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Survivors of Covid-19: Testing, Symptoms, Severity, and Post-Exposure Conditions among New Yorkers

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Abstract The novel Coronavirus Disease 2019 (COVID-19) is a pandemic of great public health and clinical concern due to its high rate of infectivity, and subsequent morbidity and mortality. The objectives of the study were to 1) assess individual experiences with testing and symptoms of COVID-19 infection; 2) determine the extent to which individuals experienced COVID-19 post-exposure symptoms; and 3) determine if an association exists between pre-existing conditions and severity of COVID-19 symptoms with post-exposure symptoms. One hundred and twenty-one (N= 121) New York State residents who had COVID-19 symptoms and were tested positive for the virus participated in this study. The survey was created in Qualtrics, and the link was posted online (Facebook, Twitter, Snap Chat), and sent to New Yorkers via email and WhatsApp to gather data. Data were exported from Excel spreadsheet to Statistical Package for the Social Sciences (SPSS), version 25, where Chi-Square tests were conducted. Results indicated that most of the participants were between ages 18-35 (54.5%), African Americans (50.4%), non- Hispanic (65%), female (69.4%), had less than a college degree (51%), and made an income in 2019 of less than $55,000 per year (62%). Eighty-seven (approximately 73%) of the participants reported that getting access to testing was easy/very easy. More than one-half reported that they experienced fatigue (66.9%), lack of energy (61.2%), headache (57.9%), muscle ache (53.7%), cough (50.4%), and loss of smell (50.4%) while infected with COVID-19. Participants who experienced symptoms described their most bothersome symptom as severe (37%), followed by mild (33%), and moderate (27%). There was a statistically significant relationship between severity of symptoms and post-exposure problems experienced by participants (X^2 = 13.69; df = 2; p = .001); as well as between pre-existing conditions and post-exposure problems experienced by participants (X^2 = 10.53; df = 1; p = .001). Information from this study could benefit public health practitioners and clinicians by improving their knowledge about COVID-19 and its impacts on survivors.

Keywords: *symptoms of COVID-19, severity of symptoms of COVID-19, COVID-19 testing, long haulers, lingering symptoms, COVID-19 and pre-existing conditions*

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1. Introduction

In December 2019, a cluster of cases of pneumonia was reported Wuhan, China, which was later identified as the Coronavirus Disease 2019 (COVID-19) and has now become a global pandemic [1]. To date, there are over 33 million confirmed cases, and approximately 605 thousand deaths in the US [2]. In 2020, COVID-19 was the third highest cause of death in the US after heart disease and cancer [3]. COVID-19 virus is transmitted primarily from person-to-person through droplets of saliva or discharge from the nose when a person who has the infection coughs or sneezes [4].

COVID-19 symptoms are non-specific and disease presentation can range from asymptomatic to severe pneumonia and/or death. It is most contagious during the pre-symptom and symptomatic stages [5]. Most people who are infected with COVID-19 experience mild to moderate respiratory symptoms and recover without medical care [6]. The most common acute symptoms are fever, fatigue, dry cough, shortness of breath, production of mucus, and a sore throat [7,8,9]. Additional symptoms include loss of taste and smell [8,10,11].

However, patients from around the world have reported that they experienced an extended and complex list of symptoms that originated after the acute phase (post-acute COVID-19) of the disease [12]. In addition, researchers and doctors have reported cases where

lingering symptoms have affected multiple organ systems [10,11,13,14,15]. These symptoms include fatigue, dyspnea, joint pain, chest pain, cognitive disturbance, shortness of breath, and brain fog [15,16]. Some of the commonly reported long-term symptoms include permanent decrease in lung function, chronic fatigue, blood clotting complications, heart attack, arrhythmia, cardiomyopathy, stroke, diabetes, kidney damage (that require dialysis), cognitive impairment such as delirium, especially if patients were treated in the intensive care unit (ICU), anxiety, depression, confusion, and decreased quality of life [10,11,13,14], dizziness, and embolisms [15,16,17]. Older people and people with underlying medical conditions such as cardiovascular diseases, chronic respiratory diseases, diabetes, obesity, chronic kidney disease, chronic lung disease, immunocompromised, and cancer are more likely to develop serious illnesses [9,18].

The Families First Coronavirus Response Act guarantees that COVID-19 testing is free to anyone in the U.S., including the uninsured [19]. Two types of viral tests can be used to indicate current infections, Nucleic Acid Amplification Tests (NAATs) and antigen tests [20]. An antibody test can be used to indicate past infections [20]. Every state provided information on their health departments' website for testing sites and vaccine information [20]. People are encouraged to make appointments to get tested.

The World Health Organization (WHO) encourages countries to prioritize rehabilitation for long-term symptoms of COVID-19 and systematically gather information [21]. This suggests that there is a gap in knowledge regarding post-acute COVID-19 symptoms. Long-term COVID-19 symptoms will be a public health issue that leads to the consumption of health care resources. Therefore, the purpose of this study was to 1) assess individual experiences with testing and symptoms of COVID-19 infection; 2) determine the extent to which individuals experienced COVID-19 post-exposure symptoms; and 3) determine if an association exists between pre-existing conditions and severity of COVID-19 symptoms with post-exposure symptoms.

2. Methods

2.1. Study Design and Area

The study utilized a cross-sectional research design to collect data from New York State residents who tested positive for COVID-19 and have recovered (self-reported) from the virus. A non-probability, convenience sampling technique was used to collect data from participants.

2.2. Study Population

The study population consisted of 121 adult New York State residents who tested positive for COVID-19 and have recovered (self-reported) from the virus. Prescreening questions were used to determine eligibility for the study. To be eligible for the study, participants had to be 18 years or older, a resident of New York State, have tested positive for COVID-19 (self-reported), and have recovered from the virus. Individuals who did not meet the inclusion criteria were excluded from the study.

2.3. Instrumentation

The research instrument was obtained from the National Institutes of Health (NIH) [22]. It consists of 11 modules, however, only some questions from Module 1 (demographics) and Module 4 (COVID-19 Symptoms and Testing Experience) were used for this study. The NIH encouraged researchers to test the modules and/or make modifications before administering them, therefore the researchers modified some of the questions to reflect changes as the disease evolves.

2.4. Data Collection

The survey was created using Qualtrics. A link was provided after the survey was created, which was posted on Facebook, Twitter, Snap Chat, and sent to contacts in the researchers' WhatsApp and email contacts. In addition, the researchers asked potential participants to forward the link to other people who survived COVID-19. Participants read the electronic informed consent, then they clicked on "I agree" to indicate that they read the informed consent and were willing to participate in the study. Participants who met the inclusion criteria proceeded to answer the survey. Data were collected between November 2020 and April 2021. The data were collected on an Excel spreadsheet then exported into Statistical Package for the Social Sciences (SPSS), version 25.

2.5. Statistical Analysis

Data were coded before they were entered in SPSS, version 25. Descriptive analyses were conducted for the demographic variables (age, race, ethnicity, sex at birth, education, and income); independent variables (severity of symptoms, pre-existing conditions); and the dependent variable (post-exposure symptoms). Results were reported in counts and percentages, and Chi-square statistics was used to examine the effects of pre-existing conditions and symptom severity on post-exposure conditions.

2.5.1. Assessment of Severity

Severity of COVID-19 symptoms were categorized based on the most bothersome (severe) symptom that the individuals experienced. These responses were "a little bit, somewhat, quite a bit, and very much." These responses were recoded into mild (a little bit and somewhat) moderate (quite a bit), and severe (very much).

2.5.2. Assessment of Comorbid Conditions

An index was created by combining the individual comorbid conditions. The scores ranged from 0 (minimum) to 6 (maximum). The index was recoded to create a new variable, where 0 = no comorbid conditions and 1 = one or more comorbid conditions.

2.5.3. Assessment of Post-Exposure Symptoms

An index was created by combining the individual post-exposure symptoms. The scores ranged from 0 (minimum)

to 8 (maximum). The index was recoded to create a new variable, where 1 = 0 or 1 post-exposure symptom; and 2 = 2 or more post-exposure symptoms.

3. Results

3.1. Description of the Sociodemographic Variables

Table 1 shows the socio-demographic characteristics of the participants. Most of the participants were between ages 18-35 (54.5%), were African Americans (50.4%), non- Hispanic (65%), female (69.4%), had less than a college degree (51%), and made an income of less than $55,000 (62%) in 2019.

Table 1. Sociodemographic Characteristics of Participants

	Sociodemographic Variables		Numbers (%)
1	Age	18-25	39 (32.2)
		26-35	27 (22.3)
		36-45	23 (19.0)
		46-55	15 (12.4)
		56-65	14 (11.6)
		Over 65	3 (2.5)
2	Race	White	32 (26.4)
		Black/African	61 (50.4)
		American	14 (11.6)
		Asian	3 (2.5)
		AI/AN	7 (5.3)
		Pacific Islander	4 (3.3)
3	Ethnicity	Hispanic/Latinx	42 (34.7)
		Non-Hispanic/Latinx	79 (65.3)
4	Sex at Birth	Female	84 (69.4)
		Male	37 (30.6)
5	Education	Never attended school	2 (1.7)
		Grades 1-8	25 (20.7)
		Grades 9-12	35 (28.9)
		Associate Degree	35 (28.9)
		Bachelor's Degree	23 (19.0)
		Master's Degree	1 (0.8)
6	Income in 2019	$0-$9,999	29 (24.0)
		$10,000 - $14,999	7 (5.8)
		$15,000 - $24,999	9 (7.4)
		$25,000 - $34,999	9 (7.4)
		$35,000 - $44,999	13 (10.7)
		$45,000 - $54,999	9 (7.4)
		$55,000 - $64,999	11 (9.1)
		$65,000 - $74,999	9 (7.4)
		$75,000 and over	25 (20.7)

3.2. Testing

Eighty-seven (approximately 73%) of the participants reported that getting access to testing was easy/very easy; 98 (81%) did nose swabs, and 67 (55%) tested for antibodies. Of those who got tested for antibodies, 59 (88%) were positive (Table 2).

Table 2. Testing for COVID-19

	Options	Number (%)
Testing Experience	Very easy	37 (30.6)
	Easy	50 (42.0)
	Difficult	22 (18.2)
	Very Difficult	10 (8.3)
	Missing	2 (1.7)
Testing Route	Nose Swab	98 (81.0)
	Mouth Swab	2 (1.7)
	Blood Test/Antibody Test	19 (15.7)
	Missing	2 (1.7)
Tested for Antibodies	Yes	67 (55.4)
	No	45 (37.2)
	Don't Know	7 (5.9)
	Missing	2 (1.7)
Antibody Test Results	Positive	59 (88.1)
	Negative	7 (10.4)
	Don't Know	1 (1.5)

3.3. Symptoms Experienced During COVID-19 Infection

Participants were asked to check all the symptoms that they experienced from a list provided (Table 3). This is a multiple response table; hence the percentages add up to more than 100%. Only eight (6.6%) participants had no symptom. The remainder of the participants experienced one or more symptoms. More than one-half of the participants experienced fatigue (66.9%), lack of energy (61.2%), headache (57.9%), muscle ache (53.7%), cough (50.4%), and loss of smell (50.4%). Of the COVID-19 symptoms that participants experienced, they were most bothered by muscle ache, cough, shortness of breath, fatigue, and headache.

Table 3. Symptoms Experienced During COVID-19 Infection

Symptoms	Multiple Response (N=121)	Percent (%)
Fatigue	81	66.9
Lack of Energy	74	61.2
Headache	70	57.9
Muscle Ache	65	53.7
Cough	61	50.4
Loss of Smell	61	50.4
Loss of Taste	59	48.8
Chills	57	47.1
Loss of Appetite	55	45.5
Sore Throat	52	43.0
Shortness of Breath	46	38.0
Running Nose	42	34.7
Joint Ache	41	33.9
Fever	38	31.4
No Symptom	8	6.6

3.4. Severity of Symptoms

The most bothersome symptoms that the participants experienced during COVID-19 infection were fatigue,

shortness of breath, cough, muscle ache, headache, loss of taste and smell. Participants were asked to describe the severity of the most bothersome symptoms they experienced (Figure 1). Approximately 45% of the participants reported that their most bothersome symptom was severe, followed by moderate (33%), and mild (18%). Four percent (4%) of the respondents did not respond.

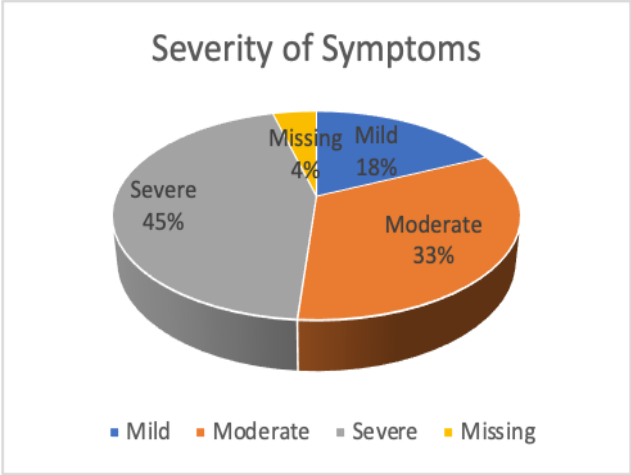

Figure 1. Severity of Symptoms Experienced by Participants

3.5. Hospitalization and Treatment

Approximately 12% of all participants infected with COVID-19 were hospitalized. Most (53.3%) were hospitalized for up to a week, however 2 (13.3%) were hospitalized for over a month. They received different forms of treatment such as oral medications and oxygen therapy (86.7%) each, IV (73.3%), and two persons (13.3%) were placed on ventilators (Table 4).

Table 4. Hospitalization and Treatment

	Options	Number (%)
Were you hospitalized?	Yes	15 (12.4)
	No	104 (86.0)
	Missing	2 (1.7)
Treatment During Hospitalization	Oral medications	13 (86.7)
	Intravenous (IV)	11 (73.3)
	Oxygen	13 (86.7)
	Ventilator	2 (13.3)
Duration of Stay	1-7 days	8 (53.3)
	1-2 weeks	3 (20.0)
	3-4 weeks	2 (13.3)
	1-2 months	2 (13.3)

3.6. Pre-Existing Conditions

There were 170 responses because some participants had more than one pre-existing conditions (Table 5). Seventy-four (61.2%) of the participants had at least one pre-existing condition before they were infected with COVID-19. Most of the participants with pre-existing conditions were obese (19%), had depression (16.5%), asthma 15.7%), hypertension (13.2), and diabetes (9.9%).

Table 5. Self-Reported Pre-Existing Conditions

Pre-Existing Conditions	Multiple Response (N=121)	Participants (%)
No known Condition	47	38.8
Obesity	23	19.0
Depression	20	16.5
Asthma	19	15.7
Hypertension	16	13.2
Diabetes	12	9.9
Other Mental Health Conditions	9	7.4
Other Chronic Conditions	5	4.1
Bronchitis	4	3.3
Crohn's Disease	4	3.3
Cancer	3	2.5
Alcohol/Substance Use Disorder	3	2.4
Chronic Kidney Disease	2	1.7
Hepatitis B	2	1.7
Hepatitis C	1	0.8
COPD	1	0.8

3.7. Post-Exposure COVID-19 Symptoms

Fifty-one (42.1%) participants had no new post-exposure symptoms due to COVID-19. The other participants experienced one or more symptoms after they recovered from COVID-19. The top five post-exposure symptoms that participants experienced (Table 6) were persistent tiredness (32.2%), anxiety (18.2%), weakness (15.7%), brain fog (15.7%), and trouble breathing (14%). Most of them (89.7%) reported that their symptoms were mild/moderate. Only 40% of the participants visited the doctor for post-COVID-19 symptoms.

Table 6. Post-Exposure Symptoms

Symptoms	Multiple Response (N=121)	Percent (%)
No Symptom	51	42.1
Persistent Tiredness	39	32.2
Anxiety	22	18.2
Weakness	19	15.7
Brain Fog	19	15.7
Trouble Breathing	17	14.0
Muscle Ache	15	12.4
Insomnia	14	11.6
Weight Loss	11	9.1
Leg Soreness	10	8.3
Malaise	8	6.6
Confusion	7	5.8
Change in Mental Health	5	4.1
Dizziness	5	4.1
Changes in Skin Color	4	3.3
Eye Problem	2	1.7
Gastrointestinal Problems	1	0.8
Rashes	1	0.8
Arthritis	1	0.8
Other Conditions	13	10.7

Table 7. Severity of Symptoms, Pre-Existing Conditions, and Post-exposure Symptoms

Variables	Options	COVID-19 Post Recovery Symptoms (%)		X^2	df	p-value
		0-1 Symptom	2 or more Symptoms			
Severity of Symptoms	Mild	18 (81.8)	4 (18.2)	13.69	2	.001
	Moderate	26 (65.0)	14 (35.0)			
	Severe	21 (38.9)	21 (38.9)			
Pre-existing Conditions	No Condition	37 (75.5)	12 (24.5)	10.52	1	.001
	1 or more conditions	33 (45.8)	39 (54.2)			
Age	18-25	27 (69.2)	12 (30.8)	7.06	4	.132
	26-35	16 (59.3)	11 (40.7)			
	36-45	11 (47.8)	12 (52.2)			
	46-55	10 (66.7)	5 (33.3)			
	56 and over	6 (35.3)	11 (64.7)			
Race	White	15 (46.9)	17 (53.1)	2.67	1	.103
	Other	54 (63.5)	31 (36.5)			
Sex at Birth	Male	25 (67.6)	12 (32.4)	2.06	1	.151
	Female	45 (53.6)	39 (46.4)			
Education	No College	38 (61.3)	24 (38.7)	0.61	1	.432
	Some College	32 (54.2)	27 (47.8)			
Income (2019)	Low Income	43 (64.2)	24 (35.8)	2.47	1	.116
	High Income	27 (50.0)	27 (50.0)			
Employment	Employed	47 (54.7)	39 (45.3)	1.25	1	.264
	Other	23 (65.7)	12 (34.3			

3.8. Association between Severity of Symptoms, Pre-existing Conditions, and Post-exposure Conditions

Table 7 shows the relationship between severity of symptoms, and pre-existing conditions versus post-exposure conditions. There was a statistically significant relationship between severity of symptoms and post-exposure symptoms experienced by participants ($X^2 = 13.69$; df = 2; p = .001). Participants who experienced severe COVID-19 symptoms were more likely to develop more post-exposure symptoms (61.1%) compared to those who experienced mild symptoms (18.2%). Similarly, a statistically significant relationship between pre-existing conditions and post-exposure symptoms experienced by participants ($X^2 = 10.53$; df = 1; p = .001). Participants who had one or more pre-existing conditions were more likely to develop two or more post-exposure symptoms (54.2%) compared to those who had no pre-existing condition (24.5%). None of the demographic variables was statistically significant when compared to post-exposure symptoms (Table 7).

4. Discussion

Covid-19 testing is a diagnostic tool, therefore easy access to testing is essential to achieving the goals of controlling the spread of the virus, preventing further disease transmission, and promoting the health of the population [23]. Robust and easy access to free testing, and contact tracing are essential secondary prevention public health measures that promotes early identification of positive cases and asymptomatic transmitters [24]. Majority of participants in this study (73%) reported easy or very easy access to testing.

The top symptoms that participants experienced were fatigue (66.9%), lack of energy (61.2%), headache (57.9%), muscle ache (53.7%), cough (50.4%), and loss of smell (50.4%). These results were similar to previous studies [7,25], in which the researchers reported that the top symptoms experienced by participants were cough, headache, and sore throat [7], while other researchers [25] reported cough and fatigue as the top symptoms in their study.

This study sought to determine the extent to which individuals experienced new health symptoms after they recovered from COVID-19 virus. Of the 121 participants, 42.1% had no new post-exposure symptoms due to COVID-19. The other participants experienced one or more symptoms after they recovered from COVID-19. The top five post-exposure symptoms that participants experienced were persistent tiredness (32.2%), anxiety (18.2%), weakness (15.7%), brain fog (15.7%), and trouble breathing (14%). Most of them (89.7%) reported that their symptoms were mild/moderate. These results align with researchers from around the world that reported an array of cases of post-exposure symptoms [10-14].

In this study, the results indicated that a statistically significant relationship ($X^2 = 13.69$; df = 2; p = .001) exists between severity of COVID-19 symptoms and post-exposure symptoms. Participants who experienced severe COVID-19 symptoms were more likely to develop post-exposure symptoms compared to those with mild symptoms. The findings of this study are supported by a study [26], where an association existed between the severity of the disease and presence of persistent COVID-19 symptoms after hospitalization. According to [27], it is unclear whether the severity of symptoms experienced by persons hospitalized for COVID-19 was due to the virus itself, attributable to post-intensive care

syndrome experienced by persons following an intensive unit care or a combination of both, however further investigation is needed. There is limited data available on the incidence of persons experiencing post-exposure symptoms. There is also limited data available on the underlying cause of post-exposure symptoms or prevalence of these symptoms [26,27], but studies conducted to date, including this study, have identified an association between severity of COVID-19 symptoms and post-exposure symptoms. While there is a paucity of data, public health practitioners are encouraged to continue to respond to the health needs of persons who are experiencing post-exposure symptoms to promote health and prevent further deterioration through rehabilitation efforts that limit the impact of symptoms on quality of life [21].

The presence of pre-existing conditions in individuals can influence the course of and recovery from COVID-19 [28]. The study found a statistically significant relationship between pre-existing conditions and post-exposure symptoms experienced by participants ($X^2 = 10.53$; df = 1; p = .001). In this study, seventy-four (61.2%) of the participants had at least one pre-existing condition before they were infected with COVID-19, which included obesity (19%), depression (16.5%), asthma (15.7%), hypertension (13.2%), and diabetes (9.9%). Results of this study showed that participants who had one or more pre-existing conditions were more likely to develop two or more post-exposure symptoms compared to those who had zero to one pre-existing condition. These results correspond with previous studies [25,29,30], that found an association between increased incidence of COVID-19 infections in persons with pre-existing chronic diseases, which include diabetes, hypertension, obesity, respiratory and heart diseases. Researchers have examined the concept of the application of social determinants of health on chronic diseases and concluded that a causal link exists between social determinants of health and chronic diseases [31,32].

Morbidity and mortality rates that are associated with the COVID-19 pandemic have substantially declined due to the availability of effective vaccines in combination with behaviors to reduce risk. Although these measures have proven to be effective, many individuals continue to be at an increased risk of infection and reinfection, which may lead to an increase of long-term post-exposure symptoms. The impacts of long-term post-exposure health effects of COVID-19 are largely unknown. Public health practitioners and Healthy People 2030 are poised to examine the epidemiology of pre-existing conditions on the development of COVID-19 infections and post-exposure symptoms [33].

5. Limitations

The study has some limitations: (1) the study design was cross-sectional, therefore causal inferences cannot be made; (2) the sample size was small, therefore generalizations cannot be made beyond the study population; and (3) participants self-reported their symptoms, severity of symptoms and post-exposure symptoms.

6. Conclusion and Recommendations

Most people continue to have symptoms after the initial recovery from the acute phase of COVID-19 infection. Majority of the persons diagnosed with COVID-19 reported that they experienced fatigue, lack of energy, headache, muscle ache, cough, and loss of taste and smell. People with severe symptoms were more likely to experience two or more post-exposure symptoms. Similarly, people who had pre-existing conditions were more likely to suffer from additional symptoms even after recovery from the virus.

Given the myriad of symptoms that COVID-19 produces, especially in people with comorbid conditions, it is recommended for all eligible persons to get vaccinated [34] and follow other public health guidelines to reduce infections and severity of symptoms. People who experienced post-COVID symptoms should also seek medical care because their quality of life may be negatively impacted.

Statement of Competing Interest

The authors declare that there is no competing interest regarding this research.

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