Exploring the Prevalence and Impact of Post-COVID Symptoms Among Individuals with Chronic Obstructive Pulmonary Disease

by

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ABSTRACT

Background: Chronic Obstructive Pulmonary Disease (COPD) affects about 300 to 400 million individuals worldwide and has been linked to severe outcomes of COVID-19. About 10% to 30% of individuals who have COVID-19 develop post-COVID symptoms (PCS). COPD is associated with more severe cases of COVID-19 and severe COVID-19 is a known risk factor for PCS. It is possible that individuals with COPD have a higher likelihood of developing PCS. However, the prevalence and impact of PCS in individuals with COPD remains unclear.

Objectives: To explore the prevalence of PCS in COPD, assess the impact of post COVID condition on symptoms, physical activity level (PAL), health-related quality of life (HRQoL), and the use of healthcare services (UHcS) among COPD individuals, and to explore the differences in these variables between COPD individuals with and without PCS.

Methods: This cross-sectional study used a patient-reported online survey that incorporated standardized assessment instrument and collected sociodemographic data among Manitoba adult residents. Recruitment was conducted through multiple channels, including social media platforms (Facebook, and Instagram), online support groups/communities, walk-in clinics, pharmacies, community centers and senior facilities.

Results: Seventy-eight individuals with COPD were included, half were females with age range between 60-69 years (48.4%), residing in urban areas (75.9%). The prevalence of PCS in our group of participants with COPD was 91.3% (n=63). The most reported PCS were cough (78.0%), joint pain (76.2%), muscle weakness (75.6%), shortness of breath at rest (73.9%), fatigue at rest (75.5%) and on exertion (72.7%). There was a statistically significant negative impact of PCS on PAL (p = 0.011), and HRQoL, with worsening observed across all EQ-5D-5L domains (mobility (p=

0.016), self-care ($p < 0.001$), usual activities ($p < 0.001$), pain/discomfort ($p < 0.001$), anxious/depression ($p < 0.001$)), and in COPD Assessment Test (CAT) ($p < 0.001$) when comparing now to before COVID-19. Utilization of most healthcare services and providers increased significantly post COVID (Specialist $p= 0.020$, Respiratory therapist $p=0.021$, Physical therapist $p< 0.001$, Occupational therapist $p= 0.004$, Psychologist $p= 0.011$, Social worker $p= 0.004$, Hospitalization $p< 0.001$), except for primary ($p= 0.414$) and urgent care visits ($p= 0.083$). We found greater decline on HRQoL among COPD individuals with PCS in 4 domains (mobility, selfcare, pain/discomfort, anxiety/depression) of the EQ-5D-5L and CAT scores but not in PAL, usual activity domain, EuroQol Visual Analogue Scale (EQ-VAS) and UHcS compared to those without PCS.

Conclusion: COPD individuals with PCS reported a substantial burden of persistent symptoms, marked decline in PAL, reduce in HRQoL and increased use of several health care services. However, these findings should be interpreted with caution due to study limitations and are therefore considered exploratory rather than conclusive. Nevertheless, these results offer valuable insights to guide the development of safe and effective rehabilitation intervention, and to inform the planning of tailored services to meet the specific needs of this patient group.

Keywords: Chronic Obstructive Pulmonary Disease, Post COVID Symptoms, Physical Activity Level, Health-Related Quality of Life, Use of Healthcare Services, COPD Assessment Test.

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LIST OF ABBREVIATIONS

CAT- COPD Assessment Test

COPD- Chronic Obstructive Pulmonary Disease

GOLD- Global Initiative for Chronic Obstructive Lung Disease

HRQoL- Health-Related Quality of Life

LCQ- Leicester Cough Questionnaire

NASEM- National Academies of Sciences, Engineering, and Medicine

PAL-Physical Activity Level

PASC- Post Acute Sequelae of COVID-19

PCS- Post-COVID Symptoms

PFT- Pulmonary Function Test

SARS-CoV 2- Severe Acute Respiratory Syndrome Coronavirus 2

UHcS- Use of Healthcare Service

WHO- World Health Organization

1. INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a significant health condition characterized by recurring respiratory symptoms and restricted airflow due to inflammation and abnormalities in the airway (1). It is a major cause of chronic morbidity and mortality globally and the third main cause of preventable death (2). This condition affects around 10% of the population in affluent countries (3), with approximately 300 to 400 million individuals impacted worldwide (4). In Canada across nine cities, it was estimated that about 8.6% and 6.4% of the population had COPD severity I and II, respectively in 2021 (5). COPD symptoms (e.g., breathlessness, cough, dyspnea, and excessive production of sputum) (6) and decreased lung function may significantly impact a patient's quality of life (7). Individuals with COPD may experience a severe acute form of the SARS-CoV-2 infection, resulting in an elevated rate of hospital admissions and mortality, and the survivors could be at risk of experiencing persistent symptoms (8,9).

Evidence indicates that the effect of SARS-CoV-2 could persist beyond the initial viral infection causing post-COVID symptoms (PCS), also known as long COVID or post-acute sequelae of COVID-19, defined as “an infection-associated chronic condition that occurs after SARS-CoV-2 infection and is present for at least 3 months as a continuous, relapsing and remitting, or progressive disease state that affects one or more organ systems” (10). Approximately 10% to 30% of individuals who have COVID-19 develop PCS, and this prevalence may increase to 50% among those who have been hospitalized due to severe COVID-19 (11). This condition affects multiple body systems resulting in fatigue, muscle weakness, angina pectoris, anxiety, depression, and impaired cognition (12). Respiratory problems, including shortness of breath and

cough, are also prevalent in individuals with PCS, persisting for at least seven months in 40% and 20% of cases, respectively (13). However, only a few studies have reported PCS symptoms in individuals with respiratory or airway diseases (3,9,12).

Although PCS may occur irrespective of disease severity, it is more prevalent in those who have moderate to severe COVID-19 infection (15). The presence of respiratory diseases, particularly COPD, was shown to be linked to severe outcomes of COVID-19 (16). Since COPD is associated with the severity of COVID-19 and severe COVID-19 is one of the factors associated with PCS, it is possible that individuals with COPD have a higher likelihood of developing PCS. However, the prevalence of PCS among individuals with COPD and its impact on patient's physical activity level (PAL), health-related quality of life (HRQoL), and the use of healthcare services (UHcS) has not been reported. Therefore, it is essential to explore the prevalence and impact of PCS in individuals with COPD.

2. LITERATURE REVIEW

2.1 Chronic Obstructive Pulmonary Disease (COPD)

The Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2023 defines COPD as a "heterogeneous lung condition characterized by chronic respiratory symptoms (dyspnea, cough, expectoration, and exacerbations) due to abnormalities of the airways and/or alveoli that cause persistent, often progressive, airflow obstruction" (17). This disease can manifest as either chronic bronchitis (identified by persistent coughs and excessive production of sputum) or emphysema, which is recognized by severe breathlessness due to enlarged lung air spaces and

damage. The severity of COPD exacerbations may worsen as the illness progresses, potentially leading to life-threatening outcomes (18).

2.1.1 Epidemiology of COPD

The global prevalence of COPD varies around 12% in the overall population (19). It is ranked as the 12th highest cause of years of life lost and the eighth highest cause of years lived with disability worldwide (19). Currently, COPD stands as the third leading cause of mortality worldwide, resulting in three million deaths, just behind cardiovascular diseases (CVDs) and cancer. Statistics Canada reported that a total of 92,597 Manitoba residents had COPD in 2019/2020, accounting for about 12.4 % of adults aged 35 and above. The prevalence of COPD was notably higher among residents of the Northern Health Region compared to other parts of Manitoba (20). Among randomly selected Vancouver residents aged 40 and older, the prevalence of COPD was estimated to be 19%, with 8% having moderate-to-severe COPD. In Ontario, 21% of primary care individuals aged 40 or older with a smoking history had a COPD confirmed by pulmonary function testing (21). The lifetime risk of developing COPD is over 1 in 4 (27.6%), with males facing a higher risk (29.7%) compared to females (25.6%) (22). Overall, COPD affects a large number of Canadians and contribute to a growing number of hospital admissions each year, imposing a significant burden on the Canadian health system (23,24). In 2017, the Canadian Institute for Health Information estimated that COPD-related hospitalization cost the system approximately $1.5 billion per year (25).

According to the Global Burden of Disease Study, the age-standardized mortality rate of COPD has declined from 74.8 per 100,000 in 1990 to 50.7 per 100,000 in 2013 (19). However, predictions indicate that the global prevalence of COPD will increase in the next four decades,

potentially leading to an annual death toll surpassing 5.4 million by 2060 (17). While the overall mortality rate for COPD is still greater in males worldwide, there has been a noticeable increase in mortality among females. This increase may be attributed to the evolving trends in smoking prevalence between males and females over recent decades (26).

2.1.2 Pathophysiology of COPD

Upon inhalation of an irritant, the epithelium in the airway makes repeated efforts to safeguard itself and restore the damage caused by the harmful substance (27). A process better understood with a basic knowledge of lung anatomy in comprehending the disease course. The respiratory system is anatomically separated into the upper and lower airway/pulmonary tracts, each serving distinct functions. The upper airways are moistened and cleared of trapped particles by the circulation of mucus generated by goblet cells, while the lower airways comprise the tracheobronchial tree that originates from the trachea and extends to the alveoli, essential for the process of air conduction, distribution and efficient gas exchange in the lungs, of which are critical for maintaining respiratory health (28).

The primary location of obstruction in COPD is the peripheral airways, particularly in the smaller conducting airways, such as bronchi and bronchioles (29). The airways in COPD are constricted to a diameter of less than 2 mm, which may lead to decreased forced expiratory flow, with smoke inhalation causing degradation of alveolar support and changes in elastin recoil of the peripheral airways. This results in reduced elastic pressure (29), along with excessive production of mucus, which is responsible for the obstruction of the airway passage (30). Additionally, there is an influx of many types of immune cells in the lungs (e.g., neutrophils, macrophages, CD8+ T lymphocytes, and B cells) (31), which may produce inflammatory mediators when triggered by

tobacco smoke that contributes to the development of this disease. Furthermore, increased oxidative stress, disruption in the protease–antiprotease balance (increased protease production and decreased antiprotease levels), increased programmed cell death, and profibrotic conditions in the lower airways are the mechanisms underlying the persistent inflammation and lung damage associated with COPD (32,33).

2.1.3 Symptoms of COPD

The daily burden of this disease is defined by a variety of symptoms and its impact on the patient's life. Dyspnea is the primary symptom of COPD, other predominant symptoms include cough, sputum production, wheezing, chest tightness, and chest congestion. However, the frequency of symptoms reported varies based on the specific patient characteristics and the severity of the condition (34). For instance, cough has been identified as the predominant symptom in people with moderate COPD, affecting 90% of cases. Individuals with COPD have indicated that mornings are the most symptomatic time of day, characterized by increased cough and sputum production (35).

There is a growing body of evidence indicating that the collective burden of COPD symptoms (such as cough, sputum production, wheezing, and chest tightness) significantly impairs health status, quality of life, and daily functioning. Additionally, these symptoms contribute to increased levels of anxiety and depression, increased susceptibility to exacerbations, and a poorer prognosis of the disease (36,37).

2.1.4 Risk factors for COPD

The development of COPD is influenced by a combination of genetic and environmental factors. Cigarette smoking is the primary environmental risk factor associated with COPD (38), which is responsible for 15% of the development of this condition, particularly in high-income nations. However, in low-income countries, the majority of COPD individuals are non-smokers, females, and older adults (39). Yang et al. identified several risk factors in individuals who have never smoked, which include exposure to biomass smoke within the household, outdoor air pollution, job-related exposure to dust and fumes, poorly controlled asthma, second-hand smoke, a history of pulmonary tuberculosis, persistent respiratory tract infections, and low socioeconomic status. Notably, these non-smoking related factors have a greater impact on females due to house hold air pollution and occupational environments (40). Although gene mutations, causing alpha 1-antitrypsin deficiency, are the most significant genetic risk factor for COPD, other genetic variations linked to decreased lung function may also contribute to an increase in the risk of COPD (34).

2.1.5 Diagnosis and Investigation of COPD

COPD may be diagnosed by the pulmonary function test, along with relevant history and physical examination (41,42). A study showed that only 32% of individuals who were newly diagnosed with COPD had undergone spirometry to officially confirm their diagnosis (43). Spirometry is a common type of pulmonary function test that measures the ability to inhale and exhale air from the lungs over a period of time, done in a standard sitting position; it measures the decrease in forced vital capacity (FVC) caused by air trapping, and an alteration in forced expiratory volume in the first second (FEV_1) (42). A post-bronchodilator FEV_1/FVC ratio of less

than 0.7 is often used as a diagnostic criterion for COPD. The GOLD approach classifies airflow restriction, also known as COPD severity, into four stages: mild (stage 1) when the $FEV_1 \geq 80\%$ of the predicted value, moderate (stage 2) if the FEV_1 is between 50% and 79% of the predicted value, severe (stage 3) if the FEV_1 is between 30% and 49% of the predicted value, and extremely severe (stage 4) if the $FEV_1 < 30\%$ of the predicted value (44).

Nevertheless, COPD continues to be often undiagnosed and incorrectly diagnosed. A research survey revealed that more than 70% of individuals who showed signs of chronic airway obstruction on spirometry testing did not get a medical diagnosis (45). A potential limitation is that some individuals with COPD may underestimate their symptoms due to the avoidance of activities, which may trigger symptoms, or their tendency to attach symptoms to physical deconditioning or advanced age.

2.1.6 Effects of COPD on Physical Activity

The ability to engage in physical activity is consistently linked to clinical and functional factors of COPD, such as dyspnea, quality of life, and exercise capacity (46). Symptoms of COPD have been observed to significantly contribute to reducing individuals' physical activity level (PAL), regardless of the time of day (34). Individuals with COPD have reported that various daily activities, such as climbing stairs, doing household chores, shopping, and participating in sports and hobbies, are significantly affected by their symptoms.

Additionally, morning-specific activities like washing, dressing, and getting out of bed can also be significantly impaired in individuals with COPD. In some cases, individuals may require assistance to complete these tasks, this need for support can contribute to the feelings of being a

burden on others (47,48). COPD individuals commonly begin to reduce their PAL at an early stage of the illness to prevent symptoms like breathlessness (49). However, it is crucial to maintain regular physical activity in these individuals, since it is associated with improved disease prognosis and lower rates of hospitalization and mortality (50,51).

2.1.7 Effects of COPD on Health-Related Quality of Life (HRQoL)

Scientific evidence indicates that individuals with COPD who encounter symptoms in the early morning and at night are much more prone to have significantly lower HRQoL than those without these symptom pattern (48,52). In addition, 1-year follow-up data from a multicenter study involving 791 individuals with COPD revealed that a decline in HRQoL was linked to significant increase in COPD-related respiratory symptoms, such as difficulty breathing, coughing, and production of phlegm (36).

An analysis of survey responses from 1100 individuals diagnosed with COPD revealed that the symptoms with the most significant negative effect on overall well-being were coughing (42%), difficulty breathing (37%), fatigue (37%), and increased production of sputum (35%) (53). Two studies conducted in primary care confirmed that HRQoL was significantly compromised in all stages of COPD, even among those with mild airway obstruction. COPD symptoms prevalent throughout the 24-hour period (including night-time, early morning, and daytime) found to be closely associated with poorer HRQoL, increased dyspnea, lower physical activity, reduced sleep quality, and increased anxiety and depression (34,54).

2.1.8 Effect of COPD on the Use of Healthcare Services

There is a significant utilization of healthcare services by individuals with COPD, which imposes a substantial burden on healthcare systems. In the United States, COPD accounts for approximately 1 million hospitalizations and 27 million visits to doctors' offices annually, with associated costs ranging from $21 to 25 billion (55). In Ontario, Canada, individuals with COPD similarly demonstrated high rates of healthcare use, representing approximately 20% of all healthcare services used. They accounted for 24% of hospital admissions and emergency department (ED) visits and 18.8% were readmitted to the ED within 30 days in 2013. The projected rise in COPD prevalence is expected to place an increasing strain on healthcare system in Canada and globally (55).

2.1.9 Cigarette Smoking and Risk of COVID-19 Infection in COPD

Cigarette smoking is the predominant environmental (lifestyle) risk factor for COPD, accounting for 80-90% of cases. A study examining the effects of aging and smoking duration on COPD severity reported that 15% to 50% of individuals who smoked developed COPD, and 80% to 90% of those diagnosed with COPD are either current or former smokers (56). The pathophysiological process by which smoking results in the development of COPD can be attributed to oxidative stress, inflammation and structural damage to the lungs, as the inhalation of cigarette smoke introduces reactive oxygen species and toxic chemicals into the airways. This processes leads to alveolar wall destruction and small airway remodeling, including fibrosis and goblet cell hyperplasia, which collectively contribute to a progressive airflow limitation (57).

According to WHO, individuals who smoke cigarettes have an increased susceptibility to SARS-CoV-2 infection due to the frequent contact between their hands and face when smoking, and sharing of smoking products/devices as these activities might potentially facilitate the entrance of the virus (58). Moreover, evidence has shown that smoking is strongly associated with the adverse development and severe outcomes of COVID-19 (16,59). An analysis conducted on individuals with COVID-19 revealed that 12.7% of those who smoked either died or had a severe medical illness, compared to 4.7% of those who have never smoked (60). Furthermore, the proportion of individuals who were ever-smokers was higher in severe (16.9%) compared with mild cases (11.8%) (61).

2.1.10 Impact of COVID-19 on COPD

COVID-19 has a wide range of clinical presentations, from no symptoms to severe illness, respiratory failure, and death (62). SARS-CoV-2 enters through the nasal passage and attaches to the angiotensin-converting enzyme 2 (ACE2) in cells lining the airways and utilizes it as a receptor. Cell invasion needs the presence of the transmembrane protease responsible for activating the SARS-CoV-2 spike protein (62). This elucidates why respiratory symptoms, such as runny nose, loss of smell, cough, and difficulty breathing, are the most prevalent in COVID-19, independent of whether they are accompanied by fever, fatigue, muscle pain, or diarrhea (62). Pre-existing medical conditions, such as cancer, cardiovascular disease, diabetes, obesity, and COPD, worsen the effects of COVID-19 (63).

COPD has been recognized as a risk factor for more severe cases of COVID-19 and unfavorable outcomes (64). Individuals diagnosed with both COPD and COVID-19 have a higher probability of experiencing severe pneumonia, acute respiratory distress syndrome,

bacterial/fungal infection, and septic shock (8). Consequently, they are more likely to require healthcare services, such as hospitalization, admission to the ICU, mechanical ventilation, and experience greater risk of mortality (8,65). The prevalence of COPD among COVID-19 patients admitted to hospitals and ICUs, ranges from 0% to 10% and 4% to 38% worldwide, respectively (8). This variation may be attributed to either under- or over-reporting of the condition.

A study showed that the majority of people with COPD and COVID-19 are males who have a history of heavy smoking and a higher prevalence of pre-existing medical conditions compared to those with asthma but without COPD (61). This phenomenon may be partly attributed to the heightened expression of ACE-2 seen in the bronchial epithelial cells of people with COPD, compared to those without the condition. A study found comparable outcomes in those who now smoke and those who have never smoked or quit smoking, suggesting a correlation between ACE-2 expression and exposure to cigarette smoke (8). It has been shown that individuals with COPD are more prone to a heightened susceptibility to COVID-19. This increased risk remains significant, regardless of the individual's age or other frequent comorbidities (66).

2.2 Post-COVID Symptoms (PCS)

Some individuals who have recovered from the COVID-19 infectious period have persistent or newly emerging symptoms for many weeks or even months. This condition is referred to as PCS, long COVID, or post-acute COVID syndrome. WHO defines PCS as symptoms that arise around 3 months after the first onset of the disease, persist for at least 2 months, and cannot be attributed to any other diagnosis (67). The condition may manifest as continuous or intermittent periods of relapse and remission (68), accompanied by the persistence or emergence of one or more symptoms. Most individuals with PCS test negative for polymerase chain reaction indicating

that they have recovered microbiologically but maybe not clinically, hence the reason for experiencing PCS (69).

2.2.1 Epidemiology of PCS

The prevalence of PCS varies depending on several factors, such as demographic characteristics and the criteria used to identify cases (11). Statistics Canada found that about 14.8% of Canadians reported experiencing symptoms suggestive of PCS for at least three months after COVID-19 infection (70). A descriptive analysis of PCS in an urban Canadian cohort revealed that 27% of participants had this condition, with in-patients exhibiting a higher prevalence rate. Both inpatients and outpatients were significantly affected along with those who managed their acute phase at home (71). As of June 2022, the United States Centres for Disease Control and Prevention reported that 1 in 5 individuals who had COVID-19 experienced PCS (72). Conversely, in the UK, it was estimated that nearly 2 million individuals, or 2.8% of the entire population aged 2 years and older have experienced PCS defined as "symptoms persisting for more than four weeks after the first suspected coronavirus (COVID-19) infection that were not explained by something else" (73).

2.2.2 Risk factors of PCS

Certain individual characteristics have been linked to the development of PCS. Females are twice as likely to experience PCS compared to males (68), and advanced age has also been identified as a contributing factor. Other factors associated with a higher risk of PCS include the presence of more than five symptoms during the acute stage of the COVID-19 infection (74) and pre-existing conditions such as type 2 diabetes, reactivation of Epstein-Barr virus, the pre-existence of specific autoantibodies (75), connective tissue disorders (76), attention deficit

hyperactivity disorder, chronic urticaria, and allergic rhinitis (77). However, approximately one-third of individuals with PCS may not present any known pre-existing conditions (77). Specific ethnicities, like those of Latino or Hispanic origin, have been shown to have a greater prevalence of PCS (72). However, the role of disease severity is not clear, as even individuals with minor symptoms during the first manifestation have been observed to experience long-term effects of COVID-19(78).

2.2.3 Post-COVID Symptoms (PCS)

PCS has been associated with over 200 reported symptoms; however, the most frequently reported by affected individuals include severe exhaustion or fatigue, difficulty breathing, persistent cough, chest discomfort, irregular heartbeat, headache, joint discomfort, muscle pain and weakness, insomnia, tingling sensations, diarrhea, skin rash or hair loss, impaired coordination and movement, and cognitive problems (memory and concentration difficulties) (79). Recent studies have reported two main symptom patterns in individuals with PCS; the first is fatigue, headache, sore throat, and upper respiratory issues (shortness of breath, persistent cough, and loss of smell), whereas the second is multi-system complaints that involve ongoing fever and gastroenterological symptoms (74). Individuals who experience fatigue are more likely to be diagnosed with depression or anxiety, particularly among females (80).

2.2.4 Pathophysiology of PCS

The persistence of symptoms can be attributed to several reasons, including the consequences of organ damage, the severity of injury to organs, persistence of chronic

inflammation during the recovery phase, immune responses or autoantibodies, virus persistence, the non-specific effects of hospitalization, the consequences of critical illness, post-intensive care syndrome, complications related to COVID-19 infection, complications related to pre-existing health conditions, and adverse effects of medications used (81). The persistence of SARS-CoV-2 infection may arise from prolonged viremia in individuals with impaired immune systems and recurrent infection (81).

2.2.5 PCS and its relation to systemic damage

Despite SARS-CoV-2 entering the body through the nose and was initially thought to be a respiratory disease, it is found that the virus may also affect other systems (13). Although the mechanism is not fully understood, it has been suggested that the harm seen in different body systems may not be due to viral infection of cells but rather to an immune-mediated response and persistent inflammation:

Circulatory system

Acute COVID-19 and post-COVID syndrome may contribute to thrombosis through the formation of micro-clots (82). In addition, alterations in blood cell size and stiffness, which can impair oxygen transport, have also been linked to PCS (83). Supporting this, a study comparing individuals with PCS with healthy controls identified a persistent reduction in vascular density, particularly in small capillaries, even 18months after COVID-19 infection (84). This microvascular impairment is further reflected in retinal circulation, as decreased retinal microcirculation, and retinal organoids have shown to be susceptible to SARS-CoV-2 infection and replication (85).

Nervous system

Sensorimotor symptoms, impaired memory, intellectual disability, paresthesia, dizziness, balance disorders, sensitivity to light and noise, loss of smell or taste, and dysfunction of the autonomic nervous system are some of the neurological and cognitive symptoms of PCS that may have a significant influence on everyday life (86). Based on a report of over 1.3 million people infected with COVID-19, mental health conditions like anxiety and depression returned to their baselines over time. Still, higher risks of cognitive dysfunction, epileptic events, Alzheimer's disease, psychosis, and other neurocognitive diseases persisted for up to 2 years after SARS-CoV-2 infection (87). Also, loss of corneal tiny nerve fibers, a rise in dendritic cell density, and drastic changes in pupillary light reactions have all been linked to PCS (88).

Respiratory system

The most prevalent respiratory symptoms, cough and shortness of breath, persisted for a minimum of seven months in 40% and 20% of individuals with PCS, respectively (14). Pulmonary abnormalities, such as air entrapment and lung perfusion issues, have been detected in imaging investigations of non-hospitalized PCS patients (89). Apoptosis and epithelial injury were observed in the airway in a study conducted 3 to 6 months after infection, but not in the bloodstream (90). Another study of individuals with PCS revealed the presence of reduced pulmonary function, systemic inflammation, and SARS-CoV-2 specific T cells compared to those who had recovered from COVID-19 (91).

2.3 Rationale for the Study

COPD is a highly prevalent respiratory disorder characterized by chronic airflow restriction, a high burden of symptoms, and decreased quality of life (1). COVID-19 mainly affects the respiratory system and can exacerbate pre-existing lung conditions, such as COPD (13). The functional status and quality of life of about 144 million individuals globally are significantly affected by the persistent, episodic, and complex symptoms of COVID-19, leading to the increasing global burden of PCS (92). COVID-19 severity and clinical outcomes may be worse in individuals with COPD (93). Therefore, the co-existence of COPD and PCS may worsen the individual's well-being, particularly PAL and HRQoL, and increase their use of health care services. However, these associations have not been determined, hence the need to explore the prevalence and impact of PCS among individuals with COPD.

2.4 General Objective of the Study

The general objective was to explore the prevalence and impact of PCS among individuals with pre-existing COPD.

2.5 Specific Objectives of the Study

The specific objectives of the study were to explore:

1) The prevalence of Post COVID-19 Symptoms (PCS) in COPD.
2) Post COVID-19 Symptoms in individuals with COPD.
3) The impact of PCS on physical activity level among individuals with COPD.
4) The impact of PCS on the health-related quality of life among individuals with COPD.
5) The impact of PCS on the use of healthcare service among individuals with COPD.

6) Differences in symptoms, physical activity level, health-related quality of life, and use of healthcare service among individuals with COPD with and without PCS.

2.6. Hypotheses

We hypothesize that:

1) Individuals with COPD may have a higher prevalence of PCS compared to that reported in the literature for the general population.

2) Individuals with COPD and PCS may experience a high prevalence of respiratory symptoms.

3) PCS may contribute to reduced PAL in individuals with COPD.

4) PCS may contribute to reduced HRQoL in individuals with COPD.

5) PCS may lead to increased UHcS in individuals with COPD.

6) There might be significant differences between COPD individuals with and without PCS in relation to their COVID-19 symptoms, PAL, HRQoL, and the UHcS. Specifically, COPD individuals with PCS may have more COVID-19 symptoms, lower PAL, lower HRQoL, and higher UHcS compared with those without PCS.

3. METHODS AND MATERIALS

3.1 Methods

3.1.1 Ethical Consideration

This study was approved by the Health Research Ethics Board of the University of Manitoba Bannatyne campus on November 5th, 2024, with ethics number HS26584 (H2024:243). Informed consent was obtained from all participants, as they decided to continue with the survey after reading a clear explanation of the study's purpose and procedures (See appendix 2).

3.1.2 Research Design

A cross-sectional design was used in this study.

3.1.3 Sampling Technique

A convenience sampling was used.

3.1.4 Sample Size

The sample size was determined using the equation below:

$$n = Z^2 \frac{pq}{d^2} \quad (94)$$

Where:

n=sample size to be determined

d= 0.05 (desired level of precision 5% corresponding to effect size)

Z^2= 1.96 (Z score)

p= prevalence of diagnosed COPD individuals in Manitoba (12.4%) in 2019/2020 (20), which is the latest estimation available

q= 1-p= 1- 0.124 (0.876)

$$n=1.96^2 \frac{(0.124)\,(0.876)}{0.05^2}$$

n= 166.9

n= 167

3.2 Participants

3.2.1 Inclusion Criteria

We included:

- Manitoba adult residents who were willing to participate in the study
- Individuals with a diagnosis of COPD
- Individuals who have had COVID-19

3.2.2 Exclusion Criteria

The exclusion criteria for this study were:

- Individuals who cannot understand or provide informed consent in English language
- Individuals that do not meet the inclusion criteria

3.2.3 Participant Recruitment

COPD participants were recruited using a multi-channel strategy aimed at reaching a diverse sample. Digital recruitment was conducted via social media platforms including Facebook

and Instagram, utilizing both organic posts and paid advertisements to enhance the poster's visibility to reach a larger audience. Each post had a direct link to the online survey via a URL (https://www. respirabilitylab.com/participate) and scannable barcodes (see appendix 4). Recruitment was further supported through COPD-related online patient support groups/ communities such as Manitoba Lung Association platforms, Manitoba Quits, COPD/COAD Support, COPD Awareness, COPD Christians and Long COVID Support Group. In addition to the digital outreach, printed flyers with the same survey access were disseminated to various physical locations, including several community centers, private healthcare clinics, pharmacies, senior facilities, and local healthcare providers to increase recruitment among participants who are not part of any of the above-mentioned platforms (see appendix 3).

3.2.4 Procedure for Data Collection

Data collection occurred over a period of 18 weeks from January 9th- May 9th, 2025, using a patient-reported online survey that included validated assessment instruments and sociodemographic variables. The survey was administered via the secure Research Electronic Data Capture (REDCap) platform. Before formally initiating data collection, there was pilot testing with about seven English fluent-speaking adults to identify any potential issues (e.g., ambiguous or confusing questions, response options, or technical glitches). Subsequently, it was revised based on feedback to ensure clarity, comprehensibility, and accuracy.

3.2.5 Participation Incentive

Participants who completed the survey were given the option to enter a raffle for a $50 VISA gift card. Of those, 23 participants chose to participate, and a random winner was selected using an online number picker wheel.

3.3 Materials/ Instrument

3.3.1 Data collection instrument

Demographic information

Questions were asked about the participant's sex with response options including male, female, prefer not to say. Age was categorized from 18 to 70 years and above, and respondents were asked to indicate their living condition either rural or urban setting, along with their current employment status. Smoking history was assessed to identify current or past smoking behaviour. Additionally, participants were also asked to indicate any existing comorbidities apart from COPD.

COVID-19 Symptoms

Information on COVID-19 and PCS were gathered using the format from the University of Buffalo Western New York Community-Based long COVID registry (United States). It consisted of 19 most common COVID-19 symptoms including fever, cough, fatigue at rest and on exertion, malaise, shortness of breath at rest and on exertion, and so on covering questions about their occurrence, duration, and current status (95).

Questions on the impact of cough on patient's quality of life was asked in this study using the Leicester Cough Questionnaire (LCQ), a reliable cough-specific instrument designed to assess the influence of cough on an individual's quality of life. It demonstrates good construct validity and test-retest reliability, and has been effectively applied in individuals with COPD (96). It consists of 19 questions about the impact of cough on physical, psychological, and social well-being. The scoring system assigns a value of 1 (highest impact) to 7 (lowest impact) to each question. An average score was produced for each domain; physical (eight items), psychological (seven items), and social (four items), with the three domains summed up to give a total score

ranging from 3 to 21, categorized as severe (3.00- 12.28), moderate (12.29- 17.53) and mild (17.54-21.00). The greater the score, the less the impact (97).

Physical Activity Level (PAL)

The International Physical Activity Questionnaire (IPAQ) was used to assess PAL in this study. It is a questionnaire designed to assess physical activity in many cultural regions worldwide that has shown acceptable reliability with its short version consisted of nine questions that recall physical activity over the past 7 days. The questionnaire covered four domains of physical activity: leisure time, domestic activities, work-related activities, and transport-related activities. PAL is expressed in MET min/week and physical activity category score. Within each domain were four types of physical activity: sitting (0.0 MET), walking (3.3 METs), moderate-intensity activities (4.0 METs), and vigorous-intensity activities (8.0 METs). For the scoring, high (health enhancing physical activity- HEPA active) PAL represented vigorous-intensity activities for at least 3 days achieving a minimum of at least 1500 MET min/week, and/or 7 or more days of any combination of walking or moderate-intensity activities or vigorous-intensity activities, achieving a minimum of at least 3000 MET min/week. Moderate (minimally active) PAL was regarded as 3 or more days of vigorous-intensity of at least 20 mins per day and/or walking at least 30 mins per day and/or 5 or more days of moderate intensity/walking, totally achieving a minimum of at least 600 MET min/week. Low (inactive) PAL was scored when the criteria for either moderate or high PAL were unmet (98). In this study, participants were asked the frequency they engaged in physical activities over the last 7 days and whether their current level of activity was the same, less or more compared to before COVID-19.

Health-Related Quality of Life (HRQoL)

The EuroQol- 5 Dimensions- 5 levels (EQ-5D-5L) is a valid, reliable and responsive instrument for measuring health-related quality of life in individuals with COPD. It evaluates their quality of life according to five domains (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) using a 5-point Likert scale. Scoring involved assigning a numerical value to each response level (with 1 indicating 'no problem' and 5 indicating an 'extreme problem'), a higher score reflects a poorer HRQoL (99,100). The total scores, known as the EQ-5D-5L index, could be calculated by converting the item scores using a value set specific to the Canadian population and ranges from -0.59 (worse than death) to 1.00 (optimum health) (101). Individuals also rated their health on a visual analog scale (EQ-VAS) that ranges from 0 (worst possible health) to 100 (best possible health). In this study, questions on the five domains and the EQ-VAS were asked for both currently and before they had COVID-19.

The COPD Assessment Test (CAT) is a brief, validated and disease-specific self-administered instrument consisting of eight items (cough, sputum, breathlessness, chest tightness, confidence, activity limitation, sleep, and energy levels). It is designed to assess the impact of COPD on a person's daily life and overall health status with high test-retest reliability and sensitive for interpreting clinical changes (102). The score for each item varied from 0 to 5, and the overall score from the eight areas ranged from 0 to 40 graded as low (0-10), medium (11-20), high (21-30), very high (31-40). Higher scores denote a more severe impact of COPD on the patient's life (103,104). This study asked participants to reflect on how they perceived the impact of COPD on their daily life and health, indicating if they experienced less, the same or more problems prior to COVID-19 compared to now.

Use of healthcare services

The use of healthcare services was assessed with the Resources Utilization Questionnaire (RUQ). It is a self-reported questionnaire initially developed to evaluate the expenses incurred by families of children (105). The instrument was also used in a study with hospitalized older adults. It encompasses direct healthcare resources, such as emergency room visits, hospitalizations, visits by healthcare practitioners (nurse practitioner, family practice physician, physician assistant, and therapists), home healthcare visits (nurses or other home care providers) (106). Questions on how often they use healthcare services both before and after they had COVID-19 were asked in this study. Participants were also asked to compare their current use of healthcare services to their usage before they had COVID-19.

3.3.2 Structure of the survey

The online survey was self-administered and anonymous, allowed participants to skip questions, and required approximately 20–25 minutes to complete. It began with informed consent (see appendix 2) outlining the research objective, inclusion criteria and the researcher's contact information. Selecting the continuation button was regarded as their consent to participate. This was followed by some screening questions, including province of residence and the first three digits of postal code, as the study aimed to collect only data from residents of Manitoba.

There were 13 sections of questions in this survey. The first section included questions on Chronic Obstructive Pulmonary Disease (COPD). If they do not have COPD, they were required to discontinue the rest of questions. The second section asked about COVID-19 and its persistent symptoms using the long COVID Registry questionnaire. It included a table with different COVID-19 symptoms, asking if they had experienced each symptom, its duration, if it was

currently present or had been in existence prior to COVID-19. If they have never experienced COVID-19, they were required to proceed to the non-COVID section.

The third section inquired about their current physical activity level (PAL) using the IPAQ. Participants were also asked to indicate whether they perceived their current activity level to be the same, more or less compared to before COVID-19. Section four involved questions on health-related quality of life with the EQ-5D-5L instrument, asking information on how much their health limits their activities currently and before they had COVID-19. The fifth section on the use of health care services through the RUQ included questions on how often they use these services currently and before COVID-19, and their perception of use to determine if it is less, more or same.

The sixth section asked more about the patient's health as an individual living with COPD, with questions to describe their current situation regarding the presence of phlegm, chest tightness, sleep, energy level using the CAT instrument. Participants were also asked to compare these current symptoms with their perceived health status before COVID-19 to determine if it was the same, more or less. The seventh section included questions on cough symptoms (LCQ) and assessed their impact on various aspect of participants' lives.

For the group who never experienced COVID-19, they proceeded from section two to section 8-12, with questions on current PAL, HRQoL, UHcS, CAT, LCQ respectively. The last section was on demographic information like the age, sex, living in either urban or rural area, few questions on smoking history and other existing co-morbidities if any. The survey ended with a thank-you message to the participants and provided the researcher's email for any questions regarding the survey. Participants were also given the option to indicate their interest in entering a raffle for a $50 gift card.

3.4 Data Cleaning

A total of 176 responses were entered into REDCap. During data cleaning, participants were excluded from the analysis for the following reasons: discontinuation after reading the informed consent (n=2), not having a diagnosis of COPD (n=2), residents outside of Manitoba (n=11), being between 18-29 years of age (n=4) and repetitive responses, including automated responses from robots (n=63) and repeated entry from the same individual (n=1). Therefore, only 78 participants were included in the statistical analysis (Figure 1).

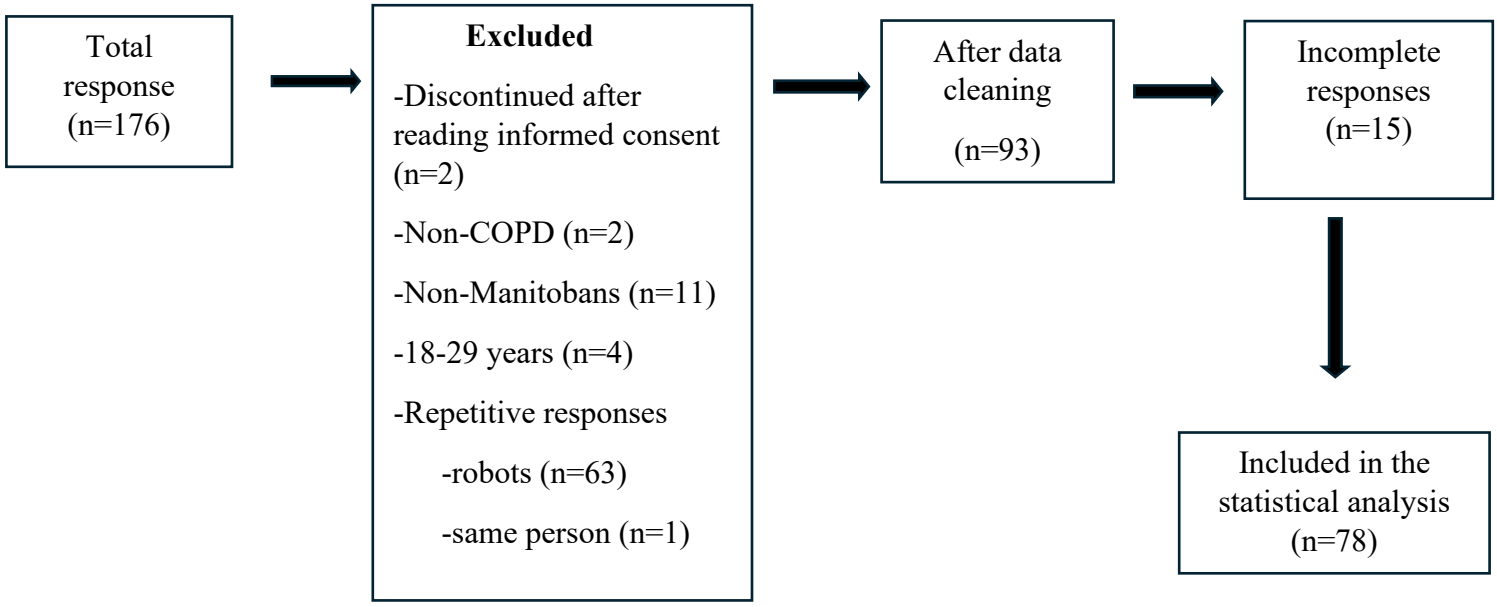

Figure 1: Flowchart of participant survey responses

3.5 Statistical Analyses

1. Descriptive statistics of the participants, including the mean ± standard deviation (continuous variables), absolute and relative frequencies (categorical variables), were used to present the characteristics of COPD (duration, severity, presence of COVID-19), demographic information (sex, age, location, employment status, etc.), characteristics of PCS in individuals with COPD, as well as the other variables studied (PAL, HRQoL, UHcS).

2. Fisher's exact test was used to assess PAL and CAT in comparison to their perception prior to COVID-19 in COPD participants with PCS.

3. The Shapiro-Wilk test of normality and graphical distribution were used to assess data normality. As the data were not normally distributed, Wilcoxon-signed rank (non-parametric test for paired group) was used to compare HRQoL before and after COVID-19.

4. McNemar test was used to assess the differences in the use of healthcare services (UHcS) before and after COVID-19 infection among COPD participants with PCS, as the data were paired and categorical.

5. Mann-Whitney U test (non-parametric test for independent t-test) was used to analyze the comparison of HRQoL, CAT, and LCQ between two independent groups (COPD individuals with and without PCS), while the Fisher's exact test was applied to compare PAL and UHcS between the same groups.

Effect sizes were interpreted as r=0.10 which indicated a small effect, r=0.30 a medium effect, and r=0.50 a large effect (107).Statistical significance level was set at p-value < 0.05.

All data were analyzed using the Statistical Package for Social Science (SPSS) software version 30.0 (IBM Corp, Chicago, USA).

4. RESULTS

4.1 Demographic information and baseline characteristics of COPD participants

A total of seventy-eight individuals with COPD completed the survey at least partially (Table 1). Response rates varied across survey items, as participation was voluntary and some participants did not provide a response to all questions. Half of the participants were identified as female (n= 31), while 1.6% (n=1) preferred not to disclose their sex. The most represented age group was 60-69 years accounting for 48.4% (n=30), followed by 19.4% of those aged 70 years and older (n=12). Seventy-six percent of the participants resided in urban areas (n=44), with most located in Winnipeg. However, other regions of Manitoba were also represented (Appendix 1). Eighty-four percent (n=52) of the participants reported a history of cigarette smoking and 68.9% (n=42) reported having at least one comorbidity. Half of the individuals had been living with COPD for 5-10 years, while 26.9% (n=21) had been diagnosed within the past 1 to 5 years. Thirty-nine percent (n=29) of the participants had severe or very severe COPD. Eighty-nine percent of the participants (n=69) reported a history of COVID-19. Among them, 73.9% (n= 51) required hospitalization and 58.8% (n= 40) were admitted to an intensive care unit (ICU) during the course of their SARS-CoV-2 infection.

Table 1: Demographic information and baseline characteristics of COPD participants

Sex	**N=62 (%)**
Male	30 (48.4)

Female	31 (50.0)
Prefer not to say	1 (1.6)
Age	**N=62 (%)**
30-39	6 (9.7)
40-49	3 (4.8)
50-59	11 (17.7)
60-69	30 (48.4)
≥70	12 (19.4)
Location	**N=58 (%)**
Urban	44 (75.9)
Rural	14 (24.1)
Employment status	**N=61 (%)**
Employed/self-employed	10 (16.4)
Unemployed	6 (9.8)
Retired	38 (62.3)
Sick/disability	4 (6.6)
Choosing not to work	1 (1.6)
Prefer not to say	2 (3.3)
Cigarette smoking	**N=62 (%)**
Yes	52 (83.9)
No	10 (16.1)
Vape	**N=61 (%)**
Yes	20 (32.8)

No	41 (67.2)
Existing co-morbidities	**N=61 (%)**
Yes	42 (68.9)
No	19 (31.1)
COPD duration	**N=78 (%)**
<1 year	6 (7.7)
1-5 years	21 (26.9)
5-10 years	39 (50.0)
>10 years	12 (15.4)
COPD stage	**N=75 (%)**
1st (mild)	7 (9.3)
2nd (moderate)	22 (29.3)
3rd (severe)	15 (20.0)
4th (very severe)	14 (18.7)
unknown	17 (22.7)
Experienced COVID-19	**N=78 (%)**
Yes	69 (88.5)
No	9 (11.5)
Hospital admission due to COVID-19	**N=69 (%)**
Yes	51 (73.9)
No	18 (26.1)
ICU visit due to COVID-19	**N=68 (%)**

Yes	40 (58.8)
No	28 (41.2)

Numbers may vary as survey questions were not compulsory, and some participants did not provide a response to all questions.

4.2 Non-COVID among individuals with COPD

Of the COPD participants who completed the survey, nine individuals (11.5%) reported that they have not had COVID-19 (Figure 2). However, the absence of a self-reported COVID-19 diagnosis does not definitely confirm the lack of infection, as some individuals may had experienced asymptomatic cases. Due to this uncertainty and the small sample size, no further analyses were conducted for this subgroup.

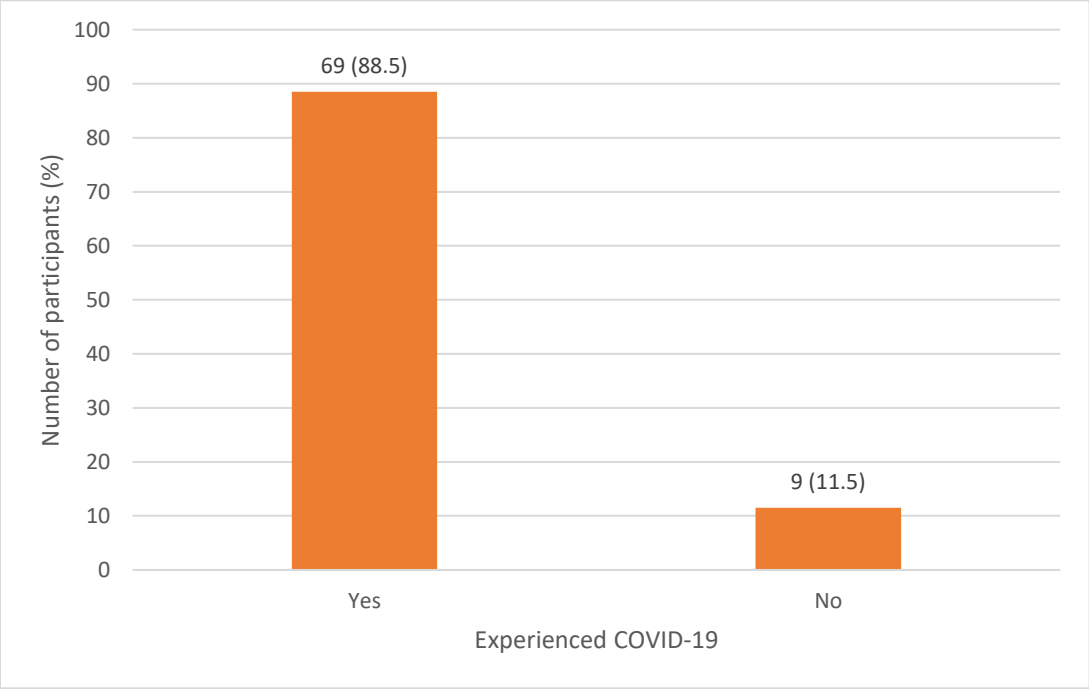

Figure 2: COPD participants with and without COVID-19 (n=78)

4.3 Prevalence of Post- COVID Symptoms (PCS) in COPD

Sixty-nine participants with COPD (88.5%) reported a history of COVID-19. A substantial majority of them 91.3% reported experiencing post-COVID symptoms lasting 3 months or longer following SARS-CoV-2 infection (Figure 3).

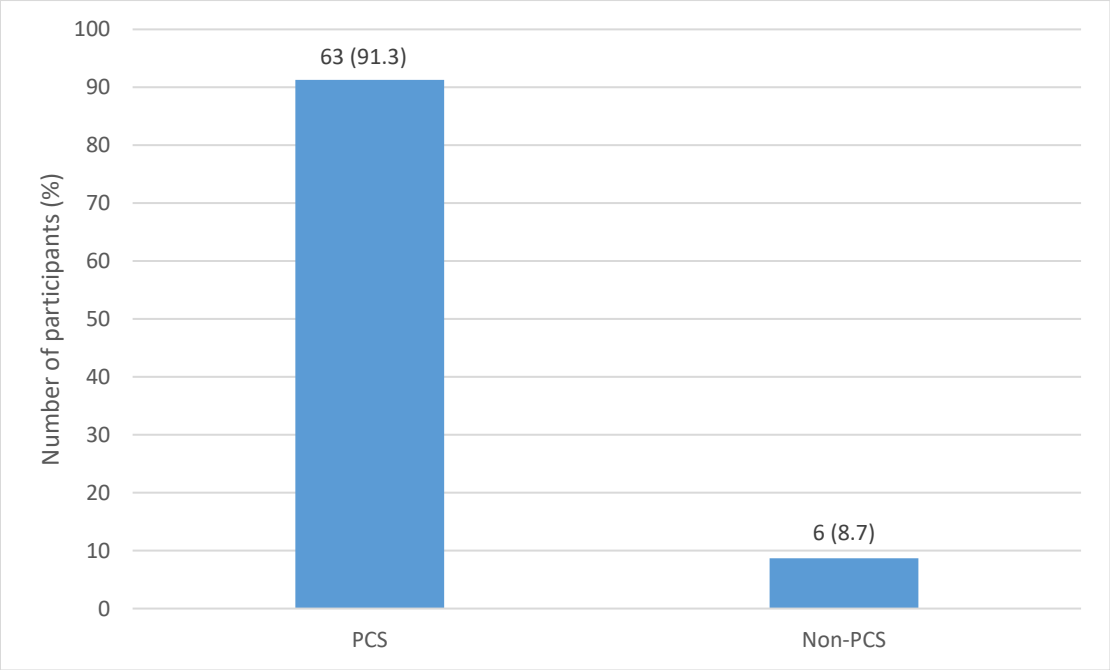

Figure 3: COPD participants with and without post-COVID symptoms (PCS) (n=69)

4.4 Post- COVID Symptoms among individuals with COPD

Individuals who had COVID-19 were asked to indicate whether they had experienced any of nineteen common symptoms during their SARS-CoV-2 infection (Table 2). The most prevalent symptoms reported were fever 95.2% (n=59), malaise 95.2% (n=59), cough 93.5% (n=58), headache 91.9% (n=57) and fatigue at rest 88.7% (n=55). Figure 4 shows the duration of COVID-

19 symptoms among COPD participants, distinguishing between less and more than 3 months. Symptoms that resolved within 3 months included fever 48.0% (n=24), headache 40.8% (n=20), and muscle pain 36.2% (n=17). In contrast, the most commonly reported symptoms persisting beyond 3 months were cough 78.0% (n=39), joint pain 76.2% (n=32), muscle weakness 75.6% (n=34), fatigue at rest 75.5% (n=37), wheezing at exertion 73.9% (n=34), shortness of breath at rest 73.9% (n=34), and fatigue with exertion 72.7% (n=32).

Participants indicated whether their symptoms were present or absent prior to SARS-CoV-2 infection (Figure 5). Symptoms present before the onset of COVID-19 included shortness of breath on exertion 68.3% (n=28), cough 68.1% (n=32), and wheezing at rest 62.2% (n=28), indicating a substantial burden of pre-existing symptoms predominantly respiratory in nature, which is consistent with their COPD diagnosis. Frequently reported newly emerging symptoms were fatigue at rest 54.3% (n=25), malaise 54.2% (n=26), fever 53.2% (n=25), and muscle weakness 52.4% (n=22).

Table 2: COVID symptoms among COPD participants with PCS

Symptoms	**Did you experience any of these symptoms when you had COVID?**	
	Yes	**No**
Fever (n=62)	59 (95.2)	3 (4.8)
Fatigue (at rest) (n=62)	55 (88.7)	7 (11.3)
Fatigue (with exertion) (n=62)	52 (83.9)	10 (16.1)
Generalized feelings of illness (Malaise) (n=62)	59 (95.2)	3 (4.8)

Headache (n=62)	57 (91.9)	5 (8.1)
Dizziness (n=62)	49 (79.0)	13 (21.0)
Chest pain (at rest) (n=61)	50 (82.0)	11 (18.0)
Chest pain (with exertion) (n=61)	44 (72.1)	17 (27.9)
Chest tightness/Angina (n=61)	45 (73.8)	16 (26.2)
Fast beating heart, heart pounding (palpitations) (n=62)	50 (80.6)	12 (19.0)
Short of breath (at rest) (n=62)	49 (79.0)	13 (21.0)
Short of breath (at exertion) (n=62)	49 (79.0)	13 (21.0)
Wheezing (at rest) (n=61)	51 (83.6)	10 (16.4)
Wheezing (at exertion) (n=62)	52 (83.9)	10 (16.1)
Cough (n=62)	58 (93.5)	4 (6.5)
Joint pain (n=62)	48 (77.4)	14 (22.6)
Muscle pain (n=62)	54 (87.1)	8 (12.9)
Tingling/burning sensation (n=45)	44 (72.1)	17 (27.9)
Muscle weakness	52 (85.2)	9 (14.8)

(n=45)

Numbers may vary as survey questions were not compulsory, and some participants did not provide a response to all questions.

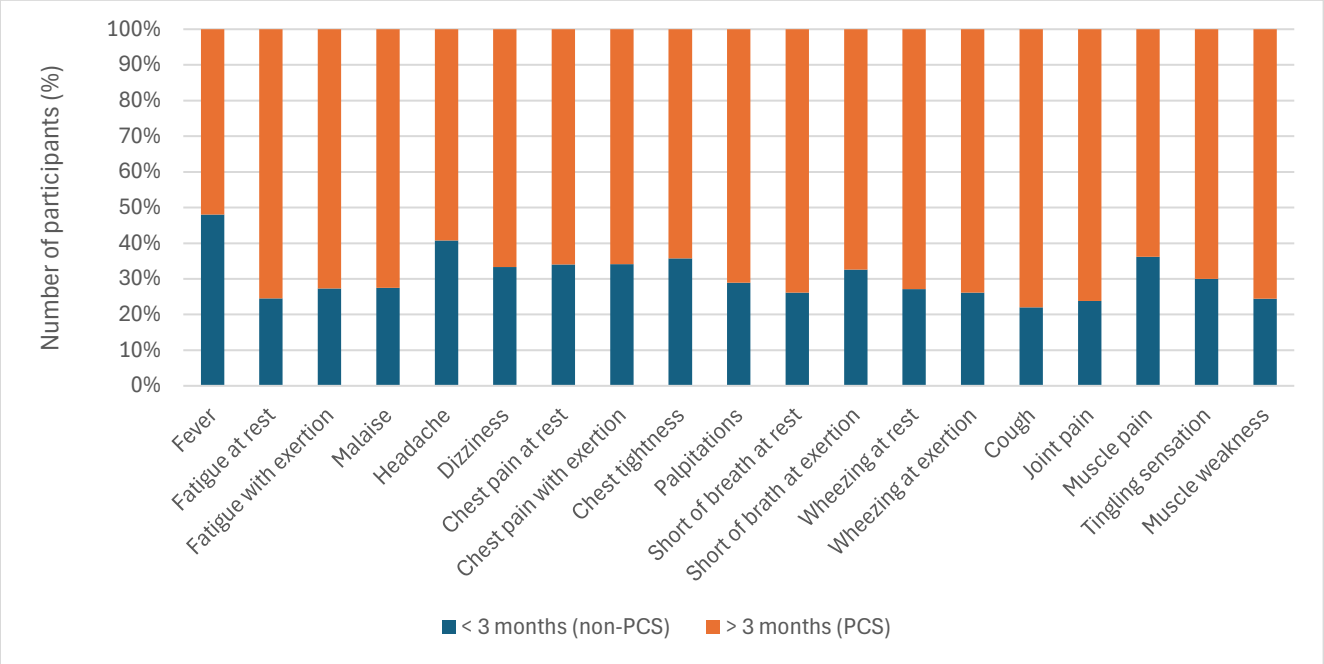

Figure 4: Duration of COVID-19 symptoms among COPD participants

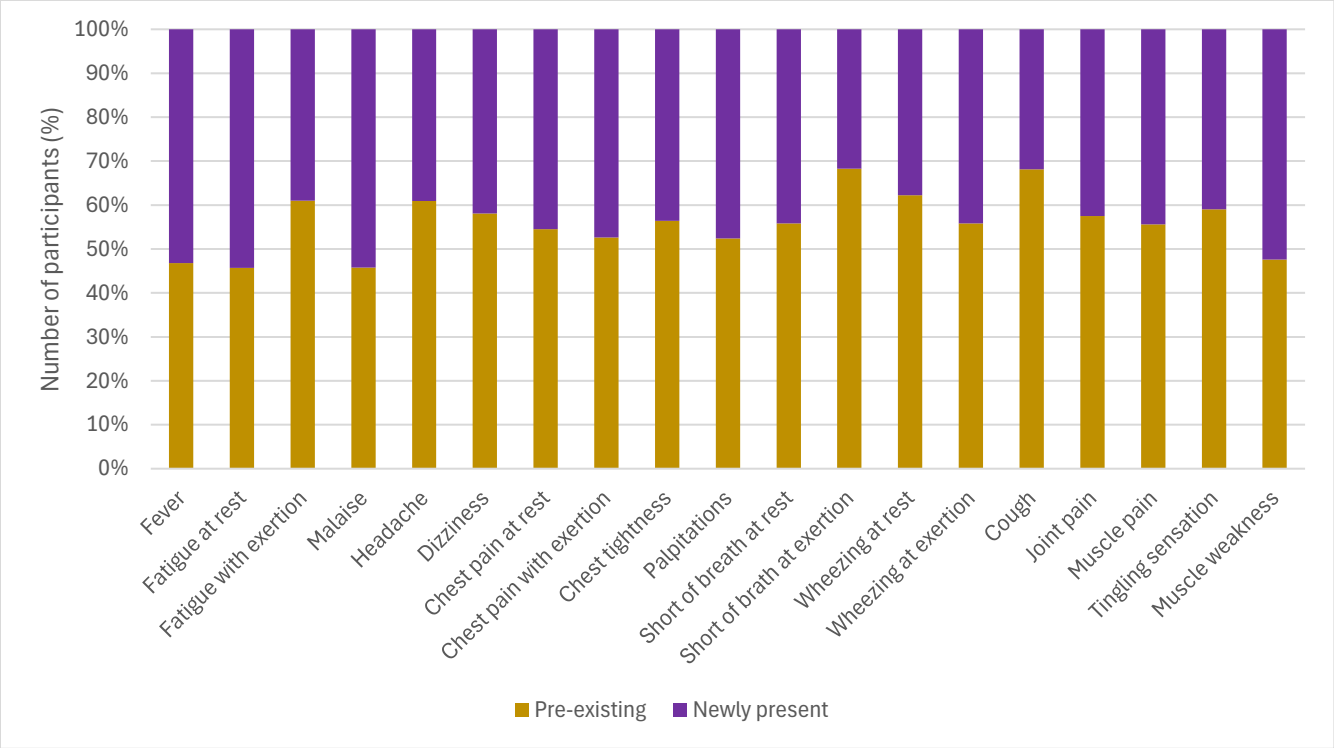

Figure 5: Pre-existing vs Newly reported COVID-19 symptoms among COPD participants with PCS

A total of 38 (82.6%) respondents with PCS reported experiencing cough (Figure 6). The Leicester Cough Questionnaire (LCQ) was used to evaluate the impact of cough on their quality of life, indicating a severely negative effect with most of the participants (84.2%) (Figure 7).

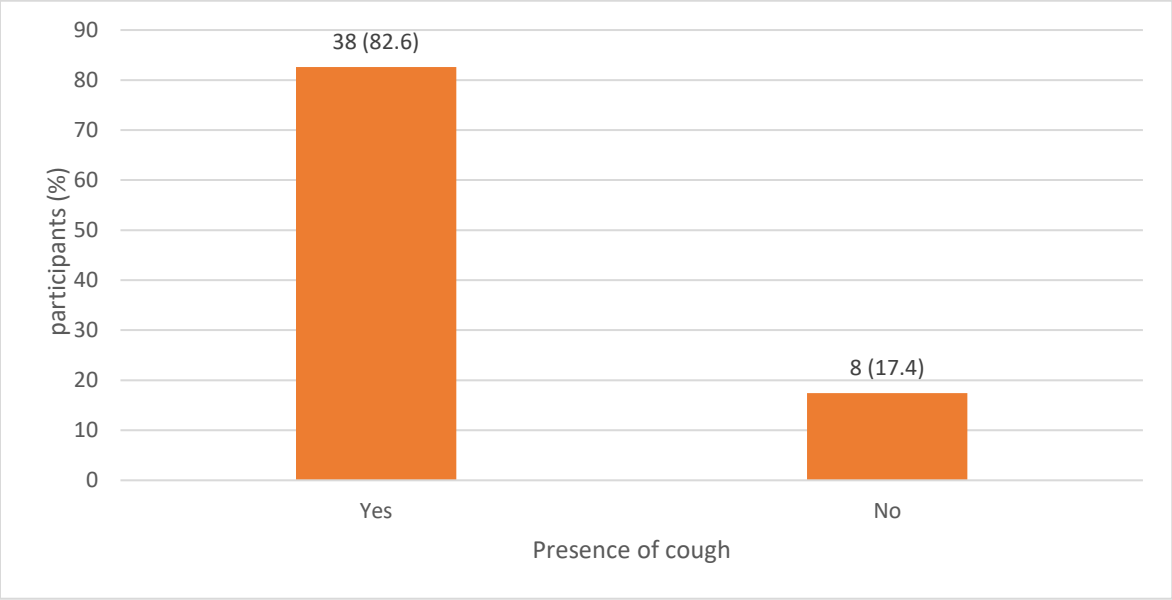

Figure 6: Prevalence of cough in participants with PCS (n=38)

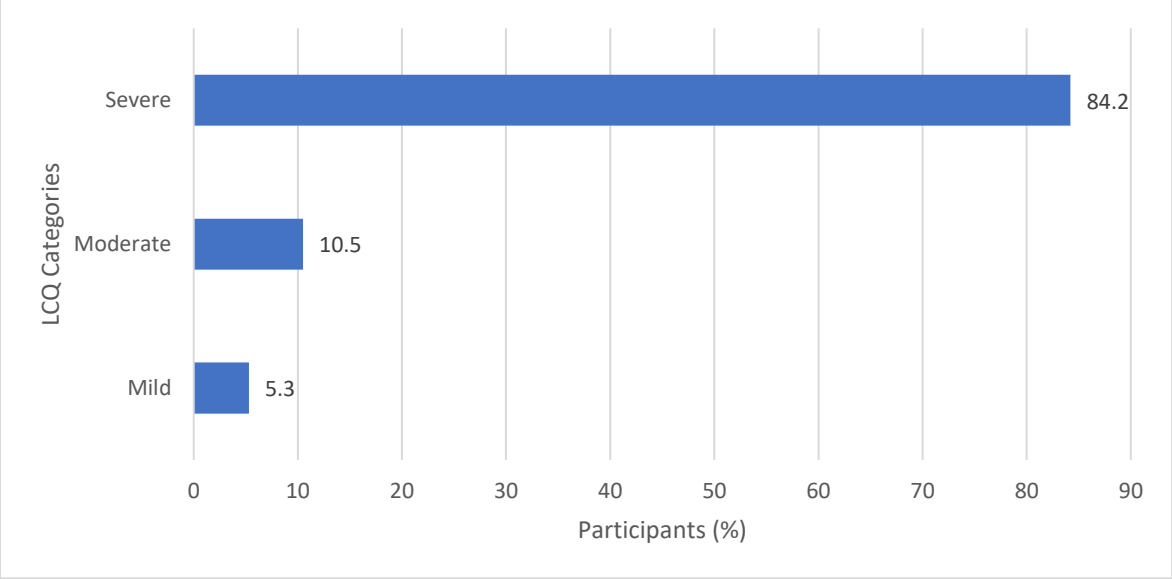

Figure 7: Impact of cough on patient's life among COPD individuals experiencing PCS (n=38)

4.5 Physical Activity Level (PAL) among COPD individuals experiencing PCS

A total of 42 participants with PCS provided responses regarding their current physical activity levels. Of these, half (n=21) were classified as inactive, 38.1% (n=16) as minimally active and 11.9% (n=5) as active (Health-Enhancing Physical Activity (HEPA)). Participants were also asked to compare their current PAL to their pre-COVID status. Seventy-eight percent (n=38) of the responders reported being less physically active now. There was a statistically significant association ($X^2 = 10.859$, $p = 0.011$), between patient's current PAL and their perceived decline. Among those currently classified as inactive, 48.8% (n=20) of participants reported doing less physical activity now than before COVID-19, none reported doing the same and only 2.4% (n=1) of participant reported doing more. In the HEPA active group, 4.9% (n=2) reported less, 2.4% (n=1) the same and 4.9 % (n=2) more PAL than before. This suggests that individuals reported significantly lower levels of physical activity now compared to their pre-COVID-19 levels (Figure 8), indicating that most participants experienced a decline in physical activity levels post-infection.

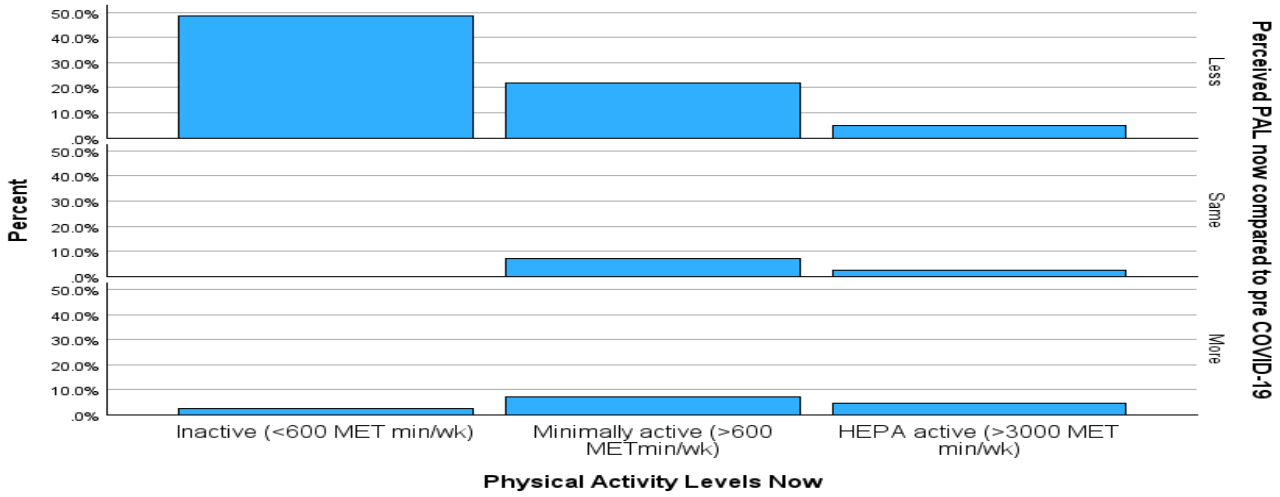

Figure 8: Perceived impact of PCS on physical activity level now compared to pre-COVID-19

4.6 Health-Related Quality of Life among COPD individuals experiencing PCS

Table 3 presents the mean scores across the five dimensions of the EQ-5D-5L for 49 COPD participants with PCS, comparing current health-related quality of life (HRQoL) to pre-COVID levels. Statistically significant declines were observed across all the domains indicating a substantial deterioration in HRQoL following COVID-19. Specifically, significant worsening was observed in mobility (p= 0.016), self-care ($p < 0.001$), usual activities ($p < 0.001$), pain/discomfort ($p < 0.001$), anxiety/depression ($p < 0.001$), and overall health measured by the Visual Analogue Scale (p= 0.011). Most of these changes were associated with large effect sizes showing clinically meaningful differences pre and post COVID (Table 4). This indicates that PCS may have a detrimental effect on health-related quality of life among these participants.

Table 3: Health-related quality of life among COPD participants with PCS

Variables	**PCS group (n= 49)**	
	Today Mean± SD	Before COVID Mean± SD
Mobility (0 – 5)	3.47 ± 1.28	2.76 ± 1.33
Self-care (0 – 5)	3.35 ± 1.36	2.37 ± 1.17
Usual activities (0 – 5)	3.55 ± 1.28	2.51 ± 1.18
Pain/discomfort (0 – 5)	3.61 ± 1.30	2.29 ± 1.11
Anxious/depression (0 – 5)	3.70 ± 1.35	2.53 ± 1.21
EQ-5D-5L utility index (-0.59 – 1.00)	0.22 ± 0.33	0.57 ± 0.28
Rate your health VAS (0 -100)	39.56 ± 29.51	51.60 ± 26.81

(0- no problem to 5- severe problem), (-0.59 (worse than death) to 1.000 (full health), (0 (the worst health you can imagine) to 100 (the best health you can imagine))

SD-Standard deviation, VAS- visual analog scale, PCS- post COVID symptoms

Table 4: Health-related quality of life today versus before COVID-19

Variables	**Health-related quality of life (Today and before COVID)**		
	Z-value	p-value	r-value
Mobility	-2.402	0.016	0.34
Self-care	-3.994	<0.001	0.57
Usual activities	-3.697	<0.001	0.53
Pain/discomfort	-4.791	<0.001	0.69
Anxious/depression	-3.654	<0.001	0.53
EQ-5D-5L utility index	-4.601	<0.001	0.66
Rate your health VAS	-2.529	0.011	0.37

Wilcoxon-signed rank (non-parametric test for paired t-test), Z-test statistic, r (effect size) = 0.1 (small), r=0.3 (medium), r=0.5 (large) (107), VAS- visual analog scale

Most of the participants with PCS had very high (52.1%; n=25) and high (31.3%; n=15) COPD assessment test scores (CAT) indicating a severe impact of COPD-related problems on health and daily functioning. The majority 56.3% (n=27) of participants perceived that COPD-related problems had a lesser impact on their health prior to COVID-19 infection. A statistically significant association was observed between patient's current CAT scores and the perceived impact of COPD-related problems on their health prior to COVID-19 (X^2 = 19.200, p <0.001). Among those currently classified within the very high CAT category, 39.6% (n=19) of participants perceived less impact (having better health) before COVID-19 infection, none reported the same and 6 participants (12.5%) perceived more impact (having worse health) (Figure 9). This suggests that individuals with severe CAT scores currently, reported significantly better health status prior

to SARS-CoV-2 infection, indicating a deterioration in health and function following the development of PCS.

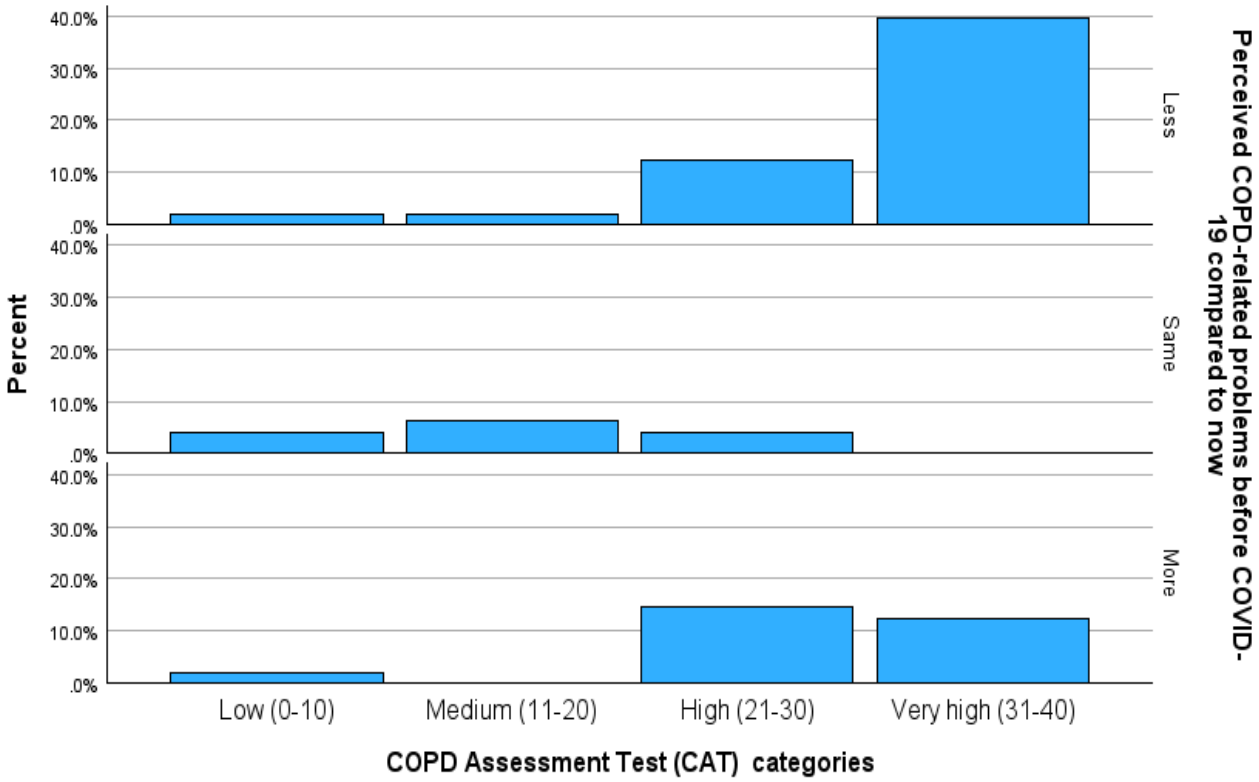

Figure 9: Impact of COPD-related problems on patient's health status compared to pre- COVID-19 infection

4.7 Use of Healthcare Services among COPD individuals experiencing PCS

Individuals with COPD who developed PCS exhibited a significant increase in their current utilization of healthcare services, particularly in acute and primary care, specialist consultations, and rehabilitation services (Table 5). Weekly primary care visits increased remarkedly from 12.2% (n=6) to 30.6% (n=15). Specialist services such as respirologists or cardiologists also saw an increase in monthly use from 16.3 % (n=8) to 26.5% (n=13) and quarterly visits from 26.5% (n=6) to 34.7% (n=17). In terms of rehabilitation services, weekly visits to respiratory therapists

increased from 2.0% (n=1) to 14.3% (n=7), and visits to physical therapists rose from 4.2% (n=2) to 11 (22.4%). Similarly, the use of occupational therapists' services increased with combined weekly and monthly visits growing from 18.8% (n=8) to 27.5% (n=18). The proportion of participants requiring hospital admission also rose from 18.8% (n=9) to 31.8% (n=15). These differences were statistically significant for the utilization of most healthcare services and/providers post COVID-19, including Specialists (p= 0.020), Respiratory therapists (p= 0.021), Physical therapists (p < 0.001), Occupational therapists (p= 0.004), Psychologists (p= 0.011), Social workers (p= 0.004), and Hospitalization services (p <0.001). However, no significant change was found in the use of family physicians or emergency room services (Table 6). Among 44 individuals who responded, 79.5% (n=35) reported an increase in healthcare utilization, 15.9% (n=7) indicated no change, and only 4.5% (n=2) reported a decrease compared to their usage prior to having COVID-19 (Figure 10).

Table 5: Use of healthcare services/ providers among COPD patient experiencing PCS

Health care services/ providers	**Today**	**Before COVID**
Family physician or nurse	**N=49 (%)**	**N=49 (%)**
Once a week	15 (30.6)	6 (12.2)
Once a month	9 (18.4)	8 (16.3)
Once in 3 months	9 (18.4)	11 (22.4)
Once in 6 months	10 (15.9)	11 (22.4)
Once a year	2 (4.1)	7 (14.3)
Never	4 (6.3)	6 (12.2)

One or more specialist (e.g. respirologist, cardiologist, etc.)	**N=49 (%)**	**N=49 (%)**
Once a week	4 (8.2)	2 (4.1)
Once a month	13 (26.5)	8 (16.3)
Once in 3 months	17 (34.7)	13 (26.5)
Once in 6 months	7 (14.3)	8 (16.3)
Once a year	4 (8.2)	7 (14.3)
Never	4 (8.2)	11 (22.4)
Respiratory therapist	**N=49 (%)**	**N=49 (%)**
Once a week	7 (14.3)	1 (2.0)
Once a month	11 (22.4)	9 (18.4)
Once in 3 months	12 (24.5)	11 (22.4)
Once in 6 months	6 (12.2)	8 (16.3)
Once a year	5 (10.2)	4 (8.2)
Never	8 (16.3)	16 (32.7)
Physical therapist	**N=49 (%)**	**N=48 (%)**
Once a week	11 (22.4)	2 (4.2)
Once a month	6 (12.2)	8 (16.7)
Once in 3 months	9 (18.4)	7 (14.6)
Once in 6 months	11 (22.4)	9 (18.8)
Once a year	7 (14.3)	6 (12.5)
Never	5 (10.2)	16 (33.3)
Occupational therapist	**N=48 (%)**	**N=48 (%)**
Once a week	6 (12.5)	1 (4.2)

Once a month	12 (25.0)	7 (14.6)
Once in 3 months	8 (16.7)	10 (20.8)
Once in 6 months	8 (16.7)	4 (8.3)
Once a year	7 (14.6)	8 (16.7)
Never	7 (14.6)	17 (35.4)
Psychologist/Psychotherapist	**N=48 (%)**	**N=46 (%)**
Once a week	7 (14.6)	2 (4.3)
Once a month	11 (22.9)	7 (15.2)
Once in 3 months	9 (18.8)	10 (21.7)
Once in 6 months	9 (18.8)	6 (13.0)
Once a year	7 (14.6)	8 (17.4)
Never	5 (10.4)	13 (28.3)
Social worker	**N=48 (%)**	**N=49 (%)**
Once a week	8 (16.7)	3 (6.1)
Once a month	10 (20.8)	10 (20.4)
Once in 3 months	10 (20.8)	6 (12.2)
Once in 6 months	5 (10.4)	4 (8.2)
Once a year	6 (12.5)	7 (14.3)
Never	9 (18.8)	19 (38.8)
Emergency room	**N=49 (%)**	**N=49 (%)**
Once a week	1 (2.0)	0 (0.0)
Once a month	9 (18.4)	5 (10.2)
Once in 3 months	10 (20.4)	13 (26.5)

Once in 6 months	8 (16.3)	6 (12.2)
Once a year	8 (16.3)	6 (12.2)
Never	13 (26.5)	19 (38.8)
Hospitalization	**N=48 (%)**	**N=48 (%)**
Once a week	7 (14.6)	1 (2.1)
Once a month	8 (16.7)	8 (16.7)
Once in 3 months	10 (20.8)	7 (14.6)
Once in 6 months	6 (12.5)	5 (10.4)
Once a year	8 (16.7)	5 (10.4)
Never	9 (18.8)	22 (45.8)

Numbers may vary as survey questions were not compulsory, and some participants did not provide a response to all questions. n= number of respondents

Table 6: Use of healthcare services Today and before COVID-19

Variables	**Differences in the UHcS (Today and before COVID-19)**		
	Z-value	p-value	r-value
Family physician or nurse	-0.816	0.414	0.11
One or more specialist (e.g. respirologist, cardiologist, etc.)	-2.333	0.020	0.33
Respiratory therapist	-2.309	0.021	0.32
Physical therapist	-3.317	<0.001	0.48
Occupational therapist	-2.887	0.004	0.42
Psychologist/Psychotherapist	-2.530	0.011	0.38
Social worker	-2.887	0.004	0.42
Emergency room	-1.732	0.083	0.25

Hospitalization	-3.357	<0.001	0.49

McNemar test (paired samples for proportion), UHcS-Use of healthcare services, r (effect size) = 0.1 (small), r=0.3 (medium), r=0.5 (large) (107)

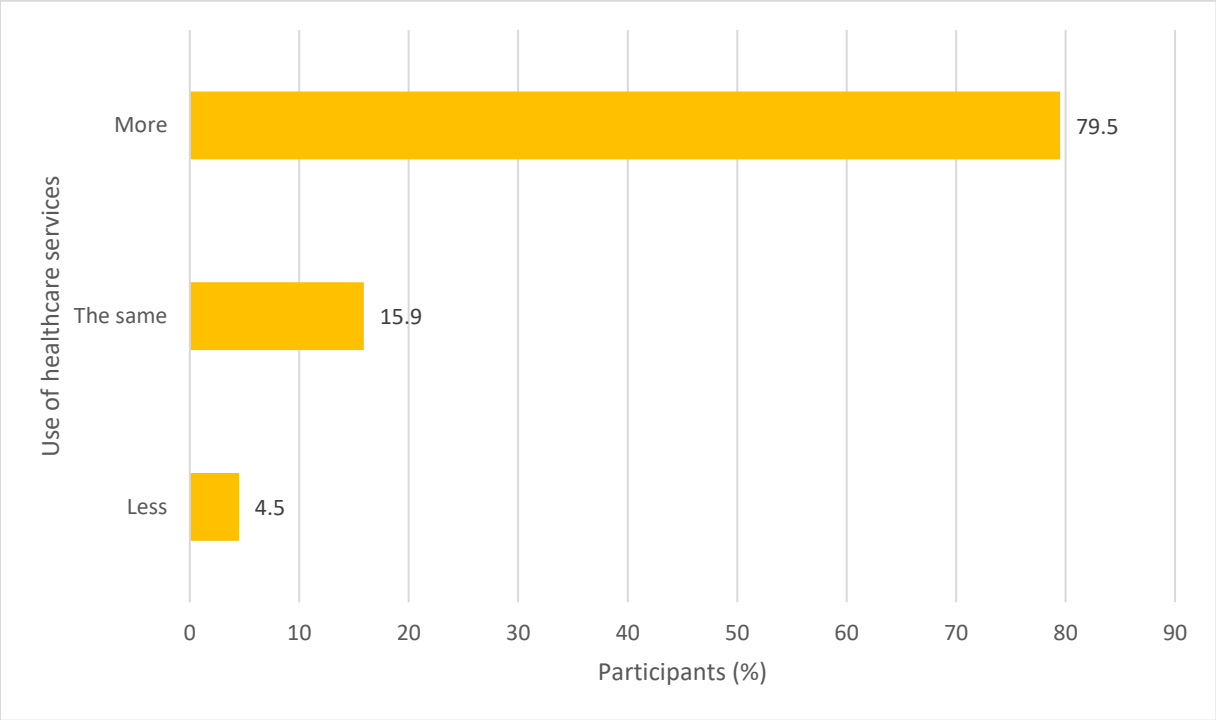

Figure 10: Current healthcare services use compared to before COVID-19 (n=44)

4.8 Differences in Symptoms, Physical Activity Level, Health-Related Quality of Life, and Use of Healthcare Services in COPD individuals with and without PCS

Descriptives statistics for demographics and characteristics of COPD are presented in table 7. In the PCS group (n=63), the majority 56.3% were males (n=27), whereas in the non-PCS group (n=6), 80% were females (n=4). The most common age range among participants with PCS was 60-69 years, while the majority were aged 70 years and above in those without.

Table 7: Demographic information and baseline characteristics for PCS and non-PCS groups

	PCS N= 63 (%)	**Non- PCS N= 6 (%)**	**p-value**
Sex	**N=48 (%)**	**N=5 (%)**	0.147
Male	27 (56.3)	1 (20.0)	
Female	20 (41.7)	4 (80.0)	
Prefer not to say	1 (2.1)	0 (0.0)	
Age	**N=48 (%)**	**N=5 (%)**	0.923
30-39	5 (10.4)	1 (20.0)	
40-49	2 (4.2)	1 (20.0)	
50-59	9 (18.8)	0 (0.0)	
60-69	23 (36.5)	1 (20.0)	
≥70	9 (18.8)	2 (40.0)	
Location	**N=45 (%)**	**N=5 (%)**	0.827
Urban	34 (75.6)	4 (80.0)	
Rural	11 (24.4)	1 (20.0)	
Employment status	**N=47 (%)**	**N=5 (%)**	0.029
Employed/self-employed	4 (8.5)	3 (60.0)	
Unemployed	6 (12.8)	0 (0.0)	
Retired	31 (66.0)	2 (40.0)	
Sick/disability	4 (8.5)	0 (0.0)	

Choosing not to work	1 (2.1)	0 (0.0)	
Prefer not to say	1 (2.1)	0 (0.0)	
Cigarette smoking	**N=48 (%)**	**N=5 (%)**	0.750
Yes	41 (85.4)	4 (80.0)	
No	7 (14.6)	1 (20.0)	
Vape	**N=48 (%)**	**N=5 (%)**	0.913
Yes	18 (37.5)	2 (40.0)	
No	30 (62.5)	3 (60.0)	
Existing co-morbidities	**N=48 (%)**	**N=5 (%)**	0.131
Yes	35 (72.9)	2 (40.0)	
No	13 (27.1)	3 (60.0)	
COPD duration	**N=63 (%)**	**N=6 (%)**	0.116
<1 year	4 (6.3)	2 (33.3)	
1-5 years	15 (23.8)	1 (16.7)	
5-10 years	34 (54.0)	1 (16.7)	
>10 years	10 (15.9)	2 (33.3)	
COPD stage	**N=61 (%)**	**N=6 (%)**	0.804
1st (mild)	4 (6.6)	2 (33.3)	
2nd (moderate)	19 (31.1)	0 (0.0)	
3rd (severe)	14 (23.0)	1 (16.7)	

4th (very severe)	13 (21.3)	1 (16.7)	
unknown	11 (18.0)	2 (33.3)	
Hospital admission due to COVID-19	**N=63 (%)**	**N=6 (%)**	0.675
Yes	47 (74.6)	4 (66.7)	
No	16 (25.4)	2 (33.3)	
ICU visit due to COVID-19	**N=62 (%)**	**N=6 (%)**	0.648
Yes	37 (59.7)	3 (50.0)	
No	25 (40.3)	3 (50.0)	

Numbers may vary as survey questions were not compulsory, and some participants did not provide a response to all questions.

4.8.1 Differences in symptoms presentation

Participants with PCS reported a significantly higher number of COVID-19 symptoms during the infection period compared to non-PCS individuals (12 symptoms vs 7 symptoms, p=0.02). Cough, chest pain on exertion, and muscle pain were reported significantly more frequently by participants with PCS compared to those without PCS (Figure 11). COVID-19 symptom profiles showed differences between the PCS and non-PCS groups (Table 8). Individuals in the PCS group had more frequently reported fatigue on exertion and respiratory-related pre-existing symptoms, such as shortness of breath on exertion, cough, and wheezing at rest. In contrast, the non-PCS group had more commonly reported pre-existing symptoms, including

dizziness and palpitations. During the acute phase of COVID-19, both groups reported newly emerging symptoms such as fever and fatigue at rest. However, wheezing at rest, shortness of breath at rest and on exertion were more frequently reported as a new symptom among those without PCS, while malaise was more commonly reported in the PCS group. Severe chronic cough was reported by participants in both groups, those with PCS (n=32) and without (n=1). However, there was no significant difference in the impact of cough on quality of life between the two groups, as assessed by the LCQ (p=0.671).

Table 8: Pre-existing and newly emerging symptoms for PCS and non-PCS groups

Variables	**Pre-existing symptoms**		**Newly emerging symptoms**	
	PCS n (%)	Non-PCS n (%)	PCS n (%)	Non-PCS n (%)
Fever	22 (46.8)	1 (20.0)	25 (53.2)	4 (80.0)
Fatigue (at rest)	21 (45.7)	1 (16.7)	25 (54.3)	5 (83.3)
Fatigue (at exertion)	25 (61.0)	2 (50.0)	16 (39.0)	2 (50.0)
Malaise	22 (45.8)	3 (50.0)	26 (54.2)	3 (50.0)
Headache	28 (60.9)	2 (50.0)	18 (39.1)	2 (50.0)
Dizziness	25 (58.1)	2 (66.7)	18 (41.9)	1 (33.3)
Chest pain (at rest)	24 (54.5)	1 (33.3)	20 (45.5)	2 (66.7)
Chest pain (at exertion)	20 (52.6)	0 (0.0)	18 (47.4)	1 (100.0)
Chest tightness	22 (56.4)	0 (0.0)	17 (43.6)	2 (100.0)

Palpitation	22 (52.4)	2 (66.7)	20 (47.6)	1 (33.3)
Short of breath (at rest)	24 (55.8)	0 (0.0)	19 (44.2)	4 (100.0)
Short of breath (at exertion)	28 (68.3)	1 (20.0)	13 (31.7)	4 (80.0)
Wheezing (at rest)	28 (62.2)	0 (0.0)	17 (37.8)	5 (100.0)
Wheezing (at exertion)	24 (55.8)	0 (0.0)	19 (44.2)	3 (100.0)
Joint pain	23 (57.5)	1 (25.0)	17 (42.5)	3 (75.0)
Muscle pain	25 (55.6)	0 (0.0)	20 (44.4)	1 (100.0)
Tingling sensation	23 (59.0)	1 (50.0)	16 (41.0)	1 (50.0)
Muscle weakness	20 (47.6)	1 (16.7)	22 (52.4)	5 (83.3)
Cough	32 (68.1)	1 (33.3)	15 (31.9)	2 (66.7)

Numbers may vary as survey questions were not compulsory, and some participants did not provide a response to all questions.

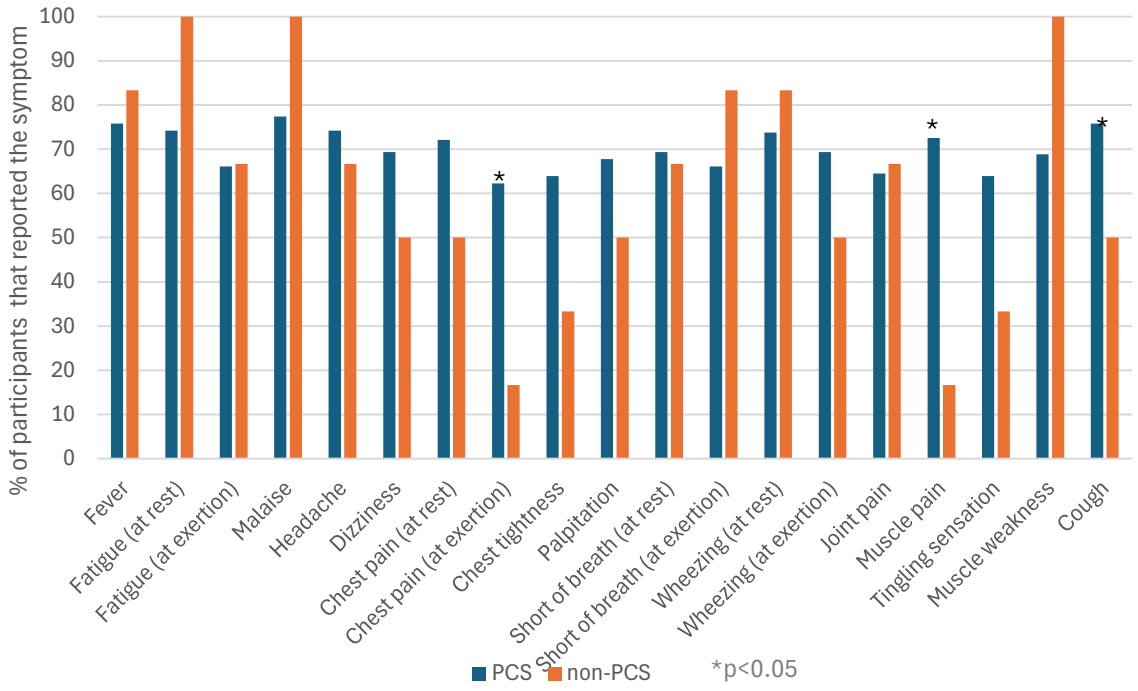

Figure 11: Symptoms experienced during COVID-19 infection among COPD participants with and without PCS

4.8.2 Differences in physical activity level

There was no statistically significant differences in physical activity level between respondents with PCS and those without (Table 9). The great majority of respondents in both groups were inactive or minimally active.

Table 9: Differences in PAL between PCS and non-PCS groups

Physical activity level	PCS N=42 (%)	Non-PCS N=5 (%)	Fisher's exact value	p-value
Inactive	21 (50.0)	3 (60.0)	0.403	1.000
Minimally active	16 (38.1)	2 (40.0)		
HEPA active	5 (100.0)	0 (0.0)		

Fisher's exact test was appropriate when any cell count is less than 5. HEPA- Health-enhancing physical activity, Inactive-<600 MET min/wk, Minimally active->600 MET min/wk, HEPA active->3000 MET min/wk.

4.8.3 Differences in health-related quality of Life

Statistically significant differences were observed across the EQ-5D-5L domains, showing individuals with PCS may have greater impairment in mobility (p= 0.009), self-care (p= 0.010), pain/discomfort (p= 0.011), anxiety/depression (p= 0.006). CAT scores were also higher among PCS individuals compared to those without (p= 0.001) indicating a greater negative impact of COPD on health status and daily function. These results reported moderate effect sizes in the EQ-5D-5L domains, with CAT score showing moderate to large effect size (r=0.44). This indicates that the differences between the two groups are not only statistically significant but also of meaningful magnitude. We found no statistically significant differences in the usual activity domain and EQ-VAS of the EQ-5D-5L (Table 10).

Table 10: Differences in HRQoL and CAT between PCS and non-PCS groups

Variables	**PCS group (n= 49)**	**Non-PCS group (n=5)**	**Z-value**	**p-value**	**r-value**
	Mean± SD	Mean± SD			
Mobility (0 – 5)	3.47 ± 1.28	1.80 ± 0.84	-2.596	0.009	0.35
Self-care (0 – 5)	3.35 ± 1.36	1.60 ± 0.89	-2.563	0.010	0.35
Usual activities (0 – 5)	3.55 ± 1.28	2.40 ± 1.14	-1.918	0.055	0.26
Pain/discomfort (0 – 5)	3.61 ± 1.30	2.00 ± 0.00	-2.546	0.011	0.35
Anxious/depression (0 – 5)	3.70 ± 1.35	1.80 ± 0.84	-2.730	0.006	0.38
EQ-5D-5L utility index (-0.59 – 1.00)	0.22 ± 0.33	0.77 ± 0.13	-2.854	0.004	0.20

Rate your health VAS (0 -100)	39.56 ± 29.51	60.40 ± 17.40	-1.463	0.143	0.44
CAT score	29.69 ± 10.76	12.40 ± 8.20	-3.199	0.001	0.35

(0- no problem to 5- severe problem), (-0.59 (worse than death) to 1.000 (full health), (0 (the worst health you can imagine) to 100 (the best health you can imagine)) Mann- Whitney U (non-parametric test for independent t-test), Z-test statistics, r (effect size) = 0.1 (small), r=0.3 (medium), r=0. 5 (large) (107) SD-Standard deviation, VAS- visual analog scale, PCS- post COVID symptoms

4.8.4 Differences in the use of healthcare services

There were no statistically significant differences in healthcare utilization between COPD participants with PCS and those without (Table 11).

Table 11: Differences in Health Services use between PCS and non-PCS groups

Healthcare services/ providers	**PCS N= 49 (%)**	**Non-PCS N=5 (%)**	**Fisher's exact value**	**p-value**
Family physician or nurse			2.575	0.895
Once a week	15 (30.6)	2 (40.0)		
Once a month	9 (18.4)	0 (0.0)		
Once in 3 months	9 (18.4)	2 (40.0)		
Once in 6 months	10 (15.9)	1 (20.0)		
Once a year	2 (4.1)	0 (0.0)		
Never	4 (6.3)	0 (0.0)		
One or more specialist			7.070	0.086
Once a week	4 (8.2)	2 (40.0)		
Once a month	13 (26.5)	0 (0.0)		
Once in 3 months	17 (34.7)	1 (20.0)		

Once in 6 months	7 (14.3)	0 (0.0)		
Once a year	4 (8.2)	1 (20.0)		
Never	4 (8.2)	1 (20.0)		
Respiratory therapist			3.061	0.756
Once a week	7 (14.3)	1 (20.0)		
Once a month	11 (22.4)	0 (0.0)		
Once in 3 months	12 (24.5)	2 (40.0)		
Once in 6 months	6 (12.2)	0 (0.0)		
Once a year	5 (10.2)	1 (20.0)		
Never	8 (16.3)	1 (20.0)		
Physical therapist			6.489	0.093
Once a week	11 (22.4)	1 (20.0)		
Once a month	6 (12.2)	0 (0.0)		
Once in 3 months	9 (18.4)	1 (20.0)		
Once in 6 months	11 (22.4)	0 (0.0)		
Once a year	7 (14.3)	0 (0.0)		
Never	5 (10.2)	3 (60.0)		
Occupational therapist			6.003	0.152
Once a week	6 (12.5)	1 (20.0)		
Once a month	12 (25.0)	0 (0.0)		
Once in 3 months	8 (16.7)	1 (20.0)		
Once in 6 months	8 (16.7)	0 (0.0)		
Once a year	7 (14.6)	0 (0.0)		

Never	7 (14.6)	3 (60.0)		
Psychologist/Psychotherapist			7.003	0.059
Once a week	7 (14.6)	1 (20.0)		
Once a month	11 (22.9)	0 (0.0)		
Once in 3 months	9 (18.8)	1 (20.0)		
Once in 6 months	9 (18.8)	0 (0.0)		
Once a year	7 (14.6)	0 (0.0)		
Never	5 (10.4)	3 (60.0)		
Social worker			4.059	0.494
Once a week	8 (16.7)	1 (20.0)		
Once a month	10 (20.8)	0 (0.0)		
Once in 3 months	10 (20.8)	1 (20.0)		
Once in 6 months	5 (10.4)	0 (0.0)		
Once a year	6 (12.5)	0 (0.0)		
Never	9 (18.8)	3 (60.0)		
Emergency room			5.338	0.327
Once a week	1 (2.0)	1 (20.0)		
Once a month	9 (18.4)	0 (0.0)		
Once in 3 months	10 (20.4)	0 (0.0)		
Once in 6 months	8 (16.3)	1 (20.0)		
Once a year	8 (16.3)	1 (20.0)		
Never	13 (26.5)	2 (40.0)		
Hospitalization			4.278	0.465
Once a week	7 (14.6)	2 (40.0)		

Once a month	8 (16.7)	0 (0.0)
Once in 3 months	10 (20.8)	0 (0.0)
Once in 6 months	6 (12.5)	0 (0.0)
Once a year	8 (16.7)	1 (20.0)
Never	7 (18.4)	2 (40.0)

Numbers may vary as survey questions were not compulsory, and some participants did not provide a response to all questions. Fisher's exact test was appropriate when any cell count is less than 5.

5. DISCUSSION

This study evaluated the prevalence and impact of post-COVID symptoms (PCS) on physical activity level (PAL), health-related quality of life (HRQoL), and use of healthcare services (UHcS) among individuals with COPD, as well as the differences in these outcomes between individuals with and without PCS. A significant association was found between the presence of PCS and lower PAL, reduced HRQoL and increased healthcare utilization among individuals with COPD. Furthermore, individuals with COPD and PCS experienced significant impairments in quality of life compared to those without PCS.

COPD has traditionally been perceived as a disease primarily affecting older males. While earlier studies reported a higher prevalence of COPD among males across various regions globally (108,109), recent Canadian studies (23,24,110) have indicated an increasing prevalence of COPD among females aged 50 years and older which is consistent with the demographic characteristics of participants enrolled in this study. COVID-19 was associated with a significant burden among individuals with COPD in this study, with high rates of hospital and intensive care unit (ICU) admissions. This findings aligns with previous research, which reported that 48.2% of COPD

individuals with COVID-19 required hospitalization and among those, 45.6% were admitted to the ICU (111). In our study, only few individuals reported no history of COVID-19 infection. However, since the absence of infection could not be confirmed and some participants may have been asymptomatic, no further analyses were conducted in the subgroup of participants. A previous systematic review research (112) estimated that approximately 35.1% of SARS-CoV-2 infections remained entirely asymptomatic throughout its course, which indicated that a substantial proportion of individuals may be unaware of their infection due to the absence of symptoms and formal testing.

A high prevalence 91.3% (n=63) of post-COVID symptoms (PCS) was observed among participants with COPD in our study. This aligns with the findings from another study that also reported high odds (OR 9.64) of experiencing long term COVID symptoms in COPD (113). However, the high PCS prevalence identified in our study may be attributed to the severity of SARS-CoV-2 infection as many participants were hospitalized and admitted to the ICU. Previous studies established that PCS could develop irrespective of the severity of COVID-19 infection. However, it is commonly associated with moderate to severe illness during the acute phase (15,114). Additionally, self-selection bias could further explain the high PCS in this sample, as COPD individuals experiencing persistent symptoms may have been more likely to participate in the study. This is a well-recognized limitation in studies relying on surveys. However, this methodology, still remains widely used and accepted in health research especially when aiming to capture patient perspectives, as symptom burden and quality of life are often best assessed through self-report measures (115,116).

Cough, shortness of breath, muscle weakness, fatigue at rest and with exertion were the main PCS present in this group of participants, potentially worsening their respiratory function

and decreasing their overall energy levels. Similarly, musculoskeletal, pulmonary, neurological symptoms have been commonly reported among individuals experiencing PCS, with fatigue and breathing difficulties identified as the most debilitating (86). Recent studies has shown that COPD individuals with PCS may experience worsened respiratory symptoms than those typically reported in general COPD population (117,118). Notably, dyspnea was previously found as the most prevalent symptoms among individuals with COPD experiencing PCS beyond six months (113). In this study, there was a distinction between symptoms potentially attributed to underlying COPD condition, as they were present before COVID-19, and those more likely associated with the onset of COVID-19. A considerable proportion of participants reported respiratory-related symptoms (shortness of breath on exertion, cough and wheezing at rest) prior to experiencing COVID-19, indicating that these were likely manifestations of their pre-existing pulmonary condition that may have worsened following infection. Conversely, symptoms such as fatigue at rest, malaise, and muscle weakness were newly reported after the infection, suggesting these may be more directly related to the effects of COVID-19 and its long term impact. This distinction helps differentiate post-viral complications from baseline health condition. This is consistent with a previous systematic review which reported that although COVID-19 and COPD may share similar respiratory symptoms, clinical presentation of COVID-19 such as worsening of dyspnea, fever, dry cough, profound fatigue distinguishes between the two conditions (119). Cough is a common symptom associated with COPD and may potentially be worsened with PCS, therefore, to better understand the burden of chronic cough in individuals with PCS, this study evaluated its physical, psychological and social impact. The majority of the participants scored within the severe range on the cumulative LCQ scores, indicating a significant negative impact of cough on their quality of life (120).

Among the individuals with PCS that participated in our study, physical activity levels were substantially low with about 50% engaging in less than 600 MET min/week of activity. This finding is particularly concerning in a population with pre-existing chronic respiratory condition, where physical activity is one of the most powerful tools for managing COPD, as it lessens symptoms, extends life expectancy, reduces inflammation, improves exercise capacity while enhancing quality of life (121,122). Current guidelines recommend that individuals with COPD engage in moderate-intensity physical activity at least 20-30 minutes per day for 3-5 days per week (123). This recommendation is consistent with the WHO global physical activity for individuals with chronic conditions, which advises 150-300 minutes of moderate-intensity activity or 75-150 minutes of vigorous activity per week (124). In our study, the majority of participants reported a substantial decrease in their current PAL compared to their pre-COVID lifestyle. Evidence suggests that the COVID-19 pandemic, along with the ongoing burden of PCS, has significantly reduced the motivation to engage in physical activity, contributing to increased sedentary behaviour (125,126).

This study revealed a significant decrease in HRQoL among individuals with PCS. The comparison of mean scores across the EQ-5D-5L domains (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) demonstrated substantial post-infection increased burden when comparing to before COVID-19. Multiple studies (127–129) support our findings, indicating that individuals with PCS experienced significantly greater limitations in both physical and psychological domains of daily life compared to their pre-COVID-19 baseline. Additionally, PCS participants reported a statistically significant decline in general health, consistent with findings from a recent cross-sectional study involving 1024 participants. That study found significantly lower EQ-VAS scores among those with PCS compared to those without, with the greatest impact

observed in older adults and individuals with chronic conditions (130). The self-reported decline in health status observed in our study suggested that post COVID-19 may have exacerbated pre-existing COPD symptoms such as cough, breathlessness, sleep disturbances and reduced energy levels as captured by the CAT instrument and perceived as having worsened after infection. These findings align with a study that reported individuals with severe COVID-19 experienced more persistent symptoms and had a significant higher CAT scores which indicated greater health impairment (131).

A marked increase in health service utilization among PCS individuals with COPD was identified in the present study, with significant proportion of participants reporting an increased frequency of visits to various healthcare providers, including primary care, specialists (e.g., respirologist and cardiologists), and rehabilitation professionals such as respiratory, physical, and occupational therapists. These patterns reflect a growing demand for multidisciplinary management in the post-COVID condition, driven by multiple persistent symptoms and functional decline (132,133). The increase in weekly visits to physical and respiratory therapists, in particular, may reflect a greater need for rehabilitative care aimed at restoring respiratory capacity and physical function. Conversely, no significant change was found in the use of family physicians or emergency services, suggesting either saturation of primary care resources or an increasing need for specialised and rehabilitative services to manage the chronic nature of PCS in individuals with COPD. This findings aligns with to a US based case-control study evaluating healthcare utilization pattern before and after long COVID diagnosis, which reported a decline in emergency care use and highlighted greater benefits from care provided by specialized clinical services (134). Overall, these individuals may require support from comprehensive, multidisciplinary healthcare teams, emphasizing the critical need for integrated and sustained long-term services to effectively address

their complex healthcare needs. Policy makers and other relevant decision-makers should consider strategies to integrate these services and allocate the necessary resources to support this population effectively.

Individuals with post-COVID symptoms (PCS) reported a significantly greater number of COVID-19 symptoms during their acute infection than those without PCS, which aligns with existing literatures indicating that a higher symptom burden is associated to an increased risk of post-COVID complications (135,136). Individuals with PCS experienced significantly reduced health-related quality of life compared to those without PCS, highlighting the considerable burden of PCS among people with COPD. This reduction in HRQoL may be explained by the persistence and severity of symptoms commonly associated with PCS (such as fatigue, dyspnea, chronic cough) known to exacerbate daily challenges already faced by individuals with COPD. This finding align with literature which reported that post-COVID syndrome may increase symptom burden in individuals with chronic respiratory conditions, thereby worsening their functional status and perceived quality of life (137,138). No significant differences were observed between groups in physical activity or healthcare utilization. However, the marked imbalance in group sizes may have limited the reliability of these comparisons and increased the risk of Type II error (false negative), potentially contributing to inconclusive results.

5.1 Strengths

To the best of our knowledge, this is the first study that aimed at assessing the effect of PCS on multiple outcomes (symptoms, PAL, HRQoL and UHcS) in individuals with COPD, contributing new insights to the body of evidence on the impact of this complex and prevalent condition. Multiple strategies were employed to disseminate the survey across the province and to

optimize data collection, resulting in a well-distributed and representative sample. This study incorporated standardized and validated tools, enhancing the reliability and credibility of the findings. Additionally, appropriate statistical methods (non-parametric tests for non-normally distributed data) were used, ensuring analytical accuracy. This study also captured patient voice and perception of their lived experience. Collectively, these strengths enhance the generalizability of the results and their relevance for guiding future research and interventions.

5.2 Limitations

The survey was disseminated through various recruitment platforms and yielded over 170 initial responses; however, only 78 responses were deemed eligible for inclusion following data cleaning. Nevertheless, the final sample exhibited broad geographic representation across the main regions of the province (appendix 1). The substantial disparity in group sizes between participants with and without PCS may have compromised the reliability of the comparisons (PAL, HRQoL and UHcS) and increased the probability of obtaining inconclusive findings, hence should be regarded as exploratory rather than conclusive. Despite this limitation, the observed decrease in HRQoL among COPD individuals with PCS indicated a substantial impact associated with the condition. Additionally, the use of self-reported data collected through survey questionnaires, could lead to recall bias and the possibility of under/over-reporting of result outcomes. Uncertainty remains regarding how the natural course of COPD influences the reporting of patients' symptoms. Furthermore, the possibility of self-selection bias cannot be ruled out as individuals experiencing PCS may be more likely to participate due to the perceived relevance of the research to their condition. Overall, the results should be interpreted cautiously in light of the above-mentioned limitations.

5.3 Recommendations

Future research should consider larger and more balanced sample sizes to accurately identify PCS cases and evaluate its overall impact, including the effects within specific population groups such as individuals with COPD. This would enhance statistical power, improve generalizability of findings, and allow for more detailed subgroup analyses. Longitudinal studies would be valuable to understand how PCS in COPD individuals evolve over months or years following infection. Furthermore, research that investigates the feasibility and effectiveness of telehealth, remote monitoring and home-based rehabilitation interventions for COPD individuals experiencing PCS, may help identify practical strategies for delivering continuous care. Such approaches could particularly benefit individuals experiencing post-COVID-related fatigue or breathlessness, as they may reduce the need for frequent in-person visits. Additionally, studies that evaluates the implementation of specialized PCS clinics for integrated management tailored specifically for individuals with COPD and/or other respiratory conditions may be beneficial to provide a structured setting for comprehensive assessment, individualized intervention plans and to enhance continuity of holistic care.

5.4 Conclusion

Our study highlights the significant impact of PCS on individuals living with COPD. Participants reported a substantial symptoms burden, encompassing worsening of pre-existing and emerging new issues such as cough, shortness of breath fatigue, and muscle weakness. In addition, declines in PAL and HRQoL, along with increased utilization of healthcare services were also identified in COPD individuals experiencing PCS. However, these findings should be interpreted with caution due to study limitations and, hence, regarded as exploratory rather than conclusive.

Nevertheless, these results offer valuable insights to guide the development of safe and effective rehabilitation treatments, inform the planning of tailored services to meet the specific needs of this patient group, and contribute to the development of future research.

GLOSSARY

Definition of Terms

Post-COVID symptoms- also known as Long COVID, according to 2024 NASEM is defined as "an infection-associated chronic condition that occurs after SARS-CoV-2 infection and is present for at least 3 months as a continuous, relapsing and remitting, or progressive disease state that affects one or more organ systems" (10).

Chronic Obstructive Pulmonary Disease- "This is a chronic lung illness characterized by long-term respiratory symptoms and decreased airflow, with symptoms including shortness of breath and cough that may or may not produce mucus" (139).

Physical Activity- It is defined as "any voluntary bodily movement produced by skeletal muscles that requires energy expenditure. It encompasses all activities, at any intensity, performed during any time of day or night" (140).

Health-Related Quality of Life- is a "multidimensional concept that encompasses at least three major categories (physical, psychological, and social functioning) that are influenced by a person's health" (141).

APPENDIX 1

Supplementary materials

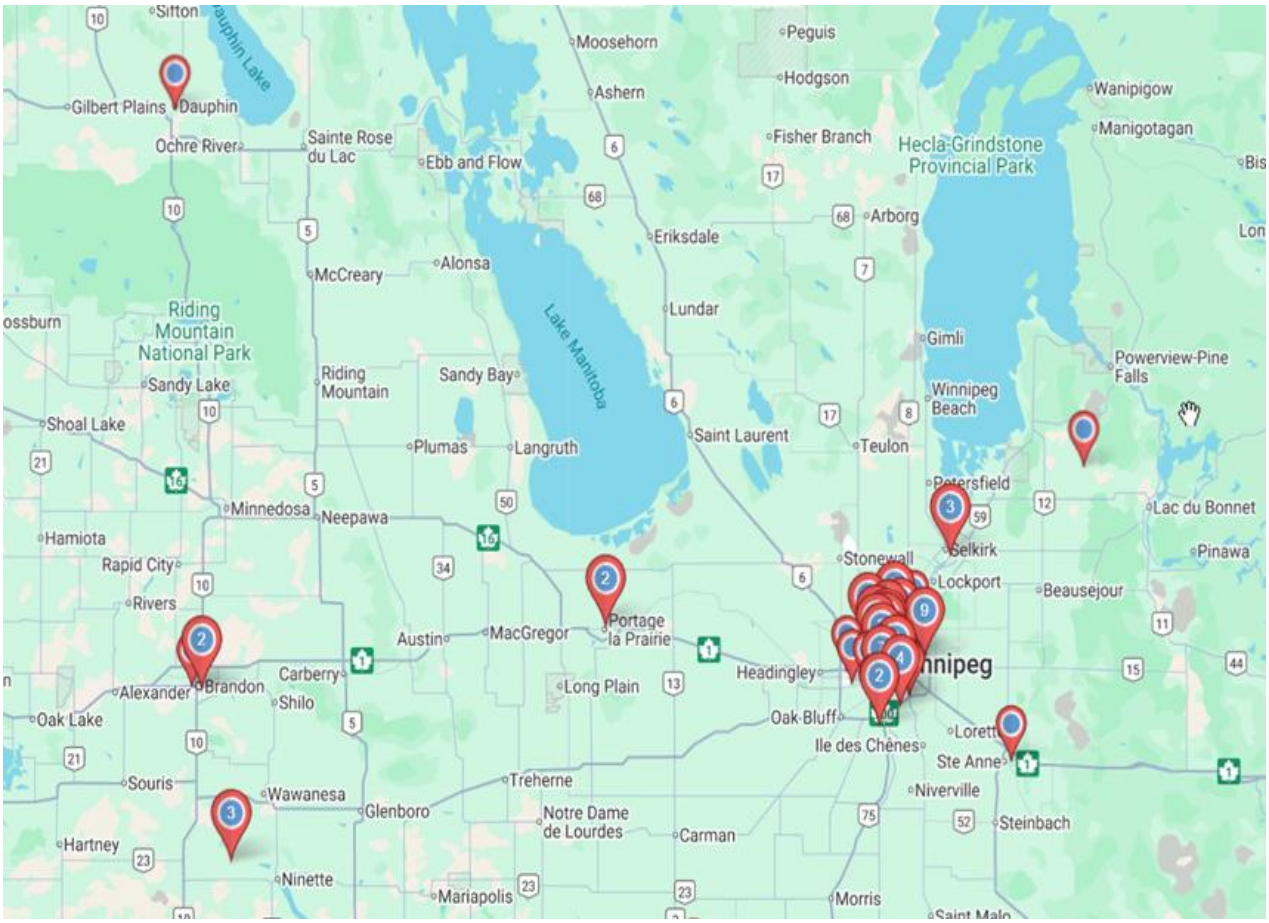

Figure 1a: Distribution of respondents through Manitoba based on a postal code

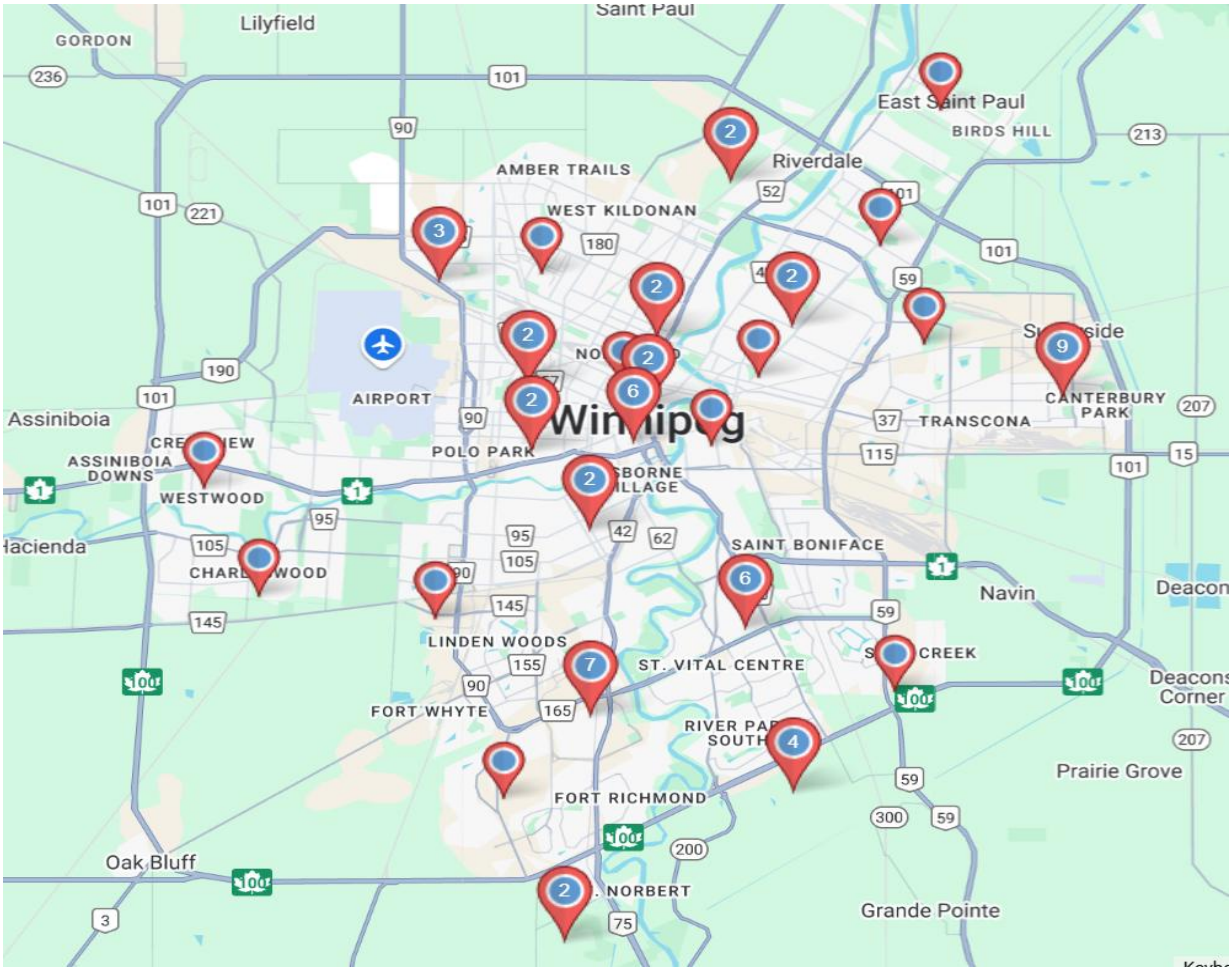

Figure 1b: Distribution of respondents through Winnipeg based on a postal code

UM | Rady Faculty of Health Sciences

APPENDIX 2

Exploring Post-COVID Symptoms in Adults with COPD

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Web: http://umanitoba.ca/rehabsciences/sanchez-ramirez.html https://www.respirabilitylab.com/

Dear Sir/ma,

The RespirabilityLab of the university of Manitoba is conducting a research study to assess the prevalence of symptoms of post COVID-19 in adults with Chronic Obstructive Pulmonary Disease (COPD) and to explore the impact of this condition on patient's physical activity level, health-related quality of life, and the use of healthcare services.

This online survey seeks adult participants who have COPD, have had COVID-19, can read, and write in English, and are willing to complete a survey of approximately 20-25 minutes. There are no risks or direct benefits associated with participating in this survey. We would greatly appreciate it if you could please answer all questions completely and to the best of your knowledge.

Your participation is completely voluntary, and you may choose to skip questions. The survey system will not record your e-mail address or Internet protocol (IP) address. The information provided will be treated with strict confidence i.e., nobody will be able to trace the responses to you. The information from the survey responses will be grouped with the responses from other participants which will be used only for research purposes. This study and survey have been approved by the University of Manitoba Health Research Ethics Board.

In acknowledgement of your time to complete this survey, at the end of the survey you can enter a draw to win a $50 online gift card. A total of one $50 gift card will be given out. At the end of the survey, if you want to enter the draw, you will be directed to a new page to enter your email address. This information will NOT be linked to your survey responses in any way and will be immediately destroyed once all the prizes have been awarded. Please note that once you submit your survey responses you will NOT be able to withdraw them as we cannot link the survey responses back to you. Only completed surveys are eligible to be entered for the draw. Your chance of winning depends on the number participating. Draw prizes will be done within May-June 2025 of the survey being closed.

If you have any questions, please get in touch with okaforp1@myumanitoba.ca or diana.sanchez-ramirez@umanitoba.ca

By selecting "continue" and answering this survey you are consenting to participate.

Continue ☐

Do you live in Manitoba? A. Yes B. No

If no, please discontinue the survey, Thanks for your time.

Please, provide the first 3 digits of your postal code ----------

<u>Section 1: Chronic Obstructive Pulmonary Disease (COPD)</u>

1. Have you been diagnosed with COPD? A. Yes B. No

   If **no**, please discontinue with the rest of the questions. Thanks for your time.

2. If yes, for how long? A. less than 1 year B. 1-5 years C. 5-10 years D. more than 10 years
3. What is the current stage of COPD? A. 1st B. 2nd C. 3rd D. 4th E. unknown

Section 2: COVID-19 and its persistent symptoms

4. Have you had COVID-19? A. No B. Yes

If **no**, please move to **section 8 (page 15)**

5. If yes, how many times? A.1 B. 2 C.3 D.4 E. 5 F. >5

If you had COVID-19 more than once, refer to the **first time**

6. When was it? ----------(mm/yy)

7. Was COVID-19 confirmed with a test (PCR or rapid test)? A. Yes B. No
8. How many COVID-19 vaccines did you have at the time you had COVID-19? A. 0 B)1 C) 2 D) more than 2
9. Were you admitted to the hospital because of COVID-19? A. Yes B. No
10. Did you require treatment in the intensive care unit (ICU) because of COVID-19? A. Yes B. No
11. Did you have any persistent COVID-19 symptoms after you have recovered from COVID-19 infection? (Persistent COVID-19 symptoms are a wide range of symptoms and conditions that some people experience 3 months or more after an initial infection by SARS-CoV-2, the virus that causes COVID-19).

A. Yes B. No

12. The questions below show different COVID-19 symptoms, how long you have had them, and if you experienced these symptoms before COVID-19. Please select appropriately. (UB- Co-V; assessing long covid in WNY)

Symptoms	Did you experience any of these symptoms when you had COVID?		How long did you have them?		Currently experiencing these symptoms			Did you have these symptoms before you had COVID?	
	No	Yes →	Less than 3 months	More than 3 months	No	Yes, a little bit	Yes, a lot more	No	Yes
Fever	O	O	O	O	O	O	O	O	O
Fatigue (at rest)	O	O	O	O	O	O	O	O	O
Fatigue (with exertion)	O	O	O	O	O	O	O	O	O
Generalized feelings of illness (Malaise)	O	O	O	O	O	O	O	O	O
Headache	O	O	O	O	O	O	O	O	O
Dizziness	O	O	O	O	O	O	O	O	O
Chest pain (at rest)	O	O	O	O	O	O	O	O	O
Chest pain (with exertion)	O	O	O	O	O	O	O	O	O

Chest tightness/Angina	O	O	O	O	O	O	O	O	O
Fast beating heart, heart pounding (palpitations)	O	O	O	O	O	O	O	O	O
Short of breath (at rest)	O	O	O	O	O	O	O	O	O
Short of breath (at exertion)	O	O	O	O	O	O	O	O	O
Wheezing (at rest)	O	O	O	O	O	O	O	O	O
Wheezing (at exertion)	O	O	O	O	O	O	O	O	O
Cough	O	O	O	O	O	O	O	O	O
Joint pain	O	O	O	O	O	O	O	O	O
Muscle pain	O	O	O	O	O	O	O	O	O
Tingling/burning sensation	O	O	O	O	O	O	O	O	O
Body weakness	O	O	O	O	O	O	O	O	O

Section 3: Physical activity level

13. The following are questions about the frequency of how you engage in physical activities in a typical week (IPAQ, short form)

1a. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ days per week

……No vigorous physical activities

1b. How much time did you usually spend doing vigorous physical activities on one of those days?

_____ hours per day

_____ minutes per day

……Don't know/Not sure

.

1c. Compared to before you had COVID-19, your vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling was?

A. the same B. more C. less D. not applicable

2a. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ days per week

….. No moderate physical activities

2b. How much time did you usually spend doing moderate physical activities on one of those days?

_____ hours per day

_____ minutes per day

…. Don't know/Not sure

2c. Compared to before you had COVID-19, your moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis was?

A. the same B. more C. less D. not applicable

3a. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

_____ days per week

….. No walking

3b. How much time did you usually spend walking on one of those days?

_____ hours per day

_____ minutes per day

……Don't know/Not sure

3c. Compared to before you had COVID-19, your walk for at least 10 minutes at a time was?

A. the same B. more C. less D. not applicable

4. During the last 7 days, how much time did you spend sitting on a weekday? _____ hours per day

_____ minutes per day

…… Don't know/Not sure

4b. Compared to before you had COVID-19, the time you spent sitting on a weekday was?

A. the same B. more C. less D. not applicable

5. In general, your physical activity level now compared to before you had COVID-19 is?

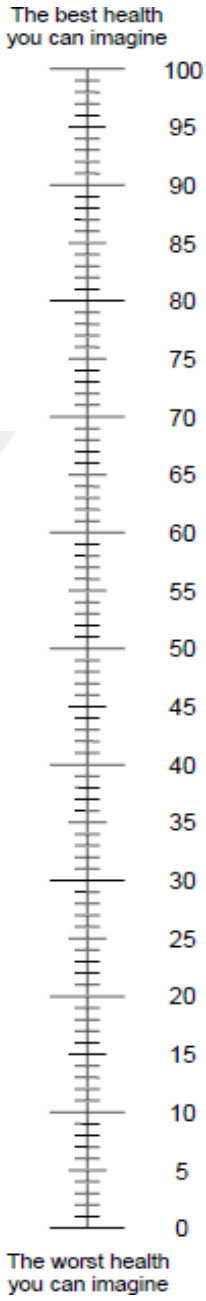
A. the same B. less C. more

Section 4: Health-related quality of life

14. Under each heading, please select ONE box in each column that best describes your health Today and Before you had COVID (EQ-5D).

	Today	Before you had COVID
MOBILITY I have no problems walking about	O	O
I have slight problems walking about	O	O
I have moderate problems walking about	O	O
I have severe problems walking about	O	O
I am unable to walk about	O	O
SELF-CARE I have no problems washing or dressing myself	O	O
I have slight problems washing or dressing myself	O	O
I have moderate problems washing or dressing myself	O	O
I have severe problems washing or dressing myself	O	O
I am unable to wash or dress myself	O	O
USUAL ACTIVITIES (e.g., work, study, housework, family or leisure activities) I have no problems doing my usual activities	O	O
I have slight problems doing my usual activities	O	O
I have moderate problems doing my usual activities	O	O

I have severe problems doing my usual activities	O	O
I am unable to do my usual activities	O	O
PAIN/DISCOMFORT I have no pain or discomfort	O	O
I have slight pain or discomfort	O	O
I have moderate pain or discomfort	O	O
I have severe pain or discomfort	O	O
I have extreme pain or discomfort	O	O
ANXIOUS/DEPRESSION I am not anxious or depressed	O	O
I am slightly anxious or depressed	O	O
I am moderately anxious or depressed	O	O
I am severely anxious or depressed	O	O
I am extremely anxious or depressed	O	O



We would like to know how good or bad your health is TODAY and BEFORE COVID-19.

This scale is numbered from 0 to 100.

100 means the best health you can imagine.

0 means the worst health you can imagine.

Now, please write the number you marked on the scale in the box below.

YOUR HEALTH TODAY =

YOUR HEALTH BEFORE YOU HAD COVID =

Section 5: Use of Health care services

15. Please select how often you use the healthcare services both before and after you had COVID-19 (resource utilization (RU) questionnaire).

Health Services or healthcare providers	**After you had COVID, how often have you been using the following services?**						**Before you had COVID, how often have you been using the following services?**					
	Never	Once a week	Once a Month	Once in 3 months	Once in 6 months	Once a year	Never	Once a week	Once a Month	Once in 3 months	Once in 6 months	Once a year
Family physician or nurse	O	O	O	O	O	O	O	O	O	O	O	O
One or more specialist (e.g. respirologist, cardiologist, etc.)	O	O	O	O	O	O	O	O	O	O	O	O
Respiratory Therapist	O	O	O	O	O	O	O	O	O	O	O	O
Physical Therapist	O	O	O	O	O	O	O	O	O	O	O	O
Occupational therapist	O	O	O	O	O	O	O	O	O	O	O	O
Psychologist/Psychotherapist	O	O	O	O	O	O	O	O	O	O	O	O
Social worker	O	O	O	O	O	O	O	O	O	O	O	O

Emergency room	O	O	O	O	O	O	O	O	O	O	O	O
Hospitalization	O	O	O	O	O	O	O	O	O	O	O	O

15b. In general, the use of healthcare services now compared to before you had COVID-19 is?

A. the same B. more C. less

Section 6: COPD Assessment Test (CAT)

16a. For each item below, place a mark (X) in the box that best describes your current situation. Please ensure that you select only one response for each question.

E.g. I am very happy	0	1	2 X	3	4	5	I am very sad
I have no phlegm (mucus) on my chest at all	0	1	2	3	4	5	My chest is full of phlegm (mucus)
My chest does not feel tight at all	0	1	2	3	4	5	My chest feels very tight When I walk up a hill or a flight of stairs
I am not out of breath	0	1	2	3	4	5	When I walk up a hill or a flight of stairs I am completely out of breath
I am not limited to doing any activities at home	0	1	2	3	4	5	I am completely limited to doing all activities at home
I am confident leaving my home despite my lung condition	0	1	2	3	4	5	I am not confident leaving my home at all because of my lung condition
I sleep soundly	0	1	2	3	4	5	I do not sleep soundly because of my lung condition
I have lots of energy	0	1	2	3	4	5	I have no energy at all
I never cough	0	1	2	3	4	5	I cough all the time

16b. Compared to before you had COVID-19, your situation from the above table was

A. the same B. worse C. better

Section 7; Cough Symptoms

17. Do you have cough symptoms? A. Yes B. No

If you do not have any cough symptoms, please proceed to section 13 (page 22)

18. These questions are to assess the impact of cough on various aspects of your life. Mark one option from 1 to 7 that best applies to you (Leicester Cough Questionnaire).

1=all the time 2=most of the time 3=a good bit of the time 4=some of the time 5=a little bit of the time 6=hardly any of the time 7=none of the time							
	1=all	2	3	4	5	6	7=none
In the past 2 weeks, have you had chest or stomach pains as a result of your cough?	O	O	O	O	O	O	O
In the last 2 weeks, have you been bothered by sputum (phlegm) production when you cough?	O	O	O	O	O	O	O
In the last 2 weeks, have you been tired because of your cough?	O	O	O	O	O	O	O
How often during the last 2 weeks have you felt embarrassed by your coughing?	O	O	O	O	O	O	O
In the last 2 weeks, has your cough made you feel anxious?	O	O	O	O	O	O	O
In the last 2 weeks, has your cough interfered with your job or other daily tasks?	O	O	O	O	O	O	O
In the last 2 weeks, have you felt that your cough interfered with the overall enjoyment of your life?	O	O	O	O	O	O	O
In the last 2 weeks, has exposure to paints or fumes made you cough?	O	O	O	O	O	O	O
In the last 2 weeks, has your cough disturbed your sleep?	O	O	O	O	O	O	O
In the last 2 weeks, how many times a day have you had coughing bouts?	O	O	O	O	O	O	O
In the last 2 weeks, has your cough made you feel frustrated?	O	O	O	O	O	O	O

In the last 2 weeks, has your cough made you feel fed up?	O	O	O	O	O	O	O
In the last 2 weeks, have you suffered from a hoarse voice as a result of your cough?	O	O	O	O	O	O	O
In the last 2 weeks, have you worried that your cough may indicate serious illness?	O	O	O	O	O	O	O
In the last 2 weeks, have you been concerned that other people think something is wrong with you, because of your cough?	O	O	O	O	O	O	O
In the last 2 weeks, has your cough interrupted conversations or telephone calls?	O	O	O	O	O	O	O
In the last 2 weeks, do you feel that your cough has annoyed your partner, family, or friends?	O	O	O	O	O	O	O

1=none of the time 2=hardly any of the time 3=a little of the time 4=some of the time 5=a good bit of the time 6=most of the time 7=all of the time							
	1=none	2	3	4	5	6	7=all
In the last 2 weeks, have you felt in control of your cough?	O	O	O	O	O	O	O
In the last 2 weeks, have you had a lot of energy?	O	O	O	O	O	O	O

Section 8: Physical activity level

The following are questions about the frequency of how you engage in physical activities in a typical week (IPAQ, short form)

1a. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ days per week

……No vigorous physical activities

1b. How much time did you usually spend doing vigorous physical activities on one of those days?

_____ hours per day

_____ minutes per day

……Don’t know/Not sure

2a. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ days per week

….. No moderate physical activities

2b. How much time did you usually spend doing moderate physical activities on one of those days?

_____ hours per day

_____ minutes per day

…. Don’t know/Not sure

3a. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

_____ days per week

….. No walking

3b. How much time did you usually spend walking on one of those days?

_____ hours per day

_____ minutes per day

……Don’t know/Not sure

4. During the last 7 days, how much time did you spend sitting on a weekday? _____ hours per day

_____ minutes per day

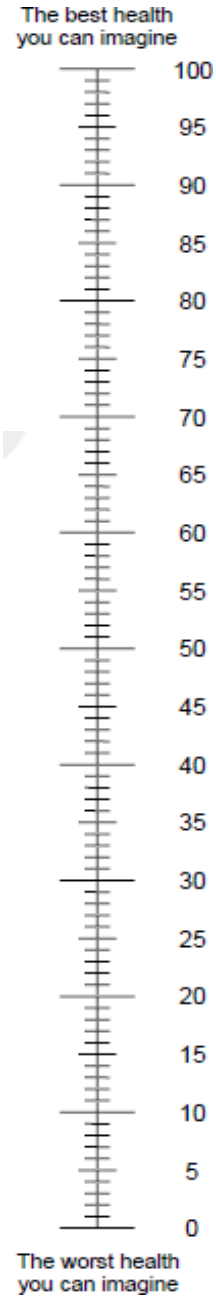
…… Don’t know/Not sure

Section 9: Health-related quality of life

Under each heading, please select ONE box in each column that best describes your health Today (EQ-5D).

	Today
MOBILITY I have no problems walking about	O
I have slight problems walking about	O
I have moderate problems walking about	O
I have severe problems walking about	O
I am unable to walk about	O
SELF-CARE I have no problems washing or dressing myself	O
I have slight problems washing or dressing myself	O
I have moderate problems washing or dressing myself	O
I have severe problems washing or dressing myself	O
I am unable to wash or dress myself	O
USUAL ACTIVITIES (e.g., work, study, housework, family or leisure activities) I have no problems doing my usual activities	O
I have slight problems doing my usual activities	O

I have moderate problems doing my usual activities	O
I have severe problems doing my usual activities	O
I am unable to do my usual activities	O
PAIN/DISCOMFORT I have no pain or discomfort	O
I have slight pain or discomfort	O
I have moderate pain or discomfort	O
I have severe pain or discomfort	O
I have extreme pain or discomfort	O
ANXIOUS/DEPRESSION I am not anxious or depressed	O
I am slightly anxious or depressed	O
I am moderately anxious or depressed	O
I am severely anxious or depressed	O
I am extremely anxious or depressed	O



We would like to know how good or bad your health is TODAY

This scale is numbered from 0 to 100.

100 means the best health you can imagine.

0 means the worst health you can imagine.

Now, please write the number you marked on the scale in the box below.

YOUR HEALTH TODAY = ☐

Section 10: Use of Health care services

Please select how often you use the healthcare services now (resource utilization (RU) questionnaire).

Health Services or healthcare providers	After you had COVID, how often have you been using the following services?					
	Never	Once a week	Once a Month	Once in 3 months	Once in 6 months	Once a year
Family physician or nurse	O	O	O	O	O	O
One or more specialist (e.g. respirologist, cardiologist, etc.)	O	O	O	O	O	O
Respiratory Therapist	O	O	O	O	O	O
Physical Therapist	O	O	O	O	O	O
Occupational therapist	O	O	O	O	O	O
Psychologist/Psychotherapist	O	O	O	O	O	O
Social worker	O	O	O	O	O	O

Emergency room	O	O	O	O	O	O
Hospitalization	O	O	O	O	O	O

Section 11; COPD Assessment Test (CAT)

For each item below, place a mark (X) in the box that best describes your current situation. Please ensure that you select only one response for each question.

E.g. I am very happy	0	1	2 X	3	4	5	I am very sad
I have no phlegm (mucus) on my chest at all	0	1	2	3	4	5	My chest is full of phlegm (mucus)
My chest does not feel tight at all	0	1	2	3	4	5	My chest feels very tight When I walk up a hill or a flight of stairs
I am not out of breath	0	1	2	3	4	5	When I walk up a hill or a flight of stairs I am completely out of breath
I am not limited to doing any activities at home	0	1	2	3	4	5	I am completely limited to doing all activities at home
I am confident leaving my home despite my lung condition	0	1	2	3	4	5	I am not confident leaving my home at all because of my lung condition
I sleep soundly	0	1	2	3	4	5	I do not sleep soundly because of my lung condition
I have lots of energy	0	1	2	3	4	5	I have no energy at all
I never cough	0	1	2	3	4	5	I cough all the time

Section 12; Cough Symptoms

Do you have cough symptoms? A. Yes B. No

If you do not have any cough symptoms, please proceed to section 13 (page 22)

These questions are to assess the impact of cough on various aspects of your life. Mark one option from 1 to 7 that best applies to you (Leicester Cough Questionnaire).

1=all the time 2=most of the time 3=a good bit of the time 4=some of the time 5=a little bit of the time 6=hardly any of the time 7=none of the time							
	1=all	2	3	4	5	6	7=none
In the past 2 weeks, have you had chest or stomach pains as a result of your cough?	O	O	O	O	O	O	O
In the last 2 weeks, have you been bothered by sputum (phlegm) production when you cough?	O	O	O	O	O	O	O
In the last 2 weeks, have you been tired because of your cough?	O	O	O	O	O	O	O
How often during the last 2 weeks have you felt embarrassed by your coughing?	O	O	O	O	O	O	O
In the last 2 weeks, has your cough made you feel anxious?	O	O	O	O	O	O	O
In the last 2 weeks, has your cough interfered with your job or other daily tasks?	O	O	O	O	O	O	O
In the last 2 weeks, have you felt that your cough interfered with the overall enjoyment of your life?	O	O	O	O	O	O	O
In the last 2 weeks, has exposure to paints or fumes made you cough?	O	O	O	O	O	O	O
In the last 2 weeks, has your cough disturbed your sleep?	O	O	O	O	O	O	O
In the last 2 weeks, how many times a day have you had coughing bouts?	O	O	O	O	O	O	O
In the last 2 weeks, has your cough made you feel frustrated?	O	O	O	O	O	O	O
In the last 2 weeks, has your cough made you feel fed up?	O	O	O	O	O	O	O
In the last 2 weeks, have you suffered from a hoarse voice as a result of your cough?	O	O	O	O	O	O	O

In the last 2 weeks, have you worried that your cough may indicate serious illness?	O	O	O	O	O	O	O
In the last 2 weeks, have you been concerned that other people think something is wrong with you, because of your cough?	O	O	O	O	O	O	O
In the last 2 weeks, has your cough interrupted conversations or telephone calls?	O	O	O	O	O	O	O
In the last 2 weeks, do you feel that your cough has annoyed your partner, family, or friends?	O	O	O	O	O	O	O

1=none of the time 2=hardly any of the time 3=a little of the time 4=some of the time 5=a good bit of the time 6=most of the time 7=all of the time							
	1=none	2	3	4	5	6	7=all
In the last 2 weeks, have you felt in control of your cough?	O	O	O	O	O	O	O
In the last 2 weeks, have you had a lot of energy?	O	O	O	O	O	O	O

Section 13: Demographic Information and Smoking History

1.What sex were you assigned at birth? A. Male B. Female C. Prefer not to say

2.What is your age? A. 18-29 B. 30-39 C.40-49 D. 50-59 E. 60-69 F. 70 and above

3. Where do you reside? A. Urban area B. Rural area

4. What is your current employment status? A. Employed/self-employed B. Unemployed C. Retired D. Sick or disability leave E. choosing not to work F. Prefer not to say

5. Have you ever smoked cigarette? A. Yes B. No

If No, Skip to No. 9

6. If yes, for how long? A. 0-12 months B. 1- 5 years C. +6 years

7. Do you smoke cigarettes currently? A. Yes B. No

8. If yes, on average, how many times per day do you smoke cigarettes? A. 1 B. 2 C.3 D. 4 E.5 F. >5

9. Do you currently live with anyone who smokes cigarettes? A. Yes B. No

10. Do you smoke cannabis? A. Yes B. No

11. Do you vape? A. Yes B. No

12. Do you have any other health condition aside from COPD? A. Yes B. No

If yes, please specify----------

Thanks for completing this survey!

If you have any questions regarding this survey, please don't hesitate to contact okaforp1@myumanitoba.ca or diana.sanchez-ramirez@umanitoba.ca

Are you interested in participating in a raffle draw to win a $50 online gift card? A. Yes B. No

If yes, please email me at okaforp1@myumanitoba.ca.

APPENDIX 3

Recruitment of study participants

1. Social media platforms
    - Facebook
    - Instagram

2. Individuals support groups
    - Manitoba Quits
    - COPD/COAD support
    - COPD Awareness
    - COPD Christians
    - Long COVID Support Group

3. Support from Manitoba Lung Association
4. Advertised poster on Respiratory therapy research day 2025
5. Support from Respiratory therapists and other health professionals
6. Accommodation for physical copies
7. Walk-in clinics and pharmacies
    - Assiniboine Medical clinic- spirometry lab
    - Pembina medical clinic
    - Markham medical clinic
    - Astro medical clinic
    - Winnipeg clinic
    - Access fort Garry clinic
    - Elite sport injury clinic
    - Dakota clinic
    - St vital physio clinic
    - South Winnipeg physio clinic

- Save on food pharmacy
- Freshco pharmacy
- The medicine shopper pharmacy
- Pure lifestyle
- St vital physio clinic
- South Winnipeg physio clinic
- Save on food pharmacy
- Freshco pharmacy
- The medicine shopper pharmacy
- Pure lifestyle
- Winnipeg Lung Diagnostics

8. Community Centres (CC)

- Norberry –Glenn's CC
- Greendell park CC
- Dakota CC
- Winakwa CC
- Earl Grey CC
- Reh Fit center
- Norwood CC
- Windsor CC
- Southdale CC
- Youville community health center
- Youville diabetic center

9. Seniors Facilities

- The Westhaven Atria retirement
- Seine River retirement residence
- Riverside Lions senior residence
- Misericordia terrace
- Golden rule senior resources center

- Good Neighbours active center
- St vital knight villa
- Kirchhoff Gardens

10. Public Libraries
    - Louis riel library
    - St vital library
    - Windsor park library
    - Osborne library

APPENDIX 4

Posters for Recruitment

Do you have Chronic Obstructive Pulmonary Disease (COPD)?
And you have had COVID-19?

Please help us understand the impact of post COVID-19 on COPD patients living in Manitoba, Canada.

National Emphysema Foundation

Who can participate?

- Adults in Manitoba who have COPD and have experienced COVID-19 symptoms.

How can you participate?

- Scan this QR code with the camera of your phone or click the link below, complete the survey and get a chance to be in a raffle draw to win a $50 online gift card
  https://redcap.link/qqogsx7v

Respirability Lab

Questions? Contact us:
204-480-1346 RespirabilityLab@gmail.com
or okaforp1@myumanitoba.ca

UM | Rady Faculty of Health Sciences

DO YOU HAVE COPD?

SIGN UP HERE!

SURVEY PARTICIPANTS WANTED!

We are launching an upcoming study that will look at the impact that post-COVID symptoms have had on people living with COPD. This study is an anonymous one-time survey questionnaire that can be completed online, but eligible participants can be provided alternative methods (e.g. paper questionnaire, large text format, phone survey) to accommodate any accessibility needs.

ELIGIBILITY:

- Currently living with COPD
- Experiencing post-COVID symptoms
- Willing to talk about their experiences
- Willing to answer an online survey
- Chance to win one (1) $50 Gift Card!

CONTACT US TO LEARN MORE!

204-480-1346

respirabilitylab@gmail.com

Use the QR code above or go to:
respirabilitylab.com/participate

Respirability Lab

University of Manitoba

Respirability Lab

University of Manitoba

DO YOU LIVE WITH COPD?

WE WANT TO HEAR FROM YOU!

PARTICIPANTS WANTED!

ONLINE SURVEY
FOR PEOPLE LIVING WITH COPD AND POST-COVID SYMPTOMS

TELL US ABOUT IT!
SURVEY QUESTIONS WILL ASK YOU ABOUT YOUR EXPERIENCES

ENTER FOR A CHANCE TO WIN!
PARTICIPANTS WHO COMPLETE THE SURVEY WILL BE ENTERED FOR A CHANCE TO WIN ONE (1) $50 VISA GIFT CARD!

*FULL DETAILS AVAILABLE AT SURVEY LINK

SURVEY LINK:

Scan the QR code to access the survey

Or go to:

respirabilitylab.com/participate

Questions?

204-480-1346

respirabilitylab@gmail.com

DO YOU HAVE COPD?

SCAN HERE!

We are looking for research survey participants!

We are launching an upcoming study that will look at the impact that post-COVID symptoms have had on people living with COPD. This study is an anonymous one-time survey questionnaire that can be completed online, but eligible participants can be provided alternative methods (e.g. paper questionnaire, large text format, phone survey) to accommodate any accessibility needs.

- *Currently living with COPD*
- *Has experienced COVID symptoms*
- *Willing to provide information on their experiences*
- *Willing to answer a survey questionnaire*

Enter for a chance to win one (1) $50 Visa Gift Card!

204-480-1346

respirabilitylab@gmail.com

Use the QR code above or to go respirabilitylab.com/participate

University of Manitoba

Respirability Lab

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