Health Inequalities in Infectious Disease Epidemics Pre-dating COVID-19 in the United States: A Rapid Review

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Prepared by:
Evidence Synthesis Program (ESP) Center
Portland VA Health Care System
Portland, OR
Devan Kansagara, MD, MCR, Director

Authors:
Karli Kondo, PhD
Chelsea K. Ayers, MPH
Beth E. Williams, MSN, MPH
Devan Kansagara, MD, MCR
Mia Smith, MPH
Katherine M. Mackey, MD
Shailesh Advani, MD, PhD
Somnath Saha, MD, MPH

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PREFACE

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- Develop clinical policies informed by evidence;
- Implement effective services to improve patient outcomes and to support VA clinical practice guidelines and performance measures; and
- Set the direction for future research to address gaps in clinical knowledge.

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Comments on this report are welcome and can be sent to Nicole Floyd, Deputy Director, ESP Coordinating Center at Nicole.Floyd@va.gov.

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EXECUTIVE SUMMARY

AIMS

We conducted a systematic review of infectious disease epidemics predating COVID-19 to better understand the potentially modifiable factors that may have contributed to differential infection rates and health outcomes, as well as the interventions and programs implemented to mitigate them.

METHODS

We searched electronic databases and reference lists from database inception through May 20, 2020 for studies of adult populations examining health inequalities by race/ethnicity, SES, disability, or geographic location related to infectious disease epidemics predating COVID-19 or disasters (KQ2 only) in the United States. We abstracted data on study design, factors, interventions, and outcomes. Dual assessment of studies' full text, quality, and strength of evidence (where applicable) was agreed upon by consensus using published criteria.

RESULTS

We identified 50 articles relevant to health inequalities in infectious disease epidemics in the United States predating COVID-19. We found 14 studies (16 articles) that examined potential mediating factors associated with health inequities, and 12 studies (3 articles) and 5 CDC expert panel reports that provide examples of interventions and lessons learned from previous epidemics and disasters to guide us forward in mitigating health inequalities during the COVID-19 pandemic and beyond. We also identified 20 studies that examined inequalities in H1N1 vaccine uptake and mediating factors, and 1 vaccine-related intervention study.

To our knowledge, this is the first review of studies aimed at identifying both the factors that mediate health disparities in infectious disease epidemics and also potential avenues for mitigating then. Our conceptual framework was guided by the work of Quinn and Kumar, who considered the potential causes of epidemic influenza based on measures of exposure, susceptibility, and access to care as they applied to data collected in 2009-2010 during the H1N1 pandemic. The framework points to proximal and distal determinants of disease burden with the ultimate goal of identifying potential points of policy and programmatic intervention.

Across Key Questions, studies were heterogeneous in their operationalization of potentially mediating factors, populations, programs and interventions. Studies of potentially mediating factors generally, and those related specifically to H1N1 vaccine uptake specifically, were largely cross-sectional. Several included studies did not control for confounding variables or their methods were unclear; however, many were well conducted and adequately reported. A few of the qualitative studies clearly reported their methodology and/or findings. However, more did not. We identified very few interventions or program evaluation studies specific to infectious disease epidemics; most were focused on post-disaster needs or disaster preparedness.

KEY QUESTION 1. What factors contribute to disparate infection rates and health-related outcomes among different segments of the

population during infectious disease epidemics or pandemics in the United States?

Our findings related to mediators associated with differential exposure or the transmission of infectious disease were unsurprising. Despite looking across racial/ethnic groups and socioeconomic status independently, the findings that disparities were related to societal-based structural and work-related factors, rather than individual factors such as hygiene and cleaning, were consistent across studies. We identified few significant differences in social distancing attitudes and intentions between groups. Instead, it was clear that the meaningful differences lay in the ability or inability to social distance. Only 1 study examining variables related to exposure to illness disaggregated the Latino population by language proficiency, and 1 additional study provided qualitative input in the form of stakeholder interviews. In contrast with other populations we examined, compared to either English-proficient Latinos or Whites, limited English-proficient Latinos (and/or migrant and seasonal farm workers) were at higher risk across both structural and work-related variables measured (see Table 9).

Susceptibility to illness played a major role in H1N1 severity and mortality; however, access to care (*ie*, having a primary care provider or health insurance) did not. Significantly greater proportions of every racial and ethnic minority group reported having experienced discrimination while seeking healthcare, and many reported being less informed or were less prepared. Much of the literature guiding communication is dated due to advances in technology, and findings of proportionally high rates of trust in the federal governmental, particularly in AA/Black and Latino adults, may be out of date.

KEY QUESTION 2. What interventions or intervention components have been used to reduce health inequalities (or identified in preliminary studies) in infectious disease transmission or health outcomes in disasters, or infectious disease epidemics or pandemics in the United States?

Of the 12 studies that described interventions or intervention components, only 1 study examined effectiveness outcomes, while the majority described acceptability and feasibility of the studied interventions. We identified only 1 randomized controlled trial and 1 longitudinal cohort study.

While many focus on disaster preparedness and response, the interventions in this review often represent real world applications of CDC and expert panel recommendations. For instance, the positive effect that interpersonal, culturally appropriate education delivered by a community health worker can have on disaster preparedness in vulnerable communities validates the recommendation for using lay *promotoras* in delivery of health services, goods, and messaging in the case of a pandemic. These results could be translated into an intervention to reach vulnerable populations during the current COVID-19 pandemic.

The importance of community engagement and partnership with community leaders was repeated often in expert-based recommendations, and was empirically grounded in some studies we examined. For example, 1 study found that African American clergy could be integral as community liaisons in facilitating the delivery of mental health services after Hurricane Katrina, and that churches could serve as sites for delivery of community-based services. These findings

mirror the recommendations of partnering with faith-based organizations and community leaders in order to "allay distrust and ensure successful implementation of mitigation interventions in minority communities" in the setting of an influenza pandemic. These recommendations support the use of such partnerships to lessen the disproportionate burden of COVID-19 in racial and ethnic minorities. While it is too early in the pandemic to expect a rigorous evaluation of the effect of faith-based partnerships on COVID-19 disparities, the popular media has already chronicled that such interventions are underway.

The interventions described here emphasize that preparedness efforts must be prioritized and that marginalized communities must be included *before* disaster hits. Nevertheless, some of the lessons learned may be relevant to the current pandemic phase: months into the trajectory of pandemic response but prior to a safe and widely available vaccine or treatment. Proven preparedness interventions could also be considered for implementation now given the potential for future waves of COVID-19 or new epidemics to emerge.

What remains missing from the studies in this review are examples of successful systems-level interventions that target the distal determinants of worse outcomes of influenza illness in vulnerable populations. This is despite evidence from the H1N1 pandemic that variables of exposure that occur at higher rates among these vulnerable groups, such as inability to take sick leave, can drastically affect disease rates. In key stakeholder reports, we find multiple systems-level recommendations, such as liberal workplace leave and teleworking policies, wage freezes and childcare vouchers, and creating an ethical and equitable system for ensuring access to treatment and vaccination, particularly among the uninsured. These interventions may already be underway, and researchers and policymakers should actively test their impact on health disparities so that lessons learned may be applied to our current and possible future disease epidemics.

INEQUITIES IN H1N1 VACCINE UPTAKE, CONTRIBUTING FACTORS, AND INTERVENTIONS

We identified 10 studies examining disparities in H1N1 vaccine uptake in the US during the 2009-2010 flu season. We found moderate-strength evidence that vaccine uptake was lower in AA/Black than White populations from 4 of 6 studies presenting unadjusted data. We also found low-strength evidence of lower vaccine uptake for Latino populations, although there was some inconsistency in results. The evidence for Asian, AI/AN, and Pacific Islander populations compared to Whites was insufficient.

Three studies looked at disparities by socioeconomic status (SES) and provide low-strength evidence that lower-SES individuals were less likely to have been vaccinated. Lastly, a very small study of rural versus urban participants provided insufficient evidence for H1N1 vaccine uptake between those populations. There was no evidence by disability status (see Table i).

Table i. Strength of the Evidence for Studies of H1N1 Vaccine Uptake

Population of interest	Comparator population	# of studies	Vaccine uptake likelihood	Strength	SOE justification
AA/Black	White	6	Less likely	Moderate	
Latino		7	Less likely	Low	Inconsistency
Asian		2	Unclear	Insufficient	Inconsistency, imprecision, indirectness
AI/AN		2	Unclear	Insufficient	Indirectness, imprecision
Pacific Islander		1	Unclear	Insufficient	Indirectness
Asian/Pacific Islander		1	Unclear	Insufficient	Indirectness, imprecision
Lower SES (education and/or income)	Higher SES	3	Less likely	Low	Inconsistency
Rural	Urban	1	Unclear	Insufficient	Single, small study with multiple limitations
With Disabilities	Without Disabilities	0	No evidence	---	---

Abbreviations: AA = African American, AI = American Indian, AN = Alaska Native, SES = socioeconomic status

Studies examining H1N1 vaccines explored a wide range of factors that were either proximal or distal to H1N1 vaccine uptake. Health insurance coverage and availability of/access to vaccines were both important factors. Also important were receipt of the seasonal influenza vaccine, vaccine-related safety and effectiveness beliefs, and perceived susceptibility to H1N1. Across all factors AA/Black adults, and often Latino and low SES adults as well, were at higher risk.

We did not identify any studies of interventions specifically targeting disparities in H1N1 vaccine uptake. However, the single vaccine intervention study we did find demonstrated greater Hepatitis A vaccine uptake in an ED setting after the implementation of an EHR alert system that informed providers of the patient's homeless status and prompted them to recommend vaccination during a regional outbreak. This suggests that EHR notification systems may be useful in increasing vaccination, and potentially could be used in the COVID-19 vaccination campaign to prompt providers to recommend vaccination, especially for vulnerable groups.

CONCLUSION

The literature examining health disparities associated with previous infectious disease epidemics, and in some cases disasters, may provide some guidance for the current COVID-19 response. Evidence consistently pointed to disparities in structural and work-related exposure to infection as underlying disparities, with the impact of comorbid conditions on susceptibility for more severe infection and higher rates of mortality playing a less certain role. Discrimination was reported more frequently by all racial and ethnic minorities. However, its impact on disparities during infectious disease epidemics is uncertain. African American/Black and Latino adults generally were disproportionately affected. However, Latinos with limited English proficiency were at especially high risk. There is moderate-strength evidence that AA/Black adults were less

likely to receive a H1N1 vaccine, and low-strength evidence of lower vaccination rates for Latinos adults of lower SES. Advances in technology, and sociopolitical shifts over the past decade call into question the applicability of findings. Interventions and programs from the disaster literature bring to light recommendations for infectious disease response by the CDC and other experts. In order to better prevent widespread health disparities that emerge in the wake of the current and future disease epidemics, more research is needed on policy- and systems-level interventions and their effect on the distal determinants of poor health outcomes among vulnerable groups.

EVIDENCE REPORT

BACKGROUND

Health inequalities in the United States generally, and in Veteran populations specifically, are well documented.[1,2] Infectious disease-related outbreaks create unique challenges, as they involve rapid transmission and may necessitate public health measures (*eg*, social distancing, school, business and facility closures) that could inadvertently differentially impact disadvantaged populations, and potentially contribute to higher burdens of morbidity and mortality among certain populations.

Since the first cases of severe acute respiratory syndrome (SARS) Coronavirus Disease 2019 (COVID-19) were detected in the US in early 2020, the effects of the disease have varied greatly between and across regions and communities. Recent studies have shown poorer health outcomes for those of lower socioeconomic status and racial/ethnic minorities and higher rates of hospitalization among African Americans/Blacks.[3-5] A study of Veterans Health Administration (VHA) data examined COVID-19 testing patterns and results from early February to early May, and found that African American/Black and Latino Veterans were more likely to test positive, regardless of underlying medical conditions and geographic location.[6]

Similar disparities in health outcomes have been observed in past infectious disease outbreaks. In the 2009 H1N1 pandemic, African Americans/Blacks and Hispanics had higher rates of hospitalizations and mortality in Illinois.[7] Patients of low socioeconomic status (SES) were also found to have higher odds of hospitalization in New York City.[8] While it is early in the pandemic to know the true impact of the novel SARS- CoV2 virus on vulnerable populations, it is likely the US will be feeling the ripple effects of these unequal health outcomes for years. For this reason, research on the root causes and potential mitigating strategies of these disparities is crucial.

The VHA places a high priority applying lessons learned from past experience to develop and target evidence-based interventions to mitigate health inequalities in the current COVID-19 pandemic and future epidemics and pandemics.

THE CURRENT STUDY

The scope of this review was refined through a process that included a preliminary review of published peer-reviewed literature and iterative discussions with our operational partners. Our approach is guided by existing frameworks used to describe: 1) health inequalities specifically related to infectious disease epidemics[9,10] and 2) health inequality research generally.[11-13]

The conceptual framework we adapted was initially developed in 2008 by Blumenshine et al[14] to describe the mechanisms through which inequalities in influenza health outcomes occur, and was later adapted by Quinn, Kumar, et al to describe evidence from the H1N1 pandemic.[9,10] Factors contributing to inequalities are categorized into the following domains: 1) exposure (*eg*, structural factors such as working and living conditions; work-related factors such as the inability to work from home or fear of job loss; and other factors related to childcare or public transportation), 2) susceptibility (*eg*, existing chronic conditions), 3) access to care (*eg*, lack of a

regular healthcare provider, insurance, or ability to pay co-insurance or copays), and 4) experiencing health-care related discrimination (see Figure 1). We expanded the model to add hygiene and health-related behaviors to the exposure category, broadened discrimination to go beyond experiences of interpersonal mistreatment and include community discrimination, as well as trust in healthcare systems and government, and added a category to take into consideration information and knowledge.

We categorized studies based on the framework initially developed by Kilbourne in 2006,[11] and later refined by Saha[13] and Thomas.[12] This framework describes 3 types of health inequality research. First generation studies are those that identify health inequalities, second generation studies examine mediating and moderating factors that may contribute to inequalities for any given group/population, and third generation studies examine interventions to mitigate or reduce inequalities.

The aims of this evidence synthesis are to: 1) examine existing literature of infectious disease pandemics or epidemics predating COVID-19 to better understand the potentially modifiable factors that may have contributed to differential infection rates and health outcomes; and 2) identify interventions that have been used to mitigate and reduce health inequalities in past infectious disease pandemics, epidemics, or disasters.

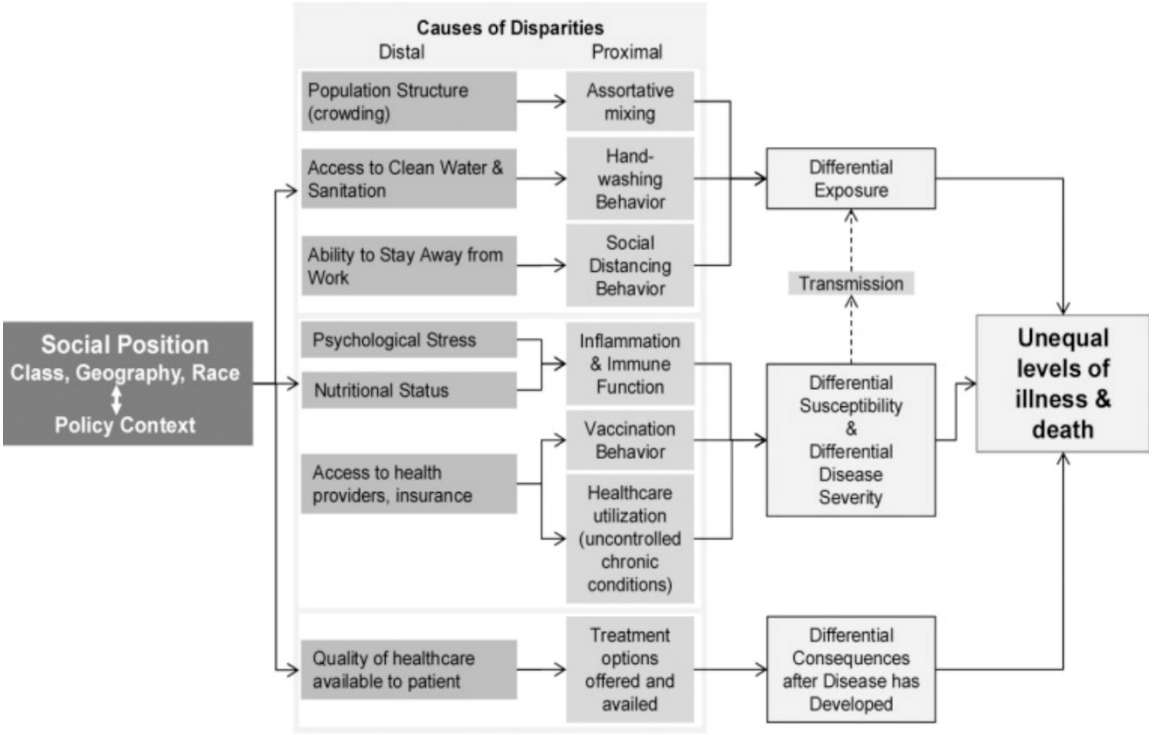
KEY QUESTIONS

The Key Questions (KQs) for this study are:

KQ1: What factors contribute to disparate infection rates and health-related outcomes among different segments of the population during infectious disease epidemics or pandemics in the United States?

KQ2: What interventions or intervention components have been used to reduce health inequalities (or identified in preliminary studies) in infectious disease transmission or health outcomes in disasters, or infectious disease epidemics or pandemics in the United States?

Figure 1. Organizational Framework Developed by Quinn, Kumar, and Colleagues



Note. Framework was developed by Quinn, Kumar, et al.[9,10]

SEARCH STRATEGY

We searched MEDLINE ALL, PsycINFO, Cochrane Database of Systematic Reviews, and Cochrane Central Register of Controlled Trials from database inception through May 20, 2020. Searches included controlled vocabulary terms (*eg*, MeSH), along with free-text words, related to previous epidemics, pandemics, disasters, and health disparities. We reviewed the bibliographies of relevant articles and contacted experts to identify additional studies. Search strategies were designed and conducted by an experienced systematic review/medical reference librarian with input from the investigators (Appendix 1).

We further refined search results by performing keyword searches in EndNote (X9.3.3) to exclude articles that are not studies (*ie*, errata, comments, replies, proposals), basic science studies and studies of animals, studies that are not of infectious disease pandemics or epidemics relevant to the US, and studies of only non-US state or territory populations. Titles and abstracts excluded via keyword search were confirmed by an investigator.

LANGUAGES

We searched for English-language publications.

METHODS

INCLUSION/EXCLUSION CRITERIA

Criteria for population, interventions, comparators, outcomes, timing, and setting (PICOTS) were developed in collaboration with our operational partners (see Table 1). We included studies of adult populations examining health inequalities by race/ethnicity, SES, disability, or geographic location related to infectious disease epidemics predating COVID-19 or disasters (KQ2 only) in the United States. To examine the effectiveness of interventions, we included studies with a comparison group (pre-, other-, or no intervention). We also included studies that would help to identify potentially important components and strategies to target in future interventions. In preliminary searches we found very little intervention effectiveness literature. Given the immediacy of the pandemic and the need to identify even potentially relevant information that might help guide intervention development we were more inclusive. For these studies (*eg*, cross-sectional surveys, qualitative), no comparator was required.

SCREENING PROCESS

A single reviewer screened titles and abstracts, and 2 reviewers independently assessed the full text of studies for inclusion based on pre-specified criteria. All discordant results were resolved through consensus or consultation with a third reviewer. Articles meeting eligibility criteria were included for data abstraction.

OUTCOMES SELECTED

For all key questions, we examined outcomes related to the utilization and the quality of healthcare, health outcomes, and outcomes that were a result of measures implemented during an infectious disease pandemic/epidemic that may have impacted a health outcome (*eg*, job loss due to social distancing mandates).

RISK OF BIAS ASSESSMENT

Two reviewers independently assessed the methodological quality of each study using established methods for each study design. For trials, we adapted criteria established by the Cochrane Collaboration.[15] The Newcastle-Ottawa scale[16] was used for observational studies, and we used the Critical Appraisal Skills Programme (CASP) Qualitative Checklist for qualitative studies.[17] Disagreements were resolved by consensus or a third reviewer.

Table 1. PICOTS

	KQ1: What factors contribute to disparate infection rates and health-related outcomes among different segments of the population during infectious disease epidemics or pandemics?	KQ2: What interventions or intervention components have been used to reduce health inequalities (or identified in preliminary studies) in infectious disease transmission or health outcomes in disasters, infectious disease epidemics or pandemics in the United States?
Populations	Adult Subgroups: race or ethnicity, socioeconomic status, disability, geographic location (*eg*, urban/rural, high density neighborhoods)	
Intervention/ Mediating and Moderating Factors	Risk of exposure: • Structural (employment, urban/rural, living arrangement, crowding) • Work-related inability to social distance • Other measures of inability to social distance (childcare access, need for public transport, language or cultural barriers) • Access to clean water and sanitation • Hygiene and health-related behaviors Susceptibility: • Comorbid chronic diseases • Immunosuppression • Psychologic and nutritional stress Access to care: • Regular health care provider • Insurance • Quality of health care Discrimination and trust • Interpersonal mistreatment • Community discrimination • Trust in healthcare systems and government Information/Knowledge	• Emergency preparedness • Messaging and communication • Employment, telework • Childcare • Health care access
Comparator	• Comparison group within the same group • Comparison to other groups relevant to the population	• Standard public health response • No intervention or pre-intervention • Other interventions • No comparator necessary for pre-intervention studies
Outcomes	• Mortality • Health care utilization and access • Infectious-disease-related hospitalizations	

	KQ1: What factors contribute to disparate infection rates and health-related outcomes among different segments of the population during infectious disease epidemics or pandemics?	KQ2: What interventions or intervention components have been used to reduce health inequalities (or identified in preliminary studies) in infectious disease transmission or health outcomes in disasters, infectious disease epidemics or pandemics in the United States?
	• Burden of illness • Severity of illness • Loss of job due to epidemic/pandemic/disaster	
Timing	Related to an infectious disease pandemic or epidemic	Related to an infectious disease pandemic or epidemic, or disaster
Setting	United States and Territories	
Study design	Trials, quasi-experimental, observational, descriptive, case series (depending on search yield), qualitative. Systematic reviews will be included if they directly address key questions. If not, reference lists will be pearled.	

SYNTHESIS

For studies examining proximal and distal factors that may contribute to health inequalities during infectious disease epidemics predating COVID-19, we qualitatively synthesized the evidence and present it in tables organized by the framework we adapted from Quinn, Kumar, and colleagues.[9,10] We organized studies examining interventions designed to mitigate health inequalities according to whether they were an individual or system focused intervention. We summarized findings from expert panel interviews and present them in tabular form. We identified a number of studies examining H1N1 vaccine uptake, factors associated with differential rates, and interventions to mitigate inequities in vaccination. We qualitatively synthesized the evidence from these studies and present them after Key Question 2.

ASSESSING THE OVERALL BODY OF EVIDENCE

For studies examining H1N1 vaccine uptake we assessed the overall strength of evidence for each population using a method developed for the Agency for Healthcare Research and Quality's (AHRQ) Evidence-based Practice Centers (EPCs).[18] The AHRQ EPC method considers study limitations, directness, consistency, precision, and reporting bias to classify the strength of evidence for individual outcomes independently for randomized controlled trials (RCTs) and observational studies, with supplemental domains of dose-response association, plausible confounding that would decrease the observed effect, and strength of association, as well as separate guidance for applicability.[19] Ratings were based on the following criteria:

- High = Very confident that the estimate of effect lies close to the true effect for this outcome. The body of evidence has few or no deficiencies, the findings are stable, and another study would not change the conclusions.

- Moderate = Moderately confident that the estimate of effect lies close to the true effect for this outcome. The body of evidence has some deficiencies and the findings are likely to be stable, but some doubt remains.

- Low = Limited confidence that the estimate of effect lies close to the true effect for this outcome. The body of evidence has major or numerous deficiencies (or both). Additional evidence is needed before concluding either that the findings are stable or that the estimate of effect is close to the true effect.

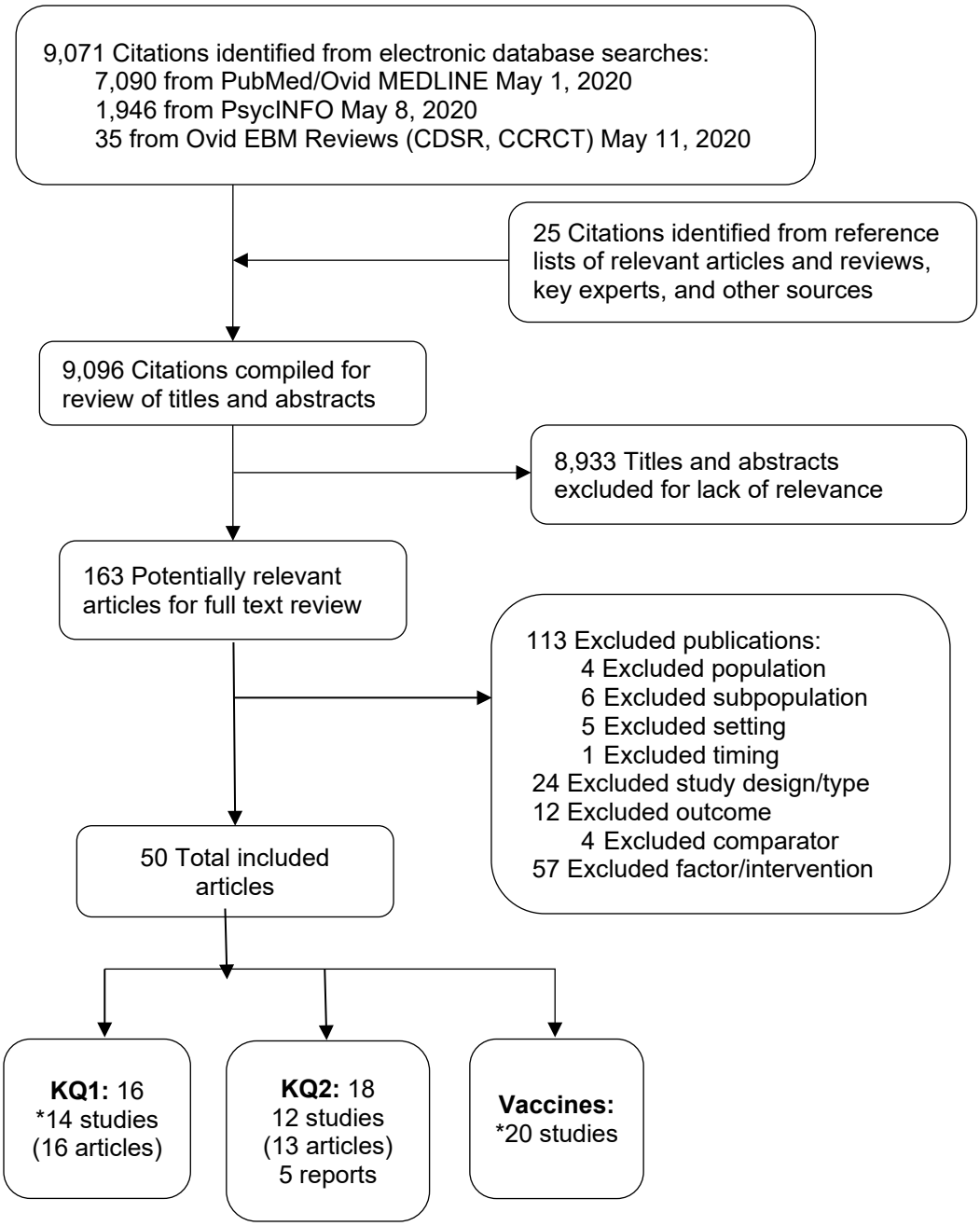
- Insufficient = No evidence, unable to estimate an effect, or no confidence in the estimate of effect for this outcome. No evidence is available, or the body of evidence has unacceptable deficiencies, precluding reaching a conclusion.

We did not assess the strength of evidence for factors related to disparate infection rates, health-related outcomes (KQ1), or vaccine uptake due to heterogeneity, nor did we assess SOE for interventions (KQ2), as our approach to the intervention literature was exploratory.

RESULTS

We reviewed a total of 9,071 articles. After title and abstract review, 163 met inclusion criteria. Upon full text review, we included a total of 41 studies (in 45 articles) and 5 expert panel papers. 14 studies (16 articles) were included in Key Question 1, 12 studies (13 articles) and the 5 expert panel papers were included in Key Question 2, and 20 studies examined H1N1 vaccines. Seven studies included in Key Question 1 also examined H1N1 vaccines (see Table 2 and Figure 2; the complete quality assessment is presented in Appendices C and D).

Figure 2. Literature Flow Chart



*7 studies were included in both KQ1 and Vaccines

Table 2. Studies of Risk Factors by Population

Study **Author, year** **N participants** **Setting** **Dates** **Study design** **Study timing** ***Focus***	**Demographics** **% female** **Age (SD)** **Race/Ethnicity** **Education** **Unemployed** ***Other***	**Key Question**	**African American/Black**	**Latino**	**Asian and/or Pacific Islander**	**American Indian or Alaska Native**	**Limited English Proficient**	**Low Socio-economic Status**	**Rural**	**Disability**	**Applicability**	**Study Quality Ratings and Concerns**
Andrulis, 2011[20] N = 17 California statewide + 4 regions (Central Coast, Bay Area, Central Valley, and Los Angeles) June and Aug 2008 Qualitative: Key informant interviews *Disaster Planning*	6 Nonprofit agencies; 3 County; PH Depts; 3 CBOs; 2 Local EMR orgs; 2 State agencies; 1 Academic	2	✓	✓	✓	✓	✓	✓			Fair	Generally good, lacks some methods reporting.
Aten, 2010[21] Aten, 2011[22] N = 41 Southern Mississippi (Hancock, Harrison, and Forrest Counties) ~1 year after Hurricane Katrina Qualitative: semi-structured interviews with pastors of AA churches *Post Disaster Mental Health Disparities*	7% Female Age: 51.2(10.81) 1 Catholic; 2 African Methodist Episcopal; 38 Missionary Ministry experience: 16.91(10.41)	2	✓								Fair	No issues. Good qualitative methods described.
Bouye, 2009[23] N = 26 CDC Stakeholder meeting May 1-2, 2008 *Influenza Pandemic: Low-SES, Public Housing Residents, Single-Parent Families*	Federal, State, and Local HUD Depts.; State and Local agencies; CBOs and FBOs; Academics; Community Members	2						✓			Good	NA: CDC Stakeholders
Boyd, 2013[24] N = 56 (30 rural, 26 urban) Atlanta GA June-Aug 2010	<u>Clients:</u> Rural (n = 30) vs urban (n = 26) Median age 23 vs 25 AA/Black: 100% vs 88% Latino: 0 vs 4%	V							✓		Fair	---

Study **Author, year** **N participants** **Setting** **Dates** **Study design** **Study timing** ***Focus***	**Demographics** **% female** **Age (SD)** **Race/Ethnicity** **Education** **Unemployed** ***Other***	**Key Question**	**African American/Black**	**Latino**	**Asian and/or Pacific Islander**	**American Indian or Alaska Native**	**Limited English Proficient**	**Low Socio-economic Status**	**Rural**	**Disability**	**Applicability**	**Study Quality Ratings and Concerns**
Qualitative interviews of WIC clients and staff Low-SES women *H1N1 Vaccine*	< HS: 7% vs 12% HS: 55% vs 31% Not working: 47% vs 35% <u>Staff:</u> 39.5 Median age AA/Black: 80% White: 20% HS or less: 0%											
Burger, 2018[25] N = 11,834 National Health Interview Survey 2010 Cross-sectional Survey *H1N1 Vaccine*	White: 74.2%* Latino, US born: 9.6%* Latino, foreign born: 16.2%* White vs US-born Latino vs Latino immigrant: Female: 51% vs 52% vs 46% 18-34yrs: 27% vs 52% vs 37%; 35-64 yrs: 53% vs 41% vs 54%; 65+ yrs: 19% vs 7% vs 9% Uninsured: 13% vs 25% vs 47% <$20K: 14% vs 16% vs 26% <HS: 10% vs 18% vs 48%	V		✓			✓				Good	No reporting on non-respondents
Cassady, 2012[26] N = 90 California 2010 Qualitative focus groups *H1N1 Vaccine*	66% Female Age (mean): 36 Mean yrs in US: 16 8 focus groups: Central Valley and Central Coast; 2 in suburbs of a large city in Southern CA	V		✓			✓				Good	Good quality
Castillo, 2018[27] N = 1,131 ED, San Diego, CA Retrospective pre- post- Aug 2016 - Jan 2018 *Hepatitis A Vaccine for the Homeless population*	NR	V						✓			Fair	Good quality

Study **Author, year** **N participants** **Setting** **Dates** **Study design** **Study timing** ***Focus***	**Demographics** **% female** **Age (SD)** **Race/Ethnicity** **Education** **Unemployed** ***Other***	**Key Question**	**African American/Black**	**Latino**	**Asian and/or Pacific Islander**	**American Indian or Alaska Native**	**Limited English Proficient**	**Low Socio-economic Status**	**Rural**	**Disability**	**Applicability**	**Study Quality Ratings and Concerns**
Eisenman, 2009[28] and Glik, 2014[29] N = 187 Los Angeles County 2006-2007 Randomized longitudinal cohort *Disaster Preparedness Intervention*	I vs C % Female: 66.67% vs 68% Age: 37.08 vs 36.97 ≤HS: 77% vs 75% HS+: 23% vs 25% Below FPL: 66.67% vs 71% Not working: 24.14% vs 29%	2		✓			✓				Fair	Fair quality
Etingen 2012[30] LaVela[31] N = 3,384 Hines, Illinois Veterans with Spinal Cord Disabilities August 2010 Cross-sectional Survey *H1N1 and H1N1 Vaccine*	3% Female Age: 61.82(11.70) AA/Black: 14.71% Latino: 8.42% White: 73.05% < HS: 6.39% HS: 20.21%	1 V	✓	✓				✓		✓	Fair	Veteran sample, low response rate
Freimuth, 2014[32] N = 1,543 Nationally Represented June-July 2009 Cross-sectional Survey *H1N1*	51.8% Female Age: 46.3(0.54) AA/Black: 11.4% Latino:13.7% White: 68.8% <HS: 13.6% HS: 31.7%	1 V	✓	✓							Good	--
Frew, 2012[33] N = 503 Atlanta, GA Sept-Dec 2009 Cross-sectional Survey *H1N1 Vaccine*	50.9% female 18-24: 22.1%; 25-63; 70.4%; 64-70: 2.4% Latino: 6.2% AA/Black: 79.3% Multiracial: 5.6% Asian: 2.4% AI/AN: 1.2% < HS: 16.7% Unemployed: 48.7% ≤$40K/year: 81.9%	V	✓					✓			Fair	Multivariable regression on some, but not all relevant factors.

Study **Author, year** **N participants** **Setting** **Dates** **Study design** **Study timing** ***Focus***	**Demographics** **% female** **Age (SD)** **Race/Ethnicity** **Education** **Unemployed** ***Other***	**Key Question**	**African American/Black**	**Latino**	**Asian and/or Pacific Islander**	**American Indian or Alaska Native**	**Limited English Proficient**	**Low Socio-economic Status**	**Rural**	**Disability**	**Applicability**	**Study Quality Ratings and Concerns**
Galarce, 2011[34] N = 1,569 Nationally Representative March 2010 Cross-sectional Survey *H1N1 Vaccine*	Female: 50.9%* Age: 18-29: 21.4%*; 30-44: 27.9%*; 45-59: 27.9%*; 60+: 22.9%* White: 66.6%* AA/Black: 10.6%* Latino: 14.5%* <HS: 13.9%*	V	✓	✓				✓	✓		Good	---
Gargano, 2011[35] N = 102 Two rural counties in GA September 2009 Cross-sectional Survey *H1N1 Vaccine*	Female: 69% Age range: 23-67 White: 72% AA/Black: 25% Latino: 2%	V	✓	✓							Fair	High nonresponse rate, small sample
Goodman, 2009[36] N = 6 New Orleans, LA post-Hurricane Katrina *Culturally Competent Disaster Response mental health students*	100% Female Age: 31 1 Haitian American 1 Indian American 4 European Americans	2	✓								Fair	NA: Program Evaluation
Hennessy, 2015[37] N = 381 AI/AN N = 72 AK, AZ, NM, OK, and WY 2009 Case Control *H1N1 Mortality*	Cases vs Controls Female: 50% vs 54% ≤ 20: 19% vs 50%; 21-60: 59% vs 47%; ≥ 61: 22% vs 3% AI/AN: 17% vs 11% AA/Black: 4% vs 1% Asian: 0% vs 6% White: 76% vs 72%	1				✓					Fair	Issues with method of ascertainment and comparability of cases and controls.
Hernandez, 2019[38] N = 225 Pregnant women in 2 large midwestern cities 2009-2010	100% Female Age: 29.9(5.3) White: 67.7% AA/Black: 5.4% Latino: 5.8%	V						✓			Fair	Response rate low, and unclear if non-responders were different

Study **Author, year** **N participants** **Setting** **Dates** **Study design** **Study timing** ***Focus***	**Demographics** **% female** **Age (SD)** **Race/Ethnicity** **Education** **Unemployed** ***Other***	**Key Question**	**African American/Black**	**Latino**	**Asian and/or Pacific Islander**	**American Indian or Alaska Native**	**Limited English Proficient**	**Low Socio-economic Status**	**Rural**	**Disability**	**Applicability**	**Study Quality Ratings and Concerns**
Cross-sectional Survey *H1N1 Vaccine*	Other race: 21.5% ≤HS: 8.9% Some college: 12.5% College graduate: 38.8%											
Hutchins, 2009[39] N = NR CDC Stakeholder Meeting May 1-2 2008 *Influenza Pandemic: Racial and Ethnic Minorities*	State and Local PH officials; health care providers, State and Local EMR professionals, Academics, CBOs, FBOs, advocacy organizations, racial and ethnic minorities	2	✓	✓	✓	✓	✓				Good	NA: CDC Stakeholder
Kumar, 2012[40] Kumar, 2012[41] N = 2042 Nationally Representative Jan 2010 Cross-sectional Survey *H1N1 and H1N1 Vaccine*	Women: 51.7% Age: 44.9 (SE = 0.4) AA/Black: 28.94% Latino: 29.48% White: 41.58% <$25K: 30.5% < HS: 18.8%	1 V	✓	✓				✓			Good	--
Levy[8] N = 374 New York City Oct 2009-Feb 2010 Case Control *H1N1 Hospitalization*	Cases vs Controls 58% vs 57% Female Age: 47 vs 42 AA/Black: 22% vs 9% Latino: 24% vs 12% White: 22% vs 46% <HS: 35% vs 5%; HS: 41% vs 44%	1						✓			Fair	Expected uneven response rate, so controls were oversampled. Matched 2:1 as planned.
Lin, 2014[42] Lin, 2018[43] N = 1,569 Nationally Representative Feb-March 2010 Cross-sectional Survey *H1N1 and H1N1 Vaccine*	51% Female Age: 49% were ≤44 AA/Black: 11% Latino: 14% White: 68% <HS 14% Unemployed: 21%	1 V						✓			Good	--

Study **Author, year** **N participants** **Setting** **Dates** **Study design** **Study timing** ***Focus***	**Demographics** **% female** **Age (SD)** **Race/Ethnicity** **Education** **Unemployed** ***Other***	**Key Question**	**African American/Black**	**Latino**	**Asian and/or Pacific Islander**	**American Indian or Alaska Native**	**Limited English Proficient**	**Low Socio-economic Status**	**Rural**	**Disability**	**Applicability**	**Study Quality Ratings and Concerns**
Lin, 2017[44] N = 627 Nationally Representative December 2013 Cross-sectional Survey *MERS and Previous Pandemics*	51% Female 18-29: 19%; 30-39: 15%; 40-49: 20%; 50-59: 20%; ≥60: 26% AA/Black 13% Latino 17% White 69% < HS 12%	1	✓	✓				✓			Fair	Unclear whether confounding factors were controlled.
Liu, 2017[45] N =148 Washington, DC Dec 2015- June 2016 Qualitative: Intercept interviews *Medical Countermeasures*	Female: 35% Age: 32 (15.47) Caucasian: 33.8%‡ African American: 35.8%‡ Hispanic/Latino: 22.3%‡ Unreported race: 8.1%‡	V	✓	✓							Fair	Generally good, lacks some methods reporting.
McCabe, 2013[46] N = 178 Maryland Date: NR Program Evaluation *Community-level Disaster Preparedness*	Faith-based Participants: 73% Female AA/Black: 31% Latino: 1% Biracial: 2fx%	2							✓		Fair	NA: Program Evaluation
McCauley[47] N = 46 Four Communities in New England Focus Groups *H1N1*	City A Only: 57.7% Female Age: 45 AA/Black: 81.25% Latino: 12.5% White: 6.25% < HS: 43.75%; HS: 43.75% < Poverty: 50%	1	✓								Poor	Qualitative synthesis not very more robust.
Mesch, 2014 N = 968 National October 2009 Cross-sectional Survey	51% Female Age: 45.80(17.84) AA/Black: 11% Latino: 7.6% < HS: 14.2%	1 V	✓	✓				✓			Good	Unclear if respondents similar to non-respondents.

Study **Author, year** **N participants** **Setting** **Dates** **Study design** **Study timing** ***Focus***	**Demographics** **% female** **Age (SD)** **Race/Ethnicity** **Education** **Unemployed** ***Other***	**Key Question**	**African American/Black**	**Latino**	**Asian and/or Pacific Islander**	**American Indian or Alaska Native**	**Limited English Proficient**	**Low Socio-economic Status**	**Rural**	**Disability**	**Applicability**	**Study Quality Ratings and Concerns**
H1N1 and H1N1 Vaccine	HS: 30.9%											
Nassar, 2014 [48] N = 50 Washington DC 2010 Feasibility RCT *Monitoring H1N1 Symptoms*	100% women I vs C Age: 24.1(6.3) vs 23.5(5.2) AA/Black: 87% vs 84.6% Medicaid Eligible: 87% vs 80.7%	2						✓			Fair	Poor quality, unblinded, small feasibility trial
Obaid, 2017[49] N = 667 participants Rural Nebraska 2010-2013 Program evaluation *Rural Infectious Disease Disaster Preparedness*	83 agencies across 3 medical response systems/coalitions Also: EMS, Fire, Emergency Management, county officials, health care and public health staff	2							✓		Fair	NA: Program Evaluation
Person, 2014[50] N = 70+ people, 50 agencies/orgs April 2003 NCID/CDC Response Focus Groups (11) *SARS-related Stigma*	Chamber of Commerce, trade associations, school officials, public health, mental health professionals, academics	2			✓						Good	NA: NCID/CDC
Plough, 2011[51] N =163,087 Oct-Dec 2009 Cross-sectional *H1N1 Vaccine*	Black: 3.0% Asian: 28.5% White: 20.5% Latino: 47.0% AI/AN: 0.3% Pacific Islander: 0.7%	V	✓	✓	✓	✓					Fair	No control for confounders; Inappropriate denominator; Sample not representative
Price, 2013[52] N = 1,180 2 South Carolina counties (Galveston and Chambers) ~1 yr post-Hurricane Ike Pre-post feasibility study, qualitative follow-up	50.7% Female Age: 47(17) AA/Black: 13.7% Latino: 6.3% White: 80% HS: 21.4% Some college: 36.1%	2	✓	✓							Fair	--

Study **Author, year** **N participants** **Setting** **Dates** **Study design** **Study timing** ***Focus***	**Demographics** **% female** **Age (SD)** **Race/Ethnicity** **Education** **Unemployed** ***Other***	**Key Question**	**African American/Black**	**Latino**	**Asian and/or Pacific Islander**	**American Indian or Alaska Native**	**Limited English Proficient**	**Low Socio-economic Status**	**Rural**	**Disability**	**Applicability**	**Study Quality Ratings and Concerns**
Post-Disaster Mental Health Intervention	<$40K: 21.4%											
Quinn, 2009[53] Quinn, 2011[10] 2009 N = 1,543 2011 N = 1,479 Nationally Representative June 2009 Cross-sectional Study *H1N1 and H1N1 Vaccine*	2009 51.8% Female Age: 46.3 AA/Black: 11.4% Latino: 13.7% < HS: 13.6%; HS: 31.7% 2011 51.2% Female 18-34: 27.9%; 35-64: 57%; ≥65: 15.1% AA/Black: 13.1% Latino (LEP): 15.5% English-speaking Latino: 4.4% <$25K: 25.5% <HS: 14%	1 V	✓	✓			✓				Good	--
Redelings, 2012[54] N =1,541 Los Angeles County public health clinics June-August 2010 Cross-sectional Survey *H1N1 Vaccine*	Female: 48% 18-24 yrs: 24% 25-34 yrs: 29% 35-44 yrs: 18% 45-54 yrs: 15% 55-64 yrs: 8% 60+ yrs: 2% Asian/PI: 11% Black: 33%	V	✓	✓	✓						Fair	---
Rosenbaum, 2018[55] N = 22 (completed training) Oceana County, MI	NR	2		✓			✓				Fair	NA: Program Evaluation

Study **Author, year** **N participants** **Setting** **Dates** **Study design** **Study timing** ***Focus***	**Demographics** **% female** **Age (SD)** **Race/Ethnicity** **Education** **Unemployed** ***Other***	**Key Question**	**African American/Black**	**Latino**	**Asian and/or Pacific Islander**	**American Indian or Alaska Native**	**Limited English Proficient**	**Low Socio-economic Status**	**Rural**	**Disability**	**Applicability**	**Study Quality Ratings and Concerns**
June & October 2016 Program Evaluation *Disaster Preparedness Training for MSFW*												
Santibanez,2013[56] N = 55,850 2009 National H1N1 Flu Survey (CDC-sponsored) Nov 2009-June 2010 Cross-sectional Survey *H1N1 Vaccine*	50.8% Female Age: 46.9 (0.6) White: 69.3% Black: 11.5% Latino:14.3% Uninsured: 12.9% <HS: 13.9%/ HS: 31.1%	V	✓	✓				✓			Good	---
Schoch-Spana, 2010[57] N = 33 Multiple sites nationally July - October 2009 Qualitative stakeholder interviews *H1N1*	18 Community clinic executives 6 Government agencies 7 MSFW advocacy groups 2 Industry and academic contacts	1		✓			✓				Good	Stakeholder interviews, qualitative methods not adequately described.
Steege, 2009[58] Briefing report from National Farmworker Health Conference and Western Migrant Stream Forum organizers May 2008 *Influenza Pandemic: Farmworkers*	NR	2		✓			✓				Good	NA: Report
SteelFisher, 2015[59] N = 2,355 Nationally Representative March-April 2010 Cross-sectional Survey *H1N1 and H1N1 Vaccine*	Female: NR AA/Black: 14.3% Latino: 13.8% Asian: 11.7% AI/AN: 11.4% White: 48.8%	1 V	✓	✓	✓	✓		✓			Good	--
Truman, 2009[60] CDC Stakeholder meeting May 1-2, 2008	Public health scientists Service program managers	2	✓	✓	✓		✓				Good	NA: CDC

Study **Author, year** **N participants** **Setting** **Dates** **Study design** **Study timing** ***Focus***	**Demographics** **% female** **Age (SD)** **Race/Ethnicity** **Education** **Unemployed** ***Other***	**Key Question**	**African American/Black**	**Latino**	**Asian and/or Pacific Islander**	**American Indian or Alaska Native**	**Limited English Proficient**	**Low Socio-economic Status**	**Rural**	**Disability**	**Applicability**	**Study Quality Ratings and Concerns**
Influenza Pandemic: Immigrants and Refugees												
Uscher-Pines, 2011[61] N = 4,040 Nationally Representative March 2010 Cross-sectional Survey *H1N1 Vaccine*	White vs AA/Black vs Latino (unweighted): Female: 49% vs 63% vs 51% 18-49: 24% vs 24% vs 32%; 50-64: 37% vs 50% vs 44%; ≥65: 39% vs 26% vs 24% HS graduate: 28% vs 22% vs 26%; College graduate: 33% vs 32% vs 27% Uninsured: 9% vs 15% vs 17% Income <$25K: 18% vs 28% vs 17%	V	✓	✓							Good	---
Vaughan, 2009[62] CDC Stakeholder meeting May 1-2, 2008 *Influenza Pandemic: Risk Communication and Vulnerable Populations*	Public health experts Program managers	2	✓	✓	✓	✓	✓	✓		✓	Good	NA: CDC
Witrago, 2011[63] N = 209 Fresno County, CA Cross-sectional Survey *Influenza Pandemic Preparedness: Rural Latinos*	71% Female 18-34: 35%; 35-54: 57%; 55-64: 5%; 65 older: 1% Born in Mexico: 89% <HS: 53%	1		✓			✓		✓		Fair	No control for confounders, methods poorly reported.
Wyte-Lake, 2014[64] N = 7 Single urban VHA HBPC program Qualitative: semi-structured interviews *Disaster Preparedness*	Associated chief of staff Program manager HBPC practitioners (nursing, OT, social work, psychology)	2								✓	Fair	Small study, poorly reported

Study **Author, year** **N participants** **Setting** **Dates** **Study design** **Study timing** ***Focus***	**Demographics** **% female** **Age (SD)** **Race/Ethnicity** **Education** **Unemployed** ***Other***	**Key Question**	**African American/Black**	**Latino**	**Asian and/or Pacific Islander**	**American Indian or Alaska Native**	**Limited English Proficient**	**Low Socio-economic Status**	**Rural**	**Disability**	**Applicability**	**Study Quality Ratings and Concerns**
Wyte-Lake, 2019[65] N = 754 patients 10 VA HBPC sites in 8 states April-October 2017 Cross-sectional survey evaluating a patient assessment tool *Disaster Preparedness*	16% high risk; 44% medium risk; 40% low risk 25% on oxygen 30% chair-bound 55% assistive device 33% cognitive impairment 20% communication limitation	2								✓	Poor	No control for confounders, methods poorly reported
Yip, 2009[66] N = 100 Seattle, WA April - June 2009 Cross-sectional Survey *H1N1*	73% Female Age: Median 47.5 Years in US: 0-5: 39%; 6-10: 27%; >10: 35%	1					✓				Fair	Pilot study, no control for confounders, methods poorly reported.

Abbreviations: AA = African American; AI/AN = American Indian/Alaska Native; C = control; CBO = community based organization; CDC = Centers for Disease Control; ED = emergency department; EMR = electronic medical record; HBPC = Home-based Primary Care; HS = high school; I = intervention; LEP = limited English proficiency; MSFW = migrant and seasonal farmworkers; NCID = National Center for Infectious Disease; OT = Occupational Therapy; PH = public health; PI = Pacific Islander; RCT = randomized controlled trial; SD = standard deviation; SES = socioeconomic status; US = United States; V=Vaccine-related study; VHA = Veterans Health Administration

KQ1: What factors contribute to disparate infection rates and health-related outcomes among different segments of the population during infectious disease epidemics or pandemics?

We identified 14 studies (16 articles) that met criteria for Key Question 1. All but 2 studies focused on factors that potentially contributed to health disparities during the 2009 H1N1 influenza pandemic. Other studies examined the 2012 Middle East respiratory syndrome (MERS) outbreak,[44] or planning for future infectious disease epidemics.[63] Six studies examined both African American/Black and Latino populations.[10,30,32,40,44,59] Two studies examined Asian populations,[50,59] and 2 focused on American Indian/Alaska Natives.[37,59] Five studies examined participants with limited English proficiency (LEP), 4 were of Latino populations,[10,47,57,63] and 1 of Chinese immigrants.[66] Five studies (6 articles) examined persons with low SES,[8,30,42-44,59] and 1 study was of Veterans with spinal cord disorders[30] (see Table 2).

We have organized findings in this section to report: 1) associations between demographic characteristics (*eg*, race/ethnicity, SES) and hypothesized mediating risk factors (*eg,* exposure, susceptibility); 2) associations between risk factors and outcomes (*eg,* influenza-like illness, hospitalization); 3) evidence of mediation of associations between demographic characteristics and outcomes by hypothesized risk factors; and 4) findings from qualitative studies.

Exposure

Structural

Three studies examined structural factors of exposure.[10,40,57] Two nationally representative cross-sectional studies examined measures of density by race and ethnicity. After controlling for sociodemographics, the studies by Kumar et al (N = 2,042)[40] and Quinn and colleagues (N = 1479)[10] both found that compared to Whites, AA/Black and Latino (both English-speaking and those with Limited English Proficiency [LEP]) participants were more likely to live in apartments and metropolitan areas. Both studies also found that AA/Black participants had a similar number or fewer children per household than Whites, and Kumar and colleagues found that Latino families reported significantly more children per household than Whites.[40] Quinn et al disaggregated Latinos by language and found that while English-speaking Latino participants reported fewer children per household, Latino participants with LEP reported more.[10]

Kumar et al also examined the relationship between structural factors and the likelihood of a self-reported influenza like illness (ILI) in both the participant and their household. They found the number of children in a household was positively related to the likelihood of ILI in the household (OR = 1.10, 95% CI NR). Neither apartment nor metropolitan living were related.[40]

No studies directly addressed the role of structural factors of exposure in mediating disparities in epidemic-related outcomes.

The third study, by Schoch-Spana et al, was a qualitative analysis of interviews with stakeholders from government agencies, community health clinics, advocacy groups, and academia engaged in work related to H1N1 and Latino migrant and seasonal farmworkers (N = 33). Study methods were not well described. Stakeholders acknowledged that labor camp living conditions, with 10-

12 people or 2-3 families sharing small cabins, inhibited compliance with official H1N1 containment guidance (see Tables 2 and 3 for more detail).[57]

Work-Related

The same 3 studies also looked at work-related exposure factors.

The studies by both Quinn and colleagues[10] and by Kumar et al[40] used a work-related social distancing index that assessed the ease or difficulty of staying home from work if needed (*eg*, paid sick leave, ability to work from home), and found that compared to Whites, AA/Black participants were similarly[40] or better able to social distance.[10] Kumar and colleagues found that Latinos were less able to social distance.[40] Examining the role of LEP, Quinn and colleagues found that there was no difference between English-speaking Latinos and Whites, but that Latinos with LEP reported more work-related barriers to social distancing.[10]

Kumar and colleagues[40] also examined the relationship between work-related factors and self-reported ILI and found an 8% increase in the likelihood of an ILI in the participant and a 6% increase for each unit increase in the social distancing index.

No studies directly addressed the role of work-related exposure factors in mediating disparities in epidemic-related outcomes.

Findings from Schoch-Spana and colleagues' qualitative study suggest that Latino migrant and seasonal farmworkers have numerous barriers to staying home from work. As a result it is not uncommon for them to go to work when sick and also to take their (sick or well) children with them (see Tables 2 and 3 for more detail).[57]

Social Distancing

Four studies (5 articles) examined measures of social distancing by race, ethnicity, and SES.[10,40,42,43,59] Across studies, findings comparing AA/Black and Latino to White participants were inconsistent. Two studies found that AA/Black participants were similar to Whites or were more likely to social distance (*eg*, avoid public transportation, air travel, social gatherings, people with flu-like symptoms).[40,59] However, Quinn et al found that AA/Blacks reported being more dependent on public transportation.[10] One study found that Latinos were better able to social distance.[59] However, both Quinn et al[10] and Kumar and colleagues[40] found that both English-speaking Latinos and those with LEP reported more barriers to social distancing than Whites.

Quinn et al found that AA/Black and Latino participants with LEP reported more difficulty than Whites in securing childcare that wasn't with a group of children. However, English-speaking Latinos and Whites were similar.[10]

Only 1 study (N = 2,355) examined Asian and American Indian/Alaska Native (AI/AN) populations and found that both groups were as or more likely than Whites to avoid social gatherings, air travel, and public transportation, and to avoid people with flu-like symptoms during the H1N1 epidemic.[59]

Two studies (3 articles) examined the relationship between SES and social distancing and also reported conflicting findings.[42,43,59] One was a cross-sectional study (reported in 2 articles) of the H1N1 epidemic (N = 1569) that found no association between educational attainment and "staying home," social distancing (including using public transportation), and the reduction of contact with non-household members.[42,43] The other found that participants with less than a high school education were more likely to avoid social gatherings, air travel, and public transportation but less likely to avoid people with flu-like symptoms.[59]

Kumar and colleagues examined the relationship between dependence on public transportation and self-reported ILI in the self and household. No differences were reported (see Tables 2 and 3). [40]

No studies directly addressed the role of social distancing in mediating disparities in epidemic-related outcomes.

Hygiene-Related Behaviors

Two cross-sectional studies (3 articles) examined hygiene-related behaviors during the 2009 H1N1 pandemic.[42,43,59] Findings were consistent that participants with lower education attainment were as or more likely than those with some college or college graduates to report adhering to recommended cleaning and hygiene practices during H1N1 (*eg*, frequent handwashing, hand sanitizer, coughing with mouth covered, cleaning more frequently). One study compared White to AA/Black, Latino, Asian, and AI/AN participants. Racial and ethnic minority participants were not significantly less likely to report following recommended cleaning and personal hygiene practices (see Tables 2 and 3 for detail).[59]

No studies examined associations of hygiene-related behaviors with epidemic-related outcomes, or the role of hygiene-related behaviors as mediators of racial or socioeconomic disparities in outcomes.

Susceptibility

One cross-sectional study examined comorbid conditions associated with susceptibility to H1N1 complications and found that AA/Black, English-speaking Latino participants, and Latino participants with LEP all had similar or fewer comorbid conditions than Whites.[10]

Two case control studies examined the relationship between comorbid conditions associated with susceptibility to H1N1 complications and patient outcomes. One study (N = 374) was conducted in New York City, and looked at the impact of both education and neighborhood poverty on hospitalization for H1N1. It found that overall, adults with 1 or more comorbid conditions associated with susceptibility to H1N1 complications were significantly more likely to be hospitalized. (OR = 12.83, 95% CI [4.99-32.97]). In a model adjusted for education and access to care, adults with 1 or more comorbid conditions remained more likely to be hospitalized (AOR = 7.61, 95% CI [2.68-21.65]). Comorbid conditions (and access to care) only partially mediated the relationship between education and hospitalization. After adjustment, compared to adults with some college or more, both adults with less than or equal to a high school education (AOR = 21.21, 95% CI [5.32-84.53]) and high school graduates (AOR = 3.82, 95% CI [1.64-8.90]) were still more likely to be hospitalized.[8]

The findings were similar for the relationship between neighborhood poverty and hospitalization. After controlling for access to care and the percentage of residents below the federal poverty level (FPL) in a neighborhood, adults with 1 or more comorbid conditions were 10 times more likely to be hospitalized (AOR = 10.05, 95% CI [3.65-27.64]). After adjusting for comorbid conditions (and access to care) adults from neighborhoods with 30% or more residents under the FPL remained 5 times more likely to be hospitalized (AOR = 5.02, 95% CI [1.83-13.89]).[8]

The second case control study (N = 381) found that although American Indian/Alaska Natives were nearly twice as likely to die from H1N1 (OR = 1.95, 95% CI [1.03–3.68]), comorbid conditions and age mediated the relationship and AI/AN race was not an independent risk factor for H1N1 mortality.[37]

Access to Care

Findings across a disparate array of studies were mixed in terms of the association among race/ethnicity, SES, access to care variables, and health outcomes. Three cross-sectional studies[10,59,63] and a qualitative study[57] examined factors related to access to care during H1N1. Findings indicated that AA/Black and English-speaking Latino participants were no different from Whites on an access to care index measure (see Table 3). However, Latinos with LEP scored significantly lower.[10] In addition, controlling for demographics, access to healthcare, and H1N1-related attitudes, AA/Black, Latino, and AI/AN participants were more likely than Whites to have spoken to a doctor or other healthcare professional about how to protect themselves or their families from H1N1. There was no difference for Asians or low SES participants.[59] Other studies found that among LEP Latinos, a primary reason for not having medication on hand in case of an influenza pandemic was a lack of health insurance.[63] (see Tables 2 and 3).

One additional study examined the relationship between measures of access to care and hospitalization for H1N1 in New York City. Findings indicated no difference in hospitalization when comparing adults with and without health insurance (OR = 0.42, 95% CI [0.12-1.49]). However, people with private (versus public) insurance were less likely to be hospitalized (OR = 0.15, 95% CI [0.07-0.32]). There was no significant relationship between having a primary care provider and hospitalization for H1N1 (OR = 0.88, 95% CI [0.35-2.18]). In a model adjusted for participant education and comorbid conditions, the relationships between having a primary care provider (AOR = 1.88, 95% CI [0.50-7.05]) and having health insurance (AOR = 0.73, 95% CI [0.14-3.70]) and hospitalization for H1N1 remained nonsignificant. When adjusting for access to care (and comorbid conditions), compared to adults with some college or more, both adults with less than or equal to a high school education (AOR = 21.21, 95% CI [5.32-84.53]) and high school graduates (AOR = 3.82, 95% CI [1.64-8.90]) were more likely to be hospitalized.

The findings were similar for the relationship between neighborhood poverty and hospitalization. After controlling for comorbid conditions and the percentage of residents below the federal poverty level (FPL) in a neighborhood, neither having a primary care provider (AOR = 1.50, 95% CI [0.42-5.30]) nor health insurance (AOR = 0.42, 95% CI [0.09-2.04]) were significantly associated with hospitalization. After adjusting for access to care (and comorbid conditions) adults from neighborhoods with 30% or more residents under the FPL were 5 times more likely to be hospitalized (AOR = 5.02, 95% CI [1.83-13.89]).[8]

A qualitative study of migrant and seasonal farmworkers found that ingrained barriers for low healthcare utilization such as lack of money for care, lack of insurance or ability to access public assistance, lack of knowledge of migrant health clinics, lack of Spanish and indigenous language materials and support at health centers, lack of transportation, and fear of deportation, would likely impede treatment for H1N1.[57]

Discrimination and Trust

One cross-sectional study[10] and 1 qualitative study[57] examined experiences of discrimination in health care settings. Findings indicated that compared to Whites, AA/Black, and Latino participants (both English-speaking and LEP) were more likely to have ever experienced discrimination when seeking health care.[10]

Three cross-sectional studies[32,53,67] and 1 qualitative study[47] examined trust in the government and government agencies regarding the handling of H1N1. Findings indicated similar or higher government trust scores among AA/Black and Latino participants,[53,67] and that AA/Black and Latino participants were more likely than Whites to trust the Federal Government specifically, including President Obama specifically, with no difference for the Centers for Disease Control (CDC), or state or local governments.[32] There was no difference in trust by SES (see Tables 2 and 3).[32]

No studies examined associations of discrimination or trust with epidemic-related outcomes, or the role of discrimination and trust as mediators of racial or socioeconomic disparities in outcomes.

Findings from a qualitative study suggests that AA/Black participants were unsure who to trust with regard to H1N1 due to mixed messages in the media and by government officials.[47] Another found that providers-stakeholders reported knowledge of stigmatization directed towards Latino migrant and seasonal farmworkers by other providers. For example, 1 participant reported overhearing a colleague say, “People [are] coming from Mexico and they’re bringing in the swine flu” (see Tables 2 and 3).[57]

Information and Knowledge

Five cross-sectional studies examined factors related to information and knowledge of pandemics predating COVID-19. A study of Veterans with spinal cord injuries (N = 3,384) found that, compared to Whites, fewer AA/Black and Latino Veterans, and fewer low SES participants reported receiving “adequate” information about H1N1.[30] Another study asked respondents about the MERS outbreak and previous pandemics. AA/Black and Latino participants were similar to Whites in their awareness of previous pandemics; however, participants with lower SES (education) had less awareness. Both AA/Blacks and Latino participants were less likely than Whites to have heard of MERS, and AA/Black participants were less likely to have accurate knowledge about MERS. There was no difference by SES for having heard of or having accurate knowledge of MERS (see Table 3).[44]

Two studies examined information and knowledge by English proficiency. A small cross-sectional survey of Latinos in a rural setting in California (N=209) compared English-speaking Latinos to LEP Latinos and found that those with LEP scored lower on an influenza pandemic

preparedness scale.[63] The second was a study of Chinese residents in Seattle. It found that compared to those with better English skills, LEP participants were less likely to feel well informed about H1N1. Commonly used channels for information among LEP participants were TV (including Chinese-language channels; 81%), Chinese-language newspapers (69%), and community-based organizations (30%; see Table 3 for more detail). The study did not control for confounding variables.[66]

A study (N = 1,569) examined H1N1 knowledge and misconceptions by SES (education), and found that after controlling for sociodemographics and communication behaviors, there were no differences on an H1N1 transmission knowledge and misconception index. However, even after controlling for confounders, participants with less than a high school education were more likely than those with a college degree to avoid eating pork products.[42,43]

No studies examined associations of information and knowledge with epidemic-related outcomes, or the role of information and knowledge as mediators of racial or socioeconomic disparities in outcomes.

Table 3. Studies Examining Measures of Exposure, Susceptibility, Access to Care, Trust and Discrimination, and Information and Knowledge

Author, Year N Participants Focus Population(s) of Interest	Mediating Factors
Exposure	
Structural	
Kumar, 2012[40] N = 2,042 *H1N1* • AA/Black • Latino	Children per Household: • Controlling for age, gender, and SES, Latinos had significantly more children per household (b = 0.43; p < 0.001.). • There was no difference between AA/Blacks and Whites. • Each additional child resulted in a 10% increase in the likelihood of an influenza like illness in the household (b = 0.10; p < 0.05). Density: • Controlling for age, gender, and SES, Latinos (b = 0.95; p < 0.01) and AA/Blacks (b = 0.66; p < .05) were more likely to live in an apartment building. • Latinos (b = 1.08; p < 0.001) and AA/Blacks (b = 0.64; p < 0.001) were also more likely to live in a metropolitan area. • There was no relationship between density and likelihood of an influenza like illness.
Levy 2013[8] N = 374 *H1N1 Hospitalization* • Low SES: Neighborhood Poverty	Hospitalization: • Multivariate analysis that also included SES (education), having a primary care provider, health insurance, and 1+ comorbid condition found that those living in neighborhoods with 30+% poverty were more likely to be hospitalized (AOR = 5.02 [95% CI 1.82-13.89])
Quinn 2011[10] N = 1,479 *H1N1* • AA/Black • Latino (English and LEP)	Number of People in a Household: • Controlling for age, gender, and SES, Spanish-speaking Latinos had more adults (b = 0.55, p < 0.001) and children (b = 0.33, p < 0.001) per households than Whites. • AA/Blacks had fewer adults per household (b = -0.22, p = 0.01). • There was no difference between English-speaking Latinos and Whites. Apartment and Metropolitan Living: • Controlling for age, gender, and SES, AA/Blacks (AOR = 2.4, 95% CI [1.3-4.3]); AOR = 3.1, 95% CI [1.9-5.1]), English-speaking Latinos (AOR = 5.1, 95% CI [1.4-19.7]); AOR = 2.1, 95% CI [1.0-4.4]), and Spanish-speaking Latinos (AOR = 3.9, 95% CI [2.1-7.1]); AOR = 3.2, 95% CI [1.8-5.7]) were more likely to live in a metro area and an apartment, respectively.
Schoch-Spana, 2010[57]	People per Household:

Author, Year N Participants Focus Population(s) of Interest	Mediating Factors
N = 33 *H1N1* • Latino (LEP)	• Participants reported 10-12 people or 2-3 families sharing a small cabin.
Work-related	
Kumar, 2012[40] N = 2,042 *H1N1* • AA/Black • Latino	<u>Work-Related Inability to Social Distance</u>: • Controlling for age, gender, and SES, compared to Whites, Latinos were less able to social distance due to work (b = 0.37; p < 0.001). • There was no significant difference between AA/Blacks and Whites. increase in the household (b = 0.06; p < 0.05). • For each unit increase in the work-related social distancing index there was an 8% increase in the likelihood of an ILI in the participant and a 6% increase in the likelihood of an ILI in their household. Index included: *ability to work at home, sick leave (general), sick leave for the flu, fired for no-show, job can only be done in workplace.*
Quinn 2011[10] N = 1,479 *H1N1* • AA/Black • Latino (English and LEP)	<u>Work-Related Inability to Social Distance</u>: • Controlling for age, gender, and SES, compared to Whites, Spanish-speaking Latinos were less able to social distance due to work (b = 0.89; p < 0.001). • AA/Blacks were better able to social distance (b = -0.57, p = 0.01). • There was no difference between English-speaking Latinos and Whites. Index included: *ability to work at home, sick leave (general), sick leave for the flu, fired for no-show, job can only be done in workplace.*
Schoch-Spana, 2010[57] N = 33 *H1N1* • Latino (LEP)	<u>Limited Work Benefits</u> • Dependence on jobs with poor benefits (*eg*, sick leave, low wages) – unable to stay home when sick <u>School Closures and Sick Children:</u> • Limited ability to stay home from work when schools close or children are sick – lack of consistent childcare, children may go to work with parents.
Social Distancing	
Kumar, 2012[40] N = 2,042 *H1N1* • AA/Black • Latino	<u>Public Transportation:</u> • Controlling for age, gender, and SES, Latinos were significantly more dependent on public transportation than Whites (b = 0.35; p < .01). • There was no significant difference between AA/Blacks and Whites. • There was no relationship between public transportation and self-reported ILI in the participant or household.

Author, Year N Participants Focus Population(s) of Interest	Mediating Factors
Lin, 2014,[42] 2018[43] N = 1,569 *H1N1* • Low SES: Education	Social Distancing (Including Public Transportation): • There was no difference in social distancing, staying home, or the reduction of human contact outside the household by education
Quinn 2011[10] N = 1,479 *H1N1* • AA/Black • Latino (English and LEP)	Public Transportation: • Controlling for age, gender, and SES, AA/Blacks (AOR = 3.0, 95% CI [1.9-4.6]), English-speaking Latinos (AOR = 2.8, 95% CI [1.5-5.3]), and Spanish-speaking Latinos (AOR = 4.0, 95% CI [2.5-6.5]) were more dependent on public transportation than Whites. Group Childcare: • Controlling for age, gender, and SES, AA/Blacks (AOR = 3.0, 95% CI [1.6-5.6]) and Spanish-speaking Latinos (AOR = 10.3, 95% CI [5.9-18.2]) had difficulty obtaining childcare that wasn't with a group of children. • There was no difference between English-speaking Latinos and Whites.
SteelFisher 2015[59] N = 2,355 *H1N1* • AA/Black • Latino • Asian • AI/AN • Low SES: Education	Social Distancing: • Controlling for covariates, healthcare, and attitude, AA/Blacks, Latinos, Asians, and AI/ANs were more likely than Whites to avoid both air travel and public transportation. • Latinos and Asians, but not AA/Blacks were more likely to avoid social gatherings (no difference for AA/Blacks). • There was no difference in avoiding people with flu-like symptoms by race/ethnicity. • Controlling for covariates, healthcare, and attitude, adults with a HS diploma or less were less likely to avoid air travel and public transportation, social gatherings, and people with flu-like symptoms.
Hygiene-related Behaviors	
Lin, 2014,[42] 2018[43] N = 1,569 *H1N1* • Low SES: Education	Personal Hygiene • There was no difference in the frequency of handwashing or hand sanitizer, and no difference in coughing with mouth covered by education.
SteelFisher 2015[59] N = 2,355 *H1N1* • AA/Black • Latino • Asian	Personal Hygiene • Controlling for covariates, healthcare, and attitude racial/ethnic minorities were similar to or more likely than Whites to adopt hygiene-related behaviors (*eg*, covering nose and mouth, cleaning more frequently). • Adults with a HS education or less were similar to or more likely than higher educated adults to adopt hygiene-related behaviors (*eg,* covering nose and mouth, cleaning more frequently).

Author, Year N Participants Focus Population(s) of Interest	Mediating Factors
• AI/AN • Low SES: Education	
Susceptibility	
Hennessey, 2015[37] N = 381 *H1N1 Mortality* • AI/AN	Preexisting Conditions • AI/ANs had higher rates of H1N1 mortality (OR = 1.95, 95% CI [1.03-3.68]). • However, preexisting conditions associated with susceptibility to H1N1 complications mediated the relationship between AI/AN race and H1N1 mortality (no data provided)
Levy 2013[8] N = 374 *H1N1 Hospitalization* • Low SES: Education • Low SES: Neighborhood Poverty	Comorbid Conditions: • Having 1+ comorbid conditions associated with susceptibility to H1N1 complications significantly increased the odds of hospitalization in adults (OR = 12.83, 95% CI [4.99-32.97]). Comorbid Conditions adjusted for education and access to care: • In multivariate analysis also including education, having a primary care provider, and health insurance, having 1+ comorbid condition significantly increased the odds of hospitalization (AOR = 7.61, 95% CI [2.68-21.65]). • After adjusting for access to care and comorbid conditions, adults with ≤ HS education (AOR = 21.21, 95% CI [5.32-84.53]) and HS graduates (vs some college or more; AOR = 3.82, 95% CI [1.64-8.90]) remained more likely to be hospitalized. Comorbid Conditions adjusted for % neighborhood residents below FPL and access to care: • In multivariate analysis also including having a primary care provider, health insurance, and % neighborhood below FPL, those with 1+ comorbid condition (AOR = 10.05, 95% CI [3.65-27.64]) were more likely to be hospitalized. • After adjusting for access to care and comorbid conditions, adults living in neighborhoods with 30%+ below the FPL remained more likely to be hospitalized (AOR = 5.02, 95% CI [1.83-13.89]).
Quinn 2011[10] N = 1,479 *H1N1* • AA/Black • Latino (English and LEP)	Comorbid Conditions: • Controlling for confounders, Spanish-speaking Latinos had fewer comorbidities associated with susceptibility to H1N1 complications than Whites (b = -0.37; p < 0.001). • There was no difference from Whites for English-speaking Latinos or AA/Blacks.
Access to Healthcare	
Levy 2013[8] N = 374 *H1N1 Hospitalization* • Low SES: Education	Public vs Private Insurance • Adults with private insurance were less likely to be hospitalized (OR = 0.15, 95% CI [0.07-0.32]). Primary Care Provider: • Having a primary care provider was not significantly related to the odds of hospitalization in adults (OR = 0.88, 95% CI [0.35-2.18]).

Author, Year N Participants Focus Population(s) of Interest	Mediating Factors
• Low SES: Neighborhood Poverty	Health Insurance: • Having health insurance was not significantly related to the odds of hospitalization in adults (OR = 0.42, 95% CI [0.12-1.49]). Primary Care and Health Insurance adjusted for education and comorbidities: • In multivariate analysis that also included education, and 1+ comorbid condition, neither having a primary care provider (AOR = 1.88, 95% CI [0.50-7.05]) nor having health insurance (AOR = 0.73, 95% CI [0.14-3.70]) were related to hospitalization.]). • Controlling for comorbidity and access to care, adults with ≤ HS education (AOR = 21.21, 95% CI [5.32-84.53]) and being a HS graduate (vs some college or more; AOR = 3.82, 95% CI [1.64-8.90]) remained more likely to be hospitalized. Primary Care Provider and Health Insurance adjusted for % neighborhood residents below FPL and comorbidities: • In multivariate analysis that also included % neighborhood residents below FPL and having 1+ comorbid condition, neither having a primary care provider (AOR = 1.50, 95% CI [0.42-5.30]) nor health insurance (AOR = 0.42, 95% CI [0.09-2.04]) were significantly associated with hospitalization. • Controlling for comorbidity and access to care, adults living in neighborhoods with 30%+ of residents below the FPL remained more likely to be hospitalized (AOR = 5.02, 95% CI [1.83-13.89]).
Quinn 2011[10] N = 1,479 *H1N1* • AA/Black • Latino (English and LEP)	Access to care: • Controlling for gender, age, and SES, Spanish-speaking Latinos had a harder time accessing care than Whites (b = 0.85, p < 0.001). • There was no significant difference between AA/Blacks and English-speaking Latinos and Whites. Index included: *health insurance, regular provider, and the perception that lack of insurance or money would make it difficult to receive a flu shot*
Schoch-Spana, 2010[57] N = 33 *H1N1* • Latino (LEP)	Health Centers: • MSFW are not always aware of migrant health centers, lack transportation from rural locations Insurance/Cost: • Lack of money for healthcare costs, no insurance, can't access public assistance Limited English Proficiency • Participants discussed the lack of Spanish and Indigenous language materials and support at health centers Fear: • May not seek care for fear of deportation
SteelFisher 2015[59] N = 2,355 *H1N1*	Spoke to Provider about H1N1 • Controlling for covariates, healthcare, and attitude, AA/Blacks, Latinos, and AI/ANs were more likely to have spoken to a doctor or other healthcare professional about how to protect their selves or families from H1N1.

Author, Year N Participants Focus Population(s) of Interest	Mediating Factors
• AA/Black • Latino • Asian • AI/AN • Low SES: Education	• There was no difference for Asians or low SES.
Witrago, 2011[63] N = 209 *Influenza Pandemic Preparedness* • Latino (LEP)	Lack of health insurance: • The top reason (25%) for not storing/keeping medication on hand was due to lack of money or health insurance.
Discrimination and Trust	
Freimuth 2014[32] N = 1,543 *H1N1* • AA/Black • Latino	Trust in the government's ability to cope with H1N1: • AA/Blacks and Latinos were more likely than Whites to trust the federal government (*ie*, President Obama, the HHS). • There was no difference in trust of the CDC and state and local governments. Discrimination when Seeking Health Care • There was no difference in overall trust in government information sources among those who had experienced discrimination in health care (M = 2.18 [SE = 0.02] trust score) vs those who had not (M = 2.30 [SE = 0.07] trust score).
McCauley 2013[47] N = 46 *H1N1* • AA/Black	Trust in the Government and Media: • AA/Black • Participants in a largely AA//Black focus group expressed concerns that they didn't feel that health experts, the government, and the media provided consistent adequate information and that they could believe.
Mesch, 2014[67] N = 968 *H1N1* • Latino • Low SES: Education	Confidence in the government's ability to cope with H1N1: • Latinos were more likely than Whites to trust the government's ability to deal with H1N1 (OR = 2.19, 95% CI [1.03-4.69]). • There was no difference by education (OR = 1.11, 95% CI [0.98-1.25]).
Schoch-Spana, 2010[57] N = 33 *H1N1* • Latino (LEP)	Community stigmatization: • Misinformation by the media about community health centers serving migrant workers as "hotspots," • During the H1N1 pandemic, MSFW felt they were shunned and bullied, 1 family was denied school admission despite no symptoms.

Author, Year N Participants Focus Population(s) of Interest	Mediating Factors
	Stigmatization by Providers: • Example: Provider overheard to say, "people [are] coming from Mexico and bringing the swine flu."
Quinn 2009,[53] 2011[10] 2009 N = 1,543 2011 N = 1,479 *H1N1* • AA/Black • Latino (English and LEP)	Experienced Discrimination when Seeking Healthcare: • Controlling for age, gender, and SES, AA/Blacks (AOR = 3.9, 95% CI [2.2-7.0]), English-speaking Latinos (AOR = 2.8, 95% CI [1.2-6.9]), and Spanish-speaking Latinos (AOR = 6.1, 95% CI [3.2-11.5]) were more likely than Whites to have experienced discrimination when seeking healthcare. Trust in the government's ability to cope with H1N1: • Both AA/Black and Latino participants scored higher on a scale related to government trust and H1N1 ($p < 0.001$).
Information and Knowledge	
Etingen 2012[30] N = 3,384 *H1N1* • AA/Black • Latino • Low SES: Education	Receipt of H1N1 Information: • Among Veterans with spinal cord injuries and disorders, report of the receipt of adequate information was more likely for Whites (vs non-Whites; OR = 1.67 [95 % CI 1.39-2.01]) and higher SES (college graduates; (OR 1.28, 95% CI [1.05-1.56]).
Lin, 2014,[42] 2018[43] N = 1,569 *H1N1* • Low SES: Education	H1N1 Transmission Knowledge • Participants with less education were less knowledgeable about H1N1 transmission and were more likely to avoid eating pork products. • However, both became non-significant when information barriers were considered. • There was no difference in misconceptions about H1N1 by education.
Lin, 2017[44] N = 627 *MERS and Previous Epidemics* • AA/Black • Latino • Low SES: Education	Pandemic Awareness: • Individuals with lower education (AOR = 3.67, 95% CI 1.44-9.36) were more likely to have a low awareness of pandemics compared with other groups. • There was no difference by race/ethnicity. MERS Awareness: • Compared to Whites, AA/Blacks (OR = 0.36, 95% CI [0.19–0.70], $p < 0.005$) and Latinos (OR = 0.46 [95% CI 0.23–0.91], $p = 0.03$]) were less likely to have heard of MERS. • There was no difference by SES (education). MERS Knowledge: • Compared to Whites, AA/Blacks (OR = 0.13, 95% CI [0.03–0.57]) were less likely to have accurate knowledge of MERS. • There was no difference between Latinos and Whites.

Author, Year N Participants Focus Population(s) of Interest	Mediating Factors
	• There was no difference by SES.
Witrago, 2011[63] N = 209 *Influenza Pandemic Preparedness* • Rural Latinos (LEP)	Preparation: • Regardless of SES, years in US, and demographics, rural Spanish-speaking Latinos were not prepared for an influenza pandemic Index included: *available food, water, flashlight, medical supplies etc., prep plan*
Yip, 2009[66] N = 100 *H1N1* • Chinese (LEP)	Informed about H1N1: • Compared to individuals who did not speak English, those who reported not speaking English "well" were more likely to feel that they were informed about H1N1 (OR = 2.65, 95% CI [1.04-7.01], p < 0.05).

Abbreviations: AA = African American; AI/AN = American Indian/Alaska Native; AOR = adjusted odds ratio; C = control; CDC = Centers for Disease Control; CI = confidence interval; ED = emergency department; EMR = electronic medical record; HS = high school; LEP = limited English proficiency; MERS = Middle East Respiratory Syndrome; MSFW = migrant and seasonal farmworkers; OR = odds ratio; OT = Occupational Therapy; PI = Pacific Islander; SES = socioeconomic status; US = United States

KQ2. What interventions or intervention components have been used to reduce health inequalities (or identified in preliminary studies) in infectious disease transmission or health outcomes in disasters, infectious disease epidemics or pandemics in the United States?

We included 12 studies that described interventions or intervention components to reduce health inequalities or health outcomes related to infectious disease epidemics pre-dating COVID-19 or relevant disasters. The 12 studies included 4 studies (5 publications) of individual-focused interventions [28,29,48,52,55] and 8 studies (9 publications) of systems-focused interventions.[20-22,36,46,49,64,65,50] Only 1 study[28] describes intervention effectiveness outcomes, while the majority described acceptability and feasibility of the studied interventions. We found only 1 randomized controlled trial and 1 longitudinal cohort study among those included. The remainder of the papers reviewed were program evaluations or studies to inform future interventions with resulting recommendations. Table 4 provides study details.

We additionally included 5 papers presenting expert recommendations from CDC key stakeholder meetings on pandemic influenza preparedness in vulnerable populations convened in 2008 (see Table 5).[23,58,60,62]

Individual-Focused Interventions and Programs

Four studies (5 papers) featured interventions focused at the individual level. One longitudinal cohort study aimed to improve emergency preparedness among a low-income Latino community. Participants (N=231) were randomized to receive either culturally tailored information sent by mail or to participate in discussion groups led by a community health worker. The discussion groups arm reported better disaster preparation post-intervention than the mailer-only group.[28] In a subsequent publication, the authors attributed the success of the emergency preparedness discussion groups to the use of targeted outreach provided by community-based organizations and the use of clear, consistent, culturally appropriate messaging.[29]

A poor-quality, small (N = 50), unblinded randomized controlled trial evaluated the feasibility of an automated call-monitoring system to detect H1N1 symptoms among low-income pregnant women. In addition to an individualized health education session, the intervention group received daily calls with prompts for yes or no responses for H1N1 symptoms. Participants who responded “yes” were transferred to a nurse midwife, and a same-day appointment was scheduled. Findings indicated that the intervention was feasible. There was no difference between groups in prenatal care visit attendance. One participant in the intervention group experienced H1N1 symptoms and received immediate intervention. Nearly all (93.3%) women in the intervention group recommended a similar system in future health crises.[48]

Another paper describing a program evaluation analyzed differences in completion rates by race/ethnicity of a post-disaster web-based mental health intervention. The intervention included a baseline interview and mental health screen, after which participants (N=1180) were directed to relevant online modules addressing PTSD, depression, generalized anxiety disorder, panic disorder, marijuana abuse, alcohol abuse, and smoking. The evaluation found that rates of access, use, and completion of the intervention did not differ between African-Americans, Latinos, and Whites. [52]

Finally, a program evaluation examined an intervention to train migrant and seasonal farmworkers in disaster preparedness through 2 workshops utilizing the Community Emergency Response Team curriculum.[55] Results showed that the intervention was feasible and the workshops were highly rated by participants (N=22), but challenges existed with reaching recruitment goals. An outcomes evaluation revealed lessons learned including the need for partnering with stakeholders and accounting for participants' work schedules and language needs in planning the training (see Table 4).

System-Focused Interventions and Programs

Eight studies (9 publications) focused on system-level interventions to improve emergency preparedness and response. These are categorized below as either program evaluations [36,46,49] or studies to inform future interventions [20-22,50,64,68].

Program Evaluations

A qualitative evaluation of a program that aimed to increase efficacy of counseling provided to ethnically and culturally diverse populations after a natural disaster used a critical consciousness approach to train psychology graduate students (N = 6).[36] The authors found that the experience increased participants' cultural competence and social-justice oriented perspective. While effects on the care the students provided were not directly evaluated, this training potentially increased their efficacy at serving a majority African American community.

In a paper by McCabe et al,[46] the authors describe a disaster/emergency preparedness training for lay communities in a rural region of Maryland with the goal of enhancing capacity of rural emergency response through a systems-based partnership between faith-based organizations, local health departments, and academic institutions. A post-intervention assessment demonstrated an increased understanding among participants (N = 178) of community disaster and mental health plans and increased self-efficacy to execute these plans. It also showed the feasibility of recruiting from local health departments and faith-based organizations, and potential for scale-up of the training program.

Another publication[49] described a program evaluation of a University of Nebraska Medical Center cross-agency rural health system response simulation exercise for communities in rural Nebraska. The exercise highlighted system weaknesses that included difficulties with backup communication, lack of knowledge around how to request additional medical staff and assets or to make patient transfer requests, the need to develop coordinated public messaging, and deficits in intra-agency coordination, for example not initiating a report of a notifiable disease. Overall, the program demonstrated the utility of functional exercises for testing regional disaster response coordination.

Studies to Inform Future Interventions

A qualitative study consisting of 41 interviews with pastors of African American churches in Southern Mississippi recommended that mental health professionals build relationships with churches prior to disasters and work to engage and empower pastors and congregants, building trust. Through these partnerships, mental health services could potentially be brought to the communities during disasters, increasing access.[21,22]

In a different study, a situational analysis was completed of emergency preparedness of diverse communities in California. The analysis was conducted via a literature review, an environmental scan of organizational websites, and key informant interviews (N = 17). It showed that there is a need to better engage diverse communities in all stages of disaster preparedness and response, mitigate stigma and fear, build cultural competence, and better coordinate information and resources when planning for community disaster preparedness.[20]

In Person et al (2004), the study team performed a situational analysis of stigmatization of Asian communities in the United States during the SARS pandemic in 2003. The analysis included group discussions with key informants (N = 70) from 50 different organizations, monitoring of the CDC public response service hotline, and a scan of Asian-language information services. Results demonstrated significant stigmatization and misinformation related to SARS. Important recommendations gleaned from these findings included the need to develop simple, tailored SARS prevention messages and materials in various Asian languages and to disseminate SARS information through multiple and culturally appropriate channels, including (but not limited to) community visits and town hall meetings.

In Wyte-Lake,[64] 7 interviews were conducted with Home-based Primary Care (HBPC) providers to explore issues regarding emergency management planning for homebound patients. The qualitative analysis showed that a lack of standardized policies and procedures and unclear designation of provider responsibility resulted in inconsistent preparedness among HBPC Veterans. Recommendations included better training of providers to assist their patients in disaster preparedness, and formalization of the preparedness evaluation and intervention process.

One additional study evaluated use of a disaster preparedness assessment tool among homebound Veterans enrolled in HBPC.[65] The assessment tool was deployed with patients at 10 HBPC sites in 8 states (N = 754) over a 3-week period. Results showed that in general, providers were teaching basic skills of disaster preparedness to their most vulnerable patients. Evacuation planning was the most commonly covered topic, and Veterans in the high- or medium-risk categories were more likely to receive preparedness information than those in the low-risk category (see Table 4).

Table 4. Relevant Findings from Infectious Disease and Emergency Response Literature

Author, Year N Participants Focus Population	Intervention or Program Description; Comparator	Recommendations or Findings *Relevance for COVID-19*
Individual-Focused Interventions and Programs		
Eisenman, 2009[28] and Glik, 2014[29] N = 187 *Disaster Preparedness Intervention* • Latino (English and LEP)	Intervention: Emergency preparedness program (2 groups: high-intensity [platicas = small group discussions with community health worker]; and low-intensity [culturally appropriate mailers]) Comparator: Culturally appropriate mailing	Findings: • Of those susceptible at pre-intervention, both groups improved on communication plan and some disaster supplies (*eg*, stockpiling water, food, and blankets) • *Platica* group improved significantly more on most self-reported preparedness indicators at 3-month follow-up including stockpiling of emergency water (media 66.7% vs. *platicas* 93.3%; P = 0.003) and food (media 60.6% vs *platica* 91.7%; P = 0.013) and creation of a family communication plan (media 42.3% vs *platica* 70.4%; P = 0.002) Implications for research and practice: • Clear consistent messages delivered through a community-based organization led to increased preparedness among households that were resource constrained • Importance of working with trusted community-based organizations to help translate disaster preparedness messages for disadvantaged households • More focused community-based outreach than current standard practice is needed; • Reliance on mass-media campaigns to disseminate messages may be inconsistent and they are not necessarily understood, recalled or interpreted in ways that lead to action at the level of households *Delivery of information and services related to COVID-19 to vulnerable populations will likely be more effective if delivered via trusted community intermediaries and targeted community outreach efforts rather than via print media alone.*
Goodman, 2009[36] N = 6 *Culturally Competent Disaster Response mental health students* • AA/Black	Cultural competence program; 8-day outreach experience providing disaster response counseling services, accompanied by journal and processing with peers and faculty supervisor	Results highlighted: • Participants demonstrated increased critical consciousness and social-justice oriented perspective. Also, increased cultural competence and understanding of its importance in counseling. • They integrated this understanding into their personal and professional identities. • Developing cultural competence of disaster response counselors can be achieved through outreach experience with processing using a critical consciousness lens. *A critical consciousness-based approach could be useful in training counselors to provide culturally competent counseling to vulnerable individuals who experience trauma related to COVID-19.*
Nassar, 2014 [48] N = 50 *Monitoring H1N1 Symptoms*	Intervention: Daily automated calls re: flu symptoms. If yes, they were transferred to nurse midwife for triage and next day visit. If they	• Automated call participants received and interacted with the daily automated telephone calls 45.1 % (SD = 3.2%) of the time, and 65.1 % (SD = 3.1%) received and interacted with the daily automated telephone calls at least once every 3 days.

Author, Year N Participants Focus Population	**Intervention or Program Description; Comparator**	**Recommendations or Findings *Relevance for COVID-19***
• Low SES	didn't respond to automatic calls for 3 days, they were called. Comparator: Health education	• Two (8%) participants never participated, and 5 (21%) participated in more than 58 % of calls. • There was no statistical difference in attendance rates for receiving prenatal care between the automated call group and the health information group. • One participant in intervention group developed influenza symptoms *An automated system for triage of symptoms and referral to care could help reach disadvantaged populations affected by COVID-19*
Price, 2013[52] N = 1,180 *Post-Disaster Mental Health Intervention* • AA/Black • Latino	Intervention: Brief, web-based disaster mental health intervention carried out 1 year after hurricane Ike. Participants completed a baseline telephone interview and, based on survey results, were directed to a series of online modules including depression, PTSD, generalized anxiety disorder, panic disorder, alcohol abuse, marijuana abuse, and cigarette smoking. Engagement was assessed based on 3 types of attrition.	Results highlighted: • Non-use attrition of the internet intervention (completed baseline telephone interview but did not access website): No difference between Whites and AAs (OR = 0.96; 95% CI: 0.64 to 1.43) or Whites and Latinos (OR = 1.31; 95% CI: 0.76 to 2.29) • Dropout attrition for access of intervention modules (accessed website but did not complete modules)**:** No difference between Whites and AAs (OR = 1.45; 95% CI: 0.63 to 3.29) or Whites and Latinos (OR = 0.74; 95% CI: 0.32–1.74) • Intervention module completion attrition (failing to complete a module after having accessed a module)**:** No difference between Whites and AAs (OR = 1.10; 95% CI: 0.89 to 1.36) or Whites and Latinos (OR = 1.22; 95% CI: 0.86–1.67). • Bottom line: Rates of non-use attrition, access attrition, and completion attrition did not differ between AAs, Latinos and Whites. *Web-based interventions related to COVID-19 could be useful to reach AAs, Latinos, and Whites at similar rates.*
Rosenbaum, 2018[55] N = 22 *Disaster Preparedness Training for MSFW* • Latino (LEP)	Two disaster preparedness workshops were conducted with migrant and seasonal farm workers using the Community Emergency Response Team curriculum that includes basic disaster response skills such as fire safety, light search and rescue, team organization, incident command, and disaster medical operations.	Results highlighted/lessons learned • Participants improved emergency preparedness and first aid, CPR, and AED competencies. • Community benefit of having certified participants in their midst. • Participants rated the training highly and expressed interest in continuing emergency response training among participants. • Partnerships with the university and the relevant local stakeholders were important to project planning and implementation. • Needs of participants such as work/school schedules, transportation, and childcare needs must be considered • Bilingual trainer and training materials are important • Curriculum needs to be culturally relevant

Author, Year N Participants Focus Population	Intervention or Program Description; Comparator	Recommendations or Findings *Relevance for COVID-19*
		In person COVID-19-related training of migrant and seasonal farm workers is important, needs to include culturally appropriate trainers and materials, and needs to accommodate work and personal needs of participants to allow for participation.
System-Focused Interventions and Programs		
Andrulis, 2011[20] N = 17 *Disaster Planning* • AA/Black • Latino (English and LEP) • Asian/PI • AI/AN	Through literature review, environmental scan of organizational websites, and 17 key informant interviews with public health and emergency management personnel, researchers identified barriers and disaster preparedness needs of racially/ethnically diverse communities.	Results highlighted: • Barriers to preparedness include socioeconomic factors, trust in perceived fairness of government, cultural and linguistic factors, lack of funding for diversity initiatives, limited knowledge about and collaboration with diverse communities • Program and policy priorities: enhance collaboration; increase flexibility for program development and allocation of funds; improving organizational capacity • Intervention priorities: engage diverse communities; mitigate stigma and fear; build cultural competence; coordinate information and resources *Many of the barriers to reaching racially and ethnically diverse communities that were identified in this study also apply to COVID-19. Outreach efforts must employ cultural competence, enhance collaboration, and leverage resources to enhance organization capacity.*
Aten, 2010[21] Aten, 2011[22] N = 41 *Post Disaster Mental Health Disparities* • AA/Black	Pastors of churches in South Mississippi affected by hurricane Katrina participated in semi-structured interviews 1 year after the storm. Results were synthesized to provide recommendations for fostering collaboration between African American religious leaders and mental health professionals towards better serving minority communities.	Results highlighted: • Need for pastor education on effects of disasters on mental health, referral services, stigma towards receiving mental health services and providers • Need for collaboration between AA churches and mental health professionals to perform mental health assessments • Need for collaboration to provide consultation activities to help churches better prepare for disasters (*eg*, evacuation plans) • Need for clinically focused activities offered by mental health professionals in the aftermath of a disaster; • Possibility through collaboration for bidirectional referrals; rather than churches only referring to providers, providers could also refer to spiritual resources. Recommendations: • Establish working relationships prior to disasters • Empower AA churches through participation, both empowering AA faith communities to utilize spiritual resources, but also providing leadership opportunities for pastors and congregation members • Utilize AA churches for community-based services: bringing services to the community can increase access and utilization. *AA pastors and churches could be an essential ally when considering interventions to mitigate disproportionate effects of COVID-19 on AA communities.*

Author, Year N Participants Focus Population	Intervention or Program Description; Comparator	Recommendations or Findings *Relevance for COVID-19*
McCabe, 2013[46] N = 178 *Community-level Disaster Preparedness* • Rural	Disaster/emergency preparedness intervention with 1-day didactic session and 2-day technical workshop focused around disaster preparedness and partnerships between faith-based organizations and local health departments:	Results highlighted: • Increased understanding of community disaster mental health plans and increased self-efficacy to execute these plans • Proof of feasibility of the intervention and potential for scale-up • Intervention model showed effectiveness of partnerships between faith-based organizations, local health departments, and academic institutions. • Written follow-up after in-person presentations were more effective for recruitment than postal mailings or radio spots *Providing training for FBOs through established partnerships could be 1 method of reaching vulnerable communities with information and resources related to COVID-19.*
Obaid, 2017[49] N = 667 participants *Rural Infectious Disease Disaster Preparedness* • Rural	Functional infectious disease disaster response exercises, developed by Center for Preparedness Education at the University of Nebraska Medical Center Six exercises evaluated hospitals and public health departments in rural Nebraska health care coalitions. Each facility had an evaluator and controller on-site for assessment. Exercises were debriefed, and there was an after-action conference after each functional exercise. Improvement plans were developed for each coalition.	Results highlighted: • Feasibility of disaster response exercises including quantitative evaluation of disaster preparedness • Areas needing improvement including: difficulties with backup communications, not activating incident command, lack of knowledge on whom to contact for patient transfer requests, agencies not fulfilling requests for incident actions plans. • Functional exercises that require the real exchange of information and communication across participating agencies are best suited for testing regional disaster response communication. *Provides a model for assessing preparedness of medical and public health systems prior to onset of an infectious disease disaster such as COVID-19. Could be applied in anticipation of future disease outbreaks.*
Person, 2014[50] N = 70+ people, 50 agencies/orgs *SARS-related Stigma* • Asian	NICD/CDC SARS Community Outreach Team Activities: 1) advised other SARS emergency response teams on how to minimize the risk of stigmatizing groups in their own communications by focusing messages on the virus and the relevant behavioral risk factors; 2)	Results Highlighted: • The need to develop simple, tailored infectious disease prevention messages and materials in various Asian languages • Disseminate information through multiple and culturally appropriate channels, including (but not limited to) community visits and town hall meetings

Author, Year N Participants Focus Population	Intervention or Program Description; Comparator	Recommendations or Findings *Relevance for COVID-19*
	assisted with developing culturally tailored health education materials; and 3) conducted community visits, panel discussions, and media interviews to positively influence negative behaviors occurring in communities	
Wyte-Lake, 2014[64] N = 7 *Disaster Preparedness* • Disability	Seven interviews were conducted with HBPC providers to explore issues regarding emergency management planning for homebound patients.	Results Highlighted: • Individual HBPC programs are often tasked with developing their own policy for disaster preparedness assessment as part of routine patient assessment • Tools used in initial preparedness assessment are insufficient • Provider comprehension for how to assign patients to risk categories based on acuity varied • Providers identified cognitive impairments, patient willingness, and limited resources as barriers to patient engagement in preparedness activities • Providers received limited formal training on how to prepare their patients for disaster. • Provider recommendations: (1) training to focus on better strategies to get patients to participate, (2) more consistent time spent on patient education, (3) formalizing the initial assessment to actually evaluate how prepared patients are, and (4) having emergency preparedness be formally addressed on a more consistent basis, possibly in the annual interdisciplinary review of each patient. *HBPC providers are uniquely positioned to provide education and intervention around disaster preparedness to vulnerable patients. This could include provision of education about COVID-19. Efforts should be made to standardize COVID-19 preparedness assessment among HBPC providers.*
Wyte-Lake, 2019[65] N = 754 patients *Disaster Preparedness* • Disability	Evaluation of the HBPC Patient Assessment Tool – tool to assess disaster preparedness among homebound vets. The rates at which education was provided on various items was assessed based on patient risk categorization to observe patterns in how providers communicated this information.	Results Highlighted: • The most frequent education topic covered with all patients was how to evacuate their home • Provision of education about advanced directives/POLST and reminder about the HBPC handbook were not associated with the level of patient risk. • Veterans in high/medium risk categories were more likely to receive preparedness education for 6/9 items listed in the tool • Those with less social support were more likely to receive disaster preparedness information

Author, Year N Participants Focus Population	Intervention or Program Description; Comparator	Recommendations or Findings *Relevance for COVID-19*
		• Information on how to put together an emergency kit and emergency shelter registration/emergency transport were less likely to be discussed than other preparedness topics • Home health agencies can play an important role in educating home-bound adults about disaster preparedness. These results indicate that providers are giving basic education on disaster preparedness to their most vulnerable patients, but opportunities exist for improvement *Home health agencies may be an important partner in disseminating COVID-related education to vulnerable home-bound adults.*

Abbreviations: AA = African American; AED = Automated external defibrillator; CI = Confidence interval; CPR = cardiopulmonary resuscitation; HBPC = Home-based Primary Care; LA = Los Angeles; OR = Odds ratio; SES = Socioeconomic status; VHA = Veterans Health Administration

Expert Panel Papers

Five papers presented expert recommendations resulting from CDC key stakeholder meetings on pandemic influenza preparedness in vulnerable populations. These meetings were held in 2008, with reports published in an *American Journal of Public Health* supplement in 2009. Experts were convened around the following vulnerable groups: publicly housed, single parent families, low income families, racial and ethnic minorities, migrant farm workers, and immigrants and refugees. One paper addressed communication strategies to vulnerable populations in general (see Table 5).

In Bouye et al,[23] the expert group highlighted the ways in which poverty makes those who are publicly housed, part of single parent households, or low wage earners more susceptible to a pandemic outbreak. Early implementation of community mitigation strategies were considered paramount to halt the spread of infection. The ways in which these strategies are disseminated was also considered important, as was the need for education and communication strategies to account for the distinction in cultures, lifestyles, and behaviors of these groups. The panel recommended engaging community liaisons in devising education campaigns as being essential to their success. Many of the strategies discussed hinge on preparedness planning prior to the onset of a pandemic, which would build community partnerships, establish an emergency communication plan, initiate appropriate education and training programs, and plan for advocacy for policy and program change to better enable mitigation strategies (*eg*, flexible work policies, home delivery services).

Another expert group meeting report[39] looked at the effect of influenza on racial and ethnic minorities. The experts pointed to evidence for an increased rate of comorbid conditions, increased rate of complications, inferior vaccine coverage, and higher rates of poverty as factors that may have contributed to racial/ethnic minorities having been disproportionately affected during past influenza pandemics. Similarly to Bouye et al,[23] possible solutions they proposed hinge on tailored educational strategies and strengthening of public health infrastructure. The group emphasized the importance of involving racial and ethnic minorities at all stages of planning and prevention in order to address the socioeconomic, cultural, linguistic, and educational barriers that may prevent community mitigation and vaccine delivery.

Steege et al[58] argued for the need for a distinct approach to protecting migrant farm workers against pandemic influenza. Migrant workers constitute a unique group in that they risk contracting disease due to their exposure to animals. Furthermore, working conditions and cultural or linguistic barriers may make an influenza outbreak more likely among this vulnerable group. Mitigation strategies focused on delivery of timely prevention and treatment of influenza. Two other recommended strategies included the use of mobile clinics and lay community health workers. Given that workers may delay seeking care due to fear of legal repercussions, establishing trusting relationships with service providers to enable care delivery was considered important.

Immigrants and refugees share important risk factors with the aforementioned vulnerable groups.[60] This group may be more at risk for pandemic influenza due to factors including higher rates of chronic conditions, lower seasonal influenza vaccine rates, and linguistic or cultural barriers. In the case of undocumented immigrants, they may be reluctant to seek care due to fear

of detention or deportation, similar to migrant farm workers. The authors proposed a multi-level approach to risk mitigation, with strategies that are household-focused (*eg*, remaining home while ill), provider-supervised (*eg*, vaccine provision), and agency-driven (*eg*, effective communication). This expert group also emphasized involvement of the target group in all preparedness planning and communication.

One final paper[62] focused on general communication strategies to vulnerable groups during an influenza pandemic. They recommended that communication strategies be tailored to the phase of the pandemic and that they be situation specific. For example, schools, workplaces, and public gatherings all require different communication strategies. Like the other expert panels, they emphasized the importance of linguistically and culturally appropriate communication. A participatory approach was considered important to the development of communication, with dissemination to be best done in partnership with community organizations, faith-based organizations, or other trusted intermediaries (see Table 5).

Table 5. Relevant Findings from CDC Expert Panel Meetings on Impact of Influenza in Vulnerable Populations

Author, Year N Participants Topic	General Recommendations/Findings	Strategic Partnership Recommendations
Bouye, 2009[23] N = 26 *Influenza Pandemic: Low-SES, Public Housing Residents, Single-Parent Families*	• Use culturally specific communication to impart messages related to vaccines and hygiene • Engage strategic partnerships to relay public health messaging • Create defined school policies, provide childcare vouchers, and stockpile supplies at churches and community centers • Government support for workers – aid packages and wage freezes. • Workplace flexibility and competitive compensation • Preparation for delivery of goods and services via home delivery, mobile clinics • Education around signs and symptoms of pandemic influenza	Engage faith-based organizations, CBOs, and neighborhood planning units
Hutchins, 2009[39] *Influenza Pandemic: Racial and Ethnic Minorities*	• Participatory approach to planning and preparedness process, engaging racial and ethnic minorities in every step of the process and allotting funding to do so. • Social safety net policies and procedures are needed to meet survival needs, including access to clean water, sufficient food, shelter, and utilities. • Education materials that are culturally appropriate and adapted to low-literacy populations • Educating early about use of PPE • Systems for equitable access to scarce resources including antiviral medications and vaccines	
Steege, 2009[58] *Influenza Pandemic: Farmworkers*	• Collaboration between federal, state and local public and animal health and agriculture authorities • Seasonal influenza vaccination • Training on reduction of risk of infection • Sufficient PPE • Sanitary facilities • Surveillance and early detection of disease in workers and animals • Linguistically and culturally appropriate information about vaccination • Emergency messaging via multiple media • Two-way information system to reach farm worker in remote encampments	Federal, state, and local public and animal health and agriculture authorities should collaborate with farm employers, farmworker health and social service organizations, agricultural extension agencies, and farmworker advocacy groups
Truman, 2009[60] *Influenza Pandemic: Immigrants and Refugees*	• Provision of information re. importance of staying at home while ill • Liberal workplace leave and teleworking policies • Engage faith-based and community organizations in how to best work with families to avoid social stigma in case of needed quarantine • Work with providers of services to immigrants and refugees on appropriate use, distribution, and barriers to use of PPE	Faith-based organizations, community organizations and leaders, service providers

Author, Year N Participants Topic	General Recommendations/Findings	Strategic Partnership Recommendations
	• Consider means to provide vulnerable children with lunch when schools are closed • Vaccine distribution in states where immigrants/refugees are overrepresented and along the southern border • Locate vaccination spots in easily accessible locations and provide vaccination without asking about immigration status	
Vaughan, 2009[62] *Influenza Pandemic: Risk Communication and Vulnerable Populations*	Communication strategy for during pandemic: • Phased – public health information should track with phase of pandemic (mild, moderate, severe outbreak) • Communications should be situation-specific; schools and childcare centers, workplaces, and public and social gatherings all require different communication strategies • Use of multiple communication strategies • Using communication intermediaries when mistrust exists (community leaders, faith-based leaders, *etc*) • Focus on understanding factors that affect subgroup differences in response to infectious disease and to develop and aggregate communication strategies that strengthen rather than diminish the • value of community beliefs and traditions. • All messages, materials, and documents should be culturally sensitive, match the language proficiency of targeted individuals, and be responsive to the changing conditions and needs of the audience as the crisis unfolds. • Vaccines: Communications that address concerns arising from values, beliefs, and cultural traditions, and that feature spokespersons who are credible from the perspectives of targeted populations, will be more persuasive in disseminating information about vaccine effectiveness and safety. • Social distancing: Pre-pandemic planning and communications need to identify ways to make actions feasible and communications credible. • PPE: Affordability, accessibility, availability, and appropriateness are real considerations for vulnerable populations. Equally important are language considerations and ensuring that instructions on how and when to use PPE (*eg*, masks, gloves) are clear and workable.	Partnerships with community organizations, faith-based organizations, and trusted communication intermediaries

Abbreviations: CDC = Centers for Disease Control and Prevention, CBOs = Community Based Organizations, PPE = Personal Protective Equipment

What were the H1N1 vaccination rates among different segments of the population, what factors contributed to disparate vaccination, and what were the benefits and harms of interventions designed to mitigate inequities in vaccine uptake?

We identified 20 studies examining health inequalities in H1N1 vaccine uptake, factors associated with vaccine uptake, and intervention to address disparities in vaccine uptake.

H1N1 Vaccine uptake

There were 10 studies of H1N1 vaccine uptake.[24,25,31,34,38,51,54,56,59,61] Racial and ethnic differences, comparing minority groups to Whites, were examined in the majority of studies. Nine studies reported on AA/Black participants, 8 on Latinos, 2 of Asians, and 1 each of Pacific Islanders, and Asians and Pacific Islanders as a combined group. Differences in vaccine uptake by participants with lower versus higher socioeconomic status were examined in 4 studies, and 2 studies looked at participants' uptake based on rural versus urban status. All but 1 study[51] used self-reported vaccination status, as opposed to status obtained from health records. Eight of the 10 provided data on H1N1 vaccine uptake that was unadjusted. Studies that reported adjusted rates controlled for a variety of factors, not consistent across studies. As such, we rated our strength of evidence for H1N1 vaccine uptake based only on unadjusted data. Afterwards we report the findings of adjusted models where applicable.

By Racial/Ethnic Group Affiliation

Seven studies[31,34,51,54,56,59,61] provide evidence examining vaccine uptake in AA/Black versus White participants. Of these, six[31,51,54,56,59,61] reported unadjusted data and contribute to moderate-strength evidence of lower H1N1 vaccine uptake in AA/Blacks. Four of the 6 studies found that AA/Black participants were less likely than Whites to be vaccinated with the H1N1 vaccine.[51,54,56,61] In a large (N = 55,850), national cross-sectional survey study, 17% of AA/Black participants reported receiving the H1N1 vaccine compared to 26% of Whites (P<0.05).[56] Another (N = 4,040) national study showed similar results (14% vs 20%; P = 0.02),[61] as did a Los Angeles (LA)-area survey study (N = 1,541; OR = 0.7 [95% CI 0.6 to 1.0]).[54] In LA county, Plough and colleagues conducted a study during a vaccination campaign consisting of free public mass vaccination sites throughout the county (distributing 20% of LA County's total H1N1 vaccine supply). AA/Black residents were half as likely as Whites to receive the H1N1 vaccine at 1 of the clinic sites despite targeted outreach efforts specific to that population.[51] A study of Veterans with spinal cord conditions (N = 3384) found no difference in vaccine uptake by race.[31] One other national study by Steelfisher and colleagues (N = 2,355)[59] found no difference between AA/Black and White participants for H1N1 vaccine uptake (RR = 0.92 [95% CI: 0.73 to 1.55]; See Table 6). Despite these 2 studies showing no racial differences, given the size and quality of the majority of studies finding less vaccine uptake for AA/Black populations, our strength in that finding is moderate.

One additional national cross-sectional study also examined vaccine uptake for AA/Blacks compared to Whites, but only reported adjusted data. It found that after controlling for sociodemographic factors, there was no difference in vaccine uptake (N = 1,569; OR = 0.78 [95% CI: 0.49 to 1.24]; Table 6).[34] Additionally, after controlling for sociodemographics, comorbidities, healthcare access, and attitudes towards the vaccine, the study by Steelfisher and

colleagues still found no difference (OR = 1.06 [95% CI: 0.75 to 1.50]; See Table 6).[59] These adjusted data were not reported in a manner consistent with other studies, so we did not include it in our determining our strength of evidence.

Eight studies provide evidence examining vaccine uptake in Latino versus White participants.[25,31,34,51,54,56,59,61] Seven of these studies reported unadjusted data and contribute to low-strength evidence of lower H1N1 vaccine uptake among Latinos.[25,31,51,54,56,59,61] Three studies found that Latino participants were less likely to report being vaccinated than Whites.[25,54,56] One of these was a large (N = 55,850), national cross-sectional survey study in which 21% of Latino participants reported vaccination versus 26% of Whites (P<0.05),[56] and another substantially sized study by Burger and colleagues (N = 11,834) that examined US-born and immigrant (foreign-born) Latino populations separately found similar results for both groups compared to Whites.[25] An LA-area survey also found Latino participants less likely to be vaccinated than Whites.[54] The Plough study actually found that Latino participants were more likely to have been vaccinated for H1N1 (RR = 1.45 [95% CI: 1.43 to 1.47]), but this was among LA County residents who received the H1N1 vaccine at free clinic sites.[51] A study of Veterans with spinal cord conditions (N = 3384) found no difference in vaccine uptake by race,[31] as did the remaining 2 national cross-sectional studies (N = 2,355 and 4,040).[59,61]

Adjusted analyses provide some clues about factors associated with vaccine uptake for Latinos. Burger and colleagues unadjusted findings were that Latinos (US-born and immigrants) were less likely to be vaccinated. Controlling for demographics and comorbidities accounted for the disparity for US-born Latinos. Further modeling found that after controlling for demographics and comorbidities, SES accounted for the disparity for foreign-born Latinos.[25] Another study controlling for confounders found that Latinos were more likely to be vaccinated when SES and demographic factors were accounted for.[34] However, after controlling for sociodemographics, comorbidities, healthcare access, and attitudes towards the vaccine, the study by Steelfisher and colleagues still found no difference for H1N1 vaccine uptake between Latino and White participants.[59]

Other racial groups examined included Asian, American Indian/Alaska Native (AI/AN), and Pacific Islander populations. Two studies examined H1N1 vaccine uptake for Asian participants compared to Whites. The Plough study found that Asian participants in LA County were more likely be vaccinated than Whites (RR = 3.16 [95% CI: 3.12 to 3.21]),[51] but a national survey study found no significant difference.[59] We considered these studies' findings insufficient to determine strength of evidence, due to inconsistency, imprecision, and indirectness of the evidence. Two studies examined differences in H1N1 vaccine uptake between AI/AN participants and Whites and found AI/AN participants were more likely to be vaccinated (RR = 1.87 [95% CI: 1.72 to 2.03][51]; OR = 1.36 [95% CI 1.01 to 1.84][59]), but we determined the evidence for this finding to be insufficient. Pacific Islanders in LA County were over 4 times more likely to be vaccinated than Whites.[51] Finally, an LA-area survey combining Asian and Pacific Islander identified participants into a single category found no difference for this group versus White participants.[54] The evidence for these groups was insufficient.

By Socioeconomic Status

Two of 3 studies provided low-strength evidence that low-SES participants were less likely to be vaccinated. A large (N = 55,850), national, cross-sectional survey study found that a significantly

lower percentage of low-SES adults reported receiving the H1N1 vaccine.[56] In a small cross-sectional study (N = 225) of pregnant women in 2 large, Midwestern cities, those with less than a bachelor's degree were also less likely to have been vaccinated.[38] A study of Veterans with spinal cord conditions (N = 3384) found no difference in vaccine uptake by education.[31] A study that controlled for demographic confounders found no difference in vaccine uptake by educational attainment, aside from lower uptake among those with a high school education (see Table 6).[34]

By Rural/Urban Status

One small, mixed-methods study (N = 56) of Women, Infants, and Children (WIC) clients and staff in Georgia found that rural clients were less likely than urban ones to vaccinate themselves (3% vs 15%) or their children (23% vs 35%). Among staff participants however, the rural location staff were more likely to have vaccinated themselves and their children.[24] The evidence from these unadjusted results was insufficient to draw conclusions. A study that controlled for sociodemographic factors also found that urban participants were still more likely to be vaccinated (see Table 6).[34]

Table 6. H1N1 Vaccine Uptake by Group

Author, Year **Total N** **Participants**	**Unadjusted H1N1 Vaccine Uptake Results†**	**H1N1 Vaccine Uptake Results** *Adjusted for sociodemographic factors*
By race/ethnicity	*Compared to White participants*	
AA/Black populations		
Galarce, 2011[34] N = 1,569	---	No difference when controlling for SES and demographic factors: OR = 0.78 (95% CI: 0.49 to 1.24)
LaVela 2012[31] N = 3,384	No difference by race (data not provided)	---
Plough, 2011[51] N = 163,087	**Less likely to be vaccinated**: RR = 0.49 (95% CI: 0.48 to 0.50)*	---
Redelings 2011[54] N = 1,541	**Less likely** to report having received the H1N1 vaccine: OR = 0.7 (95% CI: 0.6 to 1.0)	---
Santibanez, 2013[56] N = 55,850	**Less likely** to report being vaccinated: RR = 0.63 (95% CI: 0.59 to 0.67)*	---
SteelFisher 2015[59] N = 2,355	No difference in reported vaccination: RR = 0.92 (95% CI: 0.73 to 1.55)	---
Uscher-Pines, 2011[61] N = 4,040	**Less likely** to report: RR = 0.67 (95% CI: 0.57 to 0.80)*	---
Latino		
Burger, 2017[25] N = 11,834	**Less likely** US-born Latinos**:** RR = 0.86 (95% CI: 0.76 to 0.98)* Latino immigrants (foreign-born): RR = 0.74 (95% CI: 0.66 to 0.83)*	• US-born Latinos no longer significantly different after controlling for demographics and comorbid conditions. • SES accounts for the disparity for foreign-born Latinos. • Before SES **AOR = 0.77 (95% CI: 0.65 to 0.90)‡**

Author, Year Total N Participants	Unadjusted H1N1 Vaccine Uptake Results†	H1N1 Vaccine Uptake Results *Adjusted for sociodemographic factors*
	Among foreign-born Latinos, no difference by: language, nativity, time in the US, citizenship, region of origin	• With SES (household income, homeownership, and education): AOR = 1.04 (95% CI: 0.87 to 1.23)
Galarce, 2011[34] N = 1,569	---	More likely when controlling for age gender, urbanicity, and SES OR = 1.59 (95% CI: 1.11 to 2.28)
LaVela 2012[31] N = 3,384	No difference by race (data not provided)	---
Plough, 2011[51] N = 163,087	**More likely to be vaccinated**: RR = 1.45 (95% CI: 1.43 to 1.47)*	---
Redelings 2011[54] N = 1,541	**Less likely** to report being vaccinated.	---
Santibanez, 2013[56] N = 55,850	**Less likely** to report being vaccinated: 21.2% vs 26.4% (P<0.05) RR = 0.80 (95% CI: 0.75 to 0.86)*	---
SteelFisher 2015[59] N = 2,355	No difference in reported vaccination: RR = 0.92 (95% CI: 0.73 to 1.16)	---
Uscher-Pines, 2011[61] N = 4,040	No difference in reported vaccination: RR = 0.91 (95% CI: 0.75 to 1.10)	---
Asian and/or Pacific Islander		
Plough, 2011[51] N = 163,087	• **Asians: more likely to be vaccinated**: RR = 3.16 (95% CI: 3.12 to 3.21) • **PI: More likely to be vaccinated**: RR = 4.34 (95% CI: 4.09 to 4.60)*	---
Redelings 2011[54] N = 1,541	Asian/PI: No difference in reported vaccinations.	---
SteelFisher 2015[59] N = 2,355	• Asians: No difference: RR = 1.16 (95% CI: 0.94 to 1.45)* • **PI: More likely be vaccinated**: RR = 1.25 (95% CI: 1.02 to 1.55)*	---
AI/AN		
Plough, 2011[51] N = 163,087	**More likely to be vaccinated**: RR = 1.87 (95% CI: 1.72 to 2.03)*	---
SteelFisher 2015[59] N = 2,355	**More likely** to report being vaccinated: RR = 1.25 (95% CI: 1.02 to 1.55)*	---
By SES		
Galarce, 2011[34] N = 1,569	---	Controlling for other sociodemographic factors, no difference by education, except for those with a high school education having lower uptake than those without: OR = 0.65 (0.42–0.99)*
Hernandez, 2019[38] N = 225	**Low SES less likely**. Participants with less than a bachelor's degree were less likely to have been vaccinated than those with a bachelor's degree or higher.	---

Author, Year Total N Participants	Unadjusted H1N1 Vaccine Uptake Results†	H1N1 Vaccine Uptake Results *Adjusted for sociodemographic factors*
LaVela 2012[31] N = 3,384	No difference by SES (data not provided)	---
Santibanez, 2013[56] N = 55,850	**Low SES less likely**. Participants with < college education and making <$75k were significantly less likely to be vaccinated than those with higher education and income.	---
By rural/urban status		
Boyd, 2013[24] N = 56 (30 rural, 26 urban)	**Rural less likely** A higher percentage of low-SES urban participants were vaccinated (rural 3% vs urban 15%) and had their children vaccinated (rural 23% vs urban 35%). In contrast, among WIC staff, all rural employees were vaccinated, while none were at the urban location. A higher percentage of rural staff with children also vaccinated their children than urban staff (rural 50% vs urban 33%).	---
Galarce, 2011[34] N = 1,569	---	No difference when controlling for SES and demographic factors: Urban OR = 1.15 (95% CI 0.80 to 1.64)

*Calculated from study data by reviewers. RRs were calculated using MedCalc.[69]
†Strength of Evidence based on unadjusted results
‡Adjusted for sex, age, marital status, and preexisting conditions.
Abbreviations: AA = African American; AI/AN = American Indian/Alaska Native; AP = Adjusted prevalence; APR = Adjusted prevalence ratio; CDC = Centers for Disease Control and Prevention; CI = Confidence interval; HBPC = Home-based Primary Care; HS = High school; LA = Los Angeles; NR = Not reported; OR = Odds ratio; RR = Relative risk; SES = Socioeconomic status VHA = Veterans Health Administration; WIC = Women, Infants, and Children

Factors Associated with H1N1 Vaccine Uptake

Eighteen studies examined factors that may have been associated with H1N1 vaccine uptake. Some studies provided evidence of disparities mediation (or lack thereof) by analyzing whether the association between group status and H1N1 vaccine uptake was changed when a given factor was incorporated in a model. Others, particularly the qualitative studies, provided factors potentially contributing to lower or higher vaccine uptake for particular groups. The factors fell into 5 main categories: health insurance and healthcare access, information and knowledge about the H1N1 vaccine, vaccination intentions, seasonal influenza vaccination, and trust and beliefs (Table 7 provides details by each of these categories).

Health Insurance and Access

Four studies examined the association between health insurance coverage and H1N1 vaccine uptake.[25,40,59,61] Health insurance coverage was associated with greater H1N1 vaccine uptake in 2 studies, and further, these studies found that minority racial/ethnic and lower-SES groups were less likely to have insurance coverage.[25,59] In 1 study with multivariable modeling, health insurance status of foreign-born Latino participants was a significant factor in whether they reported receiving the H1N1 vaccine.[25] In the nationwide survey study by Uscher-Pines and colleagues (N = 4,040),[61] AA/Black participants remained less likely to be vaccinated after controlling for a number of sociodemographic factors and insurance status. However, another study did not find racial or ethnic differences in H1N1 vaccine uptake by insurance coverage.[40] Besides health insurance, other issues of H1N1 vaccine accessibility identified in studies included work-related issues, such as inflexible work schedules to take time off for vaccination, lack of availability of the vaccine, concerns about its cost, and inconvenient locations/settings for vaccination.

Information/Knowledge About Vaccine

No broadly representative studies reported on information or knowledge of H1N1 as it directly pertained vaccine uptake. Two studies in specific populations offer some insights. In 1 study among Veterans with spinal-cord related disabilities (N = 3,384), those with adequate and accurate information about H1N1 were more likely to be vaccinated, and AA/Black, Latino, and less educated participants were more likely to report not receiving enough information.[30] A small study (N = 225) among pregnant women in the American Midwest, found that while lower educational attainment predicted lower vaccination rates, the relationship was mediated by the proportion of social network connections who were college educated H1N1 vaccine supporters.[38]

Intention to Vaccinate/Vaccine-seeking Behavior

Vaccine seeking, and willingness and intention to vaccinate, did not differ by SES in 3 studies.[33,43,67] In the national survey study by Lin and colleagues (N = 1,569) [43] this was true for income and education; however, unemployed participants were more likely to vaccinated with the other factors controlled. Latino participants were more likely to be willing to get the H1N1 vaccine than White participants in a nationwide survey.[33] Similarly, a study conducted prior to the approval of the H1N1 vaccine asked about willingness to receive a new, unapproved vaccine, and found that Latinos were more willing in all analyses.[53] AA/Black participants were no different from White participants in their willingness or intention to be vaccinated in studies conducted during vaccination efforts[35,67] and before the vaccine was approved.[53]

Receipt of Seasonal Influenza Vaccine

Two studies provide evidence of an overall association between receipt of the seasonal influenza vaccine and H1N1 vaccine uptake,[33,34] with 1 specifically among minority participants.[33] In this small study (N = 503) in Atlanta, Georgia, participants who were more likely to report that they were likely to get a seasonal influenza vaccine were also more likely to report intention to get an H1N1 vaccine.[33] The other study, in a nationally representative sample (N = 1,569), found an overall association between seasonal influenza vaccination and H1N1 vaccine uptake, but there was no difference in seasonal vaccination for AA/Blacks or Latinos compared to Whites, nor by participant educational status.[34]

Trust/Beliefs

Trust (or lack thereof) in the government and healthcare providers, as well as beliefs about vaccines and government were examined in several studies. A small study (N = 503) of racial and ethnic minority adults in Atlanta, Georgia found that acceptance of the H1N1 vaccine was associated with a group of survey items indicating higher trust in the US government and greater disagreement with vaccine conspiracy beliefs.[33] It also found that participants with negative attitudes towards the H1N1 vaccine were less likely to accept the vaccine.[33] In another study of low-SES participants in Los Angeles (N = 1,750), those with negative beliefs about vaccines generally were also less likely to receive the H1N1 vaccination.[54]

In regards to trust in government, a study utilizing intercept interviews in Washington, DC found that AA/Black and Latino participants were less likely than Whites to trust the US government and its agencies when it came to medical countermeasure messages in a hypothetical scenario of an infectious disease outbreak.[45] In another national survey study (N = 1,543), within group associations were *not* found for government trust and H1N1 vaccine uptake among AA/Black or Latino participants, while a positive relationship existed for Whites.[32]

Multiple studies noted participants' concerns over the novelty of the vaccine and whether it had been adequately tested. In 1 study, an overall analysis of all participants found that belief in H1N1 vaccine safety was highly predictive of vaccination (OR = 5.11 [3.50–7.45] P<0.001), and low-SES and urban participants were less likely to believe the vaccine was safe.[34] In another survey study in which safety beliefs were associated with vaccination in the overall sample, H1N1 vaccine safety beliefs differed between racial and ethnic groups, with AA/Black participants in particular less likely to believe the vaccine was safe (Latino and AI/AN participants had more mixed views of vaccine safety, and Asian participants were no different than Whites).[59] Another study found that AA/Black participants were more concerned about safety and side effects of the H1N1 vaccine than other racial and ethnic groups.[51] A large national survey study found more fear that the vaccine was unsafe among Latino participants, followed by AA/Black participants, with White participants least likely to perceive the vaccine as unsafe.[56] However, fear of getting sick from the vaccine was counterintuitively associated with higher vaccine uptake in bivariate analysis, but after adjusting for other factors, there was no association; fear of getting sick from the vaccine did not influence vaccine uptake.[56] Another smaller national survey study found no racial differences in perceptions of vaccine safety, but in all groups the percentage who believed it was safe was less than 45%.[61] Fears about vaccine novelty and safety were also highlighted in qualitative studies. For instance, among Spanish-

speaking Latino participants of 1 qualitative study, fear of vaccine side effects including "urban legends" of vaccine adverse events were common themes.[26]

Relatedly, belief in the effectiveness of the vaccine may also be associated with uptake. The largest survey study found that AA/Black and low-SES participants were less likely to believe the vaccine was effective in preventing H1N1, and in the overall sample belief in vaccine effectiveness was associated with uptake.[56]

Perception of the risk posed by H1N1 was another factor associated with vaccination. The largest survey study found that Latinos were more likely to believe they would get sick if not vaccinated than AA/Black and White participants.[56] Concern that someone in their family could get H1N1 was higher for all surveyed racial and ethnic minority groups than for Whites in another study, and the same study found that those who were very concerned were more likely to be vaccinated than those who were less concerned in the overall sample.[59] In 2 qualitative studies, perception of susceptibility to H1N1 was low among minority participants.[24,26]

Table 7. Factors Associated with H1N1 Vaccine Uptake

Author, Year N Participants Focus Population(s) of Interest	Mediating Factors
Health insurance and access	
Boyd, 2013[24] N = 56 *H1N1 Vaccine* • Low SES women	Cost and availability: Cited as reasons for non-vaccination.
Burger, 2018[25] N = 11,834 *H1N1 Vaccine* • Latino (US and Foreign-born) • Low SES: Education	Health insurance (overall): • In a model with demographics, SES, and insurance coverage, participants with health insurance (AOR = 1.91 [95% CI 1.57 to 2.33], p < 0.001) were significantly more likely to have received the H1N1 vaccine. • In unadjusted comparison, more Latinos than Whites had no healthcare coverage. • In adjusted models vaccination remains less likely for those with less than college education – health insurance coverage doesn't account for the disparity. • Controlling for demographics and SES, foreign-born Latinos with health insurance were more likely to be vaccinated (OR = 1.53; P<0.05).
Cassady, 2012[26] N = 90 *H1N1 Vaccine* • Latinos with LEP	Healthcare Utilization: • Men, in particular, did not utilize healthcare services unless they were already very sick – prevention not a priority. Inflexible Work Environment: • The use of preventive services and time off for vaccines are challenging for male farm laborers with inflexible work schedules. Knowledge of Vaccine Availability: • Most subjects were able to list a location where the vaccine was available for free or at low cost (*eg,* clinics, flea markets, church, and schools).
Kumar, 2012[41] N = 2,079 *H1N1 Vaccine* • AA/Black • Latino	Health Insurance: • Controlling for demographics and priority status, there was no difference in vaccine uptake by health insurance in the overall sample (AOR = 1.28, 95% CI 0.63-2.63), or among AA/Blacks (AOR = 2.97, 95% CI 0.92-9.62), Latinos (AOR = 1.39 [95% CI NR; P = 0.27]), or Whites (AOR = 1.03 [95% CI NR; P = 0.95]).
Galarce, 2011[34] N = 1,569 *H1N1 Vaccine* • AA/Black • Latino • Low SES: Education	Ability to get Vaccine: • Of those who tried to obtain the vaccine, significantly more AA/Blacks, Latinos, and less educated adults reported it being unavailable.

Author, Year N Participants Focus Population(s) of Interest	Mediating Factors
SteelFisher, 2015[59] N = 2,355 *H1N1 and H1N1 Vaccine* • AA/Black • Latino • Asian • AI/AN • Low SES: Education	Health Insurance: • In the overall sample, those with health insurance were more likely to receive H1N1 vaccine than uninsured: OR = 1.51 (95% CI: 1.10 to 2.09). • AA/Black, Latino, and AI/AN (but not Asian) pts were less likely to have health insurance coverage than Whites. • After controlling for healthcare access, and attitude-related variables in addition to sociodemographics, AI/AN participants remained more likely than Whites to be vaccinated. • Asian pts were also more likely to be vaccinated after these factors were incorporated. • There were no differences by SES.
Uscher-Pines, 2011[61] N = 4,040 *H1N1 Vaccine* • AA/Black • Latino	Health Insurance: • Controlling for demographics, SES, comorbidities and insurance status AA/Black pts were still less likely to vaccinate: AOR = 0.67, P = 0.05. Provider Recommendation to Vaccinate: • No difference by race in receipt of provider recommendation to vaccinate. Vaccination Settings: • Fewer AA/Blacks (2.9%) than Whites (12.4%) reported receiving a vaccine in a retail setting (p = 0.001), or in health department flu clinics (7.7% vs 22.1%, p = 0.002). • Latinos were more likely to be vaccinated in a physician's office than Whites (42% vs 23.5%, p = 0.04). • There were no other differences by setting (*ie*, physician's office, health department, medical clinic). Vaccination in the Workplace: • Controlling for confounders, Latinos were less likely to have been vaccinated in the workplace (6.2% vs 18.8%; P = 0.01). • There was no difference between AA/Blacks and Whites.
Information/Knowledge about vaccine	
Etingen, 2012[30] N = 3,384 *H1N1 and H1N1 Vaccine* • Veterans with Spinal Cord Injuries/Disorders	Adequacy and accuracy of information • In the overall sample, those reporting that they received adequate information about H1N1 were more likely to have received an H1N1 vaccine (OR = 1.80 [95% CI 1.49 to 2.17]); likewise for those with accurate information (OR = 1.99; 95% CI [1.67 to 2.37]).

Hernandez, 2019[38]
N = 225
H1N1 Vaccine
• Low SES Pregnant Women: Education
	Social network connections:
	• Association between educational attainment (<bachelor's degree vs bachelor's degree+) and vaccination was mediated by social network connections, specifically proportion of college-educated individuals in network:
	  • Proportion of college educated people with whom participants *discussed* H1N1 partially mediated the relationship.
	  • Proportion of college-educated H1N1 vaccine *supporters* in personal network substantially mediated the relationship.

Author, Year **N Participants** **Focus** **Population(s) of Interest**	**Mediating Factors**
Intention to vaccinate/Vaccine seeking behavior	

Frew, 2012[33]
N = 503
H1N1 Vaccine
• Low SES Racial/Ethnic Minorities: Education; Income
	<u>Vaccine Acceptance/Intentions:</u>
	• SES had no impact on vaccine acceptability (*ie*, reported likelihood of getting H1N1 vaccine in next year):
	  • Education: AOR = 1.05, 95% CI [0.81 to 1.36])
	  • Income: OR = 0.82 (95% CI: 0.59 to 1.14)

Gargano, 2011[35] N = 102 *H1N1 Vaccine* • Rural AA/Black	<u>Intention to be Vaccinated</u> • There was no difference between AA/Black and White participants (AOR = 0.56, 95% CI [0.17-1.85]).
Lin, 2014[42] Lin, 2018[43] N = 1,569 *H1N1 and H1N1 Vaccine* • Low SES: Education; Income; Employment	<u>Sought Vaccine for self or loved ones</u>: • No difference by household income or education, but more likely if unemployed (vs employed). • These relationships were unchanged by adding interpersonal networks (health-related social networks and talking to a doctor about H1N1) and intrapersonal factors (concerned about self or family getting sick and knowledge of H1N1 transmission) to the model.
Mesch, 2014[67] N = 968 *H1N1 and H1N1 Vaccine* • AA/Black • Latino • Low SES: Education	<u>Willingness to take H1N1 Vaccine:</u> • Latinos were more likely to be willing to take the H1N1 vaccine than Whites (P<0.01). • No difference for AA/Blacks. • No differences based on education.
Quinn, 2009[53] N = 1,543 *H1N1 Vaccine* • AA/Black • Latino • Low SES: Education	<u>Willing to take H1N1 Vaccine under FDA EUA</u>: • Significantly fewer Latinos than Whites and AA/Blacks would refuse the vaccine. • After controlling for covariates this relationship remained (Latino [vs White] acceptance OR = 3.27 [95% CI: 1.40 to 7.63]; p < 0.003). • Undecided: AA/Black and Latino race/ethnicity ($p < 0.001$), lower income ($p = 0.002$), and a lower education level ($p < 0.001$) were associated with being undecided about accepting the vaccine. <u>Confidence in vaccine decision</u>: • Latinos were less confident in their decision than Whites and AA/Blacks ($p = 0.007$). • SES: 35.5% of pts with < high school were confident in their decision compared to 57.7% of those with college+ ($p = 0.001$).
Receipt of seasonal influenza vaccine	
Frew, 2012[33] N = 503	• Among racial/ethnic minority adults, H1N1 vaccine acceptance was associated with having had the flu shot in the past 5 years (OR = 2.50, 95% CI [1.52, 4.10])

Author, Year N Participants Focus Population(s) of Interest	Mediating Factors
H1N1 Vaccine • Low SES Racial/Ethnic Minorities: Education; Income	
Galarce, 2011[34] N = 1,569 *H1N1 Vaccine* • AA/Black • Latino • Low SES: Education • Rural	• Participants (in overall sample) who had received the seasonal influenza vaccine were more likely to have been vaccinated for H1N1 (AOR = 21.46 [95% CI 14.30 to 32.21]), P<0.001. • Seasonal flu vaccine receipt didn't differ by race/ethnicity or SES. • In a sequential model controlling for SES and demographic factors, then adding H1N1 vaccine-related beliefs and seasonal influenza vaccination status, there was no difference in H1N1 vaccine uptake for AA/Blacks vs Whites in either model. • However, the addition of beliefs and seasonal vaccine status eliminated the significantly higher odds for Latinos and lower odds for those with a high school degree (vs < HS) and resulted in significantly higher odds for urban vs rural participants.
Trust/Beliefs	
Boyd, 2013[24] N = 56 *H1N1 Vaccine* • Low SES women	<u>Trust</u>: • Both clients and staff expressed lack of clear information/what information sources to trust, perception of inadequate research/''newness'' of the vaccine, and fears related to potential side effects of vaccination. <u>Risk perception</u>: • Belief that they were personally at risk for H1N1 was especially low among rural participants.
Cassady, 2012[26] N = 90 *H1N1 Vaccine* • Latinos with LEP	<u>Reasons for not getting vaccinated</u>: • Novelty of vaccine created fear that vaccine had not been sufficiently tested for side effects (vaccine waivers contributed to fear); urban legends about vaccine dangers; and perception that H1N1 was not serious. • Lack of trust in government cited by a minority of participants. <u>Trusted vaccine information sources</u>: • Parents trusted information from their children's schools; male farm workers cited doctors as most trusted source of health information.
Freimuth, 2014[32] N = 1,543 *H1N1 Vaccine* • AA/Black • Latino	<u>Trust in government:</u> • There was no relationship between trust in the government and vaccine uptake within AA/Blacks or Latinos. • There was a significant positive relationship for Whites (Cohen's d = 0.218; P = 0.034).
Frew, 2012[33] N = 503 *H1N1 Vaccine* • Low SES Racial/Ethnic Minorities: Education; Income	• Among minority adults, H1N1 vaccine acceptance was associated with lower mistrust and greater disagreement with vaccine conspiracy beliefs [OR = 2.15, CI (1.57, 2.95)]. • Respondents who had a general negative opinion about the H1N1 vaccine-related benefits were less likely to accept vaccination [OR = 0.23, CI (0.16, 0.33)].

Author, Year **N Participants** **Focus** **Population(s) of Interest**	**Mediating Factors**
Galarce, 2011[34] N = 1,569 *H1N1 Vaccine* • AA/Black • Latino • Low SES: Education • Rural	Vaccine-Related Beliefs: • In a sequential model controlling for SES and demographic factors, then adding H1N1 vaccine-related beliefs and seasonal influenza vaccination status, there was no difference in H1N1 vaccine uptake for AA/Blacks vs Whites in either model. • However, the addition of beliefs and seasonal vaccine status eliminated the significantly higher odds for Latinos and lower odds for those with a high school degree (vs < HS). • The addition resulted in significantly higher odds for urban vs rural participants. Perceived vaccine safety • Overall, pts more likely to be vaccinated if believe vaccine is safe (vs unsafe) OR = 5.11 (3.50–7.45) P<0.001. • There were no racial/ethnic differences in belief in vaccine safety. • College graduate vs <high school were more likely to believe vaccine safe (OR = 1.69, 95% CI [1.17-2.44]). • Urban participants were less likely to perceive the H1N1 vaccine as safe (OR = 0.75, 95% CI [0.56-0.99]).
Liu, 2017[45] N = 148 *H1N1 Vaccine* • AA/Black • Latino	Trust in the US Government: • Whites reported significantly more trust in the US government (P = 0.047) and the CDC (P = 0.017) related to medical countermeasure messages than AA/Blacks and Latinos.
Plough, 2011[51] N = 1,750 *H1N1 Vaccine* • AA/Black • Latino • Asian	Trust in the Vaccine: • Concerns regarding the safety and side effects of vaccination were more prevalent among AA/Blacks than among other racial/ethnic groups. • Among those who reported being unlikely to get vaccinated, 44% of AA/Blacks felt that the vaccine may have adverse effects versus 29%, 25%, and 33% of Whites, Latinos, and Asians, respectively.
Redelings, 2011[54] N = 1541 *H1N1 Vaccine* • AA/Black	Trust in the Vaccine and Providers Recommendations: • AA/Blacks were less likely to report that they trust providers who recommend vaccines (OR = 0.5 [95% CI 0.4–0.7]), that they believe vaccines can prevent disease (OR = 0.4 [95% CI 0.3–0.5]), and that vaccines are safe (OR = 0.5 [95% CI 0.4–0.6]). • Among all participants, beliefs about vaccine safety and efficacy predicted receipt of H1N1 vaccine.

Santibanez, 2013[56]
N = 55,850
H1N1 Vaccine
• AA/Black
• Latino
• Low SES: Education; Income
	Vaccine Beliefs:
	• In overall sample, those who believed H1N1 vaccines were effective were more likely to get H1N1 vaccine (P<0.001).
	  • AA/Blacks (69.2%) were less likely to believe it effective compared to Whites (74.9%) and Latinos (73.5%); both P<0.05.
	  No difference between Whites and Latinos.
	  Low SES (income and education) were less likely to believe in effectiveness.
	• Belief that 1 will get sick if *not* vaccinated was associated with more H1N1 vaccine uptake overall (P<0.001).
	  • Latinos more likely to believe this (39.3%) than Whites (23.4%) or AA/Blacks (25.5%); both P<0.05.
	  • No difference between Whites and AA/Blacks.

Author, Year N Participants Focus Population(s) of Interest	Mediating Factors
	• Less educated more likely to believe than more educated, and lowest incomes more likely to believe than higher incomes. • **Worry about getting sick *from* vaccine was associated with more H1N1 vaccine uptake (P<0.001).** • **Latinos (45.9%) were more likely to be worried than Whites (26.6%) and AA/Blacks (36.8%), and AA/Blacks were more likely than Whites; all P<0.05.** • **Lower SES (income and education) were more worried than higher SES.** <u>After adjusting for sociodemographic factors* and opinion</u>: • White pts were still more likely to be vaccinated than Latinos • Unadjusted vs adjusted prevalence of vaccination: • Latino: 21.2 vs 16.5% • AA/Black: 16.6 vs 17.9% • White: 26.4 vs 25.6% • Lower SES remained less likely to vaccinate after adjustment
SteelFisher, 2015[59] N = 2,355 *H1N1 Vaccine* • AA/Black • Latino • Asian • AI/AN • Low SES: Education	<u>After controlling for healthcare access, attitude-related variables, and sociodemographics:</u> • AI/AN participants remained more likely than Whites to be vaccinated. • Asian pts were also more likely to be vaccinated after these factors were incorporated. • There were no differences by SES. <u>Attitude-related variables:</u> • Those very concerned about self/family getting H1N1: More likely to be vaccinated than less concerned. OR = 2.13 (95% CI: 1.66 to 2.74)† • All racial/ethnic minorities (AA/Black, Latino, Asian, and AI/AN) were significantly more likely to be very or somewhat concerned than Whites. <u>Perception of safety:</u> • Those who believed it was very safe were more likely to vaccinate than those with lesser safety beliefs: OR = 5.81 (95% CI: 4.66 to 7.24)† • Compared to Whites: • AA/Blacks: Less likely to believe vaccine is “very safe” and more likely to believe it is “not at all safe” • Latinos: More likely to believe vaccine is “not very safe” • Asians: No differences • AI/ANs: Less likely to believe vaccine is “very” safe, but more likely to believe it is “somewhat safe,” and less likely to believe is “not very safe”
Uscher-Pines, 2011[61] N = 4,040 *H1N1 Vaccine* • AA/Black • Latino	<u>Perception of Safety</u> • AA/Blacks (40.6%), Latinos (39.6%), and Whites (44.7%) were similar in their perception that the H1N1 vaccine was safe.

* adjusted for income, education, sex, and priority status
† controlled for race and SES
‡ proportions calculated by reviewers
Abbreviations: AA = African American; AI/AN = American Indian/Alaska Native; AP = Adjusted prevalence; APR = Adjusted prevalence ratio; CDC = Centers for Disease Control and Prevention; CI = Confidence interval; EUA = Emergency Use Authorization; FDA = Food and Drug Administration; HBPC = Home-based Primary Care; HS = High school; LA = Los Angeles; NR = Not reported; OR = Odds ratio; RR = Relative risk; SES = Socioeconomic status; VHA = Veterans Health Administration; WIC = Women, Infants, and Children

Interventions to Reduce Disparities in Vaccine Uptake

No studies examined interventions to address H1N1 vaccine-related disparities. We identified only 1 intervention study, aimed at increasing Hepatitis A vaccine uptake among those experiencing homelessness in San Diego, California during a regional outbreak. The intervention was a computerized alert system embedded in the electronic health record (EHR) that notified emergency department (ED) providers of the participants houseless status and suggested offering the Hepatitis A vaccine. Vaccination significantly increased after the alert was implemented (see Table 8).[27]

Table 8. Interventions for Vaccination-related Disparities

Author, Year **N Participants** **Setting** **Study Design** **Dates** ***Focus and Population***	**Intervention**	**Findings** ***Relevance to COVID-19***
Castillo, 2018[27] N = 1,131 ED, San Diego, CA Retrospective pre- post- Aug 2016 - Jan 2018 *Hepatitis A Vaccine for the Homeless population*	ED-based computerized alert system embedded within the EHR to identify patients experiencing homelessness and prompt providers to consider offering the Hepatitis A vaccine during regional outbreak.	<u>Vaccinations given:</u> Historical period: none (0/1,000 visits) Pre-intervention period: 23 (8/1,000 visits) Intervention period: 465 (184/1,000 visits) <u>Intervention period:</u> Visits with receipt of vaccine in ED: 77.5% *An automated system identifying disadvantaged populations can help to mitigate potential disparities in COVID-19 vaccinations*

Abbreviations: CA = California; ED = Emergency department; EHR = Electronic health record

DISCUSSION

We identified 50 articles relevant to health inequalities in infectious disease epidemics in the United States predating COVID-19. We found 14 studies (16 articles) that examined potential mediating factors associated with health inequities, and 12 studies (3 articles) and 5 expert panel reports that provide examples of interventions and lessons learned from previous epidemics and disasters to guide us forward in mitigating health inequalities during the COVID-19 pandemic and beyond. We also identified 20 studies that examined inequalities in H1N1 vaccine uptake and mediating factors, and 1 vaccine-related intervention study.

To our knowledge, this is the first review of studies aimed at identifying both the factors that mediate health disparities in infectious disease epidemics and also potential avenues for mitigating then. Our conceptual framework was guided by the work of Quinn and Kumar, who considered the potential causes of epidemic influenza based on measures of exposure, susceptibility, and access to care as they applied to data collected in 2009-2010 during the H1N1 pandemic (see Figure 1). The framework points to proximal and distal determinants of disease burden with the ultimate goal of identifying potential points of policy and programmatic intervention.

Across Key Questions, studies were heterogeneous in their operationalization of potentially mediating factors, populations, programs, and interventions. Studies of potentially mediating factors generally, and those related to H1N1 vaccine uptake specifically, were largely cross-sectional. Several included studies did not control for confounding variables or their methods were unclear[44,51,63,65,66]; however, many were well conducted and adequately reported. A few of the qualitative studies clearly reported their methodology and/or findings.[21,22,26] However, more did not.[20,45,47,57,64] We identified very few interventions or program evaluation studies specific to infectious disease epidemics; most were focused on post-disaster needs or disaster preparedness.

Key Question 1

Our findings related to mediators associated with differential exposure or the transmission of infectious disease were unsurprising. Despite looking across racial/ethnic groups and socioeconomic status independently, the findings that disparities were related to societal-based structural and work-related factors, rather than individual factors such as hygiene and cleaning were consistent across studies. We identified few significant differences in social distancing attitudes and intentions between groups. Instead, it was clear that the meaningful differences lay in the ability or inability to social distance. Only 1 study examining variables related to exposure to illness disaggregated the Latino population by language proficiency, and 1 additional study provided qualitative input in the form of stakeholder interviews. In contrast with other populations we examined, compared to either English-proficient Latinos or Whites, limited English-proficient Latinos (and/or migrant and seasonal farm workers) were at higher risk across both structural and work-related variables measured (see Table 9).

Susceptibility to illness played a major role in H1N1 severity and mortality; however, access to care (*ie*, having a primary care provider or health insurance) did not. Significantly greater proportions of every racial and ethnic minority group reported having experienced discrimination while seeking healthcare, and many reported being less informed or were less prepared. Much of the literature guiding communication is dated due to advances in technology, and findings of

proportionally high rates of trust in the federal governmental, particularly in AA/Black and Latino adults, may be out of date (see Table 10).

Table 9: Health Inequity Mediators by Group: Exposure

Study Timing	N	Exposure			
		Structural	Work-related	Social Distancing	Hygiene-related Behaviors
African American/Black compared to non-Hispanic White					
Kumar 2012[40] H1N1	2042	†More likely to live in an apartment †More likely to live in a metro area †No difference in the number of children per household	†No difference in ability to social distance due to work	†No difference in ability to social distance	--
SteelFisher 2015[59] H1N1	2355	--	--	‡No difference in avoiding people with flu-like symptoms	‡More likely to cover nose and mouth with a tissue, to use hand sanitizer more frequently, and not touch face.
				‡No difference in avoiding social gatherings	‡No difference in hand washing, sneezing or coughing into elbow ‡More likely to have cleaned more frequently
				‡More likely to avoid air travel and public transportation	‡More likely to have used stronger cleaners or disinfectants than usual
Quinn 2011[10] H1N1	1479	†Fewer adults per household †No difference in the number of children †More likely to live in an apartment †More likely to live in a metro area	†Better able to social distance at work	†More dependent on public transportation †Less able to obtain childcare that wasn't with a group of children	--

Study Timing	N	Exposure			
		Structural	Work-related	Social Distancing	Hygiene-related Behaviors
Hispanic/Latino compared to non-Hispanic White (general)					
Kumar 2012[40] H1N1	2042	†More children per household †More likely to live in an apt †More likely to live in a metro area	†Less able to social distance due to work	†Less able to social distance (including public transportation)	--
SteelFisher 2015[59] H1N1	2355	--	--	‡No difference in avoiding people with flu-like symptoms	‡More likely to cover nose and mouth with a tissue. ‡No difference in other personal hygiene-behaviors.
				‡More likely to avoid social gatherings	‡More likely to have cleaned more frequently
				‡More likely to avoid air travel and public transportation	‡More likely to have used stronger cleaners or disinfectants than usual
Quinn 2011[10] H1N1	1479	†No difference in adults or children per household †More likely to live in an apartment †More likely to live in a metro area	†No difference in ability to social distance due to work	†More dependent on public transportation †No difference in ability to obtain childcare that wasn't with a group of children	--
American Indian/Alaska Native compared to non-Hispanic White					
SteelFisher 2015[59] H1N1	2355	--	--	‡No difference in avoiding people with flu-like symptoms	‡More likely to cover nose and mouth with a tissue, and to cough or sneeze into elbow. ‡No difference in other personal hygiene-behaviors.
				‡No difference in avoiding social gatherings	‡More likely to have cleaned more frequently

Study Timing	N	Exposure			
		Structural	Work-related	Social Distancing	Hygiene-related Behaviors
				‡More likely to avoid air travel and public transportation	‡More likely to have used stronger cleaners or disinfectants than usual
Asian compared to non-Hispanic White					
SteelFisher 2015[59] H1N1	2355	--	--	‡No difference in avoiding people with flu-like symptoms	‡More likely to cover nose and mouth with a tissue.
				‡More likely to avoid social gatherings	‡No difference in other personal hygiene-behaviors.
					‡No difference in cleaning more frequently
				‡More likely to avoid air travel and public transportation	‡More likely to have used stronger cleaners or disinfectants than usual
Limited English Proficiency					
Latino Spanish or Indigenous language compared to Latino English speakers or non-Hispanic White					
Quinn 2011[10] H1N1	1479	†More likely to live in an apartment	†Less able to social distance due to work	†More dependent on public transportation	--
		†More likely to live in a metro area			
		†More adults and children per household		†Less able to obtain childcare that wasn't with a group of children	
Schoch-Spana, 2010[57] H1N1	33	10-12 people or 2-3 families in a small cabin	Unable to stay home when schools close or children are sick	--	--
			Limited work benefits and low wages but dependence on job – may not stay home when sick		

Study Timing	N	Exposure			
		Structural	Work-related	Social Distancing	Hygiene-related Behaviors
			Lack of consistent childcare. Children may accompany parents to work		
Lower SES compared to Higher SES					
Levy 2013[8] H1N1	374	†‡ Residents of high-poverty neighborhoods were more likely to have been hospitalized for H1N1	--	--	--
Lin 2014[42] Lin 2018[43] H1N1	1569	--	--	†‡ No difference in social distancing (Including public transportation) (education)	†‡ No difference in wearing a face mask (education)
				†‡ No difference in "staying home" (education)	†‡ No difference in the frequency of hand-washing or hand sanitizer use (education)
				†‡ No difference in the reduction of human contact with people outside of household (education)	†‡ No difference in coughing with mouth covered (education)
SteelFisher 2015[59] H1N1	2355	--	--	‡≤ HS were less likely to have avoided people with flu-like symptoms	‡≤ HS were more likely to cover nose and mouth with a tissue.
					‡No difference in other personal hygiene-behaviors by education
				‡≤ HS were more likely to avoid social gatherings	‡≤ HS were more likely to have cleaned more frequently
				‡≤ HS were more likely to avoid air travel and public transportation	‡≤ HS were more likely to have used stronger cleaners or disinfectants than usual

[1]Veteran population †Controlled for demographics and SES; ‡Controlled for demographics and additional confounders

Higher risk	No difference in risk	Lower risk

Table 10: Health Inequity Mediators by Group: Susceptibility, Access to Care, Discrimination/Trust

Study	N	Susceptibility	Access to Care	Discrimination and Trust	Information and Knowledge
African American/Black compared to non-Hispanic White					
[1]Etingen 2012[30] H1N1	3384	--	--	--	[‡] Less likely to report receiving adequate H1N1 information (patients with a disability)
Freimuth, 2014[32] H1N1	1543	--	--	[§]More likely to trust the federal government (*ie*, President Obama, HHS).	--
				[§]No difference in trust of the CDC and state and local governments.	--
				[§]No difference in overall government trust by previous experience of discrimination in health care	--
Lin 2017[44] MERS	627	--	--	--	[†]No difference in awareness of pandemics in the past 10 yrs
					[†]Less likely to have heard of MERS
					[†]Less likely to have accurate knowledge about MERS
McCauley, 2013[47] H1N1	46	--	--	Not sure who and what to trust re: H1N1 due to mixed messages in the media and by government officials.	--
Quinn 2009 H1N1	1543	--	--	Higher trust in government re: H1N1	--

Study	N	Susceptibility	Access to Care	Discrimination and Trust	Information and Knowledge
Quinn 2011[10] H1N1	1479	†No difference in number of comorbid conditions	†No difference in access to care (*ie*, insurance, primary provider, ability to pay)	†More likely to have experienced discrimination when seeking health care	--
SteelFisher 2015[59] H1N1	2355	--	‡More likely to have spoken to a provider about H1N1 protection	--	--
Hispanic/Latino compared to non-Hispanic White					
[1]Etingen 2012[30] H1N1	3384	--	--	--	‡ Less likely to report receiving adequate H1N1 information (patients with a disability)
Freimuth, 2014[32] H1N1	1543	--	--	§More likely to trust the federal government (*ie*, President Obama, HHS).	--
				§No difference in trust of the CDC and state and local governments.	--
				§No difference in overall government trust by previous experience of discrimination in health care	--
Lin 2017[44] MERS	627	--	--	--	†No difference in awareness of previous pandemics
					†Less likely to have heard of MERS
					†No difference in accurate knowledge about MERS
Mesch, 2014[67] H1N1	1000	--	--	‡More trust in the government to handle H1N1	--
Quinn 2009 H1N1	1543	--	--	Higher trust in government re: H1N1	--

Study	N	Susceptibility	Access to Care	Discrimination and Trust	Information and Knowledge
Quinn 2011[10] H1N1	1479	†No difference in number of comorbid conditions	†No difference in access to care (composite)	†More likely to have experienced discrimination when seeking health care	--
SteelFisher 2015[59] H1N1	2355	--	‡More likely to have spoken to a provider about H1N1 protection	--	--
American Indian/Alaska Native compared to non-Hispanic White					
Hennessy 2015 H1N1[37] H1N1	381	†Preexisting conditions mediated the relationship between AI/AN and H1N1 mortality	--	--	--
SteelFisher 2015[59] H1N1	2355	--	‡More likely to have spoken to a provider about H1N1 protection	--	--
Asian compared to non-Hispanic White					
SteelFisher 2015[59] H1N1	2355	--	No difference in having spoken to a provider about H1N1 protection	--	--
Limited English Proficiency					
Hispanic/Latino Spanish or Indigenous language compared to Hispanic/Latino English speakers or non-Hispanic White					
Quinn 2011[10] H1N1	1479	†Fewer comorbid conditions	†Poorer access to care (composite)	†More likely to have experienced discrimination when seeking health care	--
Schoch-Spana, 2010[57] H1N1	33	--	Not aware of migrant health centers Lack of transportation from rural locations Lack of Spanish and Indigenous language materials and support	Stigmatization by providers, "(they are) coming from Mexico and they're bringing in the swine flu."	--

Study	N	Susceptibility	Access to Care	Discrimination and Trust	Information and Knowledge
			Low utilization of care for prevention and early stages of illnesses Don't seek care due to fear of deportation Lack of money for healthcare costs No insurance, can't access public assistance		
Witrago 2011[63] Influenza Pandemic Preparedness	209	--	The primary reason reported for not having medication at home was lack of health insurance and money	--	Less prepared for an influenza pandemic (scale)
Chinese ethnicity regardless of language compared to Chinese ethnicity English speakers					
Yip 2009[66] H1N2	100	--	--	--	Less likely than English proficient to feel well informed about H1N1
Low SES compared to Higher SES					
[1]Etingen 2012[30] H1N1	3384	--	--	--	[‡] Less than a college degree were less likely to report receiving adequate H1N1 information (participants with a disability)
Lin 2014[42] Lin 2018[43] H1N1	1569	--	--	--	[†] Lower knowledge about H1N1 transmission (education)
					[‡] No difference in knowledge about H1N1 transmission (education)
					[†‡] No difference in misconceptions about H1N1 transmission (education)

Study	N	Susceptibility	Access to Care	Discrimination and Trust	Information and Knowledge
					† No difference in pork avoidance behaviors
					‡ More likely to avoid eating pork products
Lin 2017[44] MERS	627	--	--	--	†Less likely to be aware of previous pandemics
					†No difference in having heard of MERS
					†No difference in accurate knowledge about MERS
Levy 2013[8] H1N1	374	†‡ Adults with 1+ comorbidity were more likely to be hospitalized for H1N1. Comorbidities did not explain all of the association between hospitalization and low SES (education) or neighborhood SES (FPL)	Participants with public (vs private) insurance were more likely to be hospitalized with H1N1	--	--
			†‡No relationship associated with having a primary care provider and hospitalization for H1N1		
			†‡No relationship associated with having insurance and hospitalization for H1N1		
Freimuth, 2014[32] H1N1	1543	--	--	§No difference in trust in the federal government (*ie*, President Obama, HHS).	--
				§No difference in trust of the CDC and state and local governments.	
				§No difference in overall government trust by previous experience of discrimination in health care	

Study	N	Susceptibility	Access to Care	Discrimination and Trust	Information and Knowledge
Mesch, 2014[67] H1N1	1000	--	--	No difference in trust in the government to handle H1N1	--
SteelFisher 2015[59] H1N1	2355	--	‡No difference in having spoken to a provider about H1N1 protection by SES (level of education)	--	--

[1]Veteran population
[†]Controlled for demographics and SES
[‡]Controlled for demographics and additional variables
[§]Weighted by demographics, SES and additional variables
Abbreviations: AA = African American; AI = American Indian; AN = Alaska Native; CDC = Centers for Disease Control; FPL = federal poverty level; HHS = Health and Human Services; MERS = Middle East Respiratory Syndrome; SES = socioeconomic status
Note:

Higher-risk	No difference in risk	Lower-risk

Key Question 2

We identified 5 population-focused papers summarizing key stakeholder recommendations for pandemic influenza preparedness. While the recommendations generated from CDC stakeholder meetings preceded Quinn and Kumar's 2014 publication, many of them can be classified according to their framework. Collectively their recommendations address proximal causes that influence differential exposure (*eg*, hand-washing and social distancing),[23] disease susceptibility (*ie*, vaccinations),[39] and differential consequences (*eg*, mobile clinics).[58] They also provide recommendations for distal determinants of disease exposure (*eg*, liberal leave policies and job security guarantees),[60] and disease severity (*eg*, migrant health clinics).[58]

Of the 12 studies that described interventions or intervention components, only 1 study[28] examined effectiveness outcomes, while the majority described acceptability and feasibility of the studied interventions. We identified only 1 randomized controlled trial and 1 longitudinal cohort study.

While many focus on disaster preparedness and response, the interventions in this review often represent real world applications of the recommendations outlined in the 2008 CDC stakeholder meetings. For instance, the intervention studied in Eisenman[28] demonstrates the positive effect that interpersonal, culturally appropriate education delivered by a community health worker can have on disaster preparedness in vulnerable communities. This validates the recommendation for using lay *promotoras* in delivery of health services, goods, and messaging in the case of a pandemic.[58] These results could be translated into an intervention to reach vulnerable populations during the current COVID-19 pandemic.

The importance of community engagement and partnership with community leaders was repeated often in expert-based recommendations,[39] and was empirically grounded in some studies we examined. In Aten et al, the authors found that African American clergy could be integral as community liaisons in facilitating the delivery of mental health services after Hurricane Katrina. They also found that churches could serve as sites for delivery of community-based services.[21,22] These findings mirror the recommendations of partnering with faith-based organizations and community leaders in order to "allay distrust and ensure successful implementation of mitigation interventions in minority communities" in the setting of an influenza pandemic.[39] These recommendations support the use of such partnerships to lessen the disproportionate burden of COVID-19 in racial and ethnic minorities. While it is too early in the pandemic to expect a rigorous evaluation of the effect of faith-based partnerships on COVID-19 disparities, the popular media has already chronicled that such interventions are underway.[70]

The interventions described here emphasize that preparedness efforts must be prioritized and marginalized communities must be included *before* disaster hits. Nevertheless, some of the lessons learned may be relevant to the current pandemic phase: months into the trajectory of pandemic response but prior to a safe and widely available vaccine or treatment. Proven preparedness interventions could also be considered for implementation now given the potential for future waves of COVID-19 or new epidemics to emerge.

What remains missing from the studies in this review are examples of successful systems-level interventions that target the distal determinants of worse outcomes of influenza illness in vulnerable populations. This is despite evidence from the H1N1 pandemic that variables of

exposure that occur at higher rates among these vulnerable groups, such as inability to take sick leave, can drastically affect disease rates.[40] In the key stakeholder reports, we find multiple systems-level recommendations; for instance liberal workplace leave and teleworking policies,[60] wage freezes and childcare vouchers,[23] and creating an ethical and equitable system for ensuring access to treatment and vaccination, particularly among the uninsured.[39] These interventions may already be underway, and researchers and policy makers should actively test their impact on health disparities so that lessons learned may be applied to our current and possible future disease epidemics.

H1N1 Vaccine

We identified 10 studies examining disparities in H1N1 vaccine uptake in the US during the 2009-2010 flu season. We found moderate-strength evidence that vaccine uptake was lower in AA/Black than White populations from 4 of 6 studies presenting unadjusted data. We also found low-strength evidence of lower vaccine uptake for Latino populations, although there was some inconsistency in results. The evidence for Asian, AI/AN, and Pacific Islander populations compared to Whites was insufficient.

Three studies looked at disparities by SES and provide low-strength evidence that lower-SES individuals were less likely to have been vaccinated. Lastly, a very small study of rural versus urban participants provided insufficient evidence for H1N1 vaccine uptake between those populations. There was no evidence by disability status (see Table 11).

Table 11. Strength of the Evidence for Studies of H1N1 Vaccine Uptake

Population of interest	Comparator population	# of studies	vaccine uptake likelihood	Strength	SOE justification
AA/Black	White	6	Less likely	Moderate	
Latino		7	Less likely	Low	Inconsistency
Asian		2	Unclear	Insufficient	Inconsistency, imprecision, indirectness
AI/AN		2	Unclear	Insufficient	Indirectness, imprecision
Pacific Islander		1	Unclear	Insufficient	Indirectness
Asian/Pacific Islander		1	Unclear	Insufficient	Indirectness, imprecision
Lower SES (education and/or income)	Higher SES	3	Less likely	Low	Inconsistency
Rural	Urban	1	Unclear	Insufficient	Single, small study with multiple limitations
With Disabilities	Without Disabilities	0	No evidence	---	---

Abbreviations: AA = African American, AI = American Indian, AN = Alaska Native, SES = socioeconomic status

Studies examining H1N1 vaccines explored a wide range of factors that were either proximal or distal to H1N1 vaccine uptake. Health insurance coverage, and availability of/access to vaccines

were both important factors. Also important were receipt of the seasonal influenza vaccine, vaccine-related safety and effectiveness beliefs, and perceived susceptibility to H1N1. Across all factors AA/Black adults, and often Latino and low SES adults as well, were at higher risk.

We did not identify any studies of interventions specifically targeting disparities in H1N1 vaccine uptake. However, the single vaccine intervention study we did find demonstrated greater Hepatitis A vaccine uptake in an ED setting after the implementation of an EHR alert system that informed providers of the patient's homeless status and prompted them to recommend vaccination during a regional outbreak. This suggests that EHR notification systems may be useful in increasing vaccination, and potentially could be used in the COVID-19 vaccination campaign to prompt providers to recommend vaccination, especially for vulnerable groups.

Applicability

Many of the studies we identified were more than 10 years old and examined the H1N1 epidemic. Much has changed over the last decade, including advances in technology that affect the ways that we communicate, access information, and interact with health care providers. In recent years our country has shifted socio-politically, affecting factors related to discrimination and government trust. Similarly, beliefs and theories about vaccine safety may have also shifted, bringing into question the applicability of H1N1 vaccine data. In addition, the COVID-19 pandemic is very different than H1N1. Not only is SARS-CoV-2 more infectious and more widely spread in United States, it has affected the way that we live, work, and even socialize in more pervasive ways that the H1N1 epidemic did.

However, despite a decade of change, some things have remained stagnant. The societal factors that placed vulnerable populations at higher risk for health disparities are largely unchanged. Groups that were vulnerable a decade ago are similarly or more so today. Social and institutional barriers remain.

Only 3 studies were of Veterans, all of which were narrowly focused on specific populations (*ie*, Veterans who are homebound and Veterans with spinal injuries and conditions). More research is needed to elucidate pandemic-related disparities and their mitigation for the Veteran population.

Limitations

There are a number of limitations of this evidence base. Studies were largely cross-sectional, and we identified only 1 RCT, which was of poor quality. The operationalization of potential mediating factors was heterogeneous, and we identified very few studies that examined whether risk factors mediated the associations between population characteristics and outcomes. Many of the studies are a decade old, and findings may no longer be applicable. The categorization of racial and ethnic groups was not consistent across studies (*eg*, Latinos as a group or stratified by nativity or language), and very few studies examined disparities among Asian, Pacific Islander, and American Indian/Alaska Native populations, or among rural residents and adults with disabilities. Very few studies examined interventions or programs to mitigate disparities during infectious disease epidemics. The strength of H1N1 vaccine uptake was limited by imprecision and poor reporting, and vaccine uptake was measured by self-report in all but 1 study.

CONCLUSION

The literature examining health disparities associated with previous infectious disease epidemics, and in some cases disasters, may provide some guidance for the current COVID-19 response. Evidence consistently pointed to disparities in structural and work-related exposure to infection as underlying disparities, with the impact of comorbid conditions on susceptibility for more severe infection and higher rates of mortality playing a less certain role. Discrimination was reported more frequently by all racial and ethnic minorities. However, its impact on disparities during infectious disease epidemics is uncertain. African American/Black and Latino adults generally were disproportionately affected. However, Latinos with limited English proficiency were at especially high risk. There is moderate-strength evidence that AA/Black adults were less likely to receive a H1N1 vaccine, and low-strength evidence of lower vaccination rates for Latinos adults of lower SES. Advances in technology, and sociopolitical shifts over the past decade, call into question the applicability of findings. Interventions and programs from the disaster literature bring to light recommendations for infectious disease response by the CDC and other experts. In order to better prevent widespread health disparities that emerge in the wake of the current and future disease epidemics, more research is needed on policy- and systems-level interventions and their effect on the distal determinants of poor health outcomes among vulnerable groups.

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65. Wyte-Lake T, Der-Martirosian C, Claver M, Davis D, Dobalian A. Provider Delivery of Emergency Preparedness Education in Home-Based Primary Care. *Disaster Medicine & Public Health Preparedness.* 2019;13(3):547-554.
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APPENDIX A. SEARCH STRATEGIES

Ovid MEDLINE ALL 1946 to May 01, 2020
Date searched: May 4, 2020
1 Coronavirus Infections/ or COVID-19.rs. (6243)
2 ((("Corona virinae" or "corona virus" or Coronavirinae or coronavirus or COVID or nCoV) adj4 ("19" or "2019" or novel or new)) or (("Corona virinae" or "corona virus" or Coronavirinae or coronavirus or COVID or nCoV) and (wuhan or china or chinese)) or "Corona virinae19" or "Corona virinae2019" or "corona virus19" or "corona virus2019" or Coronavirinae19 or Coronavirinae-19 or Coronavirinae2019 or Coronavirinae-2019 or coronavirus19 or coronavirus-19 or coronavirus2019 or coronavirus-2019 or COVID19 or COVID-19 or COVID2019 or COVID-2019 or nCOV19 or nCOV-19 or nCOV2019 or nCOV-2019 or SARS-CoV-2 or SARS-CoV2 or SARS-CoV or "severe acute respiratory").ti,ab,hw,kw. (16846)
3 or/1-2 (20340)
4 Healthcare Disparities/ or Health Equity/ or Health Status Disparities/ or Culturally Competent Care/ or Social Determinants of Health/ or Sociology, Medical/ (35656)
5 (disadvantaged or discriminat* or disparat* or disparit* or disproportion* or inequal* or inequit* or unequal or underserved or under-served or (cultural* adj3 compet*) or (social* adj3 determin*)).ti,ab,kf. or (difference or different).ti. (679237)
6 Ethnic Groups/ or Minority Groups/ or African Americans/ or Arabs/ or Asian Americans/ or Hispanic Americans/ or Mexican Americans/ or Indigenous Peoples/ or exp Alaska Natives/ (152741)
7 (ethnic* or race* or racial* or minority or minorities or "people of color" or African-American* or Black or Blacks or Hispanic* or Chican* or Latino* or Latina* or Latinx or Mexican-American* or Asian-American* or Chinese-American or Filipino* or Japanese or Korean or Vietnamese or Native American* or Indian or Indians or indigenous).ti,ab,kf. (711222)
8 Socioeconomic Factors/ or Economic Status/ or exp Employment/ or Homeless Persons/ or Medicaid/ or Medically Uninsured/ or exp Medicare/ or Poverty/ or Poverty Areas/ or Public Assistance/ or Public Housing/ or Social Class/ or "Transients and Migrants"/ or Undocumented Immigrants/ or Veterans/ or Working Poor/ (388391)
9 ("blue collar" or impoverish* or homeless* or immigrant* or indigent or low-income or low-wage or lower-income or Medicaid or Medicare or migrant* or poverty or (public adj (assistance or housing)) or social or socio* or SES or undocumented or uninsured or veteran* or (working adj2 (class or poor))).ti,ab,kf. (876545)
10 Disabled Persons/ or Health Services for Persons with Disabilities/ or Persons With Hearing Impairments/ or Visually Impaired Persons/ or Vulnerable Populations/ (56412)
11 (disabilit* or disabled or blind or deaf or handicapped or ((visual* or hearing or physical*) adj impair*) or vulnerab*).ti,ab,kf. (557881)
12 Rural Health/ or Rural Health Services/ or Rural Population/ or Urban Health/ or Urban Health Services/ or Urban Population/ 146477)
13 (inner-city or metropol* or municipal* or neighborhood* or rural-urban or rural or urban or "New York" or "Los Angeles" or Chicago or Houston or Phoenix of Philadelphia or "San Antonio" or "San Diego" or Dallas or "San Jose" or "San Francisco" or Austin or Jacksonville or "Fort Worth" or Columbus or Charlotte or Indianapolis or Seattle or Denver or Washington or Boston or "El Paso" or Detroit or Nashville or Portland or Memphis or "Oklahoma City" or "Las

Vegas" or Louisville or Baltimore or Milwaukee or Albuquerque or Tucson or Fresno or Mesa or Sacramento or Atlanta or "Kansas City" or "Colorado Springs" or Miami or Raleigh or Omaha or "Long Beach" or "Virginia Beach" or Oakland or Minneapolis or Tulsa or Arlington or Tampa or "New Orleans").ti,ab,kf. or (city* or cities or county).ti,kf. (530985)
14 or/4-13 (3076764)
15 3 and 14 (1963)
16 15 not (Beijing or "Hong Kong" or Huangshi or Hubei or Jiangsu or London or Paris or Qingdao or Shanghai or Shenzhen or Tianjin or "Wuhan city" or Zhuhai or Caribbean or Europe* or "South America" or "South Asia" or "Southeast Asia" or "East Asia" or "North Africa" or "East Africa" or "West Africa" or "Southern Africa" or Afghanistan or Albania* or Algeria* or Andorra or Angola or Antigua or Argentin* or Armenia* or Australia* or Austria* or Azerbaijan or Bahamas or Bahrain or Bangladesh* or Barbados or Belarus or Belgium or Belize or Benin or Bhutan* or Bolivia* or Bosnia* or Botswana or Brazil* or Britain* or Brunei or Bulgaria* or "Burkina Faso" or Burundi or "Cabo Verde" or Cambodia* or Cameroon* or Canada or Canadian* or "Central African Republic" or Chad or Chile* or China or Colombia* or Comoros or Congo* or "Costa Rica" or "Cote d'Ivoire" or Croatia* or Cuba or Cyprus or Czechia or Denmark or Djibouti or Dominica or "Dominican Republic" or Ecuador or Egypt* or "El Salvador" or England or "Equatorial Guinea" or Eritrea* or Estonia* or Eswatini or Ethiopia* or Fiji* or Finland or France or French or Gabon or Gambia* or Germany or German* or Ghana or Greece or Grenada or Guatemala* or Guinea or Guinea-Bissau or Guyana or Haiti* or Honduras or Hungary or Iceland or India or Indonesia* or Iran* or Iraq* or Ireland or Israel* or Italy or Jamaica* or Japan or Jordan* or Kazakhstan or Kenya* or Kiribati or Korea or Kosovo or Kuwait or Kyrgyzstan or Laos or Latvia* or Lebanon or Lesotho or Liberia* or Libya* or Liechtenstein or Lithuania* or Luxembourg or Madagascar or Malawi or Malaysia* or Maldives or Mali or Malta or "Marshall Islands" or Mauritania* or Mauritius or Mexico or Micronesia* or Moldova or Monaco or Mongolia* or Montenegro or Morocco or Mozambique or Myanmar or Namibia* or Nauru or Nepal* or Netherlands or "New Zealand" or Nicaragua* or Niger or Nigeria* or Macedonia* or Norway or Oman or Pakistan or Palau or Palestine or Panama or "Papua New Guinea" or Paraguay or Peru or Philippines or Poland or Portugal or Qatar or Romania* or Russia* or Rwanda* or "Saint Kitts" or "Saint Lucia" or "Saint Vincent" or "San Marino" or "Sao Tome" or Saudi* or Scotland or Senegal* or Serbia* or Seychelles or "Sierra Leone" or Singapore* or Slovakia* or Slovenia* or "Solomon Islands" or Somalia* or "South Africa" or "South Sudan" or Spain or "Sri Lanka" or Sudan* or Suriname or Sweden or Switzerland or Syria* or Taiwan* or Tajikistan or Tanzania* or Thailand or "Timor-Leste" or "East Timor" or Togo or Tonga* or Trinidad or Tunisia* or Turkey or Turkmenistan or Tuvalu or Uganda* or Ukraine or "United Arab Emirates" or "United Kingdom" or UK or Uruguay or Uzbekistan or Vanuatu or Venezuela* or Vietnam or Yemen or Zambia* or Zimbabwe*).ti. (1391)
17 limit 16 to english language (1295)
18 limit 17 to yr="2020 -Current" (637)

Ovid PsycINFO 1806 to May Week 1 2020
Date searched: May 8, 2020
1 *Pandemics/ or *Epidemics/ or *Disasters/ or *Natural Disasters/ or Emergency Preparedness/ (10503)

2 (disaster* or earthquake* or epidemic* or hurricane* or pandemic* or postdisaster or post-disaster or (public adj3 emergenc*) or H1N1 or SARS or Zika or "severe acute respiratory").ti. (9540)
3 or/1-2 (13615)
4 *Health Disparities/ (6152)
5 (difference* or disadvantaged or discriminat* or disparat* or disparit* or disproportion* or inequal* or inequit* or unequal or underserved or under-served or (cultural* adj3 compet*) or (social* adj3 determin*)).ti. (116879)
6 *"Racial and Ethnic Differences"/ or *"Race and Ethnic Discrimination"/ or *Ethnic Groups/ or *Minority Groups/ or *Alaska Natives/ or *American Indians/ or *Arabs/ or exp *Asians/ or *Blacks/ or *Hawaii Natives/ or *Jews/ or exp *"Latinos/Latinos"/ or *Pacific Islanders/ (92858)
7 (ethnic* or race* or racial* or minority or minorities or "people of color" or African-American* or Black or Blacks or Hispanic* or Chican* or Latino* or Latina* or Latinx or Mexican-American* or Asian-American* or Chinese-American or Filipino* or Japanese or Korean or Vietnamese or Native American* or Indian or Indians or indigenous).ti. (130827)
8 *Disadvantaged/ or *Socioeconomic Status/ or *Lower Class/ or *Lower Income Level/ or *Poverty/ or *Social Class/ or exp *Homeless/ or *Shelters/ or *Social Services/ or *"Uninsured (Health Insurance)"/ or *"Welfare Services (Government)"/ or *Immigration/ or *Migrant Farm Workers/ or *Refugees/ (78171)
9 ("blue collar" or impoverish* or homeless* or immigrant* or indigent or low-income or low-wage or lower-income or Medicaid or Medicare or migrant* or immigrant* or poverty or "public assistance" or "public housing" or socio* or SES or undocumented or uninsured or veteran* or "working class" or "working poor").ti. (75944)
10 exp *Disabilities/ or *Disability Discrimination/ or *"At Risk Populations"/ or *Blind/ or *Deaf/ or *Partially Hearing Impaired/ (84942)
11 (disabilit* or disabled or blind or deaf or handicapped or ((visual* or hearing or physical*) adj impair*) or vulnerab*).ti. (88840)
12 exp *Neighborhoods/ or *Rural Environments/ or *Urban Environments/ (28918)
13 (city or cities or county or inner-city or metropol* or municipal* or neighborhood* or rural-urban or rural or urban or "New York" or "Los Angeles" or Chicago or Houston or Phoenix of Philadelphia or "San Antonio" or "San Diego" or Dallas or "San Jose" or "San Francisco" or Austin or Jacksonville or "Fort Worth" or Columbus or (Charlotte and (SC or Carolina*)) or Indianapolis or Seattle or Denver or Washington or Boston or "El Paso" or Detroit or Nashville or Portland or Memphis or "Oklahoma City" or "Las Vegas" or Louisville or Baltimore or Milwaukee or Albuquerque or Tucson or Fresno or Mesa or Sacramento or Atlanta or "Kansas City" or "Colorado Springs" or Miami or Raleigh or Omaha or "Long Beach" or "Virginia Beach" or Oakland or Minneapolis or Tulsa or Arlington or Tampa or "New Orleans").ti. (59491)
14 or/4-13 (543361)
15 3 and 14 (1823)
16 15 not (Beijing or "Hong Kong" or Huangshi or Hubei or Jiangsu or London or Paris or Qingdao or Shanghai or Shenzhen or Tianjin or "Wuhan city" or Zhuhai or Kathmandu).ti. (1816)
17 limit 16 to english language (1751)
18 17 not (epidemic* adj2 (cigarette or cocaine or crack or diabetes or heroin or obesity or opioid or opioids or smoking or tobacco)).ti,ab.(1701)

19 18 not (cat or cats or dog or dogs or mice or mouse or rat or rats or rodent).ti.(1700)
20 19 not (Caribbean or Europe or "South America" or "South Asia" or "Southeast Asia" or "East Asia" or "North Africa" or "East Africa" or "West Africa" or "Southern Africa" or Afghanistan or Albania or Algeria or Andorra or Angola or Antigua or Argentina Armenia or Australia or Austria or Azerbaijan or Bahamas or Bahrain or Bangladesh or Barbados or Belarus or Belgium or Belize or Benin or Bhutan or Bolivia or Bosnia or Botswana or Brazil or Brunei or Bulgaria or "Burkina Faso" or Burundi or "Cabo Verde" or Cambodia or Cameroon or Canada or "Central African Republic" or Chad or Chile or China or Colombia or Comoros or Congo or "Costa Rica" or "Cote d'Ivoire" or Croatia or Cuba or Cyprus or Czechia or Denmark or Djibouti or Dominica or "Dominican Republic" or Ecuador or Egypt or "El Salvador" or "Equatorial Guinea" or Eritrea or Estonia or Eswatini or Ethiopia or Fiji or Finland or France or Gabon or Gambia or Georgia or Germany or Ghana or Greece or Grenada or Guatemala or Guinea or Guinea-Bissau or Guyana or Haiti or Honduras or Hungary or Iceland or India or Indonesia or Iran or Iraq or Ireland or Israel or Italy or Jamaica or Japan or Jordan or Kazakhstan or Kenya or Kiribati or Korea or Kosovo or Kuwait or Kyrgyzstan or Laos or Latvia or Lebanon or Lesotho or Liberia or Libya or Liechtenstein or Lithuania or Luxembourg or Madagascar or Malawi or Malaysia or Maldives or Mali or Malta or "Marshall Islands" or Mauritania or Mauritius or Mexico or Micronesia or Moldova or Monaco or Mongolia or Montenegro or Morocco or Mozambique or Myanmar or Namibia or Nauru or Nepal or Netherlands or "New Zealand" or Nicaragua or Niger or Nigeria or Macedonia or Norway or Oman or Pakistan or Palau or Palestine or Panama or "Papua New Guinea" or Paraguay or Peru or Philippines or Poland or Portugal or Qatar or Romania or Russia or Rwanda or "Saint Kitts" or "Saint Lucia" or "Saint Vincent" or "San Marino" or "Sao Tome" or Saudi or Senegal or Serbia or Seychelles or Sierra Leone or Singapore or Slovakia or Slovenia or "Solomon Islands" or Somalia or "South Africa" or "South Sudan" or Spain or "Sri Lanka" or Sudan or Suriname or Sweden or Switzerland or Syria or Taiwan or Tajikistan or Tanzania or Thailand or "Timor-Leste" or "East Timore" or Togo or Tonga or Trinidad or Tunisia or Turkey or Turkmenistan or Tuvalu or Uganda or Ukraine or "United Arab Emirates" or "United Kingdom" or UK or Uruguay or Uzbekistan or Vanuatu or Venezuela or Vietnam or Yemen or Zambia or Zimbabwe).ti,lo. (1165)

EBM Reviews - Cochrane Central Register of Controlled Trials April 2020
Date searched: May 11, 2020
1 (disaster* or earthquake* or epidemic* or hurricane* or pandemic* or post-disaster or (public adj3 emergenc*) or H1N1 or SARS or Zika or "severe acute respiratory").ti. (1455)
2 (difference* or disadvantaged or discriminat* or disparat* or disparit* or disproportion* or inequal* or inequit* or unequal or underserved or under-served or (cultural* adj3 compet*) or (social* adj3 determin*)).ti. (8858)
3 (ethnic* or race* or racial* or minority or minorities or "people of color" or African-American* or Black or Blacks or Hispanic* or Chican* or Latino* or Latina* or Latinx or Mexican-American* or Asian-American* or Chinese-American or Filipino* or Japanese or Korean or Vietnamese or Native American* or Indian or Indians or indigenous).ti. (18233)
4 ("blue collar" or impoverish* or homeless* or immigrant* or indigent or low-income or low-wage or lower-income or Medicaid or Medicare or migrant* or poverty or (public adj (assistance or housing)) or social or socio* or SES or undocumented or uninsured or veteran* or (working adj2 (class or poor))).ti. (13475)

5 (disabilit* or disabled or blind or deaf or handicapped or ((visual* or hearing or physical*) adj impair*) or vulnerab*).ti. (87945)
6 (city or cities or county or inner-city or metropol* or municipal* or neighborhood* or rural-urban or rural or urban or "New York" or "Los Angeles" or Chicago or Houston or Phoenix of Philadelphia or "San Antonio" or "San Diego" or Dallas or "San Jose" or "San Francisco" or Austin or Jacksonville or "Fort Worth" or Columbus or (Charlotte and (SC or Carolina*)) or Indianapolis or Seattle or Denver or Washington or Boston or "El Paso" or Detroit or Nashville or Portland or Memphis or "Oklahoma City" or "Las Vegas" or Louisville or Baltimore or Milwaukee or Albuquerque or Tucson or Fresno or Mesa or Sacramento or Atlanta or "Kansas City" or "Colorado Springs" or Miami or Raleigh or Omaha or "Long Beach" or "Virginia Beach" or Oakland or Minneapolis or Tulsa or Arlington or Tampa or "New Orleans").ti. (8380)
7 or/2-6 (132248)
8 and/1,7 (112)
9 8 not (Beijing or "Hong Kong" or Huangshi or Hubei or Jiangsu or London or Paris or Qingdao or Shanghai or Shenzhen or Tianjin or "Wuhan city" or Zhuhai or Australia* or Bangladesh or Britain or Canada or China or Europe* or England or France or India or Iran or Ireland or Italy or Japan or Korea or Pakistan or Singapore or Scotland or "South Korea" or Thailand or Turkey or "United Kingdom" or UK).ti. (104)
10 9 not (epidemic* adj2 (cigarette or cocaine or crack or diabetes or heroin or obesity or opioid or opioids or smoking or tobacco)).ti,ab. (104)
11 10 not (cat or cats or dog or dogs or mice or mouse or rat or rats or rodent).ti. (104)
12 11 not (Caribbean or Europe or "South America" or "South Asia" or "Southeast Asia" or "East Asia" or "North Africa" or "East Africa" or "West Africa" or "Southern Africa" or Afghanistan or Albania or Algeria or Andorra or Angola or Antigua or Argentina Armenia or Australia or Austria or Azerbaijan or Bahamas or Bahrain or Bangladesh or Barbados or Belarus or Belgium or Belize or Benin or Bhutan or Bolivia or Bosnia or Botswana or Brazil or Brunei or Bulgaria or "Burkina Faso" or Burundi or "Cabo Verde" or Cambodia or Cameroon or Canada or "Central African Republic" or Chad or Chile or China or Colombia or Comoros or Congo or "Costa Rica" or "Cote d'Ivoire" or Croatia or Cuba or Cyprus or Czechia or Denmark or Djibouti or Dominica or "Dominican Republic" or Ecuador or Egypt or "El Salvador" or "Equatorial Guinea" or Eritrea or Estonia or Eswatini or Ethiopia or Fiji or Finland or France or Gabon or Gambia or Georgia or Germany or Ghana or Greece or Grenada or Guatemala or Guinea or Guinea-Bissau or Guyana or Haiti or Honduras or Hungary or Iceland or India or Indonesia or Iran or Iraq or Ireland or Israel or Italy or Jamaica or Japan or Jordan or Kazakhstan or Kenya or Kiribati or Korea or Kosovo or Kuwait or Kyrgyzstan or Laos or Latvia or Lebanon or Lesotho or Liberia or Libya or Liechtenstein or Lithuania or Luxembourg or Madagascar or Malawi or Malaysia or Maldives or Mali or Malta or "Marshall Islands" or Mauritania or Mauritius or Mexico or Micronesia or Moldova or Monaco or Mongolia or Montenegro or Morocco or Mozambique or Myanmar or Namibia or Nauru or Nepal or Netherlands or "New Zealand" or Nicaragua or Niger or Nigeria or Macedonia or Norway or Oman or Pakistan or Palau or Palestine or Panama or "Papua New Guinea" or Paraguay or Peru or Philippines or Poland or Portugal or Qatar or Romania or Russia or Rwanda or "Saint Kitts" or "Saint Lucia" or "Saint Vincent" or "San Marino" or "Sao Tome" or Saudi or Senegal or Serbia or Seychelles or Sierra Leone or Singapore or Slovakia or Slovenia or "Solomon Islands" or Somalia or "South Africa" or "South Sudan" or Spain or "Sri Lanka" or Sudan or Suriname or Sweden or Switzerland or Syria or Taiwan or Tajikistan or Tanzania or Thailand or "Timor-Leste" or "East Timore" or

Togo or Tonga or Trinidad or Tunisia or Turkey or Turkmenistan or Tuvalu or Uganda or Ukraine or "United Arab Emirates" or "United Kingdom" or UK or Uruguay or Uzbekistan or Vanuatu or Venezuela or Vietnam or Yemen or Zambia or Zimbabwe).ti. (95)

EBM Reviews - Cochrane Central Register of Controlled Trials April 2020
Date searched: May 11, 2020
1 (disaster* or earthquake* or epidemic* or hurricane* or pandemic* or post-disaster or (public adj3 emergenc*) or H1N1 or SARS or Zika or "severe acute respiratory").ti. (1455)
2 (difference* or disadvantaged or discriminat* or disparat* or disparit* or disproportion* or inequal* or inequit* or unequal or underserved or under-served or (cultural* adj3 compet*) or (social* adj3 determin*)).ti. (8858)
3 (ethnic* or race* or racial* or minority or minorities or "people of color" or African-American* or Black or Blacks or Hispanic* or Chican* or Latino* or Latina* or Latinx or Mexican-American* or Asian-American* or Chinese-American or Filipino* or Japanese or Korean or Vietnamese or Native American* or Indian or Indians or indigenous).ti. (18233)
4 ("blue collar" or impoverish* or homeless* or immigrant* or indigent or low-income or low-wage or lower-income or Medicaid or Medicare or migrant* or poverty or (public adj (assistance or housing)) or social or socio* or SES or undocumented or uninsured or veteran* or (working adj2 (class or poor))).ti. (13475)
5 (disabilit* or disabled or blind or deaf or handicapped or ((visual* or hearing or physical*) adj impair*) or PTSD or post-traumatic stress or posttraumatic stress or vulnerab* or ((severe* or serious* or chronic* or persistent*) adj mental* ill*)).ti. (91871)
6 (city or cities or county or inner-city or metropol* or municipal* or neighborhood* or rural-urban or rural or urban or "New York" or "Los Angeles" or Chicago or Houston or Phoenix of Philadelphia or "San Antonio" or "San Diego" or Dallas or "San Jose" or "San Francisco" or Austin or Jacksonville or "Fort Worth" or Columbus or (Charlotte and (SC or Carolina*)) or Indianapolis or Seattle or Denver or Washington or Boston or "El Paso" or Detroit or Nashville or Portland or Memphis or "Oklahoma City" or "Las Vegas" or Louisville or Baltimore or Milwaukee or Albuquerque or Tucson or Fresno or Mesa or Sacramento or Atlanta or "Kansas City" or "Colorado Springs" or Miami or Raleigh or Omaha or "Long Beach" or "Virginia Beach" or Oakland or Minneapolis or Tulsa or Arlington or Tampa or "New Orleans").ti. (8380)
7 or/2-6 (135518)
8 and/1,7 (138)
9 8 not (Beijing or "Hong Kong" or Huangshi or Hubei or Jiangsu or London or Paris or Qingdao or Shanghai or Shenzhen or Tianjin or "Wuhan city" or Zhuhai or Australia* or Bangladesh or Britain or Canada or China or Europe* or England or France or India or Iran or Ireland or Italy or Japan or Korea or Pakistan or Singapore or Scotland or "South Korea" or Thailand or Turkey or "United Kingdom" or UK).ti. (126)
10 9 not (epidemic* adj2 (cigarette or cocaine or crack or diabetes or heroin or obesity or opioid or opioids or smoking or tobacco)).ti,ab. (126)
11 10 not (cat or cats or dog or dogs or mice or mouse or rat or rats or rodent).ti. (126)
12 11 not (Caribbean or Europe or "South America" or "South Asia" or "Southeast Asia" or "East Asia" or "North Africa" or "East Africa" or "West Africa" or "Southern Africa" or Afghanistan or Albania or Algeria or Andorra or Angola or Antigua or Argentina Armenia or Australia or Austria or Azerbaijan or Bahamas or Bahrain or Bangladesh or Barbados or Belarus or Belgium or Belize or Benin or Bhutan or Bolivia or Bosnia or Botswana or Brazil or Brunei or

Bulgaria or "Burkina Faso" or Burundi or "Cabo Verde" or Cambodia or Cameroon or Canada or "Central African Republic" or Chad or Chile or China or Colombia or Comoros or Congo or "Costa Rica" or "Cote d'Ivoire" or Croatia or Cuba or Cyprus or Czechia or Denmark or Djibouti or Dominica or "Dominican Republic" or Ecuador or Egypt or "El Salvador" or "Equatorial Guinea" or Eritrea or Estonia or Eswatini or Ethiopia or Fiji or Finland or France or Gabon or Gambia or Georgia or Germany or Ghana or Greece or Grenada or Guatemala or Guinea or Guinea-Bissau or Guyana or Haiti or Honduras or Hungary or Iceland or India or Indonesia or Iran or Iraq or Ireland or Israel or Italy or Jamaica or Japan or Jordan or Kazakhstan or Kenya or Kiribati or Korea or Kosovo or Kuwait or Kyrgyzstan or Laos or Latvia or Lebanon or Lesotho or Liberia or Libya or Liechtenstein or Lithuania or Luxembourg or Madagascar or Malawi or Malaysia or Maldives or Mali or Malta or "Marshall Islands" or Mauritania or Mauritius or Mexico or Micronesia or Moldova or Monaco or Mongolia or Montenegro or Morocco or Mozambique or Myanmar or Namibia or Nauru or Nepal or Netherlands or "New Zealand" or Nicaragua or Niger or Nigeria or Macedonia or Norway or Oman or Pakistan or Palau or Palestine or Panama or "Papua New Guinea" or Paraguay or Peru or Philippines or Poland or Portugal or Qatar or Romania or Russia or Rwanda or "Saint Kitts" or "Saint Lucia" or "Saint Vincent" or "San Marino" or "Sao Tome" or Saudi or Senegal or Serbia or Seychelles or Sierra Leone or Singapore or Slovakia or Slovenia or "Solomon Islands" or Somalia or "South Africa" or "South Sudan" or Spain or "Sri Lanka" or Sudan or Suriname or Sweden or Switzerland or Syria or Taiwan or Tajikistan or Tanzania or Thailand or "Timor-Leste" or "East Timore" or Togo or Tonga or Trinidad or Tunisia or Turkey or Turkmenistan or Tuvalu or Uganda or Ukraine or "United Arab Emirates" or "United Kingdom" or UK or Uruguay or Uzbekistan or Vanuatu or Venezuela or Vietnam or Yemen or Zambia or Zimbabwe).ti. (117)

APPENDIX B. STUDY SELECTION

1. **Language**: Is the full text of the article in English?
   Yes → Proceed to #2
   No → Code **X1** (NA Language). STOP

2. **Population**: Are participants Adults?
   In mixed-age studies, findings must be reported separately for adults.
   Yes → Proceed to #3
   No → **Code X2** (NA population). Add code **B** if retaining for background/discussion. STOP

3. **Population**: Does the study provide data specific to or stratified by 1 or more of the following participant populations: racial/ethnic minorities or persons a) with disabilities; b) of low socioeconomic status; c) living in rural communities; d) living in population dense neighborhoods; e) living in high-poverty neighborhoods.
   Note: For SES, proxies may include occupation, education, neighborhoods or geographic regions, income, insurance-status, Medicare/Medicaid, SNAP, TANF, households with children qualifying for free or reduced school lunch,
   Yes → Proceed to #4
   No → **Code X3** (NA subpopulation)**.** Add code **B** if retaining for background/discussion. STOP

4. **Setting**: Is this a US-only population (including U.S territories)?
   Yes → Proceed to #5
   No → **Code X4** (NA setting). Add code **B** if retaining for background/discussion. STOP

5. **Timing**: Is the study performed during or in preparation or response to an infectious disease pandemic or epidemic, or a disaster?
   Yes → Proceed to #6
   No → Code **X5** (NA timing)**.** Add code **B** if retaining for background/discussion. STOP

6. **Study design and type**: Is the article an original research study, or a systematic review/meta-analysis?
   Excluded: Dissertations, non-systematic reviews, conference abstracts, protocols, erratum, comments, non-research letters
   Yes → Proceed to #7
   No → Code **X6** (NA study design/type)**.** Add code **B** if retaining for background/discussion. STOP

7. **Outcomes**: Is the outcome health-related?
   Examples: Utilization or access, infection, burden of illness, severity, mortality, morbidity

Note: Outcomes may also be factors that contribute to disparities in health-related outcome (eg, trust)
Yes → Proceed to #9
No → Proceed to #8

8. **Outcomes**: Is the outcome a result of measures implemented during a pandemic, epidemic, or disaster (*eg,* social distancing, school closure, etc.) that impact a health-related outcome?
Examples: Employment loss or reduction, income reduction
Yes → Proceed to #9
No → **Code X7** (NA outcome). Add code **B** if retaining for background/discussion. STOP

9. **Comparator**: Does the study include a comparison (within the same population or to a relevant comparator); or, if an intervention study, does it compare results to no intervention, pre-intervention, or another intervention or public health response?
Yes → Proceed to #11
No → Proceed to #10

10. **Pre-intervention studies**: Does the study inform a future intervention (*eg,* survey, qualitative study)
Examples: Preferred forms of communication, emergency preparedness, social distancing, access to care
Yes → Proceed to #11
No → **Code X8** (NA comparator). Add code **B** if retaining for background/discussion. STOP

11. **KQ1**: Does the study examine the COVID-19 Pandemic?
Yes → **Code KQ1.** If the study is a systematic review or meta-analysis, **Code KQ1SR**.
STOP
No → Proceed to #12

12. **Timing**: Is the study performed during, or in preparation or response to, a disaster?
Yes → Proceed to #14
No → Proceed to #13

13. **KQ2 Contributing Factors:** Does the study examine factors that **contribute to** health inequalities?
Examples: Risk of exposure, susceptibility/risk of poor outcomes, access to care, trust in healthcare system, discrimination.
Note: These are not 1st Generation/Phase I studies that simply find that a disparity exists. These are 2nd Generation/Phase II studies that help us to understand why (see Kilbourne et. al, 2006 – uploaded to Slack).

Yes → **Code KQ2.** If the study is a systematic review or meta-analysis, **Code KQ2SR**. Proceed to #14
No → proceed to #14

14. **KQ3**: Is the study a 1) program evaluation, pre-intervention study (*eg,* survey, qualitative), or an intervention study 2) designed to mitigate health inequalities? *Select "Yes" only if both 1) and 2) are true*
Yes → If the study is not also included in KQ2, **Code KQ3.** If the study is a systematic review or meta-analysis, **Code KQ3SR**.
Yes → If the study is also included in KQ2, **Code KQ2&3.** If the study is a systematic review or meta-analysis, **Code KQ2&3SR**.
No → **Code X9** (NA factors or intervention)**.** Add code **B** if retaining for background/discussion. STOP

Note: B codes can be added for any excluded study that we should retain/reference for background or discussion.

Key Questions

KQ1: In the COVID-19 pandemic:
a. What health inequalities have been described?
b. What factors have contributed to health inequalities?
c. What is the effectiveness of interventions used to address health inequalities?

KQ2: What factors contribute to disparate infection rates and health-related outcomes among different segments of the population during infectious disease epidemics or pandemics?

KQ3: What interventions have been used to reduce health inequalities in infectious disease transmission or health outcomes in disasters, epidemics or pandemics?

Codes Key:
X1: NA Language
X2: NA Population
X3: NA Subpopulation
X4: NA Setting
X5: NA Timing
X6: NA Study design/type
X7: NA Outcome
X8: NA Comparator
X9: NA factor/intervention

APPENDIX C. QUALITY ASSESSMENT

Table. Quality Ratings for Cross-sectional Studies*

Author	1	2	3	4	5	6	7	Quality concerns	Applicability[71]
Burger, 2018[25]	Y	Y	U	Y	Y, A&B	P	Y	No reporting on non-respondents.	Good
Etingen, 2013[30]	Y	Y	N	Y	Y, A&B	P	Y	Veteran sample. Low response rate.	Fair
Freimuth, 2014[32]	Y	Y	Y	Y	Y, A&B	P	Y	---	Good
Frew, 2012[33]	Y	Y	U	Y	Y, A&B	P	Y	Multivariable regression on some, but not all, relevant factors.	Fair
Galarce, 2011[34]	Y	Y	Y	Y	Y, A&B	P	Y	---	Good
Gargano, 2011[35]	Y	N	N	Y	Y, A&B	P	Y	High nonresponse rate, small sample	Fair
Hernandez, 2019[38]	Y	Y	U	Y	Y, A&B	P	Y	Response rate low, and unclear if non-responders were different	Fair
Kumar, 2012[40,41]	Y	Y	Y	Y	Y, A&B	P	Y	---	Good
Lin, 2014[42] and 2018[43]	Y	Y	Y	Y	Y, A&B	P	Y	---	Good
Lin, 2017[44]	Y	N	Y	Y	U	P	Y	Unclear whether confounding factors were controlled.	Fair
Mesch, 2015[67]	Y	Y	U	Y	Y, A&B	P	Y	Unclear if respondents similar to non-respondents.	Good
Plough, 2011[51]	N	Y	N	Y	N	Y	N	No control for confounders. Inappropriate denominator. Not representative.	Fair
Price, 2013[52]	Y	Y	Y	Y	Y, A&B	Y	Y	--	Fair
Quinn, 2009[53] Quinn, 2011[10]	Y	Y	Y	Y	Y, A&B	P	Y	---	Good
Redelings, 2012[54]	Y	Y	Y	Y	Y, A&B	P	Y	---	Fair
Santibanez,2013[56]	Y	Y	Y	Y	Y, A&B	P	Y	---	Good
SteelFisher, 2015[59]	Y	Y	Y	Y	Y, A&B	P	Y	---	Good
Tsai, 2017[72]	Y	N	N	Y	N	P	Y	Small sample size, no control for confounders, methods poorly reported.	Poor
Uscher-Pines, 2011[61]	Y	Y	Y	Y	Y, A&B	P	Y	---	Good
Wyte-Lake, 2019[65]	U	Y	NA	U	N	P	N	No control for confounders, methods poorly reported	Poor
Witrago, 2011[63]	N	N	NR	Y	N	P	N	No control for confounders, methods poorly reported.	Fair
Yip, 2009[66]	N	U	U	Y	N	P	N	Pilot study, no control for confounders, methods poorly reported.	Fair

Abbreviations: N=No; NA=Not applicable; NR=Not reported; P=Partial; U=Unclear; Y=Yes
*Criteria (Adapted Newcastle-Ottawa[16]):

Selection

1. Sample representative?
   yes = Truly representative of the average in the target population (all subjects or random sampling); or, somewhat representative of the average in the target population. (non-random sampling)
   no = Selected group of users
   unclear = No description of the sampling strategy.
2. Sample size justified and satisfactory?
   Yes/no
3. Non-respondents comparable to respondents?
   yes = Comparability between respondents and non-respondents characteristics is established, and the response rate is satisfactory.
   no = The response rate is unsatisfactory, or the comparability between respondents and non-respondents is unsatisfactory.
   unclear = No description of the response rate or the characteristics of the responders and the non-responders.
4. Ascertainment of the exposure (risk factor) appropriate?
   yes = Adequately described
   unclear = Not adequate description of the measurement tool.

Comparability

5. The subjects in different outcome groups are comparable, based on the study design or analysis. Confounding factors are controlled.
   yes = specify a, b, or a&b
   a) The study controls for the most important factor (age).
   b) The study control for any additional factor.
   no = no adjustment for potential confounders

Outcome

6. Assessment of the outcome appropriate?
   Yes = Independent blind assessment or Record linkage.
   Partial = Self report.
   unclear = No description.
7. Statistical test described and appropriate (including measurement of the association, including CIs and probability level [p- value])?
   Yes/no/unclear

Table. Quality Ratings for Cohort Studies*

Study	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Funding source	Quality	Applicability[71]
Eisenman, 2009[28] and Glik, 2014[29]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	CDC	Fair	Fair
Castillo, 2018[27]	Y	NA	Y	Y	NA	Y	NA	N	Y	Y	Y	NA	Y	N	NR	Good	Fair

Abbreviations: CDC=Centers for Disease Control and Prevention; N=No; NA=Not applicable; Y=Yes
*Criteria (Adapted Newcastle-Ottawa[16]):

Selection
1. Was the exposed cohort representative?
2. Was the non-exposed systematically selected?
3. Ascertainment of exposure reported and valid?
4. Eligibility criteria specified?

Comparability
5. Were the groups comparable at baseline?

Outcome
6. Did the study use accurate methods for ascertaining exposures, potential confounders, and outcomes?
7. Outcome assessors masked?
8. Reporting of attrition, adherence, and contamination?
9. Were outcomes pre-specified and defined, and ascertained using accurate methods?
10. Follow-up long enough for outcomes to occur?
11. Appropriate statistical analyses on potential confounders?
12. Important differential loss to follow-up or overall high loss to follow-up?
13. Appropriate Handling of Missing Data?
14. Evidence of Selective Outcome Reporting?

Table. Quality Ratings for Qualitative Studies*

Author, Year	Section A				Section B			Section C	Overall Quality Notes	Applicability
	1	2	3	4	5	6	7	How valuable is the research?		
Andrulis, 2011[20]	U	Y	Y	NR	NR	Y	U	Valuable - provides a good framework from which to address barriers in California.	Generally good, lacks some methods reporting.	Fair
Aten, 2010[21]	Y	Y	Y	Y	Y	Y	Y	Valuable and likely generalizable to other topics for this community.	No issues. Good qualitative methods described.	Fair
Aten, 2011[22]	Y	Y	Y	U	Y	Y	U	Valuable - research resulted in action.	Good quality study, except for snowball sampling.	Fair
Boyd, 2013[24]	U	Y	Y	NR	Y	Y	Y	Valuable, but unclear the value of staff interviews.	No other issues.	Fair
Cassady, 2012[26]	U	Y	Y	Y	Y	Y	Y	Valuable - well conducted, high value research.	Good quality study.	Good
Liu, 2017[45]	Y	Y	Y	NR	Y	U	Y	Valuable, although analytic methods could have been clearer.	Generally good, lacks some methods reporting.	Poor
McCauley, 2013[47]	Y	Y	Y	Y	U	Y	Y	Valuable well conducted study.	Qualitative synthesis could have been more robust.	Poor
Schoch-Spana, 2010[57]	U	Y	U	NR	NR	N	U	Valuable, this work can help guide policy.	Stakeholder interviews, qualitative methods not adequately described.	Good
Wyte-Lake, 2014[64]	U	U	Y	NR	NR	Y	U	Valuable, but suggests more research needed.	Small study, poorly reported	Poor

Abbreviations: N=No; NR=Not reported; U=Unclear; Y=Yes

*Criteria (CASP[17]):

Section A: Are the results valid?

1. Was the research design appropriate to address the aims of the research?
2. Was the recruitment strategy appropriate to the aims of the research?
3. Was the data collected in a way that addressed the research issue?
4. Has the relationship between researcher and participants been adequately considered?

Section B: What are the results?

5. Have ethical issues been taken into consideration?
6. Was the data analysis sufficiently rigorous?
7. Is there a clear statement of findings?

Section C: Will the results help locally?

Table. Quality Ratings for Case Control Studies*

Study	1	2	3	4	5	6	7	8	Overall Quality	Applicability[71]
Hennessy, 2016[37]	Y	Y	Y	Y	N	Y	N	NA	Issues with method of ascertainment and comparability of cases and controls.	Fair
Levy, 2013[8]	Y	Y	Y	Y	Y, A&B	Y	Y	U	Expected uneven response rate, so controls were oversampled. Matched 2:1 as planned.	Fair

Abbreviations: N=No; NA=Not applicable; U=Unclear; Y=Yes

*Criteria (Newcastle-Ottawa[16]):

Selection

1. Is the case definition adequate?
   Yes = with independent validation
   No = record linkage or based on self-reports
   Unclear = no description
2. Representativeness of the cases?
   Yes = consecutive or obviously representative series of cases
   No= potential for selection biases
   Unclear = not stated
3. Selection of Controls appropriate?
   Yes = community controls
   No = hospital controls
   Unclear = no description
4. Definition of Controls?
   Yes = no history of disease (endpoint)
   No/Unclear

Comparability

5. Comparability of cases and controls on the basis of the design or analysis
   Yes = specify a or a&b in response
   a) study controls for the most important factor.
   b) study controls for any additional factor.
   No = neither of the above

Exposure

6. Ascertainment of exposure
   Yes = secure record (*eg,* surgical records) or structured interview where blind to case/control status
   No= interview not blinded to case/control status or written self-report or medical record only
   Unclear = no description
7. Same method of ascertainment for cases and controls? Y/N
8. Non-Response rate adequate
   Yes = same rate for both groups
   No = non respondents just described or rate different and no designation

Table. Risk of Bias in Randomized Controlled Trials of Interventions to Reduce Pandemic/Epidemic-related Health Disparities

Study	**Randomization/ sequence generation?** Was the allocation sequence adequately generated?	**Allocation concealment:** Was allocation adequately concealed?	**Blinding:** Was knowledge of the allocated intervention adequately prevented during the study?	**Missing data:** How was incomplete data addressed?	**Selective outcome reporting:** Are reports of the study free of suggestion of selective outcome reporting?	**Other sources of bias:** Was the study apparently free of other problems that could put it at a high risk of bias (ROB)?	**Overall ROB**	**Applicability**[71]
Nassar, 2013[48]	Y	Y	N	N/A no missing data	Y	No	High	Fair

Cochrane Risk of Bias