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Prevalence, Symptoms, and Associated Factors of Long COVID-19: A Cross-Sectional Survey Study

Rapeephan R Maude MD[1], **Siriwan Tangjitgamol** MD[2], **Kasem Sirithanakul** MD[1], **Yanisa Duangduen** MNS[2], **Natapon Ativanichayapong** BSC[2]

[1] *Internal Medicine Center, MedPark Hospital, Bangkok 10110, Thailand*
[2] *Research Center, MedPark Hospital, Bangkok 10110, Thailand*

ABSTRACT

OBJECTIVE: Long COVID is defined as persistent or newly developed symptoms after the acute phase of COVID-19 infection. This study aimed to evaluate the prevalence of long COVID, types of symptoms, and associated factors.

METHODS: This was a cross-sectional survey including individuals with a history of COVID-19 infection aged ≥ 18 years who were followed up at our hospital. The presence of abnormal symptoms and clinical features were obtained through a questionnaire.

RESULTS: A total of 307 individuals with a median age of 58 years (interquartile range 35–74 years) were included in this study. Among them, 53.1% were females, and 56.0% had underlying diseases. The prevalence of long COVID was 40.1%. Cardiopulmonary (36.6%) and nonspecific general symptoms (22.0%) were the most common symptoms. We did not find significant association long COVID and any characteristic features of the participants, numbers of COVID vaccination or infection episodes.

CONCLUSION: The prevalence of long COVID was 40.1%. No factors significantly associated with long COVID were observed. Cardiopulmonary and general symptoms were the most common symptoms.

KEYWORDS: cardiopulmonary symptoms, COVID-19 infection, long COVID

INTRODUCTION

In 2020, the coronavirus disease 2019 (COVID-19) pandemic was declared a global health emergency by the World Health Organization (WHO). The WHO reported approximately 515 million COVID-19 cases and 6.25 million deaths worldwide by 2022. In Thailand, 4.71 million cases and 33,505 deaths were reported[1]. Although the Centers for Disease Control and Prevention recommends that unvaccinated individuals initiating the COVID-19 vaccination series receive a third dose[2] or above can help to reduce effect from COVID-19 infection[3], data from the Israeli Ministry of Health show that the incidence of COVID-19 infection and severe illness declined significantly following the administration of a third (booster) dose[4]. However, long COVID conditions have still been reported[5].

COVID-19 infection can have short- and long-term effects. COVID-19 symptoms, such as fever, chills, coughing, tiredness, muscle pain, headache, loss of taste and smell, sore throat, stuffy or runny nose, nausea or vomiting, diarrhea, and pale or purple color of skin, lips, or fingernails, may manifest within 2-14 days

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after infection[6]. Severe cases may experience chest pain, shortness of breath, progressive respiratory failure, confusion, or unconsciousness[6].

After recovery, some patients may continue to experience lingering symptoms or develop new abnormalities. According to the Centers for Disease Control and Prevention, the post-COVID-19 condition or "long COVID" is a phenomenon confronting the global community[6]. The WHO has defined long COVID as the persistence or emergence of symptoms within 3 months after the infection, lasting at least 2 months[7]. Others also specified that complications resulting from the acute phase of infection are not classified as part of long COVID[8].

Various symptoms can serve as indicative measures for long COVID, such as (1) general symptoms (exhaustion, fatigue, postexertional malaise, and fever); (2) cardiopulmonary symptoms (shortness of breath, dyspnea, chest pain, and unexplained tachycardia); (3) neurological symptoms (brain fog, memory loss, headache, insomnia, sleep disorder, numbness, loss of taste or smell, depression, and anxiety); (4) gastrointestinal symptoms (diarrhea and stomachache); (5) other nonspecific symptoms (joint pain, muscle pain, rash, and abnormal menstruation)[9]. Several studies have investigated the efficacy of vaccination and the course of acute COVID-19 infection. Additionally, many studies[10-17] and systematic literature reviews have been conducted on long COVID[18-25]. Moreover, a study found that older participants had higher rates of long COVID symptoms compared to younger individuals[26].

Our hospital provided medical services to many patients with COVID-19 during the outbreak. Our healthcare support was extended beyond the initial treatment to posttreatment surveillance with a scheduled follow-up visit. Half of the COVID-19 infections occurred in the central region of Thailand[27], where our hospital is located. Therefore, collecting data on the long-term effects of COVID-19 infection from an Asian perspective can provide valuable insights.

This study aimed to evaluate the prevalence of long COVID among previously infected individuals, the type of symptoms, and associated factors.

METHODS

This cross-sectional survey study was conducted at our hospital between February 1, 2021, and June 30, 2022. This study was approved by the Institutional Review Board (COA-MPIRB 004/2022). The requirement for informed consent was waived due to the nature of the study.

The sample size was determined using Cochran's Formula[28] ($N = Z^2P(1-p)/e^2$) based on data from a previous study that reported an 80% prevalence of long COVID among COVID-19 cases[18]. The population proportion was 0.8 ($p = 0.8$), the reliability level of this study was 95% ($Z = 1.96$), and acceptable sampling error was 0.05 ($e = 0.05$); therefore, a minimum of 246 participants were required to collect data in this study. After adding an attrition rate of 10%, at least 270 participants were required.

This study collected data by using the purposive sampling method. The inclusion criteria were individuals aged > 18 years with a history of COVID-19 infection within the past 14 days, who had received treatment at our hospital/hospitals network, and those who had scheduled follow-ups (in-hospital or telephone) with a physician during the study period. The exclusion criteria were individual who did not attend follow-up appointments at hospital, could not be contact, or declined to participate in the study. The researcher collected data from the Electronic Medical Record of the hospital.

After the participants were informed about the study, they were interviewed according to the questionnaire during their in-hospital or telephone follow-up. The questionnaire comprised three parts: part I involved demographic data, including age, gender, weight, height, and personal illnesses; part II was about the history of COVID-19 vaccination, including the vaccine type and

self-report side effects severity from vaccination, history of COVID-19 infection, including time of diagnosis; part III included the change of health status after COVID-19 infection and current symptoms.

Data analysis was performed using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corporation, Armonk, NY, USA). Normally distributed data were presented as mean ± standard deviation, continuous data as median and interquartile range (IQR), and categorical data as frequencies with percentages. The prevalence of long COVID was determined based on the presence of any abnormal symptoms persisting or newly developed at least 30 days after recovery from acute illness or hospital discharge[19,29]. The interval between the last COVID-19 vaccination and infection and between the infection and long COVID symptom assessment were calculated. The presence of long COVID and the type of common symptoms according to sociodemographic features, history of COVID-19 vaccination, and COVID-19 infection were examined. The association was investigated by categorizing the data as follows: age as < 60 or ≥ 60 years; body mass index (BMI) as < 30 kg/m^2 or ≥ 30 kg/m^2 [30]; underlying diseases as yes or no; number of vaccinations as ≤ 3 or > 3[3]; self-report side effects severity from vaccination as no/mild or moderate/severe; and episode of COVID-19 infection as once or more. Between-group comparisons were performed using Pearson's Chi-square test or Fisher's exact test, as appropriate. Significant features from the univariate analysis were analyzed using logistic regression to identify independent risk factors associated with long COVID. A p-value of 0.05 indicated statistical significance.

RESULTS

A total of 314 individuals who underwent either in-hospital or telephone follow-ups by our hospital staff were enrolled in this study. Of the 314 individuals, 7 were excluded due to being < 18 years old. Finally, 307 patients met the inclusion criteria and were included in the study. Of the 307 patients, 120 had follow-up visits, and 187 received telephone follow-ups.

The median age of the participants was 58 years (IQR 35–74 years), and 53.1% were females. The mean BMI was 24.0 ± 4.5 kg/m^2, with 26.0% being overweight (≥ 25 kg/m^2) and 9.1% obese (≥ 30 kg/m^2) (Table 1). Among 172 individuals (56.0%) who had underlying diseases, 109 (35.5%) had multiple illnesses with more than one system involvement, followed by cardiovascular disease including hypertension in 23 (7.5%) and endocrine disorders including diabetes mellitus in 14 (4.6%).

Table 1 Baselines characteristics of the total participants

Baselines characteristics	n	%
Age		
< 60 years	158	51.5
≥ 60 years	149	48.5
Gender		
Male	114	37.1
Female	163	53.1
Body mass index		
< 30 kg/m^2	279	90.9
≥ 30 kg/m^2	28	9.1
Underlying disease		
No	135	44.0
Yes	172	56.0

Table 1 Baselines characteristics of the total participants (continued)

Baselines characteristics	n	%
Number of vaccination		
≤ 3	165	53.7
> 3	142	46.3
Vaccine side effects		
No/ mild	281	91.5
Moderate/ severe	26	8.5
Number of COVID infection		
Once	289	94.1
More than once	18	5.9
Interval from infection to survey		
< 3 months	81	26.4
3 to < 6 months	45	14.7
6 to < 12 months	62	20.2
> 12 months	119	38.8

Abbreviations: kg/m^2, kilogram per square metre; n, number

After excluding 17 patients (5.5%) who never received COVID-19 vaccination, the remaining patients received a median of 3 doses (IQR 2.25–4.0 doses). A total of 1,006 doses were administered, with AstraZeneca and Pfizer as the most frequently used as 365 doses (36.3%) and 236 doses (23.4%), respectively. On the other hand, the percentages of COVID vaccine received for the individuals were AstraZeneca (66.4%), Pfizer (53.9%), Moderna (36.6%), Sinovac (28.5%), Sinopharm (10.2%), and Evusheld (0.7%). Of note, one participant may have one or more types of vaccines.

Episodes of COVID-19 infection ranged from 1 to 3: 94.1% of the participants had one episode, 5.2% had two episodes, and 0.7% had three episodes. Of the two participants with three episodes of infection, one had never received COVID-19 vaccination, whereas the other had already received six doses. The median interval from the preceding COVID-19 vaccination to the following infection was 23 weeks (IQR 12.3–31.0 weeks).

The median interval from (the latest) infection to the survey was 8.8 months (IQR 2.9–16.0 months; range 1.1–18.6 months). The interval was < 3 months in 26.4% of the participants, 3 months to < 6 months in 14.7%, 6 months to < 12 months in 20.2%, and > 12 months in 38.8%.

At the time of our assessment, 40.1% of the participants reported one or more abnormal symptoms after the acute phase of COVID-19 infection. The most common symptoms were cardiopulmonary symptoms (36.6%) and general symptoms (22.0%). Notably, 12.7% of the participants had multiple symptoms (Table 2). Among the 27 symptoms from 123 participants, 230 events were reported. Figure 1 shows the numbers and percentages of symptoms. Tiredness (25.2%), cough (25.2%), and breathing difficulty (10.0%) were the most common symptoms. Notably, of the 172 participants with preexisting illnesses, the conditions remained unchanged in 58.2%, worsened in 8.7%, and improved in 33.1%.

Furthermore, the prevalence of long COVID was investigated at different time points of assessment. The prevalence was highest (55.6%) with an interval of assessment between 3 months and < 6 months, followed by an interval between 6 months and < 12 months (46.8%) and within 3 months (40.7%). The prevalence decreased to 30.3% with an interval of > 12 months.

Table 2 Health condition after COVID-19 infection (n = 307)

Health condition after COVID-19 infection	n (%)
Abnormal symptoms	
None	184 (59.9)
Yes, systems involvement	123 (40.1)
General symptoms	27 (22.0)
Cardio-pulmonary symptoms	45 (36.6)
Neurological symptoms	2 (0.7)
Gastrointestinal symptoms	1 (0.3)
Musculoskeletal symptoms	1 (0.3)
Skin symptoms	8 (2.6)
Multiple symptoms	39 (12.7)
Status of pre-existent illnesses after COVID-19 infection, n=172 (56.0%)	
Stable or the same	100 (58.2)
Worse	15 (8.7)
Better	57 (33.1)

Abbreviation: n, number
Note: Percentage of each symptom obtained from number of affected individuals

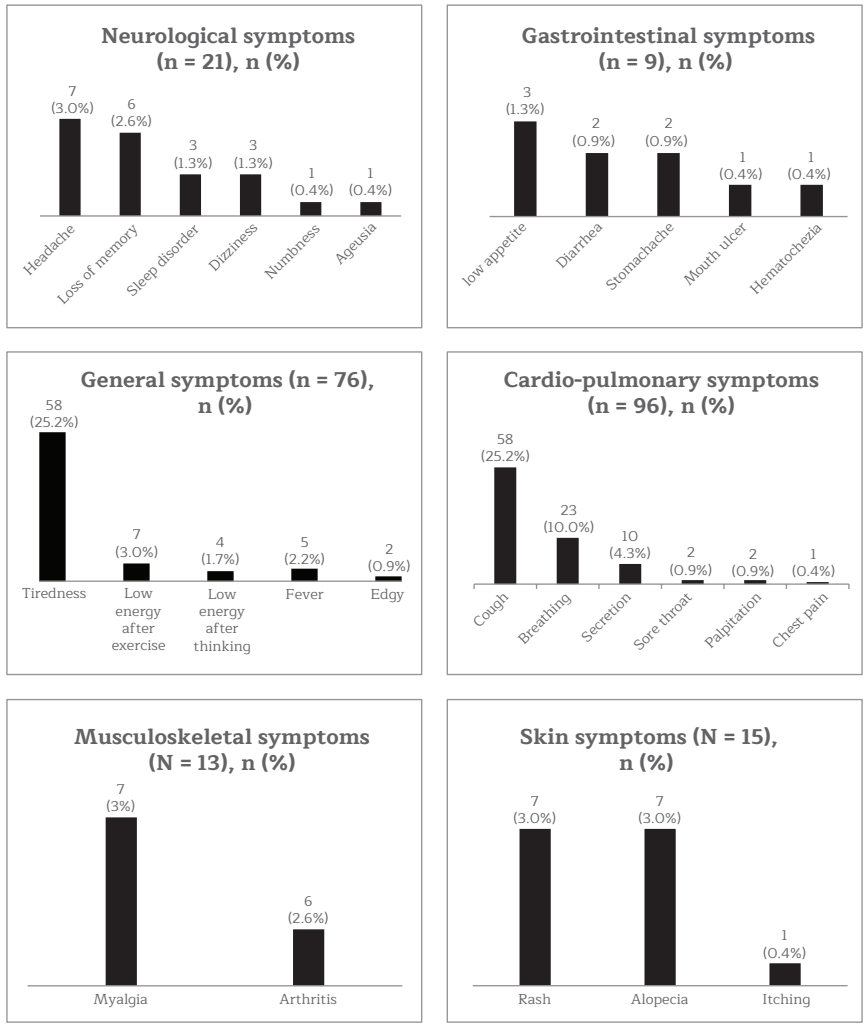

Figure 1 Number and percentages of long COVID symptoms among all symptoms by system of involvement

The association between the presence of long COVID and the characteristic features of the participants and the history of COVID-19 vaccination and infection was also investigated (Table 3). The univariate analyses revealed that moderate/severe side effects from vaccination (odds ratios [OR] 1.84), BMI ≥ 30 kg/m^2 (OR 1.56), COVID-19 infection more than once (OR 1.54), vaccination > 3 doses (OR 1.47), female (OR 1.44), age ≥ 60 years (OR 1.20), and presence of underlying diseases (OR 1.19) were associated with a higher prevalence of long COVID. However, the association was not statistically significant.

The characteristic features of the participants were analyzed according to the three common symptoms encountered: tiredness, cough, and breathing difficulty. The analysis revealed that the presence of underlying diseases and vaccination > 3 doses were significantly associated with tiredness (23.3% vs. 13.3%, p = 0.03 and 23.9% vs. 14.5%, p = 0.04, respectively), and obesity was significantly associated with cough (35.7% vs. 17.2%, p = 0.02) and breathing difficulty (17.9% vs. 6.5%, p = 0.05).

Table 3 Factors association with long COVID-19 conditions

Clinical characteristics	N=307	Long COVID-19 (%)		Crude odds ratio (95% CI)	P-value
		None	Yes		
Age					
< 60 years	158	98 (62.0)	60 (38.0)	-	-
≥ 60 years	149	86 (57.7)	63 (42.3)	1.20 (0.76-1.90)	0.441
Gender					
Male	114	93 (64.6)	51 (35.4)	-	-
Female	163	91 (55.8)	72 (44.2)	1.44 (0.91-2.29)	0.118
Body mass index					
< 30 kg/m^2	279	170 (60.9)	109 (39.1)	-	-
≥ 30 kg/m^2	28	14 (50.0)	14 (50.0)	1.56 (0.72-3.40)	0.260
Underlying disease					
No	135	84 (62.2)	51 (37.8)		
Yes	172	100 (58.1)	72 (41.9)	1.19 (0.75-1.90)	0.469
Number of vaccination					
≤ 3	165	106 (64.2)	59 (35.8)	-	-
> 3	142	78 (54.9)	64 (45.1)	1.47 (0.93-2.33)	0.097
Vaccine side effects					
No/ mild	281	172 (61.2)	109 (38.8)	-	-
Moderate/ severe	26	12 (46.2)	14 (53.8)	1.84 (0.82-4.13)	0.134
Number of COVID infection					
Once	289	175 (60.6)	114 (39.4)		
More than once	18	9 (50.0)	9 (50.0)	1.54 (0.60-3.98)	0.375
Interval from infection to survey					
< 3 months	81	48 (59.3)	33 (40.7)	Reference	
3 to < 6 months	45	20 (44.4)	25 (55.6)	1.82 (0.88-3.80)	0.112
6 to < 12 months	62	33 (53.2)	29 (46.8)	1.28 (0.66-2.50)	0.471
> 12 months	119	83 (69.7)	36 (30.3)	0.63 (0.35-1.14)	0.127

Abbreviations: CI, confidence interval; kg/m^2, kilogram per square metre; n, number
P-value = .05 was considered statistically significant.

DISCUSSION

This study showed that 40.1% of the participants who were infected with COVID-19 experienced long COVID. This rate was in the range reported in previous studies and systematic reviews (Table 4). The prevalence from each single study varied from 27% to 90%[6-17]. The prevalence of 40.1% demonstrated in this study was close to the pooled prevalence of 42%–45% from two large systematic reviews[21,23] or 49% from the most recent systematic review[25].

Table 4 Summary of selected systematic reviews and single studies of long COVID

Author, year[ref]	Study period	Population, N (studies)	Definition of persistence or *timing of survey	Prevalence	Features	Symptoms (one may have > 1 symptom)
Systematic review with or without meta-analysis						
Lopez-Leon, 2021[18]	til Jan 2021	47,910 (15 studies, each > 100 patients)	≥ 14- 110 days after infection*	80%	NA	• Fatigue 58% • Headache 44% • Attention disorder 27% • Hair loss 25% • Dyspnea 24%
Nasserie, 2021[19]	Jan 2020 to Mar 2021	9,751 (45 studies)	≥ 60 days after onset or ≥ 30 days after recovery	72.5%	NA	• Fatigue/exhaustion 40% • Breathlessness 36% • Sleep disturbance 29%
Maglietta, 2022[20]	til Sep 2021	13,340 (20 studies)	≥ 4 months	NA	Risk: female, disease severity	NA
O'Mahoney, 2022[21]	til Jan 2022	735,006 (194 studies, each > 100 patients)	≥ 28-387 days after infection*	37.8%	NA	• Abnormal CT/X-rays 45% • Fatigue 28% • Breathlessness 18% • Impaired activity, taste loss 15% each • Loss of smell 14%
Notarte, 2022[22]	til Sep 2022	2,000,973 (37 studies)	≥ 2 months	NA	Risk: female, comorbidities Non-risk: elder	NA
Woodrow, 2023[23]	Jan 2020 to Nov 2021	NA (130 studies in English, each > 100 patients)	≥ 4-12 months of follow-up*	0%–93% (pooled estimate 42.1%)	Risk: hospitalization, severity of acute infection	• Fatigue 22% • Breathlessness 15% • Sleep disturbance 13% • Tingling/ itching, joint/muscle pains 11% each
Tsampasian, 2023[24]	Dec 2022 to Feb 2023	860,783 (41 studies)	≥ 3 months	NA	• Risk: elder, female, obesity, smoking, comorbidities, hospitalization, admit ICU • Lower risk: 2-doses vaccination	NA
Frallonardo, 2023[25]	til Feb 2023	29,213 (25 studies from African countries)	≥ 0.5-12 months of follow-up*	48.6%	• Risk: elder, hospitalization	• Fatigue 35% • Psychiatric conditions 26% • Dyspnea 18% • Myalgia 16% • Loss of appetite 13% • Cough 11% • Weight loss 10%

Table 4 Summary of selected systematic reviews and single studies of long COVID (continued)

Author, year[ref]	Study period	Population, N (studies)	Definition of persistence or *timing of survey	Prevalence	Features	Symptoms (one may have > 1 symptom)
Single study						
Wong, 2023 (cross-sectional survey)[10]	June 2022	2,712	≥ 3 months	90.4%	• Risk: female, smoking, poor self-perceived health status, comorbidities, medication use, severity of infection, Lower risk: 2-doses vaccination	• Fatigue 34% • Cough 32% • Sore throat, attention disorder 31% each • Anxiety, myalgia, arthralgia 30% each
Jang, 2023 (descriptive)[11]	July-Aug, 2021	585	≥ 1 month	27.2%	• Risk: hospitalization • Non-risk: gender, elder, underlying disease, ethnicity	• Loss of smell 60% • Sore throat 38% • Fever, chills, cough 37% each
Chelly, 2023 (cross-sectional)[12]	Mar 2020 - Feb 2022	1,911	≥ 2 months	46.5%	• Risk: female, elder, obesity, comorbidities • Lower risk: complete anti-COVID vaccination	• Fatigue 64% • Memory, attention disorder 49% each • Hair loss 48% • Mood swings 41% • Sleep disturbance 39% • Depression, anxiety 36% each • Difficulty finding words, irritability 34% each • Joint pain, headache 32% each
Cazé, 2023 (prospective)[13]	Sep 2020 - Apr 2021	814	> 1 month	29.6%	• Risk: elder, having > five symptoms during the acute phase	• Fatigue 14% • Olfactory disorder 10% • Myalgia 9% • Gustatory disorder 7% • Headache 6%
Subramanian, 2022 (retrospective)[14]	Jan 2020 - Apr 2021	2,430,729	≥ 3 months	NA	• Risk: elder, female, ethnic, smoking, comorbidities, obesity, low socioeconomic	• Anosmia, hair loss, sneezing, ejaculation difficulty, reduced libido
Phu, 2023 (cross-sectional)[15]	Jan 2021 - May 2022	939	≥ 3 months	79.3%	• Risk: female, underlying disease, low socioeconomic	• Fatigue 73% • Cough 66% • Muscle pain 54% • Insomnia, headache 49% each • Joint pain 45% • Breathlessness 44% • Dizziness 42% • Amnesia 41% • Hair loss 30% • Palpitation 25% • Chest tightness 15% • Asthenia 13%
Debski, 2022 (cross-sectional)[16]	til Feb 2021	1,487	≥ 1 month	52.1%	• Risk: female, obesity	• Fatigue 58% • Headache 44% • Attention disorder 27% • Hair loss 25% • Dyspnea 24%
Somboonviboon, 2024[17]	Sep 2021 to Jan 2022	277	> 4 week after infection	80.9%	• Risk: female, oxygentherapy	• Dyspnea 48.2% • Insomnia 42.4% • Myalgia 42.1% • Fatigue 41.4% • Brain fog 37.8%

Abbreviations: n, number; NA, not applicable; ref, reference

This wide range of prevalence may be due to many factors. First, no clear consensus has been reached on the definition of long COVID[21,22], resulting in various timing criteria of symptom onset in each study (Table 4). Second, the proportion of participants with risk features for long COVID in each study, such as older age, low socioeconomic background, female gender, existing illness, obesity, smoking, history of COVID-19 vaccination, or type of participants regarding the severity of infection reflected by simple community or complexed hospital healthcare, absence of awareness, or little access to healthcare services, might have affected the prevalence[2,12-14,16,20,22,23-25]. Third, data collection or symptom assessment methods might have influenced the long COVID detection rate. For example, studies using telephone interviews reported 27%–30% prevalence[7,9], whereas other studies reported 52% prevalence based on systematic pathological investigations, 44% based on self-report, and only 14% based on medical record review[23].

This study set a 30-day interval after recovery to ensure that the symptoms were not due to active infection. This interval was set based on previous studies[19,20]. The modest prevalence of long COVID in this study may be due to some features. The participants had risk features in mixed proportions. Nearly half of the participants were aged ≥ 60 years, and slightly more than half of them were female or had comorbidities. These risk factors should be considered for long COVID. However, some features in this study may carry a lower risk profile. For example, only a few were obese, and almost all had COVID-19 vaccination and had mixed types of medical services either in hospitals of our service (less severe infection) or in the hospital (more severe infection). The interval between the survey and infection and follow-up duration were factors that may have impacted the prevalence. The highest prevalence of long COVID was observed with an interval of assessment of 3-6 months (55.6%), whereas the lowest was observed with an interval of > 12 months. These findings indicate that the participants were concerned about their symptoms as time passed beyond a recuperation period. Conversely, a lower prevalence with a long interval of assessment could be interpreted as the symptoms had resolved over time.

This study showed that 7 features were associated with a higher prevalence of long COVID, including age ≥ 60 years, female gender, BMI ≥ 30 kg/m^2, presence of underlying diseases, history of side effects from vaccination, having COVID-19 infection more than once, and interval from last infection to survey of < 6 months. Some of these risk features for long COVID were also reported in previous studies (Table 4). Although the features identified in this study were not statistically significant, the findings may be useful for comparison with previous studies.

In this study, the factor with the highest risk was moderate/severe side effects from vaccination (OR 1.84). A systematic review reported controversial findings regarding the impact of vaccination on long COVID development, either increasing the prevalence or having no effect at all[31]. Obesity (OR 1.56) and COVID-19 infection more than once (OR 1.54) were other features that posed a higher risk for long COVID in this study. Few studies[14,16] and systematic reviews[22,24] have reported an association between higher BMI or obesity and long COVID. Obesity with a metabolic proinflammatory process may enhance the inflammatory process in many organs, leading to severe or prolonged symptoms[14,16]. Several studies have reported an association between long COVID and severe acute infection[10,20,14]. Consistent with our finding, only one study showed an increased risk of long COVID after reinfection, even in vaccinated individuals[32]. Multiple infections may cause additional susceptibility to myalgic encephalomyelitis or chronic fatigue syndrome[33]. Consistent with

many single studies[10-16] and systematic reviews[18-25], female preponderance for long COVID was observed (OR 1.44). The higher incidence of long COVID among females may be due to sex hormones and higher immunoglobulin G antibodies in the early phase of the disease, leading to a higher risk of severe disease in females than in males even after recovery[34,35].

This study reported that age ≥ 60 years was a risk factor for long COVID (OR 1.20). This may be due to weak immunity and organ dysfunction, leading to poor recovery or persistent symptoms[36]. These findings are consistent with those of previous studies[12,13] and systematic reviews[24,25]. However, other studies did not show consistent findings. Some studies reported that age > 40 years was associated with lower risk[14], whereas others did not show such association[22].

Previous studies have shown an association between the presence of underlying diseases and long COVID[10,14,15,22,24]. However, our study showed a weak association between long COVID and underlying diseases (OR 1.19). We could not compare the system and severity of preexisting illnesses, which might affect the prevalence of long COVID, across the studies.

In contrast to the other studies, this study showed that vaccination > 3 doses was slightly associated with a higher risk of long COVID (OR 1.47). Other studies have found a lower risk of long COVID with at least 2 doses[10,24] or complete doses of vaccination[12]. This could be due to younger age or the absence of comorbidities in patients receiving fewer than three doses. Moreover, we remains unknown due to the uncertain safety of some COVID-19 vaccinations[37] and mixed vaccination types.

This study showed that cardiopulmonary symptoms (36.6%) were the two most prevalent symptoms, followed by general symptoms (22.0%) (Table 2). These findings are consistent with those reported in most previous studies and systematic reviews, but the order of frequency differs (Table 4)[10-13,15,18,19,22,23,25].

This study investigated features associated with the three common symptoms observed in this study: tiredness (25.2%), protracted cough (25.2%), and breathing difficulty (10.0%). A higher frequency of these symptoms was observed in certain groups: tiredness in individuals with underlying diseases and vaccination > 3 doses; cough and breathing difficulty in patients with obesity. Although the numbers in each subgroup analysis were small, and it was challenging to explore the underlying reasons for all such findings, especially when data on affected systems during the acute phase of infection were lacking, we proposed possible explanations for these findings. The presence of underlying diseases or > 3 COVID-19 vaccinations might have affected immunity, resulting in tiredness or a sense of agility. Regarding the significant association between breathing difficulty or protracted cough and obesity, it is quite clear that obesity with lower lung capacity can result in these symptoms[38].

This study has some limitations. First, this was a survey study, it is subject to potential recall bias on self-reported symptoms, which were not verified through medical examination. This may have led to an under- or overestimation of the prevalence. Second, data on the severity of infection, which may have influenced the presence of long COVID, were unavailable. Third, there is a risk of selection bias, as the study included only patients who were reachable or had a follow-up visit, which may limit the generalizability of the findings to rural areas or non-hospitalized patients. Moreover, cross-sectional study precludes the ability to establish causal relationships. Fourth, the questions were the items used in usual practice, so validation process was not performed. This might have led relative non-thorough of the questionnaire. Finally, the actual onset of symptoms was not recalled in most of the participants, and the remedies for such symptoms, which varied, could not be systemically summarized.

Despite these limitations, this study provided valuable data from our country, which is such information, particularly regarding the number of vaccine doses received and the incidence of COVID-19 infection, that has been limited. Further research in diverse settings is needed to explore the clinical implications of these findings in a broader population. Additionally, a long survey follow-up period should have revealed the duration of symptoms and the dynamic nature of long COVID symptoms. The findings of this study indicate that patients with COVID-19 infection and healthcare providers should be aware of long COVID. Additionally, an appropriate follow-up and medical care plan for this condition should be implemented.

CONCLUSION

Nearly half of the participants in this study experienced long COVID. Future studies should focus on reliable measures with direct questions about these proposed factors. This should be coupled with a thorough medical examination that will yield more reliable data on this morbidity for the future development of public health policies. Patients with COVID-19 infection and healthcare providers should be aware of the long-term COVID symptoms which may have disturbed the affected individuals' health and well-being. Healthcare services should be extended beyond the acute phase of infection.

CONFLICT OF INTEREST

The authors have no conflicts of interest associated with the material presented in this paper.

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DATA AVAILABILITY STATEMENT

Data generated or analyzed during this study are included in this article. Future enquiries can be directed to the corresponding author.

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