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EFFECTIVENESS ASSESSMENT OF COVID-19 VACCINE: ANTIBODY FORMATION POST SECOND DOSE

Penilaian Efektivitas Vaksin COVID-19: Pembentukan Antibodi Setelah Dosis Kedua

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ABSTRAK

COVID-19 adalah penyakit infeksi saluran pernapasan dan merupakan jenis virus baru yang ditemukan oleh manusia sejak kemunculannya di Wuhan, China pada Desember 2019. Sekitar 60-70% individu yang telah terpapa dari populasi telah memperoleh kekebalan kelompok terhadap SARS-CoV-2. Dosis yang diberikan kepada peserta vaksinasi COVID-19 bertujuan untuk menginduksi kekebalan yang sama seperti kelompok penyintas COVID-19. Penelitian ini bertujuan untuk mengetahui efektivitas vaksin COVID-19 dalam membentuk antibodi terhadap SARS-CoV-2 setelah dosis kedua. Desain penelitian menggunakan metode *cross sectional* atau eksperimental dengan analisis data deskriptif (kuantitatif), menggunakan alat ukur berupa pemeriksaan laboratorium, yaitu pemeriksaan antibodi menggunakan metode immunochromatographic assay. Dalam pemeriksaan ini, sampel dari 50 responden diambil dan setiap sampel diambil secara berkala, yaitu pada minggu keempat dan minggu keenam setelah dosis kedua vaksin diberikan. Hasil menunjukkan bahwa lebih banyak antibodi reaktif terbentuk pada minggu keenam, yaitu 48 orang (48%) dengan nilai p = 0,031<0,05 sehingga ada hubungan antara pemberian vaksin Covid-19 dan hasil pembentukan antibodi dan terdapat hubungan antara waktu dan pembentukan jenis antibodi, nilai p = 0,047 <0,05, ditemukan bahwa lebih banyak jenis antibodi IgG terbentuk pada minggu keenam, yaitu sebanyak 46 orang (46%). Penelitian ini menyimpulkan bahwa vaksin COVID-19 efektif dalam membentuk antibodi terhadap SARS-CoV-2, dengan peningkatan jumlah antibodi reaktif dan jenis IgG yang signifikan pada minggu keenam setelah dosis kedua vaksin diberikan, menunjukkan hubungan yang erat antara waktu pemberian vaksin dan pembentukan antibodi (p < 0,05).

Kata kunci: antibodi ,COVID-19, efektivitas, imunitas, SARS-CoV-2, vaksin

ABSTRACT

Coronavirus Disease-19 (COVID-19) is a respiratory infection caused by a novel virus first identified in Wuhan, China, in December 2019. Approximately 60-70% of individuals exposed to SARS-CoV-2 have developed herd immunity. COVID-19 vaccines aim to induce similar immunity as seen in COVID-19 survivors. This study aimed to evaluate the effectiveness of the COVID-19 vaccine in generating antibodies against SARS-CoV-2. The research employed a cross-sectional or experimental design with quantitative descriptive analysis. Antibodies were measured using the immunochromatographic assay method. The study involved 50 respondents, with samples collected at the fourth and sixth weeks after the second vaccine dose. Results indicated that reactive antibodies increased significantly by the sixth week, with 48% of respondents (48 people) showing positive results (p = 0.031 < 0.05). Furthermore, a significant relationship between time and the formation of IgG antibodies was observed, with 46% of respondents (46 people) showing IgG antibodies by the sixth week (p = 0.047 < 0.05). The study concludes that the COVID-19 vaccine is effective in generating antibodies against SARS-CoV-2. There was a significant increase in both reactive antibodies and IgG antibodies by the sixth week after the second vaccine dose. This demonstrates a strong relationship between

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the timing of vaccine administration and antibody formation ($p < 0.05$). These findings support the effectiveness of the COVID-19 vaccine in inducing immunity, comparable to natural infection, thereby contributing to herd immunity and the overall control of the pandemic.

Keywords: *antibodies COVID-19, effectiveness, immunity, SARS-CoV-2, vaccine.*

INTRODUCTION

Since the discovery of a report from Wuhan, China in 2019, the world has been shocked by the incidence of severe infectious diseases attacking the respiratory tract. The cause of the disease is the transmission of the novel Coronavirus (nCoV-19) carried by animals and transmitted to humans. This disease infection does not only attack in China but transmission has occurred in various other countries which is transmitted from human to other humans[1].

The genetic material of the Corona virus is in the form of Ribonucleic acid (RNA) with a positive single strain that infects the human respiratory tract. An infected person will experience several symptoms in the form of high fever, cough, flu, and difficulties with a history of having been in contact with people who are known to be infected with this disease or people who originated from countries with the COVID-19 pandemic[2].

Studies show that people who are able to survive SARS-COV-2 infection will get an immune system with high titers in the form of Immunoglobulin G (IgG) antibodies that are stable five to 8 months after infection. In addition, memory CD4 and CD8 cells, memory B cells, and mucosal plasmablast IgA were discovered[3]. Around 60-70% of the population who has been exposed to SARS-CoV-2 infection has acquired herd immunity against SARS-CoV-2. The population of people who have no history of being COVID-19 survivors can get vaccinated. The COVID-19 vaccine, including CoronaVac, is currently in the process of developing clinical trials with sources originating from 4 categories: whole virus (live attenuated or inactivated), subunit protein, nucleic acid (DNA or mRNA), and viral vector [4]. Vaccine doses range from one to three times depending on the category of the vaccine [5].

Vaccination aims to form defenses, especially IgG antibodies and neutralizing antibodies that can be detected for 1-2 years. However, vaccination participants need to be given gradual doses aimed at inducing immunity just like the survivor groups[6]. This study aimed to discover the effectiveness of the COVID-19 vaccine in forming antibodies against SARS-CoV-2. Although multiple studies have been conducted on COVID-19 vaccines, existing research largely focuses on the short-term immunogenicity and safety of these vaccines, especially in controlled clinical environments. However, there is limited evidence on the long-term durability of immune responses post-vaccination, particularly how these responses compare to natural infection-induced immunity over extended periods. This study aims to fill this gap by exploring the long-term effectiveness of COVID-19 vaccines in inducing and maintaining protective immunity, specifically targeting the IgG and neutralizing antibody response. It also investigates whether the immunity from vaccination parallels or surpasses that observed in natural survivors of SARS-CoV-2. Additionally, we assess the role of memory B and T cells in sustaining immunity over time, a crucial aspect that has been understudied in current literature. This research provides new insights into optimizing vaccine schedules and booster doses to extend protective immunity beyond the standard period.

METHODS

This cross-sectional study aims to assess the presence and levels of IgM and IgG antibodies against SARS-CoV-2 in individuals who have received their second dose of the COVID-19 vaccine (Sinovac). The study evaluates antibody responses at two distinct time points: the fourth and sixth weeks post-vaccination. The primary variables include

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the levels of IgM and IgG antibodies as the dependent variables, and age, sex, and time of blood collection (fourth and sixth weeks) as the independent variables. Blood samples will be collected from the capillary section of respondents and analyzed using the Lungene Antibody Rapid Test kit to determine the presence of these antibodies, and secondary data will be obtained from the Mandala Health Center.

The study population comprises individuals aged between 17 and 45 years who have received their second dose of the Sinovac vaccine, excluding those with comorbid or autoimmune diseases. A total of 50 respondents were selected through purposive sampling from the total population of 56, and the study was conducted in May 2022 at the DTP area of Mandala Health Center, Lebak Regency, Banten. Univariate analysis will be conducted to examine respondent characteristics, including age, sex, and antibody test results, while the Chi-Square test will explore differences in antibody formation between the fourth and sixth weeks post-vaccination. Relationships between independent variables and antibody detection will also be analyzed. This study has received ethical approval from the Research Ethics Committee, Faculty of Medicine, Universitas Indonesia (Number: KET-1293/UN2.F1/ETIK/PPM/00/02/2022).

RESULT

Following the collection of blood and examination for antibodies with a total of 50 respondents who had done the second vaccine in the fourth and sixth week.

Gender and Age Frequency Distribution

Table 1. Gender and Age Frequency Distribution

Variable	n	%
Gender		
female	12	24
male	38	76
Age		
Adolescence	6	12
Early adult	21	42
Late adult	23	46

Table 1 more male gender characteristics obtained, namely as many as 38 people (76%) andthe most age were in late adulthood as many as 23 people (46%).

Overview of Antibody Results

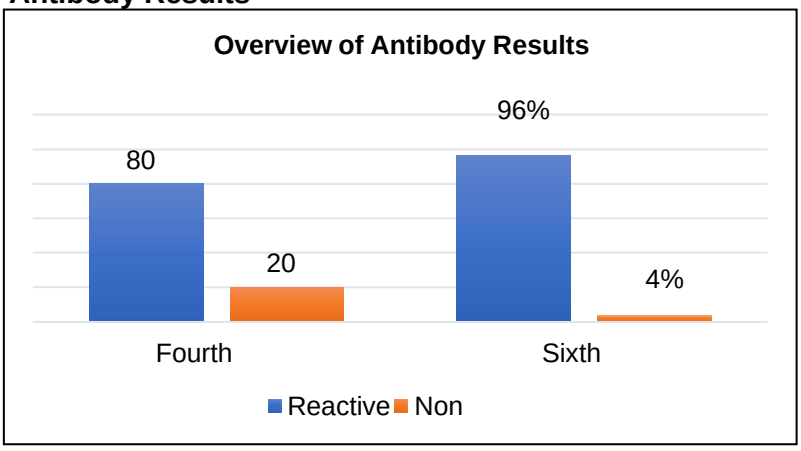

Figure 1. Diagram of Antibody Results

The result of Figure 1 based on the diagram showed in the fourth week, 80% of the antibodies were reactive and 20% non reactive. Furthermore, in the sixth week, 96% of the antibodies were reactive and 4% non-reactive.

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Overview of Antibody Types

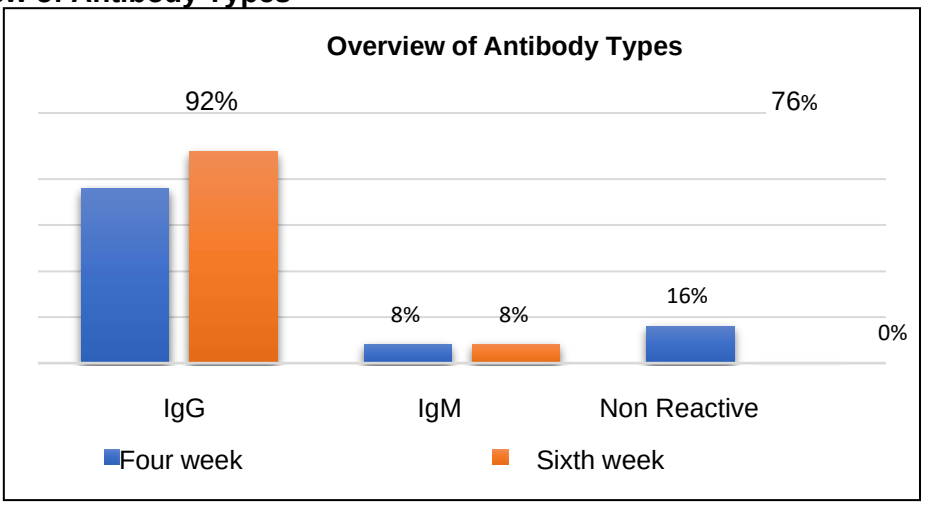

Figure 2. Diagram of Antibody Types

The result of Figure 2 based on the diagram shows in the fourth week, the types of antibodies formed in the fourth week were 76% IgG, 8% IgM, and 16% non-reactive. Furthermore, in the sixth week, the types of antibodies formed were 92% IgG, 8% IgM, and non-reactive were not formed.

Table 2. The Relation between Covid-19 Vaccine Administration andthe Formation of Antibody Results

Antibody	Covid-19 Vaccine				Total		p-value
	Fourth Week		Sixth Week				
	n	%	n	%	n	%	
Reactive	40	40	48	48	88	88	0,0031
Non-Reactive	10	10	2	2	12	12	
Total	50	50	50	50	100	100	

Table 2 showed more reactive antibody results were formed in the sixth week, namely 48 people (48%). The results of the statistical test using Chi-Square obtained a p-value = 0.031 <0.05 meaning that there is a relationship between the administration of the Covid-19 vaccine and the formation of antibody results.

Table 3. The Relation between Covid-19 Vaccine Administration and the Formation of Types of Antibody

Antibody	Covid-19 Vaccine				Total		p-value
	Fourth Week		Sixth Week				
	n	%	n	%	n	%	
IgG	38	38	46	46	84	84	0,047
IgM	4	4	0	0	4	4	
Non-Reactive	8	8	4	4	12	12	
Total	50	50	50	50	100	100	

The results of table 3 shows more types of IgG antibodies were formed in the sixth week, namely as many as 46 people (46%) and IgM antibodies were not formed. The

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results of the statistical test using Chi-Square obtained a p-value = 0.047 <0.05, meaning that there is a relation between the administration of the Covid-19 vaccine and the formation of type of antibody.

DISCUSSION

Antibody examination is carried out using the immunochromatography method, namely bydripping red blood cells and buffering on a cassette. The recombinant antigen on the rapid cassette will bind to the antibody in the red blood therefore an antigen-antibody complex bind will form. The red line color on the test line produced on the cassette occurs because the antigen-antibody complex binds to anti-human antibodies on the cassette[7]. The presence of antibodies in the sample is a form of post-vaccination immune response where the body's response attempts to eliminate the antigen. The way the vaccine behaves or the mechanism in the body until it forms an immune response, which is two weeks after the vaccine is administered. In the administration of vaccination important components that can trigger the appearance of antibodies are lymphocyte cells (T lymphocytes and B lymphocytes), as well as Antigen Precenting Cells (APC) such as macrophages and dendritic cells[8].

In broad outline, there are two groups of immune responses in the body, namely specific and non-specific immune responses. In a specific immune response, there is a cellular component, namely T lymphocytes, and a humoral component, namely B lymphocytes, where B lymphocytes will produce antibodies[9]. The existence of memory cells in individuals who have administered the vaccine will facilitate the immune response in recognizing the same antigen exposure for the second time. The secondary immune response is better than the primary immune response. Because in the secondary immune system, T cells and B cells form more antibodies quickly and long-lasting, especially forthe type of Immunoglobulin G antibody[10]. Based on data from a studyconducted by Willi regarding the effectiveness of the COVID-19 vaccine against the SARS-CoV- 2 variant, it showed a decrease in disease severity in populations that had been vaccinated, with a result that vaccine administration is effective in protecting the body from exposure to the COVID-19 virus. On day seven after the administration of the vaccine, antibodies began to form between days ten and twelve. The half-life of IgG is more than 28 days, while other immunoglobulins (IgM, IgA, IgE, IgD) have shorter half-lives.[11].

In the research conducted by Rotty regarding the formation of specificantibodies to SARS-CoV-2 after vaccination. Examinations carried out in the third week after administration of the second vaccine, the results obtained in all subjects showed the formation of antibodies (IgG)[12]. Rotty E. Ivonne et al., also stated that in the blood the formation of antibodies (IgG) can be long-lasting compared to antibodies (IgM). Subsequently according to the Press Release of the University of Indonesia Hospital in 2021 stated that the formation of IgG in a person's body appears slower than the appearance of IgM antibodies. The emergence of these antibodies can be influenced by several factors so post-vaccination antibodies are different foreveryone[13].

This research was conducted on productive age respondents, namely at the age of 17 to 45 years. Because individuals with productive age have better immune systems compared to individuals who are elderly. Because factors that affect the immune system include lifestyle, age, environment, health conditions, and consumption of drugs[14],[15]. The results of this study showed that all samples in the fourth and sixth weeks indicate the presence of IgM and IgG antibodies. The formation of these antibodies is not affected by gender. Male and female gender does not affect the increase or decrease in the body's immune status.

The small proportion of non-reactive results in the sixth week (4%) could be attributed to individual variations in immune response, including factors such as age,

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underlying health conditions, or immune system variability. These individuals may require closer monitoring to determine whether additional vaccine doses (such as boosters) would be necessary to achieve adequate immunity[16], [17].

CONCLUSION

The study demonstrates that the second dose of the COVID-19 vaccine (Sinovac) significantly enhances antibody production, particularly IgG, against SARS-CoV-2. By the sixth week after administration, there was a notable increase in reactive antibodies, with 48% of participants showing positive results compared to 40% in the fourth week, and 46% showing IgG antibodies compared to 38% earlier ($p = 0.031$ and $p = 0.047$, respectively). The absence of IgM antibodies by the sixth week further indicates the vaccine's effectiveness in generating long-lasting IgG responses. These findings highlight the critical role of the second dose in achieving a robust and sustained immune response, confirming its importance for optimal protection against the virus.

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