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The Association Between Factors That Influenced Mortality Rate in Malaysia

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Abstract
In the era of globalization life expectancy in Malaysia is increasing. After the COVID-19 presence, the mortality rate is increase and it cause the life expectancy decrease. This is because COVID-19 has resulted in significant number of deaths worldwide, particularly among older adults and individuals with underlying health conditions. To get an accurate life expectancy prediction, estimation on mortality rates is very important with the incorporation of several factors that contribute to the increment of death. Thus, this study aims to analyze the relationship between temperature, unemployment rate, education expenditure rate, economic growth rate, and the mortality rate in Malaysia. Other than that, there are many tests used like Pearson correlation test, normality test, variance test and autocorrelation test. The findings suggest that temperature has a significant association with the mortality rate in Malaysia. Higher temperatures are linked to an increased risk of mortality. Additionally, the study reveals that higher unemployment rates and lower education expenditure rates are associated with higher mortality rates, indicating the influence of socioeconomic factors on population health. Moreover, lower economic growth rates are found to be correlated with higher mortality rates, highlighting the importance of a thriving economy for overall well-being. In conclusion, this study utilizes multiple linear regression analysis to explore the association between temperature, unemployment rate, education expenditure rate, economic growth rate, and the mortality rate in Malaysia.

Keywords: mortality rate; test; multiple linear regression

1. Introduction

Many nations must deal with rapidly aging populations as life expectancy rises. The number of elderly persons is predicted to more than double globally between 2017 and 2050. The number of older people is increasing more quickly in less developed nations than in highly developed ones (World Health Organization, 2022). Similar demographic changes are expected to occur in Malaysia between 2020 and 2042, when the proportion of older individuals is expected to rise from 7 to 14% (Yee Mang Chan *et al.,* 2022). The loss of a job drastically worsens a person's condition in life (Hammarström, 1994). Numerous studies have found a higher risk of early mortality in the unemployed, although it is unclear what causes this link. Unemployment increases overall misery, worry, and depression, which may raise the risk of premature mortality in the long run (Margeratha et al., 2004). Extreme weather phenomena are expected to become more often in the future as a result of global climate change, affecting human health in a variety of ways (Vicedo-Cabrera et al., 2021). Economic growth is a common subject of debate among researchers. Basically, when the economy produces more product, the sales of business in that country will be profitable. Thus, it will encourage more foreign companies to invest more and the same time increase our foreign direct investment (FDI). Economic growth effects mortality rate. It has positive relationship on mortality rate (Raja & Amalina., 2017). For education expenditure rate it seems to have strong empirical relationship on mortality rate (Warren et al., 2020). This show that the education

expenditure has consequences on the mortality rate on that country.

A mortality rate is a measurement of how frequently people die within a given population during a certain period of time. It merely depends on what you want to measure illness or death because statistically, morbidity and mortality indicators are frequently equivalent. As we know, mostly researchers use simple linear regression to analyse the mortality rate but there are limitations on that model which is simple linear and can only have one variable or one factor for consideration. So, that model is not very accurate if we want to obtain the correlation between variables with mortality rate. Multiple linear regression can give the best solution or result rather than simple linear regression. It is because multiple linear regression can compare with each significance of variable with mortality rate. The data for the mortality rate is not linear. So, it is better and more suitable to use multiple linear regression model than simple linear regression. This study aims to analyse the response of rate of mortality due to temperature, unemployment rate, education expenditure rate and economic growth. In order to achieve this the Multiple linear regression model will be performed in this study.

The purpose of this study is to find ways to stop the mortality rate from increasing year after year. There are several elements that will determine or influence mortality. In addition to people having diseases, other factors can also have an impact on death rates in a nation. Extreme weather is another element that this study demonstrates can contribute to an increase in fatality rates. When there is extreme weather, more deaths may result. Flood is an example of the type of extreme weather that Malaysia is prone to (Fernando, 2022). The same is true of other elements including unemployment, educational costs, and economic expansion. All such factors may have an impact on the nation's rising death rate. It's because when individuals are unemployed, their conditions deteriorate and they are unable to buy food or drink, which means they will starve to death (Hammarström A, 1994). Even if the economy is now improving, people's lives are not. It's because those who are unemployed or have little funds are unable to make ends meet (Siti, 2021). The cost of education can also raise the mortality rate because if a student or family doesn't have enough money to cover their expenses, they won't be able to support their studies. Hence, all of those variables might raise the mortality rate. Many of these variables are thought to have little bearing on the nation, but if they persist without a significant improvement, things will get worse.

2. Literature review

Simple linear regression model is the simplest model for the regression. One dependent variable and one independent variable are present (Andriy, 2022). If it has an independent variable, this model is applicable. While it can provide data's skewness, correlation, and significance, it is not particularly accurate because it only uses one variable. Simple linear can get the estimation result and forecasting result. It is more suitable use for linear data and easier to use than another model. To investigate potential relationship between dependent variable and independent variable, scatterplot can be utilized. The linear relationship between the dependent variable and independent variable is measured by correlation. The correlation will be near zero if the relationship is curvilinear (JMP, 2023).

The Health Information Centre, Putrajaya (PIK) compiled daily mortality statistics from ten hospitals between 2006 and 2015. Prior to the data gathering, Ministry of Health's Medical Research Ethics Committee gave its approval. Based on the Tenth Revision of the International Classification of Diseases and Related Health Problems, the mortality data was divided into three cause-specific categories. Between the years of research (2006–2015), 69,542 natural fatalities were reported, of which 15,581 and 10,119 were due to cardiovascular illness and respiratory disease, respectively. Natural fatalities accounted for 18.9 deaths per day on average, cardiovascular deaths for 4.3, and respiratory deaths for 2.9. The finding from this study indicates that there is a nonlinear link between temperature and mortality, with high temperatures in the Klang Valley considerably ($p<0.05$) increasing the probability of fatality. The association between temperature and mortality in this study was discovered to be similar with earlier research conducted in other Southeast Asian nations. Greater relationships between high temperatures and respiratory death in the analysis of cause-specific mortality compared to natural and

cardiovascular mortality was found. This result is in line with past research that found that exposure to high temperatures can worsen people with chronic respiratory disorders' lung function and cause them to pass away.

The correlation between unemployment and mortality are the regular topic in health unemployment research. The relationship between unemployment rate and mortality rate have different correlation, either positive, negative or inconsequential correlations (Gravelle 1984). Although this relationship has flexible relationship. It is because depending on circumstances, whether short term or long term (Forbes &McGregor 1987). The unemployment is associated with an increased risk of early death. So, that shows the unemployment can influence the increasing of mortality rate (Voss et al., 2004).

There are a lot of individuals without jobs in this century. It's because most businesses now don't need to hire extra employees. If every corporation in the nation desired it, the unemployment rate would rise year after year. Following then, it may result in a continuing rise in mortality rates.

The form of money and time is an investment in human capital on education (Alvarado et al., 2021). Spending money on education can make mortality rate increase. Education expenditure is will increase depends on what education they sit. Higher the education they take, higher their spending money. Education expenditure has relationship on mortality (Kim & Lane, 2013). When a student receives a scholarship and doesn't perform well on their final test, they risk losing their scholarship, the system can notice this. Following that, they are left with no money to cover their expenses. Because they are unable to pay the payment, they will experience despair.

Education is the most crucial factor for the future, other from that. Not saying that, did not obtain better life or career, but if has strong education, possibility to acquire better workplace is higher. Individuals in modern generation need money to live. However, if a person does not find a better job, it may lead them to feel stressed and exhausted since they will need to work many jobs each day in order to live over the long run. So, that show the relationship of education expenditure on mortality rate is strong.

An important factor in the economic development of a country is economic growth (Elistia & Syahzuni, 2020). People will prioritize their life or will use all energy for completing work to earning income (Adijem & Alimi, 2021). It demonstrates that individuals did not care about their health. Those who are overworked may become ill as a result. Long-term benefit cannot be expected from this conduct. If a person has always been ill, they are more likely to fall seriously ill and come to an end. According to that show, the death rate would rise if the economy keeps growing without regard for people's health. For example, as a contactor building. They have to work day and night. If this happened every day and less rest in day, it will cause many people die because of not enough rest. The relationship between economic growth and mortality rate has a positive relationship (Coccia, 2021).

The fundamental benefit of multiple linear regression is that it takes several factors into account when analyzing data. It examines the different independent factors that have an impact on the dependent factor. There will always be errors, but by taking into account all the factors that may affect your data, you are less likely to overlook anything or draw the wrong conclusion (Adobe, 2022).

Since the COVID-19 pandemic began in India, some states like Punjab and Maharashtra have consistently had a higher number of deaths compared to the confirmed cases. On the other hand, states like Kerala and Assam have seen fewer deaths in proportion to the cases. It's important to figure out why the COVID-19 death rates vary among Indian states and union territories. This will help the government and other organizations make better policies and guidelines to reduce the number of COVID-19 deaths (Chatterjee and Sarkar, 2021).

In the analysis conducted by Chatterjee and Sarkar, they found that the healthcare capacity was significantly negatively correlated with case fatalities, whereas civil society variables and health expenses were statistically insignificant but positively correlated with case fatalities (Chatterjee and Sarkar, 2021). This implies that areas with better healthcare capacity tended to have lower fatality rates. Additionally, Banik et al. conducted a study across 29 countries to analyze various factors that affect COVID-19 fatality rates. Their findings revealed that BCG vaccination, poverty, age structure, and the strength of the public health system were significant factors influencing fatality rates (Banik et al,. 2020).

3. Materials and methods

For this study, the analysis is based on the annually data in the range 1980 to 2021. All of the data were retrieved from Department of Statistics Malaysia (DOSM) and Macrotrends. The Multiple Linear Regression model for this study is specified as follows:

$$\ln y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \alpha$$

where the dependent variable is, $\ln y$ is the linear function of k, x_1 represent of first factor which is temperature of weather, x_2 represent the second factor which is unemployment rate, x_3 represent for education expenditure rate, x_4 represent of economic growth, plus random errors, α. Meanwhile, β_0 denotes on the intercept of the linear regression line and β_1, β_2, β_3, β_4 are the coefficient of temperature of weather, unemployment rate, education expenditure rate and economic growth respectively.

Analysis that be use are hypothesis, Pearson correlation coefficient, Jarque-Berra test, Breusch-Pagan test and Durbin-Watson test. The Pearson correlation coefficient, denoted as *r*, measures the strength and direction of the linear relationship between two variables. Other than that, Jarque-Berra test is use in this study because want to check the normality of the model. Moreover, Breusch-Pagan test is used to assess the presence of heteroscedasticity in a regression model, which means the variance of the residuals may vary across the range of the predictor variables. Last but not least, Durbin-Watson test is used to detect the presence of autocorrelation in the residuals of a regression model. Autocorrelation occurs when there is a correlation between the residuals at different time points.

4. Results and discussion

The correlation coefficient, abbreviated as *r*, indicates the degree of linear dependence between two variables. A positive value of *r* (ranging from 0 to 1) indicates a positive correlation, implying that as one variable increases, the other tends to increase as well. In contrast, a negative value of r (ranging from 0 to -1) indicates a negative correlation, showing that as one variable increases, the other tends to decrease.

Table 1: Result of Pearson correlation

Age	Temperature	Unemployment	Education	Economic
0	-0.4999	0.3945	-0.1548	0.3252
5	-0.2667	-0.0220	-0.1325	0.3308
10	-0.2512	0.0495	-0.1238	0.3261
15	-0.2376	0.0740	-0.1177	0.3223
20	-0.2212	0.0921	-0.1172	0.3169
25	-0.1949	-0.1223	-0.1229	0.3150
30	-0.1591	-0.1676	-0.1219	0.3078
35	-0.1173	-0.2216	-0.1171	0.2981
40	-0.0757	-0.2812	-0.1061	0.2862

45	-0.0440	-0.3234	-0.0920	0.2715
50	-0.0129	-0.3602	-0.0875	0.2615
55	0.0209	-0.4011	-0.0794	0.2486
60	0.0549	-0.4415	-0.0699	0.2343
65	0.0884	-0.4782	-0.0603	0.2187
70	0.1255	-0.5148	-0.0537	0.2028
75	0.1604	-0.5442	-0.0489	0.1851
80	0.2054	-0.5706	-0.0566	0.1693

Table 2: Result of p-value for each factor.

Age	Temperature	Unemploy	Education	Economic
0	0.0007489	0.009736	0.3275	0.03557
5	0.08779	0.8901	0.403	0.03239
10	0.1086	0.7555	0.4347	0.03507
15	0.1297	0.6415	0.4579	0.03741
20	0.1592	0.5621	0.4596	0.04088
25	0.2161	0.4403	0.4382	0.04214
30	0.3141	0.2888	0.4419	0.04738
35	0.4594	0.1583	0.4603	0.05516
40	0.6337	0.07127	0.5036	0.06615
45	0.7818	0.03688	0.5624	0.08201
50	0.9355	0.01912	0.5818	0.0943
55	0.8956	0.008473	0.6174	0.1124
60	0.7298	0.003425	0.6601	0.1353
65	0.5776	0.001359	0.7046	0.1641
70	0.4284	0.0004863	0.7355	0.1977
75	0.3103	0.0001951	0.7583	0.2407
80	0.1919	7.951×10^{-5}	0.7217	0.2839

Table 1 shows that the result of Pearson correlations for all factors which are temperature, unemployment rate, education expenditure rate and economic growth. Based on the highlighted values in yellow the strong correlation is when the value near to 1 or -1. Correlation for temperature is moderately strong with negative correlation which is -0.4999, it is between 0 to -1. For the unemployment rate also same with temperature which is moderate negative correlation and the value for moderate negative is -0.5 to -0.7. Next, for the education expenditure rate and economic growth are weak correlation to influence mortality rate.

From Table 2, we obtain the *p*-value of each factor that affect mortality rate by age. Every factor has difference relationship between factor and mortality rate at age 0 to 80. Not all age affects with all the factors. We know that the relationship will exist when it is significance. If the p-value is less than $\alpha = 0.05$, so that we will reject H_0 and we accept it is significance and has relationship between all factors with mortality rate at all age. The highlighted value with yellow color was related to the correlation between factors with mortality rate. First and foremost, the first factor which is temperature, it is significance at age zero only. It is means that the relationship between temperature and mortality rate at age zero are exist. The other age is not significance and there is no relationship between temperature and the mortality rate at other age which are from age 5 to age 80. Next, the p-value that have relationship and significance for unemployment are mortality rate at age zero and 45 to 80 but the smallest p-value is at age 80. Moreover, based on the Table 4.2, it shows that Education Expenditure does not have relationship and not significance with mortality rate at all age. Last but not least, economic growth is the last factor that we test their significance and relationship, so the result shows that it has relationship and significance on mortality rate at age 5 because the p-value is smaller than $\alpha = 0.05$

which is 0.03239. For the other age like 0,10,15,20,25 and 30 also have relationship and significance but the smallest p-value is at age 5.

Table 3: Result of Jarque-Bera test.

Age	Jarque-Bera Test
0	0.03211
5	0.05686
10	0.04595
15	0.03782
20	0.02966
25	0.02065
30	0.01231
35	0.007229
40	0.00497
45	0.00441
50	0.004639
55	0.00582
60	0.008658
65	0.01444
70	0.02662
75	0.05002
80	0.09804

Based on the highlighted values in yellow on Table 3 after performing the Jarque-Berra test, the result obtained some *p*-value that have greater that 0.05 which are 0.05686, 0.05002 and 0.09804. Therefore, the conclusion for that is the data is normally distributed. For others, the data is not normally distributed. Start 3rd paragraph here. Please follow format of reference when citing in the text. The referenceformat can be either numbering or author system, but please make sure that the format is standardizedthroughout the manuscript.

Table 4: Result of Breusch-Pagan test.

Age	Breusch-Pagan Test
5	0.0491
75	0.133
80	0.1605

Based on Table 4, the result that highlighted in yellow at age 5 the *p*-value are less than the significance level of $\alpha = 0.05$ and the others are greater than the significance level of $\alpha = 0.05$. For the *p*-value greater than the significance level of $\alpha = 0.05$, fail to reject H_0. Thus, the result assumed that homoscedasticity is present. The residuals are distributed with equal variance.

Table 5: Result of Durbin-Watson test.

Age	Durbin-Watson Test
5	2.4751×10^{-13}
75	2.112×10^{-11}
80	2.087×10^{-11}

After applying the Durbin-Watson test to our regression model, we obtain a test statistic value between 0 and 4. The Durbin-Watson statistic measures the degree of autocorrelation, where a value

close to 2 suggests no autocorrelation, a value less than 2 suggests positive autocorrelation, and a value greater than 2 suggests negative autocorrelation.

The highlighted values in yellow on table 4.12 obtained Durbin-Watson statistic is significantly less than 2, it suggests the presence of positive autocorrelation. This implies that the residuals are positively correlated over time or across observations.

Conclusion

The findings regarding the association between temperature, unemployment rate, education expenditure rate and economic growth versus mortality rates in Malaysia are summarized. The key findings from the multiple linear regression analysis are discussed in terms of their statistical significance and effect sizes. Start paragraph here. Give very significant conclusion that can conclude the finding. First and foremost, the Pearson correlation coefficients indicates the strength and direction of the linear relationships between the factors and the mortality rate. For the first correlation the result obtained a positive correlation between temperature and mortality rate at age 80 which is 0.2054 and the p-value is 0.1919. It is suggested that as temperature increases, the mortality rate tends to decrease. It is because parents must take a good care of their children to avoid them from expose to extreme temperature. Similarly, a negative correlation coefficient between unemployment rate and mortality rate at age 80 which is -0.5706 indicates that as the unemployment rate decrease, the mortality also tends to decrease and the p-value is 7.951×10^(-5). Hence, when the parent is unemployed, it is difficult to take care of their child from aspect feeding, shelter and money. For the education expenditure rate obtained a negative correlation between education expenditure rate and mortality rate at age 80. The value of Pearson correlation is -0.0566 and the p-value is 0.7217. Thirdly, the economic growth obtained a positive correlation between economic growth and mortality rate at age 0. It is suggested that as economic growth increases, the mortality rate also tends to increases. Hence, the Pearson correlation coefficient is 0.1693 and the p-value is 0.2839. The p-value associated with this correlation which is p greater than 0.05 indicates these associations are statistically not significant. In this study, the Jarque-Bera test yielded a p-value greater than 0.05, suggesting that the mortality rate data can be assumed to be normally distributed. From the test conducted, the result obtained 0.09804 which is mortality rate at age 80 is normally distributed. In this study, Breusch-Pagan test has been conducted to test either the residuals are distributed or not with equal variance. From the result, the residuals are distributed with equal variance on mortality rate at age 10 to 80 but mortality rate at age 0 and 5 are not normally distributed with equal variance. This indicates that the assumption of equal variances across the predictor variables is satisfied, which is important for accurate interpretation and inference in the multiple linear regression model. The autocorrelation test, specifically the Durbin-Watson test, examines the presence of autocorrelation in the residuals of the regression model. In this study, the Durbin-Watson statistic obtained a value less than 2, indicating a lack of significant positive autocorrelation. This suggests that the residuals are independent of each other and do not exhibit a systematic pattern over time, supporting the assumption of no autocorrelation in the model. For the multiple linear regression model, the variable that significant to explain mortality rate is only unemployment rate with high correlation 0.5706. It is significantly contributed to the model with *p*-value less than 0.05. There exists positive relationship between temperature and mortality rate at age 80. The coefficient for unemployment rate indicating a negative relationship between unemployment rate and mortality rate at age 80. The coefficient for education expenditure rate indicating a negative relationship between education expenditure rate and mortality rate at age 80. The coefficient for economic growth rate indicating a positive relationship between economic growth rate and mortality rate at age 80. Hence, the model will become $y = -0.9395 + 0.0177x_1 - 28.9212x_2 - 2.0634x_3 + 2.1654x_4$. From the final model, the iteration of unemployment rate can be used to predict mortality rate. The study can conclude that unemployment rate is essential factor to be considered when designing regression model for mortality rate. The recommendation for the researcher is about expanding data collection. Expanding the data collection efforts involves obtaining a more comprehensive and diverse dataset. Exploring additional potential factors involves conducting a thorough literature review and consulting domain experts to

identify relevant variables that may influence the mortality rate. The data pre-processing steps ensures the accuracy and reliability of the analysis. Researchers should handle missing data, outliers, and data inconsistencies appropriately. Placing emphasis on the interpretation of the regression model coefficients involves translating the mathematical relationships into meaningful insights for policymakers and stakeholders.

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