Unveiling the Impact of Homogenous Vaccines on Clinical Symptoms and Risk Factors Following the SARS-CoV-2 Infection


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Abstract
Background: The COVID-19 pandemic is significant due to its global impact on public health and life situations. It has led to widespread infections and strained healthcare systems, causing significant loss of life. The pandemic has underscored the urgent need for effective measures to control its spread and protect communities worldwide.

Objectives: The main goal of this research was to evaluate the clinical symptoms, risk factors, and manifestations linked to COVID-19 among the vaccinated healthcare worker (HCW) population under study.

Materials and Methods: The study population comprised HCWs with respiratory symptoms who received three doses of vaccination homogeneously. Real-time polymerase chain reaction (RT-PCR) testing was conducted on nasopharyngeal and nasal swab samples using a one-step RT-PCR. The enzyme-linked immunosorbent assay also evaluated immunoglobulin G antibody levels.

Results: Among the most commonly reported symptoms, general fatigue, fever, and cough were the most prevalent, divided by vaccine type. Furthermore, among the associated risk factors, concerns about transmission to other family members, anxiety, and depression were found to be prominent.

Conclusion: The study findings highlight that the vaccine type is associated with clinical manifestations. Additionally, the result reveals the significant contribution of occupational roles to the experiences of HCWs during the COVID-19 pandemic. The findings emphasize the need for tailored support systems to address the diverse challenges faced by HCWs, such as concerns about transmission, anxiety, and occupational stress.

Keywords: COVID-19, SARS-CoV-2, Vaccination, Clinical manifestation, Risk factors

Background
SARS-CoV-2 has rapidly spread worldwide since the initial cases of COVID-19 were identified in December 2019 in Wuhan, China. The common symptoms of SARS-CoV-2 infection include cough, shortness of breath, fever, fatigue, and headache. Patients have also reported gastrointestinal symptoms or anosmia. The severity of infection can range from asymptomatic or mild cases to serious illness and death.

COVID-19 has been classified as a self-limiting infectious disease, and most individuals with mild symptoms recover within 1-2 weeks. The virus infection can lead to five different outcomes, including asymptomatic infection (1.2%), mild to moderate cases (80.9%), severe cases (13.8%), critical cases (4.7%), and death (2.3% of all reported cases), and can be deadly in some cases. Recent studies suggest that the proportion of asymptomatic infections in children under 10 years old is as high as 15.8%.

To date, the United States has documented the highest number of COVID-19 cases, deaths, and overall mortality rate both in the Americas and globally. The recorded figures for the United States stand at 103,436,829 confirmed cases and 1,127,152 deaths, corresponding to a mortality rate of 1.09%. In Asia, China has reported the highest case count, ranking second globally, with 99,256,991 confirmed cases and 121,073 deaths, resulting in a mortality rate of 0.12%. Within Europe, France has reported the highest number of cases, amounting to 38,998,402, accompanied by 163,279 deaths, yielding a mortality rate of 0.42%. Iran ranks second in Asia and 19th globally in terms of infection and mortality rates, securing the top position in the Middle East. Iran’s reported cases amount to 7,610,676, with 146,204 deaths, equating to a mortality rate of 1.92%. These statistics highlight the prevailing COVID-19 situation in each respective country, illustrating the varying degrees of severity and mortality rates across different regions.
This pandemic has presented numerous challenges due to the rapid spread of the virus and the presence of asymptomatic patients. Healthcare workers (HCWs), who have had to work tirelessly during the pandemic, have faced various difficulties, including their work environment, financial stability, and job security. These challenges give rise to concerns known as risk factors. While risk factors are not the primary cause of the disease, they are associated with an increased risk of infection. A survey conducted in 2020 involved 733 patients who responded to questions about mental health problems, and its findings revealed that anxiety, insomnia, and depression are among the most important risk factors associated with the pandemic. Additionally, concerns regarding virus transmission and the use of personal protective equipment (PPE) are considered other risk factors.

Operation Warp Speed implemented strategies to expedite vaccine development by simultaneously advancing multiple vaccine candidates based on four proven vaccine platforms. These platforms are diverse, including mRNA vaccines (e.g., Moderna), replication-defective live-viral vectors (e.g., AstraZeneca), DNA vaccines (e.g., Pfizer), inactivated virus-like Sinopharm, viral vector vaccines (e.g., Sputnik), and recombinant receptor-binding domains conjugated to tetanus toxoid-based vaccines (e.g., Soberana [Pastocovac]). The goal was to diversify the vaccine portfolio, minimize risks, and ensure the availability of 300 million doses of a successful vaccine candidate by mid-2021.

Vaccination plays a crucial role in preventing infectious diseases and minimizing their impact. It enables efficient protection and the achievement of herd immunity, leading to reduced viral transmission.

In this study, a comprehensive investigation was conducted on 57 HCWs who have tested positive for the disease despite receiving two doses of vaccination (i.e., Sinopharm, Sputnik, or AstraZeneca). The primary objective of the study was to assess the clinical manifestations, risk factors, and symptoms associated with breakthrough infections in this particular population of vaccinated HCWs.

**Materials and Methods**

**Study Population**
The participants included HCWs who presented with respiratory symptoms, including rhinorrhea, shortness of breath, fever, cough, and sore throat, between January and November 2022. The data were collected at hospitals supervised by the country’s viral diseases research network, encompassing Ali Asghar, Amin, Amiral Momenin, Imam Khomeini, Hajar, Khansari, Razi, Rouhani, Shariati, Sina, Vali Asr, and Yas Medical Center. The above-mentioned symptoms were chosen because they are commonly associated with the respiratory infection SARS-CoV-2. In addition, the HCWs had all received three doses of vaccination, and all doses were homogeneous for each individual. Specifically, 9, 20, and 28 individuals received the Sputnik, AstraZeneca, and Sinopharm vaccines, respectively. Notably, a time interval of 3–5 months had passed since the administration of the last vaccine dose. Furthermore, all participants in the study were aged 18 years or older.

In this research, participants were clearly informed about their voluntary participation rights and were reassured that they could opt out of the study at any point if they wished. Additionally, during the testing phase, no personal information, including names and surnames, was utilized, and all samples were appropriately disposed of after the necessary tests were completed.

**Sample Preparation**
Patients exhibiting respiratory symptoms upon hospital admission underwent the collection of oropharyngeal and nasal swab samples, which were stored in a viral transport medium. These samples were then transported to the laboratory for SARS-CoV-2 testing. To maintain sample integrity, they were stored at a controlled temperature of 2–8 °C until RT–PCR analysis was conducted within 24 hours of collection.

These swabs served as a means of capturing the potential viral presence in the upper respiratory tract of symptomatic patients. By preserving the swabs in a viral transport medium, the viral material was protected during transportation to the laboratory, ensuring optimal conditions for subsequent analysis. Stringent temperature control was implemented to prevent the degradation or loss of viral genetic material during storage.

**RNA Extraction and Real-Time Polymerase Chain Reaction**
In this study, viral RNA extraction was performed on all samples using the RNeasy Kit (ROJE, Iran) following the manufacturer’s instructions. The extracted RNA served as a template for the subsequent RT–PCR analysis.

The RT–PCR assay utilized in the study involved a standardized protocol to detect the presence of SARS-CoV-2 viral genetic material. The RT–PCR was performed using the Qiagen rotor gene Q instrument (Germany), following the manufacturer’s guidelines. The chosen primers and probes targeted the nucleocapsid protein (N), envelope (E), and RNA–dependent RNA polymerase (RdRp) genes of SARS-CoV-2 (Table 1).

After the completion of the PCR cycles, the obtained data were analyzed and interpreted to determine the presence or absence of the target viral RNA in the samples. The standardized thermal cycling conditions and the specific primers and probes selected for amplification ensured accurate and consistent detection of SARS-CoV-2 genetic material in the RT–PCR analysis.
**Enzyme-linked Immunosorbent Assay**

To conduct the ELISA test, a Pishtazteb (Iran) immunoglobulin G (IgG) detection kit with a 100 µL sample requirement was used for analysis. The average level of antibody (IgG) was measured in the study population, and the analysis revealed an average IgG antibody level of 38. Based on the findings, the participants had developed a measurable immune response, likely due to their prior vaccination status. The measurement of IgG antibodies provides valuable insight into the immune status of the study population and can contribute to understanding the potential protection or susceptibility to the targeted condition.

**Statistical Analysis**

The IBM SPSS package (version 27) was used in this study. Further, the R programming language (version 4.2.3) was utilized to test the equality of infected proportions. To summarize our data, medians, means, and standard deviations were calculated for the continuous variable age, and frequencies and percentages were determined for categorical variables such as gender. The frequency of clinical test results by gender and age was determined as well. The Kolmogorov-Smirnov test was applied to check normality. In addition, the Mann-Whitney U test was employed to compare age between groups. Further, Fisher’s exact test was used to investigate any relationship between gender and clinical test results, and the significance level was considered 0.05 for all statistical tests.

**Results**

**Demographic Data**

The study involved 172 HCWs, out of whom 57 individuals, comprising 22 men and 35 women, tested positive for COVID-19. Among those infected with respiratory symptoms, 35 were nurses, 8 were operating room and laboratory technicians, and 6 were healthcare attendants. In addition, 5 individuals served as service personnel, while 3 were facilities staff. The study involved 172 HCWs, representing various occupational roles within the hospital. The participants were divided into different categories, with nurses

<table>
<thead>
<tr>
<th>Gender</th>
<th>Occupation</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>Male</td>
<td>Nurses</td>
</tr>
<tr>
<td>4</td>
<td>Male</td>
<td>Technicians</td>
</tr>
<tr>
<td>2</td>
<td>Male</td>
<td>Service personnel</td>
</tr>
<tr>
<td>0</td>
<td>Male</td>
<td>Facilities staff</td>
</tr>
<tr>
<td>4</td>
<td>Male</td>
<td>Healthcare attendants</td>
</tr>
</tbody>
</table>

Regarding the vaccine distribution, all participants received a homologous vaccination regimen consisting of three doses. The HCWs were categorized based on the type of vaccine they received; overall, 9, 20, and 28 patients received the Sputnik, AstraZeneca, and Sinopharm vaccines, respectively. Further details about the gender and number of cases are available in Table 2.

**Clinical Manifestations**

The primary aim of the investigation was to explore the variations in clinical manifestations based on the type of vaccine received by the HCWs. Among the participants, 9 individuals had received the Sputnik vaccine, 20 had received the AstraZeneca vaccine, and 28 had received the Sinopharm vaccine. The collected data yielded the following results:

- The most commonly observed symptoms were fever, general fatigue, cough, and sore throat. General fatigue was the most prevalent symptom, reported by 45 individuals, followed by fever with 38 cases. Cough and sore throat were reported by 28 and 23 individuals, respectively. Other common symptoms were observed as well. Further data and details are illustrated in Figure 1.

Regarding the relationship between vaccination and clinical manifestations, it was found that HCWs who received the Sinopharm vaccine had the highest number of cases of general fatigue, including 23 individuals. This was followed by HCWs who received the AstraZeneca and Sputnik vaccines with 16 and 6 cases, respectively. In terms of fever, the highest number of cases was observed among HCWs who received the Sinopharm vaccine (20 cases), followed by AstraZeneca (13 cases) and Sputnik (6 cases) recipients. The records for cough and sore throat were relatively close among the different vaccine groups. HCWs who received the Sinopharm vaccine reported 13 cases of cough and 12 cases of sore throat for AstraZeneca recipients, there were 9 cases of cough and 7 cases of sore throat. Among Sputnik recipients, there were 6 and 4 cases of cough and sore throat, respectively. Figure 2 shows further data and details.

**Associated Risk Factors**

The study involved 172 HCWs, representing various occupational roles within the hospital. The participants were divided into different categories, with nurses

<table>
<thead>
<tr>
<th>Gender</th>
<th>Occupation</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>Male</td>
<td>Nurses</td>
</tr>
<tr>
<td>25</td>
<td>10</td>
<td>Nurses</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Technicians</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>Service personnel</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>Facilities staff</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>Healthcare attendants</td>
</tr>
</tbody>
</table>

Note: PCR: Polymerase chain reaction; RdRp: RNA-dependent RNA polymerase; E: Envelope; N: Nucleocapsid.

Table 1. Designed Primers for Selected Genes in This Study for Detection by TaqMan Real-time PCR

<table>
<thead>
<tr>
<th>Gene</th>
<th>Primer</th>
<th>Sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>RdRp</td>
<td>RdRp_SARSr-F</td>
<td>GTCARATGGTCATGTGTCGCCG</td>
</tr>
<tr>
<td></td>
<td>RdRp_SARSr-P2</td>
<td>CAGGGTAACCTACAGGATGCC</td>
</tr>
<tr>
<td></td>
<td>RdRp_SARSr-R</td>
<td>CARGTGGTAAAACACTATTAGCATATA</td>
</tr>
<tr>
<td>E</td>
<td>Sarbeco F</td>
<td>ACAGGTAGCCTATAAGTATAGCGT</td>
</tr>
<tr>
<td>E</td>
<td>Sarbeco PI</td>
<td>ACAGGTCATCGCCCTTATGCCTTG</td>
</tr>
<tr>
<td></td>
<td>E Sarbeco R</td>
<td>ATATCGCAACGAGTACAGCACA</td>
</tr>
<tr>
<td>N</td>
<td>Sarbeco F</td>
<td>CACTTGCCACCCGCAAACCTCGT</td>
</tr>
<tr>
<td>N</td>
<td>Sarbeco P</td>
<td>ACTCGCaACGGAACACATTGCCA</td>
</tr>
<tr>
<td>N</td>
<td>Sarbeco R</td>
<td>GAGGAAACGAGGAGGCGTGG</td>
</tr>
</tbody>
</table>

Table 2. Distribution of COVID-19-positive Healthcare workers by Gender and Occupation
comprising 35 individuals, operating room and laboratory technicians (n = 8), service personnel (5), facilities staff (3), and healthcare attendants (6). This diverse distribution of occupations within the study population allowed for a comprehensive understanding of the impact of identified risk factors across different healthcare positions.

The prevalence of risk factors varied among HCWs according to their respective roles. For nurses, concerns regarding transmission risks within their families emerged as the most common risk factor, followed by anxiety. Depression and work-induced insomnia were also noteworthy risk factors among nurses. Similarly, operating room and laboratory technicians identified concerns about transmission risks within their families as the primary risk factor, along with anxiety. However, to a lesser extent, depression and work-induced insomnia were observed among technicians.

Service personnel reported anxiety and PPE as the most common risk factors, in addition to concerns about transmission risks within their families. Healthcare attendants reported both depression and anxiety as the most prevalent risk factors. They also expressed concerns about transmission risks within their families. Work-induced insomnia and issues related to PPE were reported by a few individuals in this category.

Recognizing and addressing these risk factors are essential for promoting the well-being and mental health of HCWs, especially amidst the ongoing COVID-19 pandemic. The contributions of HCWs are crucial for patient care and public health. Figure 3 displays more detailed information and a comprehensive overview of the prevalence and impact of these risk factors specific to each occupation.

**Discussion**

The emergence of new viruses and the re-emergence of some others are among the most challenging threats to

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**Figure 1.** Symptoms of the Disease in Infected Healthcare Workers. Note: The total case number was 57 people, of which 22 were men and 35 were women.

**Figure 2.** Symptoms of the Disease in People Based on the Type of Vaccine. Note: Among all 57 infected people who have been fully vaccinated, the distribution of vaccine types and the corresponding number of individuals are as follows: Nine, twenty, and twenty-eight patients received Sputnik, AstraZeneca, and Sinopharm, respectively.

<table>
<thead>
<tr>
<th>Label</th>
<th>Specific symptoms</th>
<th>Number of people</th>
<th>Percentage</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Fatigue</td>
<td></td>
<td>45</td>
<td>45.22%</td>
<td>0.003</td>
</tr>
<tr>
<td>Diarrhea</td>
<td></td>
<td>19</td>
<td>19.9%</td>
<td>0.19</td>
</tr>
<tr>
<td>Nausea</td>
<td></td>
<td>8</td>
<td>8.4%</td>
<td>0.22</td>
</tr>
<tr>
<td>Hospitalization</td>
<td></td>
<td>13</td>
<td>13.4%</td>
<td>0.003</td>
</tr>
<tr>
<td>Headache</td>
<td></td>
<td>12</td>
<td>12.4%</td>
<td>0.003</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td></td>
<td>9</td>
<td>9.4%</td>
<td>0.002</td>
</tr>
<tr>
<td>Sore throat</td>
<td></td>
<td>23</td>
<td>23.11%</td>
<td>0.55</td>
</tr>
<tr>
<td>Cough</td>
<td></td>
<td>20</td>
<td>20.14%</td>
<td>0.58</td>
</tr>
<tr>
<td>Fever</td>
<td></td>
<td>38</td>
<td>38.18%</td>
<td>0.09</td>
</tr>
<tr>
<td>Rhinorrhea</td>
<td></td>
<td>12</td>
<td>12.6%</td>
<td>0.12</td>
</tr>
</tbody>
</table>
SARS-CoV-2 first surfaced in Wuhan, China, in late 2019 with a wide range of symptoms. In some cases, the symptoms were shown to be mild, while others, particularly those with underlying conditions, had severe symptoms such as respiratory failure and/or kidney failure. HCWs have been at the forefront of this pandemic since the very beginning. A systematic review of 594 studies was conducted at the peak of the pandemic, which showed that 152,888 COVID-19 infections and 1,413 deaths worldwide were from HCWs.

Studies such as this prove how imperative it is to protect HCWs from COVID-19 and properly document any post-vaccine complications, given the strain and fear put on HCWs regarding both their work and the possibility of infecting their family, household contacts, and even patients. Our analysis demonstrated that being fully vaccinated does not imply complete immunity from future infections; however, it does reduce the severity of the symptoms, though various clinical and psychological risk factors play important roles in severity. In addition, the severity of post-vaccine infections in HCWs was compared with that of infections resulting from different vaccines. Most infections seem to have been from those vaccinated with Sinopharm and showed a wide range of symptoms with fatigue and fever being the most prominent, while Sputnik had the least number of positive cases, with fatigue and fever as the most common symptoms.

According to a study by Letafati et al conducted in Tehran, Iran, the efficacy of the Sinopharm vaccine was tested both in double- and triple-dose cases in people within the 18–30 age group. The results revealed an 8.2% increase in fatigue compared to those with different vaccine complications, given the strain and fear put on HCWs regarding both their work and the possibility of infecting their family, household contacts, and even patients. Our analysis demonstrated that being fully vaccinated does not imply complete immunity from future infections; however, it does reduce the severity of the symptoms, though various clinical and psychological risk factors play important roles in severity. In addition, the severity of post-vaccine infections in HCWs was compared with that of infections resulting from different vaccines. Most infections seem to have been from those vaccinated with Sinopharm and showed a wide range of symptoms with fatigue and fever being the most prominent, while Sputnik had the least number of positive cases, with fatigue and fever as the most common symptoms.

Despite the given data, the possibility of post-vaccine COVID-19 infection is drastically less than in unvaccinated occurrences. The findings of a study by Saurabh Chandan et al represented that the pooled proportion of COVID-19 infection in HCWs dropped from 4.7% to 1.3% after full vaccination.

Furthermore, Voysey et al examined the symptoms of vaccinated patients in Wuhan, China, and reported symptoms such as fever, fatigue, headache, and muscle aches with fever and muscle pain as the most and least common, respectively. Further progression of the infection also showed signs of sinus pressure and rhinitis in all patients with a dry cough.

Aside from the severity of COVID-19, numerous clinical and psychological risk factors also affect symptom severity, such as old age, as it can affect lung function and the speed with which an acquired immune response activates, which can lead to death. Gender is also a risk factor, as it has been shown that men are more at risk of COVID-19 as they are more likely to be in crowded environments for their jobs.

Patients with cardiovascular disease are also more susceptible to COVID-19, possibly due to the expression of angiotensin-converting enzyme 2 (ACE2) in the myocytes, which can cause inflammation in the heart tissue.

In their study conducted on 828 patients, Albitar et al, stated that male gender, advanced age, hypertension patients, and diabetes were the highest risk factors for COVID-19, with 80% deaths among those with old age.

According to a study by Çalıca Utku et al on 297 COVID-19 suspicious patients, 143 cases tested positive, and among them, the most common symptoms were cough (56.6%), weakness (56.6%), taste disorder (34.3%), and fever (33.6%), which conforms to our study findings.

A highly important group of risk factors that are often left out of studies are psychological and emotional factors, which put great strain on HCWs and can both affect not only their lives but also the quality of health care they provide, not to mention that mental health problems
can result in high turnovers within hospitals that put additional financial pressure on training new HCWs.\textsuperscript{41,42} In a study conducted by Hruska et al on HCWs during the pandemic’s second wave on 852 participants, the results revealed that HCWs with post-traumatic stress symptoms (PTSS) suffered more physical health problems (88% more) and loss of sleep (36% more) than those without PTSS. PTSSs are likely caused by several factors, such as extreme and repeated exposure to traumatic events,\textsuperscript{43} lack of social contact created by quarantine, stigma, and most notably, a fear of infecting loved ones and family members.\textsuperscript{44} Studies have also shown gender to be an important factor, as women have a higher prevalence of PTSS.\textsuperscript{45} Our findings also confirmed a direct correlation between post-vaccine infection symptom severity and both clinical and psychological risk factors. Of the 57 HCWs that tested positive for COVID-19, 35 were women, and a majority showed signs of depression, anxiety, and sleeplessness. The largest group of positive subjects included nurses, further suggesting that nurses are most at risk, and the leading risk factor was stated as loneliness and separation from loved ones\textsuperscript{46} and anxiety as the second factor,\textsuperscript{47} followed by depression\textsuperscript{48} and loss of sleep.\textsuperscript{49} While full vaccination has reduced the risk and severity of COVID-19 infections, they have not completely disappeared, as even those with a high IgG count tested by ELISA have tested positive. Accordingly, it can be suggested that the type of vaccine and different risk factors impact immunity and severity. Male HCWs who received all three doses of Sputnik had the least amount of symptom severity, while women who received three doses of Sinopharm and AstraZeneca had the highest amount of symptom severity. Much like the aforementioned studies, our study also demonstrated that the majority of symptoms were fever, fatigue, cough, and sore throat. While hospitalization was reported, it was far less common than any other symptoms that further suggest the efficacy of vaccination.

While this study included an adequate number of test subjects, it is evident that further research with larger study populations is necessary to comprehensively address this matter. Moreover, it is worth noting that the majority of patients in our study received the Sinopharm vaccine, which may have contributed to the heightened associated clinical symptoms. This emphasizes the importance of conducting more extensive research in this regard.

To validate and build upon these findings, larger study groups are essential. Gaining a comprehensive understanding of the clinical manifestations and risk factors experienced by HCWs will enable healthcare organizations to develop targeted strategies for supporting and safeguarding their staff during infectious disease outbreaks. This, in turn, can significantly enhance the quality of patient care and ensure the well-being of HCWs. Additionally, it is advisable to include individuals who have received vaccines from companies such as Pfizer and Moderna in future studies, given their scarcity in the current research. Expanding the scope of this research to encompass other populations, including the general community, will further contribute to our understanding of the broader implications of the COVID-19 vaccination.

**Conclusion**

This study could provide valuable insights into the clinical manifestations and risk factors experienced by HCWs. Those who tested positive for COVID-19 exhibited diverse symptoms, with fever, fatigue, cough, and sore throat being the most common. Variations in symptom severity were observed based on the type of vaccine received, with different vaccines showing differing impacts.

Variations in symptom severity were observed based on the type of vaccine received, with different vaccines demonstrating differing impacts. Among HCWs who received the Sinopharm vaccine, reports of general fatigue, fever, and cough were higher compared to other vaccine groups. Conversely, those who received the Sputnik vaccine had the lowest incidence of clinical signs.

Regarding the risk factors, nurses reported higher levels of risk factors, including concerns about transmission risks to their families, anxiety, and depression. Other HCWs, such as facility staff, healthcare attendants, and laboratory technicians, also faced similar risk factors to varying degrees. Implementation of measures such as mental health support, adequate PPE, vaccination campaigns, testing, and stress reduction strategies is essential to addressing these risk factors.

Additional research with larger sample sizes is required to confirm and build on these findings. This will help healthcare organizations create specific measures to safeguard and assist frontline workers during infectious outbreaks, improving patient care and HCWs’ well-being.

**Authors’ Contribution**

**Conceptualization:** Amirhossein Gharehkhani.

**Data curation:** Amirhossein Gharehkhani.

**Formal analysis:** Ali Vasheghani Farahani.

**Funding acquisition:** Amirhossein Gharehkhani.

**Investigation:** Kimia Mohajeri.

**Methodology:** Amir Aboofazeli, Kimia Mohajeri.

**Project administration:** Roben Soheili.

**Resources:** Mahsa Azhdari.

**Software:** Ali Vasheghani Farahani.

**Supervision:** Mina Naderisemiromi.

**Validation:** Amir Gholamzad.

**Visualization:** Ali Vasheghani Farahani.

**Writing–original draft:** Amir Aboofazeli.

**Writing–review & editing:** Amir Aboofazeli.

**Competing Interests**

The authors declare that they have no competing interests.
Ethical Approval
This study was approved by the Ethics Committees (IR.TUMS. VCR.REC.1399.399) at Tehran University of Medical Sciences, and a letter of consent has been obtained from each patient who participated in the study.

Funding
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References