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Determinants of Household Food Security during the COVID-19 Pandemic in Indonesia

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Abstract: The COVID-19 pandemic has impacted national and household food security in Indonesia. The objectives of this study were to: (1) identify the socio-economic characteristics of Indonesian households related to food security, (2) analyze the factors that have affected household food security during the COVID-19 pandemic, and (3) provide recommendations for improving programs to increase household food security. The study was conducted in eight provinces in Indonesia, namely North Sumatra, Lampung, West Java, Central Java, East Java, South Kalimantan, South Sulawesi, and West Nusa Tenggara. Data collection was carried out from April to July 2020. The results showed that 50.63% of the households surveyed were food insecure. The binary-logit-regression-model results showed that variables of gender, age, family size, education, occupation, income, and expenditure on food had a significant effect on household food security status. Variables that had a positive influence on household food security were gender, age, education, occupation, income, and food expenditure. On the other hand, household size had a negative effect on household food security. The marginal effect of gender was 0.035, age was 0.058, education was 0.192, type of work was 0.016, income level was 0.521, and food expenditure was 0.114, while for the number of family members the marginal effect was 15.725. This study was conducted in eight provinces affected by COVID-19, using the Household-Food- Insecurity-Access-Scale and binary-logit model approaches, which had never been performed before. Policy and program recommendations for increasing household food security in Indonesia are presented.

Keywords: COVID-19 pandemic; food insecurity; food security; Indonesia

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1. Introduction

The COVID-19 pandemic in Indonesia, which began in March 2020, has had an impact on every aspect of life, both at the national and household levels. The Food and Agriculture Organization of the United Nations (FAO) has warned of a potential global food crisis due to the COVID-19 pandemic, which will affect the food security of many countries, especially poor and developing countries. The FAO has also stated that the number of malnourished people will increase to 161 million people by 2020 [1]. The pandemic was a warning of the potential for world food shortages, affecting all four pillars of food security: availability, access, utilization, and stability of food [1–3].

In Indonesia, the agricultural sector is listed as one of the sectors that consistently contributed to economic growth during the COVID-19 pandemic. During the COVID-19 pandemic in 2020, the Indonesian agricultural sector continued to grow positively with a figure of 1.75% [4]. This demonstrates that the Indonesian agricultural sector has been resilient in facing challenges during the economic crisis, due to the COVID-19 pandemic. To achieve this condition, the Indonesian government has reallocated a larger budget to

seed assistance, labor-intensive programs, and the stabilization of food stocks and prices, paying attention to food distribution, and transportation [5].

The Indonesian agricultural sector was impacted by various governmental policies to prevent transmission of the COVID-19 virus. This included the 'micro-lockdown' policy. This policy disrupted the agricultural supply chain, marked by a decrease in harvest outputs by farmers, due to a reduced availability of farm laborers [6]. Farmers found it very difficult to engage labor from outside the household, due to the government's lockdown policy [7]. In addition, production disruption occurred because farmers found it difficult to access important inputs such as fertilizers, because the movement of these inputs to production areas was limited [8].

Another rising phenomenon is a product-demand shock. The COVID-19 pandemic disrupted the supply chain of commodities, which prevented farmers from selling their products, thus affecting farmers' income. In addition, other non-agricultural economic activities in Indonesia and internationally stalled or declined, due to COVID-19. This situation caused many farmers' income from non-farming sources to decrease or disappear. This situation has certainly changed the consumption behavior of many farmer households.

The COVID-19 pandemic has the potential to cause a food crisis, which in turn can lead to food insecurity. It is therefore necessary to measure the condition of Indonesia's food security through existing indicators. According to Maxwell and Frankenberger [9], the achievement of household food security can be measured using process indicators and impact indicators. Process indicators describe the food situation in terms of the availability of, and access to, food. Impact indicators can be used to reflect the level of food consumption. Food-access indicators include sources of income, access to capital credit, and household strategies to meet food shortages. The problem is that indicators for assessing the status of household food security do not always provide valid information, and this can lead to the inaccurate distribution of household-food-security programs or activities.

Household food security can be achieved with sufficient food consumption for household members, both in quantity and quality. Changes in food consumption that lead to a decrease in food quantity and quality, including changes in the percentage of consumption of staple foods, are an illustration of food insecurity [10]. Nutritional status is an indicator of food security which is included in the dimensions of food utilization, but in this study nutritional status was not examined.

Indicators of the impact of food security include two categories, namely, direct and indirect. Direct indicators include food consumption and percentage of food, while indirect indicators include food storage and nutritional status [11]. Maxwell and Frankenberger [9] stated that process indicators were sufficient to describe household food security. Many indicators are used to measure food security, including the level of food expenditure, food consumption, and anthropometric indicators/nutritional status. The level of food expenditure is an indicator used to analyze household food security. The level of food expenditure is the cost incurred for food by a household each month, and this cost is compared with the total expenditure per month [12]. Food consumption affects a person's nutritional status. Household food security is closely related to the food consumption of household members.

Studies related to the impact of the COVID-19 pandemic on socio-economic indicators of farmer households have been carried out in several countries. In a study in Punjab, Pakistan, the COVID-19 pandemic caused a loss of cash income for farming households, coupled with rising prices for agricultural inputs, leaving farmers unable to buy the inputs they need for rice production [13]. Another impact of the COVID-19 pandemic was an increase in rice prices, so that the level of consumption of rice as a staple food for the majority of Papua New Guineans decreased, both for urban and rural communities, especially the poor [14]. In addition, the decline in income from agricultural products that is not matched by large consumption expenditure resulted in many difficulties for farmers, as they are only able to meet their basic needs [15].

Food security at the national or regional level may not necessarily guarantee food security at the household and individual levels. Global, national, regional, local and individual food security occurs because of a hierarchical series [16]. National and regional food security is a mandatory requirement, but is not sufficient to meet household and individual food security (a necessary but not sufficient condition). Meanwhile, the adequacy requirement for national food security is the achievement of individual and household food security. However, national or regional food sufficiency cannot guarantee the achievement of household food security. This is indicated by the fact that, although at the national and regional (provincial) levels in Indonesia there is guaranteed food-security status, in these areas there remain food-insecure households [17,18].

Given the above-described situation, there is a need for research into the impacts of the COVID-19 pandemic on the food security of Indonesian households. Specifically, the objectives of this study are to: (1) identify the socio-economic characteristics of Indonesian households related to food security, (2) analyze the factors that affected household food security during the COVID-19 pandemic, and (3) provide policy recommendations to improve food-security programs in Indonesia. This study provides recommendations for improving household food security through the identification of households at risk of experiencing food insecurity, so that program targets can be correctly determined.

2. Methodology

2.1. Study Area

This research was conducted in 8 provinces in Indonesia. The 8 provinces were selected based on the contribution of their agricultural sectors to the gross domestic product (GDP). The selected provinces were North Sumatra, Lampung, West Java, Central Java, East Java, South Kalimantan, South Sulawesi, and West Nusa Tenggara (Figure 1).

Figure 1. The location of the study area and the number of respondents [4].

The selection of 8 provinces is based on the contribution of GDP by taking into account the representation of each region in Indonesia, namely Sumatra, Java, Kalimantan, Sulawesi, and Eastern Indonesia. In 2020, the amount of GDP of North Sumatera was IDR 36.175 billion, Lampung was IDR 26.743 billion, West Java was IDR 30.413 billion, Central Java was IDR 28.695, East Java was IDR 41.512 billion, South Kalimantan was IDR 32.210, South Sulawesi was IDR 37.474 billion and West Nusa Tenggara was IDR 17.583 billion [4].

2.2. Sampling and Data Collection

The selection of study sites within the 8 provinces involved a multistage-random-sampling approach. Within each province, 1 district with the highest agricultural GDP was determined and 1 district with a medium agricultural GDP was determined. From each selected district, 2 sub-districts and 2 villages were selected, based on their having the largest agricultural area within the sub-district and village. The selection of respondents at the village level was carried out randomly, ensuring that respondents were not located close to each other. This sampling approach resulted in a total of 1341 respondents, spread over 16 districts, 32 sub-districts, and 64 villages. The number of respondents in each province and district is shown in Table 1.

Table 1. The research location and number of respondents, 2022.

No	Province	Number of Respondents
1	North Sumatra	173
2	Lampung	151
3	West Java	241
4	Central Java	223
5	East Java	213
6	South Kalimantan	94
7	South Sulawesi	101
8	West Nusa Tenggara	145
Number		1341

The study also used secondary data, drawn from research conducted by the Center for Data and Information Systems (Pusdatin) in April–July 2020. The secondary data utilized included food security and rice stock data, and household socio-economic characteristics including gender, age, family size, education, occupation, agricultural commodities cultivated, agricultural land ownership, knowledge about the COVID-19 pandemic, and income and expenses during the COVID-19 pandemic.

One method used to measure the level of household food security is the household-food-insecurity access scale (HFIAS). The advantages of this method are that it is simple and cheap to implement. The HFIAS method is an adaptation of the approach used to estimate the prevalence of food insecurity per year in the United States of America (USA), namely the U.S. Household Food Security Survey Module (US HFSSM). The HFIAS method was originally developed to monitor food insecurity in the USA [19]. The method has been refined in the context of developing countries [20]. Countries that have validated this method include Bangladesh [20], Brazil [21], Costa Rica [22], Tanzania [23], Ethiopia [24], and Burkina Faso [25]. It is expected that the HFIAS method is also applicable to Indonesia. This is because the household is a crucial unit for ensuring access to food in sufficient quantity and quality for each individual member of the household. Sen [26] and Barret [27] stated that food availability at the macro level does not necessarily guarantee household food access and the achievement of good individual nutritional status. Indeed, household socio-economic factors and environmental conditions can also lead to household food insecurity [28,29]. Data on food security and the level of food insecurity experienced by households were collected from secondary data. The respondents were the head of the household or the person responsible for preparing food for the family; there were 9 main questions, following [30], outlined below:

1. In the last four weeks, were you worried that your household would not have enough food?
2. In the last four weeks, were you or any members of your household unable to eat your preferred type of food due to lack of resources?
3. In the last four weeks, did you or any members of your household eat a limited variety of foods due to lack of resources?

4. In the past four weeks, have you or any members of your household had to eat certain types of food that you really didn't want to eat (but were forced to eat) because of a lack of resources to obtain other types of food?
5. In the last four weeks, have you or any members of your household had to eat smaller portions of food than necessary because of insufficient food?
6. In the last four weeks, have you or other household members had to eat less food each day because not enough food was available?
7. In the last four weeks, has there ever been no food of any kind to eat in your household, due to lack of resources to obtain food?
8. In the last four weeks, have you or any member of your household gone to bed hungry at night, because of not enough food?
9. In the last four weeks, have you or any member of your household spent whole days and nights without eating anything, because of not enough food?

2.3. Data Analysis

2.3.1. Household-Food-Insecurity Access Scale (HFIAS)

In answering the HFIAS questions, if the respondent answered "YES" this was given a value of 1, while if the answer was "NO", a value of zero was applied. Each answer was been followed by a question regarding the percentage of respondents experiencing the vulnerability. Responses related to frequency were divided into 3 and given a weight of 1 if the response was 'rarely' (1–2 times in 4 weeks), 2 if 'sometimes' (3–10 times in 4 weeks), and 3 if 'often' (>10 times in 4 weeks). The final HFIAS score was then categorized into 4 categories, namely food secure if the total score obtained was 0–1, mildly food insecure for a score of 2–7, moderately food insecure for a score of 8–14, and severely food insecure for a score of 15–27 [31].

2.3.2. Binary-Logit-Regression Model

A binary-logit-regression model was used to identify the determinants of household food security. Details of the categories of each research variable are shown in Table 2.

Table 2. Categorization of variables for the Binary-Logit-Regression Model.

Var	Variable	Type of Data	Category	Coding
Y	Food Security based on the HFIAS score [30,31]	Nominal	- Food secure - Mildly Food Insecure - Moderately Food Insecure - Severely Food Insecure	0 = Food secure 1 = Food insecure
X_1	Gender	Nominal	- Female - Male	0 = Female 1 = Male
X_2	Age [32]	Ordinal	Teenagers: 13–19 years old Young adults: 20–30 years old Middle-aged: 31–50 years old Older adults: 51–75 years old Elderly: 76+ years old	0 = Teenagers: 13–19 years old 1 = Young adults: 20–30 years old 2 = Middle-aged: 31–50 years old 3 = Older adults: 51–75 years old 4 = Elderly: more than 76 years old
X_3	Family Size [33]	Ordinal	- $\leq$4 people (small family) - 5–6 people (medium family) - $\geq$7 people (large family)	- 0 = $\leq$4 people (small family) - 1 = 5–6 people (medium family) - 2 = $\geq$7 people (large family)
X_4	Education Level [34]	Ordinal	- No School - Primary School - Secondary School - Tertiary School - University	- 0 = No School - 1 = Primary School - 2 = Secondary and Tertiary School - 3 = University

Table 2. *Cont.*

Var	Variable	Type of Data	Category	Coding
X_5	Occupation [35]	Nominal	Government employees Service and Sales Employees Fisherman Processing and Crafting Blue-collar workers	0 = Non-Farmers 1 = Farmers
X_6	Household Income Per capita/Month [36]	Ordinal	- ≤Poverty Line - >Poverty Line	0 = Low Income (≤IDR 1,500,000) 1 = Medium Income (IDR 1,500,001–IDR 2,500,000) 2 = High Income (IDR 2,500,001–IDR 3,500,000) 3 = Very High Income (>IDR 3,500,000)
X_7	Food Expenditure [37]	Ordinal	- Low (≤60% total expenditure)) - High (>60% total expenditure)	0 = Low (≤60% total expenditure) 1 = High (>60% total expenditure)

Univariate analysis was carried out with frequency distribution on categorical data such as gender, age, family size, education, occupation, income, food expenditure, and household-food-security status. Bivariate analysis was conducted to determine the relationship between two variables using the chi-square test. This bivariate analysis was used to determine the relationship between the independent variables (independent), namely the socio-economic characteristics of the household (gender, age, family size, education, occupation, income, food expenditure) and the dependent variable (dependent), namely the status of food security (food secure and food insecure). The statistical test used was the chi-square test at =0.05 with a 95% confidence interval. Variables related to bivariate analysis were followed by multivariate analysis. Multivariate analysis used logistic regression to measure the relationship of the dependent variable and the independent variable after controlling for the relationship of the other independent variables. Multivariate analysis was used to determine the relationship of household socio-economic characteristics (gender, age, family size, education, occupation, income, and food expenditure) and household-food-security status. The scale of the dependent-variable category of household-food-security status is binary (food secure and food insecure), so that the multivariate analysis used is binary logistic regression. In the logistic-regression model, it is not necessary to test assumptions [34,38]. The binary-logistic-regression model can be written as follows:

$$\pi(x) = \frac{exp\, y(x)}{1 + exp\, y(x)} \quad (1)$$

The function of $\pi(x)$ can be seen from the transformation of logit, $g(x)$, which can be expressed as follows:

$$y(x) = ln\frac{\pi(x)}{1 - \pi(x)} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_7 x_7 \quad (2)$$

Note:
y: Food-security status (independent variable)
β: Constant
x_1: Gender
x_2: Age
x_3: Family Size
x_4: Education

x_5: Occupation
x_6: Household Income Per Capita
x_7: Household Food Expenditure

Simultaneous and partial parameter testing was conducted to examine the role of the independent variables in the model. Simultaneous parameter testing uses the G test, while parameter testing is carried out to examine the role of the independent variable on the dependent variable in a model. According to Hosmer and Lemeshow [38], to test the role of independent variables in the model together, the G test can be used. Meanwhile, partial parameter testing was carried out using the Wald test [38].

The interpretation of the coefficients for the binary-logistic-regression model can be carried out by looking at the resulting odds-ratio value [39]. The odds is the ratio of the probability of a successful event to an unsuccessful event of the response variable, while, according to Hosmer and Lemeshow [38], the odds ratio is a measure of determining how much the independent variable tends to influence the dependent variable.

3. Results

3.1. Characteristics of Respondents

An overview of household-food-security status based on the results of the COVID-19-Pandemic-Impact Survey on Food Security, in 2020, can be seen in Figure 2. The study found that just over half of the respondent households (684 households, 50.63%) were food insecure in 2020.

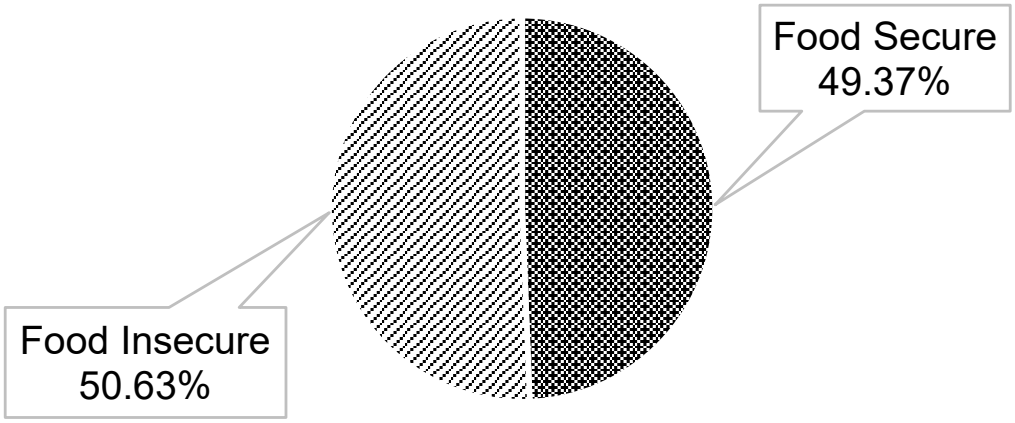

Figure 2. Food- security status of the respondent households in 2020.

Based on Figure 2, it can be seen that 657 (49.37%) households have food-secure status, while the remaining 684 (50.63%) households have food-insecure status. The socio-economic characteristics of the respondents are described in Table 3.

3.2. Bivariate Analysis with Chi-Square Test

The chi-square test was conducted to determine the relationship between socio-economic characteristics (gender, age, family size, education, occupation, income, food expenditure) and household food-security status. The results of the chi-square test are presented in Table 4.

Table 3. Socio-economic characteristics of households in relation to their food security, 2022.

No	Socio-Economic Characteristics	Food Security (n = 657) %	Food Insecurity (n = 684) %	p-Value
Demographic Characteristics				
X_1	Gender (%):			0.000 ***
	- Male	50.9	49.1	
	- Female	22.7	77.3	
X_2	Age of farmers (%)			0.000 ***
	13–19	0.0	0.0	
	20–30	13.3	86.7	
	31–50	39.2	60.8	
	51–75	69.5	30.5	
	≥76	81.8	18.2	
X_3	Number of Households (%)			0.000 ***
	≤4	55.9	44.1	
	5–6	33.7	66,3	
	≥7	9.4	90.6	
X_4	Education Level (%)			0.008 ***
	- Below Primary School	49.5	50.5	
	- Primary School	45.1	54.9	
	- Secondary and Tertiary School	52.2	47.8	
	- University	68.4	31.6	
X_5	Occupation (%)			0.000 ***
	- Agriculture	67.6	32.4	
	- Non-Agriculture	16.5	83.5	
Economic Characteristics				
X_6	Income (%)			0.000 ***
	- low	33.6	66.4	
	- intermediate	61.2	38.8	
	- high	62.3	37.7	
	- very high	74.2	25.8	
X_7	Food Expenditure (%)			
	≤60%	39.4	60.6	
	>60%	58.5	41.5	

*** indicates a statistically significance difference at 1%.

Table 4. Chi-square test of household socio-economic characteristics against household food-security status.

Var	Variables	χ^2_{count}	χ^2_{table} α=0.05	*p*-Value
X_1	Gender	22,656	3841	0.000 ***
X_2	Age	163,975	7815	0.000 ***
X_3	Family Size	69,451	5991	0.000 ***
X_4	Education	11,727	7815	0.008 ***
X_5	Occupation	320,445	3841	0.000 ***
X_6	Income	129,716	7815	0.000 ***
X_7	Food Expenditure	48,893	3841	0.000 ***

*** indicates a statistically significance difference at 1%.

3.3. Multivariate Analysis Using the Binary-Logit Regression Model

Parameter testing in the binary-logit-regression model with independent variables of gender, age, family size, education, occupation, income, and food expenditure, resulted in a G-test statistic value of 1008.617 and a *p*-value of 0.000. The null hypothesis is rejected because the resulting *p* value is smaller than the 5% significance level (α), so the conclusion obtained is that there is at least one household socio-economic characteristic that affects household-food-security status at a significant level of 5%. Partial parameter testing using the Wald test (results presented in Table 5) shows that the socio-economic characteristic which has a *p* value of less than the 5% significance level has a significant relationship on household-food-security status. Based on Table 5, the variables of gender, age, family size, education, occupation, income, and expenditure on food have a significant relationship with household-food-security status.

Table 5. Results of the Binary-Logit-Regression Model to assess household food-security status (n = 1341).

Variable	Description	Coefficient	Std. Error	*p*-Value	Odds Ratio
	Intercept	15.897	1.008	0.0000	
X_1	Gender	−3.360	0.451	0.0000	0.035
X_2	Age	−2.840	0.209	0.0000	0.058
X_3	Family size	2.755	0.226	0.0000	15.725
X_4	Education	−1.648	0.167	0.0000	0.192
X_5	Occupation	−4.151	0.260	0.0000	0.016
X_6	Income	−0.651	0.097	0.0000	0.521
X_7	Food Expenditure	−2.171	0.205	0.0000	0.114

The G test and the Wald test found that the variables of gender, age, family size, education, occupation, income, and food expenditure had a significant effect on household-food-security status. Thus, the logit model can be formed as follows:

$$\hat{y}(x) = 15,897 - 3360X_1 - 2840X_2 + 2755X_3 - 1648X_4 - 4151X_5 - 0.651X_6 - 2171X_7$$

The goodness of the binary-logit-regression model can be seen through the value of the coefficient of determination, (R^2) Nagelkerke. The value of R^2 Nagelkerke generated in the model is 70.49%. That is, the diversity of household-food-security status that can be explained by the socio-economic characteristics of the household is 70.49%, and the remaining 29.51% is explained by other variables or factors outside the model produced.

The model fit test was carried out using the Hosmer–Lemeshow test. This test involves looking at the value of the goodness-of-fit test as measured by the chi-square value at a significance level of 5%. The Hosmer–Lemeshow goodness-of-fit test in this study resulted in a chi-square value of 12.931 with a p value of 0.114. Because the p value is greater than the 5% significance level, the null hypothesis cannot be rejected, which means there is sufficient evidence to state that the hypothesized model fits the data.

Evaluation of the classification results can be carried out by looking at the accuracy of the classification. The classification accuracy shows the percentage of the goodness of the model in classifying a dataset. Based on Table 6, the overall classification accuracy of the resulting model is 86.1%. The percentage of accurately estimating the status of food security is 85.2%, while the percentage of accurately estimating the status of food insecurity is 86.9%.

Table 6. Model-classification accuracy.

Actual	Prediction		Classification Accuracy (%)
	Food Secure	Food Insecure	
Food Secure	564	98	85.2
Food Insecure	89	590	86.9
	Total		86.1

4. Discussion

4.1. Characteristics of Respondents

From the characteristics of respondents, there were more male household respondents than females. Women who experienced food insecurity represented a greater percentage than those who were food secure. Meanwhile, men who were food secure represent a higher percentage than men who were food insecure.

Most of the household respondents were aged between 31 and 50 years, and no respondents were aged 13 to 19 years. Respondents aged 20 to 30 years and those aged 31 to 50 years tended to be food insecure. Meanwhile, respondents aged 51 years and over tended to be food secure. The age of the head of the household was related to the food security of the household. When the household head was older than 60 years, the household was more likely to be food secure than if the household head was younger [40]. However, the previous results by Olaniyi [41] show that households with an older-aged household head tend to be food insecure, compared to those with a younger household head.

There were more households with a family size of less than or equal to four people than those with a family size of five–six people and more than or equal to seven people. Respondents who had a family size of less than or equal to four people tended to be food secure, while respondents who had a family size of five–six people and more than or equal to seven people tended to have food-insecure status. Family size is one of the factors that affects household food security, especially in poor households [42]. According to Olayemi [43] the number of household members is negatively related to food security, which means that the more household members, the lower the level of household food security. This is related to the distribution of food in the household.

There were more household respondents who had graduated from junior high school/equivalent and high school/equivalent than respondents who did not finish elementary school, had finished elementary school/equivalent, or had graduated from higher education. Respondents who had an education level lower than or equal to elementary school tended to be food insecure, while respondents who had an education level higher than elementary school tended to be food secure. The results from Acharya [44] suggest social capital such as the length of years of education of a husband and wife has a positive impact on household food security. According to Willows et al. [45], the higher the level of education completed by the household head, the greater the opportunity for food security. The results of Wiranthi [40] show that a higher level of education of the household head

(6, 9, 12 years of schooling) increases the chance of becoming food secure, while at university level the opportunity for food security tends to be stable.

There were more household respondents who had jobs as farmers than respondents who were employed in non-farming occupations. The non-farmer respondents tended to be food insecure, while the farmer respondents tended to be food secure. The results of the research by Wiranthi [40] show that the main occupation of the head of the household is a determinant of household food security. Working in the agriculture, fisheries and forestry sectors reduced the chances of households becoming food secure.

There were more respondents who had a low income (≤IDR 1,500,000 per month) than respondents who had a medium (IDR 1,500,001–IDR 2,500,000 per month), high (IDR 2,500,001–IDR 3,500,000 per month), and very high (>IDR 3,500,000 per month) income. The group of respondents who had low incomes tended to be food insecure, while the respondents who had medium, high, and very high incomes tended to be food secure. According to Nurlatifah [46], income per capita is a determinant factor of household food security. The level of income will determine the ability of the economy to access food. According to Misselhorn [28], poverty is a direct cause of food insecurity in northern Africa, and according to Acharya [44], livestock ownership has a significant positive impact on household food security.

There were more household respondents who had an expenditure on food above 60% than respondents who had an expenditure on food less than or equal to 60%. This latter group of respondents tended to have a food-insecure status, while those whose expenditure on food was more than 60% tended to be food secure.

In addition to income, expenditure is also a determinant of food security. According to Tanziha [47], household expenditure per capita is the main determinant of hunger. According to Rosyadi and Purnomo [48], the ability of households to access food is reflected in the share of their spending on food. Regional conditions of rural and urban areas are also related to food insecurity [46]. Living in rural areas reduces the chances of becoming food insecure [40]. The previous study by Rosyadi and Purnomo [48] found that underdeveloped villages in Sukoharjo Regency had low food security.

The performance of food production in Indonesia, especially rice, has increased significantly from year to year, but the increase in production has not kept pace with the growth in rice consumption. According to Misselhorn [30], the direct causes of food insecurity in northern Africa, besides poverty, are the influence of environmental pressures and of social conflicts/wars. Seasonal situations also affect food security. According to Olaniyi [41], access to food during the harvest season is higher than during the famine season.

4.2. Bivariate Analysis with Chi-Square Test

With bivariate analysis it can be explained that all of the socio-economic characteristics had a relationship with the household-food-security status, which is indicated by the value of χ^2_{count} being larger than χ^2_{table} or $p < \alpha$ on $\alpha = 5\%$. This means that the H_0 is rejected, with the interpretation that there is a relationship between all of the characteristics and household-food-security status. Thus, all of these household socio-economic characteristics were used for further multivariate analysis.

4.3. Multivariate Analysis Using the Binary-Logit-Regression Model

Based on the logit model presented in Table 5, a general analysis can be made that an increase in the classification of gender, age, education, occupation, income, and expenditure on food by one level will lead to a suggestion of reduced food security. Meanwhile, an increase in the classification of family size by one level will result in the household-food-security status being less secure. The statement that the suggested status of food security is less secure for each of the socio-economic characteristics can be seen from the minus sign in the logit model.

The interpretation of parameter coefficients in the logit-regression model will be easier to see from the value of the odds ratio or marginal effect. The estimated odds ratio for

the gender variable (X_1) can be interpreted as the odds of the household status being food insecure in men are 0.035 times the odds for this household status in women. This means that women are more likely to experience food insecurity than men. Mallick and Rafi [49] found that female-headed households had a lower degree of food security than male-headed households. There are three burdens for female household heads, namely: (i) as the main breadwinners, they face various losses in the labor market and productive activities; (ii) they are responsible for maintaining the household, including housework and childcare in addition to other non-household work; and (iii) they face a high dependency ratio, due to being the sole breadwinner [50]. Demeke and Zeller [51] also found that male-headed households were more food secure.

The estimated odds ratio for the age variable (X_2) can be interpreted as that an increase in age classification by one level will lead to an estimated increase in food security of 0.058 times. This means that the age classification that is one level higher is likely to be more food secure than the lower-age group. In this case, the chances of food security for the one-level-higher age classification are 17 times greater. Bashir et al. [52,53] and Gebre [54] found that the age of the head of the household was negatively related to the probability of being food insecure. On the other hand, Demeke and Zeller [51] found that food-secure households have an older head of the household. Similarly, Bogale and Shimelis [55] found that the older age of the head of the household was positively related to food security. Increasing the age of the head of the household increases food security, because they are more experienced in work. Demeke and Zeller [51] state that the age of the head of the household can positively or negatively affect food security. The older the household head, the more experienced the household head and the more knowledge and physical assets they possess that can positively affect food security. The age of the head of the household can also be negatively related to food security if they have low productivity and are less efficient at work.

The estimated odds ratio for the variable family size (X_3) can be interpreted as that a decrease in the family-size classification by one level will lead to an estimated increase in food security of 15.725 times. This means that family-size classifications that are one level higher are more likely to experience food insecurity, compared to household sizes that are one level lower. The number of household members is identified as one of the important factors affecting the degree of household food security. Ahmed et al. [54], Bashir et al. [52,53], Gebre [54], and Bogale and Shimelis [55] found that household size or the number of household members was negatively related to the probability of being food insecure. The number of household members was found to be statistically significant in influencing the degree of household food security. Bogale and Shimelis [55] stated that the number of household members must increases in line with the availability of food. An increase in the number of household members will increase the demand for food. If this cannot be met with an adequate supply of food, food insecurity will occur. A greater number of household members means that the household has a lower chance of food security than households with fewer household members. In contrast, Demeke and Zeller [51] found that food-secure households have more household members. Several studies have identified the fact that the number of household members is negatively related to food security because a large number of household members requires more resources to meet the food needs of the household. Other studies see a positive relationship, because it means there is a larger available workforce.

The estimated odds ratio for the education variable (X_4) can be interpreted as that an increase in the classification of education by one level will lead to an estimated increase in food security of 0.192 times. This means that those with higher education are one level more likely to be food insecure than those with lower education. In this case, the chance of food security for a higher education classification of one level is five times greater. Bashir et al. [52,53] and Gebre [54] found that the education of the head of the household was positively related to the probability of becoming food secure. The education of the head of the household significantly affects household food security. The higher the education of

the head of the household, the better the food security of the household. However, Bogale and Shimelis 55] found that the education of the head of the household had no effect on household food security.

The estimated odds ratio for the employment variable (X_5) can be interpreted as that the odds of household food security in farmer households are 0.016 times that of non-farmer households. This means that non-farmer households are more likely to experience food insecurity than farmer households. Nanda et al. [56] found that households with agricultural status or working in the agricultural sector had the opportunity to increase household food security. Saliem et al. [17] found that, ironically, most food-insecure households were those with a livelihood in the agricultural sector as food producers. Likewise, Sundari and Nachrowi 57] found that the work of the head of the household in non-agriculture increased the food security of the household. The results of this current study show that non-farmer households are more likely to experience food insecurity than farmer households. One reason for this is that more than 60% of the household respondents were farmer households, as presented in Table 3.

The estimated odds ratio for the income variable (X_6) can be interpreted as that an increase in income classification by one level will lead to an estimated increase in of food security of 0.521 times. This means that income classifications that are one level higher are more likely to experience food security than those with lower incomes. In this case, the chance of food security for a one-level-higher income classification is two times greater. Bashir et al. [52,53] and Bogale and Shimelis 55] found that household income has a positive impact on food security. Income per capita, which is a proxy of per capita expenditure, is an economic variable that has a significant effect on household food security. This is because an increase in income will increase the purchasing power of households, so that they can meet their food needs.

The estimated odds ratio for the food expenditure variable (X_7) can be interpreted as that the odds of food-insecure household status in the food expenditure classification > 60% are 0.114 times the food-insecure-household-status odds in the food-expenditure classification 60%. This means that if the expenditure classification for food is 60%, the household is more likely to experience food insecurity compared to the expenditure classification for food > 60%. The previous study by Sundari and Nachrowi [57] states that a larger share of food expenditure indicates poor food security because it reflects a lower purchasing power or lower access to food. The previous study by Ahmed et al. [58] state that family size, monthly income, food prices, health expenses and debt are main factors influencing the food security status of rural households.

5. Conclusions and Recommendations

5.1. Conclusions

The results of this study showed that of the 1341 household respondents from eight provinces in Indonesia, just over half (n = 684, 50.63%) were food insecure during the COVID-19 pandemic in 2020. The determinants of household food security during the COVID-19 pandemic that were investigated included gender, education, family size, occupation, income, and food expenditure. Male respondents tended to be more food secure than female respondents. Respondents aged less than 50 years tended to have food-secure status, whereas respondents aged 51 years and over tended to have food-insecure status. Respondents with smaller family sizes tended to be more food secure than larger families. Regarding the level of education, respondents who graduated from junior and senior high school tended to be more food secure than those who graduated from elementary school.

The non-farmer respondent group tended to be food insecure, while the farmer respondent group tended to have food-secure status. The group of respondents who had low incomes tended to be food insecure, while groups of respondents who had medium, high, and very high incomes tended to have food-secure status. The group of respondents who had expenditure on food of less than or equal to 60% tended to have food-insecure status,

while the group of respondents who had expenditure on food of more than 60% tend to have food-secure status.

The variables of gender, age, family size, education, occupation, income, and expenditure on food had a significant relationship with household-food-security status. Variables that had a positive influence on household food security were gender, age, education, occupation, income and food expenditure. On the other hand, the household-size variable had a negative relationship with household-food-security status. The overall accuracy of the logit-regression model in this study was 86.1%, with details of 85.2% predicting food-security status, and 86.9% predicting food-insecurity status.

The marginal-effect value for the gender variable was 0.035, age was 0.058, education was 0.192, type of work was 0.016, income level was 0.521, and food expenditure was 0.114, while for the number of family members it was 15.725.

This study underlines the important points that the variables that had a positive influence on household food security were gender, age, education, occupation, income, and food expenditure. On the other hand, the variable that had a negative effect on household food security was household size.

5.2. Recommendations

This study provides the following policy recommendations for household-food-security programs: First, given that the farmer respondent group tended to be more food secure than non-farmers, the government should give priority to programs and budgets in the agricultural sector, as a lever for economic activity to support family food security. Second, given that the group of respondents who had low incomes tended to be less food insecure than the respondents with medium, high, and very high incomes, the government should make policies and provide program assistance that have a direct impact on increasing people's income, such as social assistance, labor-intensive programs and cash-transfer programs. Third, the group of respondents whose expenditure on food was less than or equal to 60% tended to be food insecure This implies that households are empowered to be independent, especially to meet their daily food needs from the use of surrounding lands. The sustainable-food-garden program, based on horticultural crops, may therefore be a useful tool to assist in building household food security.

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