ORIGINAL CLINICAL RESEARCH REPORT

The Burden of Coronavirus Disease 2019–Related Cases, Hospitalizations, and Mortality Based on Vaccination Status and Mandated Mask Use: Statewide Data From Wisconsin and Narrative Review of the Literature

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BACKGROUND: Coronavirus disease 2019 (COVID-19) cases continue to surge in the United States with the emergence of new variants. Statewide variability and inconsistency in implementing risk mitigation strategies are widespread, particularly in regards to enforcing mask mandates and encouraging the public to become fully vaccinated.

METHODS: This is a cross-sectional study conducted on July 31, 2021, utilizing publicly available data from the Wisconsin Department of Health Services. The authors abstracted data on total COVID-19–related cases, hospitalizations, and deaths in the state of Wisconsin. The primary objective was comparison of total COVID-19–related cases, hospitalizations, and deaths in vaccinated versus unvaccinated people in the state of Wisconsin over a 31-day period (July 2021). Furthermore, we also performed a narrative review of the literature on COVID-19–related outcomes based on mask use and vaccination status.

RESULTS: In the state of Wisconsin during July 2021, total COVID-19 cases was 125.4 per 100,000 fully vaccinated people versus 369.2 per 100,000 not fully vaccinated people (odds ratio [OR] = 0.34, 95% confidence interval [CI], 0.33–0.35; $P < .001$). Total COVID-19 hospitalizations was 4.9 per 100,000 fully vaccinated people versus 18.2 per 100,000 not fully vaccinated people (OR = 0.27, 98% CI, 0.22–0.32; $P < .001$). Total COVID-19 deaths was 0.1 per 100,000 fully vaccinated people versus 1.1 per 100,000 not fully vaccinated people (OR = 0.09, 95% CI, 0.03–0.29; $P < .001$). Narrative review of the literature demonstrated high vaccine effectiveness against COVID-19 infection prevention (79%–100% among fully vaccinated people), COVID-19–related hospitalization (87%–98% among fully vaccinated people), and COVID-19–related death (96.7%–98% among fully vaccinated people). Studies have also generally reported that mask use was associated with increased effectiveness in preventing COVID-19 infection ≤70%.

CONCLUSIONS: Strict adherence to public mask use and fully vaccinated status are associated with improved COVID-19–related outcomes and can mitigate the spread, morbidity, and mortality of COVID-19. Anesthesiologists and intensivists should adhere to evidence-based guidelines in their approach and management of patients to help mitigate spread. (Anesth Analg 2022;134:524–31)

KEY POINTS

- **Question:** How do outcomes of total coronavirus disease 2019 (COVID-19) infection, hospitalization, and mortality cases compare between patients who are fully vaccinated versus those who are unvaccinated in the state of Wisconsin during July 2021?
- **Findings:** Compared to unvaccinated patients, fully vaccinated patients in the state of Wisconsin have an association of significantly lower total cases of COVID-19 infection, hospitalization, and mortality, which is further substantiated with a narrative review of the literature assessing COVID-19 outcomes based on mask use and vaccination status.
- **Meaning:** Strict adherence to public mask use and fully vaccinated status are associated with improved COVID-19–related outcomes and can mitigate the spread, morbidity, and mortality of COVID-19.

GLOSSARY

CDC = Centers for Disease Control and Prevention; **CI** = confidence interval; **COVID-19** = coronavirus disease 2019; **FDA** = US Food and Drug Administration; **OR** = odds ratio; **RNA** = ribonucleic acid; **SARS-CoV-2** = severe acute respiratory syndrome-coronavirus-2

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Severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) first presented as an outbreak in Wuhan, China, which subsequently spread rapidly worldwide leading to the coronavirus disease 2019 (COVID-19) pandemic.[1] While early mitigation efforts were executed in the United States with travel restrictions and warning of the general public, the United States federal government escalated the status of COVID-19 spread from a public health emergency to a national emergency by March 13, 2020. Despite the declaration of a national emergency, several states did not implement closure of nonessential business or enforcement of strict mask mandates.[2] Furthermore, in April 2020, there was a surge of protests that urged governments to reopen the economy and to lift COVID-19 restrictions.[2]

Mask mandates in the United States have been implemented in several waves. The first set of states, most of which were Northeastern states, introduced mask mandates in mid-June 2020.[2] Over half of the United States implemented mask mandates by early August 2020.[2] While community-level COVID-19 rates varied considerably across the United States, studies have highlighted that public mask requirements correlated with lower COVID-19 rates.[2] The variation in implementing mask mandates has stemmed from debates that have highly politicized this topic, ongoing scientific controversy, and dissemination of misinformation.[2–4]

With the development of several COVID-19 vaccines, the first vaccine was approved by the US Food and Drug Administration (FDA) in December 2020 for vaccination of individuals ≥16 years based on safety and efficacy data from a phase III randomized controlled trial.[5] Messenger ribonucleic acid (RNA)–based and adenovirus vector vaccines have demonstrated about 70% to 95% efficacy across phase III clinical trials.[5] As substantiated with real-world data, increased COVID-19 vaccination rates were associated with decreased rates of COVID-19 infection, hospitalization, and mortality.

With the emergence of the Delta and Kappa variants, there has recently been yet another surge of COVID-19 cases in the United States, with many coining this phase as the "fourth COVID-19 wave." Concurrently, many states have not implemented mask mandates or measures to increase rates of COVID-19 vaccination. Thus, concerns exist that, as another COVID-19 surge takes place in the United States, many hospitals and health care systems may again operate at crisis capacity. Concerns also exist regarding need for temporary "overflow facilities," increasing rates of symptomatic COVID-19 infection in children, and severe staffing shortages.

Low compliance with vaccination and mask mandates has implications in the field of anesthesia and intensive care. Due to the unique skillset of anesthesiologists and intensivists, they are frequently utilized for airway and hemodynamic management, ventilator management, and other desirable skills in the COVID-19 pandemic. Many anesthesiology departments worldwide have also led the development of safety and planning strategies to mitigate spread and exposure within hospitals, plan for shortages of medical supplies and personal protective equipment, and allocate and distribute vaccines.[6]

In clinical practice, common aerosol-generating procedures performed by anesthesiologists and intensivists (eg, endotracheal intubation, manual bag-mask ventilation, noninvasive positive pressure ventilation) place them at high risk for COVID-19 exposure. In light of the recent surge of cases, practice changes have been implemented (eg, postponement of elective surgical cases and heavier emphasis of relying on regional anesthesia) for preservation of respiratory function and avoidance of aerosolization from general anesthesia.[6] Hospitals have also implemented "COVID-19 airway teams" that respond to airway emergencies in the hospital and typically consist of experienced anesthesia providers.[6] Despite risk mitigation strategies within hospitals, concerns exist that the COVID-19 pandemic will continue to worsen due to low vaccinations rates and noncompliance with mask mandates.

Thus, the goal of this review is to describe COVID-19–related caseload, hospitalizations, and mortality from a statewide database in Wisconsin between vaccinated and unvaccinated people. We also review data from observational studies and real-world outcome studies demonstrating efficacy of both vaccine implementation and statewide mask mandates on COVID-19 outcomes.

METHODS

Review of Statewide COVID-19 Data in Wisconsin

The study was approved by the institutional review board, and requirement for written informed consent was waived by the institutional review board as this study analyzed publicly available data. The Wisconsin Department of Health Services website (https://www.dhs.wisconsin.gov/covid-19/vaccine-status.htm) was queried on August 1, 2021, with all numerical data being abstracted in this single day. The authors abstracted data on total COVID-19–related cases, hospitalizations, and deaths in the state of Wisconsin over a 31-day period (July 2021) as well as the total population in Wisconsin (5,822,434). These data were reported as total per 100,000 people. Furthermore, we stratified these data between fully vaccinated people and unvaccinated people.

Outcome Assessment

The primary objective was comparison of COVID-19–related cases, hospitalization, and deaths in vaccinated

versus unvaccinated people in the state of Wisconsin. We performed this categorical data comparison using χ^2 test. A P value <.05 was considered statistically significant. We adjusted significance thresholds based on the Bonferroni method.[7] Data were analyzed with SPSS (IBM SPSS Statistics for Windows, Version 21.0; IBM Corp). Secondary outcome was full vaccination rate in the state of Wisconsin at the time of data collection (July 31, 2021).

Narrative Review of Literature

A comprehensive search was performed to broadly query databases and identify relevant observational studies or clinical trials investigating impact of mask mandates and vaccination rates on COVID-19 cases, hospitalizations, and deaths. As such, we broadly searched all articles from PubMed and Scopus from inception (January 1, 2020) to August 25, 2021. Reference lists were also manually searched to identify additional publications that were not captured in the search strategy. Broad MeSH (Medical Subject Headings) terms and Boolean operators included COVID-19, mask mandate, COVID-19 vaccine, real-world outcome, observational study, and randomized controlled trial. Inclusion criteria encompassed randomized controlled trials or observational studies that compared COVID-19 cases, hospitalization, or mortality based on vaccination status and mandated mask use. As it relates to COVID-19 outcomes related to vaccination status, we will primarily focus on real-world observational data as data from randomized controlled trials leading to FDA approval of vaccines have been well-documented and reported. Exclusion criteria comprised of nonpeer reviewed publications, certain study designs (ie, case reports, case series, review articles, letters to the editor), and nonhuman trials. Two authors (R.S.D. and A.A.) selected abstracts and full-text articles from the above-listed databases using the aforementioned search strategy. The following data were extracted: (1) demographic data of included patients, (2) type of study design, and (3) outcomes of interest (COVID-19 cases, hospitalizations, and mortality). Vaccine effectiveness was reported in real-world outcomes studies and is calculated as follows: risk in unvaccinated group minus risk in vaccinated group, divided by the risk in unvaccinated group. For each included study, 2 reviewers (R.S.D. and A.A.) extracted all relevant data. The authors had determined a priori to discuss and resolve any discrepancies in the data collection process; although, no discrepancies were identified during data collection, and thus, an adjudicator was not necessary.

RESULTS

Outcome Assessment

In the state of Wisconsin, the total number of COVID-19 cases was 125.4 per 100,000 (3780 of 3,015,017) fully vaccinated people versus 369.2 per 100,000 (10,365 of 2,807,417) not fully vaccinated people (odds ratio [OR] = 0.34, 95% CI, 0.33–0.35; P < .001; Figure) over a 31-day period (July 2021). Total COVID-19 hospitalizations was 4.9 per 100,000 (148 of 3,015,017) fully vaccinated people versus 18.2 per 100,000 (511 of 2,807,417) not fully vaccinated people (OR = 0.27, 98% CI, 0.22–0.32; P < .001). Total COVID-19 deaths was 0.1 per 100,000 (3 of 3,015,017) fully vaccinated people versus 1.1 per 100,000 (31 of 2,807,417) not fully vaccinated people (OR = 0.09, 95% CI, 0.03–0.29; P < .001). These associations remained statistically significant

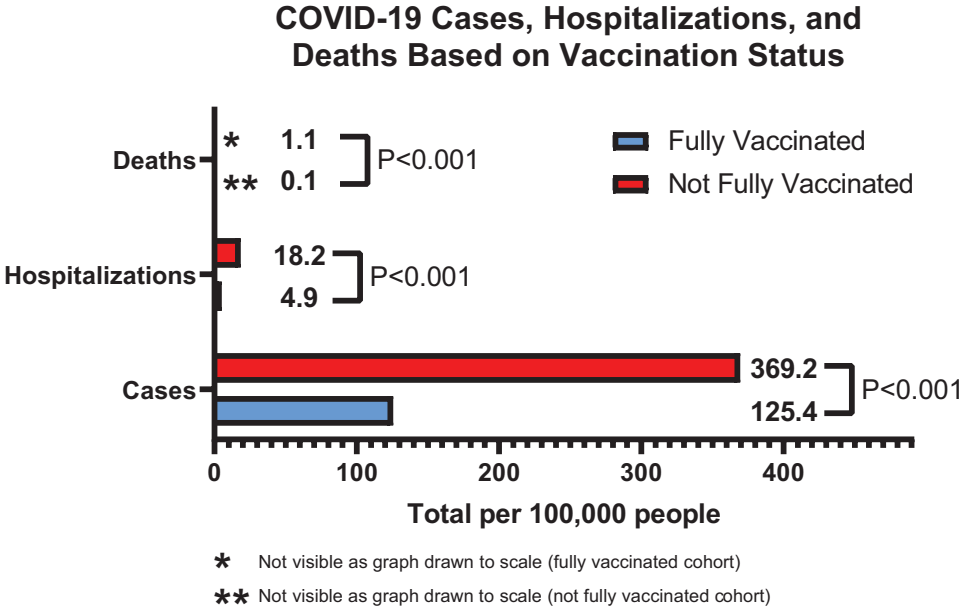

Figure. COVID-19 cases, hospitalizations, and deaths based on vaccination status. *Not visible as graph drawn to scale (fully vaccinated cohort). **Not visible as graph drawn to scale (not fully vaccinated cohort). COVID-19 indicates coronavirus disease 2019.

after adjustment for multiple comparisons using the Bonferroni method. In July 31, 2021, there were 3,015,017 total individuals in Wisconsin who were fully vaccinated (51.8% of Wisconsin population).

Narrative Literature Review: COVID-19 Outcomes Related to Implementation of Mask Mandates

A total of 10 retrospective observational studies were included, involving 4 different countries (ie, United States, China, Thailand, Bangladesh). A summary of these studies is presented in Table 1. All included studies highlighted that wearing face masks or N95 respirators had a significant association with lower risk of COVID-19 infection. In studies that investigated association of mask use and COVID-19 infection among health care workers, use of masks had an association of nearly <70% odds for infection.[8–12] Odds ratios of COVID-19 infection in those who wore a mask versus those who did not ranged from 0.127 to 0.372.

Doung-Ngern et al[10] found no protective effect of masks when performing a subgroup analysis of non–healthcare workers. However, it should be noted that overall, in their main analysis, wearing masks all the time during contact with COVID-19–positive patients had a statistically significant association with lower odds of infection rates (OR = 0.16, 95% CI, 0.07–0.36). Wearing masks only sometimes was not associated with a lower risk for infection.

Narrative Literature Review: COVID-19 Outcomes Related to Vaccination Status

A total of 20 studies were included, involving 8 different countries (ie, United States, United Kingdom, Israel, France, China, India, Italy, Canada). A summary of these studies is presented in Table 2. The type of vaccines that were investigated included ChAdOx1 nCoV-19, mRNA-1273, and mRNA-BNT162b2, and Ad26-COV2-S (adenoviral vector vaccine). All included real-world studies generally highlighted that COVID-19 vaccination was associated with a significantly reduced risk of COVID-19 infection, COVID-19–related hospitalization, and COVID-19–related mortality.

Vaccine effectiveness against COVID-19 infection after 2 weeks following the first vaccine dose ranged from 38.2% to 91%. Vaccine effectiveness against COVID-19 infection at ≥7 days after the second vaccine dose ranged from 79% to 100%. Vaccine effectiveness against COVID-19–related hospitalization

Table 1. Summary of Studies Assessing Mask Mandates on COVID-19 Disease Burden

Study	Study design and location	Summary of findings
Rader 2021[13]	Cross-sectional; United States	A 10% increase in mask use was associated with increased odds of transmission control (OR = 3.53). Communities that reported high rates of mark use and physical distancing had better predicted probability of transmission control
Adjodah 2021[14]	Retrospective; United States	There is an association of mask mandates and a significant decrease in new COVID-19 cases (−3.55 per 100,000), COVID-19–related deaths (−0.13 per 100,000), and COVID-19–related hospitalizations (−2.38 percentage points) up to 40 d postimplementation of mask mandates.
Guy 2021[15]	Cross-sectional; United States	Mask mandates were associated with decreased COVID-19 cases and mortality rates at 1–20, 21–40, 41–60, 61–80, and 81–100 d after implementation of mask mandate.
Ginther 2021[16]	Retrospective, case control; United States	After implementation of mask mandates, COVID-19 cases were 2.1 times higher in no-mask counties (44/100,000 population versus 21/100,000). The rate of hospitalizations in no-mask counties was 1.4 times higher than in counties that mandated mask use. Similarly, COVID-19–related as mortality was 1.8 times higher in no-mask counties.
Dasgupta 2021[17]	Retrospective cohort; United States	The risk of a couple becoming a rapid-riser county was 43% lower in counties that implemented statewide mask mandates during reopening (adjusted prevalence ratio = 0.57).
Wang 2020[9]	Retrospective case-control; China	Of 278 medical staff in the N95 group, none got COVID-19 infection. Of 213 medical staff in the no-mask group, 10 were infected. COVID-19 infection rate was significantly increased in the no-mask group versus the N95 group (difference: 4:65%, OR = 464.82, $P < .001$).
Chen 2020[8]	Retrospective case-control; China	COVID-19 testing was performed in 105 health care workers exposed to 4 patients with confirmed COVID-19 infection. Wearing a facemask reduced the risk of infection in exposed health care workers, compared to those not wearing a mask (OR = 0.127).
Doung-Ngern 2020[10]	Retrospective case-control; Thailand	Case-control study included 211 cases of COVID-19 infection and 839 control patients. The OR for infection for those wearing a mask at all times during contact with COVID-19 patients was 0.16 (95% CI, 0.07–0.36). Only wearing masks all the time during contact was associated with a decreased risk of COVID-19 infection. Wearing a mask sometimes did not lower risk for infection.
Guo 2020[11]	Retrospective case-control; China	A survey was completed by orthopedic surgeons. Not wearing a N95 respirator was a risk factor for COVID-19 infection (OR = 5.20). Wearing respirators or masks at all times was a protective factor for COVID-19 infection (OR = 0.15).
Khalil 2020[12]	Multicenter cross-sectional; Bangladesh	98 physicians with COVID-19 infection and 92 control physicians were included. Use of N95 masks while performing aerosol-generating procedure was a protective factor against COVID-19 infection (OR = 0.372).

Study type, location, and summary of studies comparing COVID-19 clinical outcomes based on mask use versus no mask use.
Abbreviations: CI, confidence interval; COVID-19, coronavirus disease 2019; OR, odds ratio.

Table 2. Summary of Studies Assessing Real-World Vaccination on COVID-19 Disease Burden

Study	Study design and location	Summary of findings
Glampson 2021[18]	Retrospective cohort; United Kingdom	In patients who received the Oxford/Astrazeneca vaccine, there was a 74% risk reduction for COVID-19 infection. In patients who received the Pfizer/BioNTech vaccine, there was a 78% risk reduction for COVID-19 infection. Of vaccinated individuals who tested positive, a very small proportion (0.01%) was hospitalized.
Pawlowski 2021[19]	Retrospective; United States	Vaccine effectiveness for preventing COVID-19 infection was 86.1% and 93.3% for the BNT162b2 and mRNA-1273 vaccines, respectively. Vaccine effectiveness for preventing COVID-19–related hospitalization was 88.8% and 86.0% for the BNT162b2 and mRNA-1273 vaccines, respectively.
Chodick 2021[20]	Retrospective cohort; Israel	Vaccine effectiveness in preventing COVID-19 infection after BNT162b2 vaccine was 90%. In immunosuppressed patients, vaccine effectiveness was 71%.
Vasileiou 2021[21]	Prospective cohort; United Kingdom	One dose of BNT162b2 vaccine was associated with vaccine effectiveness of 91% for reduced COVID-19–related hospitalization at 28–34 d postvaccination. One dose of ChAdOx1 vaccine at the same time interval was 88% effective for reducing hospitalization.
Pilishvili 2021[22]	Retrospective, case-control; United States	Vaccine effectiveness of a single dose of mRNA vaccine (14 d after first dose) for preventing COVID-19 infection was 82%. This increased to 94% effectiveness after 2 doses measured at least 7 d after second dose.
Moline 2021[23]	Prospective, multicenter; United States	Vaccine effectiveness for preventing hospitalization in adults age 65–74 y old was 96% for Pfizer-BioNTech, 96% for Moderna, and 84% for Janssen.
Paris 2021[24]	Prospective multicenter; France	Vaccine effectiveness in reducing COVID-19 infection was 86.2%, 38.2%, and 49.2% at 14 d after first dose for ChAdOx1 nCoV-19, mRNA-1273, and mRNA-BNT162b2, respectively. Effectiveness increased to 100% and 94.6% at 14 d after second doses of mRNA-1273 and mRNA-BNT162b2, respectively.
Li 2021[25]	Case-control; China	A single dose of inactivated SARS-CoV-2 vaccine had a vaccine effectiveness of only 13.8% against the Delta variant. Two vaccine doses had a vaccine effectiveness of 59.0% against the Delta variant
Chodick 2021[26]	Retrospective; Israel	Between 1 and 12 d after a single dose of BNT162b2 vaccine, there was a relative risk reduction of COVID-19 infection of 51.4%.
Muthukrishnan 2021[27]	Cross-sectional; India	Among fully vaccinated patients from the ChAdOx1 nCoV-19 vaccine, there was a 12.5% mortality, while it was 31.45 % among the unvaccinated ($P < .0001$).
Puranik 2021[28]	Retrospective; United States	Both mRNA-1273 vaccine and BNT162b2 vaccine had high effectiveness against COVID-19 infection (mRNA-1273: 86%; BNT162b2: 76%) as well as high effectiveness in reducing COVID-19–related hospitalization (mRNA-1273: 91.6%; BNT162b2: 85%).
Hall 2021[29]	Prospective multicenter; United Kingdom	A single dose (BNT162b2 vaccine) was associated with vaccine effectiveness of 70% at 21 d after administration of first dose and 85% at 7 d after 2 doses.
Dagan 2021[30]	Retrospective; Israel	For documented cases, vaccine effectiveness (BNT162b2 mRNA vaccine) was 46% at days 14–20 after first dose, and 92% at 7 or more days after the second dose. For hospitalization, vaccine effectiveness was 75% at days 14–20 after first dose, and 87% at 7 or more days after the second dose. For mortality, vaccine effectiveness was 72% at days 14–20 after first dose.
Pritchard 2021[31]	Prospective cohort; United Kingdom	Vaccination (ChAdOx1 or BNT162b2) reduced COVID-19 infections at 21 d or later after the first dose (61% and 66%, respectively) with greater reductions seen after a second dose (79% and 80%, respectively)
Fabiani 2021[32]	Retrospective; Italy	At 14–21 d from the first dose and 7 or more days after the second dose, vaccine effectiveness (BNT162b2) in preventing COVID-19 infection was 84% and 95%, respectively.
Haas 2021[33]	Retrospective; Israel	Vaccine effectiveness at 7 d or later after second dose (BNT162b2) was 95.3%, 91.5% against asymptomatic infection, 97.0% against symptomatic infection, 97.2% against COVID-19–related hospitalization, and 96.7% against COVID-19–related death.
Swift 2021[34]	Retrospective; United States	Vaccine effectiveness following 2 doses of 2 different brands of mRNA vaccine at a single-institution exceeded 96%.
Lopez Bernal 2021[35]	Retrospective, case-control; United Kingdom	Vaccine effectiveness at 10–13 d after first dose reached 70%. After 14 after the second dose, effectiveness was 89%.
Chung 2021[36]	Retrospective, case-control; Canada	Vaccine effectiveness at 14 d or later after first dose was 60% against symptomatic infection, but increased to 71% after 35–41 d. Vaccine effectiveness after 7 d after second dose was 91%. Vaccine effectiveness against COVID-19–related hospitalization or death observed at 14 or more days after 1 dose was 70%, while it was 91% at ≥35 d. Effectiveness rose to 98% at ≥7 d after 2 doses.
Shrotri 2021[37]	Prospective cohort; United Kingdom	Relative to unvaccinated residents, the adjusted hazard ratio for COVID-19 positive test in single-dose vaccinated individuals declined to 0.44 after 28 d after the first dose.

Study type, location, and summary of real-world studies comparing COVID-19 clinical outcomes based on vaccination status.
Abbreviations: COVID-19, coronavirus disease 2019; SARS-CoV-2, severe acute respiratory syndrome-coronavirus-2.

following the first vaccine dose ranged from 70% to 75%. Vaccine effectiveness against COVID-19–related hospitalization following the second vaccine dose ranged from 87% to 98%. Vaccine effectiveness against COVID-19–related death following the first vaccine dose ranged from 70% to 72%. Vaccine effectiveness against COVID-19–related death following the second vaccine dose ranged from 96.7% to 98%.

With the emergence and increasing prevalence of the Delta-variant, Li et al[25] studied effectiveness of inactivated SARS-CoV-2 vaccine and reported a vaccine effectiveness of only 13.8% (−60.2% to 54.8%) against the Delta variant. However, administration of 2 doses of the vaccine has a vaccine effectiveness of 59% (16%–81.6%) against the Delta variant.

Another unique population includes immunosuppressed patients. Chodick et al[20] performed a study in Israel and reported that BNT162b2 vaccine effectiveness in preventing COVID-19 infection was 90% (79%–95%) in normal patients. However, in immunosuppressed patients, the vaccine effectiveness was 71% (37%–87%).

DISCUSSION

In this cross-sectional study analyzing statewide public health data from the state of Wisconsin, we report that fully vaccinated people had a significant association with lower odds of COVID-19 infection, COVID-19–related hospitalization, and COVID-19–related mortality compared to unvaccinated people. Furthermore, our narrative review of the literature reporting real-world outcomes also demonstrated that vaccine effectiveness was high against COVID-19 infection prevention (79%–100% among fully vaccinated people), COVID-19–related hospitalization (87%–98% among fully vaccinated people), and COVID-19–related death (96.7%–98% among fully vaccinated people). Studies also generally highlight that full vaccination (2 doses) is associated with lower infection rate compared to partial vaccination (1 dose). These findings align with the findings reported from phase III randomized controlled clinical trials that investigated various COVID-19 vaccines, highlighting that vaccination is effective and useful in improving outcomes related to COVID-19.[38] While the positive direction of associations is consistent, variations in specific percentages of real-world outcome studies versus phase III randomized trials may stem from differences in defining confirmed COVID-19 cases (positive test + presence of symptoms versus positive test alone), decreased representation of patients with significant comorbidities in phase III randomized controlled trials, and inclusion of immunosuppressed patients in real-world outcomes studies.

The generalizability of outcomes from real-world studies and the initial phase III randomized controlled trials is limited and unknown, particularly in countries that are afflicted with variants of the SARS-CoV-2 virus, namely the Delta and Kappa variants recently. One included study in our narrative review by Li et al[25] reported that effectiveness after the first dose of inactivated SARS-CoV-2 vaccine was only 13.8% against the Delta variant. Even after administration of the second vaccine dose, the vaccine effectiveness only increased to 59% against the Delta variant. These findings are concerning, and future studies are warranted to investigate vaccine effectiveness against other variants of the SARS-CoV-2 virus. Furthermore, vaccine effectiveness studies should also implement longer follow-up periods to assess the duration of protection provided by COVID-19 vaccination.

Immunosuppressed patients are a special population that warrants further investigation in terms of COVID-19–related outcomes. Concerns exist whether this patient population would have a decreased response to vaccine.[20] One included study in our narrative review[20] reported that that BNT162b2 vaccine effectiveness in preventing COVID-19 infection was 90% in normal patients. However, in immunosuppressed patients, the vaccine effectiveness was 71%. This would suggest that, although effectiveness may be lower in immunosuppressed patients, it may still be reasonable to offer vaccination to decrease the risk of COVID-19 infection and its associated morbidity and mortality. Currently, data on the safety and efficacy of vaccines in immunosuppressed patients remain very limited. The aforementioned phase III randomized controlled trials excluded patients who received immunosuppressive therapy.[38] However, it is important to note that, in 1 randomized controlled trial by Polack et al[38] that led to vaccine approval, 1395 included patients had a history of malignancy, and 118 included patients had a history of rheumatic disease.[38] While not a primary outcome of the study, vaccine efficacy and safety was similar in the cohort of patients with malignancy and rheumatic disease versus other vaccinated patients. Despite limited data, most health authorities in the United States, United Kingdom, and other countries recommend that all immunocompromised patients should still receive the COVID-19 vaccine.[39] Immunocompromised patients and other patients with significant comorbid disease are considered high risk for severe disease and death and should be prioritized to receive the COVID-19 vaccine.

In our narrative review, we also identified that all included studies reported that wearing face masks or N95 respirators had a significant association with reduced risk of COVID-19 infection. This reached up to a 70% reduced risk of infection in health care workers wearing a mask. Studies also stressed that strict adherence to wearing a mask at all times while caring for COVID-19–positive patients is paramount. Wearing masks only sometimes during patient interaction is not protective. Pathological evidence has highlighted that aerosol transmission is the predominant mode of transmission.[40] By wearing a mask at all times, this can reduce inhalation of aerosols and large droplets.[40] This has also been substantiated by a prior meta-analysis that reported that the risk of respiratory viral infections

(ie, influenza, SARS, H1N1) was lower when mask protection was utilized (pooled OR = 0.35).[41]

Of note, included studies that compared COVID-19 infection rates between respirators and standard masks did not identify differences and found both to be effective. However, the US Centers for Disease Control and Prevention (CDC) have recommended that respirators should be reserved for health care workers and not implemented for general public use. This is concordant with a prior meta-analysis highlighting that both N95 respirators and surgical masks effectively reduced spread of respiratory viruses.[42] Despite real-world data not highlighting any differences in clinical outcomes based on mask type, laboratory evidence has suggested that N95 respirators are more effective than surgical masks due to having improved facial sealing features.[42]

As COVID-19 cases surge in the setting of low vaccination rates and noncompliance with mask mandates, anesthesiologists and intensivists should adhere to up-to-date guidelines in their approach and management of patients to help mitigate spread and ensure safety to both patients and other health care providers. As aforementioned, anesthesiologists have led COVID-19 treatment efforts in many hospitals worldwide.[6] Additional responsibilities may include managing COVID-19 patients' airways as part of dedicated rapid response teams, participating in hospital crisis management, and providing clinical training and simulation scenarios to help prepare health care providers in other disciplines to care for COVID-19 patients.[6] Being at the forefront of leadership, anesthesiologists and intensivists may promote additional improvements including the purchase new airway equipment, improvement of training of clinical providers, implementation of telemedicine practices, improvement of dissemination of accurate and educational health care information to patients that encourage compliance with vaccination and mask mandates, and encouragement of the new COVID-19 research efforts.

In conclusion, based on the presented statewide data and narrative review of the literature, implementation of mask mandates and higher vaccination rates are associated with significantly reduced COVID-19 infection, COVID-19–related hospitalization, and COVID-19–related mortality. As the literature has continually evolved, a large number of studies have accumulated on this topic since the onset of the COVID-19 pandemic and thus some studies may not be captured by our search strategy. Furthermore, at the time of data abstraction, no data were available on the statewide database regarding patient comorbidities. Thus, unadjusted analyses are very likely subject to confounding bias. While observational studies introduce a significant source of confounding bias, it is important to abstract phase IV observational studies to determine if significant associations established from prior randomized controlled trials are consistent with real-world outcomes. Nonetheless, the studies that we presented in our qualitative analysis consistently delivered the same message and illustrated the issues of low compliance with vaccine administration and mask mandates. ■

DISCLOSURES

Name: Alaa Abd-Elsayed, MD.
Contribution: This author helped with study conception and design, performed background of research, drafted portions of the manuscript, revised the manuscript critically for intellectual content, and gave final approval of the manuscript.
Conflicts of Interest: A. Abd-Elsayed is a consultant of Medtronic and Avanos.
Name: Ryan S. D'Souza, MD.
Contribution: This author helped perform background of research, analysis, generation of figures, and analysis and interpretation of data and draft the manuscript.
Conflicts of Interest: None.
This manuscript was handled by: Zeev N. Kain, MD, MBA.

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