

Characterization and Prevalence of Post-COVID Symptoms among Recovered Patients in Bangladesh

By

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A thesis submitted to the Department of Biotechnology in partial fulfillment of the requirements for the degree of
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Declaration

It is hereby declared that

1. The thesis submitted is my/our own original work while completing a degree at BRAC University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material that has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I have acknowledged all main sources of help.

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Ethics Statement

I hereby humbly declare that this thesis entitled “Characterization and Prevalence of Post-COVID Symptoms among Recovered Patients in Bangladesh” is based on work carried out by me and that no part of it has been presented previously for any higher degree.

The research work was carried out under the supervision of Dr. Mohammad Rafiqul Islam at BRAC University, during the Covid-19 pandemic.

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Abstract

Among the developing nations, Bangladesh was one of the countries severely impacted by the Covid-19 pandemic. The healthcare sector was overwhelmed with patients, and economic development came to a halt. Returning back to a normal lifestyle have been incredibly difficult for survivors due to certain effects of the disease that persist even after recovery. Termed ‘long-Covid’ or ‘post-Covid’ symptoms, these symptoms have not yet been widely studied in Bangladesh, although research has already taken momentum in other countries, particularly developed nations. This paper was one of the first to study the prevalence of these symptoms among recovered patients in Bangladesh, a developing nation, and also find out the possible risk factors associated with the severity of post-Covid symptoms. The aim was to understand these symptoms and also find out risk factors and treatment effects, so that survivors can be better rehabilitated. Significant risk factors found include male sex below or equal to the age of 40, occupation that requires frequently going outside, female sex with unhealthy BMI, comorbidities such as chronic urological disease, severity and duration of the Covid-19 disease. 77.7% survivors who opted for medication noted significantly better improvement in conditions after 2 months of tolerating post-Covid symptoms compared to those without medication. This study also found 19.7% of survivors who took medication possibly suffering from long-Covid, and 28% possibly suffering from long-Covid without medication. This study recommends urgent medical, psychological, and social support to Covid survivors for improvement in their quality of life, particularly survivors working in the healthcare and emergency sectors. This will help alleviate the disease burden of Covid-19 in the country and help healthcare facilities to be more capable of managing patients in the future. Routine follow-up is necessary to reduce re-infections, re-hospitalizations, and overwhelming healthcare facilities.

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List of Acronyms

WHO	World Health Organization
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
COVID-19	Coronavirus Disease 2019
ARDS	Acute Respiratory Distress Syndrome
SARS-CoV-1	Severe Acute Respiratory Syndrome Coronavirus 1
IEDCR	Institute of Epidemiology, Disease Control & Research
MERS-CoV	Middle East Respiratory Syndrome Coronavirus
CDC	Center for Disease Control & Prevention
CT Scan	Computed Tomography Scan
BMI	Body Mass Index
PTSD	Post-Traumatic Stress Disorder
ACE2	Angiotensin Converting Enzyme 2
PCR	Polymerase Chain Reaction
ICU	Intensive Care Unit

Chapter 1

Introduction

1.1 Covid-19 Origins and Symptoms

The World Health Organization (WHO) declared the fast spread of the COVID-19 disease as a global pandemic on 11 March 2020. As of 23 July 2021, the total number of confirmed cases globally is 192,284,207, with a death toll of 4,136,518 (WHO, 2021). The disease is caused by a novel coronavirus strain known as SARS-CoV-2. It is already known that the cases of the ongoing COVID-19 pandemic were first reported on the last of December 2019 in Wuhan, China (Zhu et al., 2019). These initially infected patients showed viral pneumonia-type symptoms (WHO, 2021). Eventually, the disease spread across the entire world mainly due to international traveling. Around 80% of infected individuals can experience recovery without any hospital treatment, i.e., only by means of preventive care; 15% could develop severe symptoms and require oxygen through ventilation and hospital facilities, and 5% of the patients require intensive care due to critical onset of the illness (Wu et al., 2020). The most common symptoms of COVID-19 are dry cough, fever, and fatigue. Although these symptoms are mild, severity could increase and lead to loss of taste or smell, sore throat, joint or muscle pain, chills, shortness of breath, loss of appetite, confusion, feeling of pressure or pain on the chest, etc. In critical cases leading to death, patients could experience acute respiratory distress syndrome (ARDS), respiratory failure, septic shock, thromboembolism, and multiple organ damage or injuries (Mayo Clinic, 2021). The severity of symptoms depends on a number of factors, including age and underlying medical conditions such as obesity, diabetes, and cancer, as well as the duration of the disease (Tenforde et al, 2020). It is reported that milder symptoms last around 2 weeks, while severe symptoms can last for 3 to 6 weeks. Those above 60 years of age are more prone to developing severe symptoms and facing death. In the same study, it was

found that 54.3% of hospitalized patients were men (Wang et al., 2020). As of 31 December 2020, the global case-fatality ratio of COVID-19 was reported to be 2.2% (Hasan et al., 2021), which is much lower compared to its predecessor SARS-CoV-1 epidemic outbreak in 2002-2004, which had a case-fatality ratio of 11% (Chan-Yeung et al., 2003) and MERS-CoV 2012 outbreak (endemic only to the Middle East region) which has a case-fatality ratio of 30% (WHO, 2019). However, some patients are asymptomatic, so it is still advised to take precautions such as self-distancing, isolation, wearing masks, washing hands regularly, and avoiding any form of close contact, to prevent possible transmission (WHO, 2019). Even if patients are asymptomatic, it is still possible to infect others, but transmissibility decreases within the first week (Meyerowitz et al., 2021).

1.2 Rationale of This Study

The global case-fatality ratio of Covid-19 is relatively low, meaning that survival rates are quite high. Yet, surviving patients face a wide range of debilitating short and long-term symptoms after testing negative for Covid-19. These symptoms have been widely discussed by patients across social media platforms as ‘post-Covid symptoms’, and ‘long-Covid’ depending on the duration of the symptoms, but there are very little scientific studies on this subject. The disease affects multiple organs in ways we are yet to understand, leaving behind symptoms that physically and psychologically distress patients for a long period of time. We believe following up these patients for a longer time post-recovery is necessary to truly understand the long-term impact of Covid-19, and so that reinstating recovered patients to a healthier lifestyle is easier for healthcare institutions. The aim of the current study has been to assess the prevalence of the various long and short-term symptoms observed in former COVID-19 patients in Bangladesh, which would facilitate better treatment and medical care for them to return to a normal lifestyle.

1.3 Hypothesis and Objectives

Hypothesis: There is more prevalence of post-Covid symptoms among male recovered patients compared to females.

General Objective: To find out the prevalence of post-Covid symptoms and the effectiveness of treatment among males and females.

Specific Objectives:

- To determine and compare the number of post-Covid symptoms, their severity, and general prevalence among males and females.
- To determine and compare the risk factors associated with Covid-19 and the probable risk factors associated with post-Covid symptoms.
- To understand the effectiveness of treatment of post-Covid symptoms between males and females.

Chapter 2

Literature Review

2.1 Covid-19 Situation in Bangladesh

The first case in Bangladesh was detected on 8 March 2020 (Dhaka Tribune, 2020). On 8 March 2020, the first death was reported; the patient was 70 years old with underlying medical complications (Saha et al, 2021). From March to May 2020, Bangladesh witnessed a national lockdown to curb the first wave of the pandemic, with the first peak noted on July 2020 (3810 cases per day) as noted by Saha et al. (2021). From June to December 2020, the lockdown was relaxed, case numbers went down but the public movement was still restricted. Infection rates were noticed to be below from January 2021 onwards, with mass vaccination programs using the Oxford-AstraZeneca vaccine starting from 7 February. Reports showed that the first wave was caused largely by the B.1 and B.1.1.7 variants, also known as Alpha. Around October 2020, the prevalence of B.1.351 (Beta variant) was rising, which continued through to April 2021 (Bangladesh Mutation Report, 2021). During this time period cases doubled, according to Saha et al. (2021). The third wave was caused by the B.1.617.2 (Delta) variant according to the Institute of Epidemiology, Disease Control and Research (IEDCR) (Dhaka Tribune, 2021). Being a small country with a dense population, the disease in Bangladesh has hampered economic development, infrastructure works, education, travel, businesses, and all aspects of life. Due to COVID-19 infection, many patients lost their families and livelihood and also faced severe psychological stress and social stigma. Even after recovery, reinstating back to a normal lifestyle has become difficult for some due to medium and long-term symptoms caused by the disease. Adequate follow-up is necessary in order for these individuals to get proper treatment so that they can enjoy a healthier way of life.

2.2 Transmission

According to the Centers for Disease Control and Prevention, the risk of transmission is highest within 3 to 6 feet of the infected individual (CDC, 2009). Therefore, it is established that COVID-19 transmission mainly occurs due to close contact with an infected source. Healthy people may inhale droplets or particles released by the infected persons by coughing, sneezing, breathing, or talking, which then enter the respiratory route and cause symptoms (Buonanno et al., 2020). These findings prompted countries around the world tried to ensure strict social distancing rules and lockdowns to reduce such contact transmission. However, infection could occur even in long distances, especially in enclosed spaces with poor ventilation (Li et al., 2021). The CDC guidelines also mentioned that exhaled droplets from the infected person can remain suspended in air from minutes to hours depending on the particle or aerosol size, and touching surfaces containing these droplets and particles can also lead to the disease.

2.3 Diagnosis

Diagnosis typically includes blood tests, CT scan, and PCR and requires nasopharyngeal swab samples from patients (Udugama et al., 2020). Symptoms usually begin within 5 to 6 days from the time of exposure to the virus and can last up to 14 days. As a result, the minimum isolation period of COVID-19 positive patients as per WHO guidelines is 13 days, which is 10 days after onset of symptoms and 3 additional days without symptoms (WHO, 2021). If the second PCR test confirms a negative result twice 24 hours apart, the patient can be discharged on day 14. Treatment varies case to case based on severity (Li et al., 2020), but so far it has been observed that those with mild symptoms can be treated with prescribed medicines, proper fluid intake, and a healthy diet at home either in isolation or quarantine. Those with respiratory issues may require a mix of medications including paracetamol, antivirals (Chen et al., 2020), and corticosteroids (Fadel et al., 2020) combined with ventilation and other necessary hospital interventions as deemed appropriate by physicians.

2.4 Risk Factors

Several studies have established that many factors are responsible for the severity of Covid-19 symptoms (Tenforde et al., 2020), which include underlying medical conditions, age, and even the duration of the disease. Co-morbidities such as diabetes, cardiovascular problems, pregnancy or breastfeeding, chronic diseases, cancer, allergies, metabolic disease, smoking habits, hormonal issues, immunosuppression, etc. can contribute to increasing the risk of contracting COVID-19 and its severity (Petrilli et al., 2020). Wang et al., (2020) concluded that more men had to be hospitalized due to the disease compared to women. While age and gender are accepted factors, according to several studies it has also been noted that patients with a BMI of above 35 kg/m², are more susceptible to severe COVID-19 symptoms and hospital admission (Al-Bari et al., 2021). Occupation can also be a risk factor, since those involved in essential jobs during the lockdowns such as frontline healthcare workers, government officials, law enforcement members, certain politicians, bank officials, etc. are more at risk of contracting the disease (Mutambudzi et al., 2021). These individuals were more prone to contracting and spreading the disease. Majority of the people stayed at home and worked from home, only going out when absolutely necessary, such as buying groceries, medicine, taking COVID tests, etc.

2.5 Characterization of Post-Covid Symptoms from Other Studies

Other countries have already shown emerging evidence of SARS-CoV-2 post-recovery symptoms faced by survivors. One study in Italy followed 143 individuals' post-recovery from COVID-19 and found that more than 50% of the subjects reported fatigue, 43% experienced breathlessness, and 27% dealt with joint pain (Carfi et al., 2020). Another study conducted on the very similar SARS-CoV-1 outbreak survivors showed that patients experienced long-term fatigue, depression, dementia, weakness, and sleep problems (Moldofsky et al., 2011) after recovery. Many recovered patients from SARS-CoV-1 or MERS-CoV were found to have lower lung function post-discharge (Ahmed et al., 2020), including post-traumatic stress disorder (PTSD), anxiety, and depression after 1 year of follow-up. It is likely that patients recovering from COVID-19 could face similar symptoms. Given that COVID-19 is a disease that affects multiple organ systems other than the respiratory system (Zhang et al., 2020), follow-up of recovered patients and determining long-term symptoms are important for necessary treatment and rehabilitation.

In a study conducted by Bierle et al. (2021) it was revealed that the physical distresses after the recovery from COVID-19 were mainly myalgia/pain (in 90% cases), fatigue (74% cases), dyspnea (43%), and orthostatic intolerance (38%). However, few symptoms like fatigue (8.1%), difficulty in breathing (6.5%), lack of concentration (4.8%), hair fall (4.3%), memory lapses (4.3%), sleep disturbance (3.8%), and joint pain (1.6%) persisted >60 days even after recovery according to Sultana et al (2021). COVID-19 related neurological symptoms including anosmia, ageusia, (Cho et al., 2020) dizziness, headache, and seizures may persist for a long time after the acute COVID-19 illness. There is a high probability that symptoms of psychiatric, neurological, and physical illnesses, as well as inflammatory damage to the brain in individuals with post-COVID syndrome, increase suicidal ideation and behavior in patients (Sher 2021). Studies have noted that some patients get re-infected with Covid-19 even after

recovery, and although the prevalence of re-infection is not known, the probability of re-infection might increase with the introduction of newer variants (Nonaka et al., 2021). The first study of post-Covid-19 symptoms among recovered patients in the UK noted that even after 7 weeks of hospital discharge, patients experienced breathlessness, fatigue, and psychological distress in a manner that significantly reduced their quality of life (Halpin et al., 2021).

Currently, there is very little known about post-recovery issues faced by former COVID-19 patients in Bangladesh. Researchers from Bangabandhu Sheikh Mujib Medical University conducted interviews with 186 COVID-19 recovered patients who were medical doctors, and attempted to assess the disease burden of COVID-19 along with duration and risk factors. In their study, post-COVID symptoms were defined as the presence of COVID-19-like symptoms that persist even after recovery, with more than 60 days of signs considered long-term. The study showed that around 70% of the participants had post-COVID symptoms after recovery, with 24% of them reporting more than one long-haul COVID-19 symptom (Sultana et al., 2021). The same study also showed that females and those with comorbidities are more at risk to develop post-COVID symptoms. Although this study was one of the first to assess post-COVID symptoms, the sample size was limited. It could not justify recovered patients who did not participate in the study, and could not determine whether the post-COVID symptoms were acute or chronic. These studies indicate that there are a variety of post-Covid symptoms faced by recovered patients and they require medical attention and prolonged care for improved quality of life.

Chapter 3

Methods

3.1 Study Design

Descriptive cross-sectional study

3.2 Place & Period of Study

This study was conducted in BRAC University for a total of three months, from July 2021 to September 2021, maintaining all government Covid-19 restrictions and guidelines.

3.3 Study Population

All patients residing in Dhaka who recovered from Covid-19.

3.4 Sample Size

A total of 351 individuals participated in the study. As the study was done for a limited period of time, all the available sample within the study period fulfilling the inclusion and exclusion criteria were included in the study.

3.5 Ethical Consideration

The researcher is concerned about all ethical issues involved in the study. As such, the following steps were taken to ensure that ethical values were strictly maintained.

- Confidentiality of every person and information has been maintained and observed and no unauthorized person has access to the data. Those who wished to remain anonymous were not required to mention their names.

- Only those who consented to the study participated in answering the questions.
- All participants were briefed about the nature and purpose of the study, the entire procedure, and that they have the right to refuse and withdraw participation if they intended.
- No participant gained financial benefit from this study.

3.6 Inclusion & Exclusion Criteria of Enrolling Subjects

Inclusion criteria:

- Bangladeshi citizen residing in Dhaka
- Provided informed consent
- Previously tested positive for Covid-19 via PCR and also tested negative after 2 weeks via PCR
- Patients who faced resurgence of symptoms at least 3 weeks after testing negative.

Exclusion criteria:

- Patients who provided incomplete information
- Patients who refused to answer some questions and were unavailable after some time
- Patients who had Covid-19 like symptoms but did not test positive or negative via PCR

3.7 Variables (Demographics, Risk Factors, Others)

a. Demographic variables

- Age
- Sex
- Weight and height (BMI)
- Occupation at the time of infection

b. Risk factor variables that can affect severity and duration of post-Covid symptoms

- Smoking habits
- Diabetes (type 1 and type 2)
- Hypertension or any cardiovascular disease
- Lipid abnormalities
- Pregnancy or lactation
- Cancer (active or previous)
- Any chronic respiratory condition, for example, asthma
- Chronic kidney disease
- Chronic urological disease
- Neurological disease

- Hormonal issues
- Underlying conditions or diseases
- Immunosuppressed condition or autoimmune disease
- Another infectious disease
- Genetic condition
- Any mental health condition such as anxiety, depression, suicidal thoughts
- Rheumatologic disease
- Allergies
- Other issues not listed
- Severity of Covid-19
- Duration of Covid-19
- Time of infection (first wave, second wave, or third wave)

c. Investigation variables

- Prevalence of symptoms faced after at least 3 weeks of testing negative from Covid-19
- Duration and severity of post-Covid symptoms
- Mode of treatment of post-Covid symptoms

d. Outcome variables

- Success of treatment and impact on patient
- Health status after 4 weeks (Re-infection with Covid-19, unchanged condition, improved condition, worse condition, not sure of condition)
- Vaccination status

3.8 Methodology

A questionnaire based on the characterization of symptoms was used to obtain responses of participants. The questionnaire was based on the inclusion and exclusion criteria mentioned above. The questionnaire was divided into three sections.

- Section 1 included patient demographic data including age, gender, and occupation at the time of infection, and height and weight for body mass index (BMI) calculation, to evaluate risk factors that may have contributed to the severity of their symptoms.
- Section 2 involved questions related to the patient's disease. Patients were asked about underlying conditions and co-morbidities that may have acted as risk factors for the duration and severity of Covid-19. This section also asked patients the timing of the infection and how they opted for treatment.
- Section 3 included the extensive number of symptoms that have been reported in literature. Patients reported the duration and severity of these symptoms and how they chose to handle them. Patients were also asked about their Covid-19 vaccination status.

3.9 Data Collection

The questionnaire was answered by patients voluntarily through various social media platforms online as well as direct phone interviews, maintaining all Covid-19 health guidelines as directed by the government of Bangladesh.

3.10 Statistical Methods

All statistical analysis was carried out using IBM SPSS Version 26.0 and Microsoft Excel 2013. Qualitative data has been expressed as frequencies with percentages and compared using chi-squared tests and multivariate logistic regression where applicable. Two-sided p-values were used for all tests. A probability (p) value of <0.05 has been considered as statistically significant. Any value greater than 0.05 has been considered statistically insignificant.

3.11 Grouping Subjects

Patients were divided into two groups based on their gender for comparison. The prevalence of a symptom is described as the percentage and number of patients reporting any symptom within one particular group (Halpin et al., 2021).

3.12 Operational Definitions

In this study, post-COVID-19 symptom was defined as any symptom that resurfaced at least 3 weeks after patient recovered from the first episode of Covid-19 (Salmon-Ceron et al., 2021).

If these symptoms lasted around 2 months or more, the condition has been termed as 'long COVID-19'.

- Severity of Covid-19 symptoms were defined by patients as asymptomatic, mild, moderate, or severe.
- <4 weeks of duration of Covid-19 has been defined as acute Covid-19. 4-8 weeks since symptoms started is defined as prolonged Covid-19. If duration of disease was >8 weeks, it was defined as chronic Covid-19.
- Severity of post-Covid symptoms were defined by patients as mild, very mild, moderate, severe, or none.
- If post-Covid symptoms lasted longer than 8 weeks (or 60 days) after testing negative for Covid-19, it would be called long Covid.

Chapter 4

Observation & Results

This was a descriptive cross-sectional study that took place for three months from July 2021 to September 2021 in BRAC University. The main objective of this study was to find out the prevalence of post-Covid symptoms among recovered patients in Dhaka. A total of 351 respondents participated in this study, in accordance with all Covid-19 social distancing guidelines directed by the Government of Bangladesh.

4.1 Gender & Age Distribution of Study Population

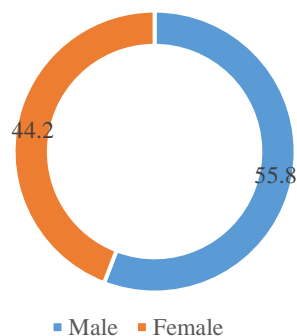


Figure 1: Gender distribution of study population

Figure 1 shows that among the 351 respondents who participated in this study, 55.8% of them were male and 44.2% were female.

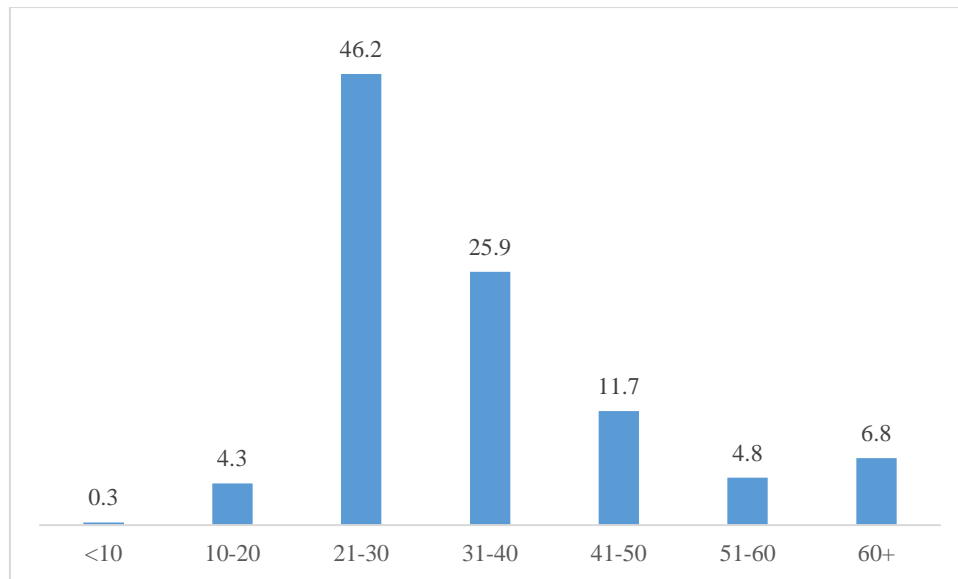


Figure 2: Age distribution of study population

Figure 2 shows the seven categories of age used in this study. Majority of the respondents belonged to the age 21-30 category (46.2%). Lowest number of respondents were found in the <10 age category. 49.2% of the respondents were 31+ years old.

Table 1: Age distribution of respondents based on gender

Age group	Gender		P-value using chi-square test: 0.079
	Male	Female	
<10	0.5 (1)	0.0 (0)	
10-20	4.1 (8)	4.5 (7)	
21-30	41.8 (82)	51.6 (80)	
31-40	30.1 (59)	20.6 (32)	
41-50	9.7 (19)	14.2 (22)	
51-60	4.6 (9)	5.2 (8)	
60+	9.2 (18)	3.9 (6)	
Total	100 (196)	100 (55)	

Table 1 shows a summary of age distribution in terms of gender. Majority of the males (41.8%) belonged to the 21-30 age category. Similarly, majority of the females (51.6%) belonged to this category as well. Least number of female respondents were found in the 60+ age category, whereas least number of male respondents (0.5%) were found in the <10 category. The association between age group and gender is insignificant ($p > 0.05$).

4.2 Age as a Risk Factor for Post-Covid Symptoms

For comparison, the study assessed the association between age group and Covid-19 severity alongside the association between age group and post-Covid symptoms severity.

Table 2: Severity of Covid-19 according to age groups

Age Group	Severity				p-value using chi-square test
	Asymptomatic	Mild	Moderate	Severe	
<10	0 (0)	0.8 (1)	0 (0)	0 (0)	0.008
10-20	0 (0)	6.1 (8)	5.1 (7)	0 (0)	
21-30	52.2 (12)	48.9 (64)	51.1 (70)	26.7 (16)	
31-40	13.1 (3)	30.5 (40)	19.7 (27)	35.0 (21)	
41-50	17.4 (4)	6.1 (8)	13.9 (19)	16.7 (10)	
51-60	4.3 (1)	4.6 (6)	4.4 (6)	6.7 (4)	
60+	13.0 (3)	3.1 (4)	5.8 (8)	15.0 (9)	
Total	100 (23)	100 (131)	100 (137)	100 (60)	

*p < 0.05 is statistically significant

**p > 0.05 is statistically insignificant

Table 2 shows that the association between age group and severity of Covid-19 is highly significant (p=0.008), as noted in multiple previous studies. 35% of the respondents faced severe Covid-19 symptoms and belonged to the 31-40 age group. 51.1% of those with moderate Covid-19 symptoms belonged to the 21-30 age group. 52.2% of respondents were asymptomatic and belonged to the same age group as well. If we consider ages under 21, only 6.1% noted mild symptoms and 5.1% noted moderate, but there are no cases of severe symptoms. If we consider ages beyond 40, severity increases with age. Of the respondents in the 51-60 age group, 6.7% noted severe symptoms. However, among those above 60+ age, 15% noted severe symptoms.

Table 3: Association of post-Covid symptoms severity with age

Age	Severity of post-Covid Symptoms						p-value
	None	Very mild	Mild	Moderate	Severe	Total	
<10	0% (0)	0% (0)	0% (0)	100% (1)	0% (0)	1	0.3068
10-19	20.0% (3)	33.3% (5)	13.3% (2)	13.3% (2)	20.0% (3)	15	
20-30	14.2% (23)	12.3% (20)	24.1% (39)	38.3% (62)	11.1% (18)	162	
31-40	12.1% (11)	17.6% (16)	15.4% (14)	40.7% (37)	14.3% (13)	91	
41-50	22.0% (9)	17.1% (7)	29.3% (12)	24.4% (10)	7.3% (3)	41	
51-60	0% (0)	23.5% (4)	29.4% (5)	41.2% (7)	5.9% (1)	17	
61+	20.8% (5)	29.2% (7)	16.7% (4)	25.0% (6)	(8.3%) 2	24	
Total	14.4% (51)	16.7% (59)	21.5% (76)	35.0% (123)	11.3% (40)	351	

Table 3 shows that there is no statistically significant association between the severity of post-Covid symptoms and age, unlike Table 2. It does show that 46.2% of respondents were between the ages of 20-30, with 38.3% of them having moderate symptoms. 25.9% of respondents belonged to the 31-40 age group. 40.7% of this particular age group faced moderate symptoms. 10-19 aged individuals have the highest number of individuals with severe symptoms (20%). All those in the age group of 51-60 have faced post-Covid symptoms. Overall, 35% of the respondents faced moderate symptoms, followed by 21.5% of the respondents who had mild symptoms. Only 11.3% of total respondents had severe post-Covid symptoms.

Table 4: Condition of post-Covid symptoms based on gender and broader age groups

Age groups	Gender	Degree of post-COVID symptom severity					p-value
		None % (n)	Very mild % (n)	Mild % (n)	Moderate % (n)	Severe % (n)	
<=40 Years	Male	17.3 (26)	19.3 (29)	21.3 (32)	29.3 (44)	12.7 (19)	0.009
	Female	9.2 (11)	10.1 (12)	19.3 (23)	48.7 (58)	12.6 (15)	
> 40 Years	Male	17.4 (8)	19.6 (9)	21.7 (10)	32.6 (15)	8.7 (4)	0.747
	Female	16.7 (6)	25 (9)	30.6 (11)	22.2 (8)	5.6 (2)	

Table 4 shows the association between age groups and severity of post-Covid symptoms among males and females. For respondents aged 40 and below, 12.7% males faced severe post-Covid symptoms and 12.6% women faced severe post-Covid symptoms. More males faced very mild or mild symptoms compared to females, but more females faced moderate symptoms compared to males (48.7% females compared to 29.3% males). The difference between the genders is highly significant ($p=0.009$). This suggests that more males faced post-Covid symptoms in varying conditions than females among those aged 40 or less.

For those above 40, 8.7% males faced severe symptoms and 5.6% females faced severe symptoms. In both cases, more females had very mild and mild post-Covid symptoms than males (25% and 30.6% respectively), but more males had moderate and severe symptoms than females, suggesting that symptoms are more severe for males above 40. However, the overall difference between males and females in the degree of post-Covid symptoms severity among those above 40 is insignificant ($p>0.05$).

4.3 Gender Itself as a Risk Factor

Table 5: Association between severity of Covid-19 and gender

Gender	Severity of Covid-19				p-value
	Asymptomatic	Mild	Moderate	Severe	
Male	65.2 (15)	54.2 (71)	55.5(76)	56.7 (34)	0.804
Female	34.8 (8)	45.8 (60)	44.5 (61)	43.3 (26)	
Total	100 (23)	100 (131)	100 (137)	100 (60)	

Table 5 shows that in all categories of Covid-19 severity the percentage of males are higher than females. 56.7% males faced severe Covid-19 compared to females. However, the difference between the genders is statistically insignificant for this study ($p>0.05$).

Table 6: Association between number of post-Covid symptoms and gender

Number of post-Covid symptoms				
Gender	None	1 to 3 symptoms	3+ symptoms	p-value
Female	4.27% (15)	16.00% (56)	23.90% (84)	0.176718
Male	7.98% (28)	15.70% (55)	32.20% (113)	
Total	12.25% (43)	31.70% (111)	56.10% (197)	

Table 6 illustrates that more males were symptom-free post-Covid (7.98%) compared to females. Of the total 22 post-Covid symptoms characterized, 16% females faced at least 1-3 symptoms. Similarly, 15.7% males faced at least 1-3 symptoms. 32.2% males had more than 3 post-Covid symptoms, while 23.9% females had more than 3 symptoms, but the difference is statistically insignificant ($p>0.05$).

Table 7: Association between post-Covid symptoms severity and gender

Gender	Severity of post-Covid Symptoms						p-value
	None	Very mild	Mild	Moderate	Severe	Total	
Female	11.0% (17)	13.5% (21)	21.9% (34)	42.6% (66)	11.0% (17)	155	0.0908 (using chi- square test)
Male	17.3% (34)	19.4% (38)	21.4% (42)	30.1% (59)	11.7% (23)	196	
Total	14.53% (51)	16.8% (59)	43.3% (76)	35.6% (125)	11.4% (40)	100% (351)	

Table 7 shows the severity of post-Covid symptoms based on gender. More males have suffered from severe or very mild symptoms than females (11.7% and 19.4% respectively). However, more females suffered from mild to moderate symptoms compared to males (21.9% and 42.6% respectively). The difference between the genders is not statistically relevant ($p > 0.05$).

4.4 Occupation at the Time of Infection as a Risk Factor

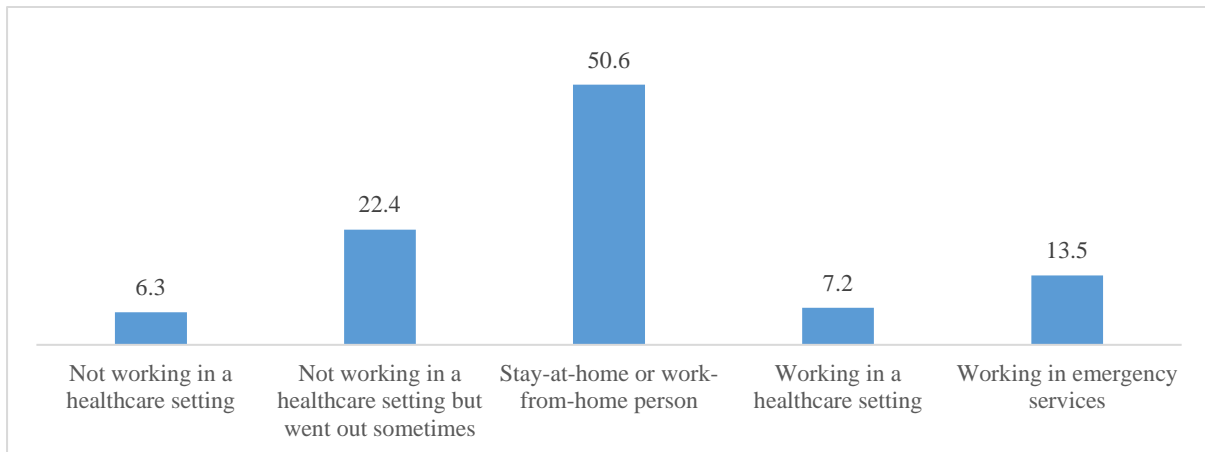


Figure 3: Frequencies of respondents in different work settings during infection

Occupation at the time of infection gives an idea of how respondents followed social distancing rules. Figure 3 shows that most respondents (50.6%) stayed at home. These individuals followed isolation and social distancing rules during the nationwide lockdown, and still got infected. 22.4% of the respondents did not work in any healthcare facility but went outside only when their work required, and thus may have not followed social distancing guidelines. 13.5% of the respondents worked in emergency services listed as compulsory by the government, and thus were more prone to infection. 7.2% respondents worked in a healthcare setting, and were at most risk of infection. 6.3% respondents were unemployed, yet went out of social distancing norms to buy daily necessities.

Table 8: Conditions of post-Covid symptoms among the sexes at home or working outside

Working status	Gender	Degree of post-Covid symptom severity					P-value
		None % (n)	Very mild % (n)	Mild % (n)	Moderate % (n)	Severe % (n)	
Not Working/Stay at Home	Male	18.6 (27)	20 (29)	22.1 (32)	29 (42)	10.3 (15)	0.137
	Female	13 (17)	14.5 (19)	20.6 (27)	43.5 (57)	8.4 (11)	
Working Outside	Male	14.3 (7)	18.4 (9)	20.4 (10)	30.6 (15)	16.3 (8)	0.233
	Female	0 (0)	8.7 (2)	26.1 (6)	39.1 (9)	26.1 (6)	

Table 8 shows that among those staying at home more females (43.5%) have moderate post-Covid symptoms than males (29%). In every other degree of post-Covid symptoms severity, males were more in percentage than females. However, the difference between both groups is statistically insignificant ($p>0.05$). Interestingly, among those working outside, there were no females without post-Covid symptoms. In all degrees, number of females with various conditions of post-Covid symptoms were more than men, especially in the moderate category (39.1% of females compared to 30.6% of males). The difference between males and females working outside has been found to be statistically insignificant ($p>0.05$).

Table 9: Association between post-Covid symptoms severity and occupation at the time of Covid-19 infection

Occupation at time of infection	Condition of post-Covid symptoms						p-value
	None	Very mild	Mild	Moderate	Severe	Total	
Stay-at-home/work-from-home person (very low)	16.5% (29)	13.1% (23)	25.0% (44)	38.1% (67)	7.4% (13)	176	0.0374
Not working in a healthcare setting but went out sometimes (low)	15.4% (12)	20.5% (16)	15.4% (12)	34.6% (27)	14.1% (11)	78	
Not working in a healthcare setting (medium)	20% (5)	36% (9)	12% (3)	20% (5)	12% (3)	25	
Working in emergency services (very high)	8.5% (4)	10.6% (5)	19.1% (9)	38.3% (18)	23.4% (11)	47	
Working in a healthcare setting (very high)	12.0% (3)	24.0% (6)	9.0% (7)	24.0% (6)	12.0% (3)	25	
Total	15.1% (53)	16.8% (59)	21.4% (75)	35.6% (123)	11.7% (41)	351	

Although there is no statistically significant difference among males and females, Table 9 shows that there is however, a significant association between the conditions of post-Covid symptoms with the work status during the time of Covid-19 infection ($p=0.0373$). 7.4% of

respondents stayed at home during infection and had severe post-Covid symptoms. 14.1% respondents went outside frequently and faced severe post-Covid symptoms. Respondents working in emergency services and healthcare settings also faced severe symptoms (23.4% and 12% respectively). This suggests that respondents who frequently went outside and gathered with other individuals faced more severe post-Covid symptoms. 38.1% stay-at-home respondents had moderate symptoms, compared to 34.6% who frequently went outside and 38.3% who worked in emergency services. Among those with mild symptoms, 25% stayed at home, while 28% worked in healthcare settings. 36% had very mild symptoms and frequently went outside, which is comparable to 24% who worked in healthcare settings or 20.5% who went outside sometimes. Among those who had no symptoms, 8.5% worked in emergency services despite high risk of infection, and 20% stayed home but went out sometimes despite a medium risk of infection.

4.5 Body Mass Index (BMI) as a Risk Factor

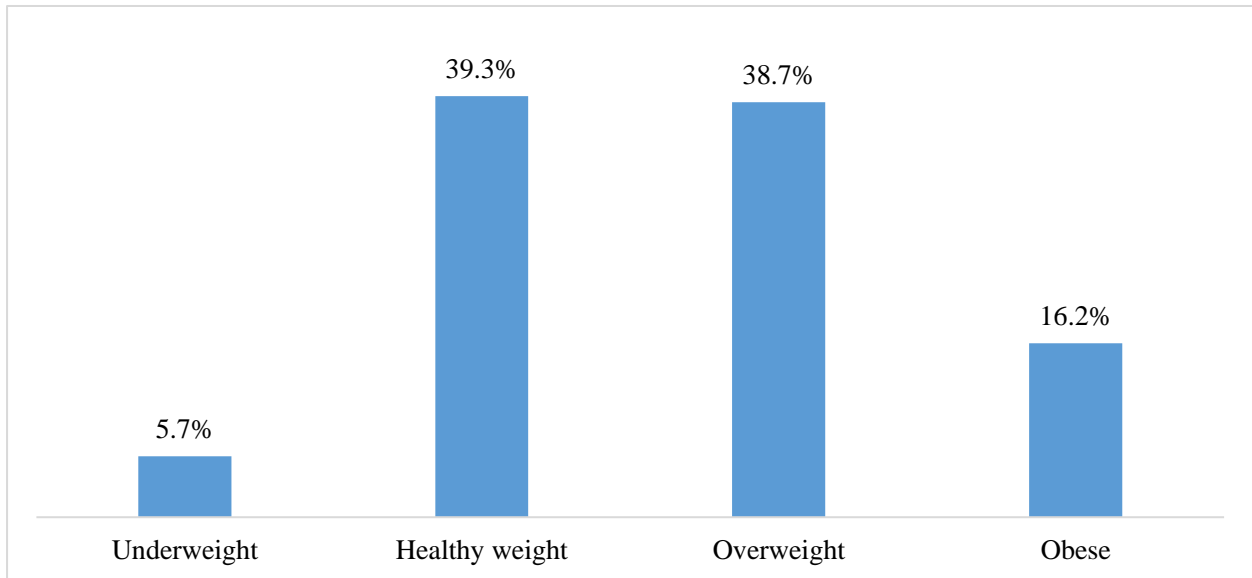


Figure 4: Nutritional status of respondents

Figure 4 shows that 5.7% of respondents were underweight, while 39.3% had healthy weight. 38.7% were overweight and 16.2% respondents were obese in this study.

Table 10: Association between BMI and post-Covid conditions based on gender

Nutritional status	Gender	Condition of Post-Covid Symptoms					p-value
		None % (n)	Very mild % (n)	Mild % (n)	Moderate % (n)	Severe % (n)	
Underweight	Male	12.5(1)	12.5(1)	37.5(3)	12.5(1)	25(2)	0.038
	Female	0(0)	41.7(5)	0(0)	50(6)	8.3(1)	
Healthy weight	Male	17.7(14)	21.5(17)	22.8(18)	24.1(19)	13.9(11)	0.152
	Female	13.6(8)	11.9(7)	18.6(11)	44.1(26)	11.9(7)	
Overweight+ Obese	Male	20(15)	20(15)	17.3(13)	32(24)	10.7(8)	0.050
	Female	6.6(4)	9.8(6)	24.6(15)	45.9(28)	13.1(8)	

Table 10 shows a breakdown of the post-Covid conditions among males and females in each BMI group. All underweight female respondents faced post-Covid symptoms ranging from very mild to severe. 41.7% females faced very mild symptoms while 50% faced moderate

symptoms. In comparison, 12.5% males faced very mild and moderate symptoms. 25% male underweight respondents faced severe symptoms compared to females (8.3%). The difference between underweight male and female respondents have been found to be significant ($p=0.038$).

Respondents with healthy weight show that 44.1% females had moderate symptoms, compared to 24.1% for males. In fact, in every BMI category except obese, more females showed moderate symptoms than males. More males with healthy weight have shown very mild, mild, and severe symptoms (21.5%, 22.8%, and 13.9% respectively) compared to women. The difference between male and female respondents with healthy weight have been found to be insignificant.

Overweight respondents show somewhat significant difference between males and females ($p=0.05$). More overweight females faced mild to moderate post-Covid symptoms than males (24.6%, 45.9%, and 13.1% respectively).

4.6 Smoking Habits as Risk Factors

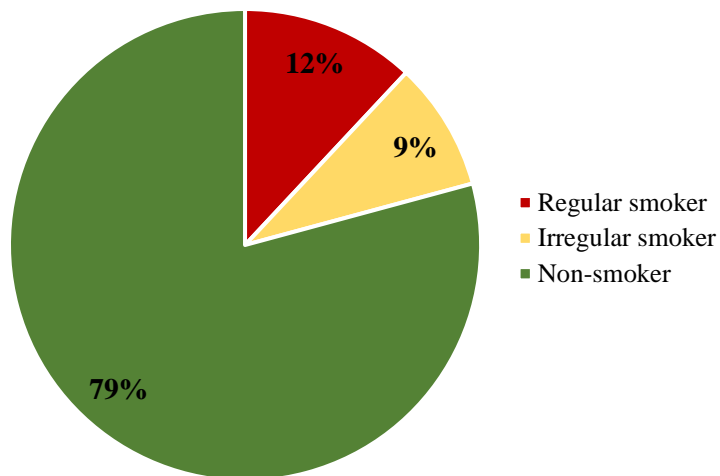


Figure 5: Smoking habits among respondents

Figure 5 displays that the majority of the participants are non-smokers (79%). 12% smoke regularly, while 9% occasionally smoke.

Table 11: Association between smoking habits and post-Covid symptoms severity

Smoking Habit	Condition of post-Covid symptoms					Total	p-value
	None	Very mild	Mild	Moderate	Severe		
Irregular smoker	12.9% (4)	19.4% (6)	22.6% (7)	38.7% (12)	6.5% (2)	31	0.656
Non-smoker	15.1% (42)	16.2% (45)	20.9% (58)	37.1% (103)	10.8% (30)	278	
Regular smoker	11.9% (5)	19.0% (8)	26.2% (11)	23.8% (10)	19.0% (8)	42	
Total	14.5% (51)	16.8% (59)	21.6% (76)	35.6% (125)	11.4% (40)	351	

Table 11 displays that non-smokers with severe post-Covid symptoms amount to 10.8%, while regular smokers with severe post-Covid symptoms amount to 19%. 15% of those with no smoking habits had no symptoms, while those with no symptoms who smoked occasionally or regularly were 12.9% and 11.9% respectively. 16.2% of those with very mild symptoms were non-smokers, yet among this group, 19% and 19.4% had regular or irregular smoking habits. 20.9% of respondents did not smoke and had mild symptoms, which is lower than those who occasionally or regularly smoked (22.6% and 26.2% respectively). 37.1% of respondents did not smoke and had moderate post-Covid symptoms, but 38.7% of irregular smokers had moderate symptoms. No significant association between smoking habits and post-Covid symptom severity was found ($p>0.05$).

Table 12: Smoking habits in the sexes and association with post-Covid symptom severity

Smoking habit	Gender	Condition of post COVID symptom					p-values
		None % (n)	Very mild % (n)	Mild % (n)	Moderate % (n)	Severe % (n)	
Regular smoker	Male	12.8 (5)	20.5 (8)	23.1 (9)	23.1 (9)	20.5 (8)	0.73
	Female	0 (0)	0 (0)	66.7 (2)	33.3 (1)	0 (0)	
Irregular smoker	Male	14.3 (4)	17.9 (5)	25 (7)	35.7 (10)	7.1 (2)	0.785
	Female	0 (0)	33.3 (1)	0 (0)	66.7 (2)	0 (0)	
Non-smoker	Male	19.4 (25)	19.4 (25)	20.2 (26)	31 (40)	10.1 (13)	0.138
	Female	11.4 (17)	13.4 (20)	21.5 (32)	42.3 (63)	11.4 (17)	

Table 12 shows the details of smoking habits among males and females and their post-Covid symptoms severity. Among regular smokers, more females had mild and moderate symptoms than males (66.7% and 33.1%), but more males had severe symptoms (20.5%). Among regular smokers, 33.3% of females showed moderate symptoms compared to 23.1% of men. In the

non-smoker group, more males showed very mild symptoms (19.4%), but more females had mild to severe symptoms (21.5%, 42.3%, and 11.4%). There were very few female irregular smokers, but they showed very mild and moderate symptoms (33.3% and 66.7% respectively). Among the males who smoked occasionally, 35.7% faced moderate symptoms and only 7.1% had severe post-Covid symptoms.

In all three categories of smoking habits, there were no statistically different significances found among males and females ($p>0.05$).

4.7 Underlying Conditions as Risk Factors

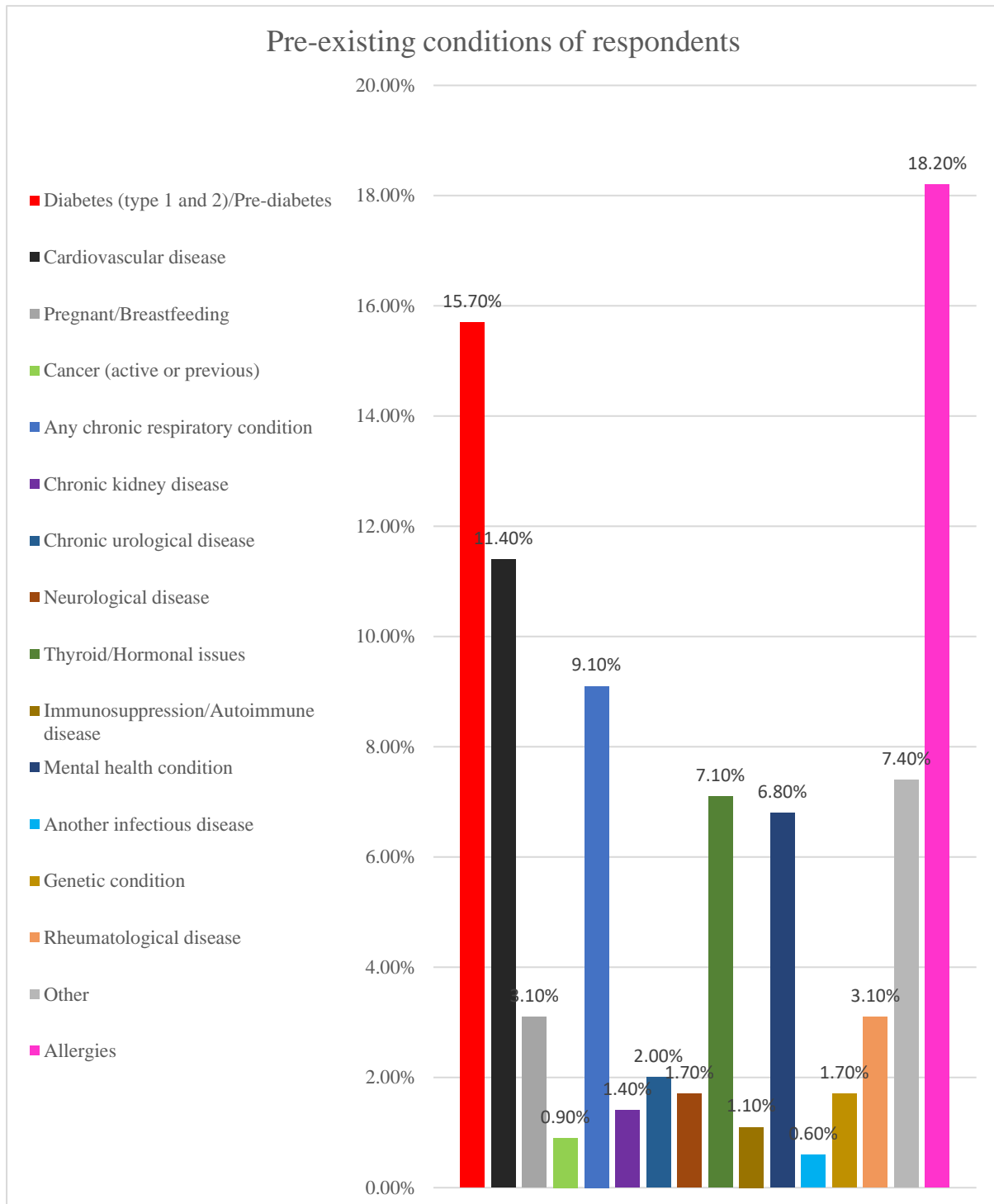


Figure 6: Prevalence of pre-existing conditions of study population

Figure 6 shows that majority of the respondents (18.2%) had some form of allergies. 15.7% of the respondents had some form of diabetes (either type 1 or type 2 or pre-diabetes). 11.10%

had cardiovascular diseases such as hypertension and arrhythmia. 9.10% had some kind of chronic respiratory condition. 3.10% were pregnant or breastfeeding. 7.10% had thyroid or other hormonal issues. 6.8% reported underlying mental health problems. 0.6% had other infectious diseases. In fact, one respondent was infected with hepatitis B. 7.4% reported other pre-existing issues such as sinusitis and tonsillitis. One respondent mentioned of having pemphigus vulgaris, an autoimmune disorder.

Table 13: Association between number of pre-existing conditions with post-Covid symptoms severity

Number of pre-existing conditions	Severity of Post-Covid Symptoms						p-value
	None	Very mild	Mild	Moderate	Severe	Total	
1 Underlying Condition	16.6% (45)	17.0% (46)	20.3% (55)	35.6% (96)	10.3% (28)	78.2% (270)	0.386
2 or more underlying conditions	8.0% (6)	17.3% (13)	22.6% (17)	37.3% (28)	14.6% (11)	21.8% (75)	
Total	14.8% (51)	17.1% (59)	20.9% (72)	35.9% (124)	11.3% (39)	100% (345)	

Table 13 shows that more cases of mild to severe post-Covid symptoms were found among those who had one pre-existing condition. In fact, 78.2% of the study population noted one underlying condition. 21.8% of the study population reported having more than 2 underlying conditions. No statistically significant association between the number of pre-existing conditions and post-Covid symptom severity was found ($p>0.05$).

Table 14: Logistic regression analysis of the impact of major pre-existing conditions on post-Covid conditions

Major Comorbidities (Independent Variables)	OR	P>z	[95% CI]	
			LL	UL
Diabetes/pre-diabetes				
No (Ref.)	1	0.142	0.15	1.32
Yes	0.44			
Cardiovascular disease				
No (Ref.)	1	0.168	0.74	5.50
Yes	2.02			
Cancer (active or previous)				
No (Ref.)	1	0.496	0.16	42.54

Yes	2.63			
Any chronic respiratory condition				
No (Ref.)	1	0.748	0.24	2.75
Yes	0.82			
Chronic kidney disease				
No (Ref.)	1	0.917	0.05	14.83
Yes	0.86			
Chronic urological disease				
No (Ref.)	1	0.856	0.16	9.26
Yes	1.21			
Immunosuppression/autoimmune disease				
No (Ref.)	1	0.728	0.11	23.35
Yes	1.61			
Mental health condition				
No (Ref.)	1	0.121	0.79	7.17
Yes	2.39			
Other				
No (Ref.)	1	0.228	0.08	1.83
Yes	0.38			
Allergies				
No (Ref.)	1	0.153	0.79	4.43
Yes	1.87			
No pre-existing condition				
No (Ref.)	1	0.121	0.16	1.23
Yes	0.45			

To further assess the individual association of each major underlying condition characterized through this study with post-Covid conditions, a multivariate logistic regression was performed.

Table 14 displays the results. At 95% CI, the prevalence of severe post-Covid symptoms is higher among respondents with cardiovascular disease compared to those with no cardiovascular disease (OR=2.02). This is also the case for respondents with cancer (active or previous), chronic urological disease, immune system issues, mental health problems, and allergies (OR=1.21, OR=1.61, OR=2.39, OR=1.87 respectively). Most of the results in this model are statistically insignificant, except for chronic kidney disease (p=0.05). Respondents

with underlying chronic kidney disease are more likely to face severe post-Covid symptoms than respondents who do not have any underlying kidney problems.

4.8 Severity of Covid-19 as Risk Factor

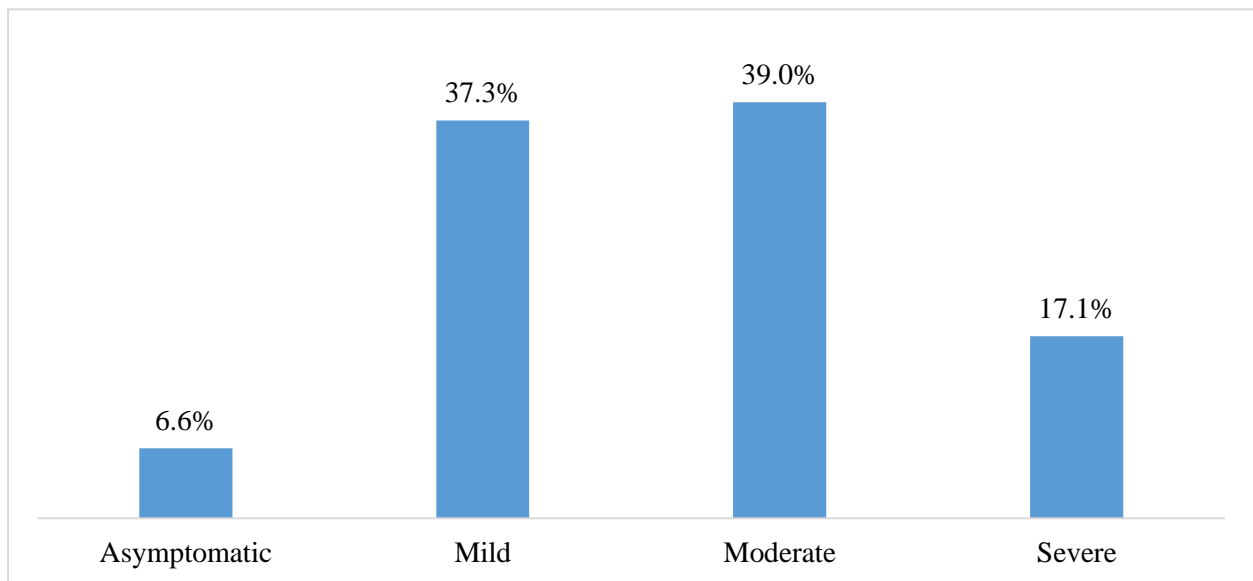


Figure 7: Severity of Covid-19 among respondents

Figure 7 shows that majority of the respondents had moderate symptoms (39%), followed by respondents with mild symptoms (37.3%), and severe symptoms (17.1%). 6.6% respondents tested positive for Covid-19 but had no symptoms.

Table 15: Relationship between severity of Covid-19 with post-Covid symptom severity

Severity of Covid-19	Severity of Post-Covid Symptoms					Total	p-value
	None	Very Mild	Mild	Moderate	Severe		
Asymptomatic	17.4% (4)	52.2% (12)	21.7% (5)	4.3% (1)	4.3% (1)	23	p<0.00001
Mild	14.5% (19)	22.9% (30)	26.7% (35)	30.5% (40)	5.3% (7)	131	
Moderate	17.5% (24)	8.0% (11)	19.0% (26)	42.3% (58)	13.1% (18)	137	
Severe	6.7% (4)	10.0% (6)	16.7% (10)	43.3% (26)	23.3% (14)	60	
Total	14.4% (51)	16.7% (59)	21.5% (76)	35.4% (125)	11.3% (40)	100% (351)	

Table 15 illustrates a highly significant relationship between the severity of the actual Covid-19 disease against severity of post-Covid symptoms. Of the 23 respondents who had asymptomatic Covid-19, majority had very mild post-Covid symptoms (52.2%) or mild symptoms 21.7%. Only 4.3% respondents with asymptomatic Covid-19 symptoms endured severe post-Covid symptoms later. Of these respondents 17.4% had no post-Covid symptoms. 131 respondents endured mild Covid-19 symptoms, of which the majority faced moderate post-Covid symptoms (30.5%). Out of 131 respondents with mild Covid-19, 5.3% endured severe post-Covid symptoms, slightly higher than the asymptomatic Covid-19 group. 137 respondents had moderate Covid-19, of which 42.3% had moderate post-Covid symptoms and 13.1% had severe post-Covid symptoms. If we consider the group of respondents who had severe Covid-19 (60 respondents), only 6.7% showed no post-Covid symptoms, but a majority of them (23.3%) also endured severe post-Covid symptoms. This goes to show that the more severe the actual disease is; it is more likely that post-Covid symptoms would be just as severe.

Table 16: Comparison of association between Covid-19 and post-Covid severity in genders

Gender	Severity of Covid-19	Severity of Post-Covid Symptoms						p-values
		None	Very Mild	Mild	Moderate	Severe	Total	
Female	Asymptomatic	0.0% (0)	75.0% (6)	12.5% (1)	12.5% (1)	0.0% (0)	8	0.001
	Mild	10.0% (6)	10.0% (6)	30.0% (18)	41.7% (25)	8.3% (5)	60	
	Moderate	14.8% (9)	6.6% (4)	18.0% (11)	45.9% (28)	14.8% (9)	61	
	Severe	7.7% (2)	19.2% (5)	15.4% (4)	46.2% (12)	11.5% (3)	26	
Total		11.0% (17)	13.5% (21)	21.9% (34)	42.6% (66)	11.0% (17)	155	
Male	Asymptomatic	26.7% (4)	40.0% (6)	26.7% (4)	0.0% (0)	6.7% (1)	15	0.0000008
	Mild	18.3% (13)	33.8% (24)	23.9% (17)	21.1% (15)	2.8% (2)	71	
	Moderate	19.7% (15)	9.2% (7)	19.7% (15)	39.5% (30)	11.8% (9)	76	
	Severe	5.9% (2)	2.9% (1)	17.6% (6)	41.2% (14)	32.4% (11)	34	
Total		17.3% (34)	19.4% (38)	21.4% (42)	30.1% (59)	11.7% (23)	196	

Table 16 demonstrates the association between Covid-19 severity and post-Covid symptom severity among both genders. In both groups, a significant association was found between Covid-19 severity and severity of post-Covid symptoms ($p < 0.05$). Among female respondents

who had asymptomatic Covid-19, there were no cases of severe post-Covid symptoms. 75% of these respondents had very mild post-Covid symptoms. Majority of female respondents (61) had moderate Covid-19, and among them 14.8% faced severe post-Covid symptoms. 26 females suffered from severe Covid-19. 46.2% of them had moderate post-Covid symptoms while 11.5% faced severe post-Covid symptoms. Similar situation was seen among the male respondents. Among the 15 males who had asymptomatic Covid-19, 40% had very mild post-Covid symptoms, while only 6.7% had severe post-Covid symptoms. The scenario changes as Covid-19 severity increases. Among the 34 male respondents who had severe Covid-19, only 5.9% faced no symptom post-Covid, but a staggering 32.4% faced severe post-Covid symptoms, which is a lot higher than females. Thus, severity of Covid-19 is significantly associated with severity of post-Covid symptoms in males as well. Therefore, it may be that the severity of Covid-19 itself contributes to the severity of post-Covid symptoms.

4.9 Time of Infection as Risk Factor

Table 17: Association between time of Covid infection and post-Covid symptom severity

Time of Infection		Severity of Post-Covid Symptoms						p-values
		None	Very Mild	Mild	Moderate	Severe	Total	
First wave (March 2020-December 2020)	Alpha strain	16.9% (11)	15.4% (10)	24.6% (16)	30.8% (20)	12.3% (8)	65	0.91
Second wave (End of 2020-April 2021)	Beta strain	13.7% (20)	15.1% (22)	19.9% (29)	38.4% (56)	13.0% (19)	146	
Third wave (May 2021-End of 2021)	Delta strain	14.3% (20)	19.3% (27)	22.1% (31)	35.0% (49)	9.3% (13)	140	
Total		14.5% (51)	16.8% (59)	21.7% (76)	35.6% (125)	11.3% (40)	351	
	Gender							
First wave	Male	24.3% (9)	29.7% (11)	18.9% (7)	16.2% (6)	10.8% (4)	37	0.65
	Female	25% (7)	32.1% (9)	14.3% (4)	7.1% (2)	21.4% (6)	28	
Second wave	Male	22.6% (19)	32.1% (27)	16.7% (14)	10.7% (9)	17.9% (15)	84	0.211
	Female	16.1% (10)	46.8% (29)	9.7% (6)	16.1% (10)	11.3% (7)	62	
Third wave	Male	18.7% (14)	28% (21)	17.3% (13)	10.7% (8)	25.3% (19)	75	0.108
	Female	26.2% (17)	43.1% (28)	10.8% (7)	7.7% (5)	12.3% (8)	65	

Table 17 shows that most of the cases with severe post-Covid symptoms were during the second wave (13%). The least number of severe post-Covid symptoms cases were observed during the third wave (9.3%). The highest number of respondents with no post-Covid symptoms were found during the first wave (16.9%).

This table also shows that in comparison, the number of respondents with very mild or mild symptoms were lowest during the second wave (15.1% and 19.9% respectively), compared to first and third wave respondents. While this implies that second wave respondents may have faced more severe post-Covid symptoms and number of recovered patients with no post-Covid effects were low, no statistically significant relationship was found between time of Covid-19 infection and severity of post-Covid symptoms ($p>0.05$).

Time of infection as a risk factor for post-Covid symptoms was also assessed among both genders. During the first wave, more females faced severe post-Covid symptoms (21.4% compared to 10.8% of males). In contrast, during the second and third wave, more males faced severe post-Covid symptoms than females (17.9% and 25.3% respectively). With each successive wave of Covid-19, more females showed very mild post-Covid symptoms than males (32.1%, 46.8%, and 43.1%). During the second and third wave, more males had severe post-Covid symptoms than females (17.9% and 25.3% respectively). However, no statistically significant differences were found between males and females during each wave of infection ($p>0.05$). The average number of individuals with post-Covid symptoms in each wave was calculated with descriptive statistics and is summarized below:

- First wave (mean \pm SD): 3 \pm 3.28
- Second wave (mean \pm SD): 6.79 \pm 6.37
- Third wave (mean \pm SD): 6.42 \pm 5.59

This study points out that the average number of recovered patients with post-Covid symptoms was the highest during the second wave. A one-way ANOVA test was used to compare the means, but no significant difference was found ($p=0.057$, $p>0.05$).

4.10 Duration of Infection as Risk Factor

Table 18: Association between duration of Covid-19 infection and post-Covid symptoms

Duration of Covid-19 Infection		Severity of Post-Covid Symptoms						p-values
		None	Very mild	Mild	Moderate	Severe	Total	
Acute Covid-19 (<4 weeks)		16.6% (47)	18.4% (52)	22.6% (64)	32.5% (92)	9.9% (28)	283	0.0107
Prolonged Covid-19 (4-8 weeks)		7.1% (4)	8.9% (5)	21.4% (12)	48.2% (27)	14.3% (8)	56	
Chronic Covid-19 (>8 weeks)		0.0% (0)	16.7% (2)	0.0% (0)	50.0% (6)	33.3% (4)	12	
Total		15% (51)	16.7% (59)	21.5% (76)	35.4% (125)	11.3% (40)	351	
	Gender							
Acute Covid-19	Female	13.1% (16)	15.6% (19)	23.8% (29)	37.7% (46)	9.8% (12)	122	0.355
	Male	19.3% (31)	20.5% (33)	21.7% (35)	28.6% (46)	9.9% (16)	161	
Prolonged Covid-19	Female	3.4% (1)	6.9% (2)	17.2% (5)	62.1% (18)	10.3% (3)	29	0.291
	Male	11.1% (3)	11.1% (3)	25.9% (7)	33.3% (9)	18.5% (5)	27	
Chronic Covid-19	Female	0.0% (0)	0.0% (0)	0.0% (0)	50.0% (2)	50.0% (2)	4	0.472
	Male	0.0% (0)	25.0% (2)	0.0% (0)	50.0% (4)	25.0% (2)	8	

Table 18 shows that most people suffered from acute Covid-19 (283 respondents), which lasts less than 4 weeks. The majority of them had moderate post-Covid symptoms (32.5%). 16.6% of them had no post-Covid symptoms.

This changes with an increase in the duration of infection. 56 respondents suffered from prolonged Covid-19, which lasts between 4-8 weeks. Among them, 48.2% had moderate post-Covid symptoms and 14.3% had severe symptoms, which is significantly higher than the results seen among the group with acute Covid-19 ($p < 0.05$). Among those who had chronic Covid-19, there were no respondents without post-Covid symptoms. In fact, 50% of them had moderate post-Covid symptoms. 33.3% of them had severe post-Covid symptoms, and this is significantly different from the other groups.

The study tried to assess if there are any differences seen among the genders. Among respondents who had chronic Covid-19, more females showed severe post-Covid symptoms than men. However, among the respondents with prolonged Covid-19, more males had severe post-Covid symptoms than females. This is also true for respondents with acute Covid-19, but the differences between the genders has been found to be insignificant ($p > 0.05$).

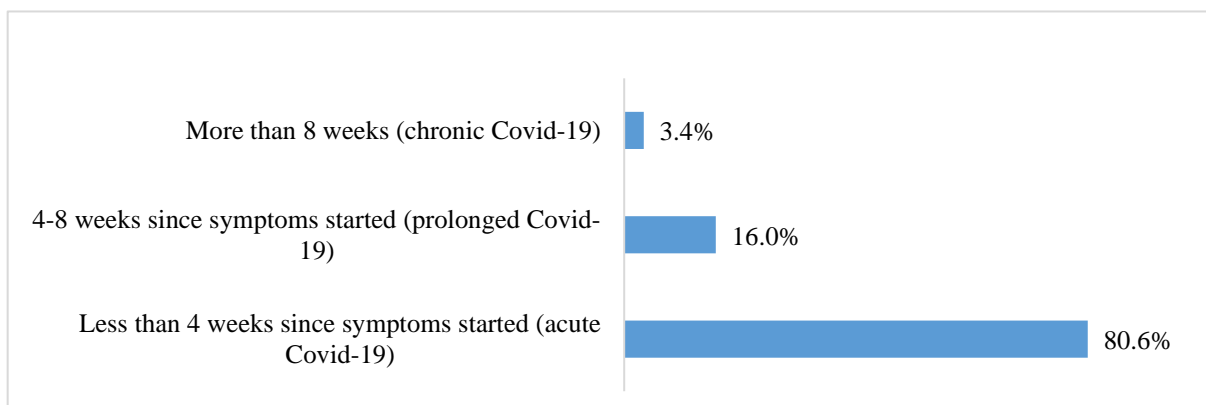


Figure 8: Duration of Covid-19 infection among respondents

Figure 8 gives an idea of the duration of Covid-19 infection among 351 respondents. 80.6% had acute Covid-19 that lasted less than 4 weeks. 16% faced prolonged Covid-19 and recovered within 8 weeks. Only 3.4% suffered from chronic Covid-19 that lasted more than 8 weeks.

4.11 Prevalence of Post-Covid Symptoms

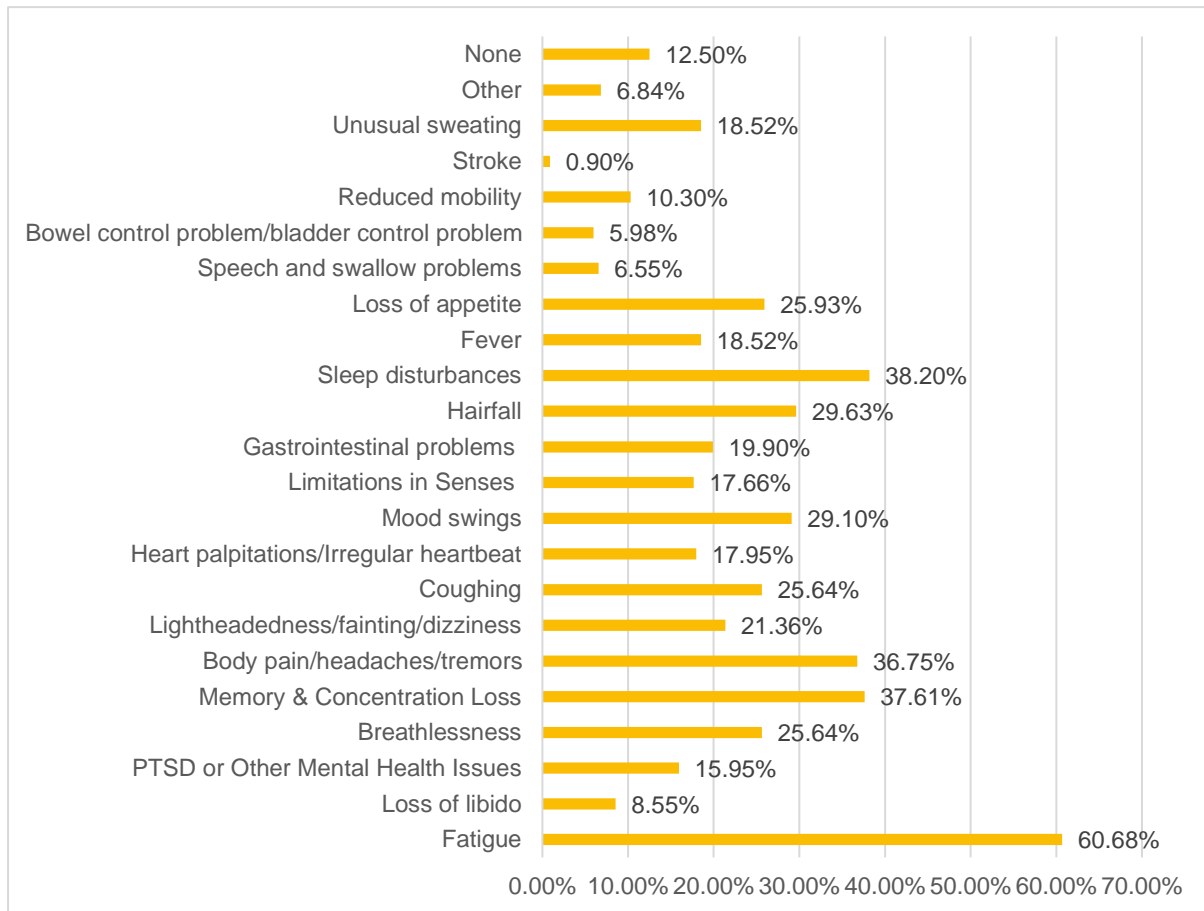


Figure 9: Prevalence of post-Covid symptoms among 351 respondents

According to Figure 9 shown above, 60.68% of the respondents suffered from fatigue and weakness after recovering from Covid-19. 8.55% of respondents felt a loss of libido, with one respondent elaborating on their condition by mentioning itching around the genitals. 15.95% of respondents reported PTSD, depression, suicidal thoughts, anxiety, increased OCD, and other mental health problems. Some respondents further elaborated on feelings of frustration, fear and trauma despite recovery. 25.64% of respondents noted breathing problems such as breathlessness and asthma. Few respondents informed of getting infected with pneumonia after recovering from Covid-19. 37.61% of respondents reported short or long-term memory & concentration loss, brain fog, and being unable to work properly. 36.75% reported body pain,

muscle or joint pain, headaches or migraines, heavy feeling or pain in chest, or tremors. 21.36% of the respondents felt dizziness, lightheadedness, and even fainting. Coughing was prevalent among 25.64% patients after recovering from Covid-19. 17.95% of the respondents mentioned having heart palpitations. 29.10% of the respondents reported having mood swings. A staggering 38.2% noted having sleep disturbances. 17.66% of respondents mentioned facing limitations in senses, such as loss of hearing, smell, taste, etc. One respondent even mentioned having an eating disorder right after recovering from Covid-19. 19.9% of the 351 respondents mentioned having some sort of gastrointestinal problem, including bloating, diarrhea, indigestion, nausea, abdominal pain, and vomiting. 29.63% of the total respondents reported extreme hair fall than before, and 18.52% patients had intermittent fevers after recovering from Covid-19. 25.93% reported going through loss of appetite. 18.52% reported unusually high amounts of sweating.

Other minor symptoms respondents faced include:

- swallowing issues
- irregular periods
- difficulty talking
- blood pressure and sugar level fluctuations
- allergies
- oral thrush or sore throat
- conjunctivitis
- stroke
- reduced mobility
- issues in bowel and bladder control
- vertigo

- dry skin
- hypothyroidism
- rashes

A cancer patient reported severe damage to health after recovering from Covid-19, prompting more chemotherapy. Another respondent mentioned getting dengue after recovering.

Figure 10: Severity of post-Covid symptoms among respondents

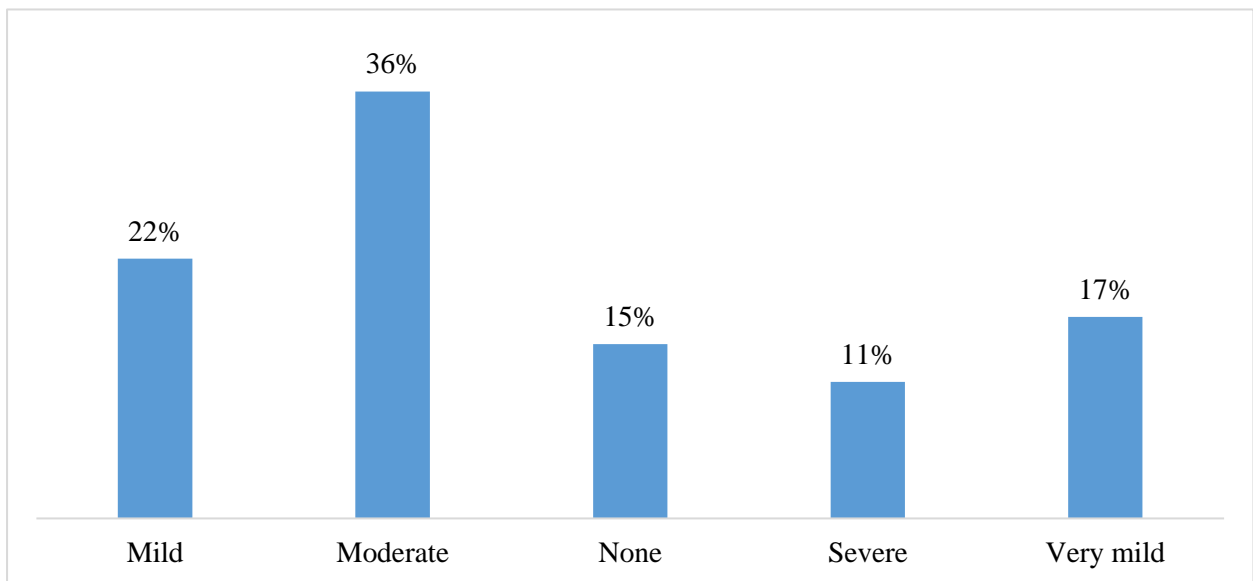


Figure 10 shows overall how severe these post-Covid symptoms were among the respondents. Most had moderate symptoms (36%), and 15% did not face post-Covid symptoms at all. 11% went through severe post-Covid effects. 17% of total respondents had very mild symptoms, while 22% had mild symptoms.

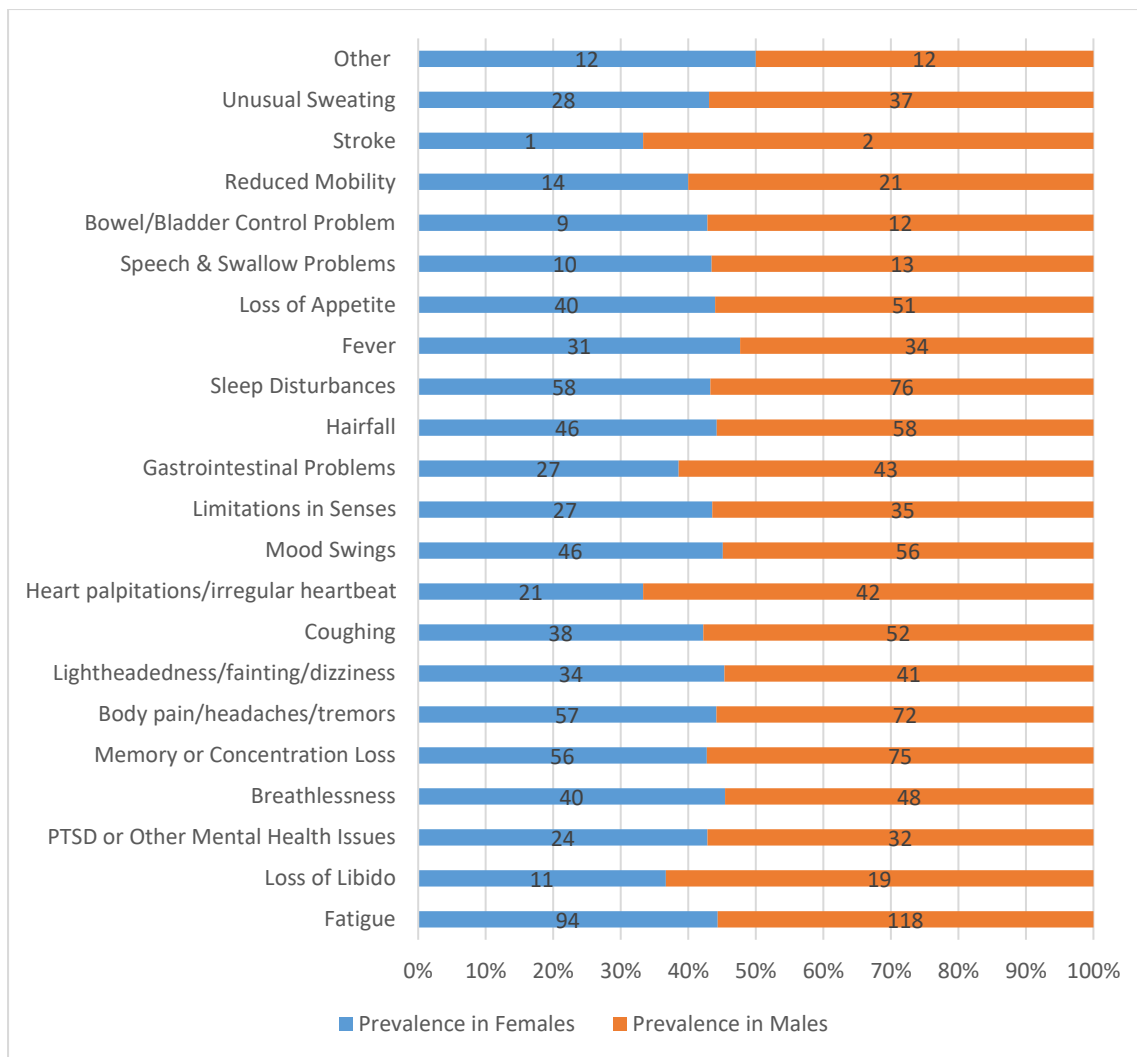


Figure 11: Prevalence of each post-Covid symptoms among males and females

Prevalence of Post-Covid Symptoms Among Males & Females

Figure 11 shows the prevalence of post-Covid symptoms among males and females. Interestingly, the prevalence of symptoms is higher in the number of males compared to number of females in every case. Most males suffered from fatigue (118 respondents), and most females also suffered from fatigue (94), yet females are lower in number.

Similarly, more males suffered from mental health issues than females. Short- or long-term memory and concentration loss was a symptom more prevalent among males than females. Body pain, headaches, and tremors were also more common in males than females. 35 males faced limitations in senses compared to 27 females.

Table 19: Difference between majorly prevalent symptoms in males and females

Majorly Prevalent Post-Covid Symptoms	Fatigue	Breathlessness	Memory /Concentration Loss	Body Pain	Coughing	Mood Swings	Hair fall	Sleep disturbances	p-value
Prevalence in Females	94	40	56	57	38	46	46	58	0.99
Prevalence in Males	118	48	75	72	52	56	58	76	
Gender	Number of Post-Covid Symptoms								

A chi-square test was conducted to test if the difference between the genders is statistically significant with regard to majorly prevalent post-Covid symptoms. According to Table 19, no significant difference was found for genders, despite prevalence of major post-Covid symptoms being higher in males compared to females ($p > 0.05$). Considering the number of symptoms, although it was higher in females, there was no significant difference from males ($p > 0.05$).

* $p < 0.05$ denotes statistically significant difference

4.12 Factors That Might Affect Treatment Success

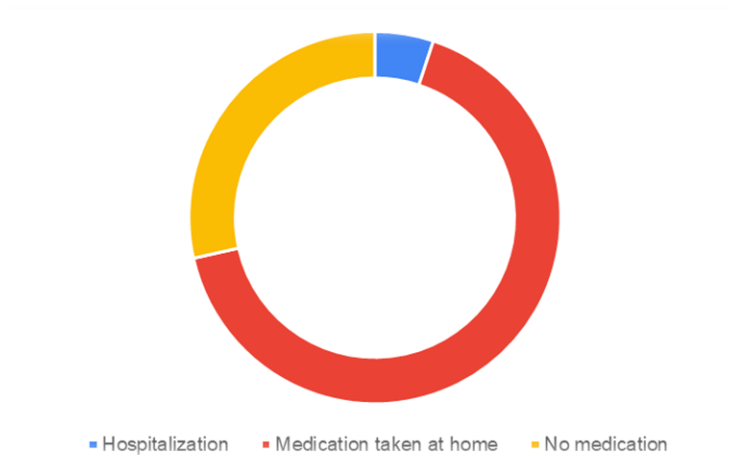


Figure 12: Preferred mode of treatment of post-Covid symptoms

Figure 12 represents how respondents chose to treat with post-Covid symptoms. 66.4% chose to treat themselves at home with medication. 5.1% had to be hospitalized, while 29% instead opted changes in lifestyle, homeopathy, change in diet, or other assumed forms of treatment. Of this particular group, 51 respondents did not have any post-Covid symptoms.

Mode of Treatment of post-Covid Symptoms

Table 20: Status post-Covid with treatment

Treatment Method	Status After Treatment			Total	p-value
	No Change	Condition Improved	Discontinued/Switched		
Medication taken at home	11.2% (26)	62.2% (145)	26.6% (62)	233	<0.00001
No Medication (Change in Lifestyle)	8.0% (8)	20.0% (20)	72.0% (72)	100	
Total	34	165	134	333	

*This chi-square test was done excluding the 18 hospitalized respondents mentioned previously. No respondent in this particular group of 233 respondents reported conditions getting worse.

Table 20 shows that of the 233 respondents who took medication at home, 62.2% had improved conditions post-Covid. 26.6% of them decided to discontinue medication at some point of time. 11.2% of them reported no change in post-Covid conditions despite medication. 100 respondents chose to not take medication and instead opted for change in lifestyle. 8% of them reported no change in conditions, and only 20% of them reported improvement, a stark contrast from the 145 respondents who reported improvement upon medication. 72% of this group switched to medication at some point of time in hopes of improving conditions. There is a highly significant difference between those who took medication and those who opted for changes in lifestyle without medication ($p < 0.05$).

Use of Vitamin Supplements

Table 21: Association of vitamins with post-Covid symptom severity

Vitamin intake post-Covid	Gender	Severity of post-Covid Symptoms					Total	P-values
		None	Very Mild	Mild	Moderate	Severe		
No	Female	27.8% (5)	22.2% (4)	16.7% (3)	27.8% (5)	5.6% (1)	100% (18)	0.863
	Male	22.6% (7)	29% (9)	16.1% (5)	19.4% (6)	12.9% (4)	100% (31)	
	Total	24.5% (12)	26.5% (13)	16.3% (8)	22.4% (11)	10.2% (5)	100% (49)	
Yes	Female	8.2% (11)	12.7% (17)	22.4% (30)	44.8% (60)	11.9% (16)	100% (134)	0.086
	Male	16.4% (27)	17.6% (29)	22.4% (37)	32.1% (53)	11.5% (19)	100% (165)	
	Total	12.7% (38)	15.4% (46)	22.4% (67)	37.8% (113)	11.7% (35)	100% (299)	

Table 21 shows that of the total respondents, 299 individuals used vitamin supplements as per their physician's instructions and continued to use them post-Covid. More males had no post-Covid symptoms, or had very mild symptoms compared to females (16.4% and 17.6% respectively). Both females and males had moderate post-Covid symptoms equally in this

group (22.4%), but more females showed moderate and severe symptoms than men (44.8% and 11.9% respectively). Respondents explained that vitamin intake was continued even after recovering from Covid-19 with physician’s recommendations.

Only 49 respondents did not have vitamins. No significant difference was found among the genders with or without vitamin intake ($p>0.05$).

Gender & Age

Table 22: Success of treating post-Covid symptoms based on gender & age

Gender	Post-Covid Status with Treatment					p-values
	Re-hospitalized	Condition Same	Condition Improved	Condition Worsened	Total Treated	
Total Females	0% (0)	9.7% (15)	49.0% (76)	0.6% (1)	92	0.31
Total Males	1.5% (3)	10.2% (20)	51.0% (100)	0% (0)	123	
Total Respondents	3	35	176	1	215	
Age group						
<10	0.0% (0)	0.0% (0)	100% (1)	0.0% (0)	1	0.578
10-19	0.0% (0)	13.3% (2)	33.8% (5)	0.0% (0)	7	
20-30	0.0% (0)	12.3% (20)	50.0% (81)	0.6% (1)	102	
31-40	1.1% (1)	11.0% (10)	40.7% (37)	0.0% (0)	48	
41-50	0.0% (0)	4.9% (2)	53.7% (22)	0.0% (0)	24	
51-60	5.9% (1)	5.9% (1)	76.5% (13)	0.0% (0)	15	
61+	4.2% (1)	0.0% (0)	70.8% (17)	0.0% (0)	18	
Total	3	35	176	1	215	

(Chi-square tests were done excluding respondents who have been inconsistent with treatment)

Gender and age were considered as possible factors that can show differences in treatment success. Table 22 summarizes this study’s findings in this regard. A total of 134 respondents were inconsistent in treatment. Among this group 40.6% are females and 37.2% are males. No female respondent in the study had to be re-hospitalized due to post-Covid symptoms, but 3 male respondents were re-hospitalized, suggesting that their conditions were extreme. Only 1 female respondent felt that treatment was not helping and the symptoms were getting worse.

Majority of the females (49%) and majority of the males (51%) noted that their conditions improved upon treatment. However, there is no statistically significant difference among the genders in the group of 215 who treated themselves ($p>0.05$).

The Table also shows that among the 3 people who had to be re-hospitalized, 2 were 50+ in age. 35 respondents declared that their treatment of post-Covid symptoms did not improve or worsened their conditions, but rather remained unchanged. 91.4% of them (32 respondents) are below 40. A total of 176 respondents mentioned that treatment improved their conditions. Out of the 176 respondents, 87 were under the age of 30. 89 respondents were above 30 in age.

38.5% of the respondents opted to not treat post-Covid symptoms. Of them, 68 individuals are under 30 and 68 individuals are above 30 in age. No significant difference was found among the age groups with respect to effectiveness of treatment ($p>0.05$).

4.13 Patients' Status 2 Months After Treating Post-Covid Symptoms

All 351 respondents were asked to report their conditions two months after they tested negative for Covid-19. This was undertaken to find out whether they are suffering from long-Covid.

Table 23: Status 4 weeks post-Covid with respect to the mode of treatment

Mode of treatment	Status 4 Weeks Post-Covid					Total	p-value	Difference between genders (p-values)
	Not Sure	Re-infected with Covid-19	Condition Same	Condition Worsened	Condition Improved			
Hospitalization	0.0% (0)	5.6% (1)	5.6% (1)	11.1% (2)	77.8% (14)	18	0.00016	0.689 (Males=7 Females=11)
Medication at home	8.6% (20)	2.6% (6)	11.1% (26)	0.0% (0)	77.7% (181)	233		0.917 (Males=98 Females=135)
No medication	14% (14)	3.0% (3)	14.0% (14)	1.0% (1)	68.0% (68)	100		0.314 (Males=50 Females=50)
Total	9.6% (34)	2.8% (10)	11.7% (41)	0.85% (3)	74.9% (263)	351		

Table 22 shows that 5.1% of the 351 respondents were hospitalized. These individuals may or may not have taken treatment at home; 3 of them were re-hospitalized despite treatment. Among these 18 respondents, 77.8% mentioned that their condition improved, while 11.1% mentioned that their conditions were worse than before, and 1 respondent reported re-infection with Covid-19 while in the hospital.

233 respondents took medication at home. 77.7% of them reported that their conditions have improved, and 11.1% noted that their post-Covid conditions remained the same. These individuals may be suffering from long Covid. 2.6% of these individuals got re-infected with Covid-19. None reported symptoms becoming worse.

100 respondents chose to not take medication either because they have had very mild post-Covid symptoms or because they chose to change their lifestyle. 68% of these respondents noted that their post-Covid symptoms got better with time, while 14% noted that their conditions remained the same. These individuals may be suffering from long Covid. 3% of this group also got re-infected with Covid-19. 1 person reported symptoms getting worse.

Difference between these three groups were found to be highly significant ($p < 0.05$). In all modes of treatment, post-Covid symptoms did get better with time, but those who chose medication at home showed better results than those who did not take medication, suggesting that proper medical intervention is necessary to ensure that long-Covid is manageable.

Of 351 respondents, 74.9% respondents improved in 2 months' time with medication, hospitalization, and changes in lifestyle. 0.85% reported symptoms getting worse, and may be suffering from long-Covid. 11.7% noted that their post-Covid symptoms did not get better, while 9.6% were not sure whether they are still suffering from post-Covid symptoms. It can be said that both these groups are suffering from long Covid since they have not reported improvement. 2.8% (10 respondents) got re-infected with Covid-19, which is a cause for concern. In each group, no significant difference between the genders was found ($p > 0.05$).

Chapter 5

5.1 Discussion

The Covid-19 pandemic severely burdened health facilities around the world. Low or middle-income countries such as Bangladesh, where this study took place, were severely affected but there is very little known about their post-Covid scenario. Recovered patients in Bangladesh are also suffering from the aftereffects of Covid-19. Studies such as Huang et al. (2021), have shown that a substantial proportion of the recovered patients deal with ongoing symptoms even 6 months after recovering from the acute phase of Covid-19. Common names of this phenomenon include post-acute sequelae of SARS-CoV-2 infection (PASC), post-Covid syndrome, post-Covid conditions, or as people call them, Covid long-haulers. Therefore, this means post-Covid symptoms are prevalent in Bangladesh as well. There is an urgent need to follow up these patients and address their issues so that their quality of life (QoL) is enhanced and health management systems can be further improved in the future (Michelen et al., 2020)

There is still very limited knowledge about the full range of post-Covid symptoms, duration of these symptoms, and the potential risk factors behind them (Munblit et al., 2021). Huang et al. (2021) noted that neutralizing antibody titers were significantly lower after recovery compared to the acute phase of Covid-19. Long et al (2020) reported that among asymptomatic Covid patients, 81% showed a reduction in neutralizing antibody concentrations. Without proper medical intervention there may be more re-infections observed in the future, or susceptibility to other infections and diseases could occur much easier among Covid-19 recovered patients. Further research is necessary to better understand the risk of Covid-19 re-infections as well.

This was an in-depth descriptive cross-sectional study conducted in BRAC University for three months from July 2021 to September 2021. To our knowledge, this is one of the first studies in Bangladesh that addresses the issues faced by Covid-recovered patients and reports the prevalence of post-Covid symptoms among males and females. Its aim was to find out the prevalence of post-Covid symptoms among recovered patients in Dhaka, the capital city of Bangladesh, and the potential risk factors behind these symptoms. Unlike some previous studies, this study stratified data further and clearly to assess the persistence of symptoms and patient status after 2 months. The study included patients who had the mildest symptoms or were completely asymptomatic, which was not done in multiple studies previously. 351 respondents participated in this study. 55.8% of the respondents were males and 44.2% were females. 46.2% of the respondents belonged to the 21-30 age group, which was the majority. 49.2% of the respondents were 31+ years old.

5.2 Age may be a possible risk factor:

Older age is considered a risk factor for severe Covid-19 (Bulut & Kato, 2020). Like previous studies of Covid-19, even in this study, age was found to be a highly significant risk factor for Covid-19 ($p=0.008$). However, the same kind of association between age and post-Covid symptoms was not as significant ($p>0.05$). The study did find a significant difference in post-Covid symptoms severity between males and females aged 40 or below ($p=0.009$). More males suffered from mild to severe symptoms compared to females. The same difference was found to be insignificant among males and females 40+ years of age. Generally, younger aged Covid-19 patients are described as low-risk individuals in terms of long Covid, but there are reports that acknowledge that post-Covid symptoms occur among survivors at all levels of severity, including those who were asymptomatic, and younger adults who did not have respiratory support, hospitalization, or intensive care (Townsend et al, 2021) (Dennis et al, 2021).

Therefore, it is considered that all age groups are equally prone to developing post-Covid symptoms (Mahmud et al, 2021).

5.3 Gender as a possible risk factor:

Although gender has been considered a risk factor for Covid-19 in several studies, in this study, there was no significant association found between gender and the severity of Covid-19 ($p>0.05$), despite more males reporting severe Covid-19 than women. This study also found no significant difference in males and females in terms of the number of post-Covid symptoms ($p>0.05$). 113 males reported at least 3 post-Covid symptoms, compared to 84 females who reported at least 3 symptoms. The study also noted that more females suffered from mild to moderate symptoms. Munblit et al. (2021) and Huang et al. (2021) reported that the risk of severe post-Covid symptoms is higher among females. However, in this particular study there was no significant difference found between both genders in terms of the severity of post-Covid symptoms ($p>0.05$), despite more males suffering from severe post-Covid symptoms. The findings are similar to a study by Jacobson et al. (2021), where no association between gender and persistent symptoms post-Covid was found. Further research with larger study populations is necessary to acquire more details and to understand causality.

Mahmud et al. (2021) conducted a similar study among 355 patients enrolled in Dhaka Medical College & Hospital and observed their post-Covid symptoms. This particular study noted that 60% patients were younger than the age of 40, mainly due to the sociocultural background of Bangladesh where younger population is way greater than the older population. This study found proportion of men with Covid-19 greater than women, and therefore prevalence of post-Covid symptoms were higher in men, but not significantly different than women. The female sex was still found to be a risk factor for post-Covid symptoms.

5.4 Occupation may be a possible risk factor:

This study considered occupation at the time of Covid-19 infection as a possible risk factor for post-Covid symptoms. This is because exposed working groups compared to those isolated at home present a more realistic situation of the burdens of Covid-19 long after recovery (Peters et al, 2022). If healthcare workers and emergency workers are heavily impacted by long-Covid, it will be a severe blow to the country's economy and health infrastructure.

It was found that 50.6% of the study participants worked from home or stayed at home. The rest of the participants were working outside in national emergency services, healthcare settings, and other essential workplaces, or had to go out sometimes for daily necessities. The study noted a significant difference in the severity of post-Covid symptoms among those who went outside and those who stayed home ($p=0.0374$). 7.4% of the respondents who stayed at home suffered from severe post-Covid symptoms. In comparison, 14.1% of respondents went outside frequently and faced severe post-Covid symptoms. Those working in emergency services had the highest prevalence of severe post-Covid symptoms (23.4%). 12% of the respondents working in healthcare settings showed severe post-Covid symptoms. Therefore, this study reports that the severity of post-Covid symptoms may be affected by individual occupation, although there was no significant difference seen among males and females ($p>0.05$). Martinez et al. (2021) reported that one-third of the staff of a Swiss hospital were suffering from post-Covid issues even 90 days after recovery, despite having mild Covid-19 symptoms. Similarly, studies in various healthcare facilities in Denmark also noted common symptoms lasting more than 90 days among staff (Kaspersen et al, 2021). Further research is required to understand the impact of post-Covid symptoms on healthcare and emergency workers to understand the disease burden and their need of long-term care and support.

5.5 BMI may be a possible risk factor:

Body Mass Index (BMI) is considered a risk factor for Covid-19. This study tried to assess whether it is also a risk factor for post-Covid symptoms. A study in Saudi Arabia compared populations without post-Covid symptoms and those with post-Covid symptoms, and found BMI as a risk factor (Mahmoud et al, 2021). It was found that a significant difference between underweight males and females exists ($p=0.038$). More underweight males suffered from severe post-Covid symptoms than females. No significant difference was found among males and females with a healthy weight ($p>0.05$), despite more males noting severe post-Covid symptoms than females. In terms of overweight respondents, there was a somewhat significant difference found between males and females ($p=0.05$). More females showed mild to moderate post-Covid symptoms than males. A study in North India (Uniyal et al, 2022) also noted that people with higher BMI were more susceptible to developing post-Covid symptoms after 6 weeks of recovery.

5.6 Smoking habits as a risk factor:

In this study we found that there were more severe post-Covid symptoms found among non-smokers, followed by regular smokers and irregular smokers. However, the difference between these groups were not statistically significant ($p>0.05$). 79% of the study population were non-smokers. The study also found no statistically significant differences among male and female non-smokers, regular smokers, or irregular smokers ($p>0.05$). A study conducted in Germany on the post-Covid situation of healthcare worker reflected similar results (Peters et al, 2022), noting that smoking status had no influence on persisting symptoms of long Covid. Uniyal et al. (2022) also reported that there was no significant difference found in the incidence of post-Covid symptoms with respect to the effects of smoking and alcohol intake.

5.7 Co-morbidities may be a risk factor:

Underlying conditions may have an impact on the severity of post-Covid symptoms as they do for Covid-19 (Gupta et al, 2020). A total of 345 respondents in this study reported having a pre-existing condition. 21.8% of the study population reported having more than 2 underlying conditions. Majority of the respondents mentioned having some form of allergies (18.2%). This was followed by various forms of diabetes (15.7%). Other major pre-existing conditions include cardiovascular diseases, chronic respiratory conditions such as asthma, diabetes, cancer, thyroid and hormonal issues, mental health problems (Williamson et al, 2020), and others. These comorbidities are established risk factors for Covid-19, but Sudre et al. (2021) suggested asthma as a risk factor for post-Covid syndrome. As Nalbandian et al. (2021) mentioned, the association of comorbidities with post-Covid symptoms is yet to be fully determined.

No statistically significant association between number of pre-existing conditions and post-Covid symptom severity was found ($p>0.05$). Through logistic regression, the study reported that the prevalence of severe post-Covid symptoms is higher among respondents with cardiovascular disease, cancer, chronic urological disease, immune system issues, mental health problems, and allergies. However, there was no statistically significant difference found between patients with these conditions and those without ($p>0.05$), except for chronic urological disease ($p=0.05$). It may be that individuals to chronic kidney problems are more likely to face severe post-Covid symptoms after recovery. More research is necessary in this regard.

5.8 Severity of Covid-19 may be a risk factor:

39% of the study population reported moderate Covid-19, 37.3% reported mild Covid-19, 17.1% reported severe symptoms, while 6.6% reported to be asymptomatic. The study

conducted by Munblit et al. (2021) explained that most patients may have had mild to moderate severity of Covid-19 due to the participants being younger in age, which is true for this study as well, since most patients fell in the 21-30 age group as mentioned previously.

This study found a highly significant relationship between the severity of Covid-19 and severity of post-Covid symptoms ($p < 0.00001$). Those who had asymptomatic Covid-19 mostly had very mild post-Covid symptoms. However, those who had moderate or severe Covid-19 had to deal with severe post-Covid symptoms as well. This association between the severity of Covid-19 and severity of post-Covid symptoms was also found to be statistically significant in males and females. Female respondents with asymptomatic Covid-19 had no cases of severe post-Covid symptoms, but females with severe Covid-19 did have severe post-Covid symptoms. This proves that there is a significant association between the degree of severity of Covid-19 and post-Covid symptoms in females ($p = 0.001$). Similar results were also found in males ($p < 0.00001$), but males are at higher risk.

Huang et al. (2021) reported similar results, stating that the severity of illness is a risk factor, especially for psychological post-Covid symptoms. This may be a direct consequence of the infection, certain side effects of medication such as corticosteroids, immune response, social isolation, and the stigma faced by patients and family members (Rogers et al. 2020). Severe Covid-19 induces severe immune response, cytokine storm, more organ damage, (Batabyal et al, 2021) and because they are treated with more aggressive medication, the consequences can also be severe.

5.9 Time of infection as a risk factor:

There was a speculation that one variant of Covid-19 may have more damaging effects than others, therefore patients infected with such variants may have harsher long Covid symptoms. Such patients would require more extensive treatment as well. This study notes that most of

the severe cases of post-Covid symptoms were from the second wave (13%), possibly due to the Beta variant. Highest number of respondents with no post-Covid symptoms were found during the first wave mostly caused by the Alpha variant (16.9%). Respondents who were infected with Covid-19 during the third wave (Delta variant) mostly showed moderate post-Covid symptoms (35%). Overall, there was no statistically significant difference between the respondents of the first, second, and third wave in terms of post-Covid symptoms severity. Although, during the first wave, more females had severe post-Covid symptoms, it was during the second and third wave that more males faced severe post-Covid symptoms. However, no significant difference was found between the males and females of each wave ($p>0.05$). The study in Germany by Peters et al. (2022) also reported similar findings of the time of infection having no significant association with severity of Covid-19.

The average number of individuals with post-Covid symptoms was highest during the second wave and lowest during the first wave, but when comparing the means via one-way ANOVA, the differences was not significant ($p>0.05$). A study by Fernandez et al. (2022) reported that the mean number of symptoms was higher among those infected with Delta strain of Covid-19 compared to Alpha strain, and the difference was statistically significant. More studies are necessary in order to understand the severity of post-Covid symptoms corresponding to each major strain. Currently there is very little information about this.

5.10 Duration of infection may be a risk factor:

This study reports that there is a significant difference in severity of post-Covid symptoms among those who have had acute, prolonged, and chronic Covid-19 ($p=0.017$). 80.6% of respondents had acute Covid-19. Acute Covid-19 respondents had only 9.9% cases of severe post-Covid symptoms and 32.5% moderate cases, but prolonged Covid-19 respondents had 14.3% severe cases and 48.2% moderate cases. This jumps to 11.3% severe post-Covid cases

and 50% moderate cases among chronic Covid-19 respondents. However, there was no statistically significant difference found between males and females ($p>0.05$). A study in Northern India conducted by Naik et al. (2021) reported that post-Covid severity is associated with a prolonged duration of Covid-19 and can lead to further damage.

5.11 Prevalence of post-Covid symptoms:

Major post-Covid symptoms include fatigue (Huang et al, 2021), short or long-term memory or concentration loss (Ritchie et al. 2020), breathlessness, PTSD or mental health issues (Kaseda et al, 2020), body pain, migraine-like headaches (Belvis 2020), tremors, coughing (Nalbandian et al, 2021), mood swings, extreme hair fall, sleep disturbances, limitations in senses, and loss of appetite. There were other post-Covid symptoms reported in lower numbers, such as stroke, irregular menstruation, swallowing issues, reduced mobility, vertigo, etc. This is not unexpected.

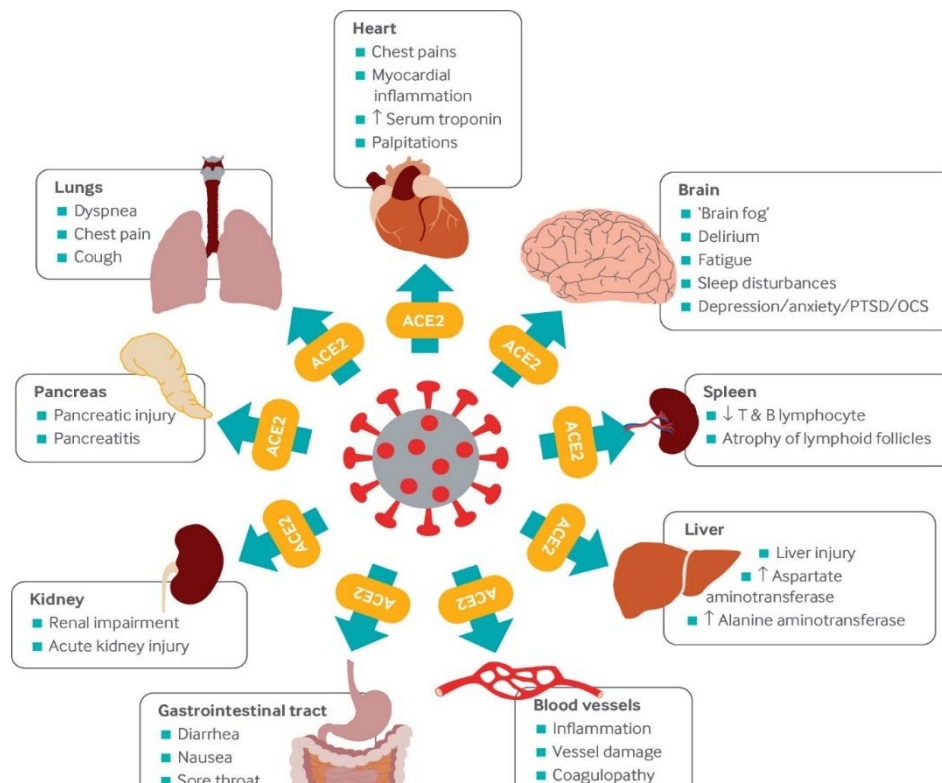


Figure 13: Pattern of ACE2 expression among organs (Crook et al. 2021)

According to a report published by The Lancet (2020), multi-organ complications are very much likely to happen due to the presence of the ACE2 receptor which is expressed in many tissues. ACE2 is found attached to the membranes of the cells in the intestines, kidney, gall bladder, heart, and also in soluble form (Hikmet et al. 2020). It acts as a receptor and point of entry to the SARS-CoV-2 virus that causes the Covid-19 infection. Figure 13 reports the possible post-Covid symptoms faced due to the expression of ACE2 receptors availability in multiple organs, resulting in lasting damage across several organ systems by Covid-19.

Overall, 36% of respondents reported moderate post-Covid symptoms, while 11% reported severe post-Covid symptoms. The prevalence of each post-Covid symptom was higher in males compared to females, but overall, the difference between the genders was found to be statistically insignificant ($p>0.05$). Similar studies such as the one conducted by Huang et al. (2021) showed prevalence of each post-Covid symptom higher among females. In this study, although this was the case for males, the difference between the genders were found to be insignificant. Similar studies have been reported (Sugiyama et al, 2022), which noted that the prevalence of post-Covid symptoms did not significantly differ by gender, place of medical care, smoking status, or co-morbidities.

Larger study populations and further research is needed to further assess differences in the genders, which may be affected by age, nutritional status, and other demographic aspects. More research is also necessary to identify the aftereffects of Covid-19 on multi-organ systems.

5.12 Mode of Treatment Affects Treatment Success:

A study by Yong (2021) recommended light aerobic exercise and 5-10 minutes of daily breathing exercises to improve post-Covid symptoms. The study further implied that treatment be personalized since symptoms vary from person to person. Due to the heterogeneous nature of post-Covid symptoms and diverse levels of severity, many opted to treat them at home with

medication, while others insisted on improving conditions by changing diet, lifestyles, and increasing exercise, even if they had no post-Covid symptoms. Treatment at home was also more viable due to the repeated national lockdowns and overwhelmed medical facilities, and the subsequent rise of telemedicine. Another plausible reason to treat and manage post-Covid symptoms at home could be the feeling of abandonment felt by patients in healthcare facilities (Ladds et al, 2020).

66.4% of the study population treated themselves at home. Studies have noted that incidence of re-hospitalization due to post-Covid patients among Covid-19 survivors range from 1.4% to 15% (Aiyegbusi et al, 2021) (Weerahandi et al, 2021). In this study, 5.1% had to be hospitalized for severe post-Covid symptoms. 29% chose to not take any medicine and instead focused on changes in lifestyle such as diet, use of home remedies and alternative methods of treatment, exercise, etc. This study found a highly significant difference between those who took medication and those who did not ($p < 0.00001$). 165 respondents mentioned that their conditions improved, out of which 62.2% took medication at home compared to 20% who did not take prescribed medication. 72% of those who did not take medication switched to medication. Studies note that therapeutic exercise can work wonders on Covid-19 survivors, even if they were hospitalized in the ICU (Udina et al, 2021). This study recommends that in case of post-Covid survivors and their rehabilitation, prescription medicine, psychological support as well as therapeutic exercises can improve their conditions significantly, but the treatment should be personalized.

5.13 Impact of Vitamin Supplements on Treatment Success:

Multiple studies have already established that the deficiency of vitamin D is linked with the severity of Covid-19 (Radujkovic et al, 2020) (Mercola et al, 2021). As a result, physicians recommended oral vitamin D supplements to Covid-19 patients, even if it is for a short time,

to cover the deficiency and alleviate symptoms (Sabico et al, 2021). 299 respondents took vitamin supplements throughout their Covid-19 infection period and even while suffering from post-Covid symptoms. No significant difference was found among the severity of post-Covid symptoms in males and females with or without vitamin intake ($p>0.05$). Therefore, whether vitamin D improves the conditions of patients of post-Covid conditions requires further research. The SARS-CoV-2 virus enters cells after the glycoprotein S (viral spike protein) binds to the ACE2 receptors of cells. This is followed by increased production of Th1 pro-inflammatory cytokines (cytokine storm), which can lead to further damage. Vitamin D works to inhibit cytokine storms and induces production of cathelicidin and defensin, which are proteins that reduce replication of the virus and promotes macrophage chemotaxis at the site of inflammation (Fiske et al, 2019). There is no harm in vitamin D intake after recovery, since it is well-established that it helps improve some symptoms such as pain, dizziness, limitations in taste and smell, etc. (Favas et al, 2020).

5.14 Impact of Gender & Age on Treatment Success:

49% of females and 51% of males reported that their conditions improved upon treatment. Among those who did not go for treatment or were inconsistent in treatment, 40.6% were females and 37.2% were males. No female respondent had to be re-hospitalized for post-Covid symptoms but 3 males were re-hospitalized. 2 of them were 50+ in age. No statistically significant difference was found among the genders in the 215 people who took treatment ($p>0.05$), although more males have shown improvement in symptoms compared to females. No significant difference was also found among the age groups who underwent treatment ($p>0.05$), with the 21-30 age group having the greatest number of respondents reporting improvement in symptoms.

5.15 Long Covid After 2 Months:

5.1% of the total study population were hospitalized for post-Covid symptoms, of which 3 had to be re-hospitalized due to deteriorating conditions. 233 respondents took treatment at home, and 77.7% noted improvement after 2 months. 100 respondents did not take any medication at all and incorporated lifestyle changes. 68% of them reported improved conditions. Difference between these groups were highly significant ($p=0.00016$), suggesting that treatment indeed helps manage post-Covid symptoms better. Those who treated their symptoms at home showed more improvement than those who did not take medication.

Out of the total study population, 0.85% reported symptoms getting worse, meaning their long Covid conditions may be deteriorating. 2.8% respondents got re-infected with Covid-19, which is alarming. 74.9% in total reported improvement in conditions. We can assume that those who reported no improvement or were not sure of improvement (21.3%) may be suffering from long Covid. In each case, no significant difference was found among the genders ($p>0.05$), although interestingly, a greater number of females showed improvement of symptoms than males. Further research is necessary to determine whether females recover quicker than males.

Chapter 6

Limitations of the Study

A major limitation of prevalence studies is the lack of a control population. This means that it is difficult to distinguish whether the post-Covid symptoms found in this study were specifically due to Covid-19 or by other causes. There may be sampling bias that could lead to an overestimation of the prevalence of post-Covid symptoms, considering that younger patients who were willing to talk, answer questionnaires and report long-term symptoms were more likely to participate than those who continue to face stigma or are older with burdens of other diseases. This study may have underestimated prevalence of post-Covid symptoms due to selection bias, as there are many individuals in Dhaka who have tested positive for Covid-19 but refused to test negative after a few weeks. Although, these individuals have been excluded from this study, they may be facing post-Covid symptoms as well. Therefore, the study population is not randomized enough to represent the entire population suffering from post-Covid symptoms. Data from patients such as their ability to recall symptoms and describe their illness may have caused some bias. The statistical tests performed did not support the hypothesis of the study, most likely due to the relatively small sample size.

Chapter 7

Summary

This was a descriptive cross-sectional study conducted in BRAC University from July 2021 to September 2021. The aim was to find out the prevalence of post-Covid symptoms among Covid-19 survivors in Dhaka, as there is little knowledge about post-Covid symptoms in low and middle-income countries such as Bangladesh. As a result, the disease burden of Covid-19 is looming in the population and needs to be addressed effectively to improve quality of life and sustain economic progress, starting with the management and treatment of post-Covid symptoms.

351 individuals participated in this study, of which 55.8% were female and 44.2% were male. Majority of the respondents belonged to the 21-30 age group.

According to this study, we have found age to be a highly significant risk factor for Covid-19, but not necessarily for post-Covid symptoms. However, this study found a significant difference in the severity of post-Covid symptoms among males and females aged 40.

Various research has previously suggested the female sex as a risk factor for Covid-19. In this study, no significant difference between males and females was found in that regard. More males reported multiple post-Covid symptoms than females as well as severe symptoms, and more females reported mild to moderate post-Covid symptoms, the difference is not statistically insignificant.

Multiple studies noted that those working in the healthcare sector, emergency services, or who frequently went outside were more prone to severe post-Covid symptoms. This study corroborated such findings as well, with the highest prevalence of severe post-Covid symptoms found among emergency and healthcare workers. No significant difference was found between males and females. Therefore, occupation may be associated with post-Covid condition severity and may prolong the disease burden of Covid-19 in the country.

BMI is an established risk factor for Covid-19 as well as long Covid. In this study, we found significant differences between underweight and overweight males and females with regard to the severity of post-Covid symptoms. More underweight males suffer from severe post-Covid symptoms than females, but more overweight females suffered from severe post-Covid symptoms than males.

This study found no significant association between smoking habits and severity of post-Covid symptoms, and no statistically relevant difference between males and females either.

345 respondents mentioned at least 1 comorbidity. Major comorbidities include allergies, cardiovascular disease, chronic respiratory issues such as asthma, diabetes, hormone issues, and mental health problems. Although, these are established risk factors for Covid-19, this study found no association between the identified comorbidities and severity of post-Covid symptoms. No statistically significant association was found between number of pre-existing conditions and post-Covid severity. However, patients having chronic kidney disease may be more likely to face severe post-Covid symptoms as reported by regression analysis.

This study found a highly significant association between the severity of Covid-19 and severity of post-Covid symptoms both in males and females.

Although the first, second, and third waves of the pandemic were caused primarily by the Alpha, Beta, and Delta variants of SARS-CoV-2 respectively, we found no significant association between time of infection and severity of post-Covid symptoms. Most of the severe cases were from the second wave. Females infected during the first wave reported more severe post-Covid symptoms, but males during the second and third waves reported more severe post-Covid symptoms. However, the difference between the sexes were found to be insignificant in each time of infection. This study found that the average number of individuals with post-Covid symptoms were highest during the second wave. No significant difference between the time waves was established with respect to the mean number of individuals with post-Covid symptoms.

This study noted that there is a significant association between duration of Covid-19 infection and severity of post-Covid symptoms. Severe Covid-19 cases tended to have severe post-Covid symptoms, but the difference between males and females was not significant.

Through this study, fatigue, short or long-term memory and concentration loss, PTSD and other mental health issues, body pain, migraine-like headaches, tremors, extreme hair fall, sleep disturbances, limitation in taste and smell, and loss of appetite were found to majorly prevalent post-Covid symptoms. Majority of the study population reported moderate post-Covid symptoms, with the incidence higher in males. However, overall the difference between the sexes were found to be not significant.

Through this study it was identified that the type of treatment has a significant impact on the improvement of symptoms. Medication is far more likely to succeed compared to only lifestyle changes. There was no significant association found between vitamin supplements and severity of post-Covid symptoms, although vitamin D works wonders to reduce Covid-19 symptoms. While light exercise, vitamin D supplements, and change in diet are suggested by researchers, medication works best. A combination of medication and change in lifestyle should be able to reduce the disease burden of Covid-19 significantly after recovery.

More males have shown improvement than females with treatment of post-Covid symptoms. However, this study found no significant difference among the 215 males and females who took medication and successfully improved post-Covid conditions. No significant difference was found among the age groups either, although the 21-30 age group reported the most improvement in conditions.

Lastly, this study noted a highly significant difference between the post-Covid status of those who have been re-hospitalized, those who have taken medication and those who did not take medication 2 months after testing negative for Covid-19. Those who took medication at home showed more improvement than those who did not. 2.8% managed to get re-infected with Covid-19, most likely due to vaccination. 21.3% reported conditions to be not improving, which means they are most likely suffering from long Covid. No significant difference was found between the sexes, although interestingly more females mentioned improvement of conditions than males.

Chapter 8

Recommendation

This study recommends urgent medical, psychological, and social support to Covid survivors for improvement in their quality of life, particularly survivors working in the healthcare and emergency sectors. This will help alleviate the disease burden of Covid-19 in the country and help healthcare facilities to be more capable of managing patients in the future. By identifying prevalence of post-Covid symptoms and associated risk factors, it is possible to provide more personalized healthcare to Covid survivors. This study recommends that each survivor is dealt with uniquely, with patience and empathy. Re-infection with Covid-19 due to vaccination or other issues is an alarming concern. Long Covid after 2 months can seriously hamper the quality of life for Covid survivors. Therefore, routine follow-up is necessary to reduce re-infections, re-hospitalizations, and overwhelming healthcare facilities.

Through this study, age, occupation, BMI, severity of Covid-19 infection, and duration of the disease, lack of medication, were found to be associated with severe post-Covid symptoms. These factors are already established risk factors for Covid-19 and post-Covid symptoms. Yet, further research with larger sample sizes is necessary to understand long Covid better.

Gender, smoking habits, comorbidities, time of infection, and vitamin supplementation did not show any significant association with the severity of post-Covid symptoms. Larger sample sizes and research in multiple centers may produce more robust results. This study details that 74.9% found improvement in post-Covid conditions 2 months later, but 21.3% were still suffering from long Covid. The difference being statistically different, demands further research in larger populations and multiple centers.

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