ORIGINAL ARTICLE

Low Proportion of COVID-19 as an Occupational Disease among Tertiary Hospital Employees in Thailand

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Objective: To examine the proportion of COVID-19 cases classified as an occupational disease and characterize COVID-19 among tertiary hospital employees (HEs) in Thailand.

Materials and Methods: The present study was a retrospective descriptive study conducted between April 2021 and January 2022. Secondary data were obtained from electronic health records. In contrast, information on surveillance procedures was obtained from the hospital's Occupational Health and Safety Management unit. The present study population included 115 HEs.

Results: The proportion of COVID-19 cases classified as occupational diseases was 2.6% (3 out of 115). The most common sources of infection were household members at 40.0%, social events at 23.5%, and co-workers at 11.3%. If all healthcare employees were at risk, the estimated prevalence of COVID-19 during that period would be 115 out of 7,280, equivalent to 1.6 per 100 personnel. Among the infected HEs, more than half, or 55.7%, of the study population were frontline HEs. Most cases, or 41.7%, received a single booster vaccine and 76.9% had mild symptoms. None of the severe cases were immunized.

Conclusion: The present study revealed a low proportion, at 2.6% of COVID-19 cases among HEs classified as occupational diseases. Their work activities contributed the least of causation. This may be due to effective strategies for hospital worker protection.

Keywords: COVID-19; SARS-CoV-2; Hospital employees; Occupational health

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Coronavirus disease, commonly known as coronavirus disease 2019 (COVID-19), is a highly infectious viral illness that first appeared in Wuhan, China, in December 2019[1-3]. To diagnose this disease, medical professionals typically test for the presence of SARS-CoV-2 RNA or antigens in respiratory samples[4,5]. COVID-19 can be spread through nasal droplets, saliva, and oral secretions when an individual inhales droplets or small particles[6-8].

The National Institutes of Health (NIH) classifies infection severity into five levels: asymptomatic or presymptomatic infection, mild, moderate, severe illness, and critical[9].

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Worldwide, there were 237,001,474 infections, 232,160,156 hospitalizations, and 4,841,314 fatalities[10]. As of October 10, 2021, Thailand had 1,710,884 cumulative infections, 110,880 of which 43,299 were treated in hospitals and 67,581 in field hospitals, and 17,691 deaths[11]. Under the Communicable Diseases Act of 2020, regarding the surveillance, prevention, and control of dangerous communicable diseases, the Ministry of Public Health declared COVID-19 a dangerous communicable disease in Thailand[12].

A systematic review and meta-analysis revealed that due to the seriousness of the situation, medical workers had more significant burdens and were more susceptible to infection. The prevalence of SARS-CoV-2 infection among hospital employees (HEs) was 11%[13]. Furthermore, the Thai Department of Disease Control stated on August 4, 2021, that between April 1 and July 7, 2021, 1,064 medical personnel had been diagnosed with COVID-19[14].

The authors conducted a study to analyze the proportion of COVID-19 cases classified as an occupational disease, to characterize COVID-19 cases and to differentiate COVID-19 cases based on

employment categories such as frontline versus back-office, at a tertiary hospital in northeastern Thailand between April 1, 2021, and January 31, 2022. The investigation spanned various outbreaks in Thailand. Medical professors, occupational medicine residents, and Office of Occupational Health and Safety assisted in retrieving data by accessing electronic health records and contact tracing documents.

Materials and Methods

Research design

A retrospective descriptive study was conducted.

Study populations

The inclusion criteria comprised individuals with confirmed COVID-19 at a tertiary hospital in the northeastern region of Thailand, encompassing both frontline personnel and back-office staff between April 1, 2021 and January 31, 2022. One hundred fifteen participants were included. No exclusion criteria were applied.

Operational definitions

1) Frontline personnel: This category included healthcare professions who had direct interaction with patients, such as physicians (2211/2212), nurses (2221), nursing assistants (3221), medical students, unskilled workers in the ward, occupational therapists (2269), dentists (2261), pharmacists (2262), physiotherapists (2264), and others. *(code) represents ISCO 08 classification code.

2) Back-office personnel: This group included individuals with non-patient-contacting roles, such as cleaners (9112), security guards (5414), logistics staff, administrative officers (3344), postgraduate students, medical records and medical statistics officers (3314/3252), kitchen helpers (9412), accountants (2411), stock clerks (4321), central sterile supply staff (5329), childcare workers (5311), laundry machine operators (8157), medical imaging and therapeutic equipment technicians (3211), maintenance workers (7115/7421), pharma-ceutical technicians and assistants (3213), and others. *(code) represents ISCO 08 classification code.

3) Confirmed case of COVID-19 disease: Individuals who had tested positive for SARS-CoV-2 via real time polymerase chain reaction (RT-PCR).

4) The categorization of COVID-19 variants in the present study included three variants: Alpha, which was between April 1, 2021 and June 30, 2021, Delta, which was between July 1, 2021 and November 30, 2021, and Omicron, which was between December 1, 2021 and January 31, 2022. These variants were analyzed to determine the source of infection for each variant and assess the proportion of infections relative to vaccination status.

5) Vaccination status: Categorization into four groups.

(A) Incomplete vaccination: Individuals who were either not immunized or had received a single dose of the CoronaVac vaccine, a single dose of the mRNA vaccine, or a single dose of the AstraZeneca vaccine.

(B) Complete vaccination: Individuals who had received two doses of the CoronaVac vaccine, one dose of CoronaVac vaccine followed by one dose of mRNA/AstraZeneca vaccine, two doses of AstraZeneca vaccine, or two doses of mRNA vaccine were administered over 14 days.

(C) Booster 1: Individuals who had received a third dose of the COVID-19 vaccine for at least 14 days.

(D) Booster 2: Individuals who had received a fourth dose of the COVID-19 vaccine at least 14 days prior.

6) Source of infection

(A) Social: Individuals who contracted the infection from social activities such as communal dining, parties, sports activities, or carpooling.

(B) Family or household member: Individuals who contracted the infection from a member of their household.

(C) Occupation: Individuals who contracted the infection through work-related activities, including clinical care for patients or interactions with colleagues while working.

(D) Co-worker: Individuals who contracted the infection from non-work-related social activities in the workplace, such as communal meals with colleagues or lack of proper personal protective equipment (PPE) during interactions.

(E) Community: Individuals who contracted the infection from a community that had confirmed COVID-19 cases during the relevant period.

(F) Unknown: Individuals for whom the source of infection could not be identified.

Strategies for hospital worker protection

The coronavirus 2019 pandemic control strategy of the Faculty of Medicine consisted of three parts:

1) Controlling disease transmission by screening health workers in the community, establishing guidelines for follow-up with contacts of patients in high-risk groups, proactive detection in high-risk

locations, establishing field hospitals to confine infected individuals, and administering the COVID-19 vaccine.

2) Healthcare service by preparing the qualified personnel, medications, medical supplies, high frequency oscillatory ventilation (HFOV) equipment, ventilators, critical care units, COVID-19 wards, field hospitals, home quarantine, community quarantine, and clinics for screening respiratory infections.

3) Prevention of infection in personnel by providing appropriate PPE and training, N95 respirator fitting, promoting social and personal distancing, double masking, face shields, handwashing, touchpoint cleaning, testing, contact tracing when personnel being exposed to patients, quarantine when there was an upper respiratory infection (URI) or suspicion of high-risk testing, screening for infections from visitors to the workplace, screening patients before entering the ward or operating room, engineering controlled ventilation systems, and COVID-19 vaccination.

In summary, the occupational health team was primarily responsible for preventing infection in staff and establishing monitoring procedures for high-risk patients.

The hospital's 2019 coronavirus disease procedures was enacted on April 8, 2020, and staff members were given instructions on the use of PPE.

1) Personnel in high-risk departments, including the triage unit who carried out assessments for patients suspected of having COVID-19, while the Emergency Department provided complete clinical care for all patients without a known history of COVID-19 exposure. The ARI Clinic, on the other hand, took care of patients with respiratory symptoms, among other duties. Staff members donned typical PPE, which comprised a chlorinated polyethylene (CPE) or operating room gown, hair cap, eye protection glasses, a surgical mask with a micropore filter or an N95 respirator when required, and disposable latex gloves.

2) Laundry workers were responsible for washing clothes, and maintenance department personnel were responsible for maintaining facilities and medical equipment, taking care of hospital rooms, and backing up power. These staff members did not meet patients directly but wore surgical scrubs, eye protection, a surgical mask with micropore seal, and disposable latex gloves, which were changed after each cleaning/work task.

3) Recommendations for the use of PPE during the 2019 coronavirus outbreak at the hospital, with updates on June 30 and September 29, 2021.

(A) Aerosol Procedures: N95 mask + disposable latex gloves + CPE or operating room gowns + goggles + disposable latex gloves

(B) Other: 2-ply surgical mask + cloth mask/ KF94/KN95 or N95 respirator.

4) Recommendations for RT-PCR testing dates for COVID-19 contact tracing for SARS-CoV-2 or antigen test kit (ATK) and quarantine dates were used to determine the risk of SARS-CoV-2 infection after exposure to COVID-19 patients. Following the update issued by the occupational health team on April 18, 2021, individuals who had been exposed to coronavirus patients in 2019 were categorized according to their risk of infection as follows:

(A) Very high risk: Personnel who performed aerosol generating procedure (AGP) activities without upper PPE and who had a history of close contact with a patient with COVID-19 two weeks before or after diagnosis;

(B) High risk: Personnel who had visited the locations with a COVID-19 cluster, had traveled to the highest-regulated areas without following the distancing, mask wearing, hand washing, and testing (DMHT) guidelines or had been in the second circle of contact at a distance of one meter for more than five minutes or cumulatively 15 minutes.

(C) Moderate risk: Personnel who cared for COVID-19 patients performing AGP activities while not wearing lower PPE, those caring for COVID-19 patients with prolonged close contact while not wearing upper PPE, those traveling to a controlled area while not wearing upper PPE, those visiting a cluster area without following DMHT guidelines, and those exposed to a confirmed patient's secretion without gloves; and,

(D) Low risk: personnel who performed AGP activities and wore full PPE to care for patients with COVID-19, those with prolonged closed contact who did not wear lower PPE, those who traveled to controlled areas but did not have a group according to DMHT guidelines, and those who traveled to the surveillance area who were exposed to confirmed patient secretion while wearing upper PPE and gloves.

5) Recommendations for COVID-19 contact-tracing RT-PCR testing dates for SARS-CoV-2 or ATK and quarantine dates were used to determine the risk of SARS-CoV-2 infection following exposure to COVID-19 patients. This update was issued by a revised version of the Occupational Health and Safety Office on June 30, 2021.

Table 1. The written procedures for COVID-19 contact tracing of post-exposure surveillance

	No vaccine April 18, 2021	Vaccine June 30, 2021	Booster 1 August 28, 2021	Booster 1 September 29, 2021 Vaccine group A[1]	Booster 1 September 29, 2021 Vaccine group B[2]	Booster 1 September 29, 2021 Vaccine group C[3]
Risk level				Very high Quarantine for 7 days PCR day 0, day 5-7	Very high Quarantine for 7 days PCR day 0, day 5-7	Very high Quarantine for 10-14 days PCR day 5-7, day 12-14
	High Quarantine for 14 days PCR day 0, day 7 after the first test, or day 13 after the last contact	High • Complete the vaccine Quarantine for 7 days PCR day 0, day 7 • Incomplete vaccine Quarantine for 14 days PCR day 0, day 5-7, day 13-14	High • Complete vaccine but no booster Quarantine for 7 days PCR day 0, day 5-7 • Incomplete vaccine Quarantine for 14 days PCR day 0, day 5-7, day 13-14	High Quarantine for 7 days or consider working normally PCR day 0, day 5-7	High Quarantine for 7 days PCR day 0, day 5-7	High Quarantine for 10-14 days PCR day 5-7 and day 12-14
	Moderate Quarantine for 14 days PCR day 0, day 7 after the first test, or day 13 after the last contact			Moderate Work or consider quarantine for 7 days PCR day 0, day 5-7	Moderate Work or consider quarantine for 7 days PCR day 0, day 5-7	Moderate Quarantine for 10 to 14 days or consider resuming work PCR day 7 and day 12-14
	Low Self-monitoring for 14 days	Low Self-monitoring for 14 days	Low Self-monitoring for 14 days	Low Self-monitoring for 14 days	Low Self-monitoring for 14 days	Low Self-monitoring for 14 days

Recommendations for COVID-19 contact tracing (continued)

	Booster 2 January 13, 2022 Vaccine group A[4]	Booster 2 January 13, 2022 Vaccine group B[5]	Booster 1 January 13, 2022 Vaccine group C[6]
Risk level	Very high Quarantine for 7 days ATK day 4 PCR day 7	Very high Quarantine for 7 days ATK day 4 PCR day 7	Very high Quarantine for 10 days ATK day 4 PCR day 10
	High Self-monitoring, ATK day 4, and PCR day 7	High Quarantine for 7 days ATK day 4, and PCR day 7	Very high Quarantine for 10 days ATK day 4, and PCR day 10
	Moderate Self-monitoring, ATK day 4, and PCR day 7	Moderate Self-monitoring, ATK day 4, and PCR day 7	Moderate Quarantine for 7 days ATK day 4, and PCR day 7
	Low Self-monitoring for 14 days	Low Self-monitoring for 14 days	Low Self-monitoring for 14 days

[1] Personnel receiving two doses of CoronaVac + mRNA/AstraZeneca booster, two doses of mRNA, or one dosage of AstraZeneca Plus one dose of mRNA over 14 days

[2] Personnel receiving 1 dose of CoronaVac + 1 dose of mRNA/ AstraZeneca or 2 doses of AstraZeneca over 14 days

[3] Personnel who were not immunized or received 1-2 doses of the CoronaVac vaccine, 1 dose of mRNA, or 1 dose of AstraZeneca

[4] Personnel receiving four doses of the COVID-19 vaccination or three doses of the mRNA vaccine for 14 days

[5] Personnel receiving three doses of the COVID-19 vaccination or two doses of the mRNA vaccine for 14 days

[6] Personnel who had no vaccine

High-risk-exposure individuals included those who:

(A) were exposed to AGP activities, such as endotracheal intubation, high-flow O_2, high-flow nebulization, and CPR, without N95 respirator or PAPR, goggles, gloves, and waterproof gowns (preferable PPE).

(B) were closed to confirmed patients, at less than 1.8 meter for five minutes or a cumulative period of 15 minutes without wearing an N95 respirator or surgical mask but with a cloth mask, eye protection such as glasses, and gloves, which were the preferable/acceptable PPE.

(C) worked in a room with poor ventilation, with a cumulative 15-minute daily exposure without wearing an N95 respirator or a surgical mask overlaid with a cloth mask, goggles, or gloves as acceptable PPE.

Community or social exposure was characterized as sitting closely/talking to one person without wearing a mask, eating together, not using serving spoons, singing, shouting, coughing, sneezing, or playing sports together without acceptable PPE.

The Recommendations for COVID-19 contact tracing were listed in Table 1.

Study tool

The form was constructed to collect gender, age, job title, infection source, symptoms, severity, and vaccination status variables.

Data collection

1) The Occupational Health and Safety Office provided data on employee infections, including name, surname, age, gender, job title, vaccination status, vaccination date, anticipated infection-causing characteristics, and onset date of illness/symptoms.

2) The hospital's electronic health records provided data on patient cases, including information regarding illness severity, treatment regimen, and hospitalization duration.

3) The community medicine department provided data on infected patients, including their names, surnames, age, gender, symptoms, illness onset date, travel history, and illness severity(9).

3.1) Asymptomatic or pre-symptomatic infection: The patient had laboratory-confirmed SARS-CoV-2 infection but had no symptoms.

3.2) Mild illness: The patient had various symptoms but had no dyspnea, shortness of breath, and/or abnormal chest radiographs.

3.3) Moderate illness: The patient had lower respiratory symptoms, abnormal chest radiographs, and blood oxygen saturation (SpO_2) of 94% or more at sea level, which was determined by pulse oximetry and/or arterial blood gas.

3.4) Severe illness: The patient had blood oxygen saturation (SpO_2) of less than 94% at sea level, a ratio of arterial oxygen pressure to oxygen concentration (PaO_2/FiO_2) of less than 300 mmHg, respiratory rate of greater than 30 bpm, and/or abnormal chest radiographs of more than 50%.

3.5) Critical illnesses: The patient had respiratory failure, septic shock, and/or multi-organ failure.

4) Contacted the patient for permission to use their information during the investigation.

Data analysis

The authors evaluated personal information, including age, gender, job title, type of vaccine, date, infection characteristics, and the underlying cause of illness severity. Descriptive statistics were performed using IBM SPSS Statistics for Windows, version 28.0 (IBM Corp., Armonk, NY, USA) and www.openepi.com, including percentage, mean, standard deviation, and confidence level of 95%. Additionally, the proportion of infections within each occupational group/source of infection was computed by dividing the number of infected personnel within each job by the total personnel count within that specific occupation.

Ethical consideration

The study was conducted following the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of the Center for Ethics in Human Research at Khon Kaen University IRB00001189 (protocol code HE651179 on 24/04/2022).

Results

The present study was conducted at a tertiary hospital in northeastern Thailand. There were 7,280 HEs, comprised of 5,192 women and 2,088 men. Of these, 5,200 frontline HEs had direct patient contact, while 2,080 back-office HEs did not. Between April 2021 and January 2022, 115 HEs were infected with SARS-CoV-2, resulting in an infection prevalence among all HEs of 1.6 per 100 personnel (115 out of 7,280). Among the infected cases, 65.0% were female (1.4% of all female HEs), and 55.7% were frontline HEs. Although back-office HEs accounted for 44.3% of the infections, the prevalence of infection at 51 out of 2,080 was 2.5 per 100 personnel, which was higher than that of frontline staff at 64 out of 5,200 was 1.2 per 100 personnel. The mean age was 35.5±11.1 years (95% CI 33.45 to 37.55), the minimum age was 20 years, and the maximum was 67. Physicians, nurses, and nursing assistants had the highest proportion of infected HEs at 13.9%, however, when compared to the prevalence in each occupational group, logistic officers, security guards, and occupational therapists had the highest infection rates at 28.6, 17.9, and 16.7 per 100 personnel, respectively (Table 2).

The most common sources of infection were household, society, and co-workers contact at 40.0%, 23.5%, and 11.3%, respectively (Figure 1a). Infections of unknown origin constituted 16.5% of infected HEs. Most infections of unknown origin, (73.7%) occurred during the Omicron wave. Infections were socially transmitted during the Alpha wave, whereas most transmissions during the Delta and Omicron waves were familial (Table 3). The proportion of COVID-19 cases classified as Occupational Diseases was low at 3 out of 115 cases (2.6%), with all affected individuals being frontline HEs.

Most infected HEs had mild symptoms at 76.5%, followed by moderate symptoms at 12.2%, and asymptomatic infections at 8.7% (Figure 1b). There were two cases of severe symptoms (1.7%) and one

Table 2. Prevalence of COVID-19 infection among hospital employees

Occupation (number of workers)	ISCO 08 code	Number of infected HEs	Proportion of infected HEs (n=115)	Prevalence in each occupation (per 100 personnel)
Frontline				
Physicians (952)	2211/2212	16	13.9	1.7
Nurses (1691)	2221	16	13.9	1.0
Nursing assistants (694)	3221	16	13.9	2.3
Medical students (820)	NA	8	7.0	1.0
Unskilled workers in wards (207)	NA	7	6.1	3.4
Occupational therapists (6)	2269	1	0.9	16.7
Other (830)	2261/2262/2264	0	0.0	0.0
Total (5,200)		64	55.7	1.2
Back-office				
Cleaning staff (128)	9112	12	10.4	9.3
Security guards (28)	5414	5	4.3	17.9
Logistic staff (14)	NA	4	3.5	28.6
Administrative officers (199)	3344	6	5.2	3.0
Postgraduate students (174)	NA	2	1.7	1.2
Medical record and medical statistics officers (55)	3314/3252	4	3.5	7.3
Kitchen helpers (73)	9412	3	2.6	4.1
Accountants (42)	2411	2	1.7	4.8
Stock clerks (40)	4321	2	1.7	5.0
Central sterile supply staff (39)	5329	1	0.9	2.6
Childcare workers (27)	5311	2	1.7	7.4
Laundry machine operators (67)	8157	1	0.9	1.5
Medical imaging and therapeutic equipment technicians (10)	3211	1	0.9	10.0
Maintenance workers (59)	7115/7421	5	4.3	8.5
Pharmaceutical technicians and assistants (67)	3213	1	0.9	1.5
Other (1,058)	3521/2131	0	0.0	0.0
Total (2,080)		51	44.3	2.5
All (7,280)		115	100	1.6

NA=not applicable

Table 3. Distribution of SARS-CoV-2 variants by the sources

SARS-CoV-2 variant	Social n (%)	Household member n (%)	Occupation n (%)	Co-worker n (%)	Community n (%)	Unknown n (%)	Total n (%)
Alpha	5 (62.5)	2 (25.0)	0(0.0)	0 (0.0)	1 (12.5)	0 (0.0)	8 (100)
Delta	10 (22.7)	22 (50.0)	1 (2.3)	4 (9.1)	2 (4.5)	5 (11.4)	44 (100)
Omicron	12 (19.0)	22 (34.9)	2 (3.2)	9 (14.3)	4 (6.4)	14 (22.2)	63 (100)
Total	27 (23.5)	46 (40.0)	3 (2.6)	13 (11.3)	7 (6.1)	19 (16.5)	115 (100)

case of critical illness symptoms (0.9%); none of the three were fully vaccinated. All infected HEs were not vaccinated or partially vaccinated during the Alpha wave, whereas for the Delta wave, 54.5% of the infected HEs received a booster, followed by those who received two doses at 34.1%, and those who were not fully vaccinated at 11.4%. Interestingly, the highest proportion of infections were those with incomplete vaccination at 2.5%. During the Omicron wave, 44.4% of the infected HEs received two boosters, followed by those who received one booster at 38.1%, and those who received only the original two doses of vaccine at 17.5%. The highest proportion of infections was observed among those who received two vaccination doses at 2.3% (Table 4). The number of infected personnel was the highest in January 2022, with 52 HEs (45.2%), corresponding to the Omicron wave. During the pandemic, the

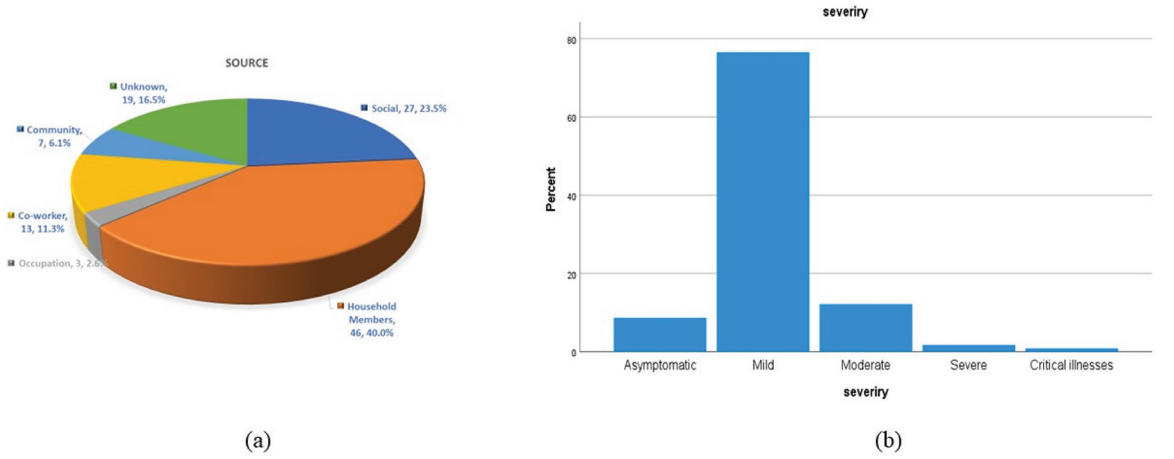

Figure 1. (a) Source of infection, (b) Percentage of severity.

Table 4. Number of vaccinations during each COVID-19 variant waves

COVID19 variant	Vaccination	Number of vaccinations	Number of infected HEs	Proportion of infected HEs (%)
Alpha	Incomplete	1,131	8	0.7
	Complete	6,149	0	0.0
	Booster 1	-	-	-
	Booster 2	-	-	-
Delta	Incomplete	198	5	2.5
	Complete	940	15	1.6
	Booster 1	6,101	24	0.4
	Booster 2	-	-	-
Omicron	Incomplete	95	0	0.0
	Complete	483	11	2.3
	Booster 1	1,075	24	2.2
	Booster 2	5,613	28	0.5

HEs=hospital employees

Omicron wave had the highest proportion of infected HEs at 54.8%, followed by Delta and Alpha waves at 38.3% and 7%, respectively.

Discussion

The present study focused on describing the existing 115 COVID-19 HEs. Only descriptive analyses were appropriate and gave valid results. The highest proportions of infections among healthcare workers were household members, social events, and co-workers at 40.0%, 23.5%, and 11.3%, respectively. A low proportion was caused by work due to hospital contact, quarantined or isolated patients, adequate PPE, or early detection by early testing. However, there were reports of infection among co-workers due to being together and not wearing the required PPE. The present study results contrasted with the research conducted in Iran, Wuhan, and the United States, which indicated that most infections were occupational and related to co-workers[15-19]. According to those studies, a co-worker was regarded as an occupational hazard, regardless of the activities during the shared time. In contrast, the present study clarified that diseases caused by activities with a co-worker were typically non-work-related behaviors, such as eating together in the office and not wearing PPE during social interactions.

The estimated prevalence of COVID-19 among HEs was 1.6 per 100 personnel. This rate, while lower than global and other comparative studies[13,15,16], aligned closely with findings from a study conducted in Malaysia, which reported a 1.03% prevalence of infection[17]. This similarity could be attributed to the implementation of early detection and isolation/quarantine strategies in healthcare settings. The primary strategy for maintaining healthcare services

and supporting the workforce was to reallocate resources and prioritize managing COVID-19 risks to healthcare workers with swift, evidence-based occupational and public health responses. The occupational group with the higher proportion was the frontline HEs with 64 workers (55.7% of all infected HEs).

Furthermore, 44.3% (51 workers) of the back-office HEs were infected. Physicians, nurses, and nursing assistants had the higher proportion at 13.9%. The comparable Iranian and Wuhan studies found nurses had the highest proportion at 51.3% and 53.4%, respectively[15,16]. However, comparing the two groups, back-office HEs had the higher prevalence of infection at 2.5 per 100 personnel compared to frontline HEs at 1.2 per 100 personnel. The present study suggested that those non-medical personnel wore inadequate PPE, unlike frontline HE; physicians and nurses who had to be vaccinated and wore adequate PPE. In Iran, participants with COVID-19 wore inadequate PPE.

The present study showed that severely ill individuals were either unvaccinated or partially vaccinated during the Alpha wave, unlike the Delta and Omicron waves, where most had received boosters and experienced symptoms. Adequate immunization was noted to prevent severe symptoms, consistent with other vaccine studies against COVID-19[20,21].

Conclusion

The present study of COVID-19 infection among HEs revealed the proportion of frontline HEs was higher than that of back-office HEs. However, the source of infection was a low proportion of work-related, potentially attributable to the effectiveness of hospital COVID-19 protection strategies, which included administrative policies, PPE, and contact tracing, and quantitative measures for high-risk HEs. Restricting off-work social activities might provide adequate added protection.

Limitation

The present study used secondary data from diverse COVID-19 variants. Consequently, vaccination policies evolved during the study period, leading to inconsistent definitions of a "complete vaccine", especially for variants such as Delta and Omicron. Additionally, data were unavailable for personnel exposed to COVID-19 but not infected, which prevented the calculation of the odds ratio for some interesting risk factors.

Recommendation

The findings of the present study can offer valuable insights for adapting and formulating strategies to safeguard healthcare personnel against COVID-19 and emerging pathogens.

What is already known on this topic?

The highest infection rate was among frontline HEs, and the source of infection among healthcare workers was occupational and related to co-workers[15-19]. However, if an in-depth study were performed, it would be non-work-related and among hospital staff.

What does this study add?

Most sources of COVID-19 in HEs were not work-related because activities with co-workers were typically non-work-related behaviors, such as having meals together and not wearing masks during social interactions. The critical measure in this study was the concrete definition of work-related COVID-19, which highlights work activities as work–related. In addition, as the organization enforced policies for hospital protection procedures and employees complied with PPE, it proved effective, and few COVID-19 cases were caused by work.

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Conflicts of interest

The authors declare no conflicts of interest.

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