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## Predicting Factors for COVID-19 Infection: A Cross-Sectional Study in Indonesia

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### Abstract

COVID-19 cases in Indonesia still remain a concern, particularly for public health. Several factors, such as gender, age, comorbidity, occupation, and vaccination status, might influence COVID-19 infection. Individuals who have many predicting factors have a higher risk of being infected by COVID-19. Other studies have not yet shown the significance of predicting factors for COVID-19 infection in Indonesia. The study explored the association between the predicting factors and COVID-19 infection in Indonesia. The study used a cross-sectional method with a population of all Indonesian communities. It was conducted in August 2021 by distributing a Google Form questionnaire in Indonesia. By a saturated sampling of the population in Jawa, Sumatera, Sulawesi, Kalimantan, and Papua, 776 Indonesians were selected; they were aged > 17 years and voluntarily completed the questionnaires. whereas respondents with incomplete data were excluded from this study. The data were analyzed using a binary logistic regression test in SPSS (version 21.0). The respondents include 134 men (17.3%) and 642 women (82.7%). The binary logistic regression analysis showed that COVID-19 infection was more common among respondents who were non-health-care workers (p 0.001) and less common among those who had been fully vaccinated (p 0.001). The COVID-19 infection was significantly associated with occupation and vaccination status.

**Keywords:** COVID-19 Infection, Predicting Factors, Public Health, Health-Care Worker, COVID-19 Vaccination, Comorbidity

### INTRODUCTION

Since the outbreak in early December 2019 in the Hubei province of the People's Republic of China, the number of confirmed COVID-19 cases has exceeded 229 million as the disease has spread globally. Based on the WHO Coronavirus (COVID-19) Dashboard on September 23, 2021, more than four million people died from COVID-19.(1) As of September 24, 2021, the total confirmed COVID-19 cases in Indonesia were 4,204,116. In total, there were 141,258.(2) Coronavirus Disease 2019 (COVID-19) has been declared a global pandemic by the

World Health Organization (WHO). The Indonesian government has declared COVID-19 a type of disease that leads to a public health emergency as well as non-natural disasters. Not only does it cause deaths but also considerable economic loss; thus, it is necessary to identify countermeasures, including prevention and control.(3)

However, the patient's gender, age, and comorbidity may be associated with an increased risk of COVID-19 infection.(4) Some studies showed that COVID-19 infects more males than females, 5–7, while others did not show similar findings. Others

showed geriatric patients (older than 50 years) are more at risk of COVID-19 infection, while another study found otherwise.(11) The influence of comorbidities in patients with COVID-19 is likely not to contribute much to the infection. Other than that, healthcare workers, especially front-line workers, are at the greatest risk of being infected by COVID-19 at work through direct or indirect contact with infected patients or other healthcare workers.(13,14) Furthermore, Wei et al. (2021) showed that 94% of the participants achieved positive antibody responses in 28 days after vaccination, regardless of age, type of vaccine given, or history of prior COVID-19 infection.(15) Further studies are needed to better understand the minimum quantitative antibody responses that are associated with vaccine-mediated protection. Positive antibody responses are expected to protect individuals from COVID-19 infection.(15) The COVID-19 infection is presumably influenced by several factors, such as gender, age, comorbidity, occupation, and vaccination status. Individuals who have many predicting factors have a higher risk of being infected by COVID-19. To answer these assumptions, this study explored the association between the predicting factors and COVID-19 infection in Indonesia. Understanding the influence of predicting factors on COVID-19 infection could improve public health messaging; thus, individuals with multiple predictor factors could be more careful in protecting themselves from COVID-19 infection.

## METHOD

### Study design

This cross-sectional study consisted of two steps: preparation and data collection. At the preparation step, the research protocols, questionnaire, and

informed consent were prepared. Subsequently, the questionnaire was set up in Google Forms. The data were collected in August 2021 through questionnaire distribution. The study population was Indonesian communities, both positive for COVID-19 or not. They were sampled using a saturated sampling technique. The study respondents were bound to complete the informed consent form before the questionnaire. This study has obtained ethical approval from the Ethics Committee of the Faculty of Public Health, Universitas Airlangga, with the registered number of ethical approval: 50/EA/KEPK/2021.

### Eligibility criteria

The study respondents were Indonesians aged more than 17 who voluntarily completed the questionnaire, while respondents with incomplete data were excluded from this study. As many as 807 respondents completed the questionnaire, but 31 were excluded for incomplete data. Out of the total number, 776 respondents were eligible for this study.

## RESULT AND DISCUSSION

### Characteristics of the Respondents

A total of 776 respondents were analyzed. The baseline characteristics of the respondents are available in Table 1. Most of the respondents are women (83%) who were more likely to be younger than 39 years old. Most of the respondents were healthcare workers who were located mostly in Java. There was one respondent from Papua, the most eastern part of Indonesia, but this number was not proportional to other locations. All respondents were mostly vaccinated. The majority of the respondents had no comorbidity (88%). About 76% of the respondents were never infected by COVID-19.

**Table 1.** Demographic and Clinical Characteristic

| Variables                 | Number of Respondents (n=776) |
|---------------------------|-------------------------------|
| <b>Gender</b>             |                               |
| Men                       | 134 (17%)                     |
| Women                     | 642 (83%)                     |
| <b>Years</b>              |                               |
| < 25                      | 215 (28%)                     |
| 25-29                     | 204 (26%)                     |
| 30-39                     | 222 (29%)                     |
| 40-49                     | 89 (11%)                      |
| 50-59                     | 22 (3%)                       |
| ≥ 60                      | 24 (3%)                       |
| <b>Comorbidity</b>        |                               |
| Asthma                    | 44 (6%)                       |
| Hypertension              | 29 (4%)                       |
| Diabetic                  | 7 (1%)                        |
| COPD                      | 1 (0.13%)                     |
| Cardiac Disease           | 3 (0.39%)                     |
| Stroke                    | 1 (0.13%)                     |
| Cancer                    | 3 (0.39%)                     |
| No Comorbidity            | 688 (88%)                     |
| <b>Occupation type</b>    |                               |
| Health care worker        | 513 (66%)                     |
| Field worker              | 4 (1%)                        |
| Office worker             | 60 (8%)                       |
| Work at home              | 14 (2%)                       |
| Others                    | 185 (24%)                     |
| <b>Vaccination Status</b> |                               |
| Fully vaccinated*         | 384 (49%)                     |
| Not fully vaccinated*     | 392 (51%)                     |
| <b>Domicile Location</b>  |                               |
| Jawa                      | 590 (76%)                     |
| Sumatera                  | 74 (10%)                      |
| Sulawesi                  | 25 (3%)                       |
| Bali                      | 13 (2%)                       |
| Kalimantan                | 57 (7%)                       |
| Nusa Tenggara - Papua     | 17(0.13%)                     |
| <b>Covid History</b>      |                               |
| Ever been Infected*       | 187 (24%)                     |
| Never been infected*      | 589 (76%)                     |

\*28 days after second vaccine

### Statistical analysis

SPSS (version 21.0) was used for all analyses. The data were analyzed using the binary logistic regression test since the dependent variable consisted of two sub-variables: ever infected by COVID-19 and never infected by COVID-19. Since one of the variables analyzed was vaccination status, the COVID-19 history was counted 28 days after the second vaccine. According to Wei et al. (2021), positive antibody responses will form 28 days after

vaccination.(15)

Regarding sexes, there are two sub-variables, including female and male. Previous research stated that COVID-19 infects more males than females.(5–7) To analyze the association between age and COVID-19 infection, two sub-variables are included: non-geriatrics ( 60 years old) and geriatrics ( 60 years old). Geriatrics are more likely to be infected by COVID-19. (6,10) The cut-off of 60 years old for the geriatrics category was based on the

Indonesian Ministry of Health (2019), which states that individuals aged 60 years have to limit meeting people to minimize the risk of COVID-19 infection. (3) Health-care workers, especially front-line workers, are at the greatest risk of being infected by COVID-19 at work because of direct or indirect contact with infected patients or infected healthcare workers.(13,14) Looking into this further, there are two categories of occupation: non-health-care worker and health-care worker. Further, patients with comorbidities such as diabetes, hypertension, cancer, asthma, chronic obstructive pulmonary disease (CPOD), cardiac disease, and stroke were analyzed. (3) The data of the respondents were retrieved from their vaccination status: not fully vaccinated and fully

vaccinated.

### Predicting Factors associated with COVID-19 infection

From the research variables included, the bivariate and the multivariate analysis were done using binary logistic regression. The results showed occupation (OR = 2.509; 95% CI = 1.681-3.745; p = 0.000007) and vaccination status (OR = 0.478; 95% CI = 0.335-0.683; p = 0.00005) had a significant association with COVID-19 infection. The results of bivariate analysis and multivariate analysis are presented in Table 2. Meanwhile, gender, age, comorbidity, and residence had shown no significant association with COVID-19 infection in the respondents.

**Table 2.** The Association between the Predicting Factor and COVID-19 Infection

| Variables                | $\frac{n(\%)}{776 (100\%)}$ | OR    | 95% CI        | P-value   | aOR   | 95% CI        | P-value   |
|--------------------------|-----------------------------|-------|---------------|-----------|-------|---------------|-----------|
| <b>Gender</b>            |                             |       |               |           |       |               |           |
| Female                   | 642<br>(82.73%)             | Ref   | Ref           | Ref       |       |               |           |
| Male                     | 134<br>(17.27%)             | 0.891 | 0.571 – 1.390 | 0.611     |       |               |           |
| <b>Age</b>               |                             |       |               |           |       |               |           |
| Non-Geriatrics           | 752<br>(96.91%)             | Ref   | Ref           | Ref       |       |               |           |
| Geriatrics               | 24 (3.09%)                  | 0.279 | 0.065 – 1.196 | 0.086     |       |               |           |
| <b>Occupation</b>        |                             |       |               |           |       |               |           |
| Non-Healthcare           | 263<br>(33.89%)             | Ref   | Ref           | Ref       | Ref   | Ref           | Ref       |
| Healthcare               | 513<br>(66.11%)             | 1.997 | 1.366 – 2.918 | 0.000353* | 2.509 | 1.681 – 3.745 | 0.000007* |
| <b>Comorbidity</b>       |                             |       |               |           |       |               |           |
| Non-comorbid             | 688<br>(88.66%)             | Ref   | Ref           | Ref       |       |               |           |
| Comorbid                 | 88 (11.34%)                 | 0.790 | 0.457 – 1.364 | 0.397     |       |               |           |
| <b>Vaccination</b>       |                             |       |               |           |       |               |           |
| Not fully vaccinated     | 392<br>(50.52%)             | Ref   | Ref           | Ref       | Ref   | Ref           | Ref       |
| Fully vaccinated         | 384<br>(49.48%)             | 0.589 | 0.422 – 0.824 | 0.002*    | 0.478 | 0.335 – 0.683 | 0.00005*  |
| <b>Domicile Location</b> |                             |       |               |           |       |               |           |
| Jawa                     | 590 (76%)                   | Ref   | Ref           | Ref       | Ref   | Ref           | Ref       |
| Sumatera                 | 74 (10%)                    | 0.536 | 0.275 – 1.044 | 0.067     | 0.507 | 0.257 – 1.000 | 0.050     |
| Sulawesi                 | 25 (3%)                     | 0.585 | 0.197 – 1.731 | 0.332     | 0.575 | 0.191 – 1.729 | 0.324     |
| Bali                     | 13 (2%)                     | 0.558 | 0.122 – 2.547 | 0.451     | 0.512 | 0.110 – 2.387 | 0.394     |
| Kalimantan               | 57 (7%)                     | 1.929 | 1.096 – 3.395 | 0.023*    | 1.718 | 0.958 – 3.082 | 0.069     |
| Nusa Tenggara - Papua    | 17 (2%)                     | 0.658 | 0.186 – 2.321 | 0.515     | 0.623 | 0.173 – 2.249 | 0.470     |

\*p-value cut off < 0.05

**DISCUSSION**

A study by Biswas et al. (2021) stated that a patient's gender, age, and comorbidity may be associated with an increased risk of COVID-19 infection. (4) In contrast with another study, these variables were likely not associated with COVID-19 infection.

The COVID-19 virus, known as SARS-CoV-2, enters the body through the angiotensin-converting enzyme 2 (ACE2). (16) ACE2 gets involved in the renin-angiotensin-aldosterone system (RAAS), a hormone system that regulates blood pressure, tissue perfusion, and the balance of the body's extracellular environment. (17) Variable expression of ACE2 throughout the body may explain the sex disparities in COVID-19 infection severity and fatality. The risk of COVID-19 infection and fatality is increased in line with the higher expression and activity of ACE2. (18) The regulatory effects of estrogen on ACE2 lead to lower ACE2 expression and activity in female patients than male patients, meaning lower severity and fatality. (16,19) The expression of ACE2 is downregulated when SARS-CoV-2 binds to ACE2, which exacerbates respiratory infection and severity. (16) Studies have shown that estrogen can upregulate the expression of ACE2. (20–21) This upregulation may be able to counteract the downregulation caused by the viral entry of SARS-CoV-2, leading to better outcomes in female patients with COVID-19 infection. (17) However, this current study did not reveal any risk of COVID-19 infection in the male respondents likely due to the imbalanced composition of the respondents (82.73% of the respondents were female).

Elderly or geriatrics in both sexes (> 50 years) are more susceptible to COVID-19 infection, which may be associated with a higher frequency of severity. Elderly or geriatric patients are more susceptible to severe COVID-19 infection because of weak immunity and other organ dysfunctions. Elderly or geriatric patients and patients with comorbidities are likely

infected by COVID-19. (22,23) In this study we could not reveal COVID-19 infection risk in geriatrics, due to the geriatric respondents who participated in this study was too small (3.09%).

All of the preexisting comorbidities are associated with a poor prognosis. Comorbidities such as hypertension, diabetes, respiratory system disease, and cardiovascular disease and their susceptibility conditions increase the risk of severe illness or death due to COVID-19 infection. Hypertension and other cardiovascular diseases are likely associated with COVID-19. The risk of COVID-19 infection is higher due to the decreasing function of the innate immunity response, macrophages, and lymphocytes. A metabolic disorder, inflammation, and infection for diabetes are likely associated with COVID-19 infection. (22) This current study did not show the relationship between COVID-19 infection risk and comorbidity, due to imbalanced respondents where 88.66% of respondents have no comorbidity.

Infection may result from ongoing community transmission. (13,14) In Wuhan, China, 29% of COVID-19 patients were healthcare workers assumed to get the infections at hospitals. (13) Compared to the general community, front-line health care workers were at increased risk of being confirmed positive for COVID-19 (adjusted OR = 11.61; 95% CI = 10.93–12.33). (14) This current study is in line with the previous studies that healthcare workers have more risk of COVID-19 infection.

Besides, a vaccine could have a substantial impact on reducing the incidence, hospitalizations, and deaths, especially among vulnerable individuals with comorbidities, and it becomes a risk factor associated with severe COVID-19. (24) This current study supports the previous study that COVID-19 infections are less common in fully vaccinated persons. Advocating for the community to get vaccinated is important to achieve herd immunity.

**Limitation**

While this study might serve as a foundation for preventive measures, it must be further developed by including more samples. The respondents included may not represent the total of Indonesia's population, which was around 270.2 million.<sup>(25)</sup> A disproportional number of respondents across regions could have the potential for bias in generalizing the results. The data in this study were self-reported by respondents instead of direct interviews or the results of assessments from health care workers, which could cause bias. However, because the research respondents came from all over Indonesia and produced valuable data, the results of the research are expected to be an initial study that can be continued by further research with a wider population and involving health care workers as assessors. Besides that, future studies could pay attention to the risk of COVID-19 infection in health care workers with specific roles.

**CONCLUSION**

Age, gender, and comorbidity are not likely associated with COVID-19 infection. The COVID-19 infection is significantly associated with occupation and vaccination status.

**CONFLICT OF INTEREST**

The authors have no conflicts of interest associated with the material presented in this paper.

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