The Epidemiology of COVID-19 Disease Progression at UPMC Mercy Hospital in Pittsburgh PA: effect of risk factors comorbidities, and personal characteristics on severity and prognosis.

by

Shekinah Immea Hudson

BS in Biological Science, Louisiana Tech University, 2017

Submitted to the Graduate Faculty of the

Department of Infectious Diseases and Microbiology

Graduate School of Public Health in partial fulfillment

of the requirements for the degree of

Master of Public Health

University of Pittsburgh

2021

UNIVERSITY OF PITTSBURGH

GRADUATE SCHOOL OF PUBLIC HEALTH

This essay was presented

by

Shekinah Hudson

It was defended on

April 26, 2021

and approved by

Essay Reader: Jeremy Martinson, DPhil, Infectious Diseases and Microbiology, Graduate School of Public Health, University of Pittsburgh

Essay Advisor: Mohamed Yassin, MD, DPhil, UPMC Mercy Hospital, Infectious Diseases and Microbiology, Graduate School of Public Health, University of Pittsburgh

The Epidemiology of COVID-19 Disease Progression at UPMC Mercy Hospital in Pittsburgh PA: effect of risk factors comorbidities, and personal characteristics on severity and prognosis.

Shekinah Hudson, MPH

University of Pittsburgh, 2021

Abstract

The SARS-CoV-2 disease (COVID-19) outbreak, officially categorized as a pandemic in March 2020, poses a greater risk for individuals with pre-disposed chronic conditions. It is important to analyze the clinical characteristics of COVID-19 and identify risk factors to reduce the incidence of severe symptoms. Individuals have chronic conditions are at a higher risk of rapid disease progression. However, personal characteristics such as age, gender, and ethnicity can be vital factors regarding disease severity. The aim of this study is to analyze the discrepancies of patients with different comorbidities and risk factors for severe COVID-19 by comparing the epidemiological and clinical data of 50 patients from UPMC Mercy in Pittsburgh, Pa. A systematic review was conducted to collect and evaluate the associations of epidemiological and comorbidity factors with the severity and prognosis of COVID-19. This study will dive into 16 comorbidities and compartmentalize them by similar characteristics to further exam divergences. The age, gender, length of stay, ventilation, mortality, and other variants were utilized during this study. The average age for severe disease progression is 78 years old. Males were more susceptible to severe cases of COVID-19. Nearly 80% of patients had Hypertension (HTN). The diagnosis of hypertension was present in 93% of severe cases. Ventilation treatment was observed in 46% of patients and 30% of patients were placed in the ICU. The Comorbidity with the highest index is Cancer (9), the most prevalent comorbidity is hypertension (Frequency 64%). Our findings suggest

a correlation in severity between age and comorbidity as well as severity and zip code. Additional research is needed to further understand the severity of COVID-19's progression.

Table of Contents

List of Tables

List of Figures

Definitions

Charlson Comorbidity Index: a method that is used to categorize comorbidities of patients based on the International Classification of Diseases (ICD) diagnosis codes found in administrative data.

Chronic Disease: conditions that last more than one year and requires on-going medical attention; limits activities of daily living

Comorbidity: The simultaneous presence of two or more diseases or medical conditions in a patient.

Epidemiology: The branch of medicine which deals with the incidence, distribution and possible control of disease and other factors relating to health.

Risk Factor: In epidemiology, it is a variable associated with an increased risk of diseases or infection.

R Naught (R0): the average number of cases of an infectious disease arising by transmission from a single infected individual in an area that has not been exposed.

Sars-Cov-2: a member of a large family of viruses called coronavirus.

Surveillance: The continued watchfulness over the distribution and trends of incidence through the systematic collection of morbidity and mortality reports.

Acknowledgements

This is made in conjunction with UPMC Mercy Infectious Disease Department and the University of Pittsburgh Graduate School or Public Health.

1.0 Introduction

1.1 What is the coronavirus?

The coronavirus is a type of virus composed of the phylogenetically distinct taxonomic subgroups alpha and beta ($\alpha \; and \; \beta$). The World Health Organization defines the coronavirus as a large family of viruses that causes illness that resembles the common cold or severe acute respiratory disease. The strain nCoV is a new strain that has recently crossed over to humans [1]. SARS-CoV, MERS-CoV, and SARS-CoV-2 are related to the β-Coronavirus cluster. Both SARS viruses are from enzootic in *Rhinolophus* or horseshoe bats. The figure below depicts the main subtypes of the coronavirus and the strains within each category.

1.2 Life Cycle of COVID-19

The virus is inhaled and enters cells in the lungs that express the ACE-2 receptor, a chimeric protein wherein SARS-CoV and SARS-CoV-2 bind ACE2 [2]. ACE2 is differentiated from other viral receptors in that it interfaces with a major endocrine vasoactive signaling pathway, the renin-angiotensin-aldosterone system (RAAS)[2]. ACE2 is present in the GI tract, adipose tissue, arterial and venous endothelial cells, heart, kidney, liver, and mucosa of the oral cavity [2], which is why underlying conditions such as heart failure and diabetes are observed. ACE2 levels change in

[1] WHO, 2020

[2] Richard, 2020

obesity, diabetes, heart disease, hypertension, and kidney and lung disease, which is another differentiating characteristic of this viral receptor [2]; therefore, by increasing viral internalization, ACE2 upregulation may enhance the viral load and increase disease severity [2]. After penetration, the cell engulfs the virus, and it releases its RNA. This prompts cellular replication wherein the RNA particles are assembled and packages, as shown in the figure above. RNA replications occur, the virus spreads, and the immune response begins.

1.3 Epidemiology of COVID-19

Data supports the theory, "emergence over detection." Disease emergence requires a bridge from the natural host to a susceptible spillover host with the ability to adapt as time progress [3]. This notion stems from the long-term circulation of these viruses remaining in their host until something prompts their spillover.

Scientists have uncovered numerous animal reservoirs of Coronavirus, mainly in Africa, Asia, and America. Over the past decade, the coronaviral ecosystem, viral response, and risk of spillover from animal to human have become more well understood. For example, the SARS-CoV virus originates from wet markets in the southern area of Asia, with the Rhinolophus species being the natural host. Research shows that the cages from these wet markets are often crowded and heavily contaminated with feces, expired food, and poorly maintained living conditions. Targeted surveillance and improved diagnostics are not efficient enough to explain the emergence of these viruses [3]. Disease outbreak evidence supports the notion that the coronavirus outbreaks were

[3] Field, 2009

inevitable as crossover events between humans and the animal reservoirs are becoming impossible to avoid. Thus, various coronavirus strains have emerged recently (SARS-COV and SAR-COv-2) as scientists believe that this is only the beginning.

The SARS-CoV-2 disease (COVID-19) outbreak, officially categorized as a pandemic in March 2020, poses a greater risk for individuals with pre-disposing chronic conditions. It is slightly different from other strains of the coronavirus due to its high transmission rate. The course of COVID-19 illness can progress rapidly, causing acute respiratory distress syndrome, Gastroesophageal reflux (GERD), and pneumonia. Patients with the disease present with fever, cough, and shortness of breath within 2 to 14 days after exposure. It is essential to analyze the clinical characteristics of COVID-19 and identify risk factors to reduce the incidence of severe symptoms. Individuals who have chronic conditions are at a higher risk of rapid disease progression. However, personal characteristics such as age, gender, and ethnicity can be vital factors regarding disease severity. It is imperative to understand the virus, its interaction with the human species, and elimination or vaccine strategies to combat future emergencies of the coronavirus.

2.0 Methods

The aim of this study is to analyze the discrepancies of patients with different comorbidities and risk factors for severe COVID-19 by comparing the epidemiological and clinical data of 50 patients from UPMC Mercy in Pittsburgh, Pa. We hypothesize that the number of risk factors experienced by each pre-disposed patient will increase the speed of progression of the virus at a higher rate varying certain risk characteristics during hospitalization. We would also like to highlight additional personal characteristics, risk factors and comorbidities that increases disease severity for public knowledge. Severity was measured by combining causes such as patients on ventilation systems, admitted into the ICU, and death records. Non-severe cases included patients who did not need supplemental oxygen, were not admitted to the ICU, and released from the hospital after five days.

2.1 UPMC Mercy

UPMC Mercy hospital is a level I (highest level) Trauma center designed to treat severe or life-threatening illnesses. A retrospective review of 50 inpatients at UPMC Mercy Hospital Pittsburgh, PA, was conducted between October 2020 and March 2021 to collect and evaluate the associations of epidemiological comorbidity factors with the severity and prognosis of COVID-19. 120 patients who tested positive for COVID19 were screened, and 50 of these patients were chosen randomly and thoroughly reviewed. Fifteen variables were recorded, including length of stay, Zip code, social history, blood pressure, and height. The screening process relied on patient

charts that were continuously updated during the study. Next, the data were entered into Microsoft Excel to calculate the statistical information necessary to accept the hypothesis.

2.2 Prognosis

This study utilized prognosis endpoints to predict COVID-19 outcomes. The prognosis in this study is the probability of risks of an individual developing COVID-19 throughout 12 months based on personal and clinical characteristics. This tool will aid in predicting disease progression [4]as a general stance. Prognosis can surround a patient's gender, age, test results (positive COVID-19), and symptoms[4]. A modified version of the Charlson Comorbidity Index will aid in determining the risk of a more severe case given the combination of causation of predictor values [4]. As these patients are in the UPMC Mercy's database, there are endless possibilities for future studies such as vaccine reactions, hospital performance differentials amongst the UPMC organization, mortality rates, and possibly clinical studies as information is continuously updated.

2.3 Chronic Disease

During the beginning of the pandemic, there were many uncertainties about the effects of the COVID-19 per individual. Research shows that patients with underlining health conditions are more prominent amongst those with more severe prognosis. Those underlining health conditions included chronic diseases such as diabetes, hypertension, cardiovascular disease, obesity, and renal

[4] Moons, 2009

diseases. The CDC's definition of chronic diseases is defined broadly as "conditions that last one year or more and require ongoing medical attention or limit activities of daily living" [5].

Diabetes is one of the leading causes of death. It is a chronic disease that occurs when the pancreas can no longer produce insulin effectively or often when the body has issues utilizing the produced dosage [6]. Chronic conditions such as diabetes have been implicated as a risk factor for poor prognosis in hospitalized patients with COVID-19. Diabetes mellitus is a significant contributor to mortality from COVID-19, with a rate of 7.3 to 35.5% globally [7]. In this study, 40% of patients suffered from diabetes. The patients' severity was increased with additional underlying medical issue that are outlined in this section.

Hypertension, known to the public as high blood pressure, is another chronic disease that many individuals suffer. Scientifically, it is "when the force of your blood pushing against the walls of your blood vessels, is consistently high" [8]. Hypertension can be an underlying condition to another chronic illness called cardiovascular disease. Many of the patients suffered from high blood pressure, aiding to disease severity.

Cardiovascular disease, chronic heart failure, is when atherosclerosis affects the heart. Atherosclerosis is a condition that develops when plaque builds up in the walls of the arteries [8]. Due to the commonality of this disease, many hospitalized COVID-19 patients endure this chronic disease as its effects are hypothesized to add to the severity of disease progression. A study in China evaluated the clinical characteristics of patients admitted for COVID-19 infection and

---

[5] CDC, 2021

[6] IDF,2020

[7] Anjorin, 2021

[8] AHA, 2016

showed that 31% of patients had hypertension and up to 15% had congestive heart failure[7]. The results for Pittsburgh, Pa were similar to those of China.

Obesity has been a public health issue in the United States for decades. Early reports from Europe and China have shown a higher prevalence of obesity among patients hospitalized with COVID-19 or who develop adult respiratory distress syndrome. An exciting hypothesis relies on fatty tissue possibly being a reservoir for viral replication and shedding. Nevertheless, obesity causes an array of underlying health concerns that, when combined with COVID-19, is hypothesized to be the cause of increasing severity and disease progression. Obesity was prevalent in people under the age of 65 years old.

Next, chronic kidney disease and renal disease become critical when the kidneys are damaged and cannot filter blood efficiently [9]. Many individuals with diabetes, hypertension, and disease are more susceptible to developing kidney disease, making this a large percentage of comorbidities globally. Patients with underlying kidney disease and undergoing dialysis were found to have increased mortality when infected with SARS-CoV-2 [7]. Many patients were on hemodialysis as noted in their charts.

Diabetes, Hypertension, cardiovascular disease, obesity, and chronic kidney diseases are chronic diseases that increase severity and mortality rates for the at-risk populations. Statistically, during the initial outbreak in Wuhan, China, the death rate among individuals with comorbidities such as chronic heart disease (10.5%), 7.3%, diabetes (7.3%), Respiratory disease (7%), hypertension (6%), and cancer (5%) (AHA,2020) raised concern. We conducted a study that

[9] NIH, 2018

analyzed comorbidities, risk factors, and personal characteristics to see if there is a pattern in cases globally.

2.4 Comorbidity Compartments

The Charlson Comorbidity Index is used to assess if a person will live long enough to benefit from a specific screening measure or medical intervention. Charlson gave each disease a one-year mortality rate scoring number ranging from 1-6 points. In the chart below, the point given is in parenthesis under the comorbidity section. With each increased level of the comorbidity index, step by step escalations in the accumulative mortality attributable to comorbid diseases [10]. The patient's disease history was categorized in the chart below.

Table 1: Comorbidity Compartments

Charlson Comorbidity Index

Comorbidity Component	Specifications	Points
Myocardial Infarction	History of coronary artery disease (CAD)	1
Congestive Heart Failure	Right or Left sided heart failure, heart disease, Atrial Fibrillation, cardiac dysrhythmias,	1
Chronic Respiratory Disease	Lung deficiency, pneumonia, acute cases, dyspnea, Respiratory failure,	3
Cerebrovascular Accident	Cerebrovascular disease, stroke, TIA transient ischemic attack, cognitive and memory impairment, seizures.	2
Renal Disease	Diagnosis	1
COPD	Emphysema, interstitial lung disease, chronic bronchitis	1
Blood Disorders	Hemiplegia, hypocalcemia, GI bleeding, hematomas, hematochezia, hypokalemia	1
Pulmonary Disease	Pulmonary embolism	1
Diabetes	Complicated, end-organ damage, retinopathy, neuropathy, nephropathy	2
Chronic Kidney Disease	Moderate to severe, hemodialysis, stones, kidney injury	2
GERD	Includes gastric ulcers, esophageal ulcers, duodenal ulcers, Barrett's esophagus, Colitis	2
Hypertension	Mild (140/90), severe (180/120)	2
Asthma	Diagnosis	1
Cancer	Metastatic, Leukemia, tumor, Leukocytosis	6
Obesity	Morbid	1
Anemia	Diagnosis	1

[10] Charlson, 1987

3.0 Results

3.1 Statistical Analysis

A comparison of clinical characteristics between severe and non-severe patients was conducted using Microsoft Excel. A *two-sided t-test* was performed using STATA to find the P-value and confidence intervals for each variable in Table 1. There were 50 patients comprised of 31 females and 19 males ranging from the ages of 21-91. Statistically, 30% of patients were severe cases. The mean age of the most severe group is 78 years, the majority of which were male. The most prevalent risk factor for this group was hypertension (93%), and 60% had congestive heart failure. For non-severe cases, the mean age is 66 years, and many suffered from HTN (68%), GERD (51%), and diabetes (48%), all of which affected more of the female patients.

Table 2 Severe Versus Non-Severe Data

Comparison of demographics and clinical characteristics between severe and non-severe patients with COVID-19

VARIABLES	ALL PATIENTS (N=50)	DISEASE SEVERITY		
		Non- Severe (n=35)	Severe (n=15)	P-value
AGE	69.92 (16.91)	66.26 (17.88)	78.8 (10.24)	
GENDER (%)	M 19 F 31	M 12 F 23	M 9 F 6	
BMI	28.49	30.45	22	
COMORBIDITY, N (%)				
NONE	1 (2.00%)	1 (2.86%)	0 (0.00%)	
CANCER	7 (14.00%)	10 (28.57%)	1 (6.67%)	0.543
CHF	12 (24.00%)	13 (37.14%)	9 (60.00%)	0.878
HYPERTENSION	38 (76.00%)	24 (68.57%)	14 (93.33%)	0.034
GERD	21 (42.00%)	18 (51.43%)	5 (33.33%)	0.623
RENAL DISEASE	4 (8.00%)	3 (8.57%)	1 (6.67%)	0.844
COPD	11 (22.00%)	6 (17.14%)	5 (33.33%)	0.938
ASTHMA	6 (12.00%)	5 (14.29%)	0 (0.00%)	0.578
ANEMIA	9 (18.00%)	7 (20.00%)	1 (6.67%)	0.805
CHRONIC KIDNEY DISEASE	9 (18.00%)	3 (8.57%)	6 (40.00%)	0.873
DIABETES	21 (42.00%)	17 (48.57%)	4 (26.67%)	0.832
MYOCARDIAL INFARCTION	2 (4.00%)	2 (5.71%)	2 (13.33%)	0.494
OBESITY	13 (26.00%)	10 (28.57%)	2 (13.33%)	0.382
CHRONIC RESPIRATORY DISEASE	7 (14.00%)	2 (5.71%)	7 (46.67%)	0.356
CVA	16 (32.00%)	12 (34.29%)	5 (33.33%)	0.101
PULMONARY DISEASE	3 (6.00%)	2 (5.71%)	1 (6.67%)	0.865
TREATMENT, N (%)				
INTENSIVE CARE UNIT	15 (30.00%)	0 (0.00%)	15 (100.00%)	
MECHANICAL VENTILATION	23 (46.00%)	10 (28.57%)	13 (86.67%)	
AIR ROOM TEMPERATURE	27 (54.00%)	27 (77.14%)	0 (0.00%)	
LENGTH OF STAY IN HOSPITAL	11.96			
MORTALITY	6 (12.00%)	0 (0.00%)	6 (40.00%)	

NOTES: DATA ARE PRESENTED AS NUMBER (%) OR MEANS (STANDARD DEVIATION) OR MEDIAN (INTERQUARTILE RANGE). P VALUES INDICATE DIFFERENCES BETWEEN SEVERE AND NON-SEVERE PATIENTS.
ABBREVIATED: COVID-19, CORONAVIRUS DISEASE-19; BMI, BODY MASS INDEX; NA, NOT APPLICABLE; CHF, CONGESTIVE HEART FAILURE; GERD, GASTROESOPHAGEAL REFLUX; COPD, CHRONIC OBSTRUCTIVE PULMONARY DISEASE; CVA, CEREBROVASCULAR ACCIDENT

The majority of patients did not receive any supplemental oxygen. Other severe cases included chronic kidney disease (40%) and Respiratory Disease (46%). It is important to note that the respiratory disease category included cases related to COVID-19 and non-SARS pneumonia cases. We received different outcomes than those of global statistics, as the rate of pulmonary disease (6%) and renal disease (8%) for our study were lower than expected. This shows that the average general comorbidities changes per region. The lung-related illness was low as COVID-19 is known to attack the lungs; therefore, conditions such as Asthma were observed, but none of the severe patients suffered from it.

The length of stay was an average of 11 days, although some patients were hospitalized for up to 40-55 days. The average BMI is 28%, with obesity in patients averaging 16%. The average ICU admission was 30%, all being severe cases. Lastly, a two-sided t-test was performed using STATA with a 95% confidence interval. The only P-value that was below the alpha (.05) is hypertension (.03). We counted the number of cases, including mild cases, to calibrate the epidemic response in Pittsburgh, PA

3.2 The Charlson Comorbidity Index

Table 3: Charlson Comorbidity Index

COMORBIDITY (Points)	AGE 20-29	AGE 30-39	AGE 40-49	AGE 50-59	AGE 60-69	AGE 70-79	AGE 80+
CANCER (6)				IIIII II	II	II	IIIII
RENAL DISEASE (1)		I		I		II	
CHRONIC KIDNEY DISEASE (2)				III	II	IIIII	III
CHRONIC RESPIRATORY DISEASE (3)					I	IIII	IIIII I
CONGESTIVE HEART FAILURE (2)				I	III	IIIII IIIII	IIIII IIIII III
CHRONIC OBSTRUCTIVE PULMONARY DISEASE (1)					II	IIIII	IIII
BLOOD DISORDERS (1)		I				II	IIII
DIABETES MELLITUS (2)		I		III	III	IIIII IIII	IIIII
HYPERTENSION (2)		II		IIII	III	IIIII IIIII IIII	IIIII IIIII IIIII
CEREBROVASCULAR ACCIDENT (2)				I	II	IIIII IIII	IIIII IIIII
ASTHMA (1)				III		II	I
MYOCARDIAL INFARCTION (1)						I	II
PULMONARY DISEASE (1)						II	IIIII
GASTROESOPHAGEAL REFLUX (2)		I		IIIII	I	IIIII I	IIIII IIII
ANEMIA (1)		I		II		II	IIII
OBESITY (1)	II	I	I	IIII	I	III	I

Scoring

Total comorbidity component index + Age index = Total comorbidity Score

Age <50 years: 0 points

Age 50-59 years: 1 point

Age 60-69 years: 2 points

Age 70-79 years: 3 points

Patient information that was recorded in October 2020 affected prognosis when rechecked in March 2021. Tally marks were used to count the frequency of the disease per patient per age group. Seniors over the age of 70 were significantly associated with the disease severity and many prognostic endpoints. Comorbidities, including hypertension, diabetes, cardiovascular disease, cerebrovascular disease, COPD, GERD, and chronic kidney disease, contributed significantly to the disease severity and prognostic endpoints of COVID-19. The Comorbidity Index for

Hypertension is 5.0 (Age70+) with a frequency of 32 (64%). Cancer has a Comorbidity of 9 (Age 70+) with a frequency of 9 (18%).

3.3 Comorbidities by Age

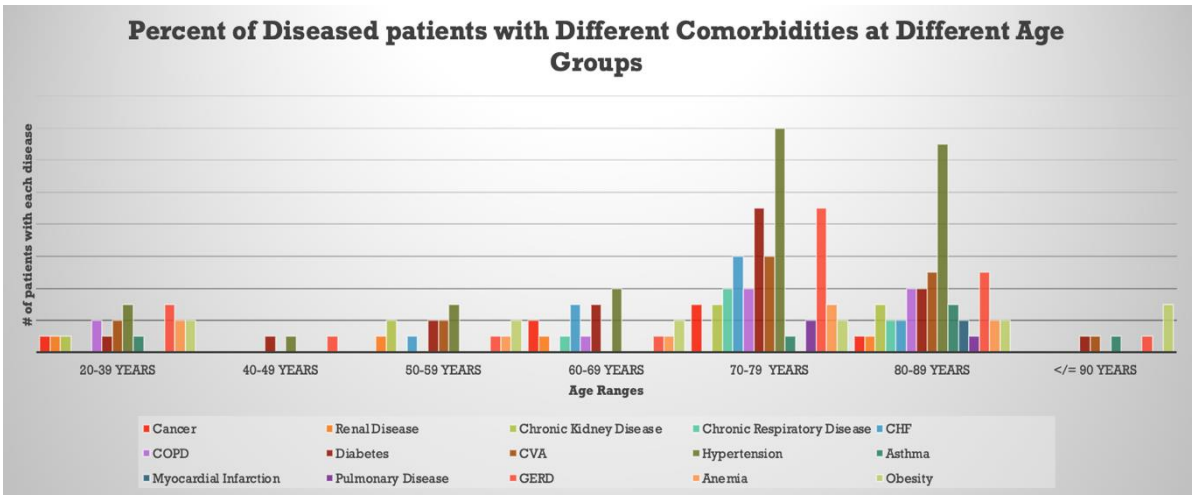

Figure 1: Comorbidities by age

The percent of comorbidities amongst the different age groups were observed from the sample of 50 sizes. The results show that the age group (70-79) patients had the highest comorbidity counts, which indicates that they are more susceptible to severe disease progression. There are no significant outliers in age groups ranging from 20-60 years. The age group 80-89 years were also susceptible to moderate to severe disease progression as they had the second-highest rate of comorbidities. The eldest age group did not suffer from strict disease progression as their disease frequency was lower than hypothesized. The comorbidity that raised the most profound concern is hypertension, and people aged 70-89 experienced high rates of diabetes and respiratory distress.

3.4 Severity between Gender and Ethnicity

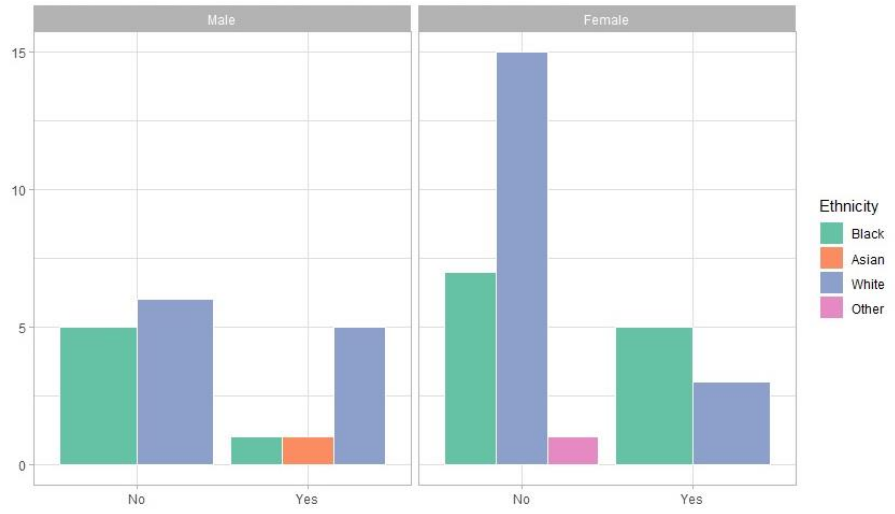

Figure 2: severe and non-severe patients amongst ethnicity and gender

The severity between gender and ethnicity was graphed to understand severity on personal characteristics better. The graph displays the dataset distribution, which shows that males are more susceptible to severe cases than females. Among ethnicities, white patients had a slight significance in disease severity; it is essential to note that the same statistic applies to non-severe cases. The confounding result in this graph is that black people are not more susceptible to severe cases as opposed to the CDC's statistic that they are. Although this is not proven to be incorrect, white males were more prominent in disease cases in the Pittsburgh area.

3.5 Regional Findings

The figure below distributes the number of cases in the Pittsburgh, PA region. It is important to note that not all patient's zip codes were from Allegheny county; thus, those patients were not represented in this portion of the paper. Areas with high cases include Shadyside,

Brentwood, and downtown Pittsburgh. Shadyside (population 13,915) and downtown Pittsburgh (population 5,201) are popular tourist sites within Pittsburgh. Brentwood is a more secluded location; therefore, the likely event of transmission occurred amongst residences nearby.

Figure 3: COVID-19 cases in Pittsburgh, PA by zip code

Figure 4: Mild, moderate and severe cases in Pittsburgh, PA by zip code

In high-income countries, the burden of comorbidities is greater in the lower socio-economic strata and in neighborhoods with poor access to healthcare infrastructure [7]. These communities may be more inclined to receive the vaccination if they know the rate of disease cases in the area. The same notion applies to the older population and knowing which areas to avoid

during this pandemic. These areas include places that college students are more prone to associate with as they tend to “go out” more than average. It is known that the R0, the average number of cases of an infectious disease arising by transmission from a single infected individual in an area that has not been exposed, has a higher value when there is a large number of residents because the virus has a greater chance to spread from one person to another.

4.0 Discussion

4.1 Findings

Males were more susceptible to severe cases of COVID-19 than females. The most concerning statistic is that 76% of all patients had hypertension. Amongst the variables, 46% of patients were placed on ventilation treatments and 30% were in the ICU, which could be due to a small sample size as we expected more severe cases. Patients under the age of 50 did not experience severe disease progression, and the mortality rate for this age group was 0%. The average length of stay was 9 days, with the more severe cases experiencing prolonged hospitalization of over 20 days. Patients with a history of smoking, vaping, COPD, compromised immune systems, or diabetes had prolonged hospitalizations of more than six days. The mortality rate was 12% of all patients. The mortality rate was equally divided amongst gender and was 80% for White patients compared with 20% for Black patients. Prognosis endpoints were concerning for Hypertension, cancer, and GERD.

Brentwood, Pa, had an unusually high number of cases, though it has a large population of 28,000 people. Lastly, severe cases were prevalent in popular tourist areas such as Shadyside and Ross Township. It is suggested that these areas be avoided for people with underlying health concerns to lower the risk of becoming infected. Additionally, low-income areas were not more susceptible to severe disease progression, this can be due to each area having their own UPMC facilities that are available in the area.

4.2 Limitations

The measures from the Charlson Comorbidity Index were interpreted with caution because it takes time for cases to become severe or for infected persons to die. It may not be possible to accurately estimate the denominator of infected people to calculate those ratios.

4.3 High Risk Population

Although serious complications resulting from COVID-19 can occur in any individual, certain populations are more susceptible to these complications. At-risk populations include older adults, those with weakened immune systems, pregnant women, and those with underlying health conditions. Our study did not include pregnant women but 99% of our patients have weakened immune systems and more than 3 underlying conditions. According to research, over 80% of deaths from the disease have been in people age 65 and older [11]. In this study, the mortality rates were more concerning for people ages 70 years and older. This shows that the mortality rate for this population is extremely high and remains a top priority during this pandemic.

The results display that the senior populations are more susceptible to the virus because of additional health impairments and personal characteristics when paired with advanced age. Germs can spread very quickly between people who live near each other[11], implying that the transmission rate can be higher amongst seniors residing in a long-term care facility without proper guidelines to protect this community. Admissions showed that over 45% of patients were admitted to the hospital from long term care facilities. Other patients, above the age 70, had spouses call an

[11] Mayo Clinic, 2021

ambulance due the patients being unconscious. These patients were often sent to the ICU and required ventilation as indicated on their charts. Some patients 4 of the patients went into Atrial Fibrillation that led to a stroke. COVID-19 for these patients were a second infection that progressed their underlying conditions.

Those with compromised immune systems are also at significant risk of severe complications resulting from Covid-19. The Mayo Clinic warns that if a person suffers from a weakened immune system, those extra precautions are necessary to avoid the virus (Mayo Clinic 2021) because their body is not equipped to defend itself from the virus, resulting in more severe complications. Patients at UPMC Mercy with compromised immune systems required a ventilator but not all cases were sent to the ICU.

5.0 Conclusion

5.1 Public Health Implementations

We have sufficient evidence to suggest that the severity experienced by patient increases the speed of progression of the virus at a higher rate varying specific risk characteristics during hospitalization. Severe cases at UPMC Mercy were analyzed and revealed that some aspects and co-infections, not mentioned by the CDC, such as HTN and GERD, increased disease progression and prognosis. This study succeeded in its effort to highlight additional personal characteristics, risk factors and comorbidities that increases disease severity for public knowledge. This study expands the CDC's findings on disease progression meant to guide people who may feel as if they do not fall into the CDC "at-risk" category and expect a mild version of the virus.

Prevention programs can increase mental health-related issues. When individuals test positive for COVID-19, their emotions are erratic. Some have feelings of shame and fear of severity levels. This burden falls heavily on the elderly population, who are in constant isolation to prevent becoming infected.

5.2 Future Direction

More research is needed to pinpoint the severity of disease progression precisely. Research is expanding in the United States as most of the research in 2020 was specific to Asia. The data from this study shows additional findings that are imperative to update the risk factors that lead to severe disease progression for better public understanding. The public may not understand different characteristics that pose a threat when combined with infections of COVID-19. An

additional future direction could be to investigate the correlation between the genetic aspect of the individual patients more susceptible to disease severity and the highlighted comorbidities discussed in this paper, as there was not much research on the topic. Lastly, as the COVID-19 vaccines are now available, the priority groups should be first to receive services, especially the elderly population and essential workers. Research should focus on the short-term and long-term effects of the vaccine and push for a standard vaccine with results of 100% efficacy to maximize benefits and outcomes. Lastly, providing better strategies to target the public in relation to the vaccine are vital. During 2020, the efforts were labelled misrepresented as there were many confounding factors (Media) that left the public with many conflictions regarding the COVID-19 vaccine. Nevertheless, since its arrival, the vaccine has lowered the incidence of COVID-19 as we saw a decrease in the number of cases per day.

Bibliography

Afrin, Lawrence B., Leonard B. Weinstock, and Gerhard J. Molderings. "Covid-19 hyperinflammation and post-Covid-19 illness may be rooted in mast cell activation syndrome." *International Journal of Infectious Diseases* 100 (2020): 327-332.

Anjorin, A., Abioye, A., Asowata, O., Soipe, A., Kazeem, M., Adesanya, I., Raji, M., Adesanya, M., Oke, F., Lawal, F., Kasali, B. and Omotayo, M. (2021), Comorbidities and the COVID-19 pandemic dynamics in Africa. Trop Med Int Health, 26: 2-13. https://doi.org/10.1111/tmi.13504

Charlson M, Peterson J, Szatrowski TP, MacKenzie R, Gold J. Long-term prognosis after peri-operative cardiac complications. J Clin Epidemiol. 1994 Dec;47(12):1389-400. doi: 10.1016/0895-4356(94)90083-3. PMID: 7730848.

Charlson, M. E., Pompei, P., Ales, K. L., & MacKenzie, C. R. (1987). A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. Journal of Chronic Diseases, 40(5), 373–383. https://doi.org/10.1016/0021-9681(87)90171-8

Fang, Xiaoyu, et al. "Epidemiological, comorbidity factors with severity and prognosis of COVID-19: a systematic review and meta-analysis." *Aging (Albany NY)* 12.13 (2020): 12493.

Field H. E. (2009). Bats and emerging zoonoses: henipaviruses and SARS. *Zoonoses and public health*, *56*(6-7), 278–284. https://doi.org/10.1111/j.1863-2378.2008.01218.x

Jin X, Lian J, Hu J, *et al* Epidemiological, clinical and virological characteristics of 74 cases of coronavirus-infected disease 2019 (COVID-19) with gastrointestinal symptoms *Gut* 2020; **69:** 1002-1009.

Li Long, Xiansheng Zeng, Xu Zhang, European Respiratory Journal May 2020, 55 (5) 2000990; DOI: 10.1183/13993003.00990-2020

Moons, K. G., Royston, P., Vergouwe, Y., Grobbee, D. E., & Altman, D. G. (2009). Prognosis and prognostic research: what, why, and how?. *Bmj*, *338*.

Morens, D. M., Breman, J. G., Calisher, C. H., Doherty, P. C., Hahn, B. H., Keusch, G. T., Kramer, L. D., LeDuc, J. W., Monath, T. P., & Taubenberger, J. K. (2020). The Origin of COVID-19 and Why It Matters. *The American journal of tropical medicine and hygiene*, *103*(3), 955–959. https://doi.org/10.4269/ajtmh.20-0849

Ray, Amit. (2020 Apr 8). *Life Cycle Analysis of Coronavirus (COVID-19) – The SARS-CoV-2 Virus*. Retrieved from https://amitray.com/life-cycle-of-coronavirus-covid-19-the-sars-cov-2-virus/

Richard A. Stein, Lauren M. Young, From ACE2 to COVID-19: A multiorgan endothelial disease International Journal of Infectious Diseases, Volume 100, 2020, Pages 425-430, ISSN 1201-9712, https://doi.org/10.1016/j.ijid.2020.08.083.

Roach, J. C. (2020). Empirical Model of Spring 2020 Decrease in Daily Confirmed COVID-19 Cases in King County, Washington. doi:10.1101/2020.05.11.20098798

Wei, Yuan-Yuan, et al. "Risk factors for severe COVID-19: Evidence from 167 hospitalized patients in Anhui, China." *Journal of Infection* 81.1 (2020): e89-e92.

World Health Organization. (2020). Coronavirus.