Attitudes Towards COVID-19 Vaccines to Support the Achievement of Government Targets: A Case Study of Bontang City

Darnah Andi Nohe[a)], Suyitno, M. Fathurahman, Rito Goejantoro, and Memi Nor Hayati

Department of Mathematics, Faculty of Mathematics and Natural Science, Mulawarman University, Samarinda, Indonesia

[a)] Corresponding author: darnah.98@gmail.com

Abstract. The vaccination program launched by the Indonesian government is the fastest and best solution to overcome the pandemic before finding a cure for COVID-19. Unwillingness to receive vaccinations a major barrier for the Indonesian government to overcome the COVID-19 pandemic and achieve the target of 70% of the total population in Indonesia receiving the vaccine. In this study, we estimate predictors of six domains of unwillingness to receive COVID-19 vaccinations or negative attitudes towards COVID-19 vaccines in the Bontang city. That predictors are gender, age, income, profession, marital status, and level of education. The Binary logistic regression analysis in this study was used to find the predictors effect of COVID-19 vaccine's attitudes in Bontang city. A total of 500 participants in the Bontang city completed the survey. The public unwillingness to receive COVID-19 vaccinations in Bontang city was still high (26,2%). There are effect age (≤ 25 years: p=0.002, OR=1.651; 36 - 45 years: p=0.006, OR=1.015; > 55 years: p=0.006, OR=1.016), income (≤ 2 million IDR: p=0.016, OR=8.816; 2.1- 3.5 million IDR: p=0.002, OR=6.216), profession (farmer: p=0.015, OR=5.876; fisherman: p=0.007, OR=6.168; employee: p=0.003, OR=3.161; laborer: p=0.045, OR=5.361), marital status (married: p=0.004, OR= 3.936; single: p=0.016, OR=3,973; divorced :0.001, p=0.007, OR=5.148), and level of education (elementary school: p=0.032, OR=2.787; junior high school: p=0.006, OR=2.420) to COVID-19 vaccine's attitudes in Bontang city. The novel to this study is that we also specifically examined factors that predict uncertainty and unwillingness to be vaccinated against COVID-19 in Bontang City. Persuasive approach and public health massaging should be continued and tailored to address these concerns, especially to certain ages, certain professions, marital statuses, and people with lower levels of education and incomes.

INTRODUCTION

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future [1]. The third Sustainable Development Goals (SDGs) goal are ensured healthy lives and promote well-being for all at all ages [2]. Coronavirus disease 2019 (COVID-19) pandemic is a challenge for SDGs to achievement their goals. The COVID-19 virus is a new virus, the first identified in Wuhan, China. The virus is linked to the same family of viruses as middle east respiratory syndrome coronavirus (MERS COV) and severe acute respiratory syndrome coronavirus (SARS COV). The COVID-19 is transmitted through direct contact with respiratory droplets of an infected person, generated through coughing or sneezing [3], [4]. In Indonesia, the President of the Republic of Indonesia was an announcement the first COVID-19 case on March 02, 2020. The first cluster was identified as a dance class, 13 people were identified as COVID-19 cases [5], [6], [7].

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The COVID-19 has become a global problem. Since the end of 2019, the COVID-19 pandemic has resulted in more than 245 M cases and more than 4.96 M deaths world life. Cases of COVID-19 in Indonesia as of March 02 2020 were still high, the government has reported 4.24 M persons with confirmed COVID-19 and more than 143 K deaths [8]. The Indonesian Government is working with World Health Organization (WHO) to monitor the situation and prevent the further spread of COVID-19 disease. The Ministry of Health (MOH) of the Republic of Indonesia has taken actions to enhance response efforts for COVID-19 in Indonesia.

In order to combat the pandemic, the Indonesian government has launched a vaccination program to reach herd immunity within the community or society. The vaccination program is the fastest and best solution to overcome the COVID-19 pandemic. The government has determined seven types of vaccines that can be used for the implementation of COVID-19 vaccination in Indonesia. As of early March 2021, of the seven types of vaccines, three vaccines have received Emergency Use Authorization (EUA) from the National Agency of Drug and Food Control (Badan Pengawas Obat dan Makanan/BPOM), namely Sinovac, AstraZeneca, and vaccines from PT Bio Farma (Persero). The first vaccine to existing and be used in Indonesia is Sinovac. The vaccine, which is produced in China, is derived from an inactivated virus, given in two injections over a period of 14 days. The Indonesian Ulema Council (MUI) has issued Fatwa Number 2/2021 which states that the COVID-19 vaccine is from Sinovac and PT. Bio Farma (Persero) is holy and halal, so it can be used for Muslims as long as its safety is guaranteed according to credible and competent experts [4]. On 13 January 2021, the President of the Republic of Indonesia was the first person to receive the Sinovac vaccine and two weeks later, he received the second shot of the vaccine. The vaccine was prioritized for people aged 18–59 years, medical personnel, both doctors and nurses [9].

Unwillingness to receive vaccinations is a major barrier for the Indonesian government to achieve the target of 75% of the total population in Indonesia receiving the vaccine. Based on a study conducted by Research and Development Agency Bontang City, 500 participants in the Bontang City, there were 131 people (26.2%) who unwillingness to receive COVID-19 vaccinations [10]. Bontang is a city on the eastern coast of the island of Borneo in Indonesia, in the province of East Kalimantan. It occupies an area of 161.88 km2 (62.50 sq mi), and the population was 140,787 at the 2010 Census, and 178,917 at the 2020 Census [11]. It is also the third most densely populated place in the province after Balikpapan and Samarinda. In this study, we estimate predictors of six domains of unwillingness to receive COVID-19 vaccinations or negative attitudes towards COVID-19 vaccines in the Bontang city using binary logistic regression. The factors considered to be influencing are gender, age, income, profession, marital status, and level of education.

MATERIAL AND METHOD

Independent Test

A Chi-square test for independence was carried out to test the relationship between predictor variables. The null hypothesis is the two categorical variables are independent the alternative hypothesis is the two categorical variables are dependent. When the null hypothesis is rejected then there is an association between the two variables. The Chi-square test for two independent two-sample is [12], [13]:

$$\chi^2 = \sum_{i=1}^{r}\sum_{j=1}^{k}\frac{(O_{ij}-E_{ij})^2}{E_{ij}} \tag{1}$$

Where O_{ij} represent an observed number of cases categorized in the *i*th row of the *j*th column and E_{ij} is a number of cases expected under null hypothesis to be categorized in the *i*th row of the *j*th column. The value χ^2 yielded by equation (1) is distributed approximately as Chi-square with $df = (r-1)(k-1)$, where r = the number of rows and k = the number of columns in the contingency table. To find the expected frequency for each cell (E_{ij}), multiply the two marginal totals common to a particular cell, and then divide this product by the total number of cases, N.

Binary Logistic Regression

Binary logistic regression is used for response variable is a binary variable, which is also called a dummy variable. The binary logistic regression model represents relationships between a binary response variable and one or more discrete or continuous predictor variables. The response variable is binary that takes the value 0 and 1, the expected value is simply the probability, $\pi(x)$ [14], [15]. The binary logistic regression model can be written as:

$$\pi(x) = \frac{\exp(\beta_0+\beta_1 x_1+...+\beta_p x_p)}{1+\exp(\beta_0+\beta_1 x_1+...+\beta_p x_p)} \tag{2}$$

where $\beta_0, \beta_1, ..., \beta_p$ are regression parameters; $x_1, x_2, ..., x_p$ are predictor variables, and $\pi(x)$ is the probability of success. $\pi(x)$ is a nonlinear function so that we could model $\pi(x)$ indirectly via what is known as the logistic transformation of $\pi(x)$:

. $$g(x) = \ln\left[\frac{\pi(x)}{1-\pi(x)}\right] = \beta_0 + \beta_1 x_1 + ... + \beta_p x_p \tag{3}$$

We may have to resort to the maximum likelihood estimation (MLE) to estimate the parameters.

To test the null hypothesis that all the slope coefficients are simultaneously equal to zero, the equivalent of the F test in the linear regression model is the likelihood ratio (LR) statistic. Given the null hypothesis, the LR statistic follows the χ^2 distribution with df equal to the number of predictor variables, the statistic is [12]:

$$LR = -2\ln\left[\frac{\text{likelihood of the current model}}{\text{likelihood of the saturated model}}\right] \tag{4}$$

The null hypothesis is rejected if the $LR > \chi^2_\alpha$ or p-value $< \alpha$.

Next, partial testing of the binary logistic regression model parameters is the Wald test. The Wald test is used to test the set of hypotheses as follows:

$H_0 : \beta_r = 0; r = 1, 2, ..., p$ vs $H_1 : \beta_r \neq 0; r = 1, 2, ..., p$.

The Wald values are obtained by dividing the slope coefficients by their standard error which is defined by:

$$W = \frac{\hat{\beta}_1}{SE(\hat{\beta}_1)} \tag{5}$$

Where SE is the standard of error. If the null hypothesis is true, the Wald value has an approximate standard normal distribution for a large sample, and the null hypothesis is rejected if the Wald value is greater than the critical standard normal value or the p-value is less than the significance level [16]. In other words, the null hypothesis is rejected if the $|W| > Z_\alpha$ or p-value $< \alpha$.

In the logistic regression model, a statistical test for goodness of fit for the model is used Hosmer–Lemeshow test. Hosmer–Lemeshow test is used frequently in risk prediction models. The test assesses whether or not the observed event rates match expected event rates in subgroups of the model population. The Hosmer–Lemeshow test specifically identifies subgroups as the deciles of fitted risk values. The Hosmer–Lemeshow test statistic is given by [17]:

$$H = \sum_{h=1}^{g} \frac{(o_h - n_h\bar{\pi}_h)^2}{n_h\bar{\pi}_h(1-\bar{\pi}_h)} \tag{6}$$

where g: number of groups; o_h :sum of response variable value; $\bar{\pi}_h$: mean of probability; n_h : number of subject the hth. The null hypothesis is rejected if the $H > \chi^2_\alpha$ or p-value $< \alpha$.

Data Source

The type of data in this study is secondary data. The data were collected from Research and Development Agency Bontang City [10]. This study was conducted as a cross-sectional study in April 2021. A convenience sample approach was adopted in this study where people from Bontang City (West Bontang, North Bontang, and

South Bontang) were invited to participate. Participants were encouraged to pass on the questionnaire to their contacts or acquaintances. The sample size has been determined based on Slovin's formula at error tolerance is 5% [18]. The sample size in this study is 500 participants.

Study Variables

The response variable in this study is the attitudes towards COVID-19 vaccines in Bontang city. Meanwhile, the predictor variables used were gender, age, income, profession, marital status, and level of education. In general, study variables used and operational definitions are presented in Table 1.

TABLE 1. Study Variables.

Variables	Category	Scale
Attitudes towards COVID-19 vaccines in Bontang city	In this case, the attitudes towards COVID-19 vaccines in Bontang city is binary, namely: 0: the public agree to receive COVID-19 vaccinations in Bontang city. 1: the public unwillingness to receive COVID-19 vaccinations in Bontang city.	Nominal
Gender	0: Female 1: Male	Nominal
Age	0: <17 years 1: 17-25 years 2: 26-35 years 3: 36-45 years 4: 46-55 years 5: >55 years.	Ordinal
Income	0: ≤ 0.5 million IDR 1: 0.6-2 million IDR 2: 2.1-3.5 million IDR 3: 6-5 million IDR 4: >5 million IDR	Ordinal
Profession	0: Government Employee 1: Trader 2: Farmer 3: Fisherman. 4: Employee 5: Laborer 6: Entrepreneur 7: Others.	Nominal
Marital Status	0: Married 1: Single 2: Divorced	Nominal
Level of Education	0: Elementary School 1: Junior High School 2: Senior High School 3: University	Nominal

Analysis Procedure

The analysis procedure in this study is as follows:

1. Conduct descriptive analysis to describe the response variable (attitudes towards COVID-19 vaccines in the Bontang city) and the predictor variables (gender, age, income, profession, marital status, and level of education).
2. Testing relationship among gender, age, income, profession, marital status, and level of education with the attitudes towards COVID-19 vaccines in the Bontang city.
3. Conducting binary logistic regression. In this study, the binary logistic regression model for six predictor variables can be written as:

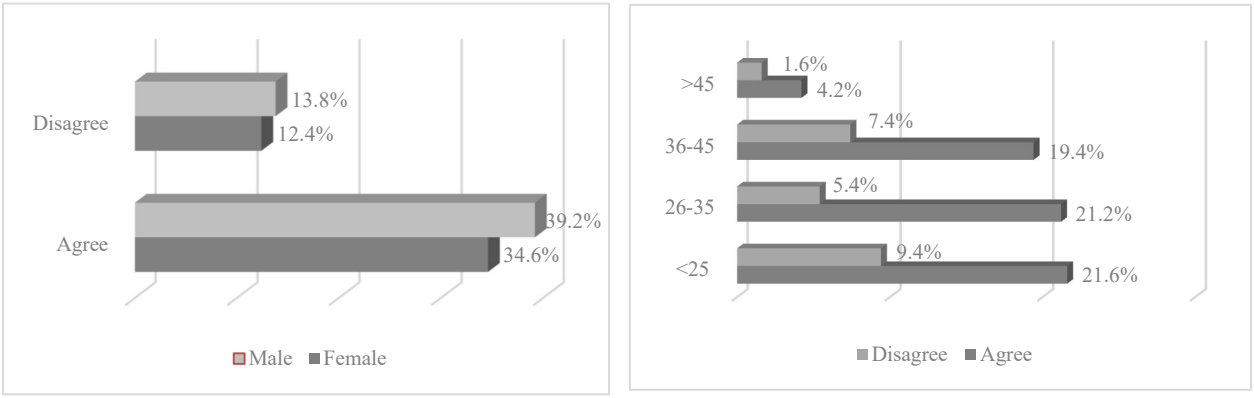
   $$\text{logit}(\pi(\text{x})) = \beta_0 + \beta_1 x_1 + ... + \beta_6 x_6$$

   where $\beta_0, \beta_1, ..., \beta_6$ are regression parameters; $x_1, x_2, ..., x_6$ are predictor variables, and $\pi(x)$ is the probability of success.
4. Estimating regression parameters using maximum likelihood estimation.
5. Conducting the likelihood ratio test to determine the effect of gender, age, income, profession, marital status, and level of education to the attitudes towards COVID-19 vaccines in the Bontang city simultaneously.
6. Conducting the Wald test to determine the effect of gender, age, income, profession, marital status, and level of education on the attitudes towards COVID-19 vaccines in the Bontang city partially.
7. Testing goodness of fit model using Hosmer-Lemeshow test.
8. Interpreting the regression coefficients and the odds ratio.
9. Make conclusions and recommendations which were obtained from data analysis.

RESULT AND DISCUSSION

Descriptive Statistics

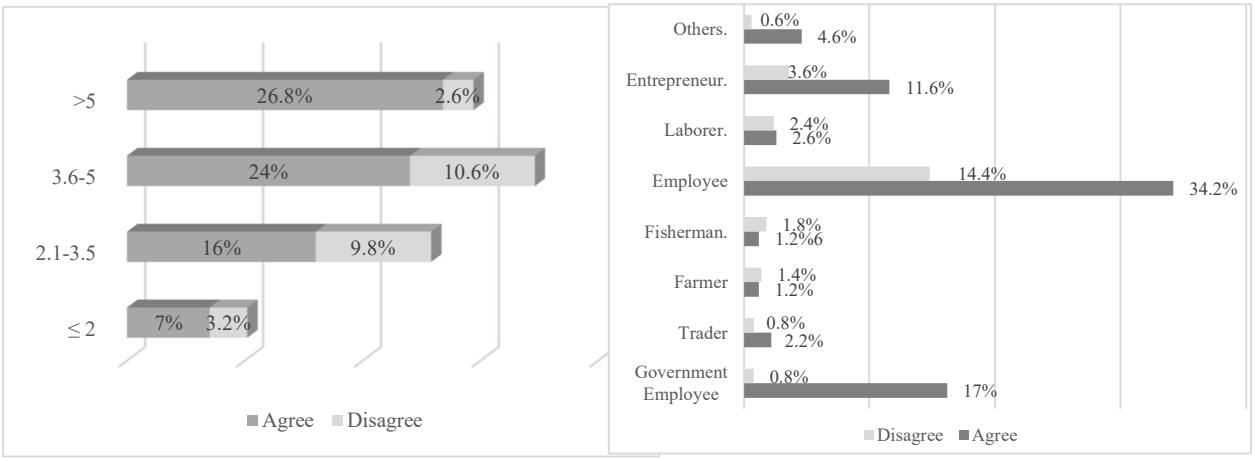
Descriptive statistics are used to describe an overview of information related to the research variable data. Based on Figure 1, the male is higher (13.8%) to disagree or unwilling (both used in this study) to receive COVID-19 vaccination in Bontang City than females (12.4%). The older age groups (<25 years old) are the most (9.4%) to unwillingness for COVID-19 vaccines and the older age groups (>45 years old) are the fewest (1.6%) to unwilling for COVID-19 vaccines.



(a) (b)

FIGURE 1. The attitudes towards COVID-19 vaccines in the Bontang city based on Gender (a) and Age (years) (b).

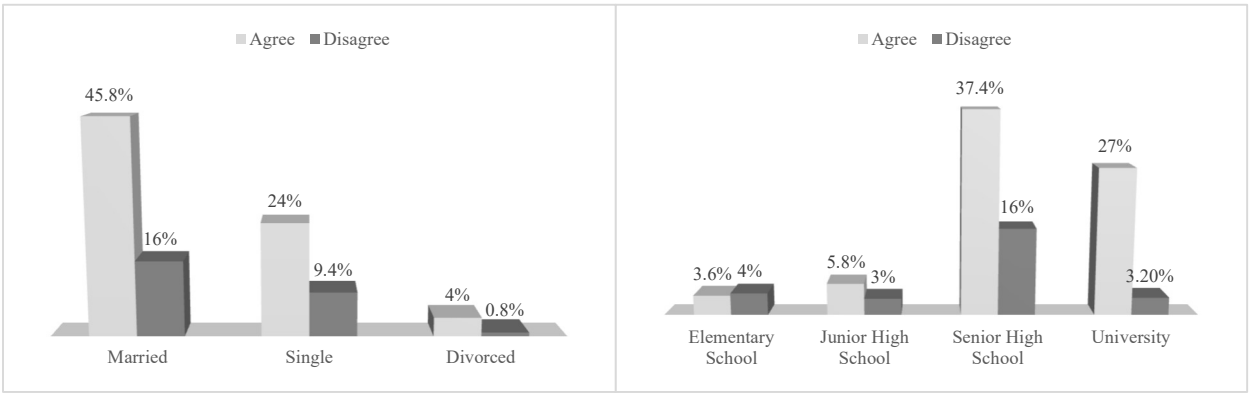
Figure 2 shows that only 2.6% of the income groups (>5 million IDR) were unwilling to COVID-19 vaccines. Participants who income groups (3.6-5 million IDR) are the most unwilling for COVID-19 vaccines. 14.4% of employees in this research had disagreed with COVID-19 vaccines.



(b) (a)

FIGURE 2. The attitudes towards COVID-19 vaccines in the Bontang city based on Income (million IDR) (a) and Profession (b).

In the marital status, 16.0% of the public unwillingness to receive COVID-19 vaccinations in the Bontang city are married and divorced are the fewest participants were unwilling to receive COVID-19 vaccinations in the Bontang city. Most participants were unwilling to receive COVID-19 vaccinations in the level of education are senior high school (16.0%) as shown in Figure 3.



(a) (b)

FIGURE 3. The attitudes towards COVID-19 vaccines in the Bontang city based on Marital Status (a) and Level of Education (b)

We tested the independence among gender, age, income, profession, marital status, and level of education with the attitude towards COVID-19 vaccines in the Bontang city using the Chi-Square test as shown in Table 2. Gender ($p=0.046$), age ($p=0.035$), income ($p=0.000$), profession ($p=0.002$), marital status ($p=0.031$), and level of education ($p=0.000$) have related with the attitude towards COVID-19 vaccines in the Bontang city at 5% significance level.

Estimation regression parameters in this study were used maximum likelihood. Next, the LR statistic value was obtained at 320.452 and $p < 0.0001$ which indicated that there is the effect of gender, age, income, profession, marital status, and level of education on the attitudes towards COVID-19 vaccines in the Bontang city simultaneously. To determine the effect of gender, age, income, profession, marital status, and level of education on the attitudes towards COVID-19 vaccines in the Bontang city partially we used the Wald test. The predictor variables, gender, age (26-35 years old), income (3.6-5 million IDR and >5 million IDR), profession (Government

Employee, Trader, Entrepreneur, and Others), level of education (Senior High School and University) have not significant effect of COVID-19 vaccine's attitudes in Bontang city (results no shown). Based on the goodness of fit model using the Hosmer-Lemeshow test, we obtained that the model is fit (p=0.002).

TABLE 2. Independent test for response variable and predictor variables.

Variables	Categorical	Attitudes		Chi-Square (Significant Value)
		Agree: Frequency (%)	Disagree: Frequency (%)	
Gender	Female	173(34.6)	62(12.4)	0.046
	Male	196 (39.2)	69(13.8)	(significant)
Age	<25 years	108(21.6)	47(9.4)	
	26-35 years	106(21.2)	27(5.4)	0.035
	36-45 years	97(19.4)	37(7.4)	(significant)
	>45 years.	21(4.2)	8(1.6)	
Income	≤ 2 million IDR	35(7.0)	16(3.2)	
	2.1-3.5 million IDR	80(16.0)	49(9.8)	0.000
	3.6-5 million IDR	120(24.0)	53(10.6)	(significant)
	>5 million IDR	134(26.8)	13(2.6)	
Profession	Government Employee	81(17.0)	4(0.8)	
	Trader	11(2.2)	4(0.8)	
	Farmer	6(1.2)	7(1.4)	
	Fisherman.	6(1.2)	9(1.8)	0.002
	Employee	171(34.2)	74(14.8)	(significant)
	Laborer.	13(2.6)	12(2.4)	
	Entrepreneur.	58(11.6)	18(3.6)	
	Others.	23(4.6)	3(0.6)	
Marital Status	Married	229(45.8)	80(16.0)	0.031
	Single	120(24.0)	47(9.4)	(significant)
	Divorced	20(4.0)	4(0.8)	
Level of Education	Elementary School	18(3.6)	20(4.0)	
	Junior High School	29(5.8)	15(3.0)	0.000
	Senior High School	187(37.4)	80(16.0)	(significant)
	University	135(27.0)	16(3.2)	
	TOTAL	369(73.8)	131(26.2)	500

Estimation regression parameters of significance can be seen in Table 3. There are effect age (≤ 25 years: p=0.002, OR=1.651; 36 - 45 years: p=0.006, OR=1.015; > 55 years: p=0.006, OR=1.016), income (≤ 2 million IDR: p=0.016, OR=8.816; 2.1- 3.5 million IDR: p=0.002, OR=6.216), profession (farmer: p=0.015, OR=5.876; fisherman: p=0.007, OR=6.168; employee: p=0.003, OR=3.161; laborer: p=0.045, OR=5.361), marital status (married: p=0.004, OR= 3.936; single: p=0.016, OR=3,973; divorced :0.001, p=0.007, OR=5.148), and level of education (elementary school: p=0.032, OR=2.787; junior high school: p=0.006, OR=2.420) to COVID-19 vaccine's attitudes in Bontang city. Results from the binary regression model predicting risk for uncertainty and a lack of intent to vaccinate against COVID-19 are shown in Table 3. Negative attitudes towards vaccines across all three age groups (most strongly concerned in the older age groups ≤ 25 years old) were with 1.651 times higher relative risk of being unwilling to get a COVID-19 vaccine (p=0.002, OR=1.651). The older age groups (>55 years old) were more likely to have an unwillingness to COVID-19 vaccines than younger age groups (p=0.006, OR=1.016). Similarly, vaccine unwillingness in the older age groups 36 - 45 years old) was predicted 1.015 times more likely to have decided against having a COVID-19 vaccine (p=0.006, OR=1.015).

Socio-economic factors were also associated with uncertainty and unwillingness to receive the COVID-19 vaccine, people with lower income, certain professions, certain marital status, and people with levels of education more likely to be unwilling, and those with lower incomes more likely to be uncertain. The income groups (≤ 2 million) were predicted 8.816 times to unwillingness for COVID-19 vaccines (p=0.016, OR=8.816). Income groups

(2.1- 3.5 million IDR) were with 6.216 times higher relative risk of being unwilling to get a COVID-19 vaccine (p=0.002, OR=6.216).
Unwillingness to receive COVID-19 vaccination across all four professional groups (most strongly concern in the fisherman) was with 6.168 times higher relative risk of being unwilling to get a COVID-19 vaccine (p=0.007, OR=6.168). The profession of farmer, laborer, and employee was predicted 5.876 times (p=0.015), 5.361 times (p=0.045), and 3.161 times (p=0.003), consecutively, more likely to have decided against having a COVID-19 vaccine.

TABLE 3. Variables That Have a Significant Influence on the Attitudes Towards COVID-19 Vaccines in the Bontang city.

Variables	Category	$\hat{\beta}$	P-Value	Odds Ratio
Age	<25 years	0.501	0.002	1.651
	36-45 years	0.015	0.006	1.015
	>55 years.	0.016	0.006	1.016
Income	≤ 2 million IDR	2.302	0.016	8.816
	2.1-3.5 million IDR	2.177	0.002	6.216
Profession	Farmer	1.771	0.015	5.876
	Fisherman.	1.819	0.007	6.168
	Employee	1.151	0.003	3.161
	Laborer.	1.679	0.045	5.361
Marital Status	Married	1.370	0.004	3.936
	Single	1.379	0.016	3.973
	Divorced	1.638	0.007	5.148
Level of Education	Elementary School	1.025	0.032	2.787
	Junior High School	0.884	0.006	2.420

CONCLUSION

Results from the binary regression model, socio-economic factors were associated with uncertainty and unwillingness to receive the COVID-19 vaccine in Bontang City. The predictor's effect of the COVID-19 vaccine's attitudes in the Bontang city is income, profession, marital status, and level of education. The older age groups (≤ 25 years old) were more likely to an unwillingness to COVID-19 vaccines than younger and older age groups. The income groups (≤ 0.5 million) were more likely to unwillingness for COVID-19 vaccines than bigger income groups. Fishermen were more likely to unwillingness for COVID-19 vaccines than other professions. Divorced in the marital status were more likely to unwillingness for COVID-19 vaccines than others and participants with the level of education in elementary school were more likely to unwillingness for COVID-19 vaccines than a higher level of education.

The recommendation in this study to support the achievement of government targets are persuasive approach and public health massaging should be continued and tailored to address these concerns, specially to the older age groups (≤ 25 years old), certain professions, certain marital status, and people with lower levels of education and incomes.

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