exacerbated health inequalities across the globe, disproportionately affecting those with poor social determinants of health (SDOH). It is imperative to understand how SDOH influences the transmission and outcomes (positive case, hospitalization, and mortality) of COVID-19. This systematic review will investigate the impact of a wide range of SDOH across the globe on the transmission and outcomes of COVID-19.

Methods and analysis:

This review will follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocol (PRISMA) guidelines. We searched articles published from January 1, 2019, to December 31, 2021, in three electronic bibliographic databases (MEDLINE via PubMed, Embase, and Scopus), as well as the WHO COVID-19 Global Research on coronavirus disease database. We will consider observational studies that report statistical relationships between the social determinants of health (as listed in PROGRESS-Plus and Healthy People 2020) and COVID-19 transmission and outcomes. There will be no limitation on the geographical location of publications. The quality of included observational studies will be assessed using a modified version of the Newcastle Ottawa Scale (NOS). A narrative Synthesis without Meta-Analysis (SWiM) reporting standards will be used to report the review findings.

Ethics and dissemination:

This review will be based on published studies obtained from publicly available sources, and therefore, ethical approval is not required. We will publish the results of this review in a peer-reviewed journal, as well as present the study findings at a national conference.

PROSPERO registration number: CRD42021228818

Keywords:

Social determinants of health, COVID-19, transmission, outcomes, geographical variations

INTRODUCTION

In December 2019, a pneumonia case associated with SARS-CoV-2 was first identified in Wuhan, Hubei province, China. As of 24 April 2021, this emerging infection has caused 154,640,649 infections and 3,232,285 deaths globally.[1] The current experience of the COVID-19 pandemic has taken the world by surprise, despite the modern advances in health sciences. Outcomes of the disease include not only an increased death toll but have put a spotlight on health inequalities.[2] According to the World Health Organization (WHO), social determinants of health (SDOH) are the non-medical factors that influence the health outcome of humans. They broadly define it by the conditions in which people are born, grow, work, live, and age and the wider set of forces and systems shaping the conditions of daily life.[3] All these conditions have a major impact on the health, wellbeing, and quality of life of an individual.[4] The transmission of any communicable disease is highly dependent on these SDOH. The vast dynamics of disease transmission may result in symptomatic or asymptomatic disease outcomes, which may lead to hospitalization and/or death. Generally, people residing in socioeconomically underdeveloped areas are at least three times more likely to die of preventable diseases compared to those in developed areas.[5] The socioeconomically disadvantaged population also has limited access to healthcare services. Studies show that even those who live above the poverty line are more prone to be affected by chronic health conditions.[6]

This pandemic has made it clear that social determinants of health differentially affect disease transmission and outcomes globally.[2] Reports and studies generated from countries with high infection rates suggest that geographic variations were signifying higher transmission rates, hospitalizations, and mortality in marginalized, densely populated, low-income, and crowded households.[7–12]. Populations living in crowded neighborhoods are at a higher risk of becoming ill and transmitting the virus at an increased rate, as social distancing may not be feasible.[13–15]

Access to health care services is described by the National Academies of Sciences, Engineering, and Medicine as the "timely use of personal health services to achieve the best possible health outcomes".[16] Access to healthcare is an influential SDOH that has gained attention during this COVID-19 pandemic.[17, 18] Accessibility to health care services may include geographic accessibility (within physical reach), economic accessibility (within financial reach), and cultural accessibility (acceptance and communication).[19–21] Health insurance is an important aspect of accessibility which is evident from several studies and reports. It has been demonstrated that there is unequal coverage of health insurance and access to services, leading to poorer health outcomes in marginalized groups. [22, 23] In a study by Gallup and West Health, it was found that 14% of adults in the U.S. do not seek healthcare when experiencing fever and dry cough due to the high cost of healthcare.[24] Given the fact that fever and dry cough are the most common symptoms of COVID-19, there is a high chance that many COVID-19 cases may go unnoticed or undiagnosed, which may result in unknowingly transmitting the disease.[25] Primary care visits may not be feasible, or people may hesitate to use health care resources without health insurance. This inability puts those without health insurance at risk of not being screened for chronic conditions, such as CVD (cardiovascular disease), hypertension, asthma, and diabetes. Therefore during this health emergency, access to health care may play a major role in whether an individual will test for COVID-19 and follow recommendations, such as social distancing and other preventive measures.[26]

In terms of racial disparities, the United States has experienced disproportionate outcomes of infection, hospitalization, and mortality among historically marginalized groups, such as African American, Hispanic and Asian populations. [27, 28] studies show that mortality due to COVID-19 is associated with socioeconomic class.[29–31] Black, Asian, and minority ethnic (BAME) backgrounds represented one-third of the ICU admission in UK hospitals, while Somali immigrants living in Norway had a ten times higher rate of infection compared to the non-immigrants.[32, 33] Those who are minorities may not be aware of their underlying conditions due to barriers in accessing primary care and might be at high risk of developing more severe symptoms during this pandemic situation.[34, 35]

It is imperative to focus on SDOH during the COVID-19 pandemic to better understand preventable health inequalities and to improve health outcomes. As such, there is an immediate need to comprehend the social determinants of COVID-19 transmission and outcomes to decrease human suffering and save lives.[36] In addition to known clinical risk factors, knowledge of social risk factors will help policymakers and healthcare decision-makers to prioritize groups who are most at-risk during the COVID-19 pandemic and formulate health messages accordingly.

Objectives

1. To find the impact of social determinants of health (SDOH) on the transmission and outcomes of COVID-19.

2. To explore the geographic variations of SDOH on transmission and outcomes of COVID-19.

METHODS

This protocol is registered with the International Prospective Register of Systematic Reviews (PROSPERO) under the registration number CRD42021228818 and follows the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines,[37] as shown in **Figure 1**. The planned start dates of this review is 24 September 2020 and the anticipated end date will be 30 April 2022.

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Figure 1: PRISMA 2009 Flow Diagram

8

Eligibility criteria

A summary of eligibility criteria is shown in **Table 1**.

Types of studies:

The types of studies that will be considered in this systematic review will include empirical quantitative studies following prospective and retrospective cohort, case-control, cross-sectional, pre-post designs, and modeling studies that report statistical relationships between exposures of interest (i.e., social determinants of health) and COVID-19 transmission and outcomes. The review will address the potential interaction effect or intersectional approach only if the analysis reports such findings, which is generally found in predictive modeling. Any hypothetical interaction or intersectional findings will be excluded from this review. This review will include studies with both self-reported and directly tested measures. We will only include studies published in the English language. Qualitative studies, reviews, narrative reviews, systematic reviews, meta-analyses, pharmacological and biochemical studies, animal model studies, conference abstracts, conference proceedings, and theses/dissertations will not be included in this systematic review. Simulation modeling, which does not report new empirical data, opinion literature, including commentaries, editorials, and analyses that discuss COVID-19 regarding equity, social determinants, and/or vulnerable populations, will also be excluded from the review.

Types of study population:

Studies in this review will include populations of all ages, ethnicity, gender, and geographic location. We will consider any population that has been tested for COVID-19.

Types of outcome measures:

Studies will be included if they use a measure for SDOH that could be hypothesized to affect the transmission and outcomes (confirmed positive case, hospitalization, and mortality) of COVID-19. We will use Healthy People 2020 and PROGRESS-Plus to classify our definition of social

determinants of health.[38, 39] Healthy People 2020 addresses five SDOH; economic stability, education, social and community context, health and health care, neighborhood, and built environment. PROGRESS-Plus refers to the place of residence, race/ethnicity/culture/language, occupation, gender, religion, education, socioeconomic status, and social capital. Plus refers to personal characteristics associated with discrimination (e.g., age, disability), features of relationships (e.g., smoking parents, excluded from school), and time-dependent relationships (e.g., leaving the hospital, respite care, other instances where a person may be temporarily at a disadvantage).

Table 1: Inclusion and exclusion criteria for the review

Inclusion criteria	Exclusion criteria
▪ Empirical-based observational quantitative studies such as cross-sectional, case-control, prospective and retrospective cohort, pre-post designs, and modeling studies ▪ Studies covering any geographical locations ▪ Studies in the English language only ▪ Studies covering people of all age groups ▪ Studies that include SDOH listed in PROGRESS-Plus & Healthy People 2020 ▪ Studies that include any COVID-19 positive population ▪ Studies that include populations tested positive for COVID-19, with underlying co-morbidities	▪ Studies in Non-English language ▪ Qualitative studies, simulation modeling studies (without new empirical data), review studies, systematic review, review of the systematic review, meta-analysis, narrative reviews, conference abstracts, proceedings, thesis ▪ Pharmacological and biochemical studies, animal model studies, ▪ Opinion literature, including commentaries, editorials, brief reports, perspectives, and analyses ▪ Studies that include COVID-19 disease outcomes among special populations (such as patients with HIV, prisoners, cancer patients, etc.)

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▪ Studies that include a population that required hospitalization or resulted in mortality due to COVID-19	▪ Articles with missing descriptions of findings and/or results

Search strategy

We have developed a comprehensive literature search to locate both published and non-traditionally literature. We will search for articles published from January 1, 2019, to December 31, 2021, in three electronic bibliographic databases (PubMed, Embase, and Scopus), as well as the WHO Global Research on Coronavirus Disease database, to ensure results focused on the novel COVID-19 pandemic and retrieve pre-print articles and non-traditionally published literature. Our COVID_19 search strategy was developed using the published Ovid Embase COVID-19 search strategy translated for use in the searched databases.[40] The full, detailed search strategy is available in **Supplement 1**. Following the search, all identified citations will be imported into EndNote X9 (Clarivate Analytics, PA, USA), and duplicates removed. Deduplicated results will be exported to an Excel spreadsheet for screening. The reference lists of all included studies will then be reviewed for eligible studies.

Study records

Selection process:

Based on the title and abstract (where available), ten (10) researchers will initially review and assess potential articles for eligibility that meet inclusion criteria, while maintaining a low threshold for consideration for further review. The same researchers will screen the full text of the potential articles for inclusion. We will resolve disagreement or uncertainty regarding the eligibility of particular studies through discussion by two independent researchers.

Data management and collection:

Ten (10) researchers will work on data extraction using a piloted data extraction tool, and the extracted data will be reviewed by a supervisor for errors.

Data to be collected:

11

a. Study details (title, year of publication, author, abstract, study design, country, region)

b. Study population characteristics (age, sex…)

c. Sampling strategy and sample size

d. SODH including participant demographics (place of residence, occupation, race/ethnicity/culture/language, education, religion, social capital, socioeconomic status, economic stability, education, social and community contexts, health and health care access, neighborhood and built environment).[38, 39]

e. Outcome severity of COVID-19

OUTCOMES

This systematic review will focus on SDOH that impacts the transmission and outcomes of COVID-19. We will also look for the geographical variations of these outcomes from the selected articles for this review. The following outcomes will be examined:

a. Positive COVID-19 cases

b. Hospitalization due to COVID-19 that includes regular bed patients admission, High Dependency Unit (HDU) patient admission, Intensive Care Unit (ICU) patient admission

c. Mortality due to COVID-19

RISK OF BIAS

To assess the quality of included observational studies, we will use a modified version of the Newcastle Ottawa Scale.[41] Two reviewers will independently assess each study, with discrepancies resolved by agreement or a third independent assessor if such agreement cannot be achieved.

DATA SYNTHESIS & ANALYSIS

This review is broad and exploratory in nature, and therefore, a meta-analysis of the effect estimate is not planned, but data will be evaluated for the possibility of conducting a meta-analysis. To avoid the shortcomings in the reporting of narrative synthesis, we will follow the Synthesis without Meta-Analysis (SWiM) reporting standards.[42] We will tabulate the results

and narrate the summary of findings for each SDOH identified in this review. Additionally, we will prepare at least three tables consisting of the study characteristics, participant characteristics, and a summary of findings that describes study setting, size, methodology, primary outcomes, secondary outcomes, summary statistics, and/or statistical results (risk ratios, odds ratios, risk differences, mean differences, standardized mean differences, the ratio of means), and relationship to SDOH.

DISCUSSION

Our systematic review will focus on the role that social determinants of health play in the transmission and outcomes of COVID-19. We hope that the concluded review will provide evidence to determine the impact and variability of social determinants of health associated with SARS-CoV-2 infection and the dynamics of transmission and outcomes. This protocol will guide the review homogeneously and methodologically. Our systematic review will address a gap in the COVID-19 literature, by exploring not only the impact social determinants of health have on the transmission and outcomes of the disease but also by exploring the global geographical differences of SDOH and its impact on the COVID-19 pandemic. Through this review, we hope to provide an empirical understanding of the diverse social determinants of COVID-19, which could appraise the global pandemic response efforts as well as provide comprehensive evidence for future public health policy implications.

PATIENT/PUBLIC INVOLVEMENT

There will be no patient or public involvement in this study.

ETHICS AND DISSEMINATION

As the data included in this review have been published or obtained from publicly available sources, ethical approval is not required. We will submit the full systematic review manuscript to a peer-reviewed journal and will present the study results at a national conference.

AUTHOR CONTRIBUTIONS

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All authors have contributed equally to the design and conceptualization of this review. MA, AW, FNR, FRO, SS, SR, CAM, and LI drafted the manuscript and protocol with UKS, FF, SRM, and LF as editors. LF developed the search strategy with input from UKS, FF, and SRM concerning keywords and databases. All review methods were planned and discussed with the authors, with LF acting as a methodological mentor.

FUNDING

All authors declare that they have not received any grant/fund for this research from any source.

COMPETING INTERESTS

Authors declare that they have no competing interests.

PATIENT CONSENT FOR PUBLICATION

Not required

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REFERENCES

1 WHO Coronavirus (COVID-19) Dashboard | WHO Coronavirus (COVID-19) Dashboard With Vaccination Data. https://covid19.who.int/ (accessed 6 May 2021).

2 Abrams EM, Szefler SJ. COVID-19 and the impact of social determinants of health. Lancet Respir. Med. 2020;8:659–61. doi:10.1016/S2213-2600(20)30234-4

3 WHO | Social determinants of health.

4 Marmot M, Allen JJ. Social determinants of health equity. Am. J. Public Health. 2014;104. doi:10.2105/AJPH.2014.302200

5 Preventable deaths and deprivation | The Health Foundation. https://www.health.org.uk/news-and-comment/charts-and-infographics/preventable-death-and-deprivation (accessed 14 Apr 2021).

6 WHO | Part Two. The urgent need for action. *WHO* Published Online First: 2015.http://www.who.int/chp/chronic_disease_report/part2_ch2/en/ (accessed 15 Apr 2021).

7 Deaths involving COVID-19 by local area and socioeconomic deprivation - Office for National Statistics. https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/deathsinvolvingcovid19bylocalareasanddeprivation/deathsoccurringbetween1marchand17april (accessed 25 Apr 2021).

8 Adhikari S, Pantaleo NP, Feldman JM, *et al.* Assessment of Community-Level Disparities in Coronavirus Disease 2019 (COVID-19) Infections and Deaths in Large US Metropolitan Areas. *JAMA Netw open* 2020;3:e2016938. doi:10.1001/jamanetworkopen.2020.16938

9 Lower income people, new immigrants at higher COVID-19 risk in Toronto, data suggests | CBC News. https://www.cbc.ca/news/canada/toronto/low-income-immigrants-covid-19-infection-1.5566384 (accessed 25 Apr 2021).

10 Millett GA, Jones AT, Benkeser D, *et al.* Assessing differential impacts of COVID-19 on black communities. *Ann Epidemiol* 2020;47:37–44. doi:10.1016/j.annepidem.2020.05.003

11 Baqui P, Bica I, Marra V, *et al.* Ethnic and regional variations in hospital mortality from

COVID-19 in Brazil: a cross-sectional observational study. *Lancet Glob Heal* 2020;8:e1018–26. doi:10.1016/S2214-109X(20)30285-0

12 Martins-Filho PR, Araújo BCL, Sposato KB, *et al.* Racial disparities in covid-19-related deaths in brazil: Black lives matter? J. Epidemiol. 2021;31:239–40. doi:10.2188/jea.JE20200589

13 Wong DWS, Li Y. Spreading of COVID-19: Density matters. *PLoS One* 2020;15:e0242398. doi:10.1371/journal.pone.0242398

14 Coronavirus: In dense Bangladesh, social distancing a tough task | Coronavirus pandemic News | Al Jazeera. https://www.aljazeera.com/news/2020/3/20/coronavirus-in-dense-bangladesh-social-distancing-a-tough-task (accessed 25 Apr 2021).

15 For India's slum dwellers, social distancing will be impossible during Covid-19 lockdown - CNN. https://edition.cnn.com/2020/03/30/india/india-coronavirus-social-distancing-intl-hnk/index.html (accessed 25 Apr 2021).

16 Kawachi I, Berkman LF. Social Capital, Social Cohesion, and Health. In: *Social Epidemiology*. Oxford University Press 2015. 290–319. doi:10.1093/med/9780195377903.003.0008

17 Ahmed SAKS, Ajisola M, Azeem K, *et al.* Impact of the societal response to COVID-19 on access to healthcare for non-COVID-19 health issues in slum communities of Bangladesh, Kenya, Nigeria and Pakistan: results of pre-COVID and COVID-19 lockdown stakeholder engagements. *BMJ Glob Heal* 2020;5:e003042. doi:10.1136/bmjgh-2020-003042

18 Shadmi E, Chen Y, Dourado I, *et al.* Health equity and COVID-19: Global perspectives. Int. J. Equity Health. 2020;19:104. doi:10.1186/s12939-020-01218-z

19 Oliver A, Mossialos E. Equity of access to health care: Outlining the foundations for action. J. Epidemiol. Community Health. 2004;58:655–8. doi:10.1136/jech.2003.017731

20 Bhatt J, Bathija P. Ensuring Access to Quality Health Care in Vulnerable Communities. *Acad Med* 2018;93:1271–5. doi:10.1097/ACM.0000000000002254

21 Access to Health Services | Healthy People 2020. https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-health/interventions-resources/access-to-health (accessed 15 Apr 2021).

22 Health Disparities by Race and Ethnicity - Center for American Progress. https://www.americanprogress.org/issues/race/reports/2020/05/07/484742/health-disparities-race-ethnicity/ (accessed 23 Apr 2021).

23 Buchmueller TC, Levinson ZM, Levy HG, *et al.* Effect of the affordable care act on racial and ethnic disparities in health insurance coverage. *Am J Public Health* 2016;106:1416–21. doi:10.2105/AJPH.2016.303155

24 In U.S., 14% With Likely COVID-19 to Avoid Care Due to Cost. https://news.gallup.com/poll/309224/avoid-care-likely-covid-due-cost.aspx (accessed 23 Apr 2021).

25 Transmission of SARS-CoV-2: implications for infection prevention precautions. https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions (accessed 23 Apr 2021).

26 Sohn H. Racial and Ethnic Disparities in Health Insurance Coverage: Dynamics of Gaining and Losing Coverage Over the Life-Course. *Popul Res Policy Rev* 2017;36:181–201. doi:10.1007/s11113-016-9416-y

27 COVID-19 Racial Disparities in Testing, Infection, Hospitalization, and Death: Analysis of Epic Patient Data | KFF. https://www.kff.org/coronavirus-covid-19/issue-brief/covid-19-racial-disparities-testing-infection-hospitalization-death-analysis-epic-patient-data/ (accessed 25 Apr 2021).

28 Risk for COVID-19 Infection, Hospitalization, and Death By Race/Ethnicity | CDC. https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/hospitalization-death-by-race-ethnicity.html (accessed 25 Apr 2021).

29 Shahbazi F, Khazaei S. Socio-economic inequality in global incidence and mortality rates from coronavirus disease 2019: an ecological study. *New Microbes New Infect* 2020;38:100762. doi:10.1016/j.nmni.2020.100762

30 Seligman B, Ferranna M, Bloom DE. Social determinants of mortality from COVID-19: A simulation study using NHANES. *PLOS Med* 2021;18:e1003490. doi:10.1371/journal.pmed.1003490

31 Karmakar M, Lantz PM, Tipirneni R. Association of Social and Demographic Factors with

COVID-19 Incidence and Death Rates in the US. *JAMA Netw Open* 2021;4:e2036462–e2036462. doi:10.1001/jamanetworkopen.2020.36462

32 Baumer T, Phillips E, Dhadda A, *et al.* Epidemiology of the First Wave of COVID-19 ICU Admissions in South Wales—The Interplay Between Ethnicity and Deprivation. *Front Med* 2020;7:569714. doi:10.3389/fmed.2020.569714

33 Indseth T, Grøsland M, Arnesen T, *et al.* COVID-19 among immigrants in Norway, notified infections, related hospitalizations and associated mortality: A register-based study. *Scand J Public Health* 2021;49:48–56. doi:10.1177/1403494820984026

34 Germain S, Yong A. COVID-19 Highlighting Inequalities in Access to Healthcare in England: A Case Study of Ethnic Minority and Migrant Women. Fem. Leg. Stud. 2020;28:301–10. doi:10.1007/s10691-020-09437-z

35 Szczepura A. Access to health care for ethnic minority populations. Postgrad. Med. J. 2005;81:141–7. doi:10.1136/pgmj.2004.026237

36 Paremoer L, Nandi S, Serag H, *et al.* Covid-19 pandemic and the social determinants of health. BMJ. 2021;372. doi:10.1136/bmj.n129

37 Page MJ, McKenzie JE, Bossuyt PM, *et al.* The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;:n71. doi:10.1136/bmj.n71

38 Social Determinants of Health | Healthy People 2020. https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-of-health (accessed 15 Apr 2021).

39 PROGRESS-Plus | Cochrane Equity. https://methods.cochrane.org/equity/projects/evidence-equity/progress-plus (accessed 9 May 2021).

40 Ovid Database Guide. https://ospguides.ovid.com/OSPguides/medline.htm (accessed 15 Apr 2021).

41 Ottawa Hospital Research Institute. http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp (accessed 3 Apr 2021).

42 Campbell M, McKenzie JE, Sowden A, *et al.* Synthesis without meta-analysis (SWiM) in systematic reviews: Reporting guideline. *BMJ* 2020;368. doi:10.1136/bmj.l6890

18

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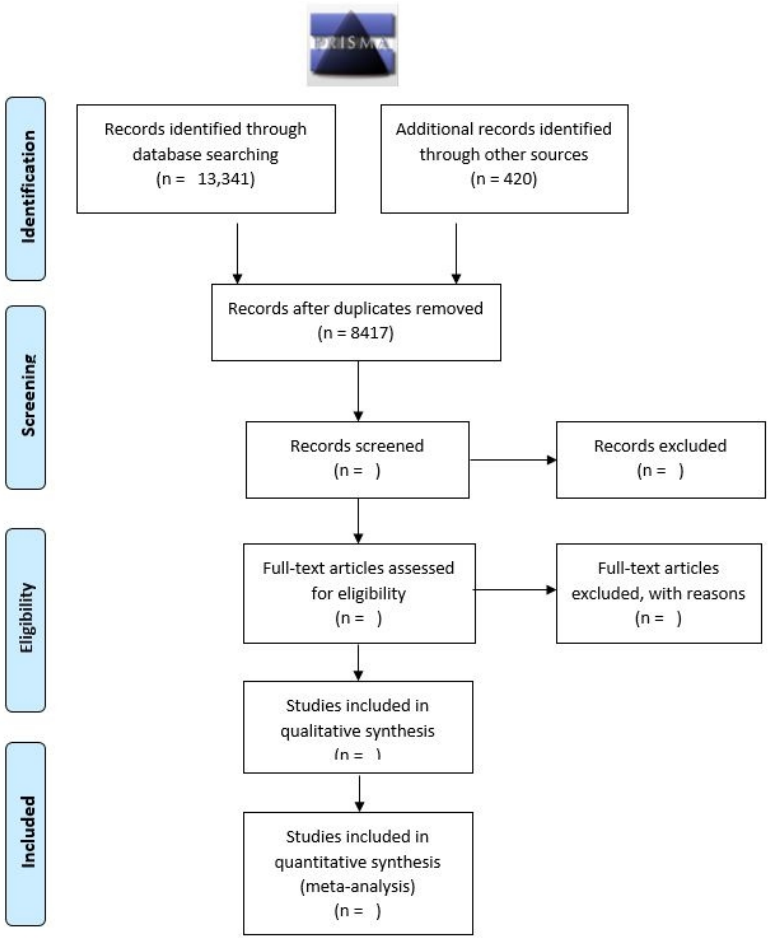

Figure 1: PRISMA 2009 Flow Diagram

Figure 1: PRISMA 2009 Flow Diagram

166x170mm (120 x 120 DPI)

1

SUPPLEMENT 1:

Embase

13	'health care access'/de
14	((acces* OR avail*) NEXT/2 (healthcare OR 'health care' OR 'health service*')):ti,ab,kw
15	'socioeconomics'/exp
16	('socioeconomic factors' OR 'health services accessibility'):ti,ab,kw,de
17	(education* achieve* OR education* status):ti,ab,kw,de
18	'health insurance'/de
19	'unemployment'/de
20	'social isolation'/exp
21	'social determinant of health'/de
22	'social environment'/de
23	'social exclusion'/de
24	('health insurance' (standard* NEXT/1 living) OR 'social determinant*' OR unemployment OR 'social isolation' OR 'psychosocial deprivation' OR 'social environment' OR 'social exclusion' OR 'social marginali*ation'):ti,ab,kw
25	('social determinant? of health' OR SDOH OR SDH OR 'social deprivation' OR 'social disadvantage' OR 'financial difficult*' OR 'financial problem?' OR 'income difference*' OR indigent* OR 'insurance status' OR jobless OR 'job insecurity*' OR 'low income' OR marginali* OR 'occupation* status'):ti,ab,kw
26	(Poverty OR SES OR 'social disparit*' OR 'social environment' OR 'social exclusion' OR 'social factor?' OR 'social gradient?' OR 'social position?' OR 'social variation?' OR 'socioeconomic status' OR 'socioeconomic circumstances' OR 'socioeconomic gradient'):ti,ab,kw
27	('socioeconomic health differences' OR 'socioeconomic position' OR 'socioeconomic variable' OR underprivilege* OR unemployed OR unemployment OR uninsur* OR 'vulnerable population' OR 'vulnerable group?' OR 'vulnerable communit*' OR 'vulnerable people' OR 'vulnerable person?'):ti,ab,kw
28	((socio* OR social*) NEXT/10 (predict* OR prognos* OR risk*)):ti,ab,kw

2

29	#13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28
30	#12 AND #29

PubMed

1	"Coronavirus"[Mesh]
2	"Coronavirus Infections"[Mesh]
3	(coronavirus*[tw] OR corona virus*[tw] OR OC43[tw] OR NL63[tw] OR 22pE[tw] OR HKU1[tw] OR HCoV*[tw] OR ncov*[tw] OR covid*[tw] OR sars-cov*[tw] OR sarscov*[tw] OR Sars-coronavirus*[tw] OR Severe Acute Respiratory Syndrome Coronavirus*[tw])
4	#1 OR #2 OR #3
5	(MERS[tw] OR MERS-CoV[tw] OR Middle East respiratory syndrome[tw] OR camel*[tw] OR dromedary*[tw] OR equine[tw] OR coronary[tw] OR coronal[tw] OR covidence*[tw] OR covidien[tw] OR influenza virus[tw] OR HIV[tw] OR bovine[tw] OR calves[tw] OR TGEV[tw] OR feline[tw] OR porcine[tw] OR BCoV[tw] OR PEDV[tw] OR PDCoV[tw] OR FIPV[tw] OR FCoV[tw] OR SADS-CoV[tw] OR canine[tw] or CCov[tw] OR zoonotic[tw] OR avian influenza[tw] OR H1N1[tw] OR H5N1[tw] OR H5N6[tw] OR IBV[tw] OR murine corona*[tw])
6	#4 NOT #5
7	(((pneumonia[tw] OR covid*[tw] OR coronavirus*[tw] OR corona virus*[tw] OR ncov*[tw] OR 2019ncov[tw] OR sars*[tw]) OR "Pneumonia"[Mesh]) AND Wuhan[tw])
8	(coronavirus disease 2019[tw] OR 2019-ncov[tw] OR 2019nCoV[tw] OR ncov2019[tw] OR ncov19[tw] OR ncov-19[tw] OR HCoV-19[tw] OR 2019-novel CoV[tw] OR severe acute respiratory syndrome coronavirus 2[tw] OR sars2[tw] OR sars 2[tw] OR sars-cov2[tw] OR sars-cov-2[tw] OR sarscov2[tw] OR sarscov-2[tw] OR Sars-coronavirus2[tw] OR Sars-coronavirus-2[tw] OR SARS-CoV-19[tw] OR SARS-like coronavirus*[tw] OR coronavirus-19[tw] OR covid19[tw] OR covid-19[tw] OR covid 2019[tw] OR ((novel[tw] OR new[tw] OR nouveau[tw]) AND (CoV OR nCoV OR

3

	covid OR coronavirus*) OR ("corona virus" OR Pandemi*) OR coronavirus pandemic[tw] OR covid pandemic [tw] OR covid19 pandemic[tw] OR covid-19 pandemic[tw])
9	"COVID-19" [Supplementary Concept]
10	"severe acute respiratory syndrome coronavirus 2" [Supplementary Concept]
11	#7 OR #12 OR #9 OR #10
12	#6 OR #11
13	"Health Services Accessibility"[Mesh]
14	(acces* healthcare[tw] OR acces* heath care[tw] OR acces* health service*[tw] OR avail* healthcare[tw] OR avail* health care[tw] OR avail* health service*[tw])
15	“socioeconomic factors”[MeSH]
16	(socioeconomic factors[tw] OR socioeconomic[tw] OR health services accessibility[tw])
17	(education* achieve*[tw] OR education* status[tw])
18	“Insurance, Health”[MeSH:NoExp]
19	“Unemployment”[MeSH]
20	"Social Isolation"[Mesh]
21	“Social Determinants of Health”[MeSH]
22	"Social Environment"[Mesh:NoExp]
23	"Social Marginalization"[Mesh]
24	(health insurance[tw] OR “standard of living”[tw] OR social determinant*[tw] OR unemployment[tw] OR social isolation[tw] OR psychosocial deprivation[tw] OR social environment[tw] OR social exclusion[tw] OR social marginalization[tw] OR social marginalisation[tw])
25	(social determinant of health[tw] OR social determinants of health[tw] OR SDOH[tw] OR SDH[tw] OR social deprivation[tw] OR social disadvantage[tw] OR financial difficult*[tw] OR financial problem[tw] OR financial problems[tw] OR income differences[tw] OR indigent[tw] OR insurance status[tw] OR jobless[tw] OR job insecurit*[tw] OR low income[tw] OR marginali*[tw] OR occupation* status[tw])

4

26	(poverty[tw] OR SES[tw] OR social disparit*[tw] OR social factor[tw] OR social factors[tw] OR social gradient[tw] OR social gradients[tw] OR social position[tw] OR social positions[tw] OR social variation[tw] OR social variations[tw] OR socioeconomic status[tw] OR socioeconomic circumstance*[tw] OR socioeconomic gradient[tw])
27	(socioeconomic health differences[tw] OR socioeconomic position[tw] OR socioeconomic variable[tw] OR underprivilege*[tw] OR unemployed[tw] OR uninsur*[tw] OR vulnerable population[tw] OR vulnerable populations[tw] OR vulnerable group[tw] OR vulnerable groups[tw] OR vulnerable communit*[tw] OR vulnerable people[tw] OR vulnerable person[tw] OR vulnerable persons[tw])
28	(socio* predict*[tw] OR socio* prognos*[tw] OR socio* risk*[tw] OR social*predict*[tw] OR social* prognos*[tw] OR social* risk*[tw])
29	#13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28
30	#12 AND #29

Scopus

1	TITLE-ABS-KEY(coronavirus* OR “corona virus*” OR OC43 OR NL63 OR 22pE OR HKU1 OR HCoV* OR ncov* OR covid* OR sars-cov* OR sarscov* OR Sars-coronavirus* OR “Severe Acute Respiratory Syndrome Coronavirus*” OR coronavirnae OR “coronavirus infection”)
2	TITLE-ABS-KEY(SARS or SARS-CoV OR MERS OR MERS-CoV OR “Middle East respiratory syndrome” OR camel* OR dromedary* OR equine OR coronary OR coronal OR covidence* OR covidien OR influenza virus OR HIV or bovine OR calves OR TGEV OR feline OR porcine OR BCoV OR PEDV OR PDCoV OR FIPV OR FCoV OR SADS-CoV OR canine or CCov OR zoonotic OR avian influenza OR H1N1 OR H5N1 OR H5N6 OR IBV OR “murine corona*”)
3	#1 NOT #2
4	TITLE-ABS-KEY((pneumonia OR covid* OR coronavirus* OR “corona virus*” OR ncov* OR 2019-ncov OR sars*) AND Wuhan)

5

5	TITLE-ABS-KEY(“coronavirus disease 2019” OR 2019-ncov OR 2019nCoV OR ncov2019 OR ncov19 OR ncov-19 OR HCoV-19 OR "2019-novel CoV" OR “severe acute respiratory syndrome coronavirus 2” OR sars2 OR “sars 2” OR sars-cov2 OR sars-cov-2 OR sarscov2 OR sarscov-2 OR Sars-coronavirus2 OR Sars-coronavirus-2 OR SARS-CoV-19 OR "SARS-like coronavirus*" OR coronavirus-19 OR covid19 OR covid-19 OR “covid 2019” OR ((novel OR new OR nouveau) W/2 (CoV OR nCoV OR covid OR coronavirus* OR "corona virus" OR Pandemi*2)) OR ((covid OR covid19 OR covid-19) AND pandemic*2) OR (coronavirus* AND pneumonia))
6	#3 OR #4 OR #5
7	TITLE-ABS-KEY((acces* OR avail*) W/2 (healthcare OR “health care” OR “health service*”))
8	TITLE-ABS-KEY(“socioeconomic factors” OR “health services accessibility”)
9	TITLE-ABS-KEY (“education* achieve*” OR “education* status”)
10	TITLE-ABS-KEY(“health insurance” (standard* W/1 living) OR “social determinant*” OR unemployment OR “social isolation” OR “psychosocial deprivation” OR “rural health” OR “social environment” OR “social exclusion” OR “social marginali?ation”)
11	TITLE-ABS-KEY(“social deprivation” OR “social disadvantage” OR “financial difficult*” OR “social determinant* of health” OR SDOH OR SDH OR “financial problem?” OR “income difference*” OR indigent* OR “insurance status” OR jobless OR “job insecurity*” OR “low income” OR marginali* OR “occupation* status”)
12	TITLE-ABS-KEY(poverty OR SES OR “social disparit*” OR “social environment” OR “social exclusion” OR “social factor?” OR “social gradient?” OR “social position?” OR “social variation?” OR “socioeconomic status” OR “socioeconomic circumstances” OR “socioeconomic gradient”)
13	TITLE-ABS-KEY(“socioeconomic health differences” OR “socioeconomic position” OR “socioeconomic variable” OR underprivilege* OR unemployed OR unemployment OR uninsur* OR “vulnerable population” OR “vulnerable group?” OR “vulnerable communit*” OR “vulnerable people” OR “vulnerable person?”)
14	TITLE-ABS-KEY((socio* OR social*) W/10 (predict* OR prognos* OR risk*))

6

15	#7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14
16	#6 AND #15

WHO Database

1	(acces* healthcare OR acces* heath care OR acces* health service* OR avail* healthcare OR avail* health care OR avail* health service*)
2	("socioeconomic factors" OR "health services accessibility")
3	(education* achieve* OR education* status)
4	("health insurance" OR social determinant* OR unemployment OR "social isolation" OR "psychosocial deprivation" OR "social environment" OR "social exclusion" OR social marginali?ation)
5	("social deprivation" OR "social disadvantage" OR financial difficult* OR "social determinants of health" OR SDOH OR SDH OR "financial problem" OR "financial problems" OR "income difference" OR "income differences" OR indigent* OR "insurance status" OR jobless OR "job insecurity" OR "low income" OR marginali* OR occupation* status)
6	(poverty OR SES OR social disparit* OR "social environment" OR "social exclusion" OR "social factor" OR "social factors" OR "social gradient" OR "social position" OR "social positions" OR "social variation" OR "social variations" OR "socioeconomic status" OR "socioeconomic circumstances" OR "socioeconomic gradient")
7	("socioeconomic health differences" OR "socioeconomic position" OR "socioeconomic variable" OR underprivilege* OR unemployed OR unemployment OR uninsur* OR "vulnerable population" OR "vulnerable group" OR "vulnerable groups" OR "vulnerable community" OR "vulnerable communities" OR "vulnerable people" OR "vulnerable person")
8	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7

PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocol*

Section and topic	Item No	Checklist item
ADMINISTRATIVE INFORMATION		
Title:		
Identification	1a	Identify the report as a protocol of a systematic review (page 1)
Update	1b	If the protocol is for an update of a previous systematic review, identify as such (N/A)
Registration	2	If registered, provide the name of the registry (such as PROSPERO) and registration number (page 3)
Authors:		
Contact	3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author (page 1)
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review (page 12/13)
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments (N/A)
Support:		
Sources	5a	Indicate sources of financial or other support for the review (page 13)
Sponsor	5b	Provide name for the review funder and/or sponsor (page 13)
Role of sponsor or funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol (N/A)
INTRODUCTION		
Rationale	6	Describe the rationale for the review in the context of what is already known (page 4/5/6)
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO) (page 6)
METHODS		
Eligibility criteria	8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review (page 8/9)
Information sources	9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage (page 10)
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated (page 10, Supplement 1)
Study records:		
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review (page 10/11)

Selection process	11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis) (page 10)
Data collection process	11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators (page 10)
Data items	12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications (page 11)
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale (page 11)
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis (page 11)
Data synthesis	15a	Describe criteria under which study data will be quantitatively synthesised (page 11/12)
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I^2, Kendall's τ) (N/A)
	15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression) (N/A)
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned (page 11/12)
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies) (at page 8)
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (such as GRADE) (page 6/7)

*** It is strongly recommended that this checklist be read in conjunction with the PRISMA-P Explanation and Elaboration (cite when available) for important clarification on the items. Amendments to a review protocol should be tracked and dated. The copyright for PRISMA-P (including checklist) is held by the PRISMA-P Group and is distributed under a Creative Commons Attribution Licence 4.0.**

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