THE FACTORS THAT INFLUENCE PEOPLE'S CONSUMPTION OF MORINGA IN SURABAYA CITY

Desy Nuriatul Fajariyah[1)]
Pismia Sylvi[2)]
[1,2)]Department of Statistics, Universitas Terbuka, Surabaya, Indonesia
e-mail: desynfajariyah@gmail.com

ABSTRACT

The decrease in the prevalence of nutrition recorded in the Indonesian Nutrition Status Survey (SSGI) in 2021-2022 by 2.8% (Ministry of Health of Indonesia, 2023) indicates an improvement in the nutritional status of the community. One of the factors that influence nutritional status is the consumption pattern of nutritious vegetables. Moringa (Moringa Oleifera), has an important role in improving nutrition due to its high nutritional content. However, the utilization of Moringa leaves is still limited due to the community's lack of understanding about the benefits and consumption of Moringa leaves. This study aims to identify the factors that influence people's consumption of moringa leaves with a case study in Surabaya City. A total of 70 respondents who had consumed moringa were selected through a two-stage cluster sampling method. Analyses were conducted to evaluate the influence of consumption goal variables, availability, price, and information sources on moringa consumption patterns. The results show that the source of information is a factor that has a significant effect on consumption patterns. These findings indicate the importance of disseminating appropriate information to increase the utilization of moringa in the moringa vegetable diet for people in Surabaya.

Keywords: moringa leaf, ordinal logistic regression, and vegetable.

INTRODUCTION

The phenomenon of urbanization and globalization has brought about changes in people's lifestyles, especially in consumption patterns. People are increasingly aware of the importance of health and balanced nutrition. This can be seen from the results of the Indonesian Nutrition Status Survey (SSGI) explaining that there was a decrease from 2021 to 2022 by 2.8%, from 24.4% to 21.6% (Kementrian Kesehatan Republik Indonesia, 2023). Consumption is a support to measure the level of household welfare. The amount of consumption carried out by each household will differ from one another (Kinanti et al., 2024). One type of food consumed by humans is vegetables.

Vegetables are plant-based foods with high water content; some can be eaten raw. However, there are also those that require prior processing such as boiling, steaming, to maximize the nutritional content contained therein or to add to the taste of the vegetables. Vegetables are an important source of many nutrients, including potassium, folic acid, dietary fiber, vitamin A, vitamin E, vitamin C and between one vegetable and another, of course, have different nutritional content or nutrients (Kementrian Kesehatan Republik Indonesia, 2018).

Moringa leaves (*Moringa Oleifera* L.) have been recognized as a superfood that is rich in nutrients and health benefits. In fact, the World Health Organization (WHO) recommends that infants and children in their growing years consume moringa leaves to fulfil their nutritional needs. Moringa root is useful as an antiscorbutic that can reduce irritation. The leaves can be used as an antitumor, lower blood pressure, antioxidant, anti-inflammatory, radio-protective, and diuretic. Moringa plants contain 46 types of antioxidants and more than 90 nutrients. In addition, there are 36 anti-inflammatory compounds (Oktaviani et al., 2019). This has led to many studies utilizing moringa as a food preparation. The use of moringa in previous research was conducted by Amalia

(2020) by utilizing moringa leaves to improve the quality of fish nuggets from tuna fish as a healthy food alternative. Based on this research, it was concluded that the more the amount of tuna fish added to processed fish nuggets with the addition of moringa leaf flour, the higher the protein content. In addition, conducted by Tjong et al. (2021) by utilizing the content of moringa leaves (*Moringa Oleifera* L.) and the potential as a decrease in blood cholesterol levels. The effective dose to reduce blood cholesterol levels in mice is 0,2 – 41,6 mg / kgBB, how to give it orally or drink it.

The popularity of moringa as an ingredient in daily food preparations is increasing in line with education and socialization efforts about its benefits. In Surabaya, this trend is reflected in community interest and MSME initiatives that incorporate moringa into various food products. For instance, MSMEs in the Rungkut Mapan Barat area have innovated food and beverages using moringa leaves (KompasTV, 2023), while the Omah Kelor ITS community has developed healthy snack products from moringa (itsmis, 2020). According to a 2022 survey by the Surabaya Health Office, approximately 42% of residents are aware of moringa's health benefits, but only 18% actively consume it on a regular basis. This gap highlights the need for further education and product innovation to promote appropriate and beneficial use of moringa in daily diets.

Based on the problems previously described, this research will analyze the factors that influence people's consumption of moringa leaves with a case study in Surabaya City. The dependent variable in this study is the Moringa Leaf Consumption Pattern, while the independent variables include Consumption Purpose, Availability of Moringa Leaves, Price of Leaves, and Sources of Information on Moringa Leaves. These independent variables were selected based on their relevance to consumer behavior in Surabaya. The Consumption Purpose reflects the diverse motivations for consuming moringa, such as for health, nutrition, or traditional practices. Availability is crucial because access to fresh or processed moringa products can influence consumption frequency. Price is a significant factor in Surabaya's economy, where income disparities may affect food choices—affordable pricing can encourage higher consumption across socioeconomic groups. Lastly, Sources of Information play an essential role in raising awareness and shaping perceptions, especially in urban areas where social media and community programs increasingly influence dietary habits. Due to the variable scale used is ordinal (level), the appropriate method is ordinal logistic regression. Ordinal logistic regression is one of the regression analyses used to analyze the relationship between the dependent variable and the independent variable, where the dependent variable is polychotomous with an ordinal scale.

The sampling technique in this research is simple random two-stage cluster sampling. Cluster sampling is used when the population is spread across several administrative or geographic areas such as provinces, districts, and sub-districts. In this study, clusters are defined based on residential neighborhoods within Surabaya, allowing for a more manageable and efficient data collection process. The first stage involves randomly selecting several sub-districts as primary clusters, and the second stage involves randomly selecting households or individuals within those sub-districts. This method helps save time, energy, and cost, while ensuring that the sample remains representative of the overall population.

METHOD

The data used in this research is primary data. Primary data was obtained by interviewing through questionnaires to the Surabaya community. The population of the study was Surabaya people who had consumed moringa leaves (consumers), and the sample used was 70 respondents who had consumed moringa leaves. The survey was conducted on 14 June - 15 August 2024.

Figure 1. Mapping Surabaya City
Source: Novriyadi, 2023

Data collection in this study by interview through a questionnaire of 70 respondents. The sample size is based on the Central Limit Theorem (CLT). CLT can interpret population parameters from samples without having to know the shape of the population distribution. The sample mean distribution approach does not require a large sample. With a sample of 30, it can approach the normal distribution. In fact, for the mean distribution with a sample of 15, the normal distribution is approached. The two-stage cluster sampling method is simple random because the population is spread over several regions. The following sampling frame and the cluster by step:

Table 1. Sampling Framework

Cluster 1 (Sub-District)	Cluster 2 (Urban-Village)
Dukuh Pakis	Dukuh Kupang
	Dukuh Pakis
	Gunung Sari
	Pradah Kalikendal
Gubeng	Airlangga
	Baratajaya
	Gubeng
	Kertajaya
	Mojo
	Pucang Sewu
Sukolilo	Gebang Putih
	Keputih
	Klampis Ngasem
	Medokan Semampir
	Menur Pumpungan
	Nginden Jangkungan
	Semolowaru

The variables used in this study are the dependent variable (Y), and the independent variable (X). The explanation of the variables used in this study will be explained in the following discussion.

Table 2. Research Variables

Variable	Indicator	Category	Scale
Moringa Leaf Consumption Pattern (Y)	Frequency of Moringa Leaf Consumption, Time of Moringa Leaf Consumption, and Types of Moringa Leaf Preparations	1 :Enough (Total Score 5-7) 2 :Good (Total Score 8-11) 3 :Better (Total Score 12-15)	Ordinal
Consumption Purpose (X_1)	Health, Curiousness (curiosity), Fulfilling food needs	1 : Choose one indicators 2 : Choose two indicators 3 : Choose three indicators	Ordinal
Availability of Moringa Leaves (X_2)		1 : Own / Neighbor 2 : Market 3 : Nominal Vegetable Vendor	Nominal
Leaf Price (X_3)		1 : Expensive 2 : Quite expensive 3 : Cheap	Ordinal
Source of Information (X_4)		1 : Directly 2 : Communication Media 3 : Social Media	Nominal

The operational definitions related to the research variables will be presented in the following discussion:

1. Consumption pattern is the arrangement of the level of needs of a person or household for a certain period of time (Yusnita, 2010). This study divides consumption patterns into three indicators, namely the frequency of moringa consumption, time of moringa consumption, and types of moringa preparations. These three indicators were chosen to comprehensively describe people's habits in consuming moringa. The frequency of consumption shows how regularly moringa leaves are consumed, the time of consumption reflects daily habits or specific times of consumption (such as morning or night), while the type of preparation provides an overview of people's preferences for the form of moringa processing. These three aspects are relevant to the study's objective of understanding consumption patterns that can support promotion efforts and increase the optimal utilization of moringa.
2. The purpose of consumption of goods and services is to use, use, spend goods and services wisely (Yusnita, 2010). Based on this explanation, it can be concluded that the purpose of consumption is to meet the needs of life, health, curiosity.
3. Knowledge or cognitive is an important domain for the shape of a person's behavior. The factors that influence a person's knowledge are (Rini & Fadlilah, 2021):
   - Internal factors : education, occupation, age, interest, experience
   - External factors : information, culture

   This research focuses on how these factors influence decision-making in consumption patterns, particularly in the context of moringa consumption. Understanding the relationship between knowledge and consumption behavior, this study aims to identify barriers and potential improvements in the community's use of moringa.
4. Price is the amount of value (in currency) that consumers must pay to buy or enjoy the goods or services offered (Muspiha, 2023).

The dependent variable in this study, moringa consumption patterns, was measured on an ordinal scale based on the level of consumption intensity of the respondents. Since the scale of the data is ordinal and the purpose of the analysis is to see the influence of several independent variables on the level of consumption, the chosen method of analysis is ordinal logistic regression.

This method is suitable for identifying factors that significantly influence category changes in the dependent variable, which is arranged sequentially. The following presents a more detailed explanation of ordinal logistic regression and its underlying assumptions.

Ordinal logistic regression is one of the statistical methods used to analyze the relationship between ordinal-scale response variables with three or more categories and predictor variables that can be categorical or continuous (Hosmer et al., 2013). Cumulative logit models are models obtained by comparing the cumulative odds, which are the odds of being less than or equal to the jth response category on p predictor variables expressed in vector $\mathbf{x}$ with the odds of being greater than the jth response category, $P(Y \leq j|\boldsymbol{x})$ (Agresti, 2013). Here is the cumulative probability $P(Y \leq j|\boldsymbol{x})$.

$$P(Y \leq j|\boldsymbol{x}) = \frac{exp\left(\alpha_j + \sum_{k=1}^{p} \beta_k x_k\right)}{1 + exp\left(\alpha_j + \sum_{k=1}^{p} \beta_k x_k\right)} \quad (1)$$

where j = 1, 2, ..., J is the response category. Estimation of regression parameters is done by decomposing them using the logit transformation of $P(Y \leq j|\boldsymbol{x})$.

$$\begin{aligned} logit\ P(Y \leq j|\mathbf{x}) &= g_j(x) = log\left(\frac{P(Y \leq j|\mathbf{x})}{P(Y > j|\mathbf{x})}\right) \\ &= log\left(\frac{P(Y \leq j|x)}{1 - P(Y \leq j|x)}\right) = \alpha_j + \sum_{k=1}^{p} \beta_k x_k \end{aligned} \quad (2)$$

with the value of βk for each k = 1, 2, ..., p in each ordinal logistic regression model is the same. If there are three response categories, j = 1, 2, 3, then the logit model of the of-*k* response is as follows:

$$\begin{aligned} logit\ P(Y \leq j|\boldsymbol{x}) = g_1(x) = log\left(\frac{P(Y \leq 1|\boldsymbol{x})}{P(Y > 1|\boldsymbol{x})}\right) = \alpha_2 + \sum_{k=1}^{p} \beta_k x_k \\ logit\ P(Y \leq j|\boldsymbol{x}) = g_2(x) = log\left(\frac{P(Y \leq 2|\boldsymbol{x})}{P(Y > 2|\boldsymbol{x})}\right) = \alpha_2 + \sum_{k=1}^{p} \beta_k x_k \end{aligned} \quad (3)$$

Then the cumulative probability of the jth response will be described in equation (4) below:

$$\begin{aligned} P(Y \leq 1|\boldsymbol{x}) = \frac{exp\left(\alpha_1 + \sum_{k=1}^{p} \beta_k x_k\right)}{1 + exp\left(\alpha_1 + \sum_{k=1}^{p} \beta_k x_k\right)} \\ P(Y \leq 2|\boldsymbol{x}) = \frac{exp\left(\alpha_2 + \sum_{k=1}^{p} \beta_k x_k\right)}{1 + exp\left(\alpha_2 + \sum_{k=1}^{p} \beta_k x_k\right)} \end{aligned} \quad (4)$$

Here are the odds for each response category.

$$
\begin{aligned}
P(Y_j = 1) &= \pi_1(x) = \frac{exp\left(\alpha_1 + \sum_{k=1}^{p} \beta_k x_k\right)}{1 + exp\left(\alpha_1 + \sum_{k=1}^{p} \beta_k x_k\right)} \\
P(Y_j = 2) &= \pi_2(x) = \frac{exp\left(\alpha_2 + \sum_{k=1}^{p} \beta_k x_k\right)}{1 + exp\left(\alpha_2 + \sum_{k=1}^{p} \beta_k x_k\right)} - \frac{exp\left(\alpha_1 + \sum_{k=1}^{p} \beta_k x_k\right)}{1 + exp\left(\alpha_1 + \sum_{k=1}^{p} \beta_k x_k\right)} \\
P(Y_j = 2) &= \pi_2(x) = \frac{exp\left(\alpha_2 + \sum_{k=1}^{p} \beta_k x_k\right) - exp\left(\alpha_1 + \sum_{k=1}^{p} \beta_k x_k\right)}{\left(1 + exp\left(\alpha_2 + \sum_{k=1}^{p} \beta_k x_k\right)\right)\left(1 + exp\left(\alpha_1 + \sum_{k=1}^{p} \beta_k x_k\right)\right)} \\
P(Y_j = 3) &= \pi_3(x) = 1 - \frac{exp\left(\alpha_2 + \sum_{k=1}^{p} \beta_k x_k\right)}{1 + exp\left(\alpha_2 + \sum_{k=1}^{p} \beta_k x_k\right)} \text{ or } 1 - \pi_1(x) - \pi_2(x)
\end{aligned}
\tag{5}
$$

Assumptions in ordinal logistic regression are very important to ensure the validity and reliability of the model built. Non-multicollinearity assumption, Goodness of Fit test, parameter significance, and data scale are some of the important aspects that must be considered. In addition, ordinal logistic regression does not require the classical assumptions of linear regression and can use polynomial models for more complex relationships. Understanding and fulfilling these assumptions will help in producing an accurate and reliable model for ordinal data analysis. The following assumptions in analyst ordinal logistic regression:

Multicollinearity Test

The multicollinearity assumption check is used to determine whether there is a linear relationship or correlation between significant predictor variables in the regression model. In ordinal logistic regression analysis, multicollinearity is not allowed (Hosmer et al., 2013). If the VIF (Variance Inflation Factor) value is greater than 10, it indicates that there is a case of multicollinearity. Some ways of dealing with multicollinearity are by removing variables, combining predictors, or using regularization techniques. The equation of VIF can be written as follows:

$$VIF = \frac{1}{1 - R_k^2} \tag{6}$$

where R_k^2 is the coefficient of determination.

Parameter Estimation

Maximum Likelihood Estimation (MLE) is a method used to estimate the parameters of the logistic regression model by providing the estimated value of β by maximizing the likelihood function (Agresti, 2013). Here is the likelihood function for a sample with n random samples.

$$l(\beta) = \prod_{i=1}^{n} [\pi_1(x)^{y_i} \pi_2(x)^{y_i} \pi_3(x)^{y_i}] \tag{7}$$

with *i* = 1, 2, ..., J. From the likelihood function, the ln-likelihood function is obtained as follows:

$$L(\beta) = \sum_{i=1}^{N} y_i \ln[\pi_1(\boldsymbol{x})] + y_i \ln[\pi_2(\boldsymbol{x})] + + y_i \ln[\pi_3(\boldsymbol{x})] \tag{8}$$

The Maximum *ln-likelihood* is obtained by differentiating L(*β*) against β_k and equating to zero. The Newton Raphson iteration formulation is as follows:

$$\beta^{(t+1)} = \beta^{(t)} - \left(H^{(t)}\right)^{-1} q^{(t)} \tag{9}$$

with t it is 1st, 2nd, …………t iteration
where,

$$\boldsymbol{q}^{(t)} = \left(\frac{\partial L(\beta)}{\partial \beta_1} \frac{\partial L(\beta)}{\partial \beta_2} \frac{\partial L(\beta)}{\partial \beta_3} \frac{\partial L(\beta)}{\partial \beta}\right)^T$$

$$\boldsymbol{H}^{(t)} = \begin{pmatrix} \frac{\partial^2 L(\beta)}{\partial \beta_1^2} & \frac{\partial^2 L(\beta)}{\partial \beta_1 \partial \beta_2} & \frac{\partial^2 L(\beta)}{\partial \beta_1 \partial \beta} \\ \frac{\partial^2 L(\beta)}{\partial \beta_1 \partial \beta_2} & \frac{\partial^2 L(\beta)}{\partial \beta_2^2} & \frac{\partial^2 L(\beta)}{\partial \beta_2 \partial \beta} \\ \frac{\partial^2 L(\beta)}{\partial \beta_1 \partial \beta_2} & \frac{\partial^2 L(\beta)}{\partial \beta_2 \partial \beta} & \frac{\partial^2 L(\beta)}{\partial \beta \partial \beta} \end{pmatrix}^T$$

Newton-Rapshon will stop when $||\beta^{(t+1)} - \beta^{(t)}|| \leq \varepsilon$.

Testing the Significance of Parameters

After obtaining the model from parameter estimation, the next step is to test the significance of parameters both simultaneously and partially (Hosmer et al., 2013).

a. Simultaneous Testing

Simultaneous testing is carried out to check the significance of the β coefficient as a whole, with the following hypothesis:
Hypothesis:
H_0: $\beta_1 = \beta_2 = ... = \beta_k = 0$
H_1: minimum by one $\beta_k \neq 0$, k = 1, 2, ..., p
Test statistic:

$$G^2 = -2ln\left[\frac{\left(\frac{n_1}{n}\right)^{n_1}\left(\frac{n_2}{n}\right)^{n_2}\left(\frac{n_3}{n}\right)^{n_3}}{\prod_{i=1}^{n}(\pi_1(\mathbf{x})^{y_i}\pi_2(\mathbf{x})^{y_i}\pi_3(\mathbf{x})^{y_i})}\right] \tag{10}$$

where,

$$n_1 = \sum_{i=1}^{n} y_{1i}\ ;\ n_2 = \sum_{i=1}^{n} y_{2i}\ ;\ n_3 = \sum_{i=1}^{n} y_{3i}\ ;\ n = n_1 + n_2 + n_3 \tag{11}$$

Description:
n_1: the number of observation values Y = 1
n_2: the number of observation values Y = 2
n_3: the number of observation values Y = 3
n: number of observations

The G^2 test statistic is a likelihood ratio test, where G^2 follows the chi-square distribution so that H_0 is rejected if $G^2 > \chi^2_{(db, \alpha)}$ with db representing the number of parameters estimated in the model.

b. Partial Testing

Partial test is used to check the significance of β coefficient individually, with the following:
Hypothesis:
H_0: $\beta_k = 0$
H_1: $\beta_k \neq 0$, k = 1, 2, ..., p

The test statistic used is the Wald test statistic.

$$W = \frac{\hat{\beta}_k}{SE(\hat{\beta}_k)} \tag{12}$$

The Wald test statistic follows a normal distribution, so H_0 is rejected if $|W| > Z_{\alpha/2}$ or $W^2 > \chi^2_{(db, \alpha)}$ where db is the number of independent variables.

Model Fit Test

This test is conducted to test whether the resulting model based on ordinal logistic regression is feasible. In other words, there is no difference between the observations and the possible predictions of the model. Testing the suitability of the model is done with the following hypothesis (Hosmer et al., 2013).
Hypothesis:
H_0: The model is appropriate (there is no significant difference between the observations and the possible predicted results of the model)
H_1: The model does not fit (there is a significant difference between the observations and the possible predicted results of the model).

Test statistics:

$$\hat{C} = \sum_{j=1}^{J} \frac{\left(O_j - n'_j \bar{\pi}_j\right)^2}{n'_j \bar{\pi}_j \left(1 - \bar{\pi}_j\right)} \tag{13}$$

Decision: Reject H_0, if $\widehat{C}_{hitung} > \chi^2_{(db;\alpha)}$ or *P-value* < a

Classification Accuracy

APER (Apparent Error Rate) is a value used to see the chance of error in classifying objects. The calculation of the APER value is (Johnson & Wichern, 2007).

$$APER = \frac{n_{12} + n_{13} + n_{21} + n_{23} + n_{31} + n_{32}}{n_{11} + n_{12} + n_{13} + n_{21} + n_{22} + n_{23} + n_{31} + n_{32} + n_{33}} \times 100\% \tag{14}$$

The Hit Ratio calculation is as follows.

$$Hit\ Ratio = \frac{n_{11} + n_{22} + n_{33}}{n_{11} + n_{12} + n_{13} + n_{21} + n_{22} + n_{23} + n_{31} + n_{32} + n_{33}} \times 100\% \quad (15)$$

RESULTS AND DISCUSSION

Data analysis of research on factors influencing people's consumption of moringa leaves in Surabaya City used primary data. Primary data was obtained by interview through questionnaires to the people of Surabaya. The methods used in the analysis were descriptive statistics and ordinal logistic analysis.

Descriptive Analysis

Respondents used in the study were 70 people with the classification of people who live in Surabaya City and consume moringa leaves. The following are the characteristics of respondents in this study. Description of the relationship between Consumption Pettern and Moringa Place.

Table 3 People who have their own moringa leaves / owned by neighbours, the consumption pattern of moringa leaves is in the good category. So, it can be concluded that moringa plants need to be cultivated in the yard to fulfil the availability of moringa leaves. At the same time, it will improve the moringa consumption pattern of the Surabaya community to be better and help supply to vegetable traders.

Table 3. Relationship between Consumption Pettern and Moringa Place

		Where to get Moringa				
Moringa Leaf Consumption Pettern		Own / Neighbour	Market	Shop	Vegetable Vendor	**Total**
	Enough	2	1	0	0	**4**
	Good	20	20	0	9	**49**
	Better	4	13	0	0	**17**
	Total	**26**	**35**	**0**	**9**	**70**

Table 4. Relationship between Consumption Pettern and Moringa Price

		Price Moringa			
Moringa Leaf Consumption Pettern		Expensive	Quite Expensive	Cheap	**Total**
	Enough	2	2	0	**4**
	Good	37	6	6	**49**
	Better	11	1	5	**17**
	Total	**50**	**9**	**11**	**70**

Table 4 explains that the relationship between moringa consumption patterns with the sufficient category is that most people think the price of moringa is cheap and quite expensive, the relationship between moringa consumption patterns with the good category is that the majority think the price of moringa is cheap, while the relationship between moringa consumption patterns with the better category is that the majority think the price of moringa is cheap. So, it can be concluded that moringa plants are plants with low prices. For this reason, moringa plants need to be innovated in processing moringa leaves so that they can follow the current food trend.

Table 5. Relationship between Consumption Pettern and Source of Information

		Source of Information			
Moringa Leaf Consumption Pettern		Directly	Communication Media	Social Media	**Total**
	Cukup	2	0	2	**4**
	Baik	41	5	3	**49**
	Lebih Baik	15	2	0	**17**
	Total	**58**	**7**	**5**	**70**

Table 5 explains that the majority of Surabaya people get information about processed moringa leaves directly or by word of mouth (*getok tular*). Whereas, Indonesian society is currently dominated by the age of 12 - 27 years (Indonesia Baik, 202) which is technology literate. So it is necessary to increase socialization in mass media (online).

Figure 2. Area Mapping by Gender

Figure 2 explains that the distribution of female respondents is evenly distributed around 6 - 8 people in each urban administrative village. Where, the number of respondents in each urban administrative village is the same, namely 10 respondents. So, the distribution of female and male respondents in each urban administrative village is the same.

Inferensial Analysis

Ordinal logistic regression has several stages in conducting, namely testing multicollinearity assumptions, parameter significance, determining the logit model, model feasibility test to model interpretation. The following are the results of the analysis of the data on the factors that influence people's consumption of moringa leaves.

1. Multicollinearities Test

Multicollinearity testing is used to see the independency between predictor variables. Where, variables are said to have no multicollinearity if the VIF value is < 10. The following are the results of testing the multicollinearity assumption in this study.

Table 6. Multicollinearities Assumption Test

Model	Collinearity Tolerence	Statistics VIF
Consumption Purpose	0,916	1,092
Availability of Moringa Leaves	0,868	1,152
Leaf Price	0,901	1,110
Source of Information	0,890	1,124

The variables influencing the consumption pattern of moringa leaves meet the required criteria based on the VIF and Tolerance values. This indicates that there is no multicollinearity among the predictor variables, which include Consumption Purpose, Availability of Moringa Leaves, Price of Moringa Leaves, and Information Sources, in the regression model. After confirming the absence of multicollinearity, we can proceed with testing the significance of the parameters

2. Testing the Significance of Parameters

Parameter significance testing is carried out simultaneously and partially to determine significant variables in factors that influence community consumption of moringa leaves.

a. Simultaneous Testing

Testing the significance of parameters simultaneously using model fitting information with the following results.

Hypothesis :

H_0 : β_1= β_2= β_3= β_4= 0 (Consumption Purpose, Moringa Leaf Availability, Price Moringa, and Information Source No Significant Effect on Moringa Leaf Consumption Patterns)

H_1 : $\beta_k \neq 0$ (One or more variables significantly affect Consumption Patterns)

Tabel 7. Simultaneous Testing

Model	-2 Log Likelihood	Chi-Square	df	P-*value*
Finish Model	42,298	21,127	8	0,007

Table 7 explains that the χ^2 by 21,127 is greater that the $\chi^2_{(8;0,2)}$ value of 15,507 and P-*value* of 0,007 less than α is 0,05. So it can be decide to Reject H_0. That is, there is at least one independent variabel that has a significant effect on the Moringa Leaf Consumption Pattern for the people of Surabaya City.

b. Partial testing

Partial parameter significance testing is carried out to determine what variables are included in the model using the results of parameter estimates. The following hypothesis is used in partial testing.

Hyphotesis :

H_0 : β_1= β_2= β_3= β_4= 0 (Consumption Purpose, Moringa Leaf Availability, Price Moringa, and Information Source No Significant Effect on Moringa Leaf Consumption Patterns)

H_1 : $\beta_k \neq 0$ (Consumption Purpose, Moringa Leaf Availability, and Information Source Significant Effect on Moringa Leaf Consumption Patterns)
where value k = 1,2,3,4

Table 8. Partial Testing

Variable	*Wald*	P-*value*	Desicion
$X_{1(1)}$	3,018	0,082	Agree H_0
$X_{1(2)}$	1,061	0,303	Agree H_0
$X_{2(1)}$	0,6	0,439	Agree H_0
$X_{2(2)}$	1,486	0,223	Agree H_0
$X_{3(1)}$	2,857	0,091	Agree H_0
$X_{3(2)}$	2,841	0,092	Agree H_0
$X_{4(1)}$	7,676	0,006	Reject H_0
$X_{4(2)}$	6,382	0,012	Reject H_0

Table 8 explains the Wald test statistic is compared to a critical value derived from the $Z_{\alpha/2}$, and decisions are made based on P-values when available. Provide a better connection between the test statistic and P-value interpretation for consistency. The results of partial parameter significance can be concluded that the influential predictor variables are the availability of moringa leaves in the unavailable category, Direct Information Sources, and Information Sources by Communication Media.

This test has different decisions between using test statistics and P-*value*. The test statistic is the value calculated based on the data, while the P-value is the limit set to determine whether to reject H_0 or not.

3. Model Logit

The logit model using significant independent variables on moringa consumption patterns is as follows.

Table 9. Estimation Parameter

Variable	Estimation	SE	Wald	df	P-value
$Y_{(1)}$	-0,367	0,9	0,167	1	0,683
$Y_{(2)}$	4,168	1,149	13,157	1	0,000
$X_{4(1)}$	3,098	1,139	7,396	1	0,007
$X_{4(2)}$	3,335	1,374	5,891	1	0,015
$X_{4(3)}$	-	-	-	0	

Using α of 0,05, the logit function is as follows :

1. Logit 1

$$g_2(x_{4(1)}) = 4{,}168 + 3{,}098X_{4(1)}$$

2. Logit 2

$$g_2(x_{4(2)}) = 4{,}168 + 3{,}335X_{4(2)}$$

Based on the logit function above, the cumulative probability model of moringa consumption patterns for each category is:

1. Leaf Consumption Pattern with Adequate Category

$$\pi_1(x) = \frac{exp\left(g_2\left(x_{4(1)}\right)\right)}{1 + exp\left(g_2\left(x_{4(1)}\right)\right)} = \frac{exp\left(4{,}168 + 3{,}098X_{4(1)}\right)}{1 + exp\left(4{,}168 + 3{,}098X_{4(1)}\right)}$$
$$= 0{,}9993 = 99{,}93\ \%$$

2. Leaf Consumption Pattern with Good Category

$$\pi_2(x) = \frac{exp\left(g_2\left(x_{4(2)}\right)\right) - exp\left(g_2\left(x_{4(1)}\right)\right)}{\left\{1 + exp\left(g_2\left(x_{4(2)}\right)\right)\right\}\left\{1 + exp\left(g_2\left(x_{4(1)}\right)\right)\right\}}$$

$$= \frac{exp\left(4{,}168 + 3{,}335X_{4(2)}\right) - exp\left(4{,}168 + 3{,}098X_{4(1)}\right)}{\left\{1 + exp\left(4{,}168 + 3{,}335X_{4(2)}\right)\right\}\left\{1 + exp\left(4{,}168 + 3{,}098X_{4(1)}\right)\right\}}$$
$$= \frac{382{,}659}{2597993} = 0{,}000147$$

3. Leaf Consumption Patterns in the Better Category

$$\pi_3(x) = 1 - \pi_1(x) - \pi_2(x) = 0{,}000551$$

The chances of people consuming enough moringa based on direct sources of information have the highest chance. So, the solution to solving problems regarding the popularity of moringa leaves into processed food ingredients with information sources both directly and by using mass media. Where at this time, the majority of Indonesian people are technology literate. These factors make it easy to restore the glory of moringa leaves as a food ingredient that has a million benefits (superfood).

4. Model Fit Test

The Goodness of Fit test, such as the *D* statistical test, is used to evaluate whether the model created aligns with the data. This test helps determine whether the ordinal logistic regression model used is a good model or not. Model suitability is used to determine whether the moringa consumption pattern model formed is suitable. The following is the hypothesis used :

Hyphotesis :

H_0 : The model is appropriate (there is no significant difference between the observation results and the possible predictions of the model)

H_1 : The model does not fit (there is a significant difference between the observations and the possible predictions of the model)

Table 10. Model of Fit

	Chi-square	**df**	**P-*value***
Pearson	0,316	2	0,854
Deviance	0,559	2	0,756

The results of fit testing show that using α of 0.05, the decision Agree H_0 because the P-value is greater than 0.05. So, it can be concluded that the model is suitable or there is no significant difference between the observations and the model predictions.

5. Classification Accuracy

Classification accuracy is obtained by comparing the number of observations and predictions based on each category. The following comparison results of observations and predictions are shown in Table 11.

Table 11. Classification Acurancy

		Prediction			Total
		Good Enough	Good	Better	
Observation	Good Enough	0	4	0	**4**
	Good	0	49	0	**49**
	Better	0	17	0	**17**
	Total	**0**	**70**	**0**	**70**

Table 11 shows that the model formed still has a classification that does not match the observation with the prediction results. The pattern of moringa consumption in the good enough category between observation and prediction is not the same. This also applies to the pattern of moringa consumption in the better category. However, in the moringa consumption pattern with a good category between observations and predictions are the same. Based on Table 11, the accuracy of classification can be calculated as follows:

$$APER = \frac{n_{12} + n_{13} + n_{21} + n_{23} + n_{31} + n_{32}}{n_{11} + n_{12} + n_{13} + n_{21} + n_{22} + n_{23} + n_{31} + n_{32} + n_{33}} \times 100\%$$

$$APER = \frac{4 + 0 + 0 + 0 + 0 + 17}{70} \times 100\% = 30\%$$

$$Hit\ Rasio = \frac{n_{11} + n_{22} + n_{33}}{n_{11} + n_{12} + n_{13} + n_{21} + n_{22} + n_{23} + n_{31} + n_{32} + n_{33}} \times 100\%$$

$$Hit\ Rasio = \frac{0 + 49 + 0}{n_{11} + n_{12} + n_{13} + n_{21} + n_{22} + n_{23} + n_{31} + n_{32} + n_{33}} \times 100\% = 70\%$$

The Hit Ratio calculation explains that the regression model equation formed can classify in the estimation of Y, which is 70%. This means that the logistic regression equation model formed predicts the level of moringa consumption patterns by 70%. This figure shows that the model is quite good, but there are still 30% of incorrect predictions. One of the contributing factors is that the predictor variables are less relevant, data mismatch, unbalanced data distribution. The way to overcome these causes is by adding new variables, balancing data, testing alternative models, and cross-validation.

CONCLUSION

The discussion of the factors that influence the consumption patterns of moringa leaves in Surabaya City using ordinal logistic regression analysis explained that the influential dependent variable is the source of information about moringa leaves. The model classification accuracy is 70%. This means that the model is able to predict correctly 70% of the total data tested. Classification accuracy is not always a benchmark for evaluating models. Especially if the data used has an unbalanced class distribution. This can be seen, in partial parameter testing where there are different decisions between using test statistics and P-*value*. And the significant level in this study uses 0.05, so researchers are willing to risk type I error. Type I error is rejecting H_0 even though H_0 is true. This figure shows that the model is quite good, but there are still 30% of incorrect predictions. One of the contributing factors is that the predictor variables are less relevant, data mismatch, unbalanced data distribution. The way to overcome these causes is by adding new variables, balancing data, testing alternative models, and cross-validation.(2012)(2023)

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