

Original article

Long Term Effects of Coronavirus Disease 2019 on Healthcare Utilization: A Prospective Cohort Study

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Background

Although most patients recover from coronavirus disease 2019 (Covid-19) in a few weeks, a significant minority can take months to resolve symptoms. The objectives of our study were to evaluate how utilization of the healthcare system differed between patients diagnosed with and without Long Covid; and to identify patient demographics that were associated with increased utilization of healthcare resources.

Methods

Patients admitted to either the Ascension Providence Hospital Novi or Southfield campuses between March 8, 2020, and May 16, 2020, with confirmed Covid-19 were contacted by phone between September 2021 and March 2022, and asked to complete a survey on their health following recovery from Covid-19. Surveys were completed over the phone with the caller, online via Qualtrics, or via a mailed paper survey. Categorical data were analyzed by Fisher's exact test, and $p < 0.05$ was considered statistically significant.

Results

Among the 84 respondents (30% response rate), 63 (75%) had Long Covid and 21 (25%) did not. There was a higher percentage of females in the Long Covid group (75%) compared to the non-Long Covid group (43%, $p = 0.008$) and a trend for a larger proportion of African American patients in the Long Covid group (77%) compared to the non-Long Covid group (55%, $p = 0.06$). Long Covid patients continued to experience an increased frequency of all 10 symptoms surveyed ($p < 0.0001$). Interestingly, there were no significant changes noted in the number of patient visits to their primary care physicians before and after Covid-19. Of significance were the differences in difficulty paying bills ($p = 0.01$) and ability to access healthcare ($p = 0.01$) for the Long Covid group before and after Covid-19 infection.

Conclusions

By understanding the nuanced experiences of individuals with Long Covid, we will be able to identify needs for implementing targeted interventions based on proper allocation of healthcare resources, thus allowing healthcare professionals to work towards mitigating the impact of this condition on individuals' health, well-being, and overall quality of life.

INTRODUCTION

For a significant number of coronavirus disease 2019 (Covid-19) survivors, recovery from the acute phase of illness has been incomplete or has provided only temporary relief.¹ Results of multiple studies have demonstrated that the average recovery time from Covid-19 is 2–3 weeks, depending on symptom severity.^{2–4} However, one in five people, regardless of the severity of their acute infection, may

exhibit symptoms for five weeks or more, while one in ten may have symptoms lasting 12 weeks or more.⁵ A survey study by Koumpias *et al.* revealed that among all individuals included in the study infected with Covid-19, symptoms persisted for at least 15 weeks following infection.⁶ The development of such long-term and chronic sequelae has been termed "Long Covid" and has been noted in multiple studies to follow asymptomatic, mild, moderate, severe, or critical acute Covid-19.⁵ For the purpose of our study, "Long Covid" was defined as the continued presence of at

least one new symptom 12 weeks after the resolution of initial Covid-19 infection that had not been present prior to hospitalization with Covid-19.

Al-Aly *et al.* predicted an increased likelihood of health resource usage by survivors of acute Covid-19 infection 30 days post-discharge in order for healthcare providers to better monitor continuing symptoms.⁷ Chopra *et al.* provided evidence of increased morbidity and physical and emotional symptoms among all recently hospitalized Covid-19 patients 60 days post-discharge, and reported that the majority of the surveyed population experienced some degree of financial impact from hospitalization.⁸ Salerno *et al.* found increased healthcare resource utilization by younger, non-Black Covid-19 patients and increased rates of hospitalization and mortality among older male or Black patients during their hospitalization with Covid-19.⁹ In addition, an observational cohort study of Covid-19 patients for six months post-diagnosis found that the highest frequency of visits occurred during the first 30 days and saw a gradual decrease over time.¹⁰ Older age, female gender, and higher body mass index were additionally seen to be associated with higher total utilization of healthcare services for hospitalized patients. These factors, as well as non-white race/ethnicity, former smoking, and greater number of pre-existing comorbidities, were all associated with increased utilization among non-hospitalized patients.¹⁰

Extending our understanding of the association of Long Covid with healthcare utilization is of significant importance in the healthcare field as Covid-19 has affected a sizable fraction of the population whose future medical needs and their implications are not well understood. Our study had two objectives, the first of which was to evaluate how utilization of the healthcare system differed between patients diagnosed with and without Long Covid. The second objective was to identify patient demographics such as age, gender, race/ethnicity, medical comorbidities, and other factors that increased patient utilization of healthcare resources.

MATERIALS

The study included a cohort of Covid-19 positive patients from the Ascension Providence Hospital's Covid-19 registry who met the following criteria: 18 years of age or older, diagnosed with Covid-19 via polymerase chain reaction test, and hospitalized at either the Novi or Southfield campus between March 8, 2020, and May 16, 2020. Next of kin of patients who died while in the hospital or were discharged to hospice were not contacted for the study. Only patients who were discharged alive and had contact information listed in the Covid-19 registry were eligible to participate. This project was submitted to and received approval by the Ascension Providence Hospital Institutional Review Board.

Patients received phone calls and a follow up email. A detailed spreadsheet was maintained to keep track of phone calls made, emails sent, participant responses, and \$10 gift card distribution status used to incentivize participation. Study personnel used a standardized script for phone calls, and an email template was used for participants contacted

via email. Participants who opted to complete the survey online via Qualtrics were asked for their preferred email address, while those choosing the paper-and-pencil format were asked for their preferred mailing address to receive the survey, information sheet, and return envelope with pre-paid postage. The email script served as the information sheet for participants contacted via email. Data collection occurred within a 7-month time frame, between September 2021 and March 2022, and was considered complete when all patients were contacted twice. Patients were considered "unresponsive" or "lost to follow-up" after a total of 2 calls per patient with one voicemail message. The start of the survey contained information about the study, including its nature, purpose, risks and benefits of participation, and the voluntary nature of participation. Completion of the online and paper-and-pencil survey implied consent, while participants contacted via phone were asked for verbal consent to proceed with the survey.

The survey consisted of questions covering demographics, health, education, stress/mental well-being, finances, behavior, sleep, healthcare disparities, and other potential health-related effects of Covid-19. To obtain data on symptoms before and after Covid-19, patients were given a list of symptoms and asked to indicate what symptoms they continued to experience after their Covid-19 diagnosis. They were also asked to indicate which symptoms they experienced before Covid-19. For healthcare utilization, patients were asked to indicate whether the problem existed before Covid-19 and after Covid-19. Responses from the phone and paper-and-pencil survey were recorded in Qualtrics by study personnel, while those who completed the survey online received a link to the survey via email. Responses were saved only if the participant completed the survey in its entirety and confirmed submission. A separate database linked patient names and contact information to their study ID number, which also linked their responses to their Covid-19 registry data.

Descriptive statistics were used to summarize survey responses. Fisher's exact test or Chi-square analysis was used to examine associations between Long Covid and non-Long Covid groups for certain responses and demographic or outcome categorical variables. McNemar's (exact) test was used to compare before and after response differences within each group. The Student's t-test or one-way analysis of variance was used to analyze continuous variables. $P < 0.05$ was considered statistically significant.

RESULTS

In the Covid-19 registry, we identified 292 unique patients who met our study criteria. Among this cohort, 87 patients completed the survey and 205 did not (response rate 30%). Three respondents were unable to be identified after completion of the survey and were excluded from the data set. Differences in demographics between the Long Covid and non-Long Covid groups were evaluated (Table 1). There were no significant differences in age when comparing the two groups for the proportion of responders <65 versus 65 years of age and older ($p = 0.35$) or by mean ($p = 0.20$).

Table 1. Patient demographics.

Characteristic	Long Covid (n=63) N (%)	Non-Long Covid (n=21) N (%)	p-value
Age, years			0.35
<65	43 (68.3)	12 (57.1)	
65+	20 (31.8)	9 (42.9)	
Mean (SD)	57.7 (14.2)	61.9 (13.5)	0.20
Gender			0.008
Female	47 (74.6)	9 (42.9)	
Male	16 (25.4)	12 (57.1)	
Race^a			0.06
Caucasian	14 (23.0)	9 (45.0)	
African American	47 (77.0)	11 (55.0)	
Body mass index, kg/m²			0.16
<30	22 (34.9)	11 (52.4)	
30+	41 (65.1)	10 (47.6)	
Mean (SD)	34.6 (9.8)	30.7 (5.6)	0.14
Charlson Comorbidity Index			0.69
<4	42 (66.7)	15 (71.4)	
≥4	21 (33.3)	6 (28.6)	
Mean (SD)	3.0 (2.3)	3.1 (2.8)	0.90
qSOFA score			0.30
0	41 (65.1)	11 (52.4)	
1-2	22 (34.9)	10 (47.6)	
Mean (SD)	0.41 (0.61)	0.48 (0.51)	0.44
SpO₂/FiO₂			0.45
<445	33 (52.4)	9 (42.9)	
445+	30 (47.6)	12 (57.1)	
Mean (SD)	382.8 (124.1)	386.0 (122.1)	0.74

Abbreviations: Covid, coronavirus disease; SD, standard deviation; qSOFA, quick Sequential Organ Failure Assessment; SpO₂/FiO₂, oxygen saturation captured by the arterial oxygen saturation to fraction of inspired oxygen

^aAsian race and "other" race were not included in this table due to extremely low frequencies of individuals in these groups.

Body mass index differences for neither the proportion of responders <30 versus 30 and higher ($p = 0.16$) nor by mean ($p = 0.14$) were statistically significant between the two groups. However, a significant gender difference was observed ($p = 0.008$), with a higher percentage of females in the Long Covid group (75%) compared to the non-Long Covid group (43%). Similarly, race distribution approached significance ($p = 0.06$), as a larger proportion of individuals in the Long Covid group were African American (77%) compared to the non-Long Covid group (55%). Other clinical characteristics of the two groups, such as Charlson Comorbidity Index, oxygen saturation and the quick Sequential Organ Failure Assessment score, did not show statistically significant differences between the two groups.

Both Long Covid and non-Long Covid patients experienced similar frequencies of symptoms prior to Covid-19 (Table 2). Not surprisingly, when the presence of various symptoms was analyzed for the patients in the Long Covid and non-Long Covid groups, before and after contracting

Covid-19, it was clear that a significantly higher number of patients in the Long Covid group developed symptoms after Covid-19 as compared to before Covid-19 (all $p < 0.0001$, Table 2). Non-Long Covid patients showed no difference before and after Covid-19.

INDICATORS OF HEALTHCARE UTILIZATION

Table 3 provides insights into aspects of participants' lifestyle that reflect their utilization of the healthcare system, including visits to primary care physicians as reported under "access to healthcare", difficulty paying medical and other bills, and Covid-19 vaccine receipt, safety, and effectiveness as perceived by each participant. No significant differences between the two groups emerged in responses to these questions, though varying patterns between the two groups were apparent. Interestingly, there were no significant changes noted in the number of patient visits to their primary care physicians before and after Covid-19. Of

Table 2. Presence of symptoms before and after coronavirus disease 2019 infection.

Symptom	Long Covid (N=63) N (%)		Non-Long Covid (N=21) N (%)		p-value (Long vs Non-Long)
	Before	After	Before	After	
Body Aches					
Yes	8 (12.7)	35 (55.6)	4 (19.0)	3 (14.3)	0.48 (Before), 0.001 (After)
No	55 (87.3)	28 (44.4)	17 (81.0)	18 (85.7)	
p-value (Before vs. After)	<0.0001		1.00		
Brain Fog					
Yes	1 (1.6)	36 (57.1)	0 (0)	3 (14.3)	1.00 (Before), 0.0008 (After)
No	62 (98.4)	27 (42.9)	21 (100)	18 (85.7)	
p-value (Before vs. After)	<0.0001		NA		
Cough					
Yes	6 (9.5)	34 (54.0)	4 (19.0)	1 (4.8)	0.2589 (Before), <0.0001 (After)
No	57 (90.5)	29 (46.0)	17 (81.0)	20 (95.2)	
p-value (Before vs. After)	<0.0001		0.3750		
Difficulty Breathing or Shortness of Breath					
Yes	4 (6.3)	49 (77.8)	3 (14.3)	1 (4.8)	0.3591 (Before), <0.0001 (After)
No	59 (93.7)	14 (22.2)	18 (85.7)	20 (95.2)	
p-value (Before vs. After)	<0.0001		0.5000		
Difficulty Sleeping					
Yes	5 (7.9)	31 (49.2)	2 (9.5)	1 (4.8)	1.00 (Before), 0.0002 (After)
No	58 (92.1)	32 (50.8)	19 (90.5)	20 (95.2)	
p-value (Before vs. After)	<0.0001		1.00		
Fatigue					
Yes	4 (6.3)	49 (77.8)	3 (14.3)	1 (4.8)	0.3591 (Before), <0.0001 (After)
No	59 (93.7)	14 (22.2)	18 (85.7)	20 (95.2)	
p-value (Before vs. After)	<0.0001		0.6250		
Hair Loss					
Yes	2 (3.2)	24 (38.1)	0 (0)	1 (4.8)	1.00 (Before), 0.0047 (After)
No	61 (96.8)	39 (61.9)	21 (100)	20 (95.2)	
p-value (Before vs. After)	<0.0001		NA		
Headache					
Yes	6 (9.5)	35 (55.6)	0 (0)	0 (0)	0.3291 (Before), <0.0001 (After)
No	57 (90.5)	28 (44.4)	21 (100)	21 (100)	
p-value (Before vs. After)	<0.0001		NA		
Joint Pain					
Yes	15 (23.8)	35 (55.6)	4 (19.0)	4 (19.0)	0.7697 (Before), 0.005 (After)
No	48 (75.2)	28 (44.4)	17 (81.0)	17 (81.0)	
p-value (Before vs. After)	<0.0001		1.00		
Loss of Taste or Smell					
Yes	0 (0)	38 (60.3)	1 (4.8)	2 (9.5)	0.250 (Before), <0.0001 (After)
No	63 (100)	25 (39.7)	20 (95.2)	19 (90.5)	
p-value (Before vs. After)	NA		1.00		
Other (free text by participants)					
Yes	0 (0)	17 (27.0)	1 (4.8)	1 (4.8)	0.250 (Before), 0.033 (After)
No	63 (100)	46 (73.0)	20 (95.2)	20 (95.2)	
p-value (Before vs. After)	<0.0001		1.00		

Abbreviations: Covid, coronavirus disease; NA, not applicable

Table 3. Indicators of utilization of healthcare services before and after coronavirus disease 2019 infection.

Characteristic	Long Covid (N=63) N (%)		Non-Long Covid (N=21) N (%)		p-value (Long vs Non-Long)
	Before	After	Before	After	
Difficulty paying medical bills?					
Yes	11 (18.3)	25 (41.7)	5 (23.8)	6 (28.6)	0.75 (Before), 0.43 (After)
No	49 (81.7)	35 (58.3)	16 (72.2)	15 (71.4)	
p-value (Before vs. After)	<0.0001		1.00		
Difficulty paying other bills?					
Yes	7 (11.7)	23 (38.3)	6 (28.6)	7 (33.3)	0.09 (Before), 0.80 (After)
No	53 (88.3)	37 (61.7)	15 (71.4)	14 (66.7)	
p-value (Before vs. After)	<0.0001		1.00		
Access to healthcare					
In person only	47 (74.6)	20 (31.8)	17 (81.0)	9 (42.9)	0.77 (Before), 0.43 (After)
Virtual/other	16 (25.4)	43 (68.2)	4 (19.1)	9 (57.1)	
p-value (Before vs. After)	<0.0001		0.008		
Covid vaccine doses received					
None	NA	12 (19.1)	NA	2 (9.5)	0.51 (After)
One	NA	1 (1.6)	NA	0 (0)	
Two	NA	50 (79.4)	NA	19 (90.5)	
Covid vaccine safe?					
Yes	NA	38 (60.3)	NA	15 (71.4)	0.66 (After)
No	NA	4 (6.4)	NA	2 (9.5)	
Unsure	NA	17 (27.0)	NA	4 (19.1)	
Missing	NA	4 (6.4)	NA	0	
Covid vaccine effective?					
Yes	NA	33 (52.4)	NA	16 (76.2)	0.23 (After)
No	NA	7 (11.1)	NA	2 (9.5)	
Unsure	NA	19 (30.2)	NA	3 (14.3)	
Missing	NA	4 (6.4)	NA	0	

Abbreviation: Covid, coronavirus disease; NA, not applicable (Covid vaccines were not available at this time)

significance was the differences in paying bills ($p < 0.0001$) and access to healthcare ($p < 0.0001$) for the Long Covid group before and after Covid-19. Similar differences were only seen in access to healthcare ($p = 0.008$) in the non-Long Covid group.

The healthcare coverage of participants was analyzed with respect to private insurance, Medicare/Medigap, Medicaid/Healthy MI, and other coverage types. Our data indicated that there were no statistically significant differences in healthcare coverage before and after COVID-19 infection (Table 4). The proportions of participants with private insurance remained relatively consistent, while there were fluctuations in the percentages of individuals covered by Medicare/Medigap and Medicaid/Healthy MI.

DISCUSSION

The presence and prevalence of Long Covid has been well documented in the aftermath of the pandemic.¹¹ The va-

riety and number of symptoms experienced by individuals with Long Covid were reported by our survey participants at significantly higher rates compared to those participants without Long Covid.⁹⁻¹¹ In our sample, 75% of respondents had Long Covid, which is consistent with a recent meta-analysis that reported 80% of Covid-19 survivors had at least one persisting symptom¹² and another study that found a prevalence rate of 89% for at least one persisting symptom after 12 weeks in hospitalized Covid-19 survivors.¹³

The key contribution of this study lies in our attempt to analyze healthcare utilization patterns among individuals with Long Covid. Upon collection of initial data, the numbers suggested some patterns of variance between those with Long Covid and those without regarding their utilization of healthcare services based on number of visits with primary care physicians, access to healthcare, and difficulty paying medical and/or other bills. However, once these analyses were conducted, our data did not show a

Table 4. Participant healthcare coverage before and after coronavirus disease 2019 infection.

Characteristic	Long Covid (N=63) N (%)		Non-Long Covid (N=21) N (%)	
	Before	After	Before	After
Healthcare coverage*				
Private	39 (61.9)	34 (54.0)	18 (85.7)	17 (81.0)
Medicare/Medigap	25 (39.7)	25 (39.7)	3 (14.3)	3 (14.3)
Medicaid/Healthy MI	7 (11.1)	10 (15.9)	0	2 (9.5)
Other	8 (12.7)	7 (11.1)	4 (19.1)	4 (19.1)

Abbreviation: Covid, coronavirus disease

* Sum of participant healthcare coverage exceeds total participants in each group since participants were allowed to select all healthcare coverage options

statistically significant difference between the two groups (Table 3). The lack of significance in the utilization of healthcare services in our data is contrary to other publications, which linked a disproportionate number of long term adverse outcomes to those with Long Covid.^{10,11} We believe this is possibly due to (1) a lack of statistical power to detect these effects, (2) potential confounding with additional risk factors included in our models and, (3) incomplete criteria on which to judge healthcare utilization.

The secondary outcome of this study was an evaluation of patient demographics and notably, we found a significantly higher percentage of females in the Long Covid group, as well as a trend for a higher percentage of African Americans. This finding corroborates the results of the study done by Bai *et al.*, which noted that female gender was associated with a higher risk of developing Long Covid.¹⁴ The gender and race disparities observed in this study warrant further attention and investigation. The higher prevalence of Long Covid among females and certain racial groups, particularly African Americans, raises important questions about potential biological, social, and healthcare-related factors contributing to these disparities. Further investigation into the potential disparities is an important next step as this would allow for identification of needs for medical, social, and policy interventions.

ADDITIONAL LIMITATIONS

Our study adds to the existing conversation surrounding long-term consequences of Long Covid with a large Covid-19 positive patient cohort and a longer follow-up period to observe evolving patient outcomes; however, patient responses and follow up were indubitably low. Additionally, this study was based exclusively on patients of the Ascension Providence Hospital System with campuses in Southfield and Novi; there may be biases in the patient mix affecting the generalizability to more diverse populations or other geographic areas. On the other hand, these patients did offer an opportunity to study Covid-19 outcomes in a local region that had been severely impacted by the pandemic. Also of note is the fact that this was a retrospective study of a small sample population in an existing electronic medical records database. As such, we are limited in our ability to draw causal interpretations from these

results, derive predictive models, or account for major new non-Covid-19 related diagnoses that could impact results. Due to the nature of electronic medical record data, there is always the possibility for misclassification bias and/or inaccurate data entry.

CONCLUSIONS

This study contributes to our understanding of Long Covid by shedding light on its association with healthcare utilization, demographic characteristics, and symptom profiles. Specifically, individuals with Long Covid presented with a number of symptoms at significantly higher frequency compared to those participants without Long Covid even after more than a year of recovery. The findings of this study emphasize the importance of recognizing Long Covid as a complex and multidimensional condition. As the global healthcare community continues to navigate the aftermath of the Covid-19 pandemic, addressing the challenges posed by Long Covid requires a collaborative effort involving medical professionals, researchers, policymakers, and public health experts. This study contributes to the understanding of the nuanced experiences of individuals with Long Covid and helps to identify the need for implementing targeted interventions, allowing us to work towards mitigating the impact of this condition on individuals' health, well-being, and overall quality of life.

AUTHOR CONTRIBUTIONS

Methodology: Heraa Hasnat (Lead), Majd Kattan (Supporting), Jeffrey C. Flynn (Supporting), Laci Zawilinski (Supporting), Abdulghani Sankari (Lead). Writing – original draft: Heraa Hasnat (Equal), Majd Kattan (Equal), Joseph Gardiner (Supporting). Writing – review & editing: Heraa Hasnat (Lead), Jeffrey C. Flynn (Supporting), Laci Zawilinski (Supporting), Abdulghani Sankari (Supporting). Project administration: Majd Kattan (Lead), Lahib Doua (Lead). Conceptualization: Lahib Doua (Supporting), Laci Zawilinski (Supporting), Abdulghani Sankari (Lead). Formal Analysis: Joseph Gardiner (Lead). Resources: Cheryl Smith (Lead). Supervision: Laci Zawilinski (Lead).

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