International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

# Socio-Demographic Profile Risk Factors and Outcomes Among Patients With COVID-19 Reinfection in A Tertiary Government COVID-19 Referral Center

**Junmar Y. Valdez[1], Rizalyn L. Banga[2]**

[1,2]Medical Officer, Southern Philippines Medical Center

**ABSTRACT**

COVID-19 reinfection is an emerging concept in the evolution of this pandemic. Protection conferred from active disease and vaccinations are not fully known. Other patient related factors need to be identified and investigated. The current study describes patients' profile and identifies possible risk factors that significantly contribute to the likelihood of COVID-19 reinfection and outcomes.

This is a single center retrospective study on COVID-19 reinfected patients admitted in a government referral center in Davao City from January 2021 to December 2021. The socio-demographic profile of the patients was analyzed using descriptive statistics. Linear and logistic regression analysis were utilized for assessment of risk factors, COVID-19 severity, and outcomes to COVID-19 reinfection.

There were 45 COVID-19 reinfected patients identified. Two thirds were adults ages 19 to 44 years-old. Female patients account for 60% of the cases. Almost fifty percent were health care workers. One third of the patients had 1 comorbidity. Sixty percent of the patients had weakened immunity. There were 71.11% of the reinfected patients were vaccinated.

Female patients and health care workers are three times more likely to be reinfected. Patients with weakened immunity are twenty-nine times more likely to be reinfected. Reinfection increases the number of hospital days by 6.51. Increasing number of comorbidities and weakened immunity are significant factors for longer ICU stay. Wherein, weakened immunity has 2.8 more days in ICU. Patients with weakened immunity are eleven times more likely to need oxygen or ventilatory support. In contrast, vaccinated patients less likely require oxygen by 29%.

## INTRODUCTION

The existence of a COVID-19 has caused a distressing pandemic that has overwhelmed the nations with a staggering speed rate since its emergence last December 2019. As of March 11, 2022, the World Health Organization (WHO) has reported 450,229,635 confirmed cases. In the Philippines, there have been 3, 669, 283 confirmed cases since it was first identified in January 2020. (1)

The causative agent of COVID-19, Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), is a RNA virus that is prone to mutations. It has been reported to have heterogenous genetic composition in different geographical locations. Protection from prior disease among patients with COVID-19 infection is unknown which have led to emergence of COVID-19 reinfection. (2)

COVID-19 reinfection was defined as individual who was infected and then recovered but later became infected more than or equal to ninety (≥90) days an after initial positive testing or ≥45 days with background information supporting contact with confirmed cases or the reappearance of COVID-19-like symptoms, according to Center for Disease Control and Prevention (CDC) (3). A study done in United Kingdom reported 304 reinfection cases with a reinfection rate of point eight percent (0.8%) (4). However, in the last months of 2021, there was reported sharp increase in reinfections, with a rate now increased to around ten percent (10%). (5)

With the a high rate of reinfection especially with emerging variants and pacing of vaccination, addressing reinfection is crucial. These reinfection cases have aroused widespread concern. A comprehensive understanding of COVID-19 reinfection is critical in guiding the ongoing vaccine development and strategic protective interventions.

Multiple of factors could have explained in the spike of reinfection. CDC defined high-risk population as those individuals who faced a higher burden of virus exposure such as the front-line healthcare workers, residents and staff of care homes and skilled nursing facilities and older patients with comorbidities (4). Studies have to be made in order to mitigate reinfection even after achieving herd immunity through natural infection or vaccination.

## REVIEW OF RELATED LITERATURE

The SARS-CoV-2 was first isolated in Wuhan City, in China last December 2019. This has started the global pandemic with overwhelming speed. COVID-19 cases in the Philippines has rapidly evolved with single case identified last January 30, 2020, to more than 200 cases in a span of two (2) months. Intensified quarantine measures were implemented to prevent community transmission that commenced last March of the same year. The number of cases plateaued in May and by June, there has been an upturn of cases in National Capital Region and in Cebu. However, as of July 7, 2020, a total of 47, 873 confirmed cases with 1, 309 deaths, and 12, 386 recovered have been reported by the WHO. (6)

The spectrum of COVID-19 disease ranges from a common cold-like illness to severe viral pneumonia resulting in a fatal acute respiratory distress syndrome (ARDS). A retrospective case series from China states that the elderly with associated co-morbidities and with pneumonia on chest radiograph has increased risk for severe disease (7-10). A meta-analysis of 10 studies done in China (n= 50,466) showed that the incidence of fever was eighty-nine-point one percent (89.1%), cough was present in seventy-two-point two percent (72.2%), and myalgia or fatigue was forty-two point five (42.5%). Diarrhea, headache hemoptysis, sore throat and other symptoms were seen only in a minority of patients. (11)

The mode of transmission remains predominant through droplet from person to person. The peak of infectiousness is before or within 5 days of symptom onset. Most transmissions are from symptomatic patients, but pre-symptomatic and asymptomatic patients may transmit the disease to a lesser extent. (12-14)

Supportive care and symptomatic respiratory management remain the standard of care for COVID-19 disease. Several re-purposed drugs showed promise on early observational and in-vitro studies that are being investigated in a clinical trial or given as compassionate use. Treatment guidelines provided by the CDC, WHO, Department of Health (DOH) and the Philippine Society for Microbiology and Infectious Diseases (PSMID) are continually updated based on available scientific evidence.

Several research suggest that infection provided natural immunity for at least three months and immunity remain stable up to six (6) to eight (8) months after the initial infection. Studies have shown that viral shedding in the respiratory tract has been reported between eighty-three to one hundred-four (83-104) days. Thus, positive polymerase chain reaction (PCR) result along with clinical symptoms roughly 3 months after COVID-19 infection suggested reinfection. (15) However, it is challenging to prove and exclude individuals who have been infected with COVID-19 on two occasions, and persistent infection or viral reactivation. Serological markers are often used to distinguish primary and reinfections but studies concerning these are not well-established. (16)

The CDC recently defined ninety (90) days as the cut-off for retesting after a COVID-19 positive PCR test, given assumptions that primary infection can still result in a positive test for up to 90 days and that people with COVID-19 are protected from true reinfection for at least 90 days (3). These may be due to reactivation of a latent virus (endogenous) or a new infection (exogenous). Circulating antibody does not necessarily protect an individual against infection with exogenous reinfection. (19)

The incidence of reinfection is also rising with the current worldwide rate of infection. Among all 2,625 total participants who experienced COVID-19 infection in Midwestern Healthcare employees in Illinois and Wisconsin, 156 (5.94%) experienced Covid-19 reinfection after the initial infection. Of these participants who experienced reinfection, 42 (26.92%) had COVID-clinical roles, 110 (70.51%) had clinical roles, and 4 (2.56%) had non-clinical roles within the healthcare system. (15)

A surge of COVID-19 occurred from March to June 2021, in New Delhi, India, linked to the B.1.617.2 (Delta) variant of SARS-CoV-2. A study reported 32.7% were diagnosed with Covid-19 among 15,244 healthcare worker who participated. The reinfection incidence was 7.26 per 100 person-years. A fully vaccinated healthcare worker had a lower risk of reinfection, both asymptomatic and symptomatic, compared to an unvaccinated one. Reinfection was observed in 12.7% of unvaccinated, 11% in partially vaccinated and 1.6% of fully vaccinated (17). Moreover, a retrospective 2021 study in 238 heath facilities in United States showed women displayed a higher cumulative reinfection risk among 131,773 patients with Covid-19 reinfection. (18)

A Bangladesh cross-sectional study reported a 1.14% reinfection cases out of 41,408 population. 28.7% of them had comorbidities. These included hypertension, diabetes, and smoking. Majority of the reinfected patients (37.1%) were healthcare workers. Healthcare workers are employed in diverse health facilities where they are exposed to COVID-19 patients increasing their vulnerability for reinfection. (21)

Reinfection could occur in different demographic spectra regardless of initial infection severity. About fifty percent of reinfections were less severe which could explained by the possibility of partial immune protection. Further study are needed to elucidate the frequency, determinants and consequences of COVID-19 reinfection. (20)

A case series of 17 genetically confirmed COVID-19 cases done in August 2020. COVID-19 reinfections were reported. Among these, 68% had similar severity, 12.5% had milder symptoms and 18.8% had worse symptoms. (22)

Lastly, natural infections had 85% or greater efficacy as protection to COVID-19. Published in New England Journal of Medicine, a reinfection case had lower likelihood for hospitalization and death. It identified that the composite outcome of severe case at reinfection was 0.10 times. (23)

**Research Question**

What are the socio-demographic profiles, identified risk factors, and outcomes of patients with Covid-19 reinfection in tertiary COVID-19 referral center?

**Significance of the Study**

Viruses are known to be constantly mutating, including the SARS-CoV-2, the causative agent of COVID-19. These changes are one of the many causes that led to reinfection. However, there are many things that are need to be understood. These include who is at high risk for reinfection, the severity of reinfections, and risk of transmission to others after reinfection. To address this gap in research, these queries needs to be answered. Hence, the current study aimed to identify the patients profile and possible risk factors that significantly contribute to the likelihood of COVID-19 reinfection. The cases identified is of great importance to public health. Furthermore, this may remarkably influence in the development of vaccine and guide in public health measures in response to COVID-19 pandemic.

**GENERAL OBJECTIVES**

The general objectives of this study is to determine the socio-demographic profile, risk factors and outcomes among patients with COVID-19 reinfections.

**SPECIFIC OBJECTIVES**

The following are the specific objectives:

1. To describe the all patients diagnosed with COVID-19 reinfection based on the following:
   a. Socio-demographics
      - Age
      - Sex
      - Body Mass Index (BMI)
      - Educational Attainment
      - Living arrangement
      - History of travel

   b. Possible risk factors
      - Occupation
      - Co-morbidities
      - Living in long-term facility
      - Weakened Immunity
      - Vaccination Status
2. To identify the significant risk factors based on socio-demographic profile and possible risk factors of COVID-19 reinfected patients.
3. To estimate the expected outcomes of COVID-19 reinfected patients using the identified risk factors based on the following:
   - Length of hospital stay
   - Length of ICU admission
   - Need for oxygen/invasive ventilation

## METHODOLOGY

### Research Design/Setting/Population

This is a single center retrospective study among patients admitted from January to December 2021 in a local tertiary Covid referral center in Davao City.

### Inclusion Criteria

- Any adult who is 19 years and above
- Must be treated and/or admitted in SPMC
- COVID-19 RT-PCR test or Rapid Antibody test done in SPMC or any DOH-accredited COVID-19 testing laboratories.
- COVID-19 individual who was infected at least once as defined by CDC as reinfection criteria.
- COVID-19 reinfection cases regardless of severity classification, comorbidity, vaccination status and outcomes.

### Exclusion Criteria

- Aged below 19-year-old
- Absence of COVID-19 RT-PCR testing or Rapid Antibody Test Result
- Covid-19 reinfection cases beyond the specified dates.

### Sampling Procedure

The study included all admitted patients included from the timeframe and who were able to fulfill the inclusion criteria. On assessing risk factors of reinfection, simple random sampling was implemented to alternative group, the patients who were not reinfected with COVID-19.

### Randomization

The research utilized the randomization from atmospheric noise from random.org, which is a better randomization procedure than the use of other software where randomization is utilized.

### Sample Size

The study sample size was estimated using G*Power 3.1 by Faul, et. Al (2009). A power analysis base on t-test in linear regression with alpha error probability of 0.05, power of 0.95, effect size of 0.15 and 11 as the number of predictors were used. The number of predictors included 6 from socio-demographic and 5 from possible risk factors. The use of linear regression required 89 samples to attain the desired power of 95%.

To ensure adequate representation between two groups (event of a null and alternative), when identifying risk factors among reinfection patients, the 44 confirmed reinfected were included. The remaining 45 samples were randomly selected from the non-reinfected population. These samples are used in estimating expected outcomes.

### Primary Outcome

The main primary outcome of this study was to identify the risk factors and COVID-19 severity classification of patients diagnosed with Covid-19 reinfection.

**Data Handling and Analysis**

The socio-demographic profiles of the patients were analyzed using descriptive statistics. Mean and standard deviation for continuous data such as the case of age and other relevant parameters measured using a standardized unit of measure were used. The occupation, co-morbidities, immune and vaccination status were identified. Linear and logistic regression analysis were utilized for assessment of risk factors, COVID-19 severity, and outcomes to COVID-19 reinfection. In the overall model, identified significant risk factors used underwent the same backward stepwise procedure.

**Definition of Terms:**

1. **COVID-19 Reinfection** – positive polymerase chain reaction (PCR) result along with clinical symptoms roughly 3 months after COVID-19 infection, or ninety (90) days after a COVID-19 infection regardless of symptoms.
2. **Comorbidity -** a disease or medical condition that is simultaneously present in COVID-19 reinfected patients that includes hypertension, heart disease, diabetes mellitus, chronic kidney disease and etc.
3. **Weakened Immunity** – a description referring to a COVID-19 reinfected patients who are immunocompromised either to medical condition (solid tumor and hematologic malignancies, moderate or severe primary immunodeficiency, advanced or untreated HIV infection or etc.) or from receipt of immunosuppressive medications.

**Ethical Considerations**

The study adhered to the Principles of the Declaration of Helsinki (2013) and conducted following the Guidelines of the International Conference on Harmonization-Good Clinical Practice (ICH-GCP) and the National Ethical Guidelines for Health and Health-Related Research (NEG HHRR 2017). The protocol and all relevant documents were reviewed and approved by the department and applicable Institutional Ethics Review Committee. Individual information of patients remained strictly confidential. Patients were anonymized in the data collection form and only case numbers and code numbers were used. General data, clinical features, and laboratory results were abstracted from the charts and recorded. The investigators are responsible for the integrity of the data including its accuracy, completeness, legibility, originality, timeliness, and consistency. All study related documents shall be kept and stored by the investigators for at least five years and will be discarded following prescribed measures.

**RESULTS, DISCUSSION, CONCLUSION AND RECOMMENDATIONS**

There were total of 45 reinfected patients treated at Southern Philippines Medical Center (SPMC) from January 2021 to December 2021.

**Socio-demographic Profile and Risk Factors of Patients with COVID-19 Reinfection**

Table 1 showed the socio-demographic profiles of the reinfected patients of the study. Two thirds of the patients were adults, ages 19 to 44 followed by patients that were 60 and above (20%). Female patients accounted for 60% of the cases while males represent the remaining 40%. More than half of the cases had normal body mass index (55.56%) with Obese II having the least percentage (8.89%). All of them had college degree. Two thirds of the patients live with their family and none of them had travel history outside Davao City. Almost fifty percent were health care worker whereas 17.78% were non-health care related. One third of the patients had 1 comorbidity followed by no comorbidity (31.11%) and only

2.22% had at least 5 comorbidities. None of the reinfected patients live in long-term facility. Sixty percent (60%) of the patients had weakened immunity. And, 71.11% of the reinfected patients were vaccinated.

| | | Freq | Col % |
|---|---|---|---|
| **Age Group** | | | |
| | Adult (19 to 44) | 30 | 66.67% |
| | Middle aged (45 to 60) | 6 | 13.33% |
| | Aged (60 and above) | 9 | 20.00% |
| **Sex** | | | |
| | Female | 27 | 60.00% |
| | Male | 18 | 40.00% |
| **Body Mass Index** | | | |
| | Normal | 25 | 55.56% |
| | Obese I | 6 | 13.33% |
| | Obese II | 4 | 8.89% |
| | Overweight | 10 | 22.22% |
| **Educational Attainment** | | | |
| | Tertiary | 45 | 100.00% |
| **Living Arrangement** | | | |
| | Lives alone | 15 | 33.33% |
| | Living with family | 30 | 66.67% |
| **Travel History** | | | |
| | None | 45 | 100.00% |
| **Occupation** | | | |
| | Health Care related | 22 | 48.89% |
| | Non-health care related | 8 | 17.78% |
| | Unemployed | 15 | 33.33% |
| **Number of Comorbidities** | | | |
| | 0 | 14 | 31.11% |
| | 1 | 15 | 33.33% |
| | 2 | 6 | 13.33% |
| | 3 | 5 | 11.11% |
| | 4 | 4 | 8.89% |
| | 5 | 1 | 2.22% |
| **Living in Long-term facility** | | | |
| | No | 45 | 100.00% |
| **Weakened Immunity** | | | |
| | No | 27 | 60.00% |
| | Yes | 18 | 40.00% |
| **Vaccination Status** | | | |
| | Unvaccinated | 13 | 28.89% |

| | | | |
|---|---|---|---|
| | Vaccinated | 32 | 71.11% |

**Table 1. Socio-demographic Profile and Risk Factors of Patients with COVID-19 Reinfection treated at Southern Philippines Medical Center**

**Significant Risk Factors Based on Socio-demographic Profile and Possible Risk Factors of COVID-19 Reinfected Patients**

To determine the possible factors affecting reinfection of patients, non-reinfected patients were randomly selected from the population of non-reinfected patients. The patients' data, being reinfected or not, were used as input in the logistic regression process. For the dependent variable, 1 signified that the patient was reinfected and 0 as otherwise.

**Table 2. The relationship of Socio-demographic Profiles and Possible Factors affecting COVID-19 Reinfection and non-reinfected patients**

| Variables | Odds Ratio | Std. Error | P-value | |
|---|---|---|---|---|
| *Intercept* | 30.65 | 1.68 | 0.04 | ** |
| Age | 0.93 | 0.03 | 0.01 | ** |
| Sex (1 if Female) | 3.04 | 0.64 | 0.08 | * |
| BMI (1 if Normal) | 0.26 | 0.69 | 0.05 | * |
| Living Arrangement (1 if Living with Family) | 0.07 | 1.20 | 0.03 | ** |
| Occupation (1 if Health care related) | 3.54 | 0.76 | 0.10 | * |
| Number of Comorbidities | 1.09 | 0.34 | 0.81 | |
| Weakened Immunity (1 if Yes) | 29.10 | 1.00 | 0.00 | *** |
| Vaccination Status (1 if vaccinated) | 2.42 | 0.63 | 0.16 | |
| *** p<0.01, ** p<0.05, * p<0.10 | | | | |

The table above presented the results from regressing socio-demographic profiles and possible factors affecting reinfection of non and reinfected patients. Notably, the number patients that have weakened immunity was statistically significant at 1% level. In addition, age, and living arrangement were statistically significant at 5% level and have odds of less than one. Interestingly, female patients were on average, three times more likely to be reinfected compared to male patients that was significant at 10% level. Moreover, body mass index and occupation were both significant too at 10% level. Specifically, occupation in health care was three times cause a reinfection.

**Clinical Outcome of COVID-19 Reinfected Patients**

A series of linear models were implemented to examine the expected effects of patients that were reinfected.

**Table 3. The Relationship of Socio-demographic Profile and Possible Risk Factors of Covid-19 Reinfection Patient in terms of Number of Hospital Stay (Days), Length in ICU (Days) and Oxygen/Ventilatory Support**

| Variables | Hospital Stay (Days) | | Length in ICU (Days) | | Oxygen/Ventilatory Support | |
|---|---|---|---|---|---|---|
| | Coefficient | P-value | Coefficient | P-value | Odds Ratio | P-value |
| *Intercept* | 7.67 | 0.41 | 1.76 | 0.53 | 3.10 | 0.60 |
| Reinfection Status (1 if Yes) | 6.51 | 0.09* | 0.97 | 0.40 | 0.10 | 0.02** |
| Age | 0.15 | 0.29 | 0.07 | 0.10* | 1.06 | 0.06* |
| Sex (1 if Female) | -6.05 | 0.06* | 0.06 | 0.95 | 0.89 | 0.86 |
| BMI (1 if Normal) | -0.53 | 0.88 | -1.77 | 0.10* | 0.76 | 0.70 |
| Living Arrangement (1 if Living with Family) | 0.43 | 0.93 | -1.31 | 0.38 | 0.02 | 0.03** |
| Occupation (1 if Health care related) | -2.33 | 0.57 | -0.78 | 0.54 | 0.64 | 0.74 |
| Number of Comorbidities | 1.33 | 0.42 | -1.06 | 0.04** | 0.81 | 0.54 |
| Weakened Immunity (1 if Yes) | 6.75 | 0.16 | 2.88 | 0.05* | 11.56 | 0.03** |
| Vaccination Status (1 if vaccinated) | -12.59 | 0.00*** | -2.01 | 0.07* | 0.06 | 0.01*** |

*** p<0.01, ** p<0.05, * p<0.10

Table 3 presented the results of socio-demographic profile, and possible risk factors to estimate the outcomes of COVID-19 reinfected patients. As a result, on average, reinfection of patients increased the number of hospital days by 6.51. Evidently, vaccination status drives most of the reduction in hospital days, on average of 12.59 days.

Reinfection has no significant effect in the length of ICU days. The factors that significantly affected the length of ICU days were patients without comorbidities who had 1.06 days lesser stay in the ICU. Out of 45 reinfected patients, most had no comorbidity and 1 comorbidity, hence they had lesser chance to be admitted at ICU. Weakened immunity had 2.88 more days in the ICU.

The significant factors that increased the likelihood of ventilation was the weakened immunity which was 11.56 times more likely to require oxygenation or ventilatory support.

**Table 4. The Magnitude of Oxygen/Ventilatory Support Covid-19 Reinfection**

| | | | | |
|---|---|---|---|---|
| **Variables** | **dF/dx** | **Std. Error** | **P-value** | |
| Reinfection Status (1 if Yes) | -0.22 | 0.11 | 0.04 | ** |
| Age | 0.00 | 0.00 | 0.09 | * |
| Sex (1 if Female) | -0.01 | 0.06 | 0.86 | |
| BMI (1 if Normal) | -0.02 | 0.06 | 0.71 | |
| Living Arrangement (1 if Living with Family) | -0.71 | 0.25 | 0.00 | *** |

| | | | | |
|---|---|---|---|---|
| Occupation (1 if Health care related) | -0.04 | 0.10 | 0.72 | |
| Number of Co-morbidities | -0.02 | 0.03 | 0.55 | |
| Weakened Immunity (1 if Yes) | 0.31 | 0.18 | 0.08 | * |
| Vaccination Status (1 if vaccinated) | -0.29 | 0.10 | 0.01 | *** |
| *** p<0.01, ** p<0.05, * p<0.10 | | | | |

Table 4 above presented the marginal effects of the logistic regression for the likelihood of ventilation. Majority of those reinfected patients had milder symptoms hence would not need oxygen support nor ventilatory support. Those who lived with their family also showed significant result of 71% less likelihood of needing oxygen support. We noted that those who were vaccinated had 29% lesser chance of needing oxygen support and ventilatory support. Lastly, those patients with weakened immunity had 31% more chance of needing oxygenation and ventilatory support. (32)

**Discussion**

Our study included all 45 reinfected patients treated in SPMC from January to December 2021. Female patients were more likely be reinfected compared to male population. In a study of Lawandi, A. et.al. (2022), women were at higher risk for reinfection than men (hazard ratio for suspected reinfection in women vs men, 1.579). The mechanistic basis for this female sex predilection for reinfection warranted an investigation (18). Health care worker noted to have higher risk for reinfection since they have to deal with and be exposed to sources of infection hence increasing the possibility of reinfection (21). Moreover, the patients that have weakened immunity was notably statistically significant for reinfection since these patients have no enough immune response production after the first COVID-19 infection. (3)

The reinfection of patients increase the number of hospital days by 6.51 as opposed to a study done by Medic et al, COVID-19 reinfected patients where mostly mild hence hospitalization were uncommon (1.08% versus 3.66% in primary infection) (25). Vaccinated patients had lesser hospital stays by 12.59 days. Vaccination appeared to offer a higher protective effect hence most of the vaccinated patients were admitted as COVID-19 asymptomatic to mild infection with lesser hospital isolation days. (17)

Reinfection has no significant effect in the length of ICU days since according to a study from Mensah, A. et. al. (2022), majority of the COVID-19 reinfected patients were admitted as either asymptomatic or mild cases hence with decreased chance to be admitted at ICU (29). The significant factor affecting ICU admission was comorbid conditions and weakened immunity. Individuals with more comorbidities has deleterious effects and substantially associated with significant morbidity and mortality (27). The study done at Kuwait showed an increased risk of ICU admission and prolonged ICU stay by 10 days for those who have weakened immunity. (30)

Weakened immunity increased the likelihood of ventilation in reinfected patients. Immunocompromised patient suffered a higher burden of symptomatic and severe COVID-19 infection. In a study of Zhang, W. et. al (2022), when compared to the general population, COVID-19 infection in renal allograft recipients was significantly more severe (48% ), required more mechanical ventilation (42%), needed more intensive care unit (ICU) admission (13%), and had greater incidence of acute kidney injury (29%). COVID-19 patients with weak immunity faced more severe clinical manifestations probably due to significantly impaired anti-viral mechanism. (32)

Lastly, reinfected patients who were vaccinated were noted to be less oxygen requiring. A study done at Norway, those who were unvaccinated had greater percentage of needing oxygen support compared to vaccinated patients (19% for unvaccinated and 14% for vaccinated) (31). These findings build on previous evidence of high vaccine effectiveness against severe disease.

## Conclusion

From the data presented and analyses made, the following conclusions were drawn:

There were 45 COVID-19 reinfected patients treated at Southern Philippines Medical Center (SPMC) from January 2021 to December 2021. Two thirds were adult ages 19 to 44 years-old. Female patients account for 60% of the cases. Two thirds of the patients live with their family and none of them had travel history outside Davao City. Almost fifty percent are health care worker. One third of the patients had 1 comorbidity. Sixty percent of the patients had weakened immunity. And, 71.11% of the reinfected patients were vaccinated.

Specifically, the patients who have weakened immunity are twenty-nine times more likely to be reinfected. Interestingly, female patients are on average, three times more likely to be reinfected compared to male patients. Health care workers were three times more likely to be reinfected.

On the expected outcomes, the reinfection of patients increased the number of hospital days to 6.51 while vaccination status drives most of the reduction in hospital days, on average. Increasing number of comorbidities and weakened immunity were significant factors for length of ICU stay, wherein, weakened immunity had 2.8 more days in ICU. Lastly, the patients with weakened immunity were eleven times more like needing oxygen or ventilatory support. While those vaccinated, are less likely oxygen requiring by 29%.

## Recommendations

Based on the findings and conclusion, it is recommended that:

Utilized identified the risk factors for COVID-19 reinfection that help determine certain group of population should have an additional infection and control precaution measures in order to prevent reinfection. Further investigations should be done on a specific comorbidity to gauge who were more likely to deteriorate after COVID-19 reinfection. Lastly, further study should be explored on mortality following COVID-19 reinfection since this outcome was not identified in this study due limited data.

## REFERENCES

1. WHO Coronavirus Disease (COVID-19) Dashboard | WHO Coronavirus Disease (COVID-19) Dashboard [Internet]. [cited 2022 Mar 11]. Available from: https://covid19.who.int/
2. Wang, J. et.al. COVID-19 reinfection: a rapid systematic review of case reports and case series [Internet]. 2022 Mar 11. Available from https://jim.bmj.com/content/69/6/1253
3. Center for Disease Control and Prevention [Internet]. 2022 Mar 11. Available from https://www.cdc.gov/coronavirus/2019-ncov/your-health/reinfection.html
4. Mao, Y. et.al. Reinfection rates among patients previously infected by SARS-CoV-2: systematic review and meta-analysis [Internet]. [cited 2022 Mar 11]. Available from: https://journals.lww.com/cmj/Fulltext/2022/01200/Reinfection_rates_among_patients_previously.3.aspx

5. COVID reinfections surge during Omicron onslaught. [Internet]. 2022 Mar 11. Available from https://www.nature.com/articles/d41586-022-00438-3
6. Disease C, Report S. Upcoming Events and Priorities. 2020;2019(July)
7. Chan K.W., Wong V.T., Tang S.C.W.. COVID-19: An Update on the Epidemiological, Clinical, Preventive and Therapeutic Evidence and Guidelines of Integrative Chinese-Western Medicine for the Management of 2019 Novel Coronavirus Disease. Am J Chin Med. 2020;48(3):737–62.
8. Mizumoto K., Chowell G., Estimating risk for death from coronavirus disease, China, January-February 2020. Emerg Infect Dis [Internet]. 2020 Jun 1 [cited 2020 Oct 29];26(6):1251–6. Available from: https://doi.org/10.3201/eid2606.200233
9. Ruan Q., Yang K., Wang W., Jiang L., Song J.. Clinical predictors of mortality due to COVID-19 based on an analysis of data of 150 patients from Wuhan, China [Internet]. Vol. 46, Intensive Care Medicine. Springer; 2020 [cited 2020 Oct 29]. p. 846–8. Available from: http://link.springer.com/10.1007/s00134-020-05991-x
10. Zhou F., Yu T., Du R., Fan G., Liu Y., Liu Z., et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet [Internet]. 2020;395(10229):1054–62. Available from: http://dx.doi.org/10.1016/S0140-6736(20)30566-3
11. Sun P., Qie S., Liu Z., Ren J., Li K., Xi J., Clinical characteristics of hospitalized patients with SARS-CoV-2 infection: A single arm meta-analysis. J Med Virol. 2020;92(6):612–7.
12. Philippine Society for Microbiology and Infectious Diseases. Interim Guidance on the Clinical Management of Adult Patients With Suspected or Confirmed Covid-19 Infection. 2020;1–54.
13. Anfinrud P., Stadnytskyi V., Bax C.E., Bax A.. Visualizing Speech-Generated Oral Fluid Droplets with Laser Light Scattering. N Engl J Med [Internet]. 2020 May 21 [cited 2020 Oct 29];382(21):2061–3. Available from: http://www.nejm.org/doi/10.1056/NEJMc2007800
14. Wölfel R., Corman V.M., Guggemos W., Seilmaier M., Zange S., Müller M.A., et al. Virological assessment of hospitalized patients with COVID-2019. Nature. 2020;581(7809):465–9.
15. Rivelli, A et. al. Incidence of COVID-19 reinfection among Midwestern healthcare employees [Internet]. 2022 Mar 11. Available from https://journals.plos.org/plosone/article?id=10.1371/ journal. pone.0262164
16. Mensah, A. et. al.Disease severity during SARS-Cov 2 Reinfection [Internet]. 2022 Mar 11. Available from https://www.journalofinfection.com/article/S0163-4453(22)00010-X/fulltext
17. Malhotra, Sumit et. al. SARS-CoV-2 Reinfection Rate and Estimated Effectiveness of the Inactivated Whole Virion Vaccine BBV152 Against Reinfection Among Health Care Workers in New Delhi, India [Internet]. 2022 Mar 11. Available from https://jamanetwork.com/journals/ jamanet-workopen/fullarticle/2787712
18. Lawandi, A. et. al. Suspected SARS-CoV-2 Reinfections: Incidence, Predictors, and Healthcare Use among Patients at 238 U.S. Healthcare Facilities, June 1, 2020- February 28, 2021 [Internet]. 2022 Mar 11. Available from https://pubmed.ncbi.nlm.nih.gov/34351392/
19. Mensah, Anna et.al. Disease severity during SARS-COV-2 reinfection: a nationwide study [Internet]. 2022 Mar 11. Available from https://www.sciencedirect.com/science/article/pii/ S016344532200010X#!
20. Babiker, A. et.al. The Importance and Challenges of Identifying SARS-CoV-2 Reinfections [Internet]. 2022 Mar 11. Available from https://pubmed.ncbi.nlm.nih.gov/33361342/

21. Islam, M. et.al. Severity of COVID-19 reinfection and associated risk factors: findings of a cross-sectional study in Bangladesh [Internet]. 2022 Mar 11. Available from https://www.medrxiv.org/content/10.1101/2021.12.26.21268408v1.full.pdf
22. Wang, J et.al. COVID-19 reinfection: a rapid systematic review of case reports and case series Available from https://jim.bmj.com/content/69/6/1253
23. Severity of SARS-CoV-2 Reinfections as Compared with Primary Infections [Internet]. 2022 Mar 11 Available from https://www.nejm.org/doi/full/10.1056/nejmc2108120#:~:text=There%20were%20no%20cases%20of%20death%20from%20Covid%2D19%20at,0.25)%20that%20at%20primary%20infection
24. Thomas, L; "COVID-19 immunity in family members reduces risk of infection by 45-97%" October 2021 Available from https://www.news-medical.net/news/20211014/COVID-19-immunity-in-family-members-reduces-risk-of-infection-by-45-9725.aspx
25. Medic et.al; ; "Risk and Severity of SARS-CoV-2 reinfections during 2020-2022 in Vojvodina, Serbia: A population-level observational study" Available from https://www.thelancet.com/journals/lanepe/article/PIIS2666-7762(22)00147-8/fulltext#:~:text=Reinfections%20were%20mostly%20mild%20(99.17,)%20per%201000%20person%2Dmonths
26. Thomas, L MD; "COVID-19 immunity in family members reduces risk of infection by 45-97%" Available from https://www.news-medical.net/news/20211014/COVID-19-immunity-in-family-members-reduces-risk-of-infection-by-45-9725.aspx
27. Ejaz, H, et al; "COVID-19 and comorbidities: Deleterious impact on infected patients" Available from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7402107/;doi 10.1016/j.jiph.2020.07.014: 2020 Dec
28. Wong J. et.al. Association of Individual Health Literacy with Preventive Behaviours and Family Well-Being during COVID-19 Pandemic: Mediating Role of Family Information Sharing Available at: https://pubmed.ncbi.nlm.nih.gov/3326115/
29. Mensah, A et.al; "Disease severity during SARS-COV-2 reinfection: a nationwide study" Available from https://www.sciencedirect.com/science/article/pii/S016344532200010X; https://doi.org/10.1016/j.jinf.2022.01.012; 2022, April
30. Kipourou, D et.al; "Probabilities of ICU admission and hospital discharge according to patient characteristics in the designated COVID-19 hospital of Kuwait" Available from https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-021-10759-z; June, 2021
31. Whittaker, R. et.al. Length of hospital stay and risk of intensive care admission and in-hospital death among COVID-19 patients in Norway: a register-based cohort study comparing patients fully vaccinated with an mRNA vaccine to unvaccinated patients Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8872711/
32. Zhang, W. et.al (2022). COVID-19 in the immunocompromised population: data from renal allograft recipients throughout full cycle of the outbreak in Hubei province, China Available at https://journals.lww.com/cmj/Fulltext/2022/01200/COVID_19_in_the_immunocompromised_population__data.15.aspx