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Review Paper

Vaccine hesitancy in American healthcare workers during the COVID-19 vaccine roll out: an integrative review

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ABSTRACT

Objective: The purpose of this integrative review is to examine the literature on vaccine hesitancy among American healthcare workers during the COVID-19 vaccine rollout.

Methods: A review of quantitative literature on acceptance, intention, refusal, or hesitation to accept the COVID-19 vaccine was conducted, searching in PubMed, Cumulative Index for Nursing and Allied Health Literature, PsycINFO, and Web of Science. Because of the immediacy of the topic, research letters were included in addition to articles. The 18 publications were appraised for quality using the Critical Appraisal Checklist for Cross-Sectional Studies by the Center for Evidence-Based Management.

Results: Estimates of vaccine hesitancy among healthcare workers were similar to the general population. The literature indicates demographic characteristics associated with vaccine hesitancy, including being younger, female, Black, Hispanic, or Latinx. However, examination of the demographic data also points to gaps in the understanding and implications of those characteristics. The newness or perceived rush of vaccine development and implementation were the most cited sources for hesitancy.

Conclusion: The studies in this review give clear areas of need for translational research on dissemination and implementation relating to the correlational data, including in areas of comorbid, diasporic, and reproductive health concerns. However, with the gravity of the pandemic and quick arrival of the COVID-19 vaccine happening in the midst of an infodemic, adjunctive interventions could be warranted to combat hesitancy.

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Introduction

For over 2 years, healthcare workers (HCWs) around the globe have been providing care and services during the COVID-19 pandemic, putting themselves at an increased risk for contracting the potentially deadly disease.1–5 In the same month that the battle against COVID-19 began, the US Department of Health and Human Services issued a statement about accelerating the development and production of vaccines under Operation Warp Speed (OWS).6 OWS had the distinct goal of speed without sacrificing safety. Development was synergized by large funding streams, previous middle east respiratory syndrome (MERS), severe acute respiratory syndrome (SARS), and RNA vaccine research, the ability of researchers to run multiple trials, and advances in manufacturing.7 The goal of OWS was subsequently attained within the first year of the pandemic by two vaccines granted emergency use authorization (EUA) by the Food and Drug Administration on December 11, 2020.8–11

Eight days before the EUAs, the centers for disease control and prevention (CDC’s) Advisory Committee on Immunization Practices recommended that HCWs be among the first Americans offered vaccination under the EUAs, citing “early protection of healthcare personnel is critical.”12 Approximately 17.5 million Americans belong to this category13 and have become subject to vaccination mandates.

General population hesitancy regarding the COVID-19 vaccine has been correlated with being female, Black, and younger. Additional correlates could include lower educational attainment, rural or geographic residence, prior vaccination hesitancy, and lower perceived risk of COVID-19.14–19 Furthermore, a perceived rush over vaccine development and approval, as well as concerns over safety and efficacy has plagued public health campaigns.14,16,18,19 Saliently, the spread of mis- and dis-information, culminating in an infodemic, has underscored the COVID-19 pandemic and vaccine
development. America has seen a relatively large distribution of misleading or false information surrounds the pandemic and vaccine rollout, and more than one-third of mis- or dis-information regarding the COVID-19 vaccine was related to vaccine development during the year of the rollout. The unprecedented nature of the virus and subsequent vaccine development, as well as the nature of the infodemic in which it has been unfolding, differentiates COVID-19 vaccine hesitancy from vaccine hesitancy among long-standing vaccines. Yet, despite the differences in context, vaccines remain the most effective way to curb the spread of infectious disease. With so many Americans employed in the healthcare sector, implications for COVID-19 spread among HCWs, their patients, and communities at large are substantial. Thus, the purpose of this integrative review is to synthesize and examine the quantitative literature specific to HCWs’ hesitancy surrounding the rollout of the COVID-19 vaccine.

Methods

This review was guided by Whittemore and Knafli (2005) and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Critical appraisal was conducted with the Critical Appraisal Checklist for Cross-Sectional Studies.

The literature search was conducted in July 2021 using the Cumulative Index for Nursing and Allied Health Literature via EBSCO. Medline via PubMed, Web of Science, and PsycINFO. Databases were searched for “COVID-19 vaccine,” and alternate terms of “Coronavirus” and “Sars-CoV-2,” paired with keywords such as “acceptance,” “intention,” “hesitancy,” “attitude,” “uptake,” “confidence,” and “refusal.” Relevant search terms for the population of interest, “healthcare workers,” included “health personnel,” “healthcare provider,” “health professional,” and “nurse.” Truncation was used when possible.

Inclusion criteria were left purposely broad to include all types of HCWs and facilities. Data collection conducted on American HCWs in or after 2020 was the primary inclusion criteria based on the United States’ unique social and healthcare landscape. The American pandemic response, which included OWS and timely access to vaccines, focused on HCWs as a primary class of vaccine recipients. Letters were included based on the immediacy of the topic, offering comprehensive coverage as data was emergent. A total of 1533 records were obtained. After duplicate removal, 922 citations were screened, 28 went to full-text review, and 18 are included in this review (Fig. 1).

Results

Of the 18 studies, 11 were peer-reviewed articles and seven were research letters. All 18 published data from cross-sectional surveys collected over short periods on participants gained from non-probability sampling frames. All studies gave a snapshot of vaccination acceptance or intention and refusal or hesitancy among their sample. Correlational trends were most often given as odds ratios. Most asked additional questions, but less than half the publications reported using trialed or validated questionnaires. Surveys included reasons for hesitancy and safety or efficacy perceptions.

The largest sample size was 16,292 participants, the smallest 81, and the median 1600. The shortest study was 3 days in length, with most completed in 2 weeks to a month. An exception was Halbrook et al., with data collected at three time points from September 2020 to February 2021. Of the studies reporting response rates, the lowest was 10%, and the highest was 82%. The oldest data collection was done in August 2020, and seven collected data in December of 2021, the month of the EUAs (Table 2).

The publications included a total sample population of 62,728 HCWs. Two articles focused on specific occupational roles of medical doctors or nurses. Apart from those exceptions, occupational totals were reported too diversely to synthesize effectively. One study was conducted in long-term care facility, and two studies were conducted in community-based care settings. The remaining 16 were conducted entirely in, or included, hospital settings. Eleven studies were multistrate, with three being multistate. More than half of the study populations came from the Northeast; however, all regions of the United States were represented.

Sample demographics

Of the studies that reported on gender (N = 46,279), 75.8% of those sampled were female. Three studies do not include any information on race (N = 16,530; 81, 16,292, and 157, respectively). For the total sample that reported race (N = 46,198), approximately 65.2% were White, which may be further underreported because Kociolek et al. queried race as Black or non-Black, which excludes 3860 participants. Similarly, Pacella-LaBarbara et al. classify race as White and non-White; however, the sample size was significantly smaller (N = 475), and the population was identified as 95% White. Hispanic or Latinx participation was either included as a classification within race or classified as a separate category of ethnicity. Five publications did not report on Hispanic or Latinx participation at all (N = 10,084). Of the studies reporting ethnicity as a category within race, the overall samples were 1.8% Hispanic or Latinx. Of those separating out ethnicity, Hispanic or Latinx identity was reported for 25.8% of the sampled population (N = 19,886); however, approximately 41% of the sample was not reported, making accurate assessment impossible.

Age was reported in a variety of ways, except for the two letters in which age was not reported. Two articles reported the mean age of participants as 40 and 42.5, respectively. Most participants’ age (N = 26,357) was reported by two articles and two letters, using a cutoff of 40 years. Participants were almost evenly distributed, with 51% being aged <40 years, 45.3% being >40 years, and 3.7% of data were unreported (Table 3).

Vaccination data

Overall, 68.8% (N = 42,284) of the sample population indicated they had or would receive a COVID-19 vaccine. Almost half the studies included an option for future vaccination intention, ranging from specific timeframes (e.g. within 30 days) to simply “sometime in the future” or to “wait and see.” Acceptance or immediate intention ranged in studies from 33% to 95%, with a median of approximately 63%. Those that either reported they would or did refuse or, if given the option, were unsure they would get the vaccine, was 31.2% (N = 19,199). If separated out, 18.8% refused, and 12.4% were unsure. If separating out positive intention, 15% of those given the option reported waiting to wait for vaccination. The number of missing or not reported answers for the total sample was 1245 or approximately 2%.

Data stratified by EUA date exhibit temporal variations in intention (Fig. 2). Of studies with data collection before the EUA month of December 2020 (N = 16,467), 77.3% of the sample report positive intention, 19.1% refusing, and 3.6% of the data are not reported. Of the data collected during the month of the EUA (N = 36,902), 59.9% reported positive intention, 37.7% were unsure or refusing, and 2.4% of the data were unreported. For the data
| Appraisal questions | 1. Did the study address a clearly focused question/issue? | 2. Is the research method (study design) appropriate for answering the research question? | 3. Is the method of selection of the subjects (employees, teams, divisions, organizations) clearly described? | 4. Could the way the sample was obtained introduce (selection) bias? | 5. Was the sample of subjects representative with regard to the population to which the findings will be referred? | 6. Was the sample size based on pre-study considerations of statistical power? | 7. Was a satisfactory response rate achieved? | 8. Are the measurements (questionnaires) likely to be valid and reliable? | 9. Was the statistical significance assessed? | 10. Are confidence intervals given for the main results? | 11. Could there be confounding factors that haven’t been accounted for? |
|---------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| Abohelwa            | Yes                                             | Can’t Tell                                      | Can’t Tell                                      | Yes                                             | Can’t Tell                                      | No                                              | 0.27                                             | Can’t Tell                                      | No                                              | No                                              | Yes                                             |
| Ciardi              | Yes                                             | Yes                                             | No                                              | Yes                                             | Can’t Tell                                      | No                                              | 0.1                                              | Yes                                             | Yes                                             | Yes                                             | (for some)                                      |
| Famuyiro            | Yes                                             | Yes                                             | No                                              | Yes                                             | Can’t Tell                                      | No                                              | 0.82                                             | Yes                                             | Yes                                             | Yes                                             | (for some)                                      |
| Fotenot             | Yes                                             | Yes                                             | Yes                                             | Can’t Tell                                      | Can’t Tell                                      | No                                              | 0.1                                              | Can’t Tell                                      | No                                              | 0.21                                            | Yes                                             |
| Hallbrook           | Yes                                             | Yes                                             | Can’t Tell                                      | Can’t Tell                                      | Can’t Tell                                      | No                                              | NR                                               | Can’t Tell                                      | Can’t Tell                                      | Yes                                             | Yes                                             |
| Kuter               | Yes                                             | Yes                                             | Yes                                             | Can’t Tell                                      | Can’t Tell                                      | No                                              | 0.345                                            | Can’t Tell                                      | Yes                                             | Yes                                             | Yes                                             |
| Pacella             | Yes                                             | Yes                                             | Can’t Tell                                      | Can’t Tell                                      | Can’t Tell                                      | No                                              | NR                                               | Can’t Tell                                      | Yes                                             | Yes                                             | Yes                                             |
| Parente             | Yes                                             | Yes                                             | Yes                                             | Can’t Tell                                      | Can’t Tell                                      | No                                              | 0.18                                             | Can’t Tell                                      | Yes                                             | Yes                                             | Yes                                             |
| Shaw                | Yes                                             | Yes                                             | Yes                                             | Can’t Tell                                      | Can’t Tell                                      | No                                              | 0.15                                             | Can’t Tell                                      | Yes                                             | Yes                                             | No                                              |
| Shekhar             | Yes                                             | Yes                                             | Yes                                             | Can’t Tell                                      | Can’t Tell                                      | No                                              | NR                                               | Can’t Tell                                      | Yes                                             | Yes                                             | (for some)                                      |
| Unroe               | Yes                                             | Yes                                             | Yes                                             | Can’t Tell                                      | Can’t Tell                                      | No                                              | 0.33                                             | Can’t Tell                                      | Yes                                             | Yes                                             | (for some)                                      |
| **Letters**         |                                                 |                                                 |                                                 |                                                 |                                                 |                                                 |                                                  |                                                  |                                                 |                                                  |                                                  |
| Fossen              | Yes                                             | Yes                                             | Yes                                             | No                                              | –                                              | –                                              | –                                               | –                                               | –                                               | Yes                                             | Yes                                             |
| Gadath              | Yes                                             | Yes                                             | Can’t Tell                                      | Yes                                             | Can’t Tell                                      | No                                              | 0.57                                             | Can’t Tell                                      | No                                              | Yes                                             | Yes                                             |
| Grumbach            | Yes                                             | Yes                                             | Can’t Tell                                      | Can’t Tell                                      | Can’t Tell                                      | No                                              | NR                                               | Can’t Tell                                      | Yes                                             | Yes                                             | Yes                                             |
| Kociolk              | Yes                                             | Yes                                             | Yes                                             | Can’t Tell                                      | Can’t Tell                                      | No                                              | 0.63                                             | Can’t Tell                                      | Yes                                             | Yes                                             | Yes                                             |
| Meyer               | Yes                                             | Yes                                             | Can’t Tell                                      | Can’t Tell                                      | Can’t Tell                                      | No                                              | 0.685                                            | Can’t Tell                                      | Yes                                             | Yes                                             | Yes                                             |
| Pamplona            | Yes                                             | Yes                                             | No                                               | –                                              | –                                              | –                                               | –                                               | –                                               | Yes                                             | No                                              | Yes                                             |
| Schrading           | Yes                                             | Yes                                             | Can’t Tell                                      | Yes                                             | Can’t Tell                                      | No                                              | NR                                               | Can’t Tell                                      | No                                              | No                                              | Yes                                             |

**Note.** NR — not reported.
collected after the EUA month, \((N = 11,075)\) 73.6% reported vaccination, 1.2% had positive intentions for future vaccination, 15.7% refused, and 3.9% were unsure, with 5.6% of the sample was unreported. Data stratified by EUA date may indicate positive intention was at its lowest, both in the crude and adjusted ratios, during EUA passages in December.

**Correlational findings**

Most correlational findings associated sociodemographic characteristics, with vaccine hesitancy, namely, gender, race/ethnicity, age, and education, whereas other factors, such as safety, perceived risk, and prior vaccination, were also explored. Eleven studies compared gender with vaccine hesitancy and found that females had greater hesitancy than males,\(^{28,30,31–38,41}\) with two studies also referencing lower intent than non-binary counterparts.\(^{33,35}\) However, Halbrook et al.\(^ {31} \) noted that while females had higher levels of hesitation, they actually had statistically significantly higher rates of vaccination acceptance than their male counterparts.

Thirteen studies reported on the correlations of hesitancy with race and/or ethnicity.\(^ {28,30,31–37,39–41,44} \) The majority cited more hesitancy among Black and/or Hispanic participants compared with their White counterparts. The data were split on hesitancy among Asian participants, with three studies reporting higher hesitancy\(^ {31,39,40} \) and four reporting less hesitancy\(^ {28,32,35,36} \) than their White counterparts. Ten studies examined correlations of age.\(^ {28,30,32–38,41} \) Two of the 10 reported no statistically significant differences,\(^ {34,41} \) whereas the other eight associated younger age with more hesitancy.

Of six articles that explored education,\(^ {34,36,39,40} \) affirmed that lower educational status correlated with higher hesitancy. Studies reporting on occupations of physicians, or advanced practice providers, correlated the roles with lower rates of hesitation or refusal.\(^ {28,29,35,39,44} \) Notably, in the study of 8243 long-term care staff, nurses were found to be more hesitant than nursing aides by 5 percentage points, and Ciardi et al.\(^ {45} \) found nurses and patient care associates to have the most hesitancy by profession.

Perceived risk was discussed in two ways: perceived occupational risk (exposure to infected patients) and perceived personal risk of infection (including comorbidities, self-reported health status, or concern over COVID-19 severity). Nine articles reported on perceived risk in some sense; however, the results were mixed.\(^ {28–30,32–36,41} \) Three articles, comprising 20,800 participants, almost all from the Northeast (83%), reported that providing patient care correlated with higher hesitancy.\(^ {32,35,36} \) Two articles of small sample size, varied location, and setting type reported perceived lower risk was statistically significantly associated with more hesitancy.\(^ {29,33} \) Parente et al.\(^ {34} \) found no statistically significant difference between vaccine acceptance and providing patient care or self-reported health in their study of 3347 workers, whereas Kocioleck et al.\(^ {41} \) reported low levels of perceived risk, as well as having self-reported high-risk medical conditions were correlated with more hesitancy in their midwestern sample \((N = 4277)\). Similarly, Kuter et al.\(^ {32} \) found that self-reported poor/fair health status correlated with higher hesitancy \((N = 12,034)\).

Twelve articles reported on safety concerns over vaccination within their samples \(^ {30,32–37,39–42,44} \) Safety concerns ranged from the rapidity of development to adverse reactions, long-term side-effects, and efficacy. Additional issues around politicization of the vaccines and/or a lack of trust in or transparency by the government or companies making the vaccines were reported by six publications \(^ {33,36,37,39,40,42} \) The most frequently cited reasons for hesitancy or refusal appeared to be the newness or perceived rush of development, and EUA, as well as the potential for side-effects.
## Table 2
Publication summaries.

| Author/Pub Info | Aims | Sample - Setting, Time of data collection, and considerations | Results | Vaccine hesitancy or attitudes |
|-----------------|------|---------------------------------------------------------------|---------|-------------------------------|
| **Abohelwa, M. et al.**[^27] | To understand residents and fellows’ attitudes toward vaccination and record any side-effects after vaccination | 81 residents and fellows South March 2021 | 77 (95.1%) accepted 3 (3.7%) refused | All 77 vaccinated reported pain at the injection site and headache in 49.4% of the sample reported that they supported vaccination |
| **Ciardi, F. et al.**[^28] | This study was conducted about attitudes toward COVID-19 vaccination among healthcare workers at a public hospital in New York City during the beginning of COVID-19 vaccination | 428 hospital workers* *physicians (28.5%), nurses (21.96%)* Northeast December 2020 to January 2021 | 274 (64%) accepted 38 (8.9%) intended 116 (27%) refused | The most predictive factors were prior vaccine attitudes and concern with the speed of testing and approval of the vaccines |
| **Famuyiro, T. B. et al.**[^29] | To assess the readiness for vaccine uptake among HCWs at three community-based, university-affiliated health centers | 205 community-based workers* *physicians (40.5%), other clinical staff (44.4%)* South December 2020 | 110 (54%) immediate intention 56 (27%) waiting 36 (18%) had no intention | Most physicians (83%) and residents (81%) expressed more enthusiasm to receive the vaccine once it became available compared with other clinical staff (nurses, medical assistant, clinical technician, etc.; 31%) |
| **Fontenot, H.B. et al.**[^30] | To assess the intentions of licensed nurses in the State of Hawaii to obtain a COVID-19 vaccine and identify factors that are associated with nurses’ intention to vaccinate | 423 nurses West December 2020 | 221 (52%) intended 118 (27.9%) waiting 84 (19.9%) had no intention | The strongest predictors of any level of intention were greater positive attitudes toward COVID-19 vaccination and lower concerns related to COVID-19 vaccine safety |
| **Fossen, M. C. et al.**[^31] | Examined vaccination rates of hospital workers by age, gender, department, and race to determine in which groups vaccine hesitancy was highest | 3401 hospital workers South March 2021 | 2245 (71%) accepted 976 (29%) refused | The strongest predictors of any level of intention were greater positive attitudes toward COVID-19 vaccination and lower concerns related to COVID-19 vaccine safety |
| **Gadoth, A. et al.**[^32] | To understand general vaccine acceptance and specific attitudes toward forthcoming coronavirus vaccines among HCWs in Los Angeles, California | 540 healthcare workers* *prescribing clinicians 37.2%, registered nurses 38.3%* West September to October 2020 | 179 (33%) immediate intention 354 (65.6%) waiting 7 (1.3%) had no intention | 46.9% of questioned the efficacy of vaccine Fast-tracking regulatory procedures and a lack of transparency were primary rationales for refusal or delay |
Grumbach, K. et al.\textsuperscript{40}
Primary authors discipline: Medicine Letter
Investigated COVID-19 vaccine intentions among racially and ethnically diverse samples of HCW and the general population
1803 healthcare workers* \textsuperscript{13} + physicians, APPs and registered nurses (76.7%) West November 2020 to January 2021
1507 (83.6%) intended Statistically significant correlations:
Race: White was least hesitant Asian > White
Black > White (most hesitant)
Multiple/other > White
Ethnicity: Hispanic > White
Statistically significant correlations:
Race: White was least hesitant Asian > White
Black > White (most hesitant)
Multiple/other > White
Ethnicity: Hispanic > White

Halbrook, M. et al.\textsuperscript{31}
Primary authors discipline: Public Health Article
The primary outcome of interest was COVID-19 vaccination intent and vaccine uptake among HCW 1507 (83.6%) intended Statistically significant correlations:
Race: White was least hesitant Asian > White
Black > White (most hesitant)
Multiple/other > White
Ethnicity: Hispanic > White

Kociolek, L. et al.\textsuperscript{41}
Primary authors discipline: Medicine Letter
Assessing frequency of vaccine hesitancy, characteristics of those reporting vaccine hesitancy, specific concerns, and communication preferences among hospital workers 4448 hospital workers Midwest December 2020–January 2021
368 (8.6%) accepted 2559 (59.8%) intended Statistically significant correlations:
Gender: Males < hesitant Age: Older (50+) < hesitant Race: Black > hesitant than White Hispanic > non-Black
Ethnicity: Hispanic > hesitant Other significant associations:
Hesitancy was associated with less concern about personal risk of severe COVID-19 and (three times) more prevalent in those with high-risk medical conditions.

Kuter, B. J. et al.\textsuperscript{32}
Primary authors discipline: Public Health Article
To understand attitudes toward COVID-19 vaccines… to obtain a better understanding of how hospital employees, both in clinical and non-clinical positions, perceive the new COVID-19 vaccines and their intention to be vaccinated 12,034 hospital workers Northeast November to December 2020
7492 (63.7%) intended 4368 (36.3%) hesitant Statistically significant correlations:
Gender: Males < hesitant Age: Older (50+) < hesitant Race: Black > hesitant than White Asian < hesitant Hispanic > hesitant Other significant associations:
Hesitancy was associated with more concern about personal risk of severe COVID-19 and (three times) more prevalent in those with high-risk medical conditions.

Meyer, M. N. et al.\textsuperscript{42}
Primary authors discipline: Bioethics Letter
To assess their intentions to [receive a COVID-19 vaccination], and understand reasons for hesitancy among HCW 16,292 healthcare workers Northeast December 2020
9015 (55.3%) intended 7277 (44.6%) hesitant Significant associations:
Patient-facing employees were less hesitant than those who do not interact with patients 90.3% of vaccine hesitant reported concerns about unknown risks of the vaccines, 44.3% reported they wanted to wait until others’ vaccine experiences are known, and 21.1% reported that they do not trust the rushed FDA process.

Pacella-LaBarbara, M. et al.\textsuperscript{33}
Primary authors discipline: Medicine Article
To determine vaccine intent/uptake, perceived COVID-19 vulnerability, and 475 emergency department and EMS workers 337 (79%) accepted or intended 98 (21%) had no intention
99.3% of vaccine hesitant reported concerns about unknown risks of the vaccines, 44.3% reported they wanted to wait until others’ vaccine experiences are known, and 21.1% reported that they do not trust the rushed FDA process.

(continued on next page)
Table 2 (continued)

| Author/Pub Info | Aims | Sample – Setting, Time of data collection, and considerations | Results | Vaccine hesitancy or attitudes |
|-----------------|------|-------------------------------------------------------------|---------|---------------------------------|
| V. Caiazzo and A. Witkoski Stimpfel | Primary author’s discipline: Health psychology | To report dialysis staff vaccination acceptance and hesitancy rates from four Renal Research Institute dialysis clinics and a home dialysis program located in New York, New York. | 157 community-based healthcare workers Northeast January 2021 | Statistically significant correlations: Gender: Males < hesitant Other significant associations: Those with a history of COVID-19 infection had lower intention Those with an advanced degree had higher intention/uptake (zero physicians reported no intention) |
| Pamplona, G. M. et al. | Primary author’s discipline: Unknown | To evaluate HCW willingness to become vaccinated against COVID-19 and identified barriers/facilitators to vaccine uptake among all personnel at a large academic medical center in the Midwest | 3347 healthcare workers Midwest August 2020 | 1241 (37%) intended 1764 (52%) waiting 331 (10%) had no intention Other findings: Reasons for delay included: recent COVID-19 infection, leave of absence from work, and pregnancy or breastfeeding |
| Parente, D. J. et al. | Primary author’s discipline: Medicine | To provide a snapshot of vaccination attitudes in order to identify areas of concern that would impinge on COVID-19 vaccination program planning and implementation | 5287 hospital workers North East November to December 2020 | 3032 (57.5%) intended 2245 (42.5%) hesitant Other significant associations: Vaccine safety, potential adverse events, efficacy, and speed of vaccine development dominated concerns listed by participants |
| Schrading, W. A. et al. | Primary author’s discipline: Medicine | To describe differences in vaccination rates among various types of ED HCP at US academic medical centers and reasons for declining vaccination | 1321 Emergency Department hospital workers* +physicians/APP 49.4%, registered nurses 25.75% Multiple US regions January 2021 | Results: 1136 (86%) received vaccine Correlations (p value unknown): Non-Hispanic Black HCWs had the lowest vaccine acceptance rate Other findings: Physicians and APPs had the lowest refusal rate (5.5% of 674), compared with nurses (22.3% of 345) and non-clinical HCWs (23.5% of 302) Vaccinated recipients planned to use the same amount of PPE at work as well as in public |
| Shekhar, R. et al. | Primary author’s discipline: Medicine | To assess the attitude of HCWs toward COVID-19 vaccination | 3479 healthcare workers *professional or graduate degree 32.5%, Multiple regions October–November 2020 | 1247 (36%) intended 1953 (56%) waiting 279 (8%) had no intention Statistically Significant Correlations Gender: Males < hesitant Age: Older (60+) < hesitant Race: Asian least hesitant Black > hesitant than White Ethnicity: Hispanic > hesitant Other significant associations: HCWs working in rural areas had more hesitancy Direct medical care providers, those with professional or doctoral degrees and those with prior flu vaccination had higher intention |
| Shaw, J. et al. | Primary author’s discipline: Medicine | To assess the attitude of HCWs toward COVID-19 vaccination | 3479 healthcare workers *professional or graduate degree 32.5%, Multiple regions October–November 2020 | 1247 (36%) intended 1953 (56%) waiting 279 (8%) had no intention Statistically Significant Correlations Gender: Males < hesitant Age: Older (60+) < hesitant Race: Asian least hesitant Black > hesitant than White Ethnicity: Hispanic > hesitant Other significant associations: HCWs working in rural areas had more hesitancy Direct medical care providers, those with professional or doctoral degrees and those with prior flu vaccination had higher intention |
Four articles examined prior vaccination status and concurred prior hesitancy or refusal correlated with hesitancy or refusal of COVID-19 vaccination. Two studies reported on geographic differences found those living in rural areas had more hesitancy.

**Discussion**

The findings of this review reflected a group of timely publications regarding the COVID-19 vaccination rollout with a particularly at-risk occupational group, HCWs. Overall, we found that estimates of vaccine hesitancy among HCWs were similar to the general population. Demographic characteristics associated with vaccine hesitancy included being younger, female, Black, Hispanic, or Latinx; however, examination of the demographic data also points to gaps in the understanding and implications of those characteristics. Furthermore, the newness or perceived rush of vaccine development and implementation were the most cited sources for hesitancy. The urgency to disseminate data on the topic is demonstrated by the number of letters included, despite their inability to provide rigorous details as articles can. As all samples were convenient, and one was a snowball, all had the potential for selection or response bias and constraints on generalizability because of their non-probability sampling structures. Over- or under-representation of responder subgroups, including by

| Table 3 | Demographic variables of study participants. |
|---|---|
| **Gender** | N = 46,279 |
| Female | 35,084 |
| Male | 9716 |
| Not reported | 1479 |
| **Age** | N = 36,693 |
| <40 | 16,883 |
| >40 | 14,695 |
| <45 | 2571 |
| >45 | 1487 |
| Not reported | 1057 |
| **Race** | N = 46,198 |
| White | 30,114 |
| Black | 3947 |
| Hispanic/Latinx | 758 |
| Asian | 2316 |
| Other | 3452 |
| Not reported | 5611 |
| **Ethnicity** | N = 19,886 |
| Hispanic/Latinx | 5134 |
| Non-Hispanic/Latinx | 6607 |
| Not reported | 8145 |
vaccination status or intentionality, may influence the robustness or magnitude of observed correlations. Overall, no study adequately addressed sample size justification, three studies included information on their reference population, and just one study tried to categorize and account for non-response bias (Table 1). Furthermore, lack of standardization is apparent in the data reporting above.

On the surface, the data presented from the 18 studies in this review echo the trends observed in the US adult population, citing higher hesitancy among those that are female, younger, Black, or Hispanic/Latinx. However, how race and ethnicity are reported and how studies manage missing data may alter the reporting of resulting correlations.\(^5\) Within the overall sample, race and ethnicity had the highest rate of undisclosed data out of the variables. The divergence of data regarding Asian participant’s hesitancy may be related to more granular details regarding country of origin. Such data are necessary when Filipino nurses make up roughly 4% of the nursing workforce and share a disproportionate amount of COVID-19 cases and death, along with their Black counterparts.\(^4\) Furthermore, no research included information on foreign-born workers, who currently make up 4.1 million workers in the healthcare and social assistance industry.\(^5\)

In addition, the lack of female-specific concerns as well as the role nursing could play in the vaccine discourse should also be examined. The data upheld that females have greater hesitancy; however, Halbrook et al.\(^1\) posit that they then have a higher rate of vaccination acceptance. Gardi et al.\(^3\) posit in the discussion that intention is lower for women of any age, which questions the importance of fertility and childbearing in vaccine decision-making. Of the postvaccine rollout literature, Pamplona et al.\(^4\) and Schrading et al.\(^4\) were the only publications to report refusal based on the discrete variables of fertility, pregnancy, or breastfeeding. Given that more than 70% of the HCW population is female, more than half of childbearing age, lack of these data warrants future study.

It is noteworthy that the clinical trials of vaccines did not include pregnant or lactating women.\(^38\) However, all major reproductive health organizations recommend pregnant women receive the vaccine.\(^49\) As HCWs are majority female, these concerns must be included in the discourse, even if to rule out their influence. This may be even more salient as concerns over vaccine development and approvals were indicated as a primary reason for hesitancy, especially within the female population.

Similarly, nursing is predominantly female, the largest sector of the healthcare industry at roughly four million workers, and consistently voted the most trusted profession.\(^50,51\) Yet nursing is the healthcare industry at roughly four million workers, and especially within the female population.

and approvals were indicated as a primary reason for hesitancy, may be even more salient as concerns over vaccine development and implementation is a priority area for those focused on worker health.\(^5\)

Global populations are increasingly subject to mis- and dis-information with the use of social media and communication apps. The COVID-19 infodemic\(^21\) or ubiquity of information, including false and misleading information, can influence health behaviors, including vaccine intention.\(^20,61\) In the climate of the pan- and info-demics, America is marching toward mandates as the Supreme Court upheld the Biden administration mandate for HCWs.\(^64\) However, it is unclear if vaccination mandates will extend beyond a yearly requirement, including booster doses, how many HCWs would resign rather than be vaccinated or how many may be covered by religious or medical exemptions. The effects of mandates on HCW employment, and potentially worker shortages, may not be felt immediately.

Mandates may be seen as an efficient and socially just way to increase vaccination\(^9\) and America is not alone in pursuing them, with other countries, including Germany, France, and Italy, mandating HCW vaccination.\(^56,67\) Vaccination Injury Compensation Programs (VICP)are available in 16 European nations, Canada, and Australia, some regardless of COVID-19 vaccination mandates.\(^58\) Given that fear of side-effects was present in the literature as a source of hesitancy, such safeguards are justified and necessary. Currently, the US does have a VICP; however, it has not been extended to COVID-19 vaccinations. The United States has a Countermeasure Injury Compensation Program, but it is not as expansive or easy to apply to as VICP.\(^59\) An alternate to vaccine mandates could include the use of personal protective equipment (PPE) and testing measures; however, under the current mandate, employers are not required to pay for testing. This may target the vaccine hesitant, as the additional cost of frequent testing could prove substantial and unsustainable.\(^59\) Other adjunctive alternatives could be explored, such as the use of spatial modeling to guide vaccination efforts through geographic targeting.\(^70\) Specific targeting, based on correlational data may be further enhanced by the concept of nudging interventions, which may include incentives, reminders, and reframing information dissemination.\(^71,72\)

Conclusion

HCWs continue to battle the COVID-19 crisis and exhibit vaccination hesitancy. Correlates of hesitancy among HCWs appear to mimic correlates found in the general population, but additional areas of investigation could give further clarity to the complex nature of vaccine hesitancy. This review of the literature was impacted by the asynchronicity of data reporting, which made comparisons difficult and limited the synthesis of information. The gravity of the pandemic and the quick arrival of the COVID-19 vaccine is happening concurrently with an infodemic, in which large amounts of mis- or dis-information are being spread and to which HCWs may not be immune. Implications of findings may evolve as trends shift in vaccination and acceptance. The United States could look to policies of other nations as well as alternative interventions to combat hesitancy as an adjunct to mandates.

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Competing interests

None declared.

References

1. Washington State Department of Health and Washington State Department of Labor and Industries. COVID-19 confirmed cases by industry sector. 2020 Dec Available from: https://www.doh.wa.gov/Portals/1/Documents/1600/coronavirus-data-tables/IndustrySectorReport.pdf.

2. Nguyen LH, Drew DA, Graham MS, Joshi AD, Guo C-G, et al. Risk of COVID-19 among front-line health-care workers and the general community: a prospective cohort study. Lancet Public Health 2020 Sep;5(9).

3. National Institute for Occupational Safety and Health. Research goals. Available from: https://www.cdc.gov/niosh/about/researchgoals.html.

4. Burrer SL, de Perio MA, Hughes MM, Kuhar DT, Luckhaupt SE, McDaniel CJ, et al. Characteristics of health care personnel with COVID-19 – United States, February 12-April 5, 2020. MMWR Morb Mortal Wkly Rep 2020 Apr 17;69(15):477–81. Available from: https://pubmed.ncbi.nlm.nih.gov/32398247/.

5. Polack FP, Thomas SJ, Kitchin N, Absalon J, Gurtman A, Lockhart S, et al. Safety and efficacy of the BNT162b2 mRNA Covid-19 vaccine. N Engl J Med 2020 Feb 4;386(5).

6. Abohelwa M, Elmassry M, Abdelmalek J, Payne D, Lugman K. 2019 Novel Coronavirus (COVID-19) Pandemic: an overview of the most recent information. J Adv Nurs 2020 Dec;7:57.

7. Malik AA, McFadden SM, Elharake J, Omer SB. Determinants of COVID-19 vaccine acceptance in the US. Tcnicmedicine 2020 Sep;26.

8. Pogue K, Jensen JL, Stancil CK, Ferguson DG, Hughes SJ, Mello EJ, et al. Vaccination rates and acceptance of SARS-CoV-2 vaccination among emergency department health care personnel. JAMA Netw Open 2021 Oct 20;4(10).

9. Pogue K, Jensen JL, Stancil CK, Ferguson DG, Hughes SJ, Mello EJ, et al. Influences on attitudes regarding potential COVID-19 vaccination in the United States. Vaccines 2020 Oct 3;8(4).

10. Reiter PL, Pennell ML, Katz ML. Acceptability of a COVID-19 vaccine among adults in the United States: how many people would get vaccinated? Vaccine 2020 Sep 38(42).

11. Bridgman A, Mcelroy E, Loewen PJ, Owen T, Rutherford D, Teichmann L, et al. The causes and consequences of COVID-19 misconceptions: understanding the role of news and social media. Harvard Kennedy School Misinfo Rev [Internet] 2020 Jun 18;1(3). Available from: https://misinforeview.hks.harvard.edu/article/the-causes-and-consequences-of-covid-19-misconceptions-understanding-the-role-of-news-and-social-media.

12. World Health Organization. Infodemic. Available from: World Health Organization.

13. Islam MS, Sarkar T, Silva I, Kamal AHM, Murshid Hasan SM, et al. COVID-19 vaccine rumors and conspiracy theories: the need for cognitive inoculation against misinformation to improve vaccine adherence. PLoS One 2021 May 1;16(5):e0251605.

14. Islam MS, Sarkar T, Silva I, Kamal AHM, Murshid Hasan SM, Kabir A, et al. COVID-19-related infodemic and its impact on public health: a global social media analysis. Am J Trop Med Hyg 2020 Oct 7;103(4):1621–9.

15. Whittemore R, Naflag K. The integrative review: updated methodology. J Adv Nurs 2005 Dec;52(5).

16. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Syst Rev 2021 Dec 20;10(1).

17. Center for Evidence Based Medicine. Critical appraisal checklist for cross-sectional study. 2014. Available from: https://www.cebm.net/wp-content/uploads/Critical-Apraisal-Questions-for-a-Cross-Sectional-Study-2014.pdf.

18. Abohelwa M, Elmassry M, Abdelmalek J, Payne D, Lugman K. 2019 Novel Coronavirus (COVID-19) Pandemic: an overview of the most recent information. J Adv Nurs 2020 Dec 29;101.

19. Society for Maternal-Fetal Medicine. COVID-19 vaccination if you Are pregnant or breastfeeding. 2021 Jul. Available from: https://s44dfgk.stackpathcdn.com/wp-content/uploads/2021/08/02141531/COVID-vaccine_Patients_JULY-29-2021_FINAL.pdf.
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