

# RELATIONSHIP BETWEEN COVID-19 VACCINATION AND COVID-19 DISEASE IN BOGOR CITY, INDONESIA

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**Abstract.** Indonesia and the world experienced a rapid increase in coronavirus disease 2019 (COVID-19) cases by the Delta variant in 2021. Clinical trials have reported positive results of vaccines on shielding COVID-19 infection. However, their effectiveness to prevent infection in the Indonesian population is limited. Using a cross-sectional design, we aimed to seek a relationship between COVID-19 vaccination and COVID-19 disease during the pandemic in 2021 in Bogor City, Indonesia. This study was an extension of the ongoing prospective cohort study in five urban villages in Bogor Tengah District, Bogor City. In total, 722 respondents were recruited in 2021 and divided into two groups according to the types of COVID-19 tests. Covariates included COVID-19 vaccination status, COVID-19 test result status, and demographic variables. Simple and multiple logistic regressions were performed. We found that there were 20.6% of respondents exposed to COVID-19. About two-thirds (69.9%) of respondents had obtained their second or third vaccinations while those who received the first vaccination were 14%. Despite the high coverage of vaccination, 15.7% were still unvaccinated. Among the vaccinated respondents, 67.7% got the Sinovac vaccine. In a multivariate analysis, we found that respondents who were vaccinated once had a risk of being exposed to COVID-19 by 2.2 times (95% confidence interval (CI): 1.354-3.613;  $p=0.002$ ) compared to those who were vaccinated  $\geq 2$  times after controlling for education and work. In summary, full vaccinations effectively protect people from COVID-19 disease.

**Keywords:** vaccination, COVID-19, Bogor

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## INTRODUCTION

The World Health Organization (WHO), on 1 July 2021, identified four types of new variants of coronavirus disease 2019 (COVID-19): Alpha (B.1.1.7), Beta (B.1.351), Delta (B.1.617.2), and Gamma (P.1) variants (WHO, 2021c). The world experienced an increase in the number of cases of the transmission of new variants, particularly the Delta variant, in June-July 2021 (CDC, 2021). Globally, the number of new COVID-19 cases reached 3.8 million, reported in the 2<sup>nd</sup> week of July 2021, with a daily average increase of 540,000 new cases compared to the previous weeks (490,000 new cases) (WHO, 2021a). In the meantime, the number of reported deaths has sharply increased by more than 69,000 deaths (21%) compared to the first week of July 2021 (WHO, 2021b).

Indonesia experienced a similar situation from the end of June 2021 until its peak in mid-July 2021. Starting on 21 June 2021, there was an observed increase in weekly cases by 59.6%, climbing from 23,231 cases to 46,844 cases. The cases continued to rise, amounting to 43.7% per weekly case from 74,339 on July 5, 2021 to 107,154 cases on 12 July 2021 (MOH RI, 2021a)

Various efforts have been made to control the spread of COVID-19 infection. Indonesian government urged citizens to achieve immediate herd immunity by establishing mass vaccinations (Subchi *et al*, 2021). The government increased the national COVID-19 vaccination target from 181.5 million to 208.3 million until the end of 2021. However, vaccine data coverage as of 18 June 2021 for Doses 1 and 2, were low at 11.3 and 6.1

percent, respectively. On the other hand, Dose 3 had not been available yet. On 28 July 2021, after passing the second pandemic wave, vaccine coverage increased significantly for dose 1 by 22.7%, dose 2 by 9.7%, and dose 3 by 0.1% (MOH RI, 2021b).

The second wave hit Indonesia in mid-2021, with an average number of new cases per day reaching 43,414 (22-28 July 2021). Meanwhile, since Bogor is regarded as a buffer city for DKI Jakarta, the mobility between residents of Bogor and DKI Jakarta is frequent. The increase in COVID-19 cases in Bogor City was comparable to the increase in national cases (Bogor City Government, 2021). A total of 1,052 new cases in Bogor (69.1% increase) were recorded in the second wave of COVID-19 infection as compared to the previous wave. The trend continued to rise and plateaued on 26 July 2021. Although the cases went upwards by 13.7%, they were lower than the cases in the 2<sup>nd</sup> wave of COVID-19 (West Java Provincial Government, 2021).

The Phase 1 COVID-19 vaccination in Bogor began on 14 January 2021 targeting health workers, assistant health workers, support staff, and medical students who worked at health service facilities. The coverage of the first semester of vaccines (January-June 2021), according to the Bogor Health Office, reported that 154,159 people (18.8%) were vaccinated for Dose 1, while for Dose 2, there were 111,416 people (13.6%) vaccinated. Dose 3 of vaccination had not been implemented (0.0%). This coverage went upward in December 2021. As of 31 December 2021, the coverage of Dose 1 rose dramatically by 100.9%. Only 9% of vaccinated participants were recorded as commuters who obtained vaccination in Bogor. Likewise, the coverage of Dose 2 increased by 78.4% (Bogor City Health Office, 2021).

Types of vaccines used in Indonesia comprise Sinovac (Sinovac Biotech Ltd, Beijing, PR China), Astra Zeneca (Oxford-AstraZeneca, Cambridge, UK), Moderna (Moderna, Cambridge, MA), Sinopharm (Sinopharm Group Co Ltd, Shanghai, PR China), and Pfizer (BioNTech, Mainz, Germany) (MOH RI, 2021c).

The prospective FRPTM Cohort Study in Bogor, a longitudinal study on non-communicable disease (NCD), had been going on for ten years. It was carried out in five sub-boroughs in Central Bogor District, namely Kebon Kalapa borough, Babakan borough, Babakan Pasar borough, Ciwaringin borough, and Panaragan borough. The FRPTM Cohort Study sample included male and female respondents aged 25 years and over. In 2020 and 2021, due to the COVID-19 pandemic, researchers added new questionnaires to record COVID-19 experiences that did not exist in the year before 2020 (Senewe *et al*, 2021).

Since an evaluation of vaccine effectiveness at the population level is limited, assessing their effect beyond clinical trials with selected respondents is needed in real-world settings. Therefore, our study aimed to determine the effectiveness of COVID-19 vaccines administered in Bogor city against COVID-19 infection.

## MATERIALS AND METHODS

A cross-sectional design was conducted to determine the effectiveness of COVID-19 vaccines administered in Bogor city against COVID-19 infection. A special data collection was conducted in 2020-2021 for COVID-19. All respondents of the 2021 FRPTM cohort study were considered for inclusion. When they came for periodical visits at a health center called POSBINDU, they were asked to fill out questionnaires related to COVID-19. As many as 3,530 respondents participated in the survey. Exclusion criteria were those with insufficient information. Some respondents volunteered to participate in COVID-19 tests either with an antigen swab test or real-time polymerase chain reaction (PCR) in 2021. A total of 722 respondents were eligible for the data analysis.

Data were extracted from the National Institute of Health Research and Development (NIHRD) electronic database; these included the

infection status to COVID-19 (approved by swab antigen or PCR) and social demographic data (age, gender, education, and occupation). In particular to occupation, it was classified into side job, housewife/unemployment, full-time job, and temporary job, according to their occupational roles. Full-time job includes citizens who had permanent jobs such as civil servants, office employees, and the army. Side job refers to those who worked part-time, including daycare workers, maids, and shopkeepers. We classified temporary jobs for those who worked based on contract agreements in a short period, including laborers and online transport employees. Respondents' behaviors (ie smoking, handwashing with soap, wearing masks, and sanitizers, and keeping a distance) were also collected. We measured vaccination status by definition of COVID-19 vaccine injection, a number of doses, and vaccine names. NCD comorbidities data were also recorded. Our primary outcome of the study consisted of COVID-19 infection which was confirmed by a PCR or swab antigen-based test.

Statistical Package for Social Science (SPSS) version 26.0 (IBM Corp, Armonk, NY) was performed for statistical analyses. The categorical variable was expressed as percentages, and bivariate analysis was performed using simple logistic regression. Multivariable logistic regression analysis was assigned to assess the relationship between vaccination and COVID-19 infection, adjusting for confounding variables (social demographic, respondents' behavior, co-morbid).

The study was approved by the ethics committee of the NIHRD with number LB.02.01/2/KE.169/2021. Informed consent was obtained from all respondents before commencing the study.

## RESULTS

### **Characteristics of respondents**

A total of 722 of 3,530 respondents were included in this analysis.

All 722 eligible respondents completed the 2021 COVID-19 examination in the Central Bogor District, whose data were filled in completely. Among 722 respondents, 149 (20.6%) respondents developed COVID-19 and 573 (79.4%) did not show COVID-19 test positive. The majority of respondents were aged >45 years (71%). Most of them were women (70.1%), held secondary education (67.3%), and had full-time jobs (50.0%). Respondents who were smokers accounted similar proportion (38.4%) to the non-smoker (40.3%). Most respondents received COVID-19 vaccines (84.3%), and 69.9% had completed the second dose. Vaccine from Sinovac was the most injected vaccine (67.7%). More than half (60.8%) of the respondents did not carry NCDs. Looking at respondents' behavior during the pandemic, we found that they had followed approved health protocols for COVID-19

Table 1

Baseline characteristics of respondents in the FRPTM Cohort Study who carried out COVID-19 test in 2021 (N = 722)

| Characteristic      | Frequency, <i>n</i> (%) |
|---------------------|-------------------------|
| Exposed to COVID-19 |                         |
| Yes                 | 149 (20.6)              |
| No                  | 573 (79.4)              |
| Age                 |                         |
| <35 years           | 36 (5.0)                |
| 36-44 years         | 173 (24.0)              |
| 45-54 years         | 255 (35.3)              |
| >55 years           | 258 (35.7)              |
| Sex                 |                         |
| Female              | 506 (70.1)              |
| Male                | 216 (29.9)              |

Table 1 (cont)

| Characteristic                           | Frequency, <i>n</i> (%) |
|--|-------------------------|
| Education                                |                         |
| Primary (Elementary-Junior School)       | 145 (20.1)              |
| Middle (Senior high school)              | 486 (67.3)              |
| High (University)                        | 91 (12.6)               |
| Occupation                               |                         |
| Side job                                 | 40 (5.5)                |
| Housewife/unemployment                   | 305 (42.2)              |
| Full time job                            | 361 (50.0)              |
| Temporary job                            | 16 (2.2)                |
| Smoking status                           |                         |
| Smoker                                   | 154 (21.3)              |
| Past smoker                              | 277 (38.4)              |
| Non-smoker                               | 291 (40.3)              |
| COVID-19 vaccinated status               |                         |
| Unvaccinated                             | 113 (15.7)              |
| Vaccinated                               | 609 (84.3)              |
| Vaccine doses for vaccinated respondents |                         |
| Received more than one dose              | 505 (69.9)              |
| Received one dose                        | 104 (14.4)              |
| COVID-19 vaccine received                |                         |
| Pfizer                                   | 34 (4.7)                |
| Moderna                                  | 5 (0.7)                 |
| AstraZeneca                              | 81 (11.2)               |
| Sinovac                                  | 489 (67.7)              |
| Unvaccinated                             | 113 (15.7)              |

Table 1 (cont)

| Characteristic                             | Frequency, <i>n</i> (%) |
|--|-------------------------|
| NCD comorbidities                          |                         |
| Yes  | 283 (39.2)              |
| No   | 439 (60.8)              |
| Handwashing with soap                      |                         |
| Yes, always                                | 691 (95.7)              |
| Yes, sometimes                             | 25 (3.5)                |
| Never                                      | 6 (0.8)                 |
| Wearing masks                              |                         |
| Not leaving the house                      | 38 (5.3)                |
| Yes, always                                | 584 (80.9)              |
| Yes, sometimes                             | 96 (13.3)               |
| Never                                      | 4 (0.6)                 |
| Use hand sanitizer                         |                         |
| Yes always                                 | 522 (72.3)              |
| Yes, sometimes                             | 153 (21.2)              |
| Never                                      | 47 (6.5)                |
| Keeping 1-meter distance outside the house |                         |
| Not leaving the house                      | 38 (5.3)                |
| Yes, always                                | 408 (56.5)              |
| Yes, sometimes                             | 204 (28.3)              |
| Never                                      | 72 (10.0)               |
| Hospitalized due to COVID-19               |                         |
| Never                                      | 630 (87.3)              |
| Ever                                       | 92 (12.7)               |

COVID-19: coronavirus disease 2019; NCD: non-communicable disease

protection. Most of them posed healthy behaviors, particularly washing hands with soap (95.7%), wearing masks (80.9%), using hand sanitizer (72.3%), and keeping their distance (56.5%). Furthermore, 87.3% of respondents had never been hospitalized due to COVID-19. Table 1 shows the statistical distribution of respondents' characteristics.

### **COVID-19 vaccination status and COVID-19 infection**

We found a relationship between COVID-19 vaccination status and COVID-19 infection with p-value of 0.002 and odds ratio (OR) = 2.05 (95% CI: 1.315-3.204). This indicates a risk of COVID-19 infection for those unvaccinated against COVID-19. They had 2.05 times higher risk of contracting COVID-19 than those who got COVID-19 vaccination. Other variables that had a significant relationship with COVID-19 infection were the number of vaccinations, vaccine names, occupation, and use of hand sanitizer ( $p < 0.001$ ). Variables of age, gender, education, smoking, NCD comorbidities, handwashing with soap, and keeping a distance of 1 meter outside the house did not have a significant relationship with COVID-19 infection ( $p > 0.05$ ), as shown in Table 2.

## DISCUSSION

COVID-19 is a new type of disease that spreads rapidly worldwide. WHO declared it a pandemic. Currently, several studies have been growing to provide epidemiological analyses. Evidence-based health is still evolving through trials and errors to find answers. Therefore, gaps are found in research results that can be cited to support findings of the COVID-19 cohort study in Indonesia. Some of our findings are mostly in line with previous studies conducted in other countries (Chico-Sánchez *et al*, 2022; Pramod *et al*, 2022; Sacco *et al*, 2022).

Table 2  
Unadjusted factors associated with COVID-19 infection

| Variable                                     | COVID-19 infection |            | OR (95% CI)       | p-value* |
|--|--------------------|------------|-------------------|----------|
|  | Yes, n (%)         | No, n (%)  |                   |          |
| COVID-19 vaccination status                  |                    |            |                   |          |
| Unvaccinated (N = 113)                       | 36 (31.9)          | 77 (68.1)  | 2.05 (1.31-3.20)  | 0.002    |
| Vaccinated (N = 609)                         | 113 (18.6)         | 496 (81.4) |                   |          |
| Sex  |                    |            |                   |          |
| Female (N = 506)                             | 111 (21.9)         | 395 (78.1) | 0.76 (0.50-1.14)  | 0.187    |
| Male (N = 216)                               | 38 (17.6)          | 178 (82.4) |                   |          |
| Education                                    |                    |            |                   |          |
| Primary (Elementary-junior school) (N = 145) | 26 (17.9)          | 119 (82.1) | 0.65 (0.34-1.22)  | 0.178    |
| Middle (Senior high school) (N = 486)        | 386 (79.4)         | 100 (20.6) | 0.77 (0.46-1.29)  | 0.316    |
| High (University) (N = 91)                   | 23 (25.3)          | 68 (74.7)  | Reference         | -        |
| Occupation                                   |                    |            |                   |          |
| Side job (N = 40)                            | 2 (5.0)            | 38 (95.0)  | Reference         | -        |
| Housewife/unemployment (N = 305)             | 65 (21.3)          | 240 (78.7) | 5.15 (1.21-21.89) | 0.027    |
| Full time job (N = 361)                      | 78 (21.6)          | 283 (78.4) | 5.24 (1.24-22.19) | 0.025    |
| Temporary job (N = 16)                       | 4 (25.0)           | 12 (75.0)  | 6.33 (1.03-38.9)  |          |

Table 2 (cont)

| Variable                              | COVID-19 infection | OR (95% CI)      | p-value* |
|---------------------------------------|--------------------|------------------|----------|
| <b>Smoking status</b>                 |                    |                  |          |
| Smoker (N = 154)                      | 24 (15.6)          | 0.64(0.38-1.08)  | 0.092    |
| Past smoker (N = 277)                 | 60 (21.7)          | 0.96 (0.65-1.43) | 0.846    |
| Non-Smoker (N = 291)                  | 65 (22.3)          | Reference        | -        |
| <b>Age</b>                            |                    |                  |          |
| <35 years (N = 36)                    | 9 (25.0)           | Reference        | -        |
| >35-44 years (N = 173)                | 36 (20.8)          | 0.79 (0.34-1.82) | 0.578    |
| 45-54 years (N = 255)                 | 56 (22.0)          | 0.84 (0.38-1.89) | 0.682    |
| >55 years (N = 258)                   | 48 (18.6)          | 0.69 (0.30-1.55) | 0.365    |
| <b>Vaccine doses</b>                  |                    |                  |          |
| Unvaccinated (N = 113)                | 36 (31.9)          | 2.34 (1.48-3.71) | 0.000    |
| Received one dose (N = 104)           | 29 (27.9)          | 1.94 (1.19-3.16) | 0.008    |
| Received more than one dose (N = 505) | 4 (16.6)           | Reference        | -        |

Table 2 (cont)

| Variable                | COVID-19 infection | OR (95% CI)       | p-value* |
|-------------------------|--------------------|-------------------|----------|
| COVID-19 vaccine names  |                    |                   |          |
| Pfizer (N = 34)         | 8 (23.5)           | Reference         | -        |
| Moderna (N = 5)         | 1 (20.1)           | 0.81 (0.08-8.35)  | 0.861    |
| Astra Zeneca (N = 81)   | 9 (11.1)           | 0.41 (0.14-1.16)  | 0.094    |
| Sinovac (N = 489)       | 95 (19.4)          | 0.78 (0.34 -1.79) | 0.562    |
| Unvaccinated (N = 113)  | 36 (31.9)          | 1.52 (0.63-3.68)  | 0.355    |
| NCD comorbidities       |                    |                   |          |
| Yes (N = 283)           | 58 (20.5)          | 0.99 (0.68 -1.43) | 0.939    |
| No (N = 439)            | 91 (20.7)          | 348 (79.3)        |          |
| Washing hands with soap |                    |                   |          |
| Yes always (N = 691)    | 143 (20.7)         | Reference         | -        |
| Yes, sometimes (N = 25) | 3 (12.0)           | 0.52 (0.15-1.77)  | 0.297    |
| Never (N = 6)           | 3 (20.6)           | 3.83 (0.77-19.19) | 0.102    |
| Wearing Mask            |                    |                   |          |
| Stay at home (N = 38)   | 9 (23.7)           | Reference         | -        |
| Yes, always (N = 584)   | 119 (20.4)         | 0.83 (0.38-1.79)  | 0.626    |
| Yes, sometimes (N = 96) | 19 (19.8)          | 0.79 (0.32-1.96)  | 0.618    |
| Never (N = 4)           | 2 (50.0)           | 3.22 (0.39-26.25) | 0.274    |

Table 2 (cont)

| Variable                                   | COVID-19 infection | OR (95% CI)       | p-value* |
|--|--------------------|-------------------|----------|
| Use hand sanitizer                         |                    |                   |          |
| Yes always (N = 522)                       | 101 (19.3)         | Reference         | -        |
| Yes, sometimes (N = 153)                   | 41 (26.8)          | 1.53 (1.00-2.32)  | 0.048    |
| Never (N = 47)                             | 7 (14.9)           | 0.73 (0.32- 1.68) | 0.457    |
| Keeping 1-meter distance outside the house |                    |                   |          |
| Stay at home (N = 38)                      | 9 (23.7)           | Reference         | -        |
| Yes always (N = 408)                       | 75 (18.4)          | 0.73 (0.33-1.59)  | 0.426    |
| Yes, sometimes (N = 204)                   | 46 (22.5)          | 0.94 (0.42-2.12)  | 0.878    |
| Never (N = 72)                             | 19 (20.6)          | 1.16 (0.46-2.88)  | 0.757    |

Note: Backward stepwise was chosen to find a robust simple model.

\*Significant at  $p < 0.05$  using logistic regression test

CI: confidence interval; COVID-19: coronavirus disease 2019; NCD: non-communicable disease; OR: odds ratio

Table 3  
Adjusted model by including the vaccine doses as the main independent variable

| Variable                            | B      | SE    | Wald   | aOR (95% CI)          | p-value* |
|-------------------------------------|--------|-------|--------|-----------------------|----------|
| <b>Vaccine doses</b>                |        |       |        |                       |          |
| Unvaccinated                        | 1.004  | 0.244 | 16.897 | 2.73 (1.691 – 4.408)  | <0.001   |
| Received one dose                   | 0.794  | 0.250 | 10.053 | 2.212 (1.354 – 3.613) | 0.002    |
| Received more than one dose         | -      | -     | -      | Reference             | -        |
| <b>Education</b>                    |        |       |        |                       |          |
| Low (Elementary-Junior High School) | -0.777 | 0.336 | 5.341  | 0.460 (0.238 – 0.889) | 0.021    |
| Middle (Senior High Scholl)         | -0.356 | 0.269 | 1.745  | 0.701 (0.413 – 1.188) | 0.186    |
| High (University)                   | -      | -     | -      | Reference             | -        |
| <b>Occupation</b>                   |        |       |        |                       |          |
| Side job                            | -      | -     | -      | Reference             | -        |
| Housewife/unemployment              | 0.318  | 0.598 | 0.283  | 1.375 (0.425 – 4.442) | 0.595    |
| Full time job                       | -1.567 | 0.744 | 4.436  | 0.209 (0.049 – 0.897) | 0.035    |
| Temporary job                       | 0.049  | 0.195 | 0.062  | 1.050 (0.717 – 1.537) | 0.803    |

Note: Backward stepwise was chosen to find a robust simple model.

\*Significant at  $p < 0.05$  using multiple logistic regression test

aOR: adjusted odds ratio; B: beta coefficient; CI: confidence interval; COVID-19: coronavirus disease 2019; NCD: non-communicable disease; SE: standard error

According to our study, the indication of COVID-19 vaccine protection can be found in a reduction of cases in respondents who received full vaccines (16.6%) versus partial and unvaccinated (27.9% and 31.9%, respectively). This finding is in accordance with Pramod *et al* (2022) who reported that a high protection rate against COVID was a result of the vaccination program in India. Similarly, a study from the USA showed that fully vaccinated individuals with BNT162b2 had 73% (95% CI: 72-74) overall effectiveness against SARS-CoV-2 infection and 90% (95% CI: 89-92) effectiveness against hospital admissions related to COVID-19 after a significant time since being fully vaccinated for 3-4 months (Tartof *et al*, 2021).

In Jakarta, Indonesia, the evaluation of the effectiveness of the COVID-19 vaccine, conducted by the National Institute of Health Research and Development (NIHRD) proved that the vaccine could reduce the risk of being infected with COVID-19, as well as reduce care and death for health workers (NIHRD MOH RI, 2021). It showed that full-dose COVID-19 vaccination can be reliable to protect health workers from the risk of treatment and death due to COVID-19 infection. The effectiveness of the complete dose of the COVID-19 vaccine in preventing COVID-19 infection in January-March is 84%. In other words, only 2 out of 10 health workers who have been fully vaccinated are likely to be infected with COVID-19 (NIHRD MOH RI, 2021). Likewise, the results of a zero survey in Indonesia showed an increase in the proportion of the population who had SARS-CoV-2 antibodies from 87.8% to 98.5%. The increase in antibodies after the population was vaccinated from 70% to 80% (Ariawan *et al*, 2022).

According to WHO, the COVID-19 virus is primarily transmitted between people through respiratory droplets and contact routes (WHO, 2020). Transmission through respiration occurs when a splash is produced by coughing or sneezing (droplets) from someone infected with COVID-19. Therefore, it is important to keep a distance from people who are infected with this virus. The main risk factors for COVID-19 infection are a

history of traveling to areas infected with COVID-19 and direct contact with patients with probable or confirmed COVID-19 infection (WHO Indonesia, n.d.). Several risk factors are believed to increase the mortality of COVID-19 patients, including age over 50 years, obesity (body mass index (BMI)  $\geq 30$  kg/m<sup>2</sup>), pregnant women, immunodeficient patients, comorbid, and others (MOH RI, 2020).

Results of a study in the United Kingdom from December 2020 to February 2021 also found that 30.9% tested positive for SARS-CoV2, and 69.1% showed negative results (Hyams *et al*, 2021). In comparison, a prospective cohort study that involved health workers and workers in the essential sector from December 2020 to April 2021 reported a higher percentage (80%) of vaccination while they were observed to have negative COVID-19 (95%). In addition, 31% of respondents had chronic diseases. One of which was mostly negative for COVID-19 infection (95%), and only 5% were positive for COVID-19 (Fowlkes *et al*, 2021). In our study, the proportion of respondents who suffered from chronic diseases was the same as those who did not carry NCDs. This indicates that the chance of being infected by the COVID-19 virus was comparable between those groups. As a consequence, misclassification occurred and could not be modified. Future work should include NCD data in more detail.

Although a study reported from a prospective cohort study conducted in the United States from December 2020 to September 2021 showed that 3.8% of active smokers were exposed to COVID-19 and 4.1% were not, our study showed the opposite. Meanwhile, the proportion of those who received the COVID-19 vaccine Dose 1 in both exposed and not exposed to COVID-19 infections was 57.8% which is in line with our result (Wesselink *et al*, 2022).

Those results mentioned above including our current results are crucial findings that added values of evidence-based health relating to the COVID vaccine effectiveness. Therefore, we could say that vaccine protection tends to show prevention for hospitalization. Hence, paramedics

are not burdened by the huge number of COVID-19 patients as it was in the first round of the pandemic. Although our cases were small, the cross-sectional design that we conducted can describe the association of the COVID-19 vaccination program. Despite the insignificant result of NCD comorbidities against COVID infection, the confidence interval of the estimate is relatively small. Exploration of this relationship may be required to improve our confidence in this variable.

Although we learn that vaccination has beneficial outcomes, keeping a healthy lifestyle behavior can then enhance protection from COVID infection. Therefore, preventing transmission will greatly affect the course of the outbreak in countries using this vaccine. WHO issued recommendations for preventing COVID-19, which are as follows: diligently wash hands with alcohol or soap and water to kill the virus, keep a distance of one meter from other people, avoid crowded places and avoid contact with others, do not touch eyes, nose, and mouth directly before cleaning hands, stay at home to avoid contact with other people; if experiencing common symptoms, COVID-19 seek medical help immediately, and always access verifiable and reliable information related to COVID-19 (WHO, 2022).

The community does not always obey the call for social distancing. This is in line with results of a quick survey on community compliance with the call for social distancing and clean and healthy life behavior which showed that 58.61% of respondents found it difficult to practice social distancing (Kurniawan *et al*, 2020). The pandemic has also severely impacted people with low economic status, members of minority groups, and women (Institute for Economic and Social Research Faculty of Economics and Business University of Indonesia, 2021).

Another study assessing the risk of COVID-19 severity in occupational groups reported the increased risk among workers in the transportation and social sector appears to be quite high. By comparing the risk of severe COVID-19 disease across occupational groups in health and social

care sectors, the higher risk for COVID-19 is particularly related to work rather than socioeconomic conditions (Mutambudzi *et al*, 2020). Based on a study conducted in Bogor in 2020, found that occupational factors in the transportation sector (driver), health workers/non-health workers, and employees (state/private) pose a 4.5 times greater risk of being exposed to COVID-19 compared to not working (Senewe *et al*, 2020). According to the authors of the vaccine program launched by the government, the priority for workers, both health workers and employees, has a significant protective effect against COVID-19. Contrary, our study found that socioeconomic might have contributed to the infection of COVID-19 since our variable of the full-time job shows a significant association with COVID-19 infection. We defined full-time jobs as respondents with occupations in the long contract agreement, for instance, civil servants, office employees, army, etc. They were less exposed to the COVID-19 virus due to our government's measures, in particular, staying at home and working from home restrictions. However, those who had uncertain jobs, including temporary jobs, appeared to have a slight chance to obtain the COVID-19 infection. People with temporary jobs are classified as a group of disadvantaged socioeconomic status within the various residences in Bogor. This indication was also reported by a study on poverty level and clinical outcomes of COVID-19 (Little *et al*, 2021). This study suggests the disadvantaged socioeconomic status had a higher prevalence of COVID-19 infection.

Our study has two limitations that are first, the study design used depends on the respondent's memory for mixed COVID tests. Therefore, it may underestimate the benefit of vaccination if respondents were given swab antigen tests. In addition, they might unlikely have suffered from COVID-19 and decided to not report themselves for testing. Secondly, undetailed inquiries regarding NCD comorbidities and occupational roles might have hindered the exploration of these variables' impact on the COVID-19 infection.

In summary, the COVID-19 vaccination Dose 2 (full dose) has been shown to provide more effective protection against COVID-19 infection than only Dose 1. In addition, those who have not been vaccinated or people who have not been vaccinated against COVID-19 are at greater risk for COVID-19 infection. The government and the public need to promote a vaccination program so that all community members get COVID-19 vaccinations more than two times and continue to carry out health protocols to prevent the transmission of COVID-19.

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#### CONFLICT OF INTEREST DISCLOSURE

The authors declare that there are no competing or potential conflicts of interest.

#### REFERENCES

Ariawan I, Jusril H, Farid MN, *et al.* SARS-CoV-2 antibody seroprevalence in Jakarta, Indonesia, 2022 [cited 2022 Dec 26]. Available from: URL: <https://journal.fkm.ui.ac.id/kesmas/article/view/6070/1484>

Bogor City Government. Bogor Mayor Circular Letter No. 440/3489/huk.Ham

about implementing coronavirus disease (COVID-19) emergency community activities restrictions in Bogor City, 2021 [cited 2022 Dec 27]. Available from: URL: <https://admincovid19.kotabogor.go.id/asset/file/sop/surat-edaran-wali-kota-bogor-nomor-440-3489-huk.ham.pdf> [in Indonesian]

Bogor City Health Office. Data on vaccination coverage Doses 1 and 2 per month in 2021, 2021 [cited 2022 Dec 27]. Available from: URL: [https://drive.google.com/file/d/1fYru6kaxxtUD1M4huE6L3zXU8zYnR3H8/view?usp=drive\\_link](https://drive.google.com/file/d/1fYru6kaxxtUD1M4huE6L3zXU8zYnR3H8/view?usp=drive_link) [in Indonesian]

Centers for Disease Control and Prevention (CDC). Science brief: COVID-19 vaccines and vaccination, 2021 [cited 2022 Dec 27]. Available from: URL: <https://archive.cdc.gov/#/details?q=https://www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/fully-vaccinated-people.html&start=0&rows=10&url=https://www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/fully-vaccinated-people.html>

Chico-Sánchez P, Gras-Valentí P, Algado-Sellés N, *et al.* The effectiveness of mRNA vaccines to prevent SARS-CoV-2 infection and hospitalisation for COVID-19 according to the time elapsed since their administration in health professionals in the Valencian Autonomous Community (Spain). *Prev Med* 2022;163: 107237.

Fowlkes A, Gaglani M, Groover K, *et al.* Effectiveness of COVID-19 vaccines in preventing SARS-CoV-2 infection among frontline workers before and during B.1.617.2 (Delta) variant predominance - Eight U.S. Locations, December 2020-August 2021. *MMWR Morb Mortal Wkly Rep* 2021; 70: 1167-9.

Hyams C, Marlow R, Maseko Z, *et al.* Effectiveness of BNT162b2 and ChAdOx1 nCoV-19 COVID-19 vaccination at preventing hospitalisations in people aged at least 80 years: a test-negative, case-control study. *Lancet Infect Dis* 2021; 21: 1539-48.

Institute for Economic and Social Research Faculty of Economics and Business University of Indonesia. Low economic community are more affected by the pandemic, 2021 [cited: 2022 Dec 27]. Available from: URL: [https://www.lpem.org/wp-content/uploads/2021/08/Newsletter\\_August\\_21\\_EN.pdf](https://www.lpem.org/wp-content/uploads/2021/08/Newsletter_August_21_EN.pdf)

Kurniawan A, Rachmawati T, Fitriani Y, *et al.* Compliance level against the warning advisory distance and living behavior clean and healthy (PHBS) as a preventive effort transmission of COVID-19 (Advanced), 2020 [cited 2022 Dec 27]. Available from : URL: [https://drive.google.com/file/d/1EHTolDHsk3mRCBmOPn\\_u\\_qdtmc1vXOKM/view?usp=drive\\_link](https://drive.google.com/file/d/1EHTolDHsk3mRCBmOPn_u_qdtmc1vXOKM/view?usp=drive_link) [in Indonesian]

Little C, Alsen M, Barlow J, *et al.* The impact of socioeconomic status on the clinical outcomes of COVID-19; a retrospective cohort study. *J Community Health* 2021; 46: 794-802.

Ministry of Health Republic of Indonesia (MOH RI). Current situation of COVID-19 reported until 27 Jun 2021, 2021a [cited: 2022 Dec 27]. Available from: URL: [https://drive.google.com/file/d/1XlixEGpk4CvE9zyHsxhicEsDNc9-BDU5/view?usp=drive\\_link](https://drive.google.com/file/d/1XlixEGpk4CvE9zyHsxhicEsDNc9-BDU5/view?usp=drive_link) [in Indonesian]

Ministry of Health Republic of Indonesia (MOH RI). COVID-19 vaccination based on Province and Regency/City, 2021b [cited 2022 Sep 19]. Available from: URL: [https://vaksin.kemkes.go.id/#/detail\\_data](https://vaksin.kemkes.go.id/#/detail_data) [in Indonesian]

Ministry of Health Republic of Indonesia (MOH RI). Decree of the Minister of Health of the Republic of Indonesia Number HK.01.07/MENKES/12758/2020 about determination of type of vaccine for implementing corona vaccination virus disease 2019 (COVID-19), 2021c [cited 2022 Sep 19]. Available from: URL: [https://drive.google.com/file/d/1GewFArajWG6hBh5LCrPbtTkqgMQrNc9i/view?usp=drive\\_link](https://drive.google.com/file/d/1GewFArajWG6hBh5LCrPbtTkqgMQrNc9i/view?usp=drive_link) [in Indonesian]

- Ministry of Health Republic of Indonesia (MOH RI). Prevention and control guidelines of coronavirus disease (COVID-19), 2020 [cited 2022 Sep 19]. Available from: URL: [https://www.sumutprov.go.id/content/userfiles/REV-05\\_Pedoman\\_P2\\_COVID-19\\_13\\_Juli\\_2020\\_compressed.pdf](https://www.sumutprov.go.id/content/userfiles/REV-05_Pedoman_P2_COVID-19_13_Juli_2020_compressed.pdf) [in Indonesian]
- Mutambudzi M, Niedzwiedz C, Macdonald EB, *et al.* Occupation and risk of severe COVID-19: prospective cohort study of 120 075 UK Biobank participants. *Occup Environ Med* 2020; 78: 307-14.
- National Institute of Health Research and Development Ministry of Health Republic of Indonesia (NIHRD MOH RI). Transmission, treatment and death due to COVID-19 among health workers in DKI Jakarta Province, January-June 2021, 2021 [cited: 2022 Sep 20]. Available From: URL: <https://sehatnegeriku.kemkes.go.id/wp-content/uploads/2021/08/Studi-Terbaru-Efektifitas-Vaksinasi.pdf> [in Indonesian]
- Pramod S, Govindan D, Ramasubramani P, Kar SS, Aggarwal R; JIPMER vaccine effectiveness study group. Effectiveness of Covishield vaccine in preventing Covid-19 – a test-negative case-control study. *Vaccine* 2022; 40: 3294-7.
- Sacco C, Del Manso M, Mateo-Urdiales A, *et al.* Effectiveness of BNT162b2 vaccine against SARS-CoV-2 infection and severe COVID-19 in children aged 5-11 years in Italy: a retrospective analysis of January-April, 2022. *Lancet* 2022; 400: 97-103.
- Senewe FP, Kristanti D, Tejayanti T, *et al.* Study of non-communicable diseases risk factors in 2021, 2021 [cited 2022 Sep 19]. Available from: URL: [https://drive.google.com/file/d/1CrwjFXVYHwsDZyJe3l6BP\\_9CG4MrMk8h/view?usp=drive\\_link](https://drive.google.com/file/d/1CrwjFXVYHwsDZyJe3l6BP_9CG4MrMk8h/view?usp=drive_link) [in Indonesian]
- Senewe FP, Wiryawan Y, Hananto M, *et al.* Relationship between comorbidities and behavior prevention of COVID-19 cases in Bogor City in 2020, 2020 [cited 2022 Sep 19]. Available from: URL: <https://>

[drive.google.com/file/d/1uWiSEZ9du0IqgmzSEqTu3TYXudryqrWz/view?usp=drive\\_link](https://drive.google.com/file/d/1uWiSEZ9du0IqgmzSEqTu3TYXudryqrWz/view?usp=drive_link) [in Indonesian]

- Subchi I, Sulistyowati N, Satibi, *et al*, editors. Pandemic in various perspectives. Depok, Indonesia: Grafindo Persada; 2021. [in Indonesian]
- Tartof SY, Slezak JM, Fischer H, *et al*. Effectiveness of mRNA BNT162b2 COVID-19 vaccine up to 6 months in a large integrated health system in the USA: a retrospective cohort study. *Lancet* 2021; 398: 1407-16.
- Wesselink AK, Hatch EE, Rothman KJ, *et al*. A prospective cohort study of COVID-19 vaccination, SARS-CoV-2 Infection, and fertility. *Am J Epidemiol* 2022; 191: 1383-95.
- West Java Provincial Government. West Java Province COVID-19 case statistics dashboard reported on 30 July 2021, 2021 [cited 2022 Sep 08]. Available from: URL: <https://dashboard.jabarprov.go.id/id/dashboard-pikobar/trace/statistik> [in Indonesian]
- World Health Organization (WHO). COVID-19 weekly epidemiological update, edition 50, 27 July 2021, 2021a [cited 2022 Dec 26]. Available from: URL: <https://apps.who.int/iris/handle/10665/343387>
- World Health Organization (WHO). Infection prevention and control in the context of coronavirus disease (COVID-19): a living guideline, 7 March 2022, 2022 [cited 2022 Dec 27] Available from: URL: <https://iris.who.int/bitstream/handle/10665/352339/WHO-2019-nCoV-ipc-guideline-2022.1-eng.pdf?sequence=1&isAllowed=y>
- World Health Organization (WHO). Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations, 2020 [cited 2022 Dec 26]. Available from: URL: <https://www.who.int/news-room/commentaries/detail/modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations>
- World Health Organization (WHO). Weekly epidemiological update on COVID-19 - 20 July 2021, 2021b [cited 2022 Dec 26]. Available

from: URL: <https://www.who.int/publications/m/item/weekly-epidemiological-update-on-covid-19---20-july-2021>

World Health Organization (WHO). Weekly Operational Update on COVID-19. Emergency Situational Updates Edition 77, 2021c [cited 2022 Dec 26]. Available from: URL: [https://www.who.int/docs/default-source/coronaviruse/situation-reports/20220201\\_weekly\\_epi\\_update\\_77.pdf](https://www.who.int/docs/default-source/coronaviruse/situation-reports/20220201_weekly_epi_update_77.pdf)

World Health Organization Indonesia (WHO Indonesia). Questions and answers: How is COVID-19 transmitted?, n.d. [cited 2022 Aug 21]. Available from: URL: <https://www.who.int/indonesia/news/novel-coronavirus/qa/qa-how-is-covid-19-transmitted> [in Indonesia]