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Re-Infection of COVID-19 in Lao health care workers: Vientiane capital, Champasak and Luangphabang, Lao PDR

Thidachanh Soukhasem[1*], Mick Soukavong[2], Angkham Ounavong[1]

[1]Institute of Research and Education Development, University of Health Sciences, Lao PDR
[2]Faculty of Medicine, University of Health Sciences, Vientiane, Lao PDR

*Corresponding author: Thidachanh Soukhasem, thidachanh_pp@hotmail.com

ABSTRACT

Background: The onset of the COVID-19 pandemic was officially declared in early 2020 with reports of re-infections emerging by mid-2020. The Centre for Disease Control and Prevention defines re-infection as cases where individuals test positive for COVID-19, either through Antigen Test Kits(ATK) or Polymerase Chain Reaction (PCR) tests, after previously recovering and testing negative for 90 days. Lao PDR witnessed a significant surge in cases among various sectors including the healthcare workers (HCWs) who were in close contacts of previously infected individuals.

Objectives: To determine the re-infection rates of COVID-19 in HCWs at Lao hospital settings.

Methods: This cross-sectional study employed standardized questionnaires to gather demographic information, history of COVID-19 infections, and associated factors from HCWs participants. After obtaining ethical approval, data was collected and meticulously recorded in Microsoft Excel 2020. Subsequently, the recorded data was entered into a database for analysis.

Results: The study included 405 participants, predominantly female (80%) with an average age of 37.9±11(20-67) years. Majority of participants (75.5%) served in patient care departments, with 47% being nurses. Remarkably, 87% had been actively engaged in hospital duties prior to the COVID-19 outbreak. Regarding vaccination, 77% had received the Sinopharm vaccine, while smaller percentages were vaccinated with Astra Zeneca (13%), Johnson & Johnson (4%), Pfizer (4%), and Sputnik (2%). Of the 245 HCWs who were infected at least once, 59 experienced re-infections (2-3 times), resulting in a re-infection rate of 24.1% (95% CI: 18.7% - 29.4%). Re-infected individuals exhibited symptoms within an average of 3.27 days, with most diagnoses made using ATK (76.27%). The majority (88.1%) of re-infected HCWs reported mild symptoms. Notably, 96% of HCWs with recurrent infections engaged in social activities weekly.

Conclusion: Despite high immunization rates among study participants, the study underscored the persistent risk of COVID-19 re-infection among healthcare workers in Lao PDR, emphasizing the importance of ongoing preventive measures. However, the study acknowledged the limitations of retrospective interviews and emphasized the need for continuous surveillance and proactive strategies to prevent future outbreaks.

Keywords: COVID-19, Healthcare worker, Lao PDR, Re-infection

1. Introduction

The SARS-CoV-2 pandemic has significantly impacted global health, primarily spreading through airborne droplets. Common symptoms include fever, headache, fatigue, and respiratory or digestive issues [1]. Healthcare workers (HCWs), as the frontline workforce, face a high risk of contracting COVID-19. In 2020, 14% of HCWs globally were infected with rates as high as 40% in some regions [2]. A systematic review found a 51.7% prevalence of positive COVID-19 tests among HCWs, with most data from China, the USA, and Europe [3]. Another meta-analysis found that 10.1% of all COVID-19 cases were among HCWs [4]. In Brazil, 42.4% of symptomatic HCWs tested positive [5].

Re-infection research indicates immunity may wane over time, increasing susceptibility. Factors such as emerging variants, immune response, and vaccination status influence re-infection risk. In the UK, re-infection rates were higher among those with mild initial infections or who were unvaccinated [6]. In India, re-infections were mainly driven by variants like Delta [7]. A systematic review suggests protection from prior infection can vary based on time elapsed since infection and individual health status [8]. Despite the availability of extensive global data, there is limited information on COVID-19 re-infection among HCWs in Lao People's Democratic Republic (Lao PDR) [9, 10]. Most studies focus on heavily affected regions like the USA, Europe, and China, neglecting Lao PDR [11]. Moreover, determinants such as symptom severity, timing between infections, vaccination status, and exposure have not been well studied in Lao PDR. This gap is crucial as HCWs are vital to pandemic management, and understanding their re-infection patterns is essential for preventing outbreaks and managing the workforce effectively.

This study aimed to address these gaps by investigating re-infection rates and contributing factors among HCWs in Vientiane Capital, Champasak, and Luangphabang, Lao PDR, thereby informing better prevention and infection control measures.

2. Methods

2.1 Study Area

The study was conducted at Mittaphab Hospital in Vientiane, as along with two provincial hospitals located in Champasak

and Luangphabang, representing the southern and northern regions of Laos PDR.

2.2 Study Design

This cross-sectional study was conducted over a one-year period from October 2022 to September 2023. Data collection took place from May to July 2023.

2.3 Sample size and sampling

The study population consisted of HCWs currently working closely with the patients at three hospitals, Lao PDR. The inclusion criteria included all HCWs present during the study period and who expressed willingness to participate.

This is the first study to identify the determinants of COVID-19 re-infection among HCWs in Lao PDR. The sample size was determined based on the total population of HCWs, estimated at 17,666 according to the overview of Lao health system development from 2009 to 2017. This study used a population size of 5,435 HCWs who were infected by COVID-19, as reported by the National Centre for Laboratory and Epidemiology (NCLE) [12]. By applying a 50% population proportion with a 95% confidence level and margin of error of 5%. The sample size was calculated using a formula (http://www.calculator.net/sample-size-calculator.html). The estimated sample size was at least 359 HCWs. We added 5% responders because HCWs were not always accessible or willing to participate. Therefore, 41 more healthcare workers were invited to participate in an interview, bringing the overall sample size to 400 respondents, which was considered adequate for our survey.

2.4 Data Collection

A multistage sampling approach was employed to systematically select participants for the study. In the first stage, one central hospital in Vientiane and two representative hospitals from the northern and southern regions of Lao PDR were randomly selected. This process ensured a geographically diverse sample of healthcare facilities. Upon arrival at the selected hospitals, departments were randomly chosen as the second stage of sampling. Finally, healthcare workers from each department were categorized into three groups: those who had never been infected, those who had experienced their first COVID-19 infection, and those who had been re-infected. Subsequently, a random selection of

healthcare workers from each of these categories was made.

All healthcare workers who were willing to participate and provided consent were included in the study. The survey administered to participants was divided into four factors: social demographics, individual characteristics, behavioural factors, and past medical history. In total, the survey consisted of 35-51 structured questions, including 6 items related to individual factors, 8 items on social demographics, 5 items concerning past medical history, and 16-32 items focused on disease conditions and behavioural factors.

All participants were informed about the study's objectives and given consent forms. Data collectors were available to clarify any questions and assist participants in completing the forms. To ensure data quality, interview forms were thoroughly checked for completeness with interviewers verifying that no information was missing. The team leader then summarized the daily number of completed forms and reported data collection conditions to the study coordinator.

2.5 Data Analysis

All data was entered twice into Microsoft Excel and then cleaned and double-checked. The data was analysed using STATA 14 (Stata Corp LP, College Station, USA). Descriptive statistics were calculated for both categorical and continuous variables and presented as numbers, percentages, means with minimum and maximum values, and standard deviation (SD).

2.6 Ethical Clearance

This survey was reviewed and approved by the Ethics Committee of the University of Health Sciences, Ministry of Health, Laos; under the title “A study of re-infection of COVID-19 and the related factors in Lao Health Care Workers Vientiane capital, Champasak and Luangphabang, Lao PDR”, N :441/REC; Date: 03 March, 2023. All data collected from HCWs were recorded anonymously, stored in a secure database. The study results were disseminated to the Institute of Research and Education Development (IRED), University of Health Sciences (UHS) and The Asian Development Bank (ADB): TA-9397 project. Confidentiality was maintained by using unique identification numbers on data collection tools instead of participant names.

3. Results

In this cross-sectional study, we investigated the occurrence of COVID-19 re-infections and the associated factors among healthcare

workers in Laos. The study was conducted at three following healthcare facilities: Mittaphab Hospital in Vientiane capital, Luangphabang Provincial Hospital, and Champasak Provincial Hospital, all located in Laos PDR. The data for this study were gathered between May 1st and July 31st, 2020, using structured interviews comprising four sections, each containing 35-51 self-administered questions. A total of 405 respondents participated in the study, and their data were subsequently analysed.

Demography of health care works

In the study population of 405 participants, the majority were female, accounting for 79.75%. The average age was 37.97 years, with standard deviation of ±11.42 (ranging from 20 to 67). Approximately 62.72% were married, and 92% identified as Lao Loum. Most respondents (76%) reported having 1-5 people in their household. Most of the participants (75.56%) worked in patient care within the hospital department. Nearly all technical staff (84%) and 47% of nurses had been employed in hospitals prior to the COVID-19 outbreak (85%). During the COVID-19 outbreak, 57.8% were engaged in patient care responsibilities, while 12% were involved in collecting samples and conducting COVID-19 tests (Table 1).

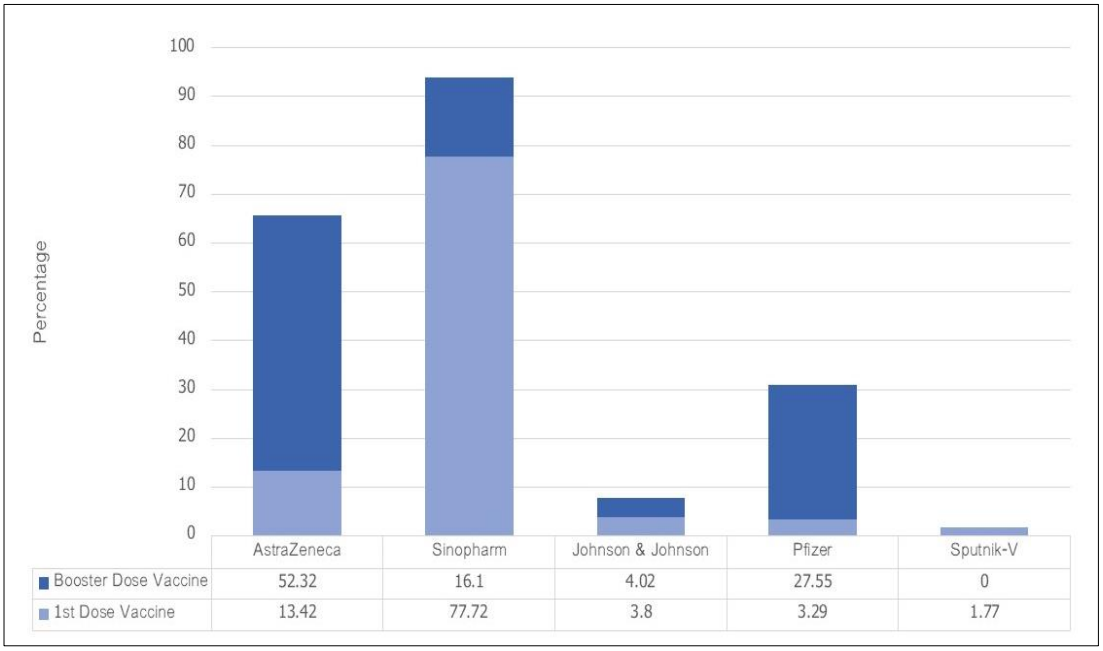
Table 1: The demography of HCWs (n=405)

Characteristics	Number (n)	Percentage (%)
Sex		
Female	323	79.75
Male	82	20.25
Ethnic Group		
Lao Loum	373	92.10
Mong, Lao Soung	14	3.46
Lao Theung	8	1.98
Other	1	2.48
Marital Status		
Single	143	35.31
Married	254	62.72
Divorce	4	0.99
Widowed	4	0.99
Number Family		
Mean (±SD)		4.67±1.74
Min-Max	1-11	

General characteristics and past health history:

Most individuals reported a history of health issues, with 38 HCWs had high blood pressure (9%). Only 2% were regular smokers, while 47% reported regular alcohol consumption. Regarding the COVID-19 vaccination, participants reported an average

of 3 administrations, with a standard deviation of ±0.86 (ranging from 0 to 5). More than 77% received the Sinopharm vaccine, while AstraZeneca, Johnson & Johnson, Pfizer, and Sputnik were administered at lower rates of 13%, 4%, 4%, and 2%, respectively (Figure 1).



	AstraZeneca	Sinopharm	Johnson & Johnson	Pfizer	Sputnik-V
Booster Dose Vaccine	52.32	16.1	4.02	27.55	0
1st Dose Vaccine	13.42	77.72	3.8	3.29	1.77

Figure 1: The receiving the COVID-19 vaccine rates

In the entire study population, 24.08% experienced a single infection, while 45.93% encountered repeated infections. Among those who experienced multiple infections, symptoms typically emerged before virus detection with an average onset of 3.27 days and a standard deviation of ±1.44 (ranging from 0 to 7). The majority (76.27%) detected the virus using ATK test kits.

Symptoms were predominantly mild (88.14%), with the most common being fever, cough, and sore throat, occurring in 84%, 83%, and 41% of participants, respectively. Nearly 89% of individuals practiced self-quarantine and managed their symptoms at home with the duration of quarantine and treatment spanning 8 to 14 days. During this period, individuals adhered to prescribed measures and monitored their symptoms closely to ensure optimal recovery. They commonly used antipyretic medicines such as Paracetamol (83%) and Vitamin C (91%). Interestingly, only 22% opted for anti-viral medications (Table 2).

Regarding behavioural factors, the infected population socialized at least once a week

(96%) and engaged in regular physical activity 4 times a week SD: ±4.97(1-5), both in/around the house (47%) and in the shade (29%). Prevention measures also involved washing hands after contact with patients, before eating, and after using the bathroom, respectively (88%, 86%, 81%). Additionally, most of them (94%) used gel or alcohol after contact with the patient, 93% wore masks when leaving the house, however, only 54% maintained a distance of 2 meters. Overall, these findings highlight the importance of implementing preventive measures such as mask-wearing, physical distancing, and minimizing social gatherings to reduce the risk of COVID-19 re-infection among HCWs (Table 2).

Table 2: General characteristics and past health history

Variables	Number (n)	Percentage (%)
Type of Diagnosis (Multiple Response)		
ATK	45	76.27
RT-PCR	15	25.42
Gene X-pert	14	23.73
Level of Severity		
No-Severe	52	88.14
Severe	4	6.78
Critical	3	5.08
Symptoms (Multiple Response)		
Fever	50	84.75
Cough	49	83.05
Tiredness	27	45.76
Loss of taste	12	20.34
Loss of smell	8	13.56
Sore throat	41	69.49
Headache	28	47.46
Aches and pains	34	57.63
Diarrhoea	2	3.39
A rash on skin	0	0
Discolouration of fingers or toes	0	0
Red or irritated eyes	1	1.69
Difficulty breathing or shortness of breath	11	18.64
Loss of speech or mobility, or confusion	2	3.39
Chest pain	5	8.47
Insomnia	9	15.25
Treatment at Hospital		
No	58	98.31
Yes	1	1.69
Non-Hospital, where other		
Home/House	53	91.38
Hotel/Guesthouse	1	1.72
Solution Centre	2	3.45
Dormitory	2	3.45
Medicine of Treatment (Multiple Response)		
Anti COVID	13	22.03
Antipyretic/Paracetamol	49	83.05

Variables	Number (n)	Percentage (%)
Anti Histamine	20	33.9
Expectorant	15	25.42
Vitamin C	54	91.53
Deewat	26	44.07
Antibiotic	23	38.98
ORS	28	47.46
Warm Water and Ginger Water	1	1.69

Rate of re-infection of COVID-19 and factors association in health care workers (HCWs):

A total of 405 participants were included in the analysis to investigate factors associated with being infected two or more times. Of the 245 HCWs who were infected at least once, 59 experienced re-infections (2-3 times), resulting in a re-infection rate of 24.1% (95% CI: 18.7% - 29.4%). The bivariate analysis revealed several key findings regarding the relationship between demographic, clinical, and occupational characteristics and infection status. The odds of being infected were lower for males compared to females, with a crude odds ratio (OR) of 0.57 (95% CI: 0.26 - 1.26), although this association was not statistically significant (P=0.10). Participants aged 40 years and older had significantly lower odds of infection compared to those aged 20-39 years (OR = 0.45, 95% CI: 0.24 - 0.84, P= 0.01), indicating that older age was associated with a reduced likelihood of infection. However, no significant associations were found between infection status and marital status, family size, prior work before January 1, 2020, comorbidity status, department, or vaccination status in participants who were re-infected ≥ 2 times (Table 3).

Table 3: Bivariate Analysis of Factors Associated with Re-infection (≥ 2 Times)

Factors	>= 2times of being infected		
	n (%)	Crude OR [95%]	P-value
Sex			
Male	51/323 (15.8)	1	
Female	8/82 (9.8)	0.57 (0.26-1.26)	0.1
Age group			
20-39	43/234 (18.4)	1	
>=40	16/171 (9.4)	0.45 (0.24-0.84)	0.01
Ethnic group			
Lao	57/376 (15.1)	1	
Hmong	1/14 (7.1)	0.43 (0.05-3.35)	0.4
Khmae	1/15 (6.7)	0.39 (0.05-3.09)	0.3
Marital status			
Single	22/143 (15.4)	1	
Married	37/262 (14.1)	0.90 (0.51-1.60)	0.7
Fam member			
≤4	32/214 (14.9)	1	

Factors	>= 2times of being infected		
	n (%)	Crude OR [95%]	P-value
>4	27/191 (14.1)	0.93 (0.53-1.62)	0.8
PoW			
Mittapharb	25/143 (17.5)	1	
Luangprabang	7/138 (5.1)	0.25 (0.10-0.60)	0.002
Champasack	27/124 (21.8)	1.31 (0.71-2.41)	0.3
Work-before-1stJan20			
No	8/58 (13.8)	1	
Yes	51/347 (14.7)	1.07 (0.48-2.40)	0.8
Comorbid			
No	47/307 (15.3)	1	
Yes	12/98 (12.2)	0.77 (0.39-1.52)	0.4
Department			
OPD	4/19 (21.0)	1	
IPD	43/306 (14.0)	0.61 (0.19-1.93)	0.4
Lab	9/23 (39.1)	2.41 (0.60-9.62)	0.2
Radio	3/16 (18.7)	0.86 (0.16-4.60)	0.8
Admin	0/41 (0)	N/A	
Vaccination against COVID-19			
No	0/10 (0)	1	
Yes	59/395 (14.9)	N/A	

N/A= Not applicable

4. Discussion

This demographic distribution suggested that the study captured a crucial segment of the healthcare workforce in Lao PDR, providing insights particularly relevant to frontline workers. Notably, 24.08% of the participants experienced a single infection whereas 45.9% reported recurrent infections, warranting an in-depth exploration of potential factors contributing to re-infection in this cohort. The findings aligned closely with the research objectives, highlighting the need for targeted interventions and preventive measures tailored to the specific needs and challenges faced by healthcare workers in the region. The re-infection rates observed among healthcare workers in our study align with emerging research on COVID-19 re-infections within this occupational group. For instance, a study by *Harvey et al.* (2021) reported re-infection rates of approximately 12% among healthcare workers, closely mirroring our finding of 13.58% [13]. Similarly, a comprehensive review by *Lumley et al.* (2021) highlighted varying rates of re-infection across different populations, emphasizing the heightened vulnerability of healthcare workers due to frequent exposure and the potential for viral transmission [14]. Moreover, a study conducted by *Hansen et al.* (2020) underscored the complexities of managing COVID-19 re-infections in healthcare settings, emphasizing the need for robust surveillance, preventive measures, and

vaccination strategies to mitigate transmission risks among frontline workers [15].

Several studies have explored the dynamics of COVID-19 re-infections among healthcare workers, offering valuable insights for contextualizing our findings. A study by *Abu-Raddad et al.* (2020) emphasized the role of vaccine efficacy in reducing re-infection rates, aligning with our observation that 77% of participants receiving the Sinopharm vaccine [16]. Furthermore, a research article by *Sheehan et al.* (2021) highlighted the challenges of maintaining preventive measures, such as maintaining physical distancing which resonated with our finding that only 54% of participants adhered to a 2-meter distance [17].

Additionally, the symptomatology observed in our study, including fever, cough, and sore throat, aligned with the findings reported by *Varia et al.* (2020), emphasizing the predominant manifestation of mild symptoms among healthcare workers [18]. Moreover, our results corroborated the self-quarantine practices and symptomatic management strategies adopted by healthcare workers, emphasizing the importance of proactive self-care and adherence to recommended guidelines [19]. Collectively, these comparative insights highlight the multifaceted challenges faced by healthcare workers in managing COVID-19 re-infections and underscore the imperative for continuous surveillance, research, and evidence-based interventions to safeguard this critical workforce.

However, this study had limitations due to the retrospective nature of interviews. Some of the answers might be predictable, so it cannot be compared in the study. It is also recommended to monitor and collect the history of infected people and find ways to deal with the outbreak again.

5. Conclusion

This study found that recurrent infections of COVID-19 among medical personnel in Lao PDR, even among vaccinated individuals. Despite, physical exercise remains an important factor to boost the immune system, and it is found that the participants were motivated to do the physical exercise. It is recommended to keep monitoring and collecting the history of infected people to prepare the plan to handle for further outbreak.

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