

## BISERIAL POINT CORRELATION TO MEASURE THE RELATIONSHIP BETWEEN THE CHARACTERISTICS OF HEALTH WORKERS AT UNDATA PALU HOSPITAL WITH ANTIBODY LEVELS

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### ABSTRACT

Correlation analysis is a term in statistics commonly used to study the relationship between variables. The purpose of this analysis technique is to get a pattern of the closeness or strength of the relationship between two variables expressed by the correlation coefficient. The correlation coefficient is a value that indicates whether or not there is a strong linear relationship between two variables. This study aims to find the relationship between the characteristics of health workers at Undata Hospital Palu and antibody levels. The characteristics of health workers are nominal data with two categories while antibody levels are measured using ratio or interval data. This type of data is suitable to be analyzed using point biserial correlation technique. There are several variables of respondent characteristics that influence immune performance, namely gender, presence or absence of comorbidities, smoking habits, health conditions, exercise habits, close contact with patients and vaccine history. The results of the correlation analysis showed that all respondent characteristic variables had a very weak correlation with antibody levels. This is indicated by the correlation coefficient value of each variable of 0.034; 0.062; 0.063; 0.074; 0.020; 0.079 and 0.119. This means that the characteristics of respondents do not really affect the rise and fall of antibody levels. However, vaccine history has the highest correlation coefficient compared to other variables. This indicates that one of the prevention efforts against infectious diseases is the administration of vaccines.

**Keywords** : Point Biserial Correlation, Respondent Characteristics, Antibody Levels

## I. INTRODUCTION

Correlation is a statistical analysis technique used to determine the relationship between two variables that are quantitative. In correlation analysis, the correlation coefficient is used to measure the strength of the relationship between variables. The correlation coefficient can be in the form of Pearson correlation coefficient, Spearman Rank correlation coefficient, Contingency correlation coefficient, and determinant correlation coefficient (KP). Pearson's correlation coefficient is used to measure the closeness of the relationship between two variables that have interval or ratio data. The value of Pearson's correlation coefficient is between -1 and 1, with a correlation coefficient of +1 indicating that the two variables are positively related linearly, a correlation coefficient of -1 indicating that the two variables are perfectly related in a linear negative, and a correlation coefficient of 0 indicating that there is no linear relationship between the two variables [1].

The correlation technique used to find correlations between two variables, where one variable is nominally scaled with two categories (dichotomy) and the other variable is measured on an interval or ratio scale called biserial point correlation. The nominal data (category) used in this correlation must be purely nominal, not data converted from other variable scales [2]. For example, the age variable. Age variables are generally numerical data, but can be converted based on productive level into a nominal scale with two categories, namely productive and unproductive age. The respondents in this study were health workers at Undata Hospital Palu.

Health workers at Undata Hospital Palu with a myriad of activities related to patients suffering from various diseases, especially infectious diseases, make health workers experience a sharp decrease in antibody levels. Given the limited number of health workers in Palu City, it is very important to evaluate problems related to post-pandemic health services as evaluation material in the development of the health service system and become a lesson in preparing if health threats arise in the future. One of the factors decreasing antibody levels of health workers is because they do not have enough rest time. Lack of rest is the main factor causing decreased body resistance. When sleeping, the body will repair damaged cells naturally so that it can make the immune system increase. As health workers, they must always look fit and fit and have good health conditions. Therefore, correlation analysis is needed to find the closeness of the relationship between variables that can affect the ups and downs of their immune system. By knowing the relationship between these variables, health workers can easily determine preventive steps in order to keep their immune system stable. In order to achieve this goal, an analytical tool called point biserial correlation is needed. This type of correlation is very suitable to be applied because one of the variables is some characteristics of respondents which are variables with a nominal scale (dichotomy) and other variables are antibody levels measured through a ratio scale.

Immune system or immunity is the body's ability to fight bacteria or viruses that cause disease. Antibodies in the body are very useful as an immune system to identify and neutralize foreign objects that enter the body such as pathogenic bacteria and viruses. The benefits of this antibody level test

are to map immunity in the community. The size of antibody levels is 1-20 BAU / mL. The higher a person's antibody levels (more than 20 BAU/mL) the better. Measurement of antibody levels is indispensable for immune immunity. If a person has a weak immune system, then his body will be more susceptible to disease. Immunity to the virus in a population is characterized by an increase in the level of antibodies in each individual. The formation of antibodies can be produced after infection or after vaccination. However, antibody levels in each individual are not the same. There are several factors that also affect immune performance such as gender, presence or absence of comorbidities, smoking habits, health conditions, exercise habits, close contact with patients and having a history of vaccines [3].

## II. METHODS

The data in this study is primary data derived from the results of direct measurements on health workers of Undata Hospital, Central Sulawesi Province, for the June-July 2023 period. While the type of data used in this study is qualitative and quantitative data. Qualitative data in the form of characteristics of health workers at Undata Hospital in Central Sulawesi Province such as gender, comorbidities, smoker status, health conditions, exercise habits, close contacts and vaccine history. Meanwhile, quantitative data in the form of antibody levels data for health workers at Undata Hospital, Central Sulawesi Province, is processed from the documentation used, which is a report on the results of antibody examination for the period June-July 2023.

Variables are a feature of the observed object. In this study, there were two variables, namely the characteristics of health workers at Undata Hospital in Central Sulawesi Province and antibody levels (BAU / mL). The following is presented a table of types of research variables equipped with categories and operational definitions.

Table 1: Types of Research Variables

No	Variable	Variable Name	Category	Operational Definition
1	X <sub>1</sub>	Gender	1 = Male 2 = Female	-
2	X <sub>2</sub>	Comorbid Diseases	1 = Yes 2 = No	Congenital diseases suffered by health workers that can aggravate health conditions
3	X <sub>3</sub>	Smoker Status	1 = Yes 2 = No	-
4	X <sub>4</sub>	Health Conditions	1 = Good 2 = Bad	Physical, mental, and social health conditions of

					health workers while on duty
5		X <sub>5</sub>	Sports Habits	1 = Routine 2 = Not Routine	-
6		X <sub>6</sub>	Close Contact	1 = Yes 2 = No	-
7		X <sub>7</sub>	Vaccine History for the Last 3 Months	1 = Ever 2 = Never	-
8		Y	Antibody Level	Data on Anti-RBD content, taken from venous blood specimens of study subjects, were measured using an enzyme-linked immunosorbent assay (ELISA) called <i>optical density</i> in arbitrary units (AU)/milliliters (ml) 6±1 months after the second Sinovac vaccine. The results obtained are then converted into <i>Binding Antibody Unit (BAU) / mL</i> , which is then presented in numerical variables.	

Based on information from Undata Hospital Palu, the target population in this study is all health workers working at Undata Hospital Palu totaling 1217 people. The determination of research samples is the first and most important step in taking data. All health workers who are selected samples have filled in the available identities and carried out antibody tests recorded in the report. Based on the calculation results using the Slovin formula, the number of samples taken in this study was 92 people. The selected sampling technique is carried out using the proportion method. Proportion sampling is a sampling technique that serves to perfect the use of stratified random sampling methods. In order for sampling to be representative, the number of samples for each stratum is balanced according to the number of its population. This means that the number of populations that are the most in a particular strata then the number of samples is also the largest. The following table is presented of the number of health workers in Undata Palu Hospital along with the calculation of the number of samples.

Table 2: Distribution of the Number of Health Workers at Undata Hospital Palu

No.	Health Workers	Number (People)
1	Medical Personnel	66
2	Nursing Personnel	437
3	Non Maintenance Personnel	149
4	Non-Medical Personnel	170
5	Non PNS/Contract Energy	395
Total		1217

$$n = \frac{N}{1 + N(\alpha)^2} = \frac{1217}{1 + 1217(0,1)^2} = 92,41 \approx 92 \text{ person}$$

The data used in this study came from the report on the results of antibody examination of health workers at Undata Hospital Palu for the period June-July 2023. The report is also equipped with the identity of respondents derived from the results of direct measurements of health workers at Undata Palu Hospital for the June-July 2023 period.

There are several stages of data analysis used in this study, namely: :

1. Write down some form of research hypothesis statement regarding the relationship between the following variables:
2. Conduct descriptions of respondents according to age and profession.
3. Conduct univariate analysis, namely a description of the data of each research variable. Descriptive statistics are carried out in order to determine the characteristics of data both through the size of concentration and the size of the spread.
4. Perform bivariate analysis, which is the relationship between two variables at once.
5. Calculate the biserial point correlation index using the following formula:

$$r_{pbis} = \frac{\bar{X}_1 - \bar{X}_2}{SD_t} \sqrt{p \cdot q} \text{ or } r_{pbis} = \frac{\bar{X}_1 - \bar{X}_t}{SD_t} \sqrt{\frac{p}{q}} \dots\dots\dots(1)$$

Information :

- $r_{pbis}$  : Biserial point correlation
- $\bar{X}_1$  : Mean Group 1
- $\bar{X}_2$  : Mean Group 2
- $SD_t$  : Simpangan Deviasi Total
- $p$  : Proportion of interval variable values associated with the first category dichotomy (n/N)
- $q$  : The proportion of interval variable values associated with the second category of the dichotomy (1 – p) [4]

6. Create auxiliary tables of each relationship between two variables for easy manual calculations using biserial point correlation
7. Interpretation of correlation coefficients based on the following table of correlation coefficient criteria [1]:

Table 3: Correlation Coefficient Value Criteria

Correlation Coefficient	Information
>0,75 – 1,00	The correlation is very strong
>0,50 – 0,75	Strong correlation
>0,25 – 0,50	The correlation is quite strong

>0,00 – 0,25	Very weak correlation
0,00	No correlation

Source : Mustafa, P, S. 2023

### III. RESULTS AND DISCUSSION

#### 3.1. Description of Respondents

Respondents in this study were health workers who were distributed in each number according to their profession and age. The description of respondents aims to find out the picture of respondents who are sampled in this study. Health workers at Undata Palu Hospital are divided into 5 categories, namely medical personnel, nursing personnel, non-treatment personnel, non-medical personnel and non-civil servants / contract personnel while the age is classified into 2 categories, namely 20-39 years and age over 39 years. The following is presented a description of respondents by profession and age.

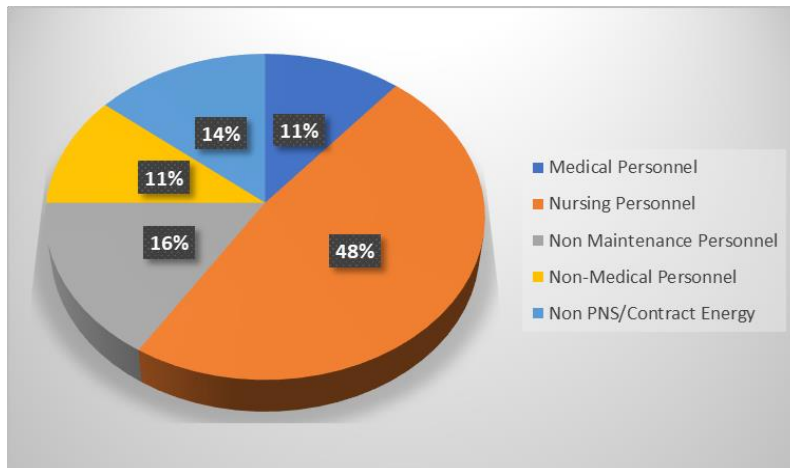


Figure 1: Distribution of the Number of Health Workers by Profession

Based on Figure 1, it can be seen that the health workers of Undata Palu Hospital who were sampled in this study were distributed according to their profession. Health workers with the most care professions are 44 people (48%), followed by each profession which is almost the same number. The largest number of care workers is based on consideration of the proportion with the largest population compared to other professional health workers.

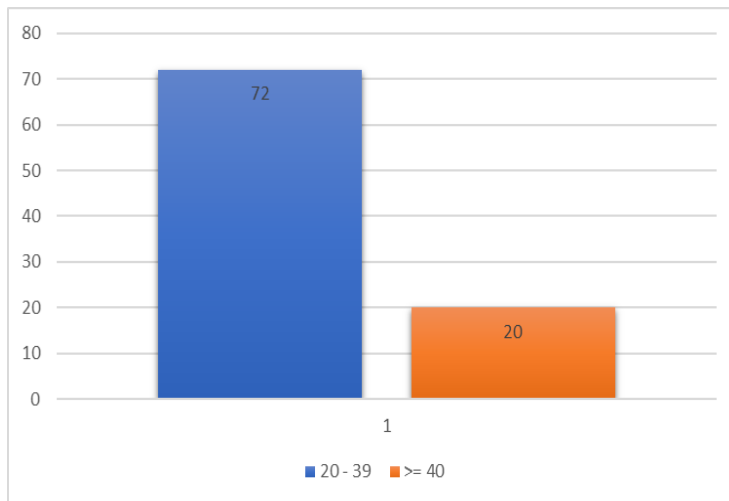


Figure 2 : Boxplot of Antibody Levels (BAU/mL) According to Vaccine History

Based on Figure 2, it can be seen that the health workers of Undata Palu Hospital who were sampled in this study were dominated by health workers with a young age (20-39 years, which is 72 people. While health workers aged 40 years and over only number 20 people. Health workers at a young age are still vulnerable with unstable emotional levels so that it is estimated to affect fluctuating antibody levels.

### 3.2. Univariate Analysis

Univariate analysis is a technique of analyzing data on one variable independently, each variable is analyzed without being associated with other variables. Univariate analysis is also called descriptive analysis or descriptive statistics. In this section will be described some of the basic characteristics of respondents. The basic characteristics of respondents are a general description of health workers at Undata Palu Hospital which are distributed according to gender, comorbid diseases, smoker status, health conditions, exercise habits, close contacts and vaccine history. The following table of basic characteristics of respondents is presented :

Table 4: Basic Characteristics

Variable	N = 92 Frequency (Percentage)
Gender, n (%)	
Male	39 (42,4%)
Female	53 (57,6%)
Comorbid Diseases, n (%)	
Yes	21 (22,8%)
No	71 (77,2%)
Smoker Status, n (%)	

Yes	8 (8,7%)
No	84 (91,3%)
Health Conditions, n (%)	
Good	86 (93,5%)
Bad	6 (6,5%)
Sports Habits, n (%)	
Routine	85 (92,4%)
Not Routine	7 (7,6%)
Close Contact, n (%)	
Yes	54 (58,7%)
No	38 (41,3%)
Vaccine History, n (%)	
3 Kali	76 (82,6%)
1 Kali	16 (17,4%)

Table 5: Antibody Level

Variabel	Median	Min-Max
Antibody (BAU/mL)	61,20	1,20 – 1794,60

### 3.3. Bivariate Analysis

Bivariate analysis is a statistical analysis technique used to determine the relationship between two variables by looking at the correlation value between those variables. The following is an example of calculating the relationship between sex and antibody levels:

Table 6: Antibody Levels by Gender

Gender	Antibody Level (BAU/mL)
Male	28,4
	12,8
	560,4
	1453,6
	⋮
	227,0
Female	39,8
	37,6
	352,6
	60,6
	⋮
	15,0



$$\bar{X}_{Male} = \frac{\sum X_{Laki-Laki}}{n} = \frac{28,4 + 12,8 + 560,4 + 1453,6 + \dots + 227}{39} = 322,133$$

$$\bar{X}_{Female} = \frac{\sum X_{Perempuan}}{n} = \frac{39,8 + 37,6 + 352,6 + 60,6 + \dots + 15}{53} = 356,981$$

$$Mean\ Total = \frac{\bar{X}_{Laki-Laki} + \bar{X}_{Perempuan}}{2} = \frac{322,133 + 356,981}{2} = 339,557$$

$$SD_{total} = \sqrt{\frac{\sum (X_i - \bar{X})^2}{n-1}} = 510,030$$

$$p = \left(\sqrt{\frac{n}{N}}\right) = \sqrt{\frac{39}{92}} = 0,424$$

$$q = 1 - p = 1 - 0,424 = 0,576$$

$$|r_{pbis}| = \frac{322,133 - 356,981}{510,030} \sqrt{0,424 \times 0,576} = -0,068 \times 0,494 = 0,034$$

$$or\ |r_{pbis}| = \frac{322,133 - 339,557}{510,030} \sqrt{\frac{0,424}{0,576}} = -0,034 \times 0,860 = 0,034$$

The complete calculation results for the relationship between other variables are presented in the Table 7.

Table 7: Anti-RBD Levels Based on Respondent Characteristics

Variable	n	Antibody (BAU/mL)			Correlation Coefficient
		Median	Min-Max	Average	
Gender					
Male	39	34,20	7,00 – 1794,60	322,133	0,034
Female	53	91,20	1,20 – 1740,60	356,981	
Comorbid Diseases					
Yes	21	57,60	7,00 – 1412,60	284,28	0,062
No	71	65,40	1,20 – 1794,60	359,34	
Smoker Status					
Yes	8	35,70	8,60 – 1453,60	238,30	0,063
No	84	63,60	1,20 – 1794,60	352,10	
Health Conditions					
Good	86	60,10	1,20 – 1794,60	332,24	0,074
Bad	6	173,70	15,00 – 1631,00	485,13	
Sports Habits					
Routine	85	59,60	1,20 – 1794,60	339,26	0,020
Not Routine	7	227,00	13,20 – 1412,60	378,00	
Close Contact					
Yes	54	59,10	1,20 – 1794,60	308,71	0,079
No	38	112,30	7,00 – 1740,60	389,81	
Vaccine History					
3 Kali	76	100,00	7,00 – 1794,60	369,98	0,119
1 Kali	16	34,70	1,20 – 1440,20	210,28	

Based on Table 7, it can be seen that all respondent characteristic variables have a relationship with antibody levels but all of these variables are classified as having a very weak correlation. Among all these characteristic variables, the one with the highest correlation coefficient with antibody levels is the vaccine history variable, which is 0.119. While the variable that has the weakest correlation with antibody levels is exercise habits of 0.020. The following boxplot image shows the difference in antibody levels according to vaccine history.

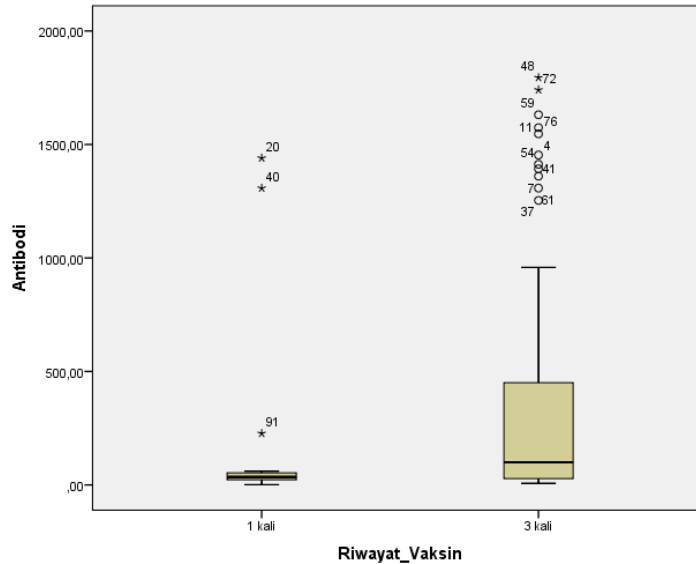


Figure 3: Boxplot of Antibody Levels (BAU/mL) According to Vaccine History

Based on Figure 3, it can be seen that vaccine history has a relationship with an increase in a person's antibody levels. This is evident from the boxplot image which shows a significant increase in antibody levels in health workers at Undata Palu Hospital who have received the vaccine 3 times compared to health workers who have only received the vaccine 1 time. One of the prevention efforts against infectious diseases is the provision of vaccines. The importance of vaccine administration can be related to the concept of *Herd Immunity*, where immunity to the virus in a population is characterized by increased levels of *Receptor Binding Domain* (RBD) antibodies in each individual.

The rise of various types of diseases caused by viruses and bacteria makes the government aware that preventive efforts must be taken to reduce the number of sufferers, especially among children and adults, such as polio, chickenpox, pneumonia, hepatitis, diphtheria and many more. To prevent a variety of acute health problems, vaccinations are given at certain ages ranging from newborns to adults.

Vaccination is the process of administering vaccines through injections or drops into the mouth to increase the production of antibodies to ward off certain diseases [3]. Vaccines are expected to be a solution in dealing with the Covid-19 pandemic. Vaccines can boost the human

immune system by producing antibodies that will fight the antigens from the vaccine [5]. That way, the body does not collapse and is attacked by diseases caused by the bacteria and viruses concerned. In addition, vaccination actually protects not only oneself but also others who for some reason cannot receive vaccinations and keep in mind that some people cannot receive vaccines, for example, due to too old age or congenital disease conditions such as autoimmune and hypothyroidism [6]. As a form of concern for others, herd immunity can be created so that this group remains protected and the community as a whole can live a healthy life and be free from the threat of bacterial and viral infections [7].

#### IV. CONCLUSION

The characteristics of health workers at Undata Palu Hospital are gender, comorbidities, smoking status, health conditions, exercise habits, close contacts and vaccine history. Based on the results of correlation analysis, it was concluded that all variables characteristic of health workers have a very weak correlation with antibody levels. This is indicated by the value of the correlation coefficient of each variable of 0.034; 0,062; 0,063; 0,074; 0,020; 0.079 and 0.119. This means that the characteristics of respondents do not greatly affect the rise and fall of antibody levels. Nevertheless, vaccine history has the highest correlation coefficient compared to other variables. This indicates that one of the prevention efforts against infectious diseases is the provision of vaccines.

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