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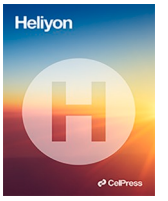

Research article

Prevalence, duration, and factors influencing post-COVID conditions among patients at several public hospitals, Alexandria governorate, Egypt 2022–2023

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ABSTRACT

Background: Post-COVID conditions (PCC), characterized by persistent symptoms following acute infection, represent an emerging chronic illness that potentially affects millions of people worldwide. SARS-CoV-2 infection has resulted in a PCC incidence ranging from 10 to 30 % in non-hospitalized individuals to 50–70 % in hospitalized patients. Most PCC patients experience mild symptoms, while a minority report severe manifestations. We aimed to estimate the prevalence of PCC among COVID-19 patients who attended three public hospitals in Alexandria, Egypt between June 2022 and February 2023, and to investigate its risk factors.

Methods: All COVID-19-confirmed patients aged >18 years attended the selected hospitals, and their household contacts were contacted. Data were collected through telephone interviews using a questionnaire adapted from World Health Organization (WHO) and Penn Medicine tools, covering demographics, COVID-19 history, and PCC symptoms. PCC was defined as symptoms starting three months after the post-acute infection and lasting for at least two months beyond. Statistical analyses employed descriptive statistics, chi-square tests, and a logistic regression model, with a significance level of $p < 0.05$.

Results: A total of 1546 patients were enrolled. Their mean age was 39.7 ± 15.9 years, 46.0 % were males, and 13.9 % had comorbidities. Of them, 760 patients (49.2 %) reported PCC symptoms including, 52.6 % seen at outpatients, 26.7 % were admitted, and 0.5 % required admission to ICU. PCC symptoms included shortness of breath (94.2 %), mood changes (13.9 %), cough (13.0 %), and fatigue (8.8 %). PCC was associated with older age, hospitalization during acute COVID-19, comorbidities including asthma, hypertension, and diabetes, as well as treatment with different COVID-19 medications. Logistic regression shows that asthma, male gender, and treatment with medicines at the hospital remained significant in the model (ORs: 6.85, 0.36, and 0.88, $p < 0.001$).

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Conclusion: This study sheds light on PCC's prevalence and influencing factors following infection in Alexandria, Egypt. Common PCC symptoms included difficulty in breathing, fatigue, and psychological manifestations. The findings emphasize the critical need for early intervention and targeted management strategies, especially for high-risk groups such as asthma patients, to alleviate the long-term health consequences of COVID-19. Study results could guide the prevention of PCC e.g., through vaccination, management of long-term sequelae of PCC e.g., rehabilitation, and psychological support initiatives.

1. Introduction

Post-COVID conditions (PCC) are a group of chronic conditions characterized by symptoms typically occurring three months after the onset of COVID-19 and lasting for a minimum of two months [1]. PCC symptoms may either continue from the initial illness or emerge after recovery, exhibiting an intermittent or relapsing pattern over time. The most prevalent symptoms associated with PCC include fatigue, shortness of breath, cognitive decline, mental disorders such as anxiety and depression, autonomic dysfunction, and other symptoms that often impact daily activities like work or household chores [2,3]. Most people with PCC experience mild or moderate COVID-19 symptoms; however, some may experience a wide range of severe symptoms for months after the initial infection [4]. PCC is significantly associated with numerous factors such as previous hospitalization, ICU admission, old age, comorbidities including diabetes and preexisting psychiatric conditions, as well as the severity of the initial COVID-19 illness. However, it is noteworthy that even young and previously healthy individuals with mild COVID-19 may experience enduring effects from the disease [5,6].

The global prevalence of PCC ranges from 5 % to 34 % in non-hospitalized patients [7,8], from 54.0 % to 74.3 % in hospitalized patients and those admitted to the ICU, with varying prevalence rates among different patient groups. However, determining the prevalence and duration of PCC remains challenging due to the absence of standardized research approaches across different studies and limited patient follow-up in clinical investigations [2]. In Egypt, few studies were conducted to estimate the prevalence of PCC and investigate its symptoms and risk factors, most of which involved small sample sizes or online surveys. A wide range of PCC prevalence rates has been reported in Egypt, between 38.8 and 87.6 % [9,10], suggesting the need for further well-designed studies to better estimate the prevalence of PCC and investigate its risk factors. The objective of this study is to estimate the prevalence of PCC and better describe its clinical symptoms, severity, and outcome among patients confirmed with COVID-19 attended three public hospitals in Alexandria, Egypt and identify the factors linked to the PCC.

2. Material and methods

2.1. Study design and setting

A cross-sectional study was conducted at three Ministry of Health and Population (MoHP) large referral hospitals located in different regions of the Alexandria governorate in Egypt. These hospitals are specialized in receiving and treating patients with COVID-19, including those with PCC.

2.2. Study population

Patients confirmed as SARS-CoV-2 positive by RT-PCR and those clinically diagnosed using CT scans were either seen at outpatient clinics or admitted to the selected hospitals between June 2022 and February 2023. This timeframe corresponds to at least three months after their acute COVID-19 diagnosis. Additionally, household contacts of those patients who developed respiratory symptoms were eligible for enrollment. Only those who consented verbally to study participation were enrolled.

2.3. Case definitions

- COVID-19 Confirmed Cases: Patients who provided oropharyngeal and nasopharyngeal swabs had positive results by reverse transcription-polymerase chain reaction (RT-PCR) test.
- COVID-19 Probable Cases: Patients diagnosed at the hospital by imaging findings (X-ray and chest CT), and/or positive serology and blood tests.
- Epidemiologically Linked Cases: Household contacts of symptomatic patients.
- Post-COVID condition: Individuals who have confirmed or probable SARS-CoV-2 infection, typically starting three months after the initial infection and lasting for at least two months, with symptoms that cannot be explained by another diagnosis.
- PCC symptoms were self-reported by patients in their own words. The primary outcome of post-acute sequelae (PASC) was defined as the presence of one or more symptoms extending beyond three months from the onset of acute COVID-19 diagnosis [11].

2.4. Data collection procedure and tool

Data collection via questionnaire was conducted between January and June 2023. Eligible patients' contact information was obtained from hospital records, after which they were contacted and interviewed via telephone using a questionnaire adapted from the World Health Organization (WHO) [12] and Penn Medicine [13] post-COVID assessment tools. The data collection tool used included patients' demographic data (age, sex, occupation, and other comorbidities), as well as information on post-COVID symptoms following acute COVID-19 infection, previous hospitalizations, and COVID-19 treatments. A Google Form was created for data collection during interviews, with up to three attempts made to contact individuals who could not initially be reached. The tool was carefully translated into Arabic to preserve the original meaning and context, thereby reducing any cultural or language-based bias.

Trained social workers conducted the interviews, they were trained to administer the questionnaire consistently, avoiding leading questions and maintaining a neutral tone throughout the interview. Participants were allowed to respond on their terms following the patient-reported outcomes (PROs) framework [14]. The tool was pilot-tested with 25 individuals, after which most of the open-ended questions were converted to closed-ended questions to reduce the call duration from 30-45 min to 10–30 min. The final interview consisted of 30 questions, of which 21 were closed-ended and the remaining were open-ended, (see Supplementary file).

2.5. Statistical analysis

Participants' sociodemographic characteristics were described using proportions, means, and standard deviations. Inferential statistics were used to compare data of patients with or without PCC. Chi-square or Exact tests were applied for categorical data, while t-tests or Mann-Whitney tests were used for numerical data. The statistical analysis was conducted using R software version 4.2.1 and SPSS version 25. The map was created using Microsoft Excel 3D Maps. Independent factors and variables with a p-value of less than 0.2 were included in a multivariable logistic regression model to account for covariates.

3. Results

Fig. 1 and Supplementary Table S1 illustrate the distribution of study participants across various regions, predominantly Alexandria (1385 participants), with Montazah, Sharq, and Wasat having the highest numbers, reflecting the city's typical population distribution. Other governorates like Behira, Kafr El Sheikh, and Greater Cairo have fewer participants due to Alexandria's popularity as a coastal and Egypt's secondary capital. 274 (36.1 %) Overall, 1600 patients were identified during the study period, of whom 1546

Fig. 1. The map of Egypt shows the distribution of participants across Alexandria and other governorates.

(96.6 %) could be reached through telephone interviews. Of them, 327 (21.2 %) were confirmed as COVID-19 positive through RT-PCR testing, 486 (31.4 %) clinically diagnosed and 733 (47.4 %) symptomatic household contacts. Of all respondents, 711 (46 %) were males, and 633 (41 %) were employed or engaged in business.

Of all respondents 760 patients reported symptoms starting three months after acute COVID-19 infection, lasting at least two months giving an overall PCC prevalence of 49.2 %, 36.1 % among hospitalized patients, and 63.9 % among non-hospitalized patients. Their mean age was 40.6 years (±16.3). Patients with PCC were slightly older than those with no PCC (mean age 40.6 vs 38.7 years, $p = 0.018$) and had higher rates of hospitalization during COVID-19 illness (36.1 % vs. 17.7 %, $p < 0.001$), and a higher proportion requiring ICU care (7.8 % vs. 3.3 %, $p < 0.001$). A higher rate of comorbidities was noted among PCC patients (89.3 % vs. 83.0 %, $p < 0.001$), diabetes mellitus (4.3 % vs. 6.9 %, $p = 0.031$), and asthma (2.8 % vs. 5.1 %, $p = 0.019$), while the lower rate of hypertension and a lower rate of hypertension (0.9 % vs. 2.8 %, $p < 0.01$) was found among PCC patients compared to non-PCC patients. PCC patients were more likely to be household contacts (57.5 % vs. 37.7 %, $p < 0.001$) and more likely to receive COVID-19 medications during hospitalization (36.1 % vs. 17.7 %, $p < 0.001$) compared to non-PCC patients. Further details about the characteristics of this cohort are provided in Table 1.

Table 2 provides an overview of the prevalence of the most frequently documented PCC. These symptoms persisted for an average duration of approximately 200 days, equivalent to roughly six and a half months. The most common PCC symptom was shortness of breath, affecting 716 (96.2 % of symptomatic patients) including 356 (46.8 %) who experienced shortness of breath multiple times a day. Dyspnea was more frequently reported (49 %) among those with close contact to COVID-19 patients.

Cough was the second most frequently reported symptom, affecting 121 respondents (15.9 %), followed by mood changes and anxiety, reported by 106 respondents (13.9 %). Other symptoms such as fatigue, memory problems, and difficulty in movement were reported by approximately 13.7 % of respondents. Muscle and joint pain, pain during swallowing, anosmia and hypogeusia, hoarseness, and sleep disorders were reported by 21.8 % of respondents. In contrast, teeth or gum problems and gastrointestinal (GIT) issues were reported by only 0.1 % of the respondents (Table 2).

Fig. 2A illustrates the variation in median PCC time (months) between patients who took medication and those who did not. Patients who refrained from taking medication experienced the longest PCC duration (median 7.1, IQR 4.7; 9.9), whereas those who received home medication had the shortest PCC time (median 6.4, IQR 4.5; 9.5). Moving to Fig. 2B, it becomes evident that disease severity also played a role in influencing PCC time. Patients with severe conditions exhibited the shortest (median 6.3, IQR 4.8; 7.1) months.

Table 1
Characteristics of the survey respondents who participated in the study.

Variable	Post-COVID Conditions (PCC)		
	Yes (n=760)	**No (n=786)**	**p-value**
Age, Mean (SD)	40.6 (16.3)	38.7 (15.4)	**0.018***
Gender, Male.	363 (47.8 %)	348 (44.3 %)	**0.169**
Occupation			**0.222**
Employed/Business	335 (42.6 %)	298 (39.2 %)	
Healthcare worker	40 (5.1 %)	33 (4.3 %)	
Student	167 (21.2 %)	155 (20.4 %)	
Unemployed/Housewife	244 (31.0 %)	274 (36.1 %)	
Hospitalization during COVID-19 illness (Yes)	274 (36.1 %)	139 (17.7 %)	**< 0.001***
Severity			**<0.001***
Mild	486 (63.9 %)	647 (82.3 %)	
Moderate	215 (28.3 %)	113 (14.4 %)	
Severe (ICU)	59 (7.8 %)	26 (3.3 %)	
Number of Comorbidities			<0.001*
None	676 (89.3 %)	652 (83.0 %)	
1	74 (9.8 %)	112 (14.2 %)	
2	7 (0.9 %)	22 (2.8 %)	
Comorbidities			
Diabetes Mellitus	33 (4.3 %)	54 (6.9 %)	**0.031***
Hypertension	7 (0.9 %)	22 (2.8 %)	**0.007***
Renal	5 (0.7 %)	9 (1.1 %)	**0.312**
Hepatic	0 (0.0 %)	1 (0.1 %)	**0.325**
Asthma	21 (2.8 %)	40 (5.1 %)	**0.019***
Hypercholesterolemia	3 (0.4 %)	1 (0.1 %)	**0.301**
COVID-19 Status			**<0.001***
Epidemiologically linked	437 (57.5 %)	296 (37.7 %)	
Probable cases	181 (23.8 %)	305 (38.8 %)	
Confirmed cases	142 (18.7 %)	185 (23.5 %)	
Medications during COVID-19			**<0.001***
COVID-19 home medications	34 (4.5 %)	34 (4.3 %)	
Hospitalized COVID-19 medications	274 (36.1 %)	139 (17.7 %)	
No medications	452 (59.5 %)	613 (78.0 %)	

***These results were statistically significant with p-value<0.05. SD: Standard deviation.**
Chi-square or Exact tests were applied for categorical data, represented as a number (%). While *t*-test was used for numerical data, represented as mean ± SD

Table 2
Reported symptoms and duration (months) of post-COVID conditions among hospitalized and non-hospitalized patients.

Symptoms	Epidemiologically linked (n = 437)	Probable (n = 181)	Confirmed (n = 142)	Total (N = 760)	p-value
Duration, months, Median (IQR)	7.0 (5.6, 9.8)	6.5 (5.6, 9.8)	6.7 (4.2, 9.8)	6.7 (5.5, 9.8)	**0.327**
i. Shortness of breath					**0.190**
Moderately	198 (45.3 %)	88 (48.6 %)	74 (52.1 %)	360 (47.4 %)	
Most times	214 (49.0 %)	86 (47.5 %)	56 (39.4 %)	356 (46.8 %)	
Never	25 (5.7 %)	7 (3.9 %)	12 (8.5 %)	44 (5.8 %)	
ii. Difficulty in movement	11 (2.5 %)	3 (1.7 %)	1 (0.7 %)	15 (2.0 %)	**0.378***
iii. Fatigue	33 (7.6 %)	9 (5.0 %)	25 (17.6 %)	67 (8.8 %)	**< 0.001***
iv. Memory Problems	10 (2.3 %)	1 (0.6 %)	11 (7.7 %)	22 (2.9 %)	**< 0.001***
Other reported symptoms					
1- Cough					**0.032***
Moderately	18 (4.1 %)	0 (0.0 %)	4 (2.8 %)	22 (2.9 %)	
Most times	55 (12.6 %)	20 (11.0 %)	24 (16.9 %)	99 (13.0 %)	
Never	364 (83.3 %)	161 (89.0 %)	114 (80.3 %)	639 (84.1 %)	
2- Hoarseness	2 (0.5 %)	0 (0.0 %)	9 (6.3 %)	11 (1.4 %)	**< 0.001***
3- Pain during swallowing	22 (5 %)	6 (3.3 %)	16 (11.3 %)	44 (5.8 %)	**0.030***
4- Anosmia/Hypogeusia	34 (7.8 %)	17 (9.4 %)	7 (4.9 %)	58 (7.6 %)	**0.320**
5- Muscle/Joint problems					**0.603**
Joint pain	8 (1.8 %)	6 (3.3 %)	5 (3.5 %)	19 (2.5 %)	
Knee pain	19 (4.3 %)	5 (2.8 %)	6 (4.2 %)	30 (3.9 %)	
Never	410 (93.8 %)	170 (93.9 %)	131 (92.3 %)	711 (93.6 %)	
6- Sleep disorders					**0.009***
Insomnia	1 (0.2 %)	0 (0.0 %)	0 (0.0 %)	1 (0.1 %)	
Nightmares	0 (0.0 %)	4 (2.2 %)	0 (0.0 %)	4 (0.5 %)	
Never	436 (99.8 %)	177 (97.8 %)	142 (100.0 %)	755 (99.3 %)	
7- Mood changes and anxiety	49 (11.2 %)	24 (13.3 %)	33 (23.2 %)	106 (13.9 %)	**< 0.001***
8- GIT Problem	0 (0.0 %)	1 (0.2 %)	0 (0.0 %)	1 (0.1 %)	**0.336**

*These results were statistically significant with a p-value<0.05. IQR: Interquartile range.
Chi-square or Exact tests were applied for categorical data, **represented as a number (%)**. while the Mann-Whitney test was used for numerical data which represented as median and IQR.

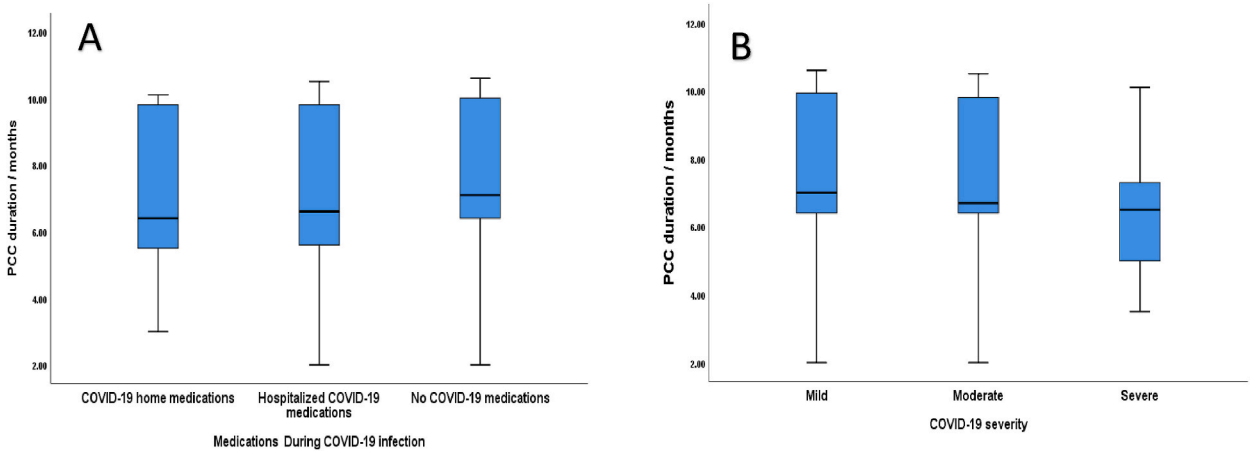

Fig. 2. Box plots representing the duration of Post-COVID Conditions (PCC) (in months), the median (horizontal line within the box), interquartile range (IQR, box edges), and minimum and maximum values within 1.5 times the IQR (whiskers). A) Regarding the type of COVID-19 medications used during the acute phase (home medication, hospitalized medication, and no medication). (B) Regarding COVID-19 severity (mild, moderate, and severe).

By logistic regression, male gender (OR 0.88; 95 % CI 0.72–1.09), receiving medication during hospitalization were less likely to have PCC compared to females and those who took no medication (OR 0.39; 95 % CI 0.22–0.58), while those with asthma were more likely to have PCC (OR 6.85; 95 % CI 2.4–19.4). Age, diabetes, hypertension, and disease severity were also included as predictors in the model, but their OR didn't achieve statistical significance. The interaction between having asthma and using home medication during COVID-19 illness significantly reduces the risk of developing PCC symptoms, as indicated by a p-value of 0.002 and an OR of 0.08, suggesting a 92 % lower likelihood of symptoms in this group. However, the interaction between having asthma and using hospitalized COVID-19 medication is not statistically significant ($p > 0.05$). Thus, while the combination of asthma and home medication shows a protective effect, the combination of asthma and hospitalized COVID-19 medication does not significantly impact PCC outcomes. The logistic regression model accounted for 69 % (R^2) of the variation in the occurrence of PCC (F statistic = 110.9, p-

value <0.0001). Refer to Table 3 for a representation of this logistic regression model.

The relation between severity and the PCC is presented in Fig. 3. Even though most patients with severe acute COVID-19 symptoms suffered from persistent PCC (70 %) these results were not statistically significant.

Fatigue is the most prevalent PCC in patients with one or more comorbid conditions. Followed by persistent loss of taste and smell and shortness of breath. The distribution of the number of comorbid patients with PCC is presented in Fig. 4.

4. Discussion

The present study investigates the frequency of PCC following COVID-19 infection within a population-based setting. A comprehensive total of 1546 patients, drawn from three distinct hospitals in Alexandria, representing Alexandria and other Egyptian governorates, all of whom were in Alexandria during the survey period, underwent phone interviews using identical questions specifically designed to ascertain the prevalence and contributing factors associated with patients experiencing PCC. This inquiry encompassed patients who had been admitted either as inpatients or outpatients in the chosen hospitals over a specified period of 9 months, from June 2022 to February 2023. The study revealed a noteworthy PCC prevalence rate of 49.2 %. Comparatively, the prevalence of PCC in adults exhibited variations across diverse studies, spanning percentages of 8.2 %, 35 %, 45 %, 49.3 %, and 49.6 % [15–18]. Tenforde et al. [16], elucidated that even young patients devoid of comorbidities and those not requiring hospitalization post-COVID are susceptible to enduring persistent PCC. Similarly, Abdelhafiz et al. [9], conducted a study in Egypt, revealing that approximately 81.31 % of the encompassed patients documented PCC. Remarkably, during the Omicron wave, the percentage of COVID-19 patients reporting PCC notably decreased compared to the Delta wave within the same geographic context [15]. The substantial disparities in the reported prevalence of PCC between various studies may be attributed to the absence of standardized criteria for participant selection, varying research cohorts, diverse data collection methodologies, and distinct variants of the SARS-CoV-2.

The disparity in mean gender between patients with PCC and the other group exhibited statistical significance, underscoring that the female sex potentially plays a contributory role in the emergence of PCC [19–21]. Furthermore, individuals with mild and non-hospitalized acute COVID-19 illnesses also manifested instances of PCC. This finding aligns with the findings of Al-Aly et al. [22]. Despite the evident relationship indicated by the bivariate analysis between the severity of COVID-19 disease and the occurrence of PCC, the findings from the multivariate binary logistic regression model show that the severity of acute COVID-19 illness has an insignificant impact on the outcomes of PCC. These results are in accordance with the research by Townsend et al., [23]. Intriguingly, the severity of acute COVID-19 did not exert a significant influence on the occurrence of PCC, yet it did significantly reduce the duration of PCC. However, Förster et al. [17], reported that at least one PCC was documented in (n = 588, 46.2 %) of non-hospitalized patients and (n = 127, 72.6 %) of hospitalized patients. Despite the substantial association between COVID-19 severity and the presence of PCC, this connection was not statistically significant within this study.

Furthermore, medications, including antivirals and corticosteroids administered during COVID-19, exhibited notable correlations with PCC. The utilization of either home-based or hospital-administered medication was linked to a significant reduction in the risk of PCC when compared to receiving no medication, irrespective of the severity of the PCC [24].

The most frequently reported PCC symptoms included shortness of breath, followed by alterations in mood, cough, and fatigue during physical exertion. These findings align with the outcomes of a comprehensive systematic review conducted by Martimbianco

Table 3
Post-COVID Conditions multivariate binary logistic regression model.

Variable	OR [95 % CI]	p-value
Intercept	1.67	0.001*
Age	0.99 [0.98, 1.01]	0.078
Gender		
Female	Reference	Reference
Male	0.88 [0.72, 1.09]	0.039*
Comorbidities		
Hypertension	2.29 [0.85, 6.13]	0.102
Diabetes	1.38 [0.80, 2.35]	0.246
Asthma	6.85 [2.4, 19.4]	<0.001*
COVID-19 severity		
Mild	Reference	Reference
Moderate	1.17 [0.70, 1.96]	0.555
Severe	1.17 [0.70, 1.96]	0.555
Medication during COVID-19 illness		
No medication	Reference	Reference
Medication, home	0.79 [0.44, 1.42]	0.436
Medication, hospital	0.36 [0.22, 0.58]	<0.001*
Interaction (Asthma & Medication)		0.010
Asthma & no medication	Reference	Reference
Asthma & home medication	0.08 [0.02, 0.41]	0.002*
Asthma & hospital medication	0 [0,0]	0.999

*Statistically significant predictors with p-value<0.05. OR: Odds ratio; CI: Confidence interval.
Model F statistic = 110.9, p-value <0.0001

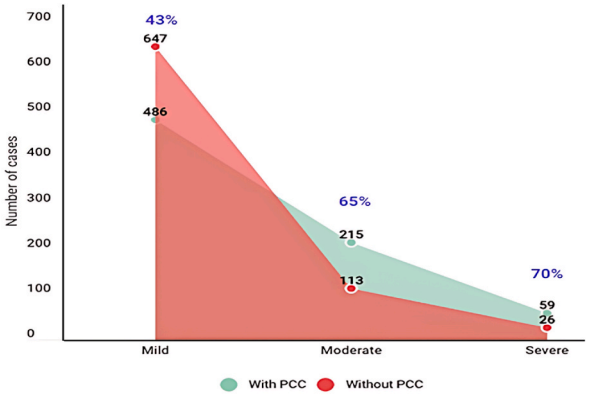

Fig. 3. This chart represents the relationship between the acute COVID-19 disease severity and the emergence of the post-COVID Conditions (PCC). The red area is the number of patients without PCC, and the green area is the number of patients with PCC.

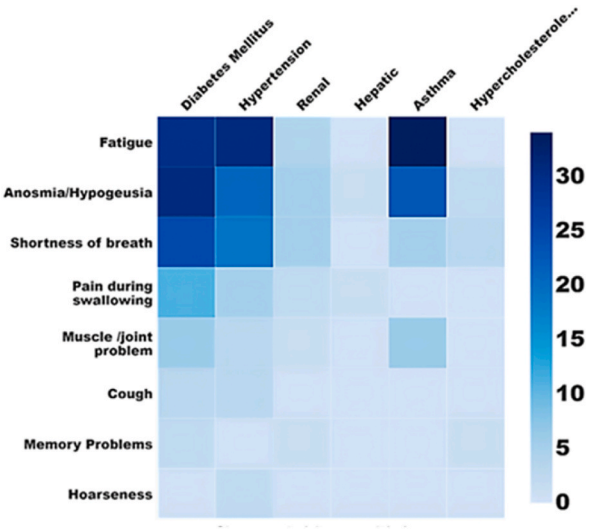

Fig. 4. Heatmap reported the number of post-COVID conditions (PCC) in patients with comorbidities. A darker blue color indicates higher reported numbers of symptoms. The X-axis is the comorbid condition; the Y-axis is the PCC.

et al. [25], wherein it was indicated that the prevalence of PCC ranged notably from 4.7 % to 80 %. Conversely, a study undertaken by Förster et al. highlighted a different perspective, observing that fatigue or lethargy (n = 297, 41.5 %) and rapid physical exhaustion (n = 292, 40.8 %) took precedence, followed by difficulty concentrating (n = 219, 30.6 %). Additionally, loss of the sense of taste and/or smell were considered rather specific manifestations of COVID-19, persisting for a duration of ≥ three months in (n = 185, 25.9 %) and (n = 182, 25.5 %) cases, respectively [17]. Notably, among patients with comorbidities, fatigue emerged as the prevailing PCC.

Given the heterogeneity of symptoms, a crucial query arises regarding whether certain ailments represent distinct phenotypes of the same underlying condition or if they originate from divergent pathophysiology. An additional study by Alghamdi et al. revealed that joint pain (14.1 %) and reduced exercise tolerance (12.7 %) were the second most prevalent symptoms, while dyspnea and neurological symptoms were the most dominant [18].

In our study, we employed a multivariate binary logistic regression model to investigate factors influencing the presence of PCC and their relationship with variations in PCC occurrence, yielding a highly significant model ($p < 0.0001$). We found asthma as a co-morbidity, gender, and medication usage to be significant predictors, collectively explaining 69 % (R^2) of the variability in PCC. Specifically, the interaction between asthma and home COVID-19 medication significantly reduced the risk of PCC symptoms, suggesting a 92 % lower likelihood of symptoms in this subgroup. However, the lack of statistical significance in the interaction between asthma and hospitalized COVID-19 medication ($p > 0.05$) implies no significant impact on PCC outcomes from this combination. These findings underscore the protective effect of home medication in asthma patients post-COVID, potentially guiding tailored therapeutic strategies for managing PCC. In contrast, a study conducted by Ha et al. focused on the primary outputs of the models. The study visualized the p-values of the variables, along with the modified R^2 values of the models [26]. Notably, the models exhibited strong performance, achieving corrected R^2-squared values as high as 0.9, as indicated by the results. Consequently, these models may

effectively account for up to 90 % of the population variation. However, while the model demonstrated favorable performance throughout the day, the values exhibited a gradual decline as the time approached midnight.

5. Strengths and limitations

This study involved a highly representative number of patients from Alexandria hospitals and fewer participants across Egypt. However, the study is subject to insufficient recall or recall bias due to its reliance on telephone surveys and patient self-reporting. The observed high prevalence of PCC may be attributed to this reliance on self-reported data. Furthermore, the lack of control and the challenge of differentiating between symptoms of post-COVID and those caused by other factors are additional factors to consider.

6. Conclusion

The study revealed a high to medium rate of post-COVID conditions (PCC) among both hospitalized and non-hospitalized COVID-19 patients, surpassing the global rates, which range from 5 % to 34 % in non-hospitalized patients and from 54.0 % to 74.3 % in hospitalized patients. This variation in PCC prevalence across different studies can be attributed to several factors. First, differences in the symptoms studied contribute to these discrepancies. Additionally, the timeframes post-infection, which range from weeks to months, further complicate comparisons. The settings in which patients were observed—whether non-hospitalized, hospitalized, or in intensive care units (ICU)—also play a significant role. Finally, the methods of assessment, including self-reporting and health records, add another layer of variability to the reported prevalence rates. This study underscores the persistent health effects post-initial COVID-19 phase. Shortness of breath is a consistently documented symptom, while fatigue prevails among patients with comorbidities. A noteworthy discovery from the study is that administering medications, including asthma medication, antivirals, and corticosteroids, during the acute phase of COVID-19 significantly reduces the prevalence of PCC.

These findings enhance our understanding of the contributing factors and enduring consequences of PCC They highlight the critical role of early medical intervention in mitigating PCC prevalence and provide valuable insights for developing strategies for managing and treating individuals with PCC. Further research is essential to explore the long-term effects and prognosis of individuals suffering from PCC, ensuring that healthcare strategies evolve in response to emerging evidence.

Ethical approval statement

The study received ethical approval from the Egyptian Ministry of Health and Population Research Ethics Committee (MoHP-REC) under reference number 20–2022/21, granted on November 30, 2022. Upon admission to MoHP hospitals, all patients provided written informed consent, explicitly authorizing the use of their medical information for research purposes. This consent was carefully documented in their hospital medical records. Additionally, before participating in the study and at the beginning of the phone interviews, verbal consent was obtained from each patient.

Consent of publication

NA.

Funding statement

NA.

Data availability statement

The study's supporting data are accessible upon request from the corresponding author. The data is not publicly accessible because of privacy or ethical constraints.

CRediT authorship contribution statement

Rasha Ashmawy: Writing – original draft, Formal analysis, Conceptualization. **Yousra A. El-Maradny:** Writing – original draft, Methodology, Conceptualization. **Amira Tahio:** Writing – review & editing, Supervision, Project administration. **Salma Afifi:** Writing – original draft, Visualization, Data curation. **Sahar Samy:** Writing – review & editing, Supervision, Project administration. **Hala BahaaEldin:** Writing – original draft, Visualization, Validation. **Nahla Gaber:** Validation, Resources, Investigation, Conceptualization. **Ibrahim A. Abdelwahab:** Writing – original draft, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e38764.

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