Predictors of COVID-19 Vaccination Among EMS Personnel

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Introduction: Unvaccinated emergency medical services (EMS) personnel are at increased risk of contracting coronavirus disease 2019 (COVID-19) and potentially transmitting the virus to their families, coworkers, and patients. Effective vaccines for the severe acute respiratory syndrome coronavirus 2 virus exist; however, vaccination rates among EMS professionals remain largely unknown. Consequently, we sought to document vaccination rates of EMS professionals and identify predictors of vaccination uptake.

Methods: We conducted a cross-sectional survey of North Carolina EMS professionals after the COVID-19 vaccines were widely available. The survey assessed vaccination status as well as beliefs regarding COVID-19 illness and vaccine effectiveness. Prediction of vaccine uptake was modeled using logistic regression.

Results: A total of 860 EMS professionals completed the survey, of whom 74.7% reported receiving the COVID-19 vaccination. Most respondents believed that COVID-19 is a serious threat to the population, that they are personally at higher risk of infection, that vaccine side effects are outweighed by illness prevention, and the vaccine is safe and effective. Despite this, only 18.7% supported mandatory vaccination for EMS professionals. Statistically significant differences were observed between the vaccinated and unvaccinated groups regarding vaccine safety and effectiveness, recall of employer vaccine recommendation, perceived risk of infection, degree of threat to the population, and trust in government to take actions to limit the spread of disease. Unvaccinated respondents cited reasons such as belief in personal health and natural immunity as protectors against infection, concerns about vaccine safety and effectiveness, inadequate vaccine knowledge, and lack of an employer mandate for declining the vaccine. Predictors of vaccination included belief in vaccine safety (odds ratio [OR] 5.5, P=<0.001) and effectiveness (OR 4.6, P=<0.001); importance of vaccination to protect patients (OR 15.5, P=<0.001); perceived personal risk of infection (OR 1.8, P=0.04); previous receipt of influenza vaccine (OR 2.5, P=0.003); and sufficient knowledge to make an informed decision about vaccination (OR 2.4, P=0.024).

Conclusion: In this survey of EMS professionals, over a quarter remained unvaccinated for COVID-19. Given the identified predictors of vaccine acceptance, EMS systems should focus on countering misinformation through employee educational campaigns as well as on developing policies regarding workforce immunization requirements. [West J Emerg Med. 2022;23(4)570–578.]
INTRODUCTION

As of August 2021, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus responsible for coronavirus disease 2019 (COVID-19), has infected more than 40 million Americans and is responsible for 649,299 deaths. The disease was classified by the World Health Organization (WHO) at a pandemic in March 2020, with more than 216 million cases and 4.5 million deaths reported globally as of August 2021. Among US healthcare workers (HCW) specifically, the Centers for Disease Control and Prevention (CDC) has reported 548,367 cases of COVID-19 and 1747 deaths.

Due to frequent interactions with potentially infected patients, combined with the shortage of personal protective equipment at the time this study was conducted, emergency medical services (EMS) professionals are at particular risk of contracting as well as disseminating COVID-19. Besides their individual risk of acquiring COVID-19 in the workplace, EMS professionals may act as a vector and transmit the disease to susceptible patients, coworkers, friends, and family. For this reason, it is essential that all EMS professionals be vaccinated against COVID-19.

At the time this study was conducted, two mRNA vaccines received emergency use authorization (EUA) by the Food and Drug Administration (FDA) in December 2020, which demonstrated 94% and 95% efficacy against symptomatic COVID-19 in clinical trials among the general population. With respect to HCWs specifically, several studies demonstrated that vaccinating employees substantially reduced illness. Notably, Swift et al reported 78% and 96% vaccine effectiveness (VE) among 3210 partially and 44,011 fully vaccinated Mayo Clinic employees. Similarly, in a large-scale study of 23,324 HCWs in England, Hall et al realized a VE of 70% and 85% among partially and fully vaccinated employees, respectively.

In addition to the mRNA vaccines, a viral vector vaccine was also granted EUA status February 27, 2021. The mRNA vaccines required a staggered two-injection process to achieve the most optimal results. While the single-dose viral vector vaccine did not offer the same protection against morbidity (66.3% in clinical trials), it did offer similar protection against mortality. Furthermore, the international Phase 3 data reported the vaccine was 85% effective in preventing severe cases of COVID-19. Of the 19,630 individuals who received the actual vaccine, there were three deaths reported, none related to either COVID-19 or the vaccine. Thus, the viral vector vaccine was deemed 100% effective in preventing COVID-19-related deaths in the study group.

Despite the protective benefits of vaccination, substantial vaccine hesitancy and resistance exists among the US general population, with 18% indicating that they are unlikely to accept the COVID-19 vaccine specifically. More importantly, overall vaccine hesitancy observed in the general population has been linked to the level of hesitancy among HCWs in general. To date, only two studies have explicitly addressed COVID-19 vaccine hesitancy and immunization rates of EMS personnel. In a cross-sectional survey of US firefighters and EMS personnel, Caban-Martinez et al reported that over half of their respondents were either uncertain or unlikely to receive the vaccine. However, this study was conducted prior to any issued EUA or formal vaccine approval by the FDA. A similar cross-sectional study conducted in Germany found a slightly higher willingness to receive the vaccine (57%), but this study was also conducted prior to widespread vaccine availability. Moreover, it is unclear whether these findings could be extrapolated to US EMS personnel.

Given the lack of investigations of vaccine receptiveness of US EMS professionals in a post-vaccine era of COVID-19, we sought to document vaccination rates in a single state and identify predictors of vaccination uptake.

METHODS

Human Subject Review

Institutional review board approval for this study was obtained from Wake Technical Community College Department of Emergency Medical Science, and electronic informed consent was obtained from each respondent at the start of the survey.

Instrument and Setting

We conducted a cross-sectional survey from April 27–May 18, 2021 to assess the attitudes, beliefs, and COVID-19 vaccination status of EMS personnel. Also included in the survey were illness profiles regarding COVID-19 illness.
and immunization for family, friends, coworkers, and the individual respondent. A unique, online survey was developed using constructs similar to the health belief model. Briefly, the health belief model posits that an individual’s assessment of their personal risk of illness, combined with their belief in the effectiveness of the recommended health behavior (eg, vaccination), predicts the likelihood of adopting the recommended behavior. Guided by these constructs, we designed the survey and then piloted it on a small group of EMS professionals. Based on the responses to the pilot, the survey was revised for clarity. The final survey consisted of 53 items and was designed to be completed within 10 minutes.

Links to the web-based survey (Qualtrics, Provo, UT) were emailed to EMS personnel listed as actively credentialed by the North Carolina Office of EMS via their data management vendor. Emergency medical technicians (EMT), advanced EMTs, and paramedic field professionals were invited to complete the survey. Due to variable and sometimes infrequent EMS responses and patient exposures, first responders certified at the emergency medical responder level were excluded from the survey. Participation was anonymous and voluntary, and no inducements to participate were provided.

Statistical Methods
All data was exported from the Qualtrics web survey platform into a Microsoft Excel spreadsheet (Microsoft Corporation, Redmond, WA) and later imported into SPSS version 27 (IBM Corp., Armonk, NY) for analysis. All statistical analyses were two-tailed with statistical significance established at $P \leq 0.05$.

Standard descriptive statistics were computed, and univariate comparisons for categorical variables were conducted using the chi square test, Fisher’s exact test, or Yate’s continuity correction as appropriate. We developed a multivariable binary logistic regression model to identify independent factors associated with uptake of the COVID-19 vaccine. All variables were entered into the model, and backward stepwise elimination was used to remove non-significant variables based on likelihood ratios. To evaluate model performance, we computed area under the curve of the receiver operating characteristic (AUC-ROC) for the final model.

RESULTS
A total of 860 EMS professionals completed the survey in its entirety. Demographic and employment characteristics of respondents are shown in Table 1. The majority of respondents were male (66.5%), White (93.3%), paramedic credentialed (66.4%), employed full-time (78.3%), and held a college degree (64.1%). The average age of the respondents was 41.1 (±12.4) years with a mean of 15.3 (±10.9) years of EMS experience. Of all respondents, only 582 (67.7%) had received the influenza vaccine during the 2020-2021 season, demonstrating some degree of underlying vaccine hesitancy in this sample.

| Parameter                          | N = 860 n (%) |
|------------------------------------|---------------|
| **COVID-19 Vaccination Status**    |               |
| Have received or plan to receive   | 642 (74.7%)   |
| Do not plan to receive             | 218 (25.3%)   |
| **Age (mean [SD])**                | 41.1 (12.4)   |
| **Male Gender**                    | 572 (66.5%)   |
| **Race**                           |               |
| White                              | 802 (93.3%)   |
| Black                              | 16 (1.9%)     |
| Multi-racial                       | 26 (3.0%)     |
| Native American                    | 10 (1.2%)     |
| Asian American or Pacific Islander | 6 (0.7%)      |
| Hispanic Origin                    | 28 (3.3%)     |
| **Employed fulltime**              | 673 (78.3%)   |
| **Level of EMS certification**     |               |
| EMT                                | 224 (26.0%)   |
| Advanced EMT                       | 65 (7.6%)     |
| Paramedic                          | 571 (66.4%)   |
| **Years of EMS experience (mean [SD])** | 15.3 (10.9) |
| **Highest level of education in any field** |    |
| High school                        | 45 (5.2%)     |
| Some college                       | 264 (30.7%)   |
| AAS degree                         | 243 (28.3%)   |
| Bachelor’s degree                  | 222 (25.8%)   |
| Master’s degree                    | 77 (9.0%)     |
| Doctoral degree                    | 9 (1.0%)      |

COVID-19, coronavirus disease of 2019; SD, standard deviation; EMS, emergency medical service; EMT, emergency medical technician; AAS, associate of applied science.

Regarding the COVID-19 vaccine, 642 (74.7%) had already received or planned to soon receive the vaccine. The individual, familial, and coworker COVID-19 disease burden was extensive. A small yet significant portion of the sample (17.7%) had been previously infected, 23.4% lived in the same household as someone with a previous diagnosis, and over half (54.3%) had family members living outside the home with a prior occurrence of COVID-19 illness (Table 2). The vast majority (95.7%) knew at least one EMS coworker previously diagnosed with COVID-19.

In general, survey respondents reported that they believed the following: they are at higher risk for COVID-19 than the general population (67.1%); COVID-19 is a moderate to severe threat to the US population (68.7%); they had received enough information to make an informed decision about being immunized against COVID-19 (87.7%); the risk of side effects from the COVID-19 vaccines is outweighed by the prevention of the disease in the general public (71.7%); the vaccines are more effective than other vaccines (71.1%); the vaccines are more safe than other vaccines (63.3%); the vaccines are recommended behavior. Guided by these constructs, we designed the survey and then piloted it on a small group of EMS professionals. Based on the responses to the pilot, the survey was revised for clarity. The final survey consisted of 53 items and was designed to be completed within 10 minutes.

Table 1. Sociodemographic characteristics of respondents.
Table 2. Differences between vaccinated and unvaccinated respondents.

| Respondent Characteristic                                      | All respondents | Unvaccinated | Vaccinated | P-value |
|---------------------------------------------------------------|----------------|--------------|------------|---------|
|                                                                | N (%)          | N (%)        | N (%)      |         |
| Received influenza vaccine for 2020-2021 season               | 582 (67.7%)    | 67 (30.7%)   | 515 (80.2%)| <0.001  |
| Previously diagnosed with COVID-19                            | 152 (17.7%)    | 52 (23.9%)   | 100 (15.6%)| <0.008  |
| Someone in same household previously diagnosed with COVID-19  | 201 (23.4%)    | 67 (30.7%)   | 134 (20.9%)| <0.004  |
| Family member(s) living outside respondent’s household previously diagnosed with COVID-19 | 467 (54.3%)    | 124 (56.9%)  | 343 (53.4%)| 0.420   |
| Friend(s) previously diagnosed with COVID-19                  | 726 (84.4%)    | 179 (82.1%)  | 547 (85.2%)| 0.327   |
| Coworker(s) previously diagnosed with COVID-19                | 823 (95.7%)    | 207 (95.0%)  | 616 (96.0%)| 0.665   |
| Has cared for anyone ill with COVID-19 while performing duties as an EMS professional | 782 (90.9%)    | 206 (94.5%)  | 576 (89.7%)| 0.047   |
| Feel my level of risk is higher than the general population for getting COVID-19 | 577 (67.1%)    | 85 (39.0%)   | 492 (76.6%)| <0.001  |
| Agree the COVID-19 vaccine is somewhat or very effective      | 654 (76.0%)    | 43 (19.7%)   | 611 (95.2%)| <0.001  |
| Agree the COVID-19 vaccine is somewhat or very safe           | 663 (77.1%)    | 48 (22.0%)   | 615 (95.8%)| <0.001  |
| Agree or strongly agree it is important for healthcare workers to receive the COVID-19 vaccine to protect themselves | 618 (71.9%)    | 23 (10.6%)   | 595 (92.7%)| <0.001  |
| Agree or strongly agree it is important for healthcare workers to receive the COVID-19 vaccine to protect their patients | 611 (71.0%)    | 20 (9.2%)    | 591 (92.1%)| <0.001  |
| Received training or education material from employer on the COVID-19 vaccine or COVID-19 illness | 726 (84.4%)    | 184 (84.4%)  | 542 (84.4%)| 0.285   |
| Recall of employer recommending COVID-19 vaccine              | 659 (76.6%)    | 129 (59.2%)  | 530 (82.6%)| <0.001  |
| Wears a mask in the ambulance when not transporting a patient | 376 (43.7%)    | 84 (38.5%)   | 292 (45.5%)| 0.125   |
| Wears a mask at the ambulance base between calls              | 253 (29.4%)    | 38 (17.4%)   | 215 (33.5%)| <0.001  |
| Socially distances at the ambulance base between calls        | 419 (48.7%)    | 66 (30.3%)   | 353 (55.0%)| <0.001  |
| Wears a mask in public while off-duty                        | 632 (73.5%)    | 89 (40.8%)   | 543 (84.6%)| <0.001  |
| Socially distances in public while off-duty                   | 644 (74.9%)    | 100 (45.9%)  | 544 (84.7%)| <0.001  |
| Received enough information to make an informed decision about being immunized against COVID-19 | 754 (87.7%)    | 171 (78.4%)  | 583 (90.8%)| <0.001  |
| Would be comfortable if a member of my family were being treated in a healthcare facility by healthcare workers unvaccinated against COVID-19 | 574 (66.7%)    | 210 (96.3%)  | 364 (56.7%)| <0.001  |
| Would be comfortable if a member of my family were being transported by ambulance and cared for by EMS professionals who have not been vaccinated against COVID-19 | 583 (67.8%)    | 211 (96.8%)  | 372 (57.9%)| 0.759   |
| Has previously reported to work despite experiencing cold or flu-like symptoms or those symptoms that could be precursors to COVID-19 | 224 (26.0%)    | 59 (27.1%)   | 165 (25.7%)| <0.001  |
| Agree or strongly agree the risk of side effects from the COVID-19 vaccine is outweighed by the prevention of the disease in the general public | 617 (71.7%)    | 74 (33.9%)   | 543 (84.6%)| <0.001  |
| Believes that COVID-19 is a moderate to severe threat to the US population as a whole | 591 (68.7%)    | 53 (24.3%)   | 538 (83.8%)| <0.001  |
| Trusts state government to take the appropriate actions to reduce the spread of COVID-19 | 360 (41.9%)    | 18 (8.3%)    | 342 (53.3%)| <0.001  |
| Believe my state government should prioritize reducing the spread of COVID-19 over individual objections to mask mandates | 470 (54.7%)    | 33 (15.1%)   | 437 (68.1%)| <0.001  |
| Believes the COVID-19 vaccine                                |                |              |            |         |
| Should not be mandatory for all EMS workers                  | 405 (47.1%)    | 206 (94.5%)  | 199 (31.0%)| <0.001  |
| Should be mandatory for all EMS workers, but with option to decline | 294 (34.2%)    | 12 (5.5%)    | 282 (43.9%)|         |
| Should be mandatory for all EMS workers                      | 161 (18.7%)    | 0 (0.0%)     | 161 (25.1%)|         |

COVID-19, coronavirus disease of 2019; EMS, emergency medical services;
somewhat or very safe (77.1%) and effective (76.0%); it is important for HCWs to receive a COVID-19 vaccine to protect themselves (71.9%) and their patients (71.0%); and recalled their employer recommending a COVID-19 vaccine (76.6%). For each of these attitudes and beliefs, a univariate analysis observed significant differences between vaccinated and unvaccinated respondents (Table 2). In addition, respondents who received a seasonal influenza vaccination were also more receptive to vaccination for COVID-19 (80.2% vs 30.7%, \(P<0.001\)).

Despite overall favorable opinions regarding vaccine safety and effectiveness, only 18.7% believed the COVID-19 vaccine should be mandatory for all EMS professionals, with most believing it should be optional (47.1%) or mandatory with the option to decline (34.2%), similar to the hepatitis B vaccination. Furthermore, respondents indicated a low level of trust in state government to take appropriate actions to reduce disease spread (41.9%) and opposition to any government actions that superseded individual objections to donning face masks while in public (45.3%).

Despite their belief that they were at greater risk of contracting COVID-19, few (43.7%) reported wearing a mask in the ambulance when not transporting a patient, or masking (29.4%) or practicing physical distancing (48.7%) while at the ambulance base. The lack of these risk-averting behaviors extended into public settings while off-duty, particularly among the unvaccinated (Table 2). The unvaccinated were also more comfortable with a member of their family being treated in a healthcare facility by unvaccinated HCWs (96.3%) or being treated and transported by unvaccinated EMS professionals (96.8%) compared to their vaccinated counterparts (66.7% and 67.8%, respectively).

The top reasons cited by respondents who did not receive one of the COVID-19 vaccines included concerns about safety and effectiveness, inadequate information to make an informed decision, concerns about vaccine side effects, reliance on the protective properties of personal health or natural immune response, and previous COVID-19 illness (Table 3). Of these, concern about vaccine safety was by far the most frequently cited reason for not accepting the vaccine (36.2%). For those respondents who did receive a COVID-19 vaccine, the most cited reasons for doing so included the desire to protect themselves, their families, and their patients; belief of increased work-related risk; seriousness of the disease; and the perception that benefits to vaccination outweighed the risks (Table 4).

Logistic regression odds ratios (OR), 95% confidence intervals (CI), and \(P\)-values for the prediction of vaccination uptake are shown in Table 5. The model adequately predicted COVID-19 vaccination uptake with an AUC-ROC of 0.96.

**Table 3. Primary reason why respondents did not receive COVID-19 vaccination**

| Reason                                                                 | N (%)  |
|-----------------------------------------------------------------------|--------|
| I am concerned about the safety of the vaccine.                       | 79 (36.2%) |
| I don’t think the COVID-19 vaccine is effective.                      | 16 (7.3%)  |
| I have not received enough information about the COVID-19 vaccine to make a decision. | 14 (6.4%)  |
| I am worried about the side effects of the COVID-19 vaccine.          | 12 (5.5%)  |
| I’m healthy and don’t worry about getting COVID-19.                   | 11 (5.0%)  |
| I have had COVID-19 and don’t think I will get COVID-19 again.        | 11 (5.0%)  |
| I don’t consider COVID-19 to be a serious illness.                   | 9 (4.1%)   |
| My natural immune system will protect me.                            | 7 (3.2%)   |
| It is not required by my employer.                                    | 7 (3.2%)   |
| I don’t consider myself to be in a targeted group for which immunization is recommended. | 4 (1.8%)   |
| Religious reasons                                                     | 4 (1.8%)   |
| I am generally against vaccines.                                      | 2 (0.9%)   |
| I believe the flu vaccine gave me the flu and I fear the COVID-19 vaccine may give me COVID-19. | 1 (0.5%)  |
| I have had a flu vaccine before and got sick anyway and would expect the same from the COVID-19 vaccine. | 1 (0.5%)  |
| I am allergic to the vaccine.                                         | 1 (0.5%)   |
| Other                                                                | 39 (17.9%) |

**Table 4. Reasons why respondents accepted COVID-19 vaccine**

| Reason                                                                 | N (%)  |
|-----------------------------------------------------------------------|--------|
| Being vaccinated protects my family.                                   | 79 (36.2%) |
| I feel I am at risk for COVID-19 because of my work.                 | 16 (7.3%)   |
| I think it protects me from getting COVID-19.                         | 14 (6.4%)  |
| COVID-19 is a serious disease.                                        | 12 (5.5%)  |
| I don’t want to expose my family to COVID-19 should I become infected at work. | 11 (5.0%)  |
| The benefits of the COVID-19 vaccine outweigh the risk of any side effects. | 11 (5.0%)  |
| Being vaccinated protects my patients.                                 | 9 (4.1%)   |
| I work with patients at risk of complications from COVID-19, and I don’t want to expose them to COVID-19. | 7 (3.2%)   |
| My employer provides free COVID-19 vaccination.                      | 7 (3.2%)   |
| I will miss fewer days of work due to illness.                       | 4 (1.8%)   |
| I’ve had the flu in the past and don’t want to experience COVID-19.  | 4 (1.8%)   |
| I was encouraged by my personal physician.                           | 2 (0.9%)   |
| I have a health condition (eg, heart disease, pulmonary disease) that might be exacerbated if I got COVID-19. | 1 (0.5%) |
| I was encouraged by my coworkers.                                    | 1 (0.5%)   |
| Other                                                                | 1 (0.5%)   |

COVID-19, coronavirus disease of 2019
Table 5. Logistic regression model results for prediction of COVID-19 vaccination.

| Parameter                                                                 | Estimate (B) | Odds ratio (95% CI) | P value |
|---------------------------------------------------------------------------|--------------|---------------------|---------|
| Did you receive the influenza vaccine during last year's influenza season? | 0.946        | 2.57 (1.37-4.81)    | 0.003   |
| Previously diagnosed with COVID (reference category = "no")              | -0.648       | 0.52 (0.25-1.08)    | 0.081   |
| Perception of greater risk of COVID infection compared to general population (reference category = "perceived risk less than or equal to general population") | 0.626 | 1.87 (1.01-3.46)    | 0.047   |
| Positive belief in effectiveness of vaccine (reference category = "not at all effective or not very effective") | 1.534 | 4.63 (2.20-9.76)    | < 0.001 |
| Positive belief in safety of vaccine (reference category = "not at all safe" or "not very safe") | 1.715 | 5.55 (2.61-11.79)   | < 0.001 |
| Positive belief in importance of healthcare workers to receive the COVID-19 vaccine to protect their patients. (reference category = "strongly disagree" or "disagree") | 2.746 | 15.58 (7.74-31.33)  | < 0.001 |
| Have you received enough information to make an informed decision about being immunized against COVID-19? (reference category = "no") | 0.903 | 2.46 (1.12-5.39)    | 0.024   |

COVID-19, coronavirus disease of 2019.

Overall prediction accuracy of the model was 92.8% with a Hosmer and Lemeshow goodness of fit test (χ2 2.44, P=0.78), and Nagelkerke R² 0.789. The factors retained in the final model included “previous receipt of influenza vaccine” (OR 2.57, P=0.003); “previously diagnosed with COVID” (OR 0.52, P=0.08); “perception of greater risk of COVID infection compared to general population” (OR 1.87, P=0.04); “positive belief in effectiveness of vaccine” (OR 4.63, P=<0.001); “positive belief in safety of vaccine” (OR 5.55, P=<0.001); “positive belief in importance of healthcare workers to receive the COVID-19 vaccine to protect their patients (OR 15.58, P =<0.001); and “received enough information to make an informed decision about being immunized against COVID-19” (OR 2.46, P=0.02).

DISCUSSION

In 2019 the WHO listed 10 threats to global health; among these were vaccine hesitancy and a global pandemic. Alas, the world is now confronting both threats simultaneously. The rationale among the non-vaccinated is complicated, but misconceptions prevail regarding the safety and effectiveness of vaccines in general, and the COVID-19 vaccines specifically. The resulting suboptimal uptake of a safe and effective vaccine for an easily transmissible and potentially lethal infection has been christened the “pandemic public health paradox.” Unfortunately, HCWs, including EMS personnel, are not immune to the misinformation energizing vaccine hesitancy.

In our cross-sectional survey, we found a COVID-19 vaccination rate among EMS professionals in North Carolina of 74.7%, which is 55% higher than the national vaccination intention rate among US firefighters and EMS workers previously reported by Caban-Martinez et al. This proportion is also substantially greater than the previously reported influenza vaccination rates of North Carolina EMS professionals. Despite this, a substantial segment of the EMS workforce, their patients, families, and other contacts are still at considerable risk. The majority of survey respondents believed that COVID-19 posed a serious threat to public health, that they were at increased risk of work-related infection, and that the COVID-19 vaccines were safe and effective. However, these beliefs alone did not ensure a higher vaccination rate, and the contrasting opinions and beliefs between the vaccinated and unvaccinated were striking.

Among respondents, the reasons for receiving the COVID-19 vaccination were similar to results reported by Maltezou et al and included the motivation to protect themselves, their families, and their patients, as well as a desire to control the continued spread of a serious disease. Reasons for not receiving one of the vaccines included concerns about vaccine safety and effectiveness, insufficient knowledge of the vaccine, concerns with respect to side effects, prior COVID-19 infection, and reliance on personal health and natural immune response to combat any potential coronavirus disease. Similarly, Schrading et al also reported concerns about vaccine safety and effectiveness, side effects, and previous COVID-19 diagnosis as reasons for declining vaccination among a survey of US emergency department personnel. These concerns were echoed in a survey of HCWs at a large university healthcare system. Additional concerns cited by this healthcare system cohort included political involvement, vaccine research methodology, EUA (ie, a lack of full FDA approval), and the novelty of the vaccine.

Our statewide survey was conducted during the period between the initial surge and the subsequent delta variant-fueled wave of the COVID-19 pandemic. During the data collection period, a statewide mandate for face coverings and social distancing in public settings was in place and daily infections were declining. There were 518–1988
daily cases reported in North Carolina during this time, and
the cumulative COVID-19 cases ranged from 966,878 to
991,376.20 By the end of the survey, roughly 9.3% of the
general population in the state had been diagnosed with
COVID-19 compared to the 17.7% in our sample, highlighting
the increased disease burden among EMS professionals.
Whether this excess case rate was the result of true illness
from work-related or off-duty exposures or a reflection of
increased access to testing remains unknown. In addition
to their own illness, most of the respondents reported either
living in the same household as someone with a previous
COVID-19 diagnosis (23.4%) or having family members
living outside the home who had a similar diagnosis (54.3%).

In addition to some degree of vaccine hesitancy, our
respondents also reported personal behaviors representing
missed opportunities to reduce work-related disease
transmission, such as wearing masks and physically distancing
when possible while not actively engaged in patient care
activities during their duty shift. These on-duty behaviors
translated into off-duty behaviors, particularly among the
unvaccinated, where most did not wear a mask or socially
distance while in public settings despite an executive order
issued by the governor of North Carolina mandating such
preventive measures.

Because EMS professionals are crucial components of
the healthcare system, maintaining wellness among this group
is paramount, and it is incumbent upon EMS administrators to
ensure a protected EMS workforce. Nonetheless, overcoming
vaccine hesitancy is particularly problematic in the context
of COVID-19 because of the unprecedented politicization
of vaccine development and public health responses to the
pandemic, as well as the unbridled spread of misinformation,
especially via social media.

Several health beliefs expressed by our respondents are
core constructs of various health behavior theories, which
include the health belief model,13 the theory of reasoned
action,22 and the multi-attribute utility model.22 Importantly,
these beliefs represent targets for interventions for addressing
vaccine hesitancy. Roughly half (50.5%) of respondents who
listed a primary reason for remaining unvaccinated referred
to vaccine misinformation including concerns about safety,
effectiveness, side effects, acquiring COVID-19 illness from
the vaccine itself, and general antivaccine sentiment (Table 3). These largely misinformation-based responses to vaccination
may prove to be among the most difficult to overcome because
broadly focused, information-based messaging alone is
likely to be ineffective, particularly in light of the “backfire
effect.” The backfire effect is the tendency of individuals
to resist accepting evidence that conflicts with their beliefs
and subsequently become even more entrenched in their
acceptance of misinformation, which can exacerbate nescience
in such situations.23 In addition, public health officials trying
to educate the populace on mask wearing or other safety
initiatives often issued confusing or contradictory information,
leading to a lack of trust in the government to handle the
pandemic properly.24 These ideas are supported in that only
6.4% of the unvaccinated attributed a lack of sufficient
information as their primary reason for declining the vaccine.

Instead of broadly focused messaging, some observers
recommend that the underlying emotions, beliefs, and
attitudes be identified and that messaging strategies be tailored
to these attitudes.25 Such strategies have included reporting
the positive experience of vaccinated people to enhance overall
trust in the vaccine26, 27; messaging that is people-centered and
uses first-person accounts with emotional verbiage28; and the
use of “trusted messengers” to disseminate information.26

Some have argued that the unvaccinated represent
economic externalities and can therefore be addressed
economically with both positive and negative financial
incentives.29 Examples of positive incentives that have been
used include gift cards, food, alcoholic beverages, lotteries,
and scholarships, while negative incentives may include
increased health insurance premiums for the unvaccinated
denied access to schools or retail spaces. However,
these strategies have not been thoroughly evaluated and
their effectiveness is unknown. It is likely that a subset of
the unvaccinated will not be swayed by either incentives
or messaging campaigns, a group that French et al dub the
“active resisters,” who decline the vaccine based on strong
personal, cultural, or religious beliefs.30 Unfortunately,
Few tools exist for increasing vaccine uptake in this group,
although one possible strategy is a mandatory workplace
vaccination policy.

Policies mandating influenza vaccination of HCWs have
gained popularity in some settings due to low vaccine uptake.
Such policies consistently yield influenza vaccine uptake rates
above 90% while simultaneously providing for medical and
religious exemptions.31 Similar policies for COVID-19 have
been implemented for HCWs in some countries, including
Greece and France.32 In the United States, compulsory
COVID-19 vaccination of HCWs is supported by 68
professional organizations, including the American Medical
Association, American Academy of Pediatrics, American
College of Physicians, American College of Surgeons,
American Public Health Association, and National League
for Nursing,33 and has been implemented by many healthcare
systems.34 Moreover, the National Association of EMS
Physicians joined these organizations in calling for mandatory
COVID-19 vaccination for EMS professionals.35

Resistance to mandatory vaccination was intense among
our surveyed EMS professionals where only 18.7% of our
total respondents supported a mandatory vaccination policy.
Again, even within this overall low level of support for
mandatory vaccination, the degree of divergence of opinions
between vaccinated and unvaccinated was stark. Mandatory
vaccination was supported by 25.1% of the vaccinated
respondents compared to 0.0% of the unvaccinated group.
A total of 294 (34.2%) respondents overall supported an
alternative policy to make COVID-19 vaccination mandatory for EMS professionals, with a declination option similar to most policies addressing the hepatitis B vaccine. Overall, nearly half (47.1%) believed that COVID-19 vaccination should be entirely optional. Comparatively, in a similar survey of North Carolina paramedics regarding compulsory influenza vaccination, 52.3% believed vaccination should be entirely optional, 38.7% supported mandatory vaccination with the option to decline, and 9.1% agreed with compulsory vaccination. Thus, it appears that opposition to mandatory COVID-19 vaccination is similar to that of influenza vaccination and has remained consistent over time among North Carolina EMS professionals. Consequently, although the feasibility and true impact of implementing such a strategy in EMS systems is unknown, resistance to a mandatory COVID-19 immunization policy in any form should be anticipated.

LIMITATIONS

This study has several notable limitations, and our results should be interpreted accordingly. First, our survey was web-based, voluntary, and subject to the usual response and recall biases, and the cross-sectional nature of the data prevented us from drawing any causal inference between attitude and belief variables and COVID-19 vaccine acceptance. Additionally, the survey invitation was emailed by the North Carolina Office of EMS via their data management vendor to ensure the provision of anonymity. The exact number of personnel who received the link is unknown. Thus, it isn’t possible to calculate a survey response rate.

Our sample was comprised entirely of North Carolina EMS personnel and the generalizability of our findings to EMS professionals outside of North Carolina is unknown. Furthermore, the data was collected prior to the delta or omicron variants becoming the predominant circulating strain. The EMS vaccination rates may have since been influenced by the extensive attention given by public health officials to this strain of COVID-19 and its accompanying surge in cases, hospitalizations, and deaths.

Our survey did not specifically question respondents regarding understanding of or acceptance of one vaccine type vs another (mRNA vs viral vector). Nor did our survey specifically look at acceptance as it related to convenience, one dose vs two, or storage and distribution factors for the mRNA vaccines. Any targeted messaging campaign created to increase vaccine uptake should consider these variables and provide additional information as appropriate. Lastly, this survey was sent to EMS professionals who were active on an EMS agency roster. We did not survey those who were in other medical fields, educators, or those who may have been between jobs.

CONCLUSION

In this cross-sectional survey of North Carolina EMS professionals, COVID-19 vaccination rates were higher than have been previously reported, but a substantial subset remain at risk. Previous influenza vaccination, a perception of an increased risk for contracting the illness, sense of duty to protect patients, adequate information for decision-making, prior COVID-19 diagnosis, and favorable beliefs about vaccine safety and effectiveness were all predictive of vaccination acceptance. Nonetheless, erroneous beliefs and vaccine safety and effectiveness concerns were extensive, and resistance to mandatory vaccination was fervent. Notably, concern about safety was the most frequently cited reason for not accepting the COVID-19 vaccine. The EMS systems should focus their efforts on combating misinformation through strategically targeted employee educational campaigns as well as developing policies regarding immunization requirements and comprehensive workplace safety practices.

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