

THE PREVALENCE AND DETERMINANTS OF SARS-CoV-2 INFECTIONS AMONG HEALTHCARE WORKERS, RESULTS OF A CROSS-SECTIONAL STUDY IN THE SILESIAN VOIVODESHIP

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Abstract

Objectives: A significant proportion of healthcare workers (HCWs) had been infected with SARS-CoV-2, which complicated the organization of patient care during the COVID-19 pandemic. However, the exact scale of infection prevalence among the group of HCWs is not known, therefore this study aimed to assess the prevalence of SARS-CoV-2 infection among HCWs in the Silesian voivodeship, Poland, and to define its determinants. **Material and Methods:** The cross-sectional study was conducted in 2 multidisciplinary hospitals in the Silesian voivodeship during the period October 2021–February 2022. The standardized WHO questionnaire *Surveillance protocol for SARS-CoV-2 infection among health workers* was completed by 242 HCWs. To assess the prevalence of SARS-CoV-2 infection and its determinants, such as personal, occupational, and work environment-related conditions and preventive behaviors, the collected data were subjected to statistical analysis. For this purpose, descriptive and analytical statistics (significance of differences in χ^2 test) were used. **Results:** Almost half (42.6%) of subjects were infected with coronavirus, most frequently care assistants (57.1%) and paramedics (50%). People suffering from chronic diseases were infected significantly more often ($p < 0.001$). The majority of the infected HCWs declared previous contact with COVID-19 patients (56.3%). Unfortunately, 10.3% of respondents refused to be vaccinated against COVID-19, most often care assistants (38.1%) and nurses (10.6%). The determinants such as sex, age, occupation, place of work (ward), participation in occupational safety and health training, use of personal protective equipment (PPE), or preventive behaviors did not significantly affect the risk of infection ($p > 0.05$). **Conclusions:** Even though the PPE was used and the percentage of fully vaccinated HCWs against COVID-19 was high (89.7%), the frequency of SARS-CoV-2 infected HCWs remains high at 42.6% (95% CI: 40.7–44.5%). The main determinants of SARS-CoV-2 infection risk among HCWs were previous contact with infected individuals and the presence of chronic disease. *Int J Occup Med Environ Health.* 2023;36(2):201–13

Key words:

COVID-19, SARS-CoV-2, pandemics, infection control, health personnel, personal protective equipment

INTRODUCTION

The COVID-19 pandemic has become a huge challenge for all healthcare systems in the world and has generated problems unprecedented on such a large scale in the daily work of healthcare workers (HCWs). For the large proportion of

the employees within healthcare systems, caring for the sick under pandemic conditions was the first such an extensive professional experience. Due to the potential risk of infection with the SARS-CoV-2 virus from patients, HCWs were forced to quickly adapt to the changed working conditions

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and implement safety procedures. Despite following recommended preventive measures, many workers became infected with the coronavirus, especially during the first wave of the pandemic [1–3]. However, these infections were not always related to the care of patients with COVID-19. They often occurred as a result of contact with patients who did not manifest signs of infection, with an infected family member, or after subsequent social contact [4,5]. Other factors contributing to an increased risk of infection include chronic diseases, type of work category (e.g., a nurse), or not use of personal protective equipment (PPE) [6,7].

The exact scale of SARS-CoV-2 infection prevalence among HCWs in Poland has not yet been identified so far. Nevertheless, some studies show estimates of the prevalence of HCWs, which are mostly based on single-center studies, ranging from 7.12% [6] through 22.9% [8] to 42.7% [7]. The prevalence of infection, therefore, varies highly depending on the time and place of the study.

For a long time, there were no separate registers of infections for the entire country in the group of HCWs. In addition, high variability of virus mutations was observed, which made diagnosis difficult and favoured the increase in the number of infections [9] and at the same time, during the pandemic, a public vaccination campaign was implemented, which led to strengthening individual immunity including HCWs [10]. According to abovementioned arguments, it was concluded that to improve work safety in hospitals, it is important to know the prevalence of SARS-CoV-2 infections among HCWs and to assess their determinants. It seems that without proper assessment, it will not be possible to effectively prevent potential future pandemic crises.

MATERIAL AND METHODS

Study design

The model of the cross-sectional epidemiological study was designed and carried out in October 2021–February 2022. The questionnaire used was developed by the WHO as a part of the Surveillance protocol for SARS-

CoV-2 infection among health workers [11]. Written consent to the use of it was obtained and subjects completed the questionnaire voluntarily and anonymously. The tool takes into account several occupational categories among HCWs, as well as the presence of symptoms accompanying the infection and its impact on the performance of professional duties (e.g., absenteeism from work, long-term complications of infection). The survey allowed the authors of the article to identify the determinants of increased risk of SARS-CoV-2 infection, such as the presence of chronic diseases of the study participant, the exact place of work, contact with a COVID-19 patient or other infected person, preparation for work in conditions of exposure to infection (training in the use of PPE) and the frequency of declared use of PPE while caring for patients. It was also possible to assess employees' attitudes towards preventive vaccinations against COVID-19 and to establish the percentage of vaccinated employees in the individual professional groups.

Paper questionnaires were delivered to all departments and units selected for the study hospitals, and their employees were invited to participate via employee e-mail. A place for submitting completed forms (closed box) has also been prepared in each department.

The study was approved by the Bioethics Committee of the Medical University of Silesia (PCN / CBN / 0022 / KB / 140/21).

The population

The study was conducted among HCWs of 2 multidisciplinary hospitals located in Katowice and Tychy (Silesian voivodeship). One of the facilities was transformed into a hospital solely dedicated to patients with COVID-19 (Tychy), while in the second only some of the departments were admitting patients infected with the SARS-CoV-2 virus (Katowice). These facilities employed a total of 2752 people (1875 in Katowice and 877 in Tychy) and all employees in both hospitals were invited to participate in the study.

Unfortunately, due to the excessive workload and numerous absences of HCWs during the study, complete responses were obtained from only 242 employees, which is <10% of the target population. From the collective information obtained from the management of hospitals regarding the number of SARS-CoV-2 infections among HCWs, only in 1 hospital (whose personnel accounted for 32% of HCWs invited to the study), it was possible to determine that 24.06% of employees were infected in the analyzed period. The second hospital did not collect mentioned above data. The criterion for inclusion in the study was practicing the medical profession in the hospitals where the study was conducted, regardless of the form of employment and written consent.

The statistical analysis

The data collected from questionnaires were subjected to statistical analysis using the methods of descriptive and analytical statistics. The analyses were based on the capabilities of the Statistica package v. 13.3 (TIBCO Software Inc., USA). For the presentation of qualitative variables, the number and percentage values were used, whereas, for quantitative variables (age or the length of daily use of personal protection during work), a transformation was made to categorical values based on the median value. The time declared by respondents when they were infected with the SARS-CoV-2 for the first time, was assigned to 3 periods: from the beginning of the pandemic to September 30, 2020 (first wave); October 1, 2020–February 28, 2021 (second wave); and March 1, 2021–September 30, 2021 (the third wave of the pandemic). The frequency of PPE wearing and preventive behaviors were assessed using an ordinal scale, within which the respondents could choose the following distractors: always, often, occasionally, or rarely. According to the questionnaire recommendations, the answer “always” referred to situations in which the use of PPE contained >95% of the working time when required, “often” referred to

situations when PPE was worn for 50–95% of the time, “occasionally” referred to 20–50% of the time, the answer “rarely” meant <20% of the working time when PPE was indicated to use.

The χ^2 test was used to determine the relationship between the prevalence of the declared coronavirus infection among HCWs and selected independent variables including gender, age (<40 years and \geq 40 years old), the occurrence of chronic disease, influenza vaccination, ward specificity, direct work with COVID-19 patients, type of contract, time of first exposure (first, second and third wave), completed training in the health and safety, duration of daily use of PPE (\leq 4 h and >4 h), exposure to bioaerosol, special protective measures in exposure to bioaerosol, frequency of hand disinfection in the workplace and outside it, frequency of wearing a protective face mask, social distance keeping and ventilation of closed rooms. The statistical significance criterion was based on the level of $\alpha < 0.05$.

RESULTS

In the study participated 242 employees of 2 selected hospitals. Among the respondents dominated women ($N = 217$, 89.7%), and subjects were aged 20–66 years. The age was $M \pm SD$ 39.7 ± 12.6 years (Me 40 years). The group of nurses and midwives ($N = 151$, 62.4%), and physicians ($N = 32$, 13.2%) were the main groups of HCWs who completed the questionnaire. The detailed structure of the respondents by occupational category is presented in Table 1.

Among the surveyed HCWs, 42 people (17.4%) declared the occurrence of chronic disease, mainly hypertension which affected 16 people (6.6%), and >1 chronic disease was diagnosed in 10 respondents (4.1%). More than half of the respondents ($N = 127$, 52.5%) were employed in medical wards (neurology, geriatrics, respiratory, internal medicine, psychiatry, neonatology), while 115 people (47.5%) worked in surgical and critical care wards such as hospital emergency department, intensive care unit

Table 1. Structure of healthcare workers employed in 2 multidisciplinary hospitals located in Katowice and Tychy, Silesian voivodeship, Poland, participants of the questionnaire survey conducted in October 2021–February 2022

Profession	Healthcare workers	
	employees of both hospitals (N = 2752) [n]	study participants (N = 242, 8.8%) [n (%)]
Physicians	798	32 (4.0)
Nurses or midwives	1237	151 (12.2)
Paramedics	88	14 (15.9)
Laboratory scientists	52	10 (19.2)
Care assistants	26	21 (72.4)
Physiotherapists	61	1 (1.6)
Dieticians	11	2 (18.2)
Psychologists	12	1 (8.3)
Pharmacists	9	0
Others	458	10 (2.1)

and surgery, orthopedics, laryngology, ophthalmology, obstetrics, and gynecology. In the primary workplace 151 respondents (62.4%) provided direct care to patients with COVID-19. Moreover, every fourth HCW (26.4%) had contact with COVID-19 patients outside their primary workplace, most often nurses (N = 47, 31.1% of all surveyed nurses). According to the respondents' declarations, the first contact with a patient infected with the SARS-CoV-2 virus usually occurred in the period from the beginning of the pandemic to the end of September 2020. The exact data are summarized in Table 2.

According to the respondents' declarations, 103 out of 242 surveyed HCWs were infected with SARS-CoV-2, which constitutes 42.6% of the surveyed HCWs in both hospitals. Such prevalence allowed the authors to estimate the potential percentage in the target population of all employees, the 95% confidence interval (CI) was 40.7–44.5%. It is worth adding that 17 respondents (7%) were not able to answer precisely whether they had been infected with the coronavirus. The most frequently infected in selected professional groups were care assistants (N = 12, 57.1%) and paramedics

(N = 7, 50%), however, the largest group were nurses and midwives (N = 60, 58.3%). The subjects tested positive for the presence of the coronavirus at various times during the COVID-19 pandemic. The highest number of infections (N = 57, 55.3%) occurred during the second wave of the pandemic (from October 2020 to the end of February 2021). Only every tenth respondent (N = 12, 11.7%) declared infection in the first months of the pandemic, i.e., from March until the end of September 2020.

In the declarations of the respondents referring to the source of potential infection, the most frequent answer was a previous contact with a patient infected with SARS-CoV-2 (<14 days from the day of the onset of symptoms or a positive results of SARS-CoV-2 test) at the workplace (N = 58, 56.3%). A smaller group of respondents (N = 40, 38.8%) could not unequivocally determine whether the infection was related to previous contact with an infected person in the work environment or the social one. The vast majority of respondents took part in OSH training dedicated to the risk of SARS-CoV-2 infection (N = 192, 79.3%), and at the same time 87.2% of employees

Table 2. Declared time of the first exposure to coronavirus in the workplace of healthcare workers in 2 multidisciplinary hospitals located in Katowice and Tychy, Silesian voivodeship, Poland, participants of the questionnaire survey conducted in October 2021–February 2022

Profession	Healthcare workers reporting exposure to the novel coronavirus (N = 236) [n (%)]		
	first wave	second wave	third wave
Physicians (N = 32)	18 (56.3)	9 (28.1)	5 (15.6)
Nurses or midwives (N = 147)	104 (68.9)	22 (14.6)	21 (13.9)
Paramedics (N = 14)	6 (42.9)	5 (35.7)	3 (21.4)
Laboratory scientists (N = 9)	4 (40.0)	4 (40)	1 (10.0)
Care assistants (N = 20)	13 (61.9)	6 (28.6)	1 (4.8)
Others (N = 14)	10 (71.4)	2 (14.3)	2 (14.3)
Total	155 (64.0)	48 (19.8)	33 (13.6)

First wave: March–September 30, 2020; second wave: October 1, 2020–February 28, 2021; third wave: March 1–September 30, 2021.

(N = 211) took part in detailed training on the correct use of special PPE. Similarly, most of the respondents (N = 155, 64%) declared participation in the training, which was conducted both in theoretical and practical form. Unfortunately, for about 16.5% of respondents, only theoretical training was conducted, and most of the training (51.2% of respondents' declarations) did not last longer than 2 h. Almost all respondents (N = 236, 97.5%) stated that the availability of appropriate PPE (surgical masks, masks with FFP2 filter, gloves, visors, barrier apron) was sufficient in their workplace. The availability of chemical skin disinfectants was similarly assessed, with 230 people (95.1%) saying that they were available near the immediate point of care for patients.

The respondents' declarations show that the daily use of disposable PPE among HCWs, who directly work with COVID-19 patients, significantly exceeded 4 h, this situation concerned 54 (48.2%) nurses and 7 (31.8%) physicians. The details about declarations of the PPE usage are presented in Table 3.

At the same time, the frequency of hand disinfection declared by the surveyed healthcare personnel was assessed, the results are presented in Table 4.

A major hazard of SARS-CoV-2 infection remains the exposure to bioaerosol from the respiratory tract of an infected patient. More than half of the respondents (57.4%) reported this form of exposure at work. The most common were nurses or midwives (N = 105, 69.5%) and physicians (N = 20, 62.5%). The respondents most often indicated exposure to bioaerosol during resuscitation (N = 104, 43%) or intubation (N = 90, 37.2%) and then during ventilation with a bad valve mask (N = 76, 31.4%), and also during bronchoscopy (N = 27, 11.2%) or tracheostomy (N = 27, 11.2%). It is worth adding that more than half of the respondents (51.6%) declared the use of dedicated PPE during mentioned procedures.

The results of differences in the percentage of HCWs infected with the SARS-CoV-2 virus in particular groups defined by demographic variables, declared health status, occupational categories, and declared exposure are presented in Table 5.

Simultaneously HCWs were asked about behavior outside the workplace, which (according to anti-epidemic recommendations) helps to reduce the potential risk of SARS-CoV-2 infection. The obtained results indicate that the respondents most often followed the recommendations

Table 3. The surveyed healthcare workers declaring the frequency of using individual personal protective equipment (PPE) during work with COVID-19 patients, Silesian voivodeship, Poland, participants of the questionnaire survey conducted in October 2021–February 2022

Frequency	Participants wearing PPE [n (%)]				
	gloves	surgical masks	FFP 2/3 masks	face protection	apron or protective coverall
Physicians					
always or often	22 (100)	17 (77.3)	22 (100)	22 (100)	22 (100)
occasionally or rarely	0	5 (22.7)	0	0	0
Nurses or midwives					
always or often	105 (100)	94 (89.5)	105 (100)	102 (97.1)	102 (97.1)
occasionally or rarely	0	11 (10.5)	0	3 (2.9)	3 (2.9)
Paramedics					
always or often	8 (100)	5 (62.5)	8 (100.0)	8 (100.0)	8 (100.0)
occasionally or rarely	0	3 (37.5)	0	0	0
Laboratory scientists					
always or often	6 (100)	6 (100)	6 (100)	6 (100)	6 (100)
occasionally or rarely	0	0	0	0	0
Care assistants					
always or often	6 (100)	6 (100.0)	6 (100.0)	5 (83.3)	6 (100)
occasionally or rarely	0	0	0	1 (16.7)	0
Others					
always or often	4 (100)	4 (100)	4 (100)	4 (100)	4 (100)
occasionally or rarely	0	0	0	0	0

FFP – filtering facepiece.

of wearing a protective face mask (82.2%), while the required social distance was the least frequently observed. Among other declared behaviors improving the safety of workers were disinfection of hands before and after contact with a patient, disinfection of hands outside work, wearing a protective face mask in everyday life, maintaining social distance, or ventilating closed rooms. It was not confirmed statistically significant differences between those behaviors in HCWs who became SARS-CoV-2 infected and who were not. Detailed data are presented in Table 6.

Following the applicable regulations, HCWs were eligible to receive free vaccination against COVID-19 in their units starting from December 31, 2020. At the time of the

study (October 2021–February 2022), all subjects were eligible to have received the full vaccination course – 2 doses of Comirnaty, Spikevax, or Vaxzevria vaccine and a booster dose. Obtained results suggest that only 75% of physicians and 70% of laboratory workers were fully vaccinated. In contrast, care assistants as well as nurses and midwives were the least vaccinated HCWs (38.1% and 10.6%, respectively). Among the most frequently declared reasons for refusal to vaccination were subjects' views (N = 14, 60% of the unvaccinated) and previous COVID-19 (N = 6, 26.1% of the unvaccinated).

The most frequently declared symptoms associated with SARS-CoV-2 infection were fatigue (67%), muscle

Table 4. Frequency of hand disinfection at different points of patient care declared by healthcare workers in 2 multidisciplinary hospitals located in Katowice and Tychy, Silesian voivodeship, Poland, participants of the questionnaire survey conducted in October 2021–February 2022

Frequency	Patients disinfecting hands [n (%)]			
	before and after touching a patient	before and after performing aseptic procedures	before and after exposure to the patient's body fluids	before and after contact with the patient's surroundings
Physicians				
always or often	21 (95.5)	22 (100)	22 (100)	21 (95.5)
occasionally or rarely	1 (4.5)	0 (0)	0 (0)	1 (4.5)
Nurses or midwives				
always or often	110 (97.3)	113 (100)	112 (99.1)	108 (95.6)
occasionally or rarely	3 (2.7)	0 (0)	1 (0.9)	5 (4.4)
Paramedics				
always or often	10 (100)	10 (100)	10 (100)	10 (100)
occasionally or rarely	0 (0)	0 (0)	0 (0)	0 (0)
Laboratory scientists				
always or often	6 (100)	6 (100)	6 (100)	6 (100)
occasionally or rarely	0 (0)	0 (0)	0 (0)	0 (0)
Care assistants				
always or often	12 (100)	11 (91.7)	12 (100)	12 (100)
occasionally or rarely	0 (0)	1 (8.3)	0 (0)	0 (0)
Others				
always or often	4 (100)	4 (100)	4 (100)	4 (100)
occasionally or rarely	0 (0)	0 (0)	0 (0)	0 (0)

pain (62.1%), loss of smell and taste (57.3%), and headache (56.3%). In the group of most rarely reported symptoms were skin changes (3.9%) and abdominal pain (2.9%). It was found that 26 HCWs (25.2% of those infected) needed medical support due to declared symptoms, and the vast majority of them were on sick leave caused by infection ($N = 75$, 72.8%). The length of absenteeism from work ranged 5–80 days. The mean duration of incapacity to work was 18.7 days ($SD = 13.9$). Unfortunately, 5 HCWs (4.8% of all infected) required hospitalization. The dominating declared complications after SARS-CoV-2 infection were fatigue (37.8%) and impaired cognitive processes (21.4%), as well as headaches (17.5%). Importantly, 14 employees (13.6%) needed specialist

treatment due to the long-term complications of the infection.

DISCUSSION

The bibliography review reveals that the prevalence of SARS-CoV-2 infection among HCWs varied depending on the pandemic period and the type of workplace. The results of the meta-analysis from the end of 2021 indicate that the prevalence of infection also depends on the used diagnostic test, it was at the level of 11% (95% CI: 7–16) in the case of testing based on PCR tests and 7% (95% CI: 3–17) for serological tests [12]. In Poland, the seroepidemiological study of over a thousand HCWs employed in 5 hospitals located in different regions of the country

Table 5. Results of the χ^2 test assessing the relationship between the frequency of declared coronavirus infection among healthcare workers (HCWs) and selected independent variables, Silesian voivodeship, Poland, participants of the questionnaire survey conducted in October 2021–February 2022

Variable	Infected HCW (N = 103) [n(%)]	p
Sex		0.5
female	91 (41.2)	
male	12 (48.0)	
Age		0.7
<40 years	50 (41.7)	
≥40 years	53 (43.4)	
Multimorbidity		0.002
yes	9 (90.0)	
no	94 (40.5)	
Chronic disease		<0.001
yes	27 (100)	
no	76 (35.4)	
Influenza vaccination		0.7
yes	37 (63.8)	
no	65 (61.3)	
Hospital department		0.07
critical care and surgical	42 (36.5)	
medical	61 (48.0)	
Work in the COVID-19 zone		0.2
yes	76 (45.0)	
no	27 (37.0)	
Profession		0.6
physicians	15 (46.9)	
nurses or midwives	60 (39.7)	
paramedics	7 (50.0)	
laboratory scientists	3 (30.0)	
care assistants	12 (57.1)	
others	6 (42.9)	
Time of the first exposure to SARS-CoV-2 in the workplace		0.01
March–September 2020 (first wave)	57 (36.8)	
October 2020–February 2021 (second wave)	29 (60.4)	
March–September 2021 (third wave)	16 (48.5)	

Variable	Infected HCW (N = 103) [n(%)]	p
Training in the principles of using personal protective equipment		0.08
yes	86 (40.8)	
no	10 (45.5)	
do not know	7 (77.8)	
Type of occupational safety and health training in the principles of using PPE		0.4
theoretical	18 (45.0)	
practical	13 (52.0)	
theoretical and practical	61 (39.4)	
Duration of wearing PPE		0.09
≤4 h	46 (51.1)	
>4 h	29 (38.2)	
Bioaerosol exposure		0.8
yes	60 (43.2)	
no	43 (41.8)	
Using special PPE in the event of exposure to bioaerosol		0.8
yes	57 (45.6)	
no	12 (41.4)	
do not know	5 (41.7)	

PPE – personal protective equipment.

estimated 41.2% (95% CI: 38.1–44.2) prevalence of SARS-CoV-2 infection [13]. A seroprevalence study conducted in the Silesian Agglomeration showed that the frequency of coronavirus infections among HCWs was 19.1% (95% CI: 16.1–22.5) [2]. On the other hand, a single-center study in Wrocław, Poland, showed only a 7.12% prevalence of SARS-CoV-2 infection among HCWs [6]. Ultimately, it is believed that although serological tests are not a sufficiently accurate method, they are still suitable for estimating the prevalence of SARS-CoV-2 virus infection [14]. In the presented study, the prevalence of infection was based on declarations of the HCWs from 2 hospitals and equalled 42.6% (95% CI: 40.7–44.5%), so it was higher than in the previously cited studies. A similar scale of infection preva-

Table 6. The relationship between the frequency of declared coronavirus infection among healthcare workers and particular prophylactic behaviors (χ^2 test), Silesian voivodeship, Poland, participants of the questionnaire survey conducted in October 2021–February 2022

Variable	Participants (N = 242) [n (%)]		p
	infected (N = 103)	not infected (N = 122)	
Frequency			
hand disinfection			
before and after contact with a patient			0.5
always	58 (77)	78 (85)	
often	15 (20)	12 (13)	
occasionally	2 (3)	2 (2)	
outside of work			0.6
always	56 (54)	76 (54)	
often	38 (37)	51 (37)	
occasionally	6 (6)	11 (8)	
rarely	3 (3)	1 (1)	
face mask wearing outside of work			0.5
always	85 (83)	114 (82)	
often	17 (16)	25 (18)	
occasionally	1 (1)	0 (0)	
Maintaining social distance			0.1
always	34 (33)	59 (42)	
often	49 (47)	64 (46)	
occasionally	14 (14)	8 (6)	
rarely	6 (6)	8 (6)	
Ventilation of closed rooms			0.8
always	44 (43)	69 (50)	
often rarely	42 (41)	51 (37)	
occasionally	14 (13)	16 (11)	
rarely	3 (3)	3 (2)	

lence was observed in a single-center study conducted at the University Hospital in Kraków, Poland (42.7%) [7]. Declarations confirming the previous SARS-CoV-2 infection most often concerned care assistants (57.1%) and paramedics (50%) who spent more time with patients. Similarly, the results of the British study confirmed

that direct contact with the patients and their environment increases the risk of infection of HCWs about 1.5–2.5 times, with the highest relative risk observed in the group of nurses OR = 2.28 (95% CI: 2.23–2.34) [15]. In contrary result of the own study did not confirm statistically significant differences between declarations of

HCWs about past infection and their age, sex or terms of employment and type of work. However, It was found that HCWs who declared the occurrence of chronic disease ($p < 0.001$) or multimorbidity were significantly more frequently infected ($p = 0.002$). Moreover, infections were more common during the second wave which was the period October 1, 2020–February 28, 2021. The increase in seroprevalence after the second wave (22.9%) compared with the first one (2.4%) (OR 12.1, 95% CI: 4.6–31.3, $p < 0.0001$) was also shown in a Polish study conducted in a teaching hospital [8]. The authors' observations differed slightly from the results of the study conducted in one of the hospitals in Oman, where women were infected more often ($p = 0.041$). Nevertheless, similarly to the authors' study, HCWs who experienced exposure to exposure while working with patients were more often infected ($p < 0.001$) [4]. The own study confirmed that as many as 56.3% of infected HCWs had contact in the workplace with a person who had a confirmed or suspected infection. Another study from Malaysia [16] confirmed that the source of coronavirus infection for HCWs, at the beginning of 2021, was related to working in the hospital, while in the later period, it was rather related to the social environment. This observation may indirectly indicate the improvement of employees' behaviors towards safety regulations while working with patients (use of PPE, disinfection, etc.), but it is also an effect of the uncontrolled influence of social contacts in the later period of the pandemic.

The vast majority of surveyed HCWs, who declared SARS-CoV-2 infection, experienced at least 1 symptom of the disease, this concerned (96% of respondents with a positive history). In contrast, a screening study conducted in Egypt, with the use of the PCR method to identify infections among HCWs, showed that most respondents (68% of infected physicians) had no symptoms of the disease [17]. The observed difference is probably a result of different collections of data regarding infection his-

tory. In the own study, HCWs only declared the previous infection but in the quoted study, a standard screening test was used. It is also worth citing the results of another study of hospital workers in Israel. In the initial phase of the pandemic, only 1 respondent (0.2%) turned out to have an asymptomatic infection [18]. It can be observed that there are large discrepancies between the compared results of studies, likely because they were based on various evaluation criteria and related to different periods of the pandemic.

The results of the own study suggest that, according to HCWs' declarations, individuals employed in medical departments got infected more often than those working in surgical and critical care departments, however, the observed difference was not statistically significant ($p = 0.07$). A similar situation applied to HCWs employed in intensive care units in the United Kingdom. The findings confirmed a lower incidence of SARS-CoV-2 infection among critical care HCWs in comparison to those employed elsewhere (aOR = 0.76, 95% CI: 0.64–0.92) [19], most likely due to better availability and experience in the use of PPE by HCWs in intensive care units. In the own study, the application of health and safety rules and the use of PPE contributed to a lower percentage of infections among the PPE-trained respondents than in untrained (40.8% vs. 45.5%). Other studies also confirmed that OSH training in the use of PPE reduces the number of infections among HCWs [20–22].

Active prophylaxis is important in reducing the number of SARS-CoV-2 virus infections among HCWs. Employees' declarations in the presented study, indicate that 90.5% of HCWs were fully vaccinated. In the systematic review of HCWs attitudes regarding vaccination against COVID-19, 21% to 95% of respondents declared full acceptance. Men, physicians, and employees who had previously been vaccinated against influenza were found to be more in favor of vaccination [10]. In the authors' study, >10% of medics were reluctant to vaccinate against

COVID-19. The main reasons for their aversion were personal views. A Chinese study [23] on the attitudes of HCWs towards vaccination against COVID-19 found that only 4.74% of the respondents were against vaccination and nearly 77% strongly accepted the use of preventive vaccinations. It is worth adding that it was a much higher percentage than that declared in the general population (56%). The results of the study conducted in Saudi Arabia [24], suggest that only 54% of HCWs working with COVID-19 patients strongly support universal vaccination against the new coronavirus.

The SARS-CoV-2 infections among HCWs also determined sickness absences, and thus the need to reorganize patient care in medical facilities. The own study showed that the average HCW's sickness absence was 18.7 days. Gohar et al. [25] indicated that the relatively long average period of HCWs' absenteeism may not only be a result of purely health factors, such as the consequences of SARS-CoV-2 infection or excessive physical workload. It may be also the consequence of frequent changes in the organization of the work in the departments or extension of working hours dictated by dynamic situations during the pandemic so these factors had a significant impact on the mental state of employees. On the other hand, the results of the study by Edge et al. [26] regarding HWC's sickness absence in England indicate no significant increase during the first 10 weeks of the pandemic compared to the corresponding period in the previous year. In the Italian cohort study, the median recovery time in the group of infected HCWs was 24 days, so it was similar to the data obtained in the authors' study. Only in the group of older HCWs, who were also hospitalized more often, this time was significantly longer and amounted to 33.5 days [27].

Finally, the results of the presented study indicate a relatively high prevalence of SARS-CoV-2 infections among HCWs employed from October 2021 to February 2022 in both hospitals. It is worth noting that infection prevalence was based on employees' declarations, and addi-

tionally, the study period was characterized by the highest number of new cases of COVID-19 in the region, and consequently, a higher number of hospitalized starting from November 2021 [28].

However, in practice, the results of this study may help to recognize the most important determinants which are necessary for planning the management of a future potential epidemiological crisis.

Limitations

The main limitation of the study is the low participation rate of HCWs (10%), which significantly could impact the assessment of the real scale of infection prevalence in occupationally active medical workers. Due to the dynamics of the pandemic, the authors decided that the changing circumstances made it impossible to continue the study with the proposed tool. Both circumstances most likely influenced the obtained results. Nonetheless, the strength of the work is the analysis of the behaviors of HCWs aimed at reducing the risk of SARS-CoV-2 infection.

CONCLUSIONS

The prevalence of declared SARS-CoV-2 infection among the researched HCWs in the Silesian voivodeship was high and amounted to 42.6% (95% CI: 40.7–44.5%). SARS-CoV-2 infection was more common among HCWs suffered from chronic diseases and those who had previous contact with coronavirus-infected patients. Determinants such as sex, age, occupation, place of work (hospital unit), participation in training in the use of PPE or particular exposure to bioaerosol did not significantly change the risk of infection. Despite the frequent declared use of PPE and participation in OSH training, prolonged sickness absence was not avoided, which resulted in a significant burden on other HCWs with professional duties. The high rate of vaccinated respondents, however, gives hope for a lower rate of severe COVID-19 cases among HCWs in the future.

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