

Article

Assessing the Impact of Household Socioeconomic Factors on Clean and Healthy Living Behaviors with Binary Logistic Regression: A Study in Probolinggo Regency

Article Info

Article history :

Received September 17, 2024
Revised November 14, 2024
Accepted November 18, 2024
Published December 30, 2024

Keywords :

Clean and Healthy Living Behaviors, Socioeconomic Characteristics, Public Health

Moch Abdillah Nafis^{1*}, Destri Susilaningrum¹, Brodjol Sutijo Suprih Ulama¹, Dwi Endah Kusrini¹

¹Departement of Business Statistics, Faculty of Vocational, Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia

Abstract. CHLB is a measure of livability in society. A high CHLB indicates a society that lives well. However, there is a problem in the probolinggo district that needs more effective public health interventions because of the area's fast population growth and a noticeable increase in infectious diseases. The adoption of Clean and Healthy Living Behaviors (CHLB) by Probolinggo district is the main focus of this study to find out who is still living below the applicable eligibility standards. In order to minimize the spread of infectious diseases and enhance general public health in Probolinggo Regency, policymakers and healthcare professionals are anticipated to find great value in the study's findings. It also examines the use of binary logistic regression with binary transformation all categorical variables as a supplemental technique for managing complex data relationships and enhancing predictive accuracy. In addition to addressing the pressing issues in public health, this study advances our knowledge of the socioeconomic factors that influence health in rural Indonesia.

This is an open acces article under the [CC-BY](https://creativecommons.org/licenses/by/4.0/) license.



This is an open access article distributed under the Creative Commons 4.0 Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. ©2024 by author.

Corresponding Author :

Moch Abdillah Nafis
Department of Business Statistics, Institut Teknologi Sepuluh Nopember Surabaya, Indonesia
Email : manafis@its.ac.id

1. Introduction

The dynamics of society are becoming more and more dynamic, particularly in light of Indonesia's annual population growth [1-2]. From 2019 to 2020, Probolinggo Regency saw an increase of 57.15% [3]. Additionally, during the same period, the number of instances of infectious diseases such as tuberculosis (TB) increased by 4.51% and diarrhea increased by 0.54%, coinciding with the population

expansion [4]. Biological agents, like bacteria or viruses, cause infectious diseases rather than physical or chemical factors, like burns or poisoning [5]. Infectious disease examples include Dengue Hemorrhagic Fever (DHF), HIV/AIDS, and other diseases [6].

Probolinggo Regency shares borders with many other regions: Situbondo Regency and Jember Regency to the east, Probolinggo City to the north, Lumajang Regency and Malang Regency to the south, and Pasuruan Regency to the west [7-8]. Probolinggo Regency's health status, however, is still worse than that of its surrounding districts [9]. For instance, Probolinggo Regency had a greater percentage of HIV/AIDS patients—0.017%—than both Malang Regency (0.010%) and Pasuruan Regency (0.016%), as well as leprosy cases [8].

It is crucial to improve Probolinggo Regency's health conditions in order to keep up with the neighboring areas, as evidenced by the rise in infectious illness cases, which even surpass the numbers in the surrounding areas [10]. To actively improve the health conditions of the community, in addition to the effective, efficient, and focused management of the rise in infectious disease cases in Probolinggo Regency, community support is required [11]. Clean and Healthy Living Behavior (CHLB) is a crucial component that underpins these handling initiatives in this setting [12]. In order for CHLB to be an integral component of preserving general public health, it incorporates family and individual understanding of hygiene and health maintenance [11-12].

The goal of CHLB is to create CHLB households, which are defined as those that meet the ten requirements of CHLB in the home [12-13]. These requirements include air-drying bedding in the sun, opening doors and windows in the morning for natural lighting and air circulation, eating fruits and vegetables every day, keeping away from smoking, and consuming alcohol inside the home [14]. Engage in regular physical exercise, wash hands frequently with soap and water, use sanitary restrooms, get enough sleep each day, and avoid sharing toiletries with other people [15].

The classification approach can be used to determine how different socioeconomic factors within a household affect the CHLB of that household [16-17]. It is intended to offer a more comprehensive perspective on enhancing the welfare of the residents of Probolinggo Regency by looking at the elements that influence a household while adopting CHLB [16-18]. Data classification with non-linear relationships between dependent and independent variables can be handled by Logistic Regression [19]. A Classification Analysis of Multiple Sclerosis Diseases that Can Be Prevented with CHLB was discovered that researcher use SVM and logistic regression method to find accuracy and this study suggests that the Logistic Regression approach performs well in solving classification difficulties [20].

Through the integration of advanced machine learning algorithms with social, economic, and demographic data, this study aims to offer a more profound understanding of the intricate patterns that underlie the behavior of CHLB households [21].

2. Experimental Section

2.1. State of The Art

There are a number of pertinent linked research to take into consideration when examining the variables influencing the implementation of CHLB in Probolinggo Regency [22]. Prameswari examined the Probolinggo Regency's infectious disease trend pattern in a 2020 study was discovered that diarrheal illnesses predominated in the majority of the sub-districts, but there were also notable cases of leprosy and dengue in a few of them [23]. Poor CHLB implementation and the percentage of communities that do not fulfil sanitation criteria are indicators of low health conditions [12],[24]. By identifying the household socioeconomic variables that are suspected to affect CHLB in the residents of Probolinggo Regency, this study offers crucial information to promote the development of policies for managing infectious diseases in the region [23], [25].

2.2. Logistic Regression

Logistic regression is a statistical method used to find the relationship between response variables (Y) that have a categorical data scale (binaries, ordinal, nominal, and multinomial) and predictor variables (X) that are categorical or continuous [26]. Binary are only 2 answer options that classified as "successful" or "failed" which is notated 1 or 0 [26-28]. Ordinal are the graded categories for each choice, i.e. category 1 represents the lowest category, and category 5 is the highest category [26-28]. Nominal is a category that is entirely neutral and as an identity. Multinomial is a type of variable with more than 2 categories [26-28]. For the i -th observation of the sample ($i=1,2,\dots,n$), Y_i follows the Bernoulli distribution with parameters π_i , having the following probability functions [28].

$$f(y_i, \pi_i) = \pi_i^{y_i} (1 - \pi_i)^{1-y_i}; y_i = 0, 1$$

The logistic regression model of y expressed as a function of x is as follows.

$$\pi(x) = \frac{\exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_p x_p)}{1 + \exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_p x_p)}$$

This method will be suitable to determine the influence of household socioeconomic characteristics on the CHLB of the people of Probolinggo Regency, with the definition of "failed" being a household with poor CHLB, while the definition of "successful" is a household with good CHLB [29].

Research from Rima *et.al* (2024) used meta analysis to investigate the factors that influence the status of CHLB behavior [13]. The study found that the relationship between knowledge, attitudes and the role of health workers each has a relationship with clean and healthy living behavior (CHLB), although at a moderate level [13],[29]. The weak influence of research on each aspect can be caused by the limited number of samples and the data being highly and moderately heterogeneous [13], [30].

In this study, classification will be carried out using biner logistic regression. Biner Logistic Regression is an effective method for data classification, which can be applied to understand patterns in factors influencing the implementation of CHLB at the household level [20].

2.3. Literature Review

The following Table 1 gives a summary of all literature reviews relevant to this research.

Table 1. Literature Review

Title	Year	Method(s)	Insight(s)
Surveillance analysis of clean and healthy living Behavior (CHLB) in household settings: a case study In lam geu eu village, pekan bada subdistrict, aceh Besar regency [31]	2022	Surveillance Analysis	These results were used by researchers to describe the pattern of disease spread and socioeconomic characteristics
Analysis of Patterns of Trends in Infectious Diseases by District in Probolinggo Regency [23]	2022	Correspondence Analysis	
Clean and Healthy Living Behavior with the Incidence of Skin Disease [32]	2021	Description and Statistics of Non-Parametric Chi Quadratic Independency Test	These results were used by the researcher to relate the mapping results with the condition of CHLB in the research area

Title	Year	Method(s)	Insight(s)
Meta Analysis: Factors Relating to Clean and Healthy Living Behaviors (CHLB) [13]	2024	Meta Analysis	Relationship between knowledge, attitudes and the role of health workers each has a relationship with clean and healthy living behavior (CHLB), although at a moderate level.
Multiple Sclerosis Disease Classification Analysis Using Logistic Regression and SVM Algorithms [20]	2024	Logistic Regression, SVM	Utilization of classification methods in the application of CHLB research with machine learning

2.4. Methodology

This study used primary data in the form of a questionnaire distributed to 118 randomly selected households in Probolinggo Regency. The variables used in this study are the socioeconomic characteristics of the household and the CHLB score, where:

Y = 0: households with less-than-good CHLB (Accumulated CHLB score < 7)

Y = 1: households with good CHLB (Accumulated CHLB score \geq 7)

The highest score for the CHLB assessment of TB patient households was 10, which was determined by using 10 CHLB indicators for TB patient households. If a home meets the requirements to be classified as having good CHLB, it is assigned a number of 1, and if it meets the requirements to be classified as having poor CHLB, it is assigned a number of 0. Households are classified as less CHLB if the total indicator value is less than 7, or as having CHLB if the total indicator value is 7 or more, provided that the indicator for CHLB that is not met is one that may still be tolerated. The CHLB score is measured by 10 CHLB indicator questions. Score 1 for "yes" answers and 0 for "no". The accumulated CHLB score is matched with the CHLB classification according to the categorization. Here is the flowchart of this research.

It is known that the output of this research is F1-Score, Confusion Matrix, and Implementation based on the most significant variables positively or negatively. The variables used in this study are presented in Table 2.

Table 2. List of Variables

Variable	Definition
X ₁	Gender
X ₂	Subdistrict
X ₃	What is the head of household's highest level of education?
X ₄	What is the head of household's occupation?
X ₅	What is the monthly income of the head of household?
X ₆	How many household members are there?
X ₇	What infectious diseases do you know of? (Multiple answers allowed)
X ₈	In the past 6 months, has any household member been diagnosed with Dengue Fever?
X ₉	Has any household member ever been diagnosed with leprosy?
X ₁₀	Does any household member have a history of serious illness? (Multiple answers allowed)

Variable	Definition
X ₁₁	Have you ever heard of Clean and Healthy Living Behaviors (CHLB)?
X ₁₂	What is the source of clean water used for daily needs?
X ₁₃	What is the 3M in the 3M Plus program for eradicating mosquito larvae? (True/False)
X ₁₄	Do you always wash your hands with soap before eating and after using the toilet?
X ₁₅	Does your house have a family latrine?
X ₁₆	If yes, does your latrine have a septic tank?
X ₁₇	Does your family take measures to eliminate mosquito larvae in the household environment?
X ₁₈	What actions does your family take to eliminate mosquito larvae in the household environment? (Multiple answers allowed)
X ₁₉	How many meals do you have per day? (e.g., if 3 times a day, answer: 3)
X ₂₀	Has your family ever incurred debt to provide food?
X ₂₁	What is your family's habit of consuming the four healthy foods (staple foods, protein, vegetables, and fruits)?
X ₂₂	What is your family's habit in providing rice or staple foods?
X ₂₃	What foods are typically consumed daily by your family? (Multiple answers allowed)
X ₂₄	What is your family's habit in providing protein-rich foods?
X ₂₅	What type of fuel is used for cooking in your house?
X ₂₆	Does your family have a habit of drinking milk?
X ₂₇	Does any household member smoke?
X ₂₈	How many people smoke in your household? (e.g., if 2 people, answer: 2)
X ₂₉	Does anyone smoke inside the house?
X ₃₀	Have you ever received counseling on Clean and Healthy Living Behaviors (CHLB)?
X ₃₁	When was the last time you received counseling on Clean and Healthy Living Behaviors?
X ₃₂	Type of roof in your house
X ₃₃	Type of walls in your house
X ₃₄	Type of flooring in your house
X ₃₅	Ventilation in your house
Y	Do you know what Clean and Healthy Living Behaviors (CHLB) are? (Multiple answers allowed, cumulative of right answers)

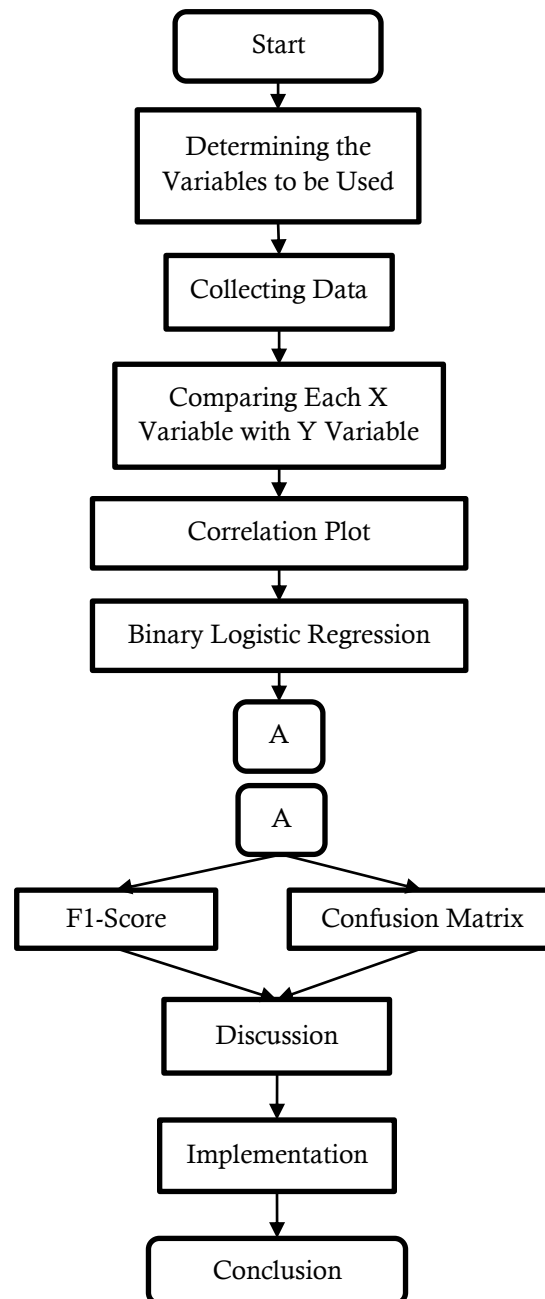


Figure 1. Flowchart

3. Results and Discussion

Researcher used logistic regression to examine the impact of household socioeconomic variables on clean and healthy living behaviors (CHLB) in Probolinggo Regency. The analysis used a series of predictor variables reflecting different socioeconomic aspects in order to classify households according to whether or not they display CHLB (dependent variable: Y). As indicated in Table 3, these predictor variables were classified as binary, multinomial, ordinal, and numeric kinds. To ensure compatibility

with the logistic regression, the data underwent preprocessing before being applied to the logistic regression modeling.

Table 3. Types of Variables

Type	Variables
Binary	X1, X10, X11, X14, X15, X16, X17, X20, X24, X26, X27, X29, X36
Multinomial	X12, X2, X25, X32, X33, X34, X4, X8, X9
Ordinal	X13, X18, X19, X23, X28, X6, X7
Numeric	X21, X22, X3, X31, X35, X5

Next, in order to evaluate the predictor variables associations and find any potential multicollinearity that might have an impact on the model's performance, researcher carried out diagnostic studies. Making a correlation plot (corrplot) to examine and quantify the degree of correlation between numerical data visually was one important diagnostic procedure. Researcher calculate the Pearson correlation coefficients for the numerical variables. The linear relationships between pairs of variables are numerically summarized in the correlation matrix, which has values ranging from -1 (perfect negative correlation) to +1 (perfect positive correlation). There is no linear relationship when the values are near to 0. Researcher used a correlation plot (corrplot), which offers a visual depiction of the correlation matrix, to help understand the correlations between the variables. Correlations were shown in the plot (see Figure 1). Researchers were able to swiftly spot clusters of strongly correlated variables due to this display, which may indicate problems with multicollinearity. No numerical variable in this instance displayed a strong correlation that could have an impact on the CHLB classification.

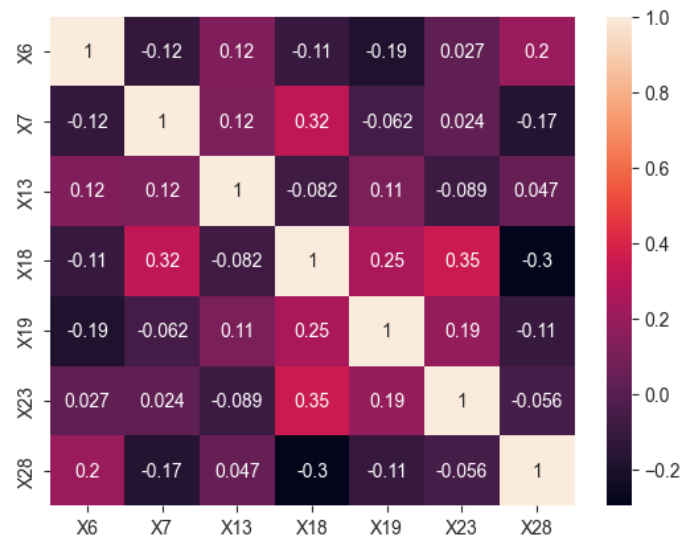


Figure 2. Correlation Plot

Before applying binary logistic regression, the data is separated into training data and testing data with a ratio of 70/30. Training data is used to perform binary logistic regression modeling, while testing data is used to evaluate the model formed and determine the accuracy of the model. Grid search with cross-validation was used to optimize the logistic regression model. The hyperparameter C was adjusted. This parameter manages the trade-off between correctly identifying the training data points and creating a smooth decision boundary. The model can match more complicated patterns with a large value of C, but overfitting is possible. There were six values tested: 1, 10, 100, 1000, 2500,

5000. Additionally, we tested various combinations of these parameters using 5-fold cross-validation, and we chose the combination that produced the greatest accuracy on the validation set. The entire training dataset was used to train the logistic regression with the ideal hyperparameters after it had been tuned. The best decision boundary that maximized the margin between homes that display CHLB and those that do not was identified by the logistic regression.

Based on the boxplot results of each X variable against variable Y, it is known that each X variable can distinguish categories in variable Y. According to the researcher, if the X variable used can distinguish categories in variable Y, then the variable can be used to classify variable Y. The classification method only distinguishes how the classification is formed and the level of accuracy obtained. Based on research [31] that not all CHLB criteria can be met in a region. Therefore, this research seeks to answer which criteria are the main reference in understanding CHLB based on various existing criteria.

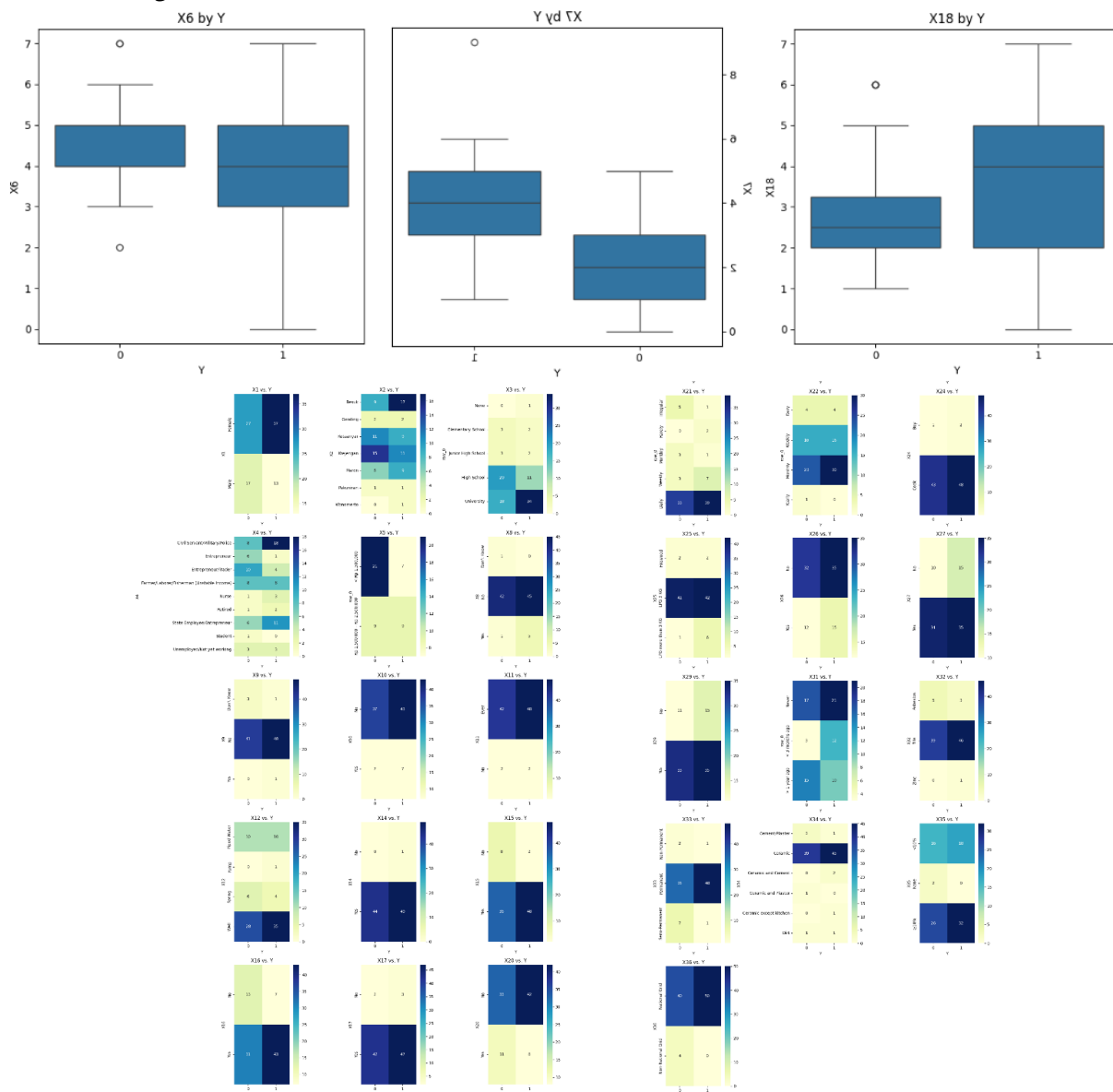


Figure 3. CHLB vs Other Variables

To assess its performance, the testing set was subjected to the trained logistic regression model. The model's efficacy was evaluated using F1 score metrics, which are the harmonic mean of precision and recall that can offer a balance between the two. Table 4 displayed the F1 score for the training and testing set. Based on the F1 results on CHLB data using the binary logistic regression method, it is known that the F1 value is quite high, which means that using the binary logistic regression analysis method can minimize false positives and false negatives. Researchers use the F1 score value because in the case of CHLB, researchers want to focus on both categories so that researchers can determine who needs assistance or socialization related to CHLB but also focus on people who are able to apply CHLB as a measure of the government's success rate in implementing CHLB in the community.

Table 4. F1 Score for Training and Testing Dataset

Training	Testing
70.769%	72.414%

Confusion Matrix was used to visualize the classification results and assess the true positive, false positive, true negative, and false negative rates for both training and testing set (see Figure 3).

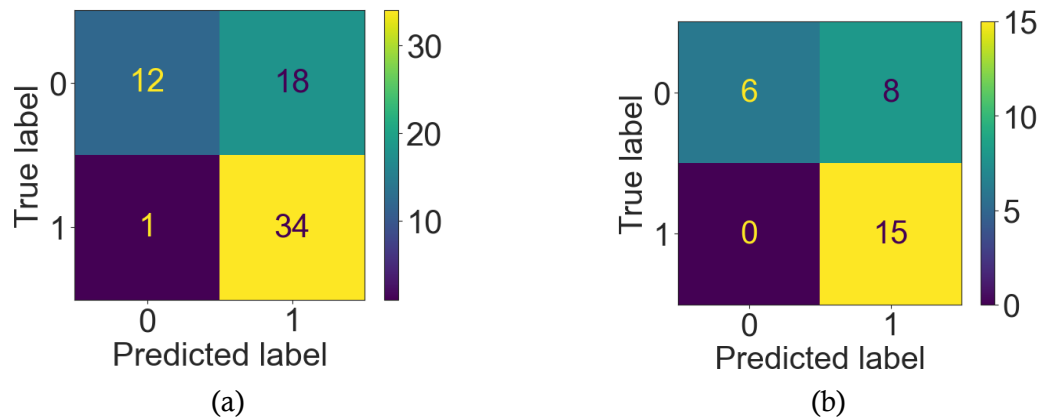


Figure 4. Confusion Matrix for (a) Training Dataset, and (b) Testing Dataset

Logistic Regression model performed well in identifying homes according to whether or not they were likely to engage in CHLB. The findings suggested that a number of socioeconomic characteristics significantly impacted the classification result. Logistic Regression successfully captured the non-linear relationship between these parameters and CHLB procedures. Additional information regarding the top 5s positives and disadvantages (refer to Figure 5 and 6).

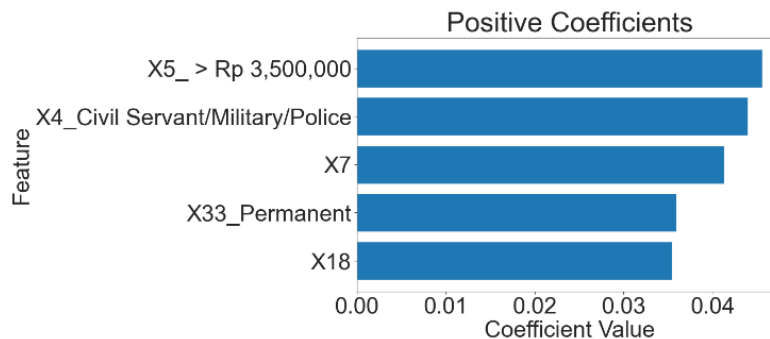


Figure 5. Top 5 Variables that Positively Influencing CHLB

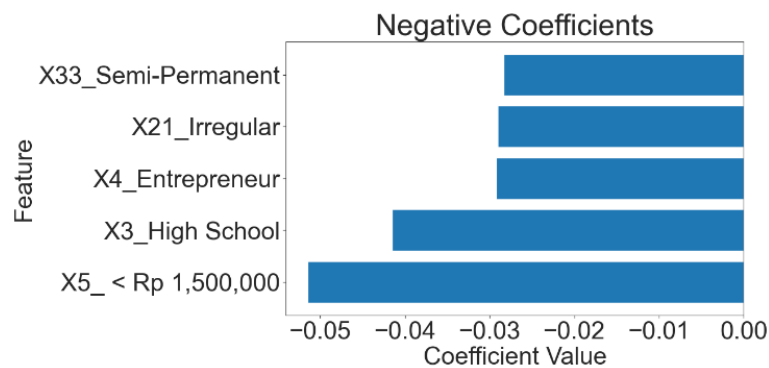


Figure 6. Top 5 Variables that Negatively Influencing CHLB

Based on research [13], it is known that the results obtained only apply in the area because there are differences in economic levels, culture, distribution of health facilities and schools in the area, so this research can only be applied in Probolinggo district. Based on the logistic regression results and comparison with previous research, the Probolinggo government could consider the following policy implications:

- Support for Households.** The "Household" variable (X4) shows the substantial positive influence on clean and healthy living behaviours. This suggests that house-hold roles and responsibilities play a vital part in promoting these behaviours. The government could support households by providing targeted community programs that raise awareness about clean and healthy living, particularly in household settings. Based on research [29], socioeconomics affects a person's mental health. Therefore, direct support is needed for people who have not been able to apply CHLB so that they avoid various diseases.
- Targeting Socioeconomic Groups.** Given the significance of variables related to income (X5) and Education (X3). Socioeconomic status, policies could target lower-income households and lower education with subsidies, training, or access to affordable solutions (such as water filters, clean cooking solutions, or regular health checkups). Socioeconomic status is an implication of the study because the class level of society can determine the intellectual level that affects a person's understanding of CHLB [16].
- Providing socialization for healthy food and proper living space assistance.** With the existence of healthy food variables (X21) and House Structure/Wall (X33), it is hoped that the government will not only provide socialization and assistance with money. But also in the form of knowledge and healthy habits by eating fruits and vegetables, as well as forming a movement to eat fruit / vegetables every day. Provide decent housing to families who have inadequate/semi-permanent homes. The importance of socialization earlier can be illustrated in research [12], which shows that socialization and healthy living guidelines bring good habits while implementing CHLB well. By focusing on these areas, the Probolinggo government could improve clean and healthy living behaviors throughout the region.

4. Conclusion

CHLB is an important basic need, as it can make life healthier, more vibrant, and avoid disease, Therefore, an appropriate classification is needed so that the entire community can implement CHLB. Based on the results of the analysis with the logistic regression model, it was found that there are several things that have a major impact on CHLB knowledge are residence, income, occupation, education, and knowledge of the disease. These five things represent the socioeconomic overview of the people. There are several ways that can be done to improve CHLB, namely support for households,

targeting socioeconomic groups, and providing socialization for healthy food and proper living space assistance.

5. Acknowledgement

This study received financial support from the Department of Business Statistics, Faculty of Vocational Studies, Institut Teknologi Sepuluh Nopember in 2024.

References

- [1] Serpa, S., Ferreira, C. M., Sá, M. J., & Santos, A. I. (2020). Digital society and social dynamics. *Digital Society and Social Dynamics*.
- [2] BKKBN (2024). *Indonesian Population Report 2023*. Directorate of Population Impact Analysis BKKBN.
- [3] BPS Probolinggo District (Accessed: Sep. 08, 2024.). Population of Probolinggo Regency per Subdistrict - Statistical Tables. Available: <https://probolinggokab.bps.go.id/id/statistics-table/2/MTI0IzI=/jumlah-penduduk-kabupaten-probolinggo-per-kecamatan.html>
- [4] Baker, R. E., Mahmud, A. S., Miller, I. F., Rajeev, M., Rasambainarivo, F., Rice, B. L., ... & Metcalf, C. J. E. (2022). Infectious disease in an era of global change. *Nature Reviews Microbiology*, 20(4), 193-205.
- [5] Paul, J. (2024). Introduction to Infectious Diseases. In *Disease Causing Microbes* (pp. 1-63). Cham: Springer International Publishing.
- [6] USAID (2022). A Story to Tell Better Health in Latin America and the Caribbean. U.S. Agency for International Development.
- [7] BPS. (2024). Probolinggo Regency in Figures 2024. BPS Catalog 1102001.3513
- [8] East Java Health Department. (2020). *East Java Health Profile Year 2020*. (Accessed: Sep. 08, 2024). [Online]. Available: <https://dinkes.jatimprov.go.id/userfile/dokumen/PROFIL%20KESEHATAN%202020.pdf>
- [9] BPS (Accessed: Sep. 08, 2024). Probolinggo District Welfare Indicators 2023. Available : <https://probolinggokab.bps.go.id/en/publication/2023/11/09/b12483f19ea34efef68caefd/in-dikator-kesejahteraan-rakyat-2023-kabupaten-probolinggo.html#:~:text=The%20publication%20of%20%22Probolinggo%20Regency%20People's>
- [10] Wicaksono, A., Sholahuddin, A., & Widjajani, R. (2022). The Health Protocol in the Probolinggo District's Tourism Development. *Cross Current Int J Econ Manag Media Stud*, 4(4), 64-71.
- [11] Morales-Garzón, S., Parker, L. A., Hernández-Aguado, I., González-Moro Tolosana, M., Pastor-Valero, M., & Chilet-Rosell, E. (2023). Addressing Health disparities through Community participation: A scoping review of Co-creation in Public Health. In *Healthcare* (Vol. 11, No. 7, p. 1034). MDPI.
- [12] Hasyim, H., Purnomo, M. E., Adhitya, B. B., Fajar, N. A., & Cahyono, H. (2021). Community Empowerment To Improve Clean And Healthy Living Behavior [Chlb]: An Action Research. *International Journal Of Community Service*, 1(3), 358-364.
- [13] Sari, R. P., Husaini, H., Suhartono, E., Arifin, S., & Febriana, S. K. T. Meta Analysis: Factors Relating to Clean and Healthy Living Behaviors (CHLB). *Jurnal Berkala Kesehatan*, 10(1), 62-69.
- [14] National Environment Agency (Accessed: Oct. 5, 2024). Updated Guidance on Improving Ventilation and Indoor Air Quality in Buildings for a Healthy Indoor Environment. <https://www.nea.gov.sg/our-services/public-cleanliness/environmental-cleaning-guidelines/advisories/guidance-on-improving-ventilation-and-indoor-air-quality-in-buildings-for-a-healthy-indoor-environment#:~:text=Keep%20windows%20and/or%20doors%20open%20at>

- [15] Bull, F. C., Al-Ansari, S. S., Biddle, S., Borodulin, K., Buman, M. P., Cardon, G., ... & Willumsen, J. F. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *British journal of sports medicine*, 54(24), 1451-1462.
- [16] Antonoplis, S. (2023). Studying socioeconomic status: Conceptual problems and an alternative path forward. *Perspectives on Psychological Science*, 18(2), 275-292.
- [17] Were, V., Foley, L., Turner-Moss, E., Mogo, E., Wadende, P., Musuva, R., & Obonyo, C. (2022). Comparison of household socioeconomic status classification methods and effects on risk estimation: lessons from a natural experimental study, Kisumu, Western Kenya. *International Journal for Equity in Health*, 21(1), 47.
- [18] Ruja, I. N., Sumarmi, & Idris. (2024). Programs, Opportunities, and Challenges in Poverty Reduction: A Systematic Review. *SAGE Open*, 14(2), 21582440241256242.
- [19] Starbuck, C. (2023). Logistic Regression. In *The Fundamentals of People Analytics: With Applications in R* (pp. 223-238). Cham: Springer International Publishing.
- [20] Laela, I. N. and Baihaqi, W. M. (2024). Classification Analysis of Multiple Sclerosis Disease Using Logistic Regression Algorithm and SVM, *Generation Journal*, vol. 8, no. 1, pp. 27–33.
- [21] Franklin, G., Stephens, R., Piracha, M., Tiosano, S., Lehouillier, F., Koppel, R., & Elkin, P. L. (2024). The Sociodemographic Biases in Machine Learning Algorithms: A Biomedical Informatics Perspective. *Life*, 14(6), 652.
- [22] Lewis, C. C., Boyd, M. R., Walsh-Bailey, C., Lyon, A. R., Beidas, R., Mittman, B., ... & Chambers, D. A. (2020). A systematic review of empirical studies examining mechanisms of implementation in health. *Implementation Science*, 15, 1-25.
- [23] Prameswari, Odellia Eka. (2022). Trend Pattern Analysis of Communicable Diseases by Subdistrict in Probolinggo Regency in 2020, *Final Assignment ITS*.
- [24] Kanda, A., Ncube, E. J., & Voyi, K. (2021). Effect of sanitation interventions on health outcomes: a systematic review of cluster-randomized controlled trials in rural communities of low-and middle-income countries. *International Journal of Environmental Research and Public Health*, 18(16), 8313.
- [25] Levesque, A. R., MacDonald, S., Berg, S. A., & Reka, R. (2021). Assessing the impact of changes in household socioeconomic status on the health of children and adolescents: a systematic review. *Adolescent research review*, 6(2), 91-123.
- [26] Das, A. (2023). Logistic Regression. In: Maggino, F. (eds) *Encyclopedia of Quality of Life and Well-Being Research*. Springer, Cham.
- [27] Atanet, I. R., Sehy, V., Sieg, M., & März, M. (2024). The Identification of Guessing Patterns in Progress Testing as a Machine Learning Classification Problem.
- [28] Sen, Bodhisattva. (2020). *GU4204: Statistical Inference*. Columbia University.
- [29] Militao, E. M., Uthman, O. A., Salvador, E. M., Vinberg, S., & Macassa, G. (2024). Association between socioeconomic position of the household head, food insecurity and psychological health: an application of propensity score matching. *BMC Public Health*, 24(1), 2590.
- [30] Ernawati, K., Nadhifah, Q., Muslikha, A., Hidayat, M., Soesilo, T. E., Jannah, F., & Widiarti, D. (2021). Relationship of knowledge and attitude with food handling practices: A systematic review. *Int. J. Public Health*, 10, 336-347.
- [31] Idroes, G. M., Riski, F., Safira, M., Ulfa, N., Wahyu, R., & Yani, S. M. (2022). Surveillance Analysis Of Clean And Healthy Living Behavior (Chlb) In Household Settings: A Case Study In Lam Geu Eu Village, Peukan Bada Subdistrict, Aceh Besar Regency. *Transpublika International Research In Exact Sciences*, 1(3), 32-43.
- [32] Patmawati, P., and Herman, N. F. (2021). Clean and Healthy Living Behavior with Skin Disease Incidence, *Journal of Professional Nursing*, vol. 2, no. 1, pp. 15–24.