



A One-Year Prospective Cohort Study of SARS-CoV-2 Infection and Sociodemographic Factors in Thailand

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Abstract

Objective: COVID-19 was declared a global health emergency in January 2020 and a pandemic in March 2020. Although its clinical features and risk factors have been widely studied, most research has relied on retrospective or cross-sectional data, limiting insight into asymptomatic or mildly symptomatic cases. This study aimed to assess the occurrence of SARS-CoV-2 infection and its association with sociodemographic factors in a Thai population.

Method: A one-year prospective cohort study was conducted from October 2021 to November 2022 at Prachathipat Hospital, Pathum Thani (N = 202), and Vichaivej International Hospital (Samut Sakhon), Samut Sakhon (N = 212). Adults aged 18–65 years who were asymptomatic at baseline were enrolled and completed self-administered questionnaires at five time points. Sociodemographic, clinical, and vaccination data were analyzed for associations with infection.

Results: The cumulative incidence of SARS-CoV-2 infection was 47% at Prachathipat Hospital and 40% at Vichaivej International Hospital (Samut Sakhon). Reinfections occurred in 5.3% and 17.9% of participants, respectively, with no relapses reported. Genomic surveillance identified Delta and Omicron as the predominant variants during the study period. Common symptoms

included cough, sore throat, fever, runny nose, and fatigue. Higher infection rates were observed among healthcare workers and individuals with specific sociodemographic profiles.

Conclusion: These findings provide important insights into infection patterns and risk factors across diverse Thai populations and may support more targeted public health strategies.

Keywords: COVID-19, Prospective cohort study, SARS-CoV-2 Infection, Epidemiology, Sociodemographic factors

What was Known

- The COVID-19 pandemic in Thailand was characterized by waves driven by different SARS-CoV-2 variants between 2020 and 2021.
- A combination of longitudinal and cross-sectional data provided valuable insights for developing targeted interventions and understanding the evolving trends of the pandemic.

What's New and Next

- The study revealed the rates of COVID-19 occurrence, relapse, and reinfection among Thai participants, while identifying key sociodemographic factors associated with infection.
- Future research should extend the study duration to explore long-term effects on body composition.

Introduction

The COVID-19 outbreak was declared a global health emergency by the World Health Organization (WHO) on 31 January 2020 and a pandemic on 11 March 2020. Thailand reported its first case outside of China in a 61-year-old woman from Wuhan.^{1,2} Local transmission cases surged in early March 2020 and were primarily driven by clusters, including the Thai boxing stadium in Bangkok.² The first wave resulted in 3017 cases and 56 deaths, with a 1.9% fatality rate. The second wave, observed from November 2020 to February 2021, significantly affected migrant workers in Samut Sakhon Province, with seven times more cases and a 0.1% fatality rate.^{3,4} Subsequent outbreaks in 2021 were caused by alpha and delta variants.¹

As the virus spread globally, numerous studies explored the clinical features of COVID-19. Commonly reported symptoms included fever, cough, myalgia, and fatigue. However, most available data were based on retrospective or cross-sectional designs, which limited

understanding of individuals with mild or asymptomatic infections who did not seek medical care.⁵ In addition, several studies investigated the influence of demographic characteristics on COVID-19 transmission and outcomes. For example, age distribution has been shown to account for much of the variation in case fatality rates across countries. Furthermore, individuals with comorbidities such as cardiovascular disease, chronic kidney disease, or neurological conditions face significantly higher risks of severe illness or death.⁶ Despite these findings, there remains a lack of comprehensive, long-term data that could support the development of effective prevention strategies, especially in middle-income countries.

To address this gap, we conducted a one-year prospective cohort study at two hospitals in Thailand: Prachatipat Hospital in Pathum Thani Province and Vichaivej International Hospital (Samut Sakhon) in Samut Sakhon Province. These hospitals were selected based on their distinct population characteristics. Prachatipat Hospital primarily serves urban residents, while Vichaivej International Hospital (Samut Sakhon) serves a large proportion of healthcare workers. The aim of this study was to assess the occurrence of SARS-CoV-2 infection and examine its association with sociodemographic factors in a Thai population, with the goal of informing more targeted and context-specific public health strategies.

Materials and Methods

Study design

A one-year prospective study was conducted from October 2021 to November 2022 at two hospital-based sites: Prachatipat Hospital in Pathum Thani and Vichaivej International Hospital (Samut Sakhon) in Samut Sakhon province. These hospitals were selected based on their differing population characteristics—Prachatipat Hospital primarily serves an urban population, while Vichaivej International Hospital (Samut Sakhon) predominantly cares for healthcare workers and migrant communities. The study enrolled both male and female participants aged 18 to 65 years who were asymptomatic for COVID-19 at the time of enrollment. The study population included both healthcare workers (HCWs) and non-healthcare workers (non-HCWs). All participants were scheduled for five follow-up visits at 0, 0.5, 2, 6, and 12 months. At each visit, participants completed self-administered questionnaires and provided blood samples. Blood specimens were collected from all participants at each time point and stored for future immunological and serological analyses. Details of these analyses have been reported to the National Research Council of Thailand (NRCT) (unpublished data) and are also described in related publications.⁷

To estimate the rates of relapse and reinfection, the SARS-CoV-2 infection and vaccination statuses of the participants were used and classified based on definitions as previously described. Briefly, COVID-19 relapse involves recurring symptoms with positive real-time reverse transcription-polymerase chain reaction (RT-PCR) within 90 days of primary infection, which can be distinguished from reinfection by confirming the same strain through whole-genome sequencing. Reinfection entails symptom recurrence, with a positive RT-PCR after 90 days.⁸ In addition to RT-PCR, results from antigen test kits (ATKs) were also included in the assessment, as ATKs have become widely used for SARS-CoV-2 detection in real-world settings. Current evidence indicates that high-quality ATKs demonstrate sensitivity and specificity comparable to RT-PCR, particularly in symptomatic individuals, and are thus considered reliable tools for infection detection in both clinical and public health contexts. Furthermore, information about outbreaks of various SARS-CoV-2 strains in Thailand at different time intervals was retrieved from covSPECTRUM (<https://cov-spectrum.org/explore/Thailand>).

Data collection

The following data were collected through a self-administered questionnaire: baseline characteristics such as age, sex, body weight, height, comorbidities, SARS-CoV-2 infection status (defined as current or past exposure to SARS-CoV-2)⁹ and vaccination status, and sociodemographic data. Infection status was defined as current or past exposure to SARS-CoV-2 and was determined based on participants' self-reported confirmed positive RT-PCR or antigen test results. Incomplete questionnaire responses were excluded from further analysis.

Statistical analysis

Continuous data are described using the mean and standard deviation or the median and interquartile range, as appropriate. Categorical data are presented as percentages. The chi-square test or Fisher's exact test was used to examine associations between categorical variables and infection status. Multiple logistic regression analysis was employed to identify sociodemographic factors independently associated with SARS-CoV-2 infection, adjusting for potential confounders. Downstream statistical analyses, including plotting, were performed using SPSS Statistics version 18.0 (SPSS Inc., Chicago, IL, USA) and R software (R Foundation for Statistical Computing, Vienna, Austria, www.R-project.org).

Results

Rates of Occurrence, Relapse, and Reinfection at Two Hospitals

The study included 202 participants at Prachatipat Hospital in Pathum Thani from October 2021 to October 2022 and 212 participants at Vichaivej International Hospital (Samut Sakhon) in Samut Sakhon from November 2021 to November 2022. Based on infection history, 23.8% (48/202) of participants at Prachatipat Hospital and 22.6% (48/212) at Vichaivej International Hospital had previously been infected. No deaths were reported during these periods. Before the start of the follow-up, 97% of participants at Prachatipat Hospital and 100% at Vichaivej International Hospital (Samut Sakhon) had a vaccination history.

The cumulative incidence of SARS-CoV-2 infection at Prachatipat Hospital was 47% (95/202). Among the participants, 51% were healthcare workers (HCWs), and 49% were non-HCWs. The cumulative incidence was higher among HCWs (55%) compared to non-HCWs (43%). At Vichaivej International Hospital (Samut Sakhon), the cumulative incidence rate was 40% (84/212). The majority of participants at this site were HCWs (211/212), with only one non-HCW enrolled. Notably, Vichaivej International Hospital (Samut Sakhon), a private institution, predominantly recruited HCWs based on an agreement with the research team to focus on this group. Due to logistical considerations and follow-up feasibility concerns, the hospital opted to exclude non-HCWs, resulting in the enrollment of only one non-HCW participant.

Upon evaluating the onset of illness among infected participants and the occurrence of various SARS-CoV-2 strains in Thailand during the study period (<https://cov-spectrum.org/explore/Thailand>), no cases of COVID-19 relapse were observed at either hospital. However, reinfection was observed at Prachatipat Hospital at a rate of 5.3% (5/95). Reinfections were caused by the Delta and BA.5 lineages (3 cases) and the BA.2 and BA.5 lineages (2 cases). At Vichaivej International Hospital (Samut Sakhon), the reinfection rate was 17.9% (15/84), involving multiple lineages, including B.1.36.16 and BA.2 (2 cases), Delta and BA.2 (4 cases), Delta and BA.5 (6 cases), BA.1 and BA.2 (1 case), BA.2 and BA.5 (1 case), and B.1.36.16, Delta, and BA.2 (1 case).

During the follow-up period, the first infection case was reported in February 2022. However, the highest number of new cases at both hospitals was observed in March 2022, coinciding with outbreaks of the Omicron variant, specifically sublineage BA.2. A notable surge occurred in March 2022, with new cases rising by 32% (30/95) at Prachatipat Hospital and 25%

(21/84) at Vichaivej International Hospital (Samut Sakhon), aligning with the Omicron BA.2 outbreak.

Clinical presentations of the studied participants with SARS-CoV-2 infection

In participants from Prachatipat Hospital, the clinical presentations observed during the infection included fever (48%), cough (71%), sore throat (62%), runny nose (45%), fatigue (32%), muscle pain (39%), chest pain/fatigue during coughing (20%), loss of smell (8%), loss of taste (6%), and diarrhea (6%). Among participants from Vichaivej International Hospital (Samut Sakhon), the clinical presentations observed during infection included fever (48%), cough (67%), sore throat (61%), runny nose (45%), fatigue (31%), muscle pain (33%), chest pain/fatigue during coughing (18%), loss of smell (15%), loss of taste (13%), and diarrhea (6%). The distribution of the clinical presentations among participants from the hospital is shown in Figure 1.

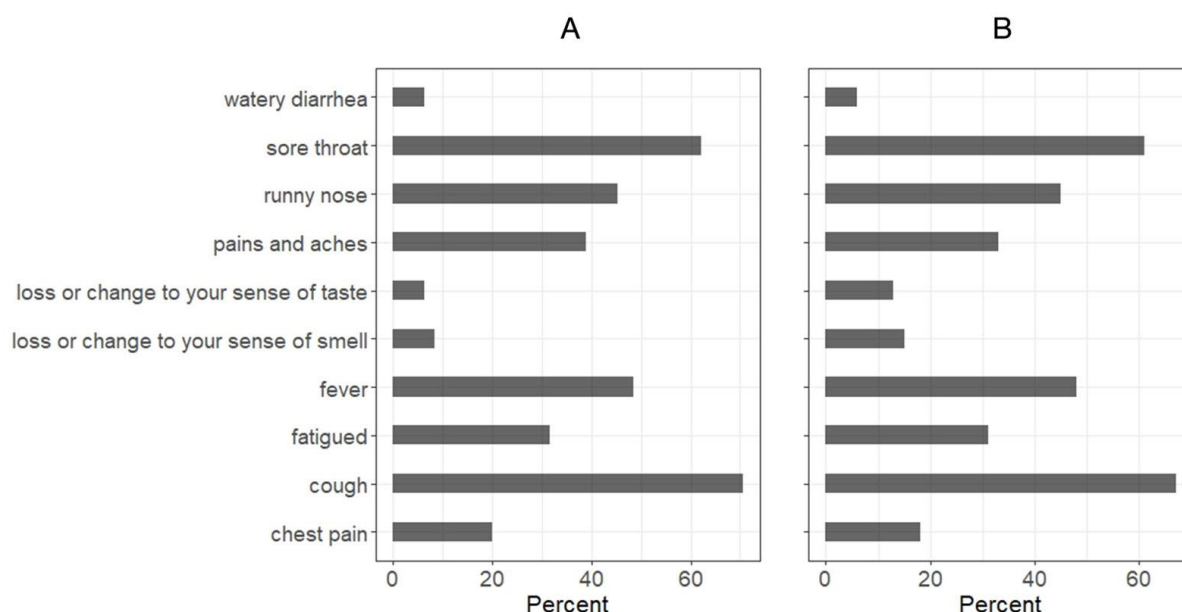


Figure 1 Distributions of clinical symptoms among the studied participants during SARS-CoV-2 infection. A) Participants from Prachatipat Hospital (N=95) B) Participants from Vichaivej International Hospital (Samut Sakhon) (N=84)

Sociodemographic characteristics of the studied participants

Multiple regression analysis of sociodemographic data from participants in both hospitals ($p < 0.05$) revealed a significant difference between the characteristics of individuals who remained uninfected with COVID-19 and those who became infected during the follow-up

period. The sociodemographic characteristics studied included sex, body mass index (BMI), underlying disease status, smoking status, education level, monthly income, type of dwelling, and household size.

The participants from Prachatipat Hospital were separated into two groups: HCWs and non-HCWs. Among HCWs, no significant differences in sociodemographic characteristics were found. However, within the non-HCW group, individuals with a history of being past smokers had a 15-fold increase in the likelihood of having SARS-CoV-2 infection compared to those who had never smoked (OR = 15.84, 95% CI, 0.85-293.74). Additionally, individuals with education levels lower than high school had a lower likelihood of infection than did those with a bachelor's degree (OR = 0.11, 95% CI, 0.02-0.56) (Table 1-2). For the HCW participants from Vichaivej International Hospital (Samut Sakhon), having a household size of 5-7 people increased the likelihood of SARS-CoV-2 infection by 3.44 times compared to living alone (OR = 3.44, 95% CI, 1.09-10.86), as shown in Table 3.

Table 1 Sociodemographic characteristics of the participants from Prachatipat Hospital in the group of HCWs

Variables	Infected participants (N=53)	Uninfected participants (N=44)	Total (N=97)	p-value	Odds ratio (95% CI)
<i>Sex</i>					
Male	10(18.9%)	5(11.4%)	15(15.5%)	N/A	
Female	43(81.1%)	39(88.6%)	82(84.5%)	N/A	
Age (years), mean (min-max)	42(19-59)	43(20-62)	42(19-62)	N/A	
<i>BMI</i>					
<25	38(71.7%)	24(54.5%)	62(63.9%)	N/A	
≥25	15(28.3%)	20(45.5%)	35(36.1%)	N/A	
<i>Underlying disease</i>					
No underlying disease	28(52.8%)	20(45.5%)	48(49.5%)	0.752	
Diabetes	1(1.9%)	4(9.1%)	5(5.2%)	0.058	
Hypertension	2(3.8%)	3(6.8%)	5(5.2%)	0.634	
Allergy (allergic to weather or dust)	10(18.9%)	5(11.4%)	15(15.5%)	0.470	

Table 1 Sociodemographic characteristics of the participants from Prachatipat Hospital in the group of HCWs (Cont.)

Variables	Infected participants (N=53)	Uninfected participants (N=44)	Total (N=97)	p-value	Odds ratio (95% CI)
<i>Smoking status</i>					
Never smoker	45(84.9%)	33(75.0%)	78(80.4%)	0.423	
Current smoker	1(1.9%)	4(9.1%)	5(5.2%)	0.400	
Past smoker	2(3.8%)	1(2.3%)	3(3.1%)	0.159	
<i>Education level</i>					
Less than high-school graduate	2(3.8%)	5(11.4%)	7(7.2%)	0.966	
High-school graduate	14(26.4%)	10(22.7%)	24(24.7%)	0.283	
Bachelor's degree	35(66.0%)	26(59.1%)	61(62.9%)	0.555	
Greater than Bachelor's degree	2(3.8%)	3(6.8%)	5(5.2%)	N/A	
<i>Monthly income (Baht)</i>					
Less than 5,000	1(1.9%)	0(0.0%)	1(1.0%)	0.346	
5,000 to 10,000	8(15.1%)	8(18.2%)	16(16.5%)	0.056	
10,001 to 15,000	8(15.1%)	5(11.4%)	13(13.4%)	0.080	
15,001 to 20,000	5(9.4%)	7(15.9%)	12(12.4%)	0.265	
20,001 to 25,000	3(5.7%)	3(6.8%)	6(6.18%)	0.062	
25,001 to above	27(50.1%)	21(47.7%)	48(49.5%)	0.056	
<i>Types of dwelling</i>					
House	34(64.2%)	25(56.8%)	59(60.8%)	0.307	
Flat/Apartment/condominium	10(18.9%)	12(27.3%)	22(22.7%)	0.131	
Commercial building/Townhouse	7(13.2%)	6(13.6%)	13(13.4%)	0.464	
<i>Number of household members</i>					
1	4(7.5%)	3(6.8%)	7(7.2%)	0.804	
2-4	26(49.1%)	21(47.7%)	47(48.5%)	0.289	
5-7	3(5.7%)	7(15.9%)	10(10.3%)	0.050	
8-10	2(3.8%)	3(6.8%)	5(5.2%)	0.362	

Table 2 Sociodemographic characteristics of the non-HCW participants from Prachatipat Hospital

Variables	Infected participants (N=40)	Uninfected participants (N=53)	Total (N=93)	<i>p</i> -value	Odds ratio (95% CI)
<i>Sex</i>					
Male	20(50.0%)	26(49.1%)	46(49.5%)	N/A	
Female	20(50.0%)	27(50.9%)	47(50.5%)	N/A	
Age (years), mean (min-max)	44(19-65)	40(19-64)	42(19-65)	N/A	
<i>BMI</i>					
<25	22(55.0%)	34(64.2%)	56(60.2%)	N/A	
≥25	18(45.0%)	19(35.8%)	37(39.8%)	N/A	
<i>Underlying disease</i>					
No underlying disease	22(55.0%)	33(62.3%)	55(59.1%)	0.496	
Diabetes	4(10.0%)	2(3.8%)	6(6.5%)	0.958	
Hypertension	1(2.5%)	4(7.5%)	5(5.4%)	0.357	
Allergy (allergic to weather or dust)	6(15.0%)	12(22.7%)	18(19.4%)	1.000	
<i>Smoking status</i>					
Never smoker	27(67.5%)	33(62.3%)	60(64.5%)	0.258	Ref.
Current smoker	1(2.5%)	8(15.1%)	9(9.7%)	0.218	
Past smoker	6(15.0%)	0(0.0%)	6(6.5%)	<0.01	15.84 (0.85 to 293.74)
<i>Education level</i>					
Less than high-school graduate	2(5.0%)	16(30.2%)	18(19.3%)	<0.01	0.11 (0.02 to 0.56)
High-school graduate	8(20.0%)	13(24.5%)	21(22.6%)	0.109	
Bachelor's degree	24(60.0%)	22(41.5%)	46(49.5%)	0.307	Ref.
Greater than Bachelor's degree	6(15.0%)	2(3.8%)	8(8.6%)	N/A	
<i>Monthly income (Baht)</i>					
Less than 5,000	1(2.5%)	6(11.3%)	7(7.5%)	0.177	
5,000 to 10,000	8(20.0%)	15(28.3%)	23(24.7%)	0.099	
10,001 to 15,000	5(12.5%)	9(16.9%)	14(15.1%)	0.728	
15,001 to 20,000	5(12.5%)	4(7.5)	9(9.7%)	0.510	

Table 2 Sociodemographic characteristics of the non-HCW participants from Prachatipat Hospital (Cont.)

Variables	Infected participants (N=40)	Uninfected participants (N=53)	Total (N=93)	p-value	Odds ratio (95% CI)
20,001 to 25,000	5(12.5%)	7(13.2%)	12(12.9%)	0.067	
25,001 to above	12(30.0%)	11(20.8%)	23(24.7%)	0.070	
<i>Types of dwelling</i>					
House	29(72.5%)	37(69.8%)	66(70.9%)	0.864	
Flat/Apartment/condominium	4(10.0%)	5(9.4%)	9(9.7%)	0.808	
Commercial building/Townhouse	6(15%)	7(13.2%)	13(13.9%)	0.742	
<i>Number of household members</i>					
1	1(2.5%)	3(5.7%)	4(4.3%)	0.428	
2-4	15(37.5%)	21(39.6%)	36(38.7%)	0.204	
5-7	8(20.0%)	13(24.5%)	21(22.6%)	0.249	
8-10	0(0.0%)	3(5.7%)	3(3.1%)	0.110	

Table 3 Sociodemographic characteristics of the participants from Vichaivej International Hospital (Samut Sakhon)

Variables	Infected participants (N=80)	Uninfected participants (N=125)	Total (N=205)	p-value	Odds ratio (95% CI)
<i>Sex</i>					
Male	11(13.8%)	39(31.2%)	50(24.4%)	N/A	
Female	69(86.3%)	86(68.8%)	155(75.6%)	N/A	
Age (years), mean (min-max)	37(19-62)	38(19-63)	38(19-63)	N/A	
<i>BMI</i>					
<25	52(65.0%)	86(68.8%)	138(67.3%)	0.491	
≥25	28(35.0%)	39(31.2%)	67(32.7%)	N/A	
<i>Underlying disease</i>					
No underlying disease	40(50%)	54(43.2%)	94(45.9%)	0.490	
Diabetes	1(1.2%)	1(0.8%)	2(1.0%)	0.732	

Table 3 Sociodemographic characteristics of the participants from Vichaivej International Hospital (Samut Sakhon) (Cont.)

Variables	Infected participants (N=80)	Uninfected participants (N=125)	Total (N=205)	p-value	Odds ratio (95% CI)
Hypertension	3(3.8%)	8(6.4%)	11(5.4%)	0.602	
Allergy (allergic to weather or dust)	8(10%)	16(12.8%)	24(11.7%)	0.495	
<i>Smoking status</i>					
Never smoker	52(65.0%)	77(61.6%)	132(64.4%)	0.556	
Current smoker	4(5.0%)	6(4.8%)	10(4.9%)	0.790	
Past smoker	4(5.0%)	7(5.6%)	11(5.4%)	0.972	
<i>Education level</i>					
Less than high-school graduate	5(6.3%)	14(11.2%)	19(9.3%)	0.622	
High-school graduate	31(38.8%)	36(28.8%)	67(32.7%)	0.761	
Bachelor's degree	38(47.5%)	63(50.4%)	101(49.3%)	0.862	
Greater than Bachelor's degree	4(5.0%)	7(5.6%)	11(5.4%)	0.977	
<i>Monthly income (Baht)</i>					
Less than 5,000	0(0.0%)	2(1.6%)	2(1.0%)	0.193	
5,000 to 10,000	5(6.3%)	6(4.8%)	11(5.4%)	0.938	
10,001 to 15,000	25(31.3%)	41(32.8%)	66(32.2%)	0.594	
15,001 to 20,000	17(21.3%)	18(14.4%)	35(17.07%)	0.828	
20,001 to 25,000	7(8.8%)	17(13.6%)	24(11.7%)	0.230	
25,001 to above	20(25.0%)	34(27.2%)	54(26.3%)	0.561	
<i>Types of dwelling</i>					
House	32(40.0%)	54(43.2%)	86(42.0%)	0.835	
Flat/Apartment/condominium	25(31.3%)	43(34.4%)	68(33.2%)	0.818	
Commercial building/Townhouse	22(27.5%)	24(19.2%)	46(22.4%)	0.794	
<i>Number of household members</i>					
1	7(8.8%)	17(13.6%)	24(11.7%)	0.772	Ref.
2-4	34(42.5%)	43(34.4%)	77(37.6%)	0.063	
5-7	17(21.3%)	12(9.6%)	29(14.1%)	0.018	3.44 (1.09 to 10.86)
8-10	0(0.0%)	3(2.4%)	3(1.5%)	0.974	

Discussion

The study followed a one-year cohort from two hospitals: Prachatipat Hospital in Pathum Thani and Vichaivej International Hospital (Samut Sakhon) in Samut Sakhon Province. During the five scheduled follow-up visits, the loss to follow-up rates at Prachatipat Hospital were 0%, 0%, 6%, 16.5%, and 13.5%, respectively. At Vichaivej International Hospital (Samut Sakhon), the corresponding rates were 0%, 1.4%, 2.4%, 7.5%, and 10.4%. The overall cumulative incidence of SARS-CoV-2 infection was 47% at Prachatipat Hospital and 40% at Vichaivej International Hospital (Samut Sakhon), equivalent to approximately 47,029 and 39,622 cases per 100,000 people, respectively. Notably, 55% of participants at Prachatipat Hospital were healthcare workers (HCWs), and 43% of non-HCWs also reported working in healthcare-related roles, suggesting a higher prevalence among individuals with occupational exposure to COVID-19 patients. The peak number of new cases at both hospitals occurred during the Omicron BA.2 outbreak in March 2022. The most commonly reported symptoms included cough, sore throat, fever, runny nose, and fatigue. No relapses were observed; however, reinfection rates were 5.3% at Prachatipat Hospital and 17.9% at Vichaivej International Hospital (Samut Sakhon). Reinfections typically involved different SARS-CoV-2 sublineages. Although many participants were vaccinated, infection still occurred within one to two months following vaccination, indicating that immunization did not fully prevent infection.

The RT-PCR assay is recognized as the standard test for the laboratory diagnosis of SARS-CoV-2 infection.¹⁰ However, during the peak of the COVID-19 outbreak in Thailand, when daily cases exceeded 20,000, the nationwide diagnostic capacity for RT-PCR testing became insufficient. Consequently, ATKs were increasingly adopted for COVID-19 screening and diagnosis beginning in July 2021. ATKs offer a rapid and accessible alternative to RT-PCR and have demonstrated acceptable sensitivity and specificity, particularly in symptomatic individuals. Their ease of use without the need for specialized personnel has made them a practical tool for large-scale public health implementation.^{10,11} Genomic surveillance of SARS-CoV-2 in Thailand revealed that the outbreak during the follow-up period of this study was caused by Delta and Omicron variants.^{12,13} Nevertheless, the Omicron variant was notably predominant, with the first infection cases detected in February 2022. The Omicron sublineage BA.2 was prevalent in Thailand in March 2022.¹² The clinical presentations of the participants during SARS-CoV-2 infection observed in this study showed that the Omicron variant tended to predominantly infect the upper respiratory tract, which was consistent with previous studies.^{14,15}

A previous report indicated that the highest incidence rates in Thailand occurred between September 2020 and March 2021, as well as from July 2021 to October 2021, in Samut Sakhon Province, with rates of 474 cases and 9,007 cases per 100,000 people, respectively. Between November 2021 and March 2022, the highest incidence rate was 8,460 cases per 100,000 people in Phuket.¹⁶ This study demonstrated higher incidence rates than did previous reports. This could be attributed to differences in the study design, which involved a one-year prospective cohort, and the potential increase in transmissibility and immune escape of the Omicron variant compared to prior variants.^{16,17} The incidence rate was markedly higher in HCWs. Furthermore, a previous report indicated that areas with a greater number of physicians not only tend to have increased rates of SARS-CoV-2 infection but are also surrounded by other areas exhibiting similar patterns.¹⁶ This could be related to factors such as virus exposure in healthcare facilities or increased population mobility in these areas.

Recurring symptoms are common among untreated COVID-19 patients, but these symptoms are not necessarily linked to the progression of severe COVID-19. However, viral characterization in these studies was limited.¹⁸ Viral relapse was infrequent among mildly affected COVID-19 patients without significant risk factors related to severity, and relapses occurred within the first 8 weeks.¹⁹ According to a meta-analysis between January 2020 and April 2021, the pooled incidence rate of SARS-CoV-2 reinfection was 2.5% person-years. The reinfection rate was 1.1% of person-years among HCWs and 3.1% of person-years among non-HCWs, with a statistically significant difference between the two groups. The likelihood of reinfection is lower in former infected individuals than in never-infected individuals.²⁰ For the meta-analysis conducted in June 2022, the pooled reinfection rate was 4.2%, showing significant variation across continents. Reinfection rates differed among populations, as they were 4.7% in Africa, 3.8% in Asia, 1.2% in Europe, and 1% in America.²¹ From May 2020 to June 2022, reinfection rates significantly increased due to the Omicron variant, increasing from 7.4% to 38.7% in a prospective cohort study. No significant associations were found between reinfected and nonreinfected individuals in terms of sex, age, race, occupation, or household size during the pre-Omicron or Omicron periods. Most comorbidities showed no differences, except for chronic rhinitis in the pre-Omicron period.²² In addition, the reinfection rate for individuals who received a booster vaccination was significantly lower than that for those who received an incomplete vaccination series. This finding suggested that hybrid immunity from

prior infection and booster vaccination lowered Omicron reinfection rates, indicating enhanced protection.²³

The statistical analysis of sociodemographic data among volunteer groups in both hospitals examined factors related to population and social aspects between individuals who were not infected and those who were infected during the follow-up. For participants from Prachatipat Hospital, no significant sociodemographic differences were found among HCWs. However, non-HCWs with a history of past smoking had a 15-fold greater likelihood of having SARS-CoV-2 infection than did never smokers. This comparison should be interpreted with caution, as it was underpowered (6 infected patients versus 0 noninfected patients who were past smokers). Additionally, individuals with education levels below high school had a lower likelihood of infection than did those with a bachelor's degree. For participants from Vichaivej International Hospital (Samut Sakhon), having a household size of 5–7 people increased the likelihood of infection by three times compared to living alone. Nevertheless, many previous studies have demonstrated that household size has no significant effect on COVID-19 transmission.^{24,26} This study also revealed that the risk of infection was greater among participants with a history of past smoking than among those who had never smoked or were current smokers. As previously described, current smokers had a lower likelihood of developing COVID-19.^{27,30} To our knowledge, the exact scientific explanation for this phenomenon is not yet clear. Nonetheless, there is evidence that smoking is a risk factor for more severe cases of COVID-19.³¹ On the other hand, we found that participants with an education level lower than high school had a lower likelihood of infection than did those with a bachelor's degree. To the best of our knowledge, a clear relationship between education level and the risk of SARS-CoV-2 infection has not yet been established. This could be attributed to the impact of the COVID-19 outbreak on the workforce³², with individuals either being unemployed or engaged in freelance work. This situation might lead to lower exposure to social interactions, which is a significant factor in the transmission of the virus.

Taken together, the findings of this study provide important insights into the cumulative incidence, relapse, and reinfection rates of SARS-CoV-2 among Thai participants. Significant associations between sociodemographic factors and infection risk were identified, offering valuable information to guide policymakers and public health stakeholders in preparing for future outbreaks. However, the reliance on self-reported questionnaires introduces potential limitations, including recall bias, subjectivity, and incomplete responses. To enhance the

robustness of future research, it is essential to address these biases and incorporate multiple data sources for a more comprehensive and accurate understanding of infection patterns.

Conclusion

This one-year prospective cohort study identified the cumulative incidence, relapse, and reinfection rates of COVID-19 among a cohort of Thai participants. Genomic surveillance data indicated that the Delta and Omicron variants were the predominant strains during the follow-up period. Notably, the incidence of infection was higher among healthcare workers. In addition, several sociodemographic factors were found to be significantly associated with SARS-CoV-2 infection. These findings offer valuable insights for policymakers, the private sector, and other stakeholders to strengthen preparedness and response strategies for potential future waves of COVID-19.

Ethical Approval Statement

The study was approved by the Ethics Committee of the Faculty of Medicine, Ramathibodi Hospital, Mahidol University (COA. MURA2021/264). All study subjects provided written informed consent prior to their participation.

Author Contributions

WC and CR conceptualized the study. CR, NN, SS, TB, OH, SC, VC undertook the data collection. CR and IS performed the data analysis. CR, IS, and WC wrote the manuscript. All authors reviewed and approved the final manuscript.

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

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