Interventions on Socioeconomic and Racial Inequities in Respiratory Pandemics: a Rapid Systematic Review

Audrey Renson[1] · Alexis C. Dennis[2] · Grace Noppert[3] · Elizabeth S. McClure[4] · Allison E. Aiello[1]

Abstract

Purpose of Review Racial and socioeconomic inequities in respiratory pandemics have been consistently documented, but little official guidance exists on effective action to prevent these. We systematically reviewed quantitative evaluations of (real or simulated) interventions targeting racial and socioeconomic inequities in respiratory pandemic outcomes.
Recent Findings Our systematic search returned 10,208 records, of which 5 met inclusion criteria, including observational (n = 1), randomized trial (n = 1), and simulation (n = 3) studies. Interventions studied included vaccination parity, antiviral distribution, school closure, disinfection, personal protective equipment, and paid sick leave, with a focus on Black (n = 3) and/or Latinx (n = 4) or low-SES (n = 2) communities. Results are suggestive that these interventions might be effective at reducing racial and/or SES disparities in pandemics.
Summary There is a dearth of research on strategies to reduce pandemic disparities. We provide theory-driven, concrete suggestions for incorporating equity into intervention research for pandemic preparedness, including a focus on social and economic policies.

✉ Audrey Renson
arenson@live.unc.edu

✉ Allison E. Aiello
aaiello@email.unc.edu

Alexis C. Dennis
acdennis@live.unc.edu

Grace Noppert
gnoppert@umich.edu

Elizabeth S. McClure
emcclure@unc.edu

[1] Department of Epidemiology, Carolina Population Center, UNC-Chapel Hill, Chapel Hill, USA

[2] Department of Sociology, Carolina Population Center, UNC-Chapel Hill, Chapel Hill, USA

[3] Social Environment and Health, Survey Research Center, Institute for Social Research, University of Michigan, Ann Arbor, USA

[4] North Carolina Occupational Safety and Health Education and Research Center, UNC-Chapel Hill, Chapel Hill, USA

Introduction

Societal causes of inequities in infectious disease were a key focus of public health in the nineteenth century [1]. In the mid-twentieth century, however, as life expectancies began to rise, the disciplinary focus shifted towards individual-level risk behaviors and prevention of non-communicable diseases [2]. Yet, as the disproportionate impact of coronavirus disease 2019 (COVID-19) on Black, Indigenous, Latinx, and poor communities clearly demonstrates [3–5], attention to mitigating the spread of infectious diseases, and particularly to addressing the societal causes of the disparate impact of infectious disease, is more salient than ever. This situation was all too predictable, as similar disparities occurred during the H1N1 influenza A pandemics in 2009 [6, 7] and 1918 [8, 9]. Similarly, the environmental justice literature has long documented that low-income families and communities of color suffer disproportionate impacts of industrial pollution [10, 11], natural disasters, and government neglect. Events such as Hurricanes Floyd [12], Katrina [13], and Maria [14]; the Chicago heat wave [15]; and the Flint, Michigan water crisis [16] are just a few of many prominent examples.

Despite this, the health disparities and social determinants of health literatures (e.g., WHO's "Closing the Gap" [17]) have not emphasized respiratory pandemics. Similarly, in the pandemic preparedness sphere, research and institutional planning have paid insufficient attention to socioeconomic and racial/ethnic disparities [18, 19]. For example, as previously noted [18], equity has not been a central focus of the most recent influenza pandemic planning and guidance documents produced by the USA [20–22], Europe [23, 24], WHO [25, 26], and many European countries [27]. While most of these documents do briefly discuss equity considerations, none gives concrete guidance in how to prevent or reduce racial/ethnic or socioeconomic disparities in pandemic outcomes, reflecting an evidence base of interventional research focused on minimizing overall, average harms and not inequalities [28]. Universal interventions aiming to minimize total harm without attention to equity have potential to exacerbate disparate impacts among already marginalized sociodemographic groups [29].

Though deeply historically rooted, pandemic disparities arise from modifiable causes such as mass incarceration (as of September 2020, the sixteen largest clusters of COVID-19 were in jails and prisons[30]); economic, social, and racial stratification of the labor market and occupation safety [31]; residential segregation; underfunded public health infrastructure [32]; a weak social safety net [33, 34]; and inequalities in healthcare access (inequitable distribution in testing and treatment access [35]). While the above structural determinants of disparities are all amenable to intervention [4], the COVID-19 literature to date has focused primarily on group- or individual-level non-pharmaceutical interventions (NPIs) that are primarily based on behaviors and/or located within the traditional public health sphere, as well as pharmaceutical interventions (PIs) [36–38].

Moreover, few studies to date have evaluated the efficacy of interventions with respect to their effects on racial, ethnic, and socioeconomic inequality in respiratory pandemics. Such research is needed in order for institutional planning around pandemic preparedness to effectively incorporate equity. Here, we systematically reviewed the existing evidence regarding real or simulated interventions on respiratory pandemic inequities, and provide a framework guided by key social epidemiologic theories to frame a research agenda for future intervention development and evaluation. We define health inequities as differences "judged to be unfair, unjust, avoidable, and unnecessary, … and that burden populations rendered vulnerable by underlying social structures and political, economic, and legal institutions" [39]. The results from this review highlight major gaps in the literature that will need to be filled in order to inform an equitable response to COVID-19 and prevent inequitable impacts of inevitable future pandemics [40].

Methods

Our systematic review methodology draws on practices from "rapid reviews," which are reviews that modify traditional systematic review methodology to expedite evidence synthesis while minimizing bias [41]. Specifically, we (1) employed two reviewers for full-text screening but only one for title/abstract screening and data extraction, and (2) searched only peer-reviewed literature, omitting gray literature. Our rationale for these modifications was to accelerate the review processes given the ongoing racial, ethnic, and socioeconomic inequity in burden of COVID-19, necessitating immediate response.

Search Strategy

We performed a systematic search of PubMed, Web of Science, Scopus, and Global Health (EbscoHost), between June 19 and 21, 2020, for literature describing quantitative tests of any (real or simulated) interventions on disparities in the impacts of respiratory pandemic disease in industrialized countries. Our definition of respiratory pandemic disease included the respiratory diseases appearing on WHO's list of diseases of pandemic, epidemic potential (https://www.who.int/emergencies/diseases/en/). These are influenza viruses, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)/COVID-19, SARS-CoV, and Middle East respiratory syndrome–associated coronavirus (MERS-CoV).

We searched abstracts/titles for terms for (1) pandemics/epidemics or specific respiratory agents (influenza, SARS-Cov-2, SARS-CoV, MERS-CoV), (2) race or SES or disparities/inequities, and (3) a list of NOT terms including specific low- and middle-income countries and specific excluded diseases (e.g., diabetes, hepatitis C, tuberculosis, opioid use). The search did not specify interventions; this selection was left to screening. We required that articles be in English.

In the PubMed search, we included MeSH term OR free text terms (in quotes) derived from MeSH entry terms, selected the box restricting to "full text," and selected boxes restricting to the following article types: classical article, clinical study, clinical trial (and all subtypes), comparative study, evaluation study, meta-analysis, multicenter study, observational study, systematic review, technical report, and validation study. Our Web of Science search ported all PubMed MeSH and entry terms to quoted free text search in "topic," with the search limited to type "article," and Science Citation Index Expanded or Social Science Citation Index. The Scopus search ported all PubMed MeSH terms to "index terms" and used the

same free text terms to search titles/abstracts, and no other limitations. Finally, for Global Health we used all Pub-Med MeSH and entry terms entered as free text search of titles and abstracts. Additional articles were identified by searching bibliographies of potentially relevant systematic reviews identified during the search.

Screening/Eligibility

To facilitate rapid screening, we required only one author to screen titles/abstracts for potential inclusion. We required that two authors further screen the full text of studies marked for potential inclusion at the title/abstract stage. We discussed and resolved any disagreements at the full text inclusion stage to reach consensus between reviewers.

We included studies reporting any health outcomes (e.g., cases, hospitalizations, or deaths, but NOT behaviors such as vaccination), and conducted in high-income countries (based on the UN 2019 Human Development Report "Very High Human Development" list [42]). We required that studies evaluated a specific real or hypothetical (i.e., simulated) intervention, but did not include studies simply evaluating an exposure. This distinction requires some judgment. For example, we included a study evaluating a hypothetical intervention to "equalize vaccination rates according to race" [43] because there are known effective interventions to do so [44, 45], but did not include an intervention to "alter influenza susceptibility" [46]. Any judgment of this manner occurred at the full text stage and thus involved consensus of the reviewers.

We required that studies either (a) were conducted in population(s) predominantly composed of individuals facing known or expected pandemic disparities according to race/ethnicity and/or SES, including Black, Indigenous, Latinx, Asian, or other groups of color, or individuals of lower income, lower wealth, lower education, or lower occupational prestige, as defined by the authors, or (b) were conducted in broader populations and reported intervention effects either separately according to a disadvantaged status (as above) or as a change in a measure of difference between disadvantaged and advantaged groups (e.g., a counterfactual disparity measure [47]). This distinction again required judgment for pure simulation studies, since "groups" are not always tied to real-world groups. We included such simulation studies if their expressed goal was to provide estimates relevant to inequities between racial, ethnic, or socioeconomic groups.

Data Extraction

We used Covidence (Melbourne, VIC) software to develop and pilot test an extraction instrument. One reviewer (A.R.) abstracted the following data from all studies: study design,

total number of participants, geographic setting, population characteristics, time period, inclusion/exclusion criteria, intervention(s), outcome(s), specific disparity considered, analytic methods, results. We contacted authors for clarification if necessary. When the study included multiple aims, we only reported on aspects of the study related to the aim that met our inclusion criteria. Due to the large variability in types of studies included (i.e., randomized trials, observational studies, simulation and cost-effectiveness analysis), and because our focus was on summarizing the topics covered in this nascent literature, we did not perform quality or risk of bias assessment but instead comment informally on key strengths and limitations of each study.

Results

Identification and Inclusion

Results of the identification, screening, and inclusion process are illustrated in Fig. 1. After screening abstracts of $n = 9688$ records identified through databases and $n = 520$ through systematic review bibliographies, we assessed $n = 101$ full-text articles and ultimately included $n = 5$.

Table 1 lists key features of the five included studies. To summarize, all included studies took place in the USA, and all primarily concerned influenza viruses. Three studies were simulation-based, one was an observational study, and one was a randomized controlled trial. Interventions considered included paid sick leave, antiviral distribution programs, school closures, personal protective equipment and disinfectant use, and influenza vaccination programs.

Studies in Human Populations

Here we summarize the included studies, ordered by type (human vs. simulation) and publication date (newest to oldest). Kumar et al. [33]. studied determinants of self-reported influenza-like illness (household crowding, urbanicity, and ability to socially distance) separately among Hispanic,[1] non-Hispanic white, and non-Hispanic Black respondents in a US-representative, cross-sectional survey ($n = 2042$). A summary index was developed to capture work-related inability to engage in social distancing, summing over indicators for ability to work at home, perceived job insecurity, and access to paid sick leave (each higher-risk response was weighted 1, and each lower-risk or no-risk response was weighted 0). In

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[1] In describing results of the included studies, we deliberately use race/ethnicity terms (e.g., Hispanic, African American) used by the authors of the original studies.

Fig. 1 Flow diagram illustrating identification, screening, and inclusion of articles
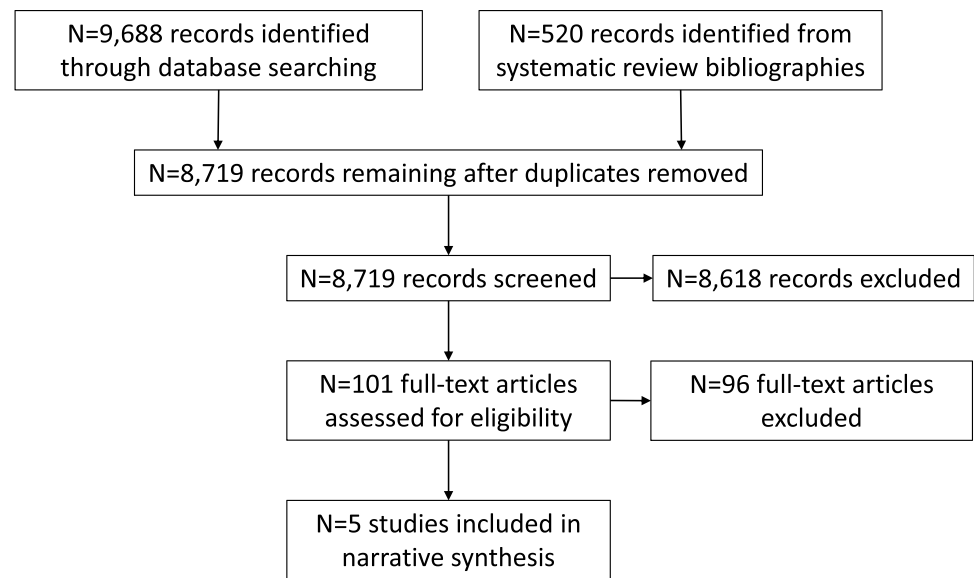
a regression model adjusting for demographics and other risk factors, a unit increase in this social distancing index was associated with 8% greater odds of influenza-like illness. The authors translate this result to an estimated 5 million overall cases of influenza-like illness attributable to lack of paid sick leave from April 2009 to January 2010, and 1.2 million cases specifically among Hispanic Americans. Similar calculations could in theory be done for other races/ethnicities and/or other items in the social distancing index, but were not provided by the authors. The nationally representative design allowed generalizability, but the strong modeling assumptions (exchangeability of index items, linearity of logit of the outcome in the index, constancy of the index association within race/ethnicity strata) challenge direct policy conclusions.

Larson et al. [48] conducted a randomized trial among $n = 509$ predominantly lower SES, Hispanic immigrant households in northern Manhattan, New York, randomizing households to receive either (1) educational materials only, (2) hand sanitizer + education, or (3) hand sanitizer + face masks + education, with continuous follow-up for respiratory symptoms and PCR-confirmed influenza. Compared to education alone, secondary attack rates within households were similar for hand sanitizer + education (OR = 1.01, 95% CI 0.85–1.21) but lower for hand sanitizer + face masks + education (OR = 0.82, 95% CI 0.70–0.97). Overall risk of confirmed influenza and number of upper respiratory infections/influenza-like illnesses per household were similar between groups. One challenge with generalizing the results of this study to realistic interventions is the fact that participants received frequent visits from research staff to ensure adherence to regular and correct use of PPE and disinfectants, possibly overstating the effect in a larger scale intervention without those supports.

Simulation Studies

Barrett et al. [49] simulated an assortment of antiviral distribution strategies (random; targeting high-risk, sick, and low-SES populations) with and without concurrent school closures, in terms of the resulting epidemic curves stratified by SES, in a synthetic population based on the demographics of a region of Southwest Virginia. Compared to the scenario with no government intervention and where high-SES individuals were more able to engage in protective behaviors (e.g., purchasing antivirals and avoiding unnecessary errands), all intervention scenarios decreased disparities in the attack rate from 2 percentage points greater in the low-SES group to between 0 and 1 percentage points greater (random and non-SES targeting strategies) and 2 percentage points lower (low-SES targeting strategy). Limitations in their modeling strategy included assuming efficacy of antivirals to be constant across SES and assuming all adults were able to take leave from work as needed.

Michaelidis et al. [50] and Fiscella et al. [43] both simulated influenza vaccination programs targeting racial/ethnic parity in vaccination in synthetic populations based on African American, Hispanic, and white adults over 65 in the USA. Both programs involved setting the African American and Hispanic vaccination rates equal to the white rate (67–70%). Michaelidis et al. [50] estimated that over 10 years, the program would result in a gain of 0.002 quality-adjusted life years per person among African American and Hispanic persons. Fiscella et al.'s [43] nearly identical program was estimated to result in 1330 and 550 fewer African American and Hispanic deaths annually, and a gain in 33,090 African American and Hispanic years of life if vaccination parity were to begin at age 65 and continue throughout life. Limitations of both studies include assuming to be

Table 1 Key features of the five included studies

First author, year	Time period	Study design	Number of participants	Population /geographic setting	Specific disparity/disadvantage	Intervention(s)	Outcome(s)	Key results
Kumar, 2012	2010	Observational study	2042	US population aged 18 and older	Black and Latinx vs. white non-Latinx	Universal paid sick leave	Self-reported influenza-like illness and PCR-confirmed influenza	Compared to the status quo, universal paid sick leave is estimated to result in 5 million fewer cases of cases of influenza-like illness overall and 1.2 million fewer among Latinx individuals
Barrett, 2011	Not specified	Simulation	N/A	Population of New River Valley region of Southwest Virginia, USA	Low vs. high household income	Antiviral distribution (targeting high risk, sick, or poor), school closures	Pandemic influenza	Compared to no government intervention, all antiviral and school closure strategies decreased disparities in attack rate by at least a percentage point
Michaelidis, 2011	2005	Simulation	N/A	US Black and Latinx population aged over 65	Black and Latinx vs. white non-Latinx	Influenza vaccination program targeting racial/ethnic parity over 10 years	Quality-adjusted life years (QALYs)	Vaccination parity is estimated to result in a gain of 0.002 QALYs per person over 10 years
Larson, 2010	2006–2008	Randomized controlled trial	509 households	A predominantly lower SES, Latinx, immigrant population in northern Manhattan, New York, USA	Latinx and low-SES (no direct comparison)	(1) Educational materials on prevention of influenza and other respiratory infections, (2) hand sanitizer+education, (3) hand sanitizer+face masks w/ instructions to use face masks when any household member develops influenza-like illness	Respiratory symptoms and PCR-confirmed influenza	Compared to education alone, secondary attack rates within households were similar for hand sanitizer only (OR=1.01, 95% CI 0.85–1.21) but lower for hand sanitizer and face mask (OR=0.82, 95% CI 0.70–0.97). Overall risk of confirmed influenza and number of upper respiratory infections/influenza-like illnesses per household were similar between groups

Table 1 (continued)

First author, year	Time period	Study design	Number of participants	Population /geographic setting	Specific disparity/ disadvantage	Intervention(s)	Outcome(s)	Key results
Fiscella, 2007	2002	Simulation	N/A	US Medicare enrollees aged 65 years and older	Black and Latinx vs. white non-Latinx	Influenza vaccination program targeting immediate racial/ethnic parity	All-cause mortality	Vaccination parity is estimated to result in 1330 and 550 fewer Black and Hispanic deaths annually. Parity in annual influenza vaccination beginning at age 65 and continuing throughout life would save 33,090 minority years of life

constant many parameters that are expected to vary across race/ethnicity, and which themselves determine disparities: vaccine effectiveness [43, 50], baseline risk of influenza, and risks of hospitalization and mortality given infection [43].

Discussion

Summary of Findings

In this systematic review, we identified five studies that mostly examined a range of biomedical, individual-level interventions to reduce racial, ethnic, or socioeconomic disparities in the impacts of respiratory pandemics. Four out of five studies assessed equity for many of the NPIs and PIs currently recommended in major guidelines [20, 28] (school closures, antiviral distribution, vaccination, disinfection, and personal protective equipment), and one assessed a social safety net program (paid sick leave) [33]. The reviewed studies suggest that paid sick leave and programs supporting face mask usage might be effective at reducing disparities among Latinx/Hispanic communities, and that racial and/or SES disparities will be reduced when school closures, antiviral distribution programs, and vaccination parity programs are implemented. While the range of interventions studied is encouraging, notably absent are studies evaluating effects of broader macrosocial interventions such as decreasing incarceration rates, providing access to nutritious food, addressing residential segregation and crowded housing, equalizing healthcare access, and expanding workplace protections beyond sick leave. Also notable is that we did not identify any studies that directly assessed the effect of an intervention on disparities per se; interventions instead focused on addressing effects within disadvantaged groups.

The reviewed studies have several limitations. One limitation, shared by four out of five studies, is strong modelling assumptions that include an assumption about homogeneity of intervention effects across race/ethnicity and/or SES. Specifically, all three simulation studies [43, 49, 50] derived parameters for the effectiveness of interventions from meta-analyses not stratified by race/ethnicity or SES, and Kumar et al. [33] modeled the association between paid sick leave and influenza in a regression forcing constancy across race/ethnicity. These assumptions are likely unrealistic. For example, immune response to vaccination is likely to vary by race/ethnicity as a result of unequal sources of psychosocial stress [51], and effects of school closures are likely to vary by SES due to parents' inability to stay home from work and/or reliance on school lunches. Since health disparities are composed of disparities both in exposure distributions *and* effects of exposures [52], accounting for differential benefit from interventions such as vaccination, behavior change, and

employment benefits is key to understanding and preventing pandemic disparities.

Interventional Research for Equitable Pandemic Response

A key impetus for this review was that pandemic response activities promoted by major public health bodies do not include concrete recommendations to target equity [20–27]. Despite extensive evidence of inequitable pandemic outcomes [6, 53, 54] and numerous reviews and commentaries highlighting this as a public health priority [18, 55–58], large-scale measures to reduce or eliminate these disparities are unlikely to be implemented unless national and international pandemic plans and guidelines propose specific actions that governments and communities can take to prevent inequities [18, 55].

A major takeaway from our review is that, in part, this omission reflects a lack of available evidence. Pandemic response plans are meant to be evidence-based [23, 25], drawing, to the extent possible, on systematic reviews of randomized trials, and often depend heavily on simulation modeling where trials are not possible [28, 59]. NPIs with such an evidence base include personal protective measures (e.g., hand hygiene, face masks), environmental measures (e.g., disinfection, ventilation), social distancing (e.g., school closures, quarantine), travel-related measures (e.g., screening, border closures) [20, 28], and activities which complement pharmaceutical strategies such as antiviral prophylaxis and vaccination [59].

Yet, research on NPIs and PIs has overwhelmingly focused on overall, average effects [18, 28]. As our review illustrates, there exists little to no research on the extent to which the above evidence-based strategies reduce or exacerbate inequities, or on effective strategies to ensure equitable outcomes. For example, unanswered questions include the following: How do school closures differentially affect populations according to race and SES at different phases of a pandemic? What are optimal testing, contact tracing, vaccination, and antiviral distribution strategies to prevent racial and socioeconomic inequities? What is the relative efficacy of implementing universal paid sick leave, income support, reducing incarceration, and expanding access to health care in different contexts? Central planning documents are unable to make evidence-based operational recommendations targeting equity unless rigorous research is available to address these and related questions.

The remainder of this paper sketches a roadmap for building an evidence base aimed at supporting equity-driven intervention recommendations in pandemic preparedness and response. The key to generating such evidence is interdisciplinarity. The dominant theoretical framework in infectious disease epidemiology has long centered factors in the human host, microbial pathogen, and environment. The "environment" as defined in Modern Infectious Disease Epidemiology includes physical, biological, and social factors [60]. Social environment is perhaps the most critical predictor of inequities in the distribution of a particular pathogen but given the least attention when planning for the emergence of an outbreak [19, 61]. While infectious disease researchers have discussed the impact of social disparities in influenza [62] and documented social inequities in the distribution of infectious diseases for centuries (e.g., cholera, tuberculosis (TB), HIV/AIDS) [19, 63], few explicitly incorporate a deeper understanding of these inequities into either their research methodologies or their proposed interventions for mitigating epidemics [19, 61]. This may best be done by (i) forming interdisciplinary research teams including not only public health and medical experts but also policy-makers, sociologists, and community-engaged stakeholders and organizations, and (ii) adapting theoretical frameworks from other disciplines to apply to infectious disease epidemiology.

Interdisciplinary Theory for Pandemic Preparedness Research

The need for interdisciplinary theory draws from the fact that underlying causes of inequitable pandemic outcomes lie outside the confines of host, agent, and immediate physical environment. For this reason, research to identify equitable pandemic responses should draw on theoretical frameworks adapted from social sciences and ecology to help predict what interventions will exacerbate or ameliorate such inequities, and under what conditions. In particular, structural and ecological theories such as Fundamental Cause Theory [64–66], Gender Theory (see, for example, [67]), Structural Racism [38, 68, 69], and Ecosocial Theory [70] all illuminate how dynamic and multifaceted macro-level social, political, and economic forces organize society to generate differential exposure, susceptibility, and care access. Structural and ecological theories form links across the macro-, meso-, and micro-levels of society, illustrating how our social world "gets under the skin" to shape the embodiment of disease in individuals [70], and gives rise to health inequities across populations [64]. These theories can also help to explain why, in the absence of equity-centered approaches [55], different population subgroups may experience inequitable effects of public health interventions.

For example, Fundamental Cause Theory posits that flexible socioeconomic resources allow advantaged members of society to benefit more from technology and information [71], which suggests that, e.g., behavioral recommendations, new vaccines, and new treatments may be more likely to generate inequality than higher level policy interventions such as school closures or workplace regulations. In a concrete example, Pirtle [72] applied Fundamental Cause

Theory to studying the impact of COVID-19 in the Detroit area, revealing that disproportionate deaths among African Americans were both predictable and preventable due to longstanding racial and socioeconomic inequities. Harmful social conditions disproportionately affecting African American residents (e.g., high rates of homelessness and incarceration, poor access to quality health care, inadequate access to clean water, inflexible jobs) meant that many in these communities were unable to access the latest treatments or follow social distancing and handwashing recommendations. As a result, interventions largely only benefited already advantaged groups.

An Interventional Research Agenda

First, a central research goal is to develop and test interventions that have as their central aim the prevention and elimination of disparities in pandemic outcomes. Fundamental Cause Theory and Critical Race Theory (CRT) will be especially useful in this pursuit, as they offer guiding principles to decide what interventions or implementation approaches are likely to reduce and/or exacerbate disparities [65, 73]. By emphasizing that racism is commonplace and embedded in social systems, CRT highlights the need to "center the margins," i.e., privilege the perspectives of people affected by those inequities [73]. Thus, interventions should be place-based and involve partnerships with impacted communities [69], and may address structural-level factors outside the confines of traditional public health [34]. For example, workplace protection interventions can be informed by workers and their families, and may include paid sick leave, income support, or workplace restructuring to facilitate social distancing. The continued spread of COVID-19 in prisons and jails suggests that policies to reduce the number of incarcerated people and/or reduce economic dependence on prison labor [74] are of central importance. Awareness that many racial health disparities observed today are the consequence of historical policies that prevented African American and Indigenous populations from accessing equitable housing, employment, and wealth-generating opportunities suggests that effective interventions will include more affordable and improved housing to reduce crowding and policies related to reparations, which may help redistribute resources needed for equitable pandemic mitigation [75].

Second, it will be necessary to incorporate equity considerations into the prolific research conducted on NPIs and PIs endorsed by the WHO, CDC, and other major bodies, and which primarily target overall, average population health. (i) Simulation models can build on examples in the non-communicable disease literature [76], as well as the example of Barrett et al. [49] and others [29, 77, 78] in the infectious disease literature, to study effects on disparities in addition to population averages. Such investigations

will ideally incorporate potentially heterogeneous effects of interventions in different population groups [52], and can draw on theory-driven assumptions, such as the idea that flexible resources allow advantaged population groups to more easily take advantage of available resources [49, 65, 79]. (ii) An equally important task is to recruit racially, ethnically, socioeconomically, and otherwise diverse populations into randomized trials and other human studies used to evaluate NPIs and PIs, and to report stratified estimates in these studies. Though a careful accounting of the populations included in trials and observational studies was outside the scope of our review [28, 59], prior systematic reviews, to our knowledge, did not report stratified estimates by race, ethnicity, or SES [80–86], and the fact that our search returned so few studies suggests pandemic intervention trials may suffer similar representation issues as trials in other fields [87]. (iii) Relatedly, evaluations of response interventions during an emergency typically draw on surveillance data [25], and influenza surveillance systems in the USA have been shown to systematically undersample low-SES regions [88]. An important goal will therefore be to improve the representativeness of these systems and/or exploit novel data sources [89].

Conclusions

Our systematic review uncovered a dearth of literature examining real or simulated interventions in terms of their effects on racial, ethnic, or socioeconomic inequities in health outcomes of pandemics, with most existing studies focusing on biomedical or behavioral rather than social or structural strategies. In light of ongoing inequitable impacts of COVID-19 and of similar and well-documented disparities in impacts of previous pandemics, this represents a critical gap. Going forward, there is an urgent need for interdisciplinary research on interventions specifically targeting these inequities, and for equity assessments to become standard practice in evaluations of non-pharmaceutical and pharmaceutical mitigation efforts.

Code Availability Not applicable.

Declarations

Conflict of Interest The authors declare no competing interests.

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