



# Analysis of the Predicted Number of HIV/AIDS Spreads in Sidoarjo Regency using Multiple Linear Regression Method

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**Abstract:** The Office of Communication and Information of East Java Province, which includes Sidoarjo Regency, is one of the data sources used to determine the fourth-highest number of HIV/AIDS cases in Indonesia. The aim of this study is to forecast an annual increase in the number of HIV/AIDS patients in Sidoarjo Regency. The Sidoarjo District Health Office is the private source of data used in this study. The information utilized spans the years 2020–2022, and it contains attributes with projected results of positive HIV/AIDS patients. The estimated number for 2023 is 795,667; for 2024, it is 934,167; and for 2025, it is 1072,667. Because there are numerous attribute data sets obtained, quick miner processes the data using multiple linear regression as the chosen approach. The root mean squared error (RSME) validation test yielded a performance score of 0.816 for the multiple linear regression model, indicating that a smaller prediction result indicates greater validity.

**Keywords:** HIV/AIDS, Rapid Miner, Multiple Linier Regression, RSME.

## Introduction

HIV-AIDS is currently still a topic of health problems in the international and national community, especially in the world of health. The number of problems that hit the immune system is always increasing from year to year, because this disease has been found in various countries (Yuliza et al., 2019). Indonesia is the country with the fastest spreading HIV/AIDS virus in Asia. The HIV/AIDS epidemic exists in almost all provinces in Indonesia (Kasmawati, 2019). HIV/AIDS has no cure, but the government provides treatment to people with HIV/AIDS (people living with HIV) with ARV (antiretroviral) therapy (Riyatin et al., 2019).

HIV or Human Immunodeficiency Virus is a virus that affects white blood cells or lymphocytes located in the human body (Kurniawati, 2022). The role of white blood cells or what is called CD4 cells is to help fight the emergence of disease factors that enter the human body after HIV has hit the body's immune system or body and caused AIDS (Elisanti, 2018). The definition of Acquired Immune Deficiency Syndrome (AIDS) is a set of indications or diseases due to the weakening of the body's immune system caused by the HIV virus, which is the final session of HIV infection itself (Hidayati, 2019).

Indonesia is one of the countries that has the potential to experience an increase in the number of HIV/AIDS cases every year. The history of HIV/AIDS can be traced in AIDS data collection from 1987 to 2014 and for HIV from 2005 to 2014, in Indonesia there has been a significant increase, one of which is the number of HIV/AIDS sufferers in East Java, which has not been entirely found. This information is sourced from the Ministry of Health's SIHA (HIV/AIDS Information System) report data on the development of HIV/AIDS in the first quarter of 2022 which reported HIV/AIDS cases between January and March. Based on SIHA reports including 514 districts or cities in Indonesia and confirmed of 514 districts or cities, namely 502 districts or cities in Indonesia, including 10,525 people out of 941,973 people tested for HIV (RI, 2022).

Based on sources of information from the Information and Communication Office, East Java Province has the fourth highest number of HIV/AIDS cases in Indonesia. Surabaya City ranks first with the highest number of HIV cases, followed by Malang City and Sidoarjo Regency. The number of deaths from AIDS is also a determining factor in the increase, the impact that will occur if the government does not immediately overcome this is feared that in the future Indonesia will become one of the contributing countries most infected with HIV / AIDS infectious diseases (Noor et al., 2021). Based on data from the three regions in East Java, researchers are interested in studying HIV/AIDS cases in Sidoarjo Regency because 70% of men are infected and 30% of women. The 25% population group is male sex workers (MSM) with an average age between 25 years and 49 years. The source is according to the head of disease prevention and control of the Sidoarjo District Health Office in the rri.co.id news article.

The number of cases of a person contracting HIV / AIDS is mostly caused by blood transfusion, unsafe or heterosexual sex and drug use using unsterile needles or piercing alternately infected with HIV / AIDS will easily transmit it (Suzana Murni et al., 2015), as well as pregnant women infected with HIV / AIDS then the baby will also be infected with HIV / AIDS (Maya et al., 2019). HIV/AIDS will also be transmitted more easily if the immune

system is weak and otherwise people with HIV/AIDS are more likely to develop active TB (tuberculosis) and meet other people with active TB (tuberculosis) (Green, 2016). Most of the others are due to the economic condition of the population with less knowledge so that there is a lack of access to education and information obtained.

Based on this, the actual development of data technology at this time is very useful for all groups including the current world of health, so that information technology is currently one of the things that is very important today. Information technology can make it easier for people to find all information, so information technology can be implemented in various fields of medicine and health. Health is the most important aspect in every life, especially for young people who often arise in the current generation of promiscuity (Prakarsya & Prambayaun, 2020).

Previous research by Muhammad Zunaidi, et al. on the application of data mining to predict the development of the number of HIV / AIDS sufferers using the multiple linear regression method, explained that the results of this study are expected to help in predicting the development of the number of HIV sufferers so that it can be used in the necessary actions because every year the number of HIV / AIDS sufferers increases, indicating that the treatment provided is still not available (Zunaidi et al., 2020).

Based on the research of Agustian Prakarsya, et al. regarding the implementation of data mining to predict the spread of the HIV / AIDS virus in Bandar Lampung using the decision tree method, it explains that these results can be expected to analyze someone infected with HIV / AIDS because some people do not understand the dangers of the disease and can make it easier for health workers to find out someone who has HIV / AIDS with the development of information technology (Wijayadhi et al., 2023).

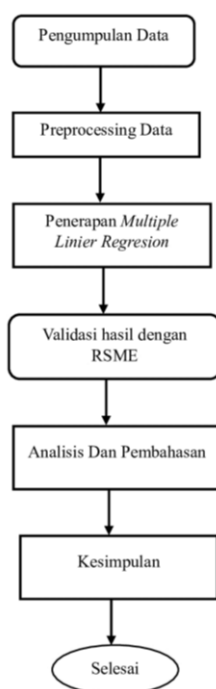
Based on the above problems, this study aims to take the right policy as early as possible to overcome the spread of HIV / AIDS, which continues to increase from year to year, by utilizing hidden information in the dataset which is then used to predict the number of people living with HIV / AIDS using multiple linear regression models (Purnama et al., 2021).

## Methodology

This research was conducted using quantitative methods, using the causal variable X, namely the number of people who tested positive for TB (tuberculosis) symptoms, the number of HIV/AIDS positive men, the number of HIV/AIDS positive women and the effect variable Y, namely the number of HIV positive patients in the period 2020-2022 for predicting the number of each year. In this study, data mining with multiple linear regression models was used to help predict the increase in the number of HIV/AIDS sufferers in the Sidoarjo Regency area. The data to be processed is by collecting raw data at the Sidoarjo District Health Office, where this research can be developed to help the government make predictions of HIV/AIDS rates in Sidoarjo district, East Java Province, which has the potential for HIV/AIDS (Purnama et al., 2021). The steps in this research are as follows:

## Data Mining Stages Process

In predicting data on the number of HIV/AIDS, the data will be tested against the data model that will be used to make it easier for researchers to implement and operate in carrying out processing, and run as desired. Therefore, the steps or stages of this research are carried out as follows (Wijayadhi et al., 2023):



**Figure 1.** Stages of processing research data

## Data Preprocessing

Preprocessing is the first step in data processing to ensure that the method used works properly. At this stage, data cleaning procedures are carried out to eliminate unnecessary information during preprocessing (Herwanto et al., 2019a).

## Data Mining

In this research, the data mining step used is multiple linear regression. The data used in this study comes from the Sidoarjo District Health Office which is private (Faria, 2019). The data obtained will be standardized according to the data mining steps so that the data is feasible and can be processed using rapid miner with multiple linear regression method (Dupont, 2020). The definition of data mining itself is one of the data exploration processes that is able to predict and extract consistent patterns using strategies such as learning algorithms with artificial intelligence (AI), or classification in statistics that can reveal hidden relationships and accurate data. Data mining application is a health information system in public and private environments that goes through a process of selection, preprocessing and data transformation that can discover patterns and generate knowledge through interpretation of the processed data (Pinheiro et al., 2021).

## Multiple Linier Regression

Multiple linear regression is an evolution of the simple linear regression model which includes one independent variable and one dependent variable. Multiple linear regression uses more than one variable ( $X_1, X_2, \dots$ ) and one dependent variable ( $Y$ ). Adding independent variables, the general form of the multiple linear regression equation includes two or more independent variables (Lusiana et al., 2021). The collection of attributes obtained by multiple linear regression can be formulated as follows:

The calculation of multiple linear regression for the two independent variables can be seen below:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + e$$

$$Y = a + a_1 X_1 + b_2 X_2 + \dots + b_n X_n \dots$$

Where:

$\hat{Y}$  = dependent variable (predicted value)

$a$  = constant

$b_1, b_2, \dots, b_n$  = estimates for constant parameters  $\beta_1, \beta_2, \dots, \beta_k$

$X_1, X_2, \dots, X_n$  = regression coefficients

The purpose of linear regression analysis is to measure the intensity of the relationship between two or more variables and include prediction/estimation of  $Y$  values and  $X$  values (Puteri & Safitri, 2020).

## Evaluation and Results

RMSE (root mean square error) is the sum of the squared error or difference between the actual value and the predicted value, then divide the sum by the number of times the data is predicted, then take the root. If the RMSE value is smaller, the model or variable prediction is valid, while if the RMSE value is large, the accuracy of the resulting value will not be accurate. The RMSE value can be formulated as follows (Normah et al., 2022):

$$RMSE = \sqrt{\sum_{i=1}^n (y_i - \hat{y}_i)^2}$$

## Result and Discussion

The implementation process of multiple linear regression to predict the number of HIV/AIDS positive patients in Sidoarjo Regency with datasets taken from the previous 3 years, namely 2020-2022 (Elaiw, 2020). The data received is calculated beforehand, from the results of the data obtained based on the summation of 4 evaluative variables that predict the number of HIV/AIDS positive men, predict the number of HIV/AIDS positive women, predict the number of HIV/AIDS with tuberculosis symptoms, predict the number of HIV/AIDS positive patients (Indriani et al., 2022). The following are the steps:

### Data Collection

The data used is private and obtained from the Sidoarjo District Health Office, this data consists of 4 attributes.

## Preprocessing Data

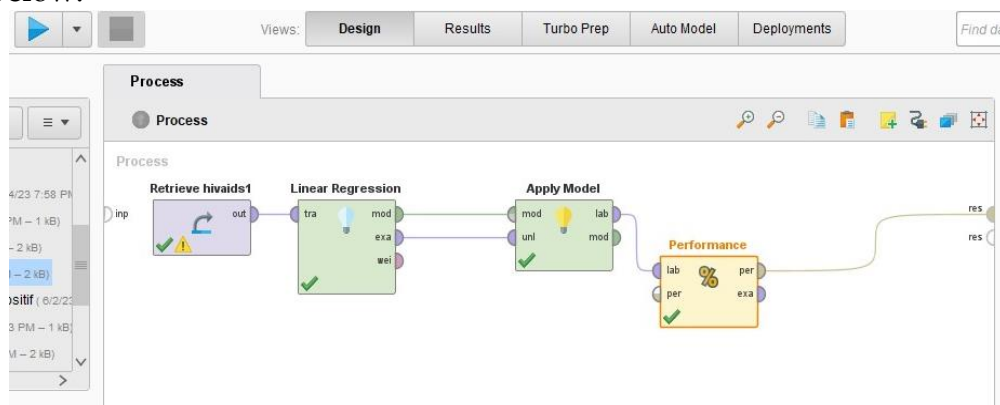
The data obtained is processed using rapid miner software. The data inputted in rapid miner is in excel / csv form, then enter the data model in the operator, namely apply the model whose purpose is to predict testing data that does not yet have a label (Anjelita et al., 2020).

**Table 1.** Data HIV/AIDS

Tahun	Jumlah positif gejala TB (tuberkulosis)	Jumlah positif laki-laki	Jumlah positif perempuan	Jumlah penderita HIV positif
2020	63	280	129	409
2021	70	328	133	461
2022	25	475	211	686

Source: Sidoarjo District Health Service, 2020-2022

Based on Table 1, the number of people infected with HIV who tested positive during the 2020-2021 period shows that the number of positive HIV/AIDS patients in Sidoarjo Regency increases every year (Harsiti et al., 2022). In processing data testing can be seen in Figure 1 below.



**Figure 1.** Testing model process

## Test and Evaluation Process

Testing is done by importing existing test data and data entry. The results of predictions made using the rapid miner application from testing test data using linear regression models can be seen in table 3.2. The prediction results of the processed data provide the coefficient value of each attribute entered.

**Table 2.** Coefficient and attribute values

Atribut	Coefficient
HIV positive with symptoms of TB (tuberculosis)	52.667
Male gender	97.500
Female gender	41.00
Number of HIV positives	138.500

Based on the attribute of positive HIV with TB (tuberculosis) symptoms, the coefficient is 52.667, for HIV/AIDS positive male gender the coefficient is 97.500, while for female gender it is 41.00, and for the total number of positive HIV/AIDS with a coefficient of 138.500. The relationship coefficient is used to measure the strength of the relationship between several variables, so that the relationship coefficient can be used using correlation analysis (Pada et al., 2021). Correlation can be positive, negative, or no correlation. The positive correlation of the independent variable is related to the dependent variable, where the value of the positive correlation is close to 1 or 1. The negative correlation of the independent variable is related to the dependent variable with a negative correlation value close to -1 or -1. In correlation, no correlation is equal to 0 (Normah et al., 2022). The table below shows the prediction results for each attribute tested.

**Table 3.** Results from positive prediction data for men and women

Tahun	Number of positive men	Prediction of positive number of men	Number of positive women	Prediction of positive number of women
2020	280		129	
2021	328		133	
2022	475		211	
2023		556,000		239,667
2024		653,500		280,667
2025		751,000		321,667

Based on Table 3, it can be seen that the test results predict the number of HIV-infected men in 2023 as many as 556,000 people and the number of HIV-positive women as many as 239,667 people, it can be concluded that HIV/AIDS sufferers in Sidoarjo Regency are mostly male. The prediction of the number of HIV/AIDS positive patients with TB symptoms can be seen in label 3.4.

**Tabel 4.** Prediction of the number of positive TB symptoms

Year	Number tested positive for TB symptoms	Prediction of the number of people who test positive for TB symptoms
2020	63	
2021	70	
2022	25	
2023-2025		52,667

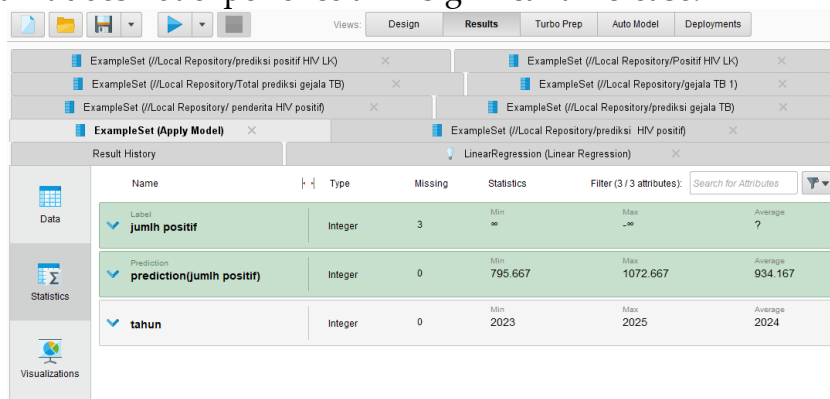
Furthermore, the results processed from the number of positive TB (tuberculosis) symptoms are predicted from year to year will remain the same and will even decrease, because it returns to the symptoms experienced by sufferers that those affected by TB symptoms will not necessarily be positive for HIV / AIDS (Ma, 2020).



**Tabel 5.** Predict the number of HIV positives

Year	Number of HIV positives	Predict the number of HIV positives
2020	409	
2021	461	
2022	686	
2023		795,667
2024		934,167
2025		1072,667

Based on Table 5, the results of the calculation of the prediction of the number of HIV / AIDS obtained in 2023 are predicted to be 795,667, in 2024 it is predicted to be 934,167, while in 2025 it is predicted to be 1072,667. The above amount is a prediction of the next year's calculation which occurs in Sidoarjo district from the data obtained that the year 2020-2022 continues to increase, it will be predicted that every year the number of HIV/AIDS increases that occur tends to increase from year to year (Gartner, 2020; Imle, 2019). Therefore, from the predictions tested, it can follow up again from the top officials so that from year to year it does not experience an insignificant increase.

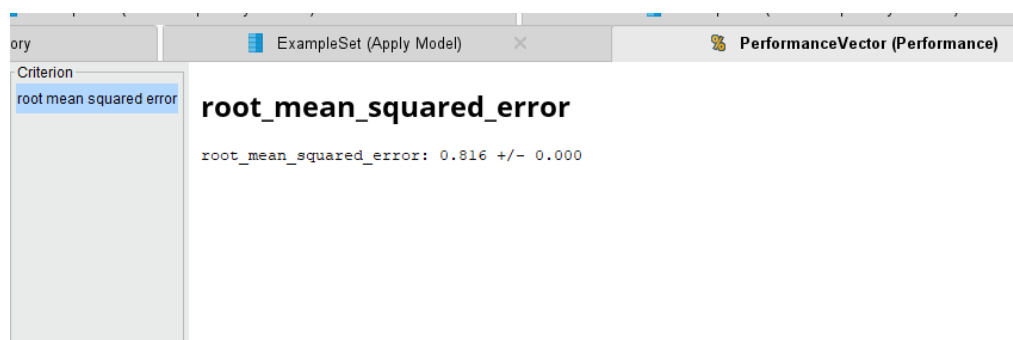
**Figure 2.** Plot view of the number of positive HIV/AIDS predictions

Based on the results of the plot view of the predicted number of HIV positives from 2023-2025 tends to increase from year to year (Herwanto et al., 2019b). This increase in HIV / AIDS if there is no change in handling it and public ignorance in the material of this infectious disease, the predicted increase in HIV / AIDS from year to year will continue to increase.

### Evaluation of RMSE Results

Calculation of RMSE (root mean squared error) with a value of 0.816. Based on Figure 3 shows a small value or close to 0, it is the result of the linear regression model performance test process, it can be concluded that the RSME value is the more accurate the prediction value (Ratmann, 2019).





**Figure 3.** Root mean squared error performance test results

## Conclusion

Data mining can be used to support the policy development process. One of the models used is predicting using multiple linear regression with the results of attributes using as many as 4 attributes. Based on the data that has been processed and analyzed using the multiple linear regression method, it is known that HIV/AIDS cases that occur in Sidoarjo Regency are expected to continue to increase every year and are often more prevalent in men than women. The performance of the multiple linear regression model is calculated using the root mean squared error, resulting in a value of 0.816. The results of this study can be a recommendation or input for the Sidoarjo District Health Office to make it easier to estimate or estimate more data when using linear regression so as to minimize HIV/AIDS in Sidoarjo District. For other studies, this research can be a reference to increase knowledge and deepen research and develop other methods with more data and compare with other studies so as to create new research. The disadvantage of this method is the use of one method model or functional model in prediction calculations. This will cause inaccuracies if there is a surge later.

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