ORIGINAL ARTICLE

Post-COVID-19 Conditions Among Health Workers: Prevalence and Occupational Impacts in a Thai University Hospital

Rangsiman Chuntirapong, MD[1], Naesinee Chaiear, MD, MMedSc, PhD[1], Piroon Mootsikapun, MD[2]

[1] Department of Community, Family and Occupational Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand; [2] Division of Infectious Diseases and Tropical Medicine, Department of Internal Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand

Objective: To determine 1) the prevalence of health workers (HWs) experiencing the World Health Organization (WHO) defined post-COVID-19 conditions (PCCs), 2) their impact on work, and 3) factors associated with PCCs in a tertiary hospital in Khon Kaen, Thailand.

Materials and Methods: The present study was a retrospective descriptive study that involved 3,285 HWs with confirmed SARS-CoV-2 infection. A simple random sample of 384 participants was selected. Data was collected using validated self-administered questionnaires, which had content validity index (CVI) scores ranging from 0.7 to 1.0, which evaluated PCCs consistent with WHO criteria, which is of two months duration or longer, as well as demographic data, professional roles, work schedules, and impact on work including absenteeism, shift modifications, and income reduction. Data were analyzed using descriptive and inferential statistics.

Results: From 346 respondents, providing a 90.0% response rate, with 84.1% female, and a mean age of 37.1±10.4 years, the prevalence of HWs experiencing PCCs was 30.9% (95% CI 26.3 to 36.0). Common symptoms included fatigue in 46.7%, chronic cough in 23.4%, and sleep disturbances in 21.5%. Among those with PCCs, 57.0% reported impacts on their work, including shift modifications for 30.8%, increased absenteeism for 16.8%, and a marked reduction in work efficiency of more than half for 5.6%. Furthermore, 72.9% reported continuing to work despite symptoms. Inferential analysis showed a statistically significant association between rotating shift work and PCCs among nurses (cOR 3.32, 95% CI 1.02 to 14.63), however, this association was not significant after adjusting for covariates (aOR 2.35, 95% CI 0.63 to 8.73).

Conclusion: The prevalence of HWs experiencing PCCs was 30.9% (95% CI 26.3 to 36.0), and more than half of the affected HWs experienced impacts on their work. No factors were found to be significantly associated with PCCs development in this study. These findings suggest that return-to-work medical assessments for HWs recovering from respiratory infections should consider appropriate job modifications when residual symptoms persist.

Keywords: Post COVID-19 condition; Health worker; Impact on work

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Post COVID-19 conditions (PCCs), as defined by the World Health Organization (WHO), refer to symptoms persisting longer than three months after COVID-19 recovery. Global prevalence is estimated at 10% to 20%[1], with higher rates reported in Europe at 44% and Asia at 51%[2]. In Thailand, prevalence ranges from 33% to 47%[3-5], similar to Malaysia's 27%[6] but higher than Singapore's 17%[7]. Among health workers (HWs), prevalence is often higher due to greater exposure and physical demands, ranging from 30% to 70% in Asia and 20% to 40% in Europe[8,9]. These variations reflect differences in definitions, symptom duration, demographics, disease severity, vaccination, viral variants, and study methods[10].

PCCs often affect multiple organ systems, common symptoms include fatigue, cognitive dysfunction, and respiratory issues, involving possible biochemical and cellular disruptions[11,12]. HWs are particularly affected due to long shifts, high workloads, and added stress from isolation and staff shortages, increasing the risk of burnout and medical errors[13-15]. Globally, PCCs has impacts on HWs' work, functional capacity, and daily life. In Sweden, 8.0% reported moderate to severe work disruptions[16], while in Switzerland, 14% experienced prolonged symptoms that led to missed work[17]. In Italy, 45%

Correspondence to:

Chaiear N.

Department of Community, Family and Occupational Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002, Thailand.

Phone: +66-81-7081866

Email: naesinee@kku.ac.th

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returned to work with restrictions nine months post-infection[18]. PCCs also impact home and social life[8].

Despite these global trends, data on PCC among HWs in Thailand remain limited[6,8,19], particularly concerning the prolonged symptoms' impact on work. Understanding the proportion and nature of PCC in HWs is essential for informed occupational health planning, targeted interventions, and policy revision. This study aimed 1) to determine the proportion of HWs presenting with PCCs, 2) to determine their impact on work, and 3) factors associated with PCC in a university hospital.

Materials and Methods

Study design, population, and sample

A retrospective descriptive epidemiological study was conducted among HWs who contracted COVID-19 between January 2022 and December 2023 at a university hospital, Thailand. The study was approved by the Human Research Ethics Committee of Khon Kaen university (approval number HE661367).

The target population comprised 3,400 HWs aged 18 to 65 years who tested positive for COVID-19 via RT-PCR or rapid test and were registered with the Occupational Health Management and Service Section of a university hospital between January 1, 2022, and December 31, 2023. After excluding 115 individuals with reinfection within three months, the final study population included 3,285 eligible HWs. The sample size, which was 384 participants, was calculated using WinPepi version 11.65, estimating a proportion with simple random sampling at a 95% confidence level and a 5% margin of error, assuming p=0.5 for a conservative estimate. Participants were selected using a Simple Random Sampling Applet online[20], with HWs listed by registration date.

Definitions

PCCs were defined as the presence of at least one residual symptom persisting for three months after COVID-19 infection. These symptoms were likely related to post-COVID-19, had an unknown origin, were not previously experienced before infection, and could not be attributed to pre-existing conditions, aligning with the WHO definition. Similarly, ongoing symptomatic COVID-19 was defined using a shorter follow-up period, with symptoms assessed up to six weeks after infection[1].

Tools

The present study employed a self-administered questionnaire designed to assess residual symptoms of PCCs and their impact on HWs. The questionnaire was based on WHO's clinical case definition of PCCs by a Delphi consensus[21], with follow-up at six weeks and three months. A panel of three experts, which included a specialist in infectious diseases, a pulmonologist, and an occupational physician, each with over five years of experience, validated the questionnaire. Only items with an index of objective congruence (IOC) score of 0.5 or greater were retained[22]. The validation process involved two rounds. In the first round, modifications were made, particularly on respiratory symptoms as per the pulmonologist's recommendations. The researchers revised the questionnaire to enhance clarity, ensuring that the symptoms reflected abnormal conditions such as fatigue/excessive tiredness beyond normal levels, or difficulty breathing unrelated to physical activity. The final version, re-evaluated by all three experts, maintained 60% of items scoring 1.0 and 40% scoring 0.7. The questionnaire was structured into four parts. The first part focused on demographic data and baseline health. The second part, PCCs self-assessment, covered symptoms experienced during the acute phase, which is within the first 14 days, and residual symptoms at six weeks and three months post-infection. The third part assessed work impact, including work efficiency compared to pre-infections, assuming 100% pre-infection efficiency, night shift performance, and absenteeism between six weeks and three months post-infection. The fourth part assessed the impact on daily activities.

Data collection

Three hundred eighty-four HWs with confirmed COVID-19 from the study period, were selected through simple random sampling. Questionnaires were distributed according to the randomized list between April first and July 31, 2024, via paper or QR code. Data was recorded in Google Sheets, with thorough re-checks to correct errors or missing entries.

Statistical analysis

Data was analyzed using IBM SPSS Statistics, version 28.0 (IBM Corp., Armonk, NY, USA; KKU license). Descriptive statistics summarized participant characteristics, PCCs, and impacts on work and daily life. Chi-square tests were used to compare categorical variables, including subgroup analysis among nurses. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. Univariable logistic regression

Table 1. Demographic data of HWs across different stages of COVID-19 infection

	HWs with COVID-19 infection during first 14 days (n=346); n (%)	HWs with ongoing symptomatic COVID-19 at 6 weeks after infection (n=187); n (%)	HWs with PCCs at 3 months after infection (n=107); n (%)
Age categories			
Below 40 years	226 (65.3)	130 (69.5)	82 (76.6)
40 years and above	120 (34.7)	57 (30.5)	25 (23.4)
Sex			
Male	55 (15.9)	25 (13.4)	17 (15.9)
Female	291 (84.1)	162 (86.6)	90 (84.1)
Job titles			
Doctors	17 (4.9)	7 (3.8)	4 (3.7)
Nurses	200 (57.8)	110 (58.8)	67 (62.6)
Medical technologists	36 (10.4)	21 (11.2)	6 (5.6)
Pharmacists	18 (5.2)	9 (4.8)	5 (4.7)
Labor	44 (12.7)	26 (13.9)	11 (10.3)
Support staffs	31 (9.0)	14 (7.5)	14 (13.1)
Shift role			
Yes	304 (87.9)	166 (88.8)	97 (90.7)
No	42 (12.1)	21 (11.2)	10 (9.3)
Co-morbidities			
No comorbidities	284 (82.1)	152 (81.3)	88 (82.2)
At least one chronic disease	62 (17.9)	35 (18.7)	19 (17.8)
Obesity	43 (12.4)	30 (16.0)	14 (13.1)
Diabetes	8 (2.3)	1 (0.5)	0 (0.0)
Immunocompromised	3 (0.9)	1 (0.5)	2 (1.9)
Cancer	2 (0.6)	0 (0.0)	1 (0.9)
Heart diseases	2 (0.6)	0 (0.0)	0 (0.0)
Chronic kidney disease	1 (0.3)	0 (0.0)	0 (0.0)

HWs=health workers; PCCs=post COVID-19 conditions

was used to identify potential risk factors for PCCs in nurses, including rotating shift role, gender, age, co-morbidities, COVID-19 severity, and vaccination status. Variables with p-values of less than 0.2 were entered into a multivariable logistic regression model to assess independent associations. A p-value of less than 0.05 was considered statistically significant.

Results

Three hundred eighty-four HWs, which included 321 females and 63 males, were invited to participate. Three hundred forty-six HWs consented to the study, resulting in a 90.0% response rate. Among the participants, 291 (90.7%) were female and 55 (15.9%) were male. The mean age was 37.1±10.4 years, with 84.1% being female and most (65.3%) were under 40 years of age. Nurses constituted the largest group at 57.8%. The majority had no pre-existing conditions. The demographic distribution of HWs across different time points showed a consistent trend in age, gender proportion, and absence of comorbidities. Detailed demographic data are presented in Table 1.

Most HWs received at least four doses of the COVID-19 vaccine and experienced non-severe symptoms during the acute phase. More than half were treated with antiviral medications. During the acute phase, the most common symptoms were fever for 66.8%, fatigue for 63.9%, and sore throat for 55.2%. Other symptoms are presented in Table 2, first panel.

At three months post-infection, 115 participants reported residual symptoms, but eight were excluded due to symptoms deemed unrelated to PCCs. Ultimately, 107 participants (30.9%) (95% CI 26.3 to 36.0) were identified as having PCCs. The most frequently reported residual symptoms included feeling fatigue for 46.7%, chronic cough for 23.4%, sleep problems for 21.5%, and dizziness for 20.6%. At six weeks post-infection, 187 participants (54.1%) (95% CI 48.8 to 59.2) reported residual symptoms consistent with ongoing symptomatic COVID-19. The most common symptoms at this

Table 2. Clinical characteristics of HWs with COVID-19 infection during first 14 days, HWs with ongoing symptomatic and HWs with PCCs

	HWs with COVID-19 infection during first 14 days (n=346) n (%)	HWs with ongoing symptomatic COVID-19 at 6 weeks after COVID-19 infection (n=187) n (%)	HWs with PCCs at 3 months after COVID-19 infection (n=107) n (%)
COVID-19 vaccination status			
Received at least 4 doses	227 (65.6)	124 (66.3)	73 (68.2)
Received less than 4 doses	119 (34.4)	63 (33.7)	34 (31.8)
Number of COVID-19 infections			
One time	247 (71.4)	131 (70.1)	75 (70.1)
More than one time	99 (28.6)	56 (29.9)	32 (29.9)
Severity level during COVID-19 infection			
Non-severe	340 (98.3)	183 (97.9)	103 (96.3)
Severe	6 (1.7)	4 (2.1)	4 (3.7)
Medications			
Supportive	163 (47.1)	84 (44.9)	46 (43.0)
Antiviral drug	183 (52.9)	103 (55.1)	61 (57.0)

HWs=health workers; PCCs=post COVID-19 conditions

stage were feeling fatigue for 48.7%, chronic cough for 45.5%, and easily tired for 34.2%. When comparing symptom proportion across stages, respiratory symptoms were higher during the acute phase and at six weeks but declined by three months. Conversely, sleep problems increased over time, peaking at three months for 21.5%. Symptoms like fatigue remained consistently high across all stages at 47.4%, 48.7%, and 46.7%, respectively, with minimal variation. Similarly, reduced concentration or brain fog at 13.6%, 15.0%, and 13.1% remained relatively stable across all stages. These findings are detailed in Figure 1.

HWs with PCCs reported work-related impacts in 57.0% of cases. In both groups, a majority maintained high work efficiency of 90% to 100%, with 72.9% in the post COVID-19 group compared to 58.3% in the ongoing symptomatic group. The average work efficiency of HWs with PCCs was 87.7% when compared to pre-infection levels. Moderate reductions in work efficiency from 51% to 89%, were reported by 21.5% of the post COVID-19 group and 31.6% of the ongoing symptomatic group. The impact on night shifts was comparable between the two groups at 30.8% versus 32.1%, as were income reductions at 30.8% versus 37.4% and absenteeism rates at 16.8% versus 15.0%. Daily activities were similarly affected across both groups at 43.0% versus 44.9%. These findings are detailed in Table 3.

When categorized by job title, the work-related impacts among healthcare workers varied, as shown in Table 4. Nurses reported the highest impact, with 62.7% experiencing work-related effects. Efficiency below 90% was most frequently reported by pharmacists for 40.0%, followed by nurses for 28.4%. Similarly, night shift impacts were most prominent among pharmacists at 40.0%, followed by nurses at 35.8%. In contrast, doctors reported no work-related impacts. Among workers and support staff, the overall impact on work was relatively lower.

Regarding risk factors for PCCs in nurses, six variables were identified in the univariable analysis

Table 3. Proportion of impacts experienced by HWs with PCCs and ongoing symptomatic COVID-19

Impacts	HWs with PCCs (n=107) n (%)	HWs with ongoing symptomatic COVID-19 (n=187) n (%)
Impact on work	61 (57.0)	139 (74.3)
Efficiency (compared to pre-infection)		
Mean±SD	87.7±14.5	83.8±17.4
90% to 100%	78 (72.9)	109 (58.3)
51% to 89%	23 (21.5)	59 (31.6)
Below 50%	6 (5.6)	19 (10.2)
Impact on night shifts	33 (30.8)	60 (32.1)
Impact on income	33 (30.8)	70 (37.4)
Impact on absenteeism	18 (16.8)	28 (15.0)
Impact on daily activities	46 (43.0)	84 (44.9)
Leisure activities	23 (21.5)	48 (25.7)
Financial activities	16 (15.0)	17 (9.1)
Self-care	15 (14.0)	25 (13.4)
Household chores	13 (12.1)	29 (15.5)
Household management	10 (9.3)	22 (11.8)
Caring for children or others	7 (6.5)	20 (10.7)

HWs=health workers; PCCs=post COVID-19 conditions; SD=standard deviation

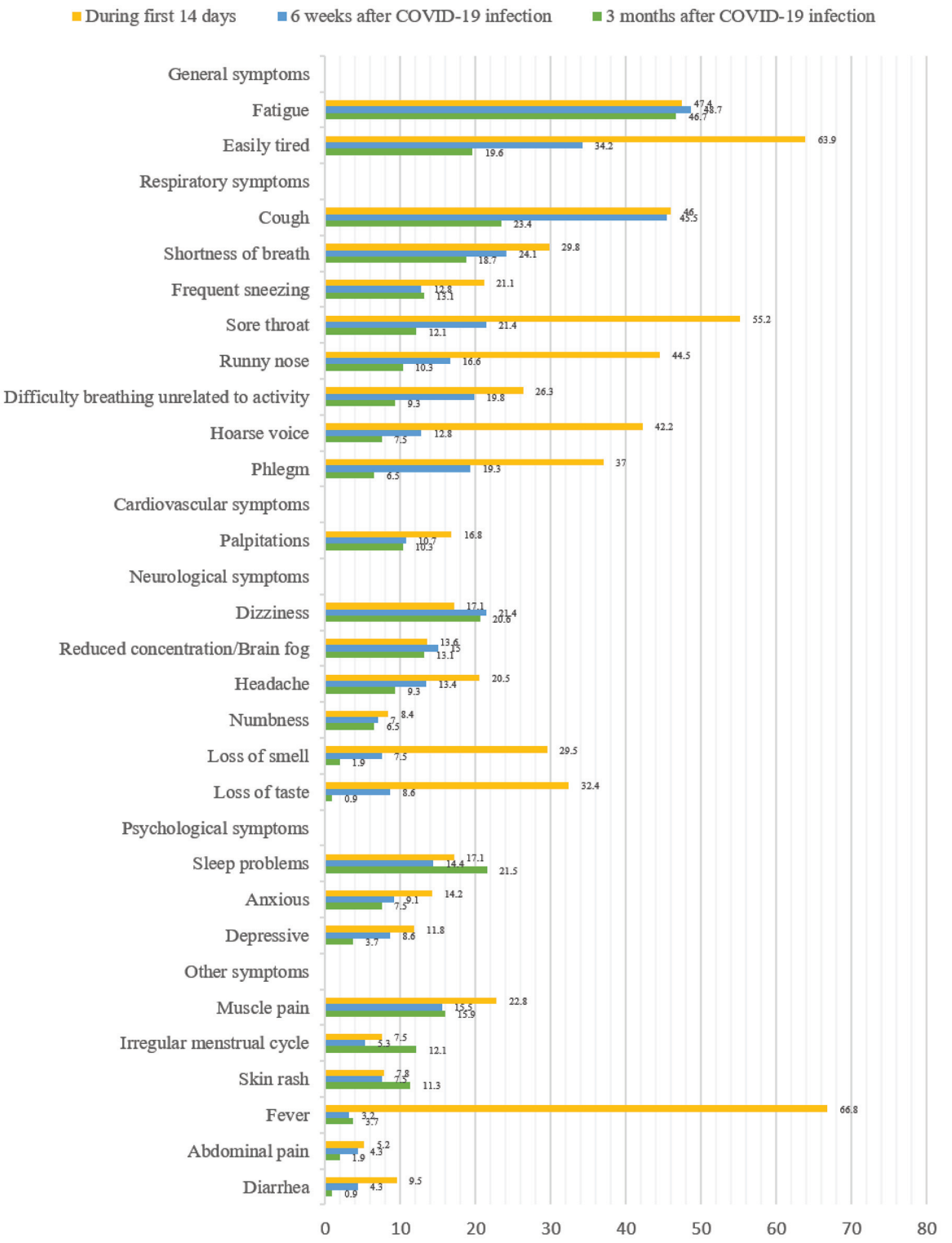

Figure 1. Percentage of residual symptoms showing changes over the 3-month period.

Table 4. Proportion of HWs with PCCs reporting work-related impacts, stratified by job title or shift role

	Feeling impact on work n (%)	Efficiency below 90% n (%)	Impact on night shifts n (%)	Impact on income n (%)	Impact on absenteeism n (%)
Job title					
Doctor (n=4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Nurse (n=67)	42 (62.7)	19 (28.4)	24 (35.8)	20 (29.9)	11 (16.4)
Medical technologist (n=6)	3 (50.0)	1 (16.7)	2 (33.3)	3 (50.0)	1 (16.7)
Pharmacist (n=5)	4 (80.0)	3 (40.0)	2 (40.0)	4 (80.0)	2 (40.0)
Labor (n=11)	5 (45.5)	3 (27.3)	2 (18.2)	3 (27.3)	1 (9.1)
Support staff (n=14)	7 (50.0)	3 (21.4)	3 (21.4)	3 (21.4)	3 (21.4)
Shift role					
Yes (n=97)	56 (57.7)	29 (29.9)	33 (34.0)	30 (30.9)	15 (15.5)
No (n=10)	5 (50.0)	0	0	3 (30.0)	3 (30.0)
Overall (n=107)	61 (57.0)	29 (27.1)	33 (30.8)	33 (30.8)	18 (16.8)

Table 5. Univariable and multivariable analysis for PCCs in nurses

Characteristics of nurse subgroup (n=200)	PCCs (%)	Univariable analysis			Multivariable analysis*		
		cOR	95% CI	p-value	aOR	95% CI	p-value
Rotating shift role							
Yes (n=179)	35.8	3.32	1.02 to 14.63	0.046	2.35	0.63 to 8.73	0.202
No (n=21)	14.3	1.00	-	-	1.00	-	-
Sex							
Male (n=14)	50.0	2.09	0.67 to 6.50	0.197	1.65	0.54 to 5.04	0.382
Female (n=186)	32.3	1.00	-	-	1.00	-	-
Age							
Below 40 years (n=138)	38.4	2.13	1.09 to 4.35	0.028	1.73	0.84 to 3.57	0.140
40 years and above (n=62)	22.5	1.00	-	-	1.00	-	-
Co-morbidities							
Yes (n=29)	34.5	1.05	0.44 to 2.40	0.893			
No (n=171)	33.3	1.00	-	-			
Severe during COVID-19 infection							
Yes (n=6)	66.7	4.13	0.71 to 32.94	0.115	3.52	0.61 to 20.11	0.158
No (n=194)	32.5	1.00	-	-	1.00	-	-
Received less than 4 doses							
Yes (n=59)	37.3	1.27	0.66 to 2.40	0.467			
No (n=141)	31.9	1.00	-	-			

PCCs=post COVID-19 conditions; cOR=crude odds ratio; aOR=adjusted odds ratio; CI=confidence interval

* Adjusted for rotating shift role, sex, severity, and age at time of infection

with p-values less than 0.2. Of these, rotating shift role, gender, age, and severity during infection were included in the multivariable logistic regression model. However, none were independently associated with PCCs after adjustment (Table 5).

Discussion

The present study revealed that 30.9% (95% CI 26.3 to 36.0) of HWs experienced PCCs. With a 90.0% response rate from 346 out of 384 respondents, the sample size was adequate, supported by a best-case analysis estimating 27.9% (95% CI 23.6 to 32.6) and a worst-case analysis estimating 37.8% (95% CI 33.1 to 42.7), confirming data robustness. According to the hospital's personnel department, the average staff age is 39.7 years with 80% female workforce[23]. The study sample showed a mean age of 37.1±10.4 years and an 84.1% female, closely matched this profile, supporting the representativeness of the findings. Data collection used a structured, validated questionnaire developed by three experts, with only items scoring IOC of 0.5 or greater being retained, ensuring content validity[22]. To enhance diagnostic accuracy, eight cases with symptoms clearly

unrelated to PCCs were excluded, aligning with WHO criteria requiring symptoms to persist for three months or longer post-infection without alternative explanations[21].

The most commonly reported symptoms among HWs with PCCs in the present study were fatigue, chronic cough, and sleep problems, consistent with Thai and international findings[6,19,24,25]. Fatigue remained the most prevalent across studies, followed by respiratory symptoms. Although the third most common symptom varied, studies in HW populations mainly comprising nurses, similar to the present study, frequently identified neuropsychological symptoms. The 30.9% PCC prevalence found here was comparable to a Canadian study at 27%[25]. While the proportion of PCCs among HWs is often higher than in the general population[8,9,19], the present study found a slightly lower rate than other reports from Thailand, which ranged from 32.9% to 47.0%[3-5]. This difference may be explained by the study population's younger age, non-severe illness, high vaccination rates, and strict exclusion of symptoms unrelated to PCCs.

In the present study, however, no variables remained significantly associated with PCCs among nurses after adjusting for covariates, possibly due to the limited sample size and the descriptive nature of the study design. According to prior research[25], an adequate sample size for multivariable logistic regression would ideally require around 200 cases and 200 controls; however, this study included only 67 nurses with PCCs. A larger cohort would be required to confirm these associations. Age and gender effects could not be fully assessed, as most participants were female and under 40. However, previous studies indicated that older adults may recover more slowly due to comorbidities, while female HWs face higher risks from immune and caregiving burdens[10]. Frontline workers like nurses and patient care assistants are more vulnerable due to high exposure, shift work, and physical strain. The relatively lower PCCs prevalence in the present study may reflect a younger, healthier workforce, milder infections, high vaccination rates, and strict exclusion of unrelated symptoms. In contrast, higher prevalence was reported in Malaysia at 50.7%[26] and Singapore at 47.5%[27], possibly due to shorter follow-up periods.

Additionally, symptom tracking over time revealed both persistence and change. PCC prevalence declined from 54.1% at six weeks to 30.9% at three months, indicating gradual recovery, in line with previous studies[2,8]. Respiratory symptoms peaked early but subsided by three months, likely due to resolving inflammation and lung repair[28]. Fatigue remained the most persistent symptom at 46.7%, possibly related to prolonged immune response, autonomic dysfunction, and hormonal imbalance[29-31]. Its persistence may reflect the predominantly young, female nurse population who faced high workloads, rotating shifts, stress, and sleep disturbances, all of which were linked to fatigue and cognitive symptoms[25,32]. Dizziness and brain fog were also commonly reported, likely due to neuroinflammation and autonomic dysfunction[29,30].

The present study differentiated between ongoing symptomatic COVID-19 at six weeks and PCCs at three months for a clearer comparison. At six weeks, respiratory symptoms were predominant and overlapped with the acute phase, showing gradual improvement over time. In contrast, symptoms persisting at three months indicated prolonged effects, confirming PCCs as defined by WHO. This distinction is essential for understanding symptom progression and identifying long-term occupational impacts on HWs, as shown in Figure 1.

Sleep problems increased over time, affecting 21.5% at three months and were more common among night-shift nurses with 35.8%, second only to pharmacists. However, the small pharmacist sample limits generalizability. Shift work disrupted sleep patterns and recovery, creating a cycle of fatigue and stress[32,33]. Work-related impacts were reported by 57.0% of HWs with PCCs, rising to 62.7% among nurses, reflecting the physical and emotional demands of their caregiving roles[25,34].

Despite these challenges, 72.9% of HWs maintained high work efficiency of 90% to 100%, though some reported declines. Absenteeism remained low, aligning with data from Srinagarind Hospital, which had 0.95 times per year and 1.7 days per person[35] and supported by studies showing generally low nurse sick leave rates[36,37], likely due to staffing shortages and professional commitment. No impacts were reported among doctors, possibly due to greater autonomy. Structured systems in university hospitals may have helped HWs with PCCs sustain work efficiency[38-40].

HWs are vital to healthcare systems and often face long hours, high exposure, and physical and psychological demands. PCCs increase this burden, affecting health, daily functioning, and job performance. The present study found nearly one-third of the HW experienced symptoms three months post-infection, particularly fatigue, respiratory issues,

and sleep disturbances, which may disrupt both individuals and healthcare operations.

Limitations of the present study include self-reported symptoms, which may introduce subjectivity. Smaller sample sizes for doctors and pharmacists limit generalizability. No work-related impacts were reported among doctors, but a larger sample may show different results. High efficiency reductions and night shift impacts among pharmacists require further study. Future research should use balanced sample sizes to better assess PCCs' occupational impacts.

Conclusion

The present study highlights the burden of PCCs among HWs, with 30.9% (95% CI 26.3 to 36.0) affected. Among those, 57.0% reported impacts on their work. Despite this, 72.9% maintained high work efficiency. No individual factors were found to be significantly associated with PCCs after adjusting for covariates, possibly due to the limited sample size. These findings underscore the importance of workplace health policies that include appropriate medical assessments before returning to work and consider job modifications to support HWs affected by PCCs.

What is already known about the topic?

- PCCs prevalence among HWs ranges from 30% to 70% in Asia and 20% to 40% in Europe. Fatigue and respiratory symptoms are the most common.
- PCCs mildly affect daily life in most cases; 10% to 15% report moderate effects. Impacts on work among HWs are less explored.

What does this study add?

- PCCs prevalence was 30.9% among HWs in a high-demand, super tertiary hospital. Sleep problems ranked among the top three symptoms.
- 57.0% reported impacts on their work, particularly among nurses with rotating shifts, which involve 35.8%, underscoring the importance of return-to-work assessments and appropriate job modifications.

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Conflicts of interest

The authors declare no conflicts of interest.

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