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MODELING OF MATERNAL MORTALITY (MMR) IN EAST JAVA 2017-2019 USING PANEL REGRESSION APPROACH

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ABSTRACT

Maternal Mortality Rate (MMR), is a country's welfare indicator especially about the women's health. It is included in the development index and the quality of life index. The determinants of maternal mortality are elements that collectively cause maternal mortality. This quantitative research used secondary data on MMR and its influencing factors in East Java Province during the 2017-2019 period and the analysis of the panel data used regression. The trend of Maternal mortality in East Java Province has decreased from year to year; in 2019, it was 89.81 per 100,000 live births. The variable pregnant women using blood-added pills (X1) with a probability value of 0.020 ($p<0.05$) is found to significantly affected the maternal mortality in the panel regression analysis utilizing the Random Effect Model. The Random Effect Model, which this study found to be the best, contains the model equation Yit = 225.7721 - 1.919457 X1it and the administration of blood-added pills is the variable that significantly affects maternal mortality. The results of this study indicate the need for educational efforts, especially regarding to the benefits of blood-added pills for pregnant women and to correct the misunderstanding about the benefits of blood-added pills in the community, so that the coverage of blood supplement consumption in pregnant women can be increased. Together with the primary health care system and obstetricians, an integrative approach and counseling among pregnant women and their partners will increase awareness of maternity health and birth management.

Kata Kunci:
AKI,
regresi panel,
Random Effect Model

ABSTRAK

Angka Kematian Ibu (AKI), merupakan indikator kesejahteraan suatu negara khususnya tentang kesehatan wanita. Hal ini termasuk dalam indeks pembangunan dan indeks kualitas hidup. Determinan kematian ibu adalah unsur-unsur yang secara bersama-sama menyebabkan kematian ibu. Penelitian kuantitatif ini menggunakan data sekunder AKI dan faktor-faktor yang mempengaruhinya di Provinsi Jawa Timur periode 2017-2019 dan analisis data panel menggunakan regresi. Tren AKI di Provinsi Jawa Timur dari tahun ke tahun mengalami penurunan, pada tahun 2019 mencapai 89,81 per 100.000 kelahiran hidup. Hasil penelitian dari analisis regresi panel menggunakan Random Effect Model diperoleh variabel yang berpengaruh signifikan terhadap AKI adalah variabel ibu hamil mendapat tablet tambah darah (X1) dengan nilai probabilitas sebesar 0.020 ($p<0.05$). Penelitian ini diperoleh model terbaik adalah Random Effect Model dengan persamaan model $Y_{it} = 225,7721-1,919457\ X_{1it}$ dan variabel yang berpengaruh secara signifikan terhadap AKI adalah pemberian tablet tambah darah. Hasil penelitian menemukan bahwa edukasi tentang manfaat dan menghilangkan kesalahpahaman tentang tablet tambah darah perlu ditingkatkan. Edukasi tersebut perlu dilakukan kepada ibu hamil dan masyarakat luas. Bersama dengan sistem pelayanan kesehatan primer dan dokter kandungan, pendekatan dan konseling integratif antara ibu hamil dan pasangannya akan meningkatkan kesadaran kesehatan maternitas dan manajemen persalinan.

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INTRODUCTION

The Sustainable Development Goals (SDGs) health development program set by the World Health Organization (WHO) as a development agenda for the 2016-2030 period is a continuation of the Millennium Development Goals (MDGs). One of the targets that must be achieved in this development is to improve the health status of the community by reducing the Maternal Mortality Rate (MMR) (1). Global achievement of the MMR target is required under the condition that no country has an MMR of more than 2 times the average and less than 70 per 100,000 live births (2).

When a woman passes away more than 42 days after her pregnancy ends but less than a year has passed, it is known as a late maternal death (3). Beyond the six-week (42-day) postpartum period, complications during pregnancy or childbirth might result in mortality; however, these deaths are not the result of trauma or accident (4). MMR is the number of moms who passed away within a specific time period for every 100,000 women who were fertile. This demonstrates that the risk of death in singleton pregnancies is the basis for the risk of death for the number of live births (5). MMR is one of the parameters used to measure the welfare of women, and it is used to determine the health condition of women as well as a component of development and quality of life index (4). Information related to MMR is very useful in maternal health programs.

The global MMR reported decline by 38% in the duration of 2000 until 2017. In details the number is decreased from 342 deaths in 2000 to 211 deaths in 2017 per 100,000 live births. The average reduction is 2.9% annually. The significant reduction was only half of the SDGs target (Sustainable Development Goal). The SDGs targeted 70 maternal deaths per 100,000 live births. Since 2000, South Asia advanced the MMR reduction into 59%. In number, reduce 395 into 163 maternal deaths per 100,000 live births). However, the highest MMR is in Assam Province in North India, it has 205 deaths per 100,000 births. The opposite was Kerala, which had the lowest MMR of 30 deaths per 100,000. MMR defined as women died from pregnancy-related causes in 42 days after a child delivery. The measurement was the number per 100,000 live births. Maternal mortality in Sub-Saharan Africa was significantly reduced by 39% during the same period (4).

Indonesian MMR is higher than other ASEAN countries and the declining trend is still slow. In general, from 1999 to 2015 the MMR of Indonesia declined from 390 to 305 per 100,000 live births. The decline rate is not significant since it does not met the MDGs target of 102 per 100,000 live births (6). East Java Province highly contributed to the rose of Indonesian MMR. However, in the last 3 years the East Java Province health profile data reported continues decline trend of MMR. The MMR per 100,000 live births, starting from 2017 was 91.92, then in 2018 was 91.45, finally in 2019 reaching 89.81 (7).

Due to both direct and indirect reasons of excessive maternal mortality, community issues in the MMR reduction program are sluggish to develop. Maternal health during pregnancy and childbirth dominates the indirect causes, which include factors like age during pregnancy, too-close birth intervals, the number of children, delays in receiving referrals to medical facilities, and delays in receiving care from medical personnel. Three factors—near, between, and far—have been identified as the predictors of maternal mortality (8). The proximal determinant is the direct cause of maternal death, such as pregnancy and various complications during pregnancy, childbirth, and postpartum. The intermediate determinants are the defined quality of maternal health, reproductive, health services access, health facilities utilize behavior, and other unpredictably occurring factors. The distant determinants are economic, socio-cultural factors, and the hierarchy of women in the family (9,10).

Regression analysis is a tool that can be used to describe MMR issues brought on by numerous circumstances. First is cross-sectional, which analyze geographical data, specifically district/city data. Second is time series data, based on the coverage of MMR and its influencing elements. Third is the panel data regression by merged the two sets of data. The panel regression is more accurate to forecast the influencing factors that affect MMR on specific time period. In contrast to conventional linear regression models, panel data regression effectively manages the dependencies of unobserved independent variables on a dependent variable that can result in biased

estimators. Often used in econometrics, where the actions of statistical units (i.e. panel units) are tracked over time.

Comparing panel data to pure time series data or cross-sectional data, more detail, more variability, and more effectiveness are present (11). The aim of this study is to identify and analysis Maternal Government Programs that influence the maternal mortality ratio during 2017-2019 based on the variables that significantly affect East Java Province. This research different from the others lies in the following independent variables. The percent of pregnant women receive blood supplement tablets (*X1*), the percent of deliveries by health workers (*X2*), and the percentage of family planning (Keluarga Berencana/KB) membership history (*X3*) in each district/city are the most significant factors that affect MMR in East Java Province land this study used random effect model which residuals may connect over time, across people, or across cross sections.

METHOD

This study took a quantitative approach and used a cross-sectional and time-series research design. Research volunteers were not directly involved and were not aware that they were participating in this study.

The MMR and influencing factors derived from secondary data. The cross-section data is in the form of MMR and factors that affect maternal mortality, while the time series data is in the form of time measured during the period from 2017 to 2019 in 38 districts/cities in East Java Province. The information was taken from the East Java Provincial Health Office's 2017–2019 East Java Health Profile publication.

This study omitted the bias of variable by employed panel data. The panel data controlled the individual heterogeneity, provide better informative data, more variability, less collinearity, and higher degrees of freedom between all variables. The result of the panel regression was a model of the effect of predictor variable to the response variable in several observed sectors of a research object over a certain period of time.

The dependent variable was maternal mortality rate (*Y*) in each district/city in East Java Province. The independent variables were the percent of pregnant women receive blood supplement tablets (*X1*), the percent of deliveries by health workers (*X2*), and the percentage of family planning membership history (*X3*) in each district/city in East Java Province. Then with the panel data regression method using the E-views 9 application. All data will be analyzed. Previously, a descriptive analysis was carried out in the case of MMR and the factors that influence it. After that, the classical assumption was tested on each variable to be studied. Furthermore, respectively Chow Test, Haussman Test, and LaGrange Multiplier Test employed to select the best model between the Common, Fixed, and Random Effect Model. Finally, the most significant variables used for the modeling equation.

RESULT

Figure 1 shows the evolution of MMR in East Java Province over the course of three years, from 2017 to 2019. MMR has been falling from 2017 to 2019 year over year. The MMR rate for the year 2019 in East Java was 89.81 per 100,000 live births. These findings suggest that MMR has declined compared to MMR in the previous two years.

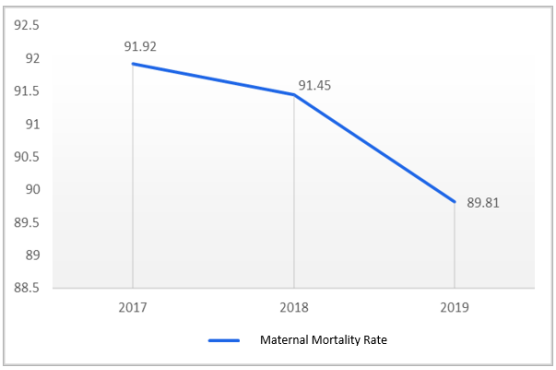

Figure 1. MMR Trends of East Java Province Indonesia during 2017-2019 (per 100.000 live births)

The Chow test, Haussman test, and the LaGrange Multiplier test performed and aimed for the best effect model. The best effect model of the panel data regression determined through the Common, Fixed, and Random Effect Model. Furthermore, the test continued by explore the classical assumptions across the variables, which consisted of normality, multicollinearity, heteroscedasticity, and autocorrelation.

Panel Regression Estimation Method

Common Effect Model and the Fixed Effect Model contested by the Chow test. The probability number is 0.040 (p<0.05) according to the test. The Fixed Effect Model demonstrated a better significance. The Fixed Effect Model re-contested against the Random Effect Model, in which the Haussman test favors the Random Effect Model by a probability value of 0.649. LaGrange Multiplier test was performed to confirm the superiority of the Random Effect Model, which resulted in 0.0062 value of Breusch-Pagan. It concluded that the Random Effect Model was the best model of the three and was used to explained the research findings.

Normality Assumption Test

The probability number takes into account the normality test. It is deemed to be normally dispersed if >0.05. According to the study's findings, each variable's data was not normally distributed, and the chance value was 0.000 (p 0.05). The Central Limit Theorem test is used to determine whether the data are regularly distributed, but it requires more than 30 data or samples (12). The data points were more than 30, which support the fact that the all the variables distributed normally.

Multicollinearity

Table 1 shows all the data free from multicollinearity between variables. It is proved by coefficient correlation less than 0.8 of all variables. This test was used to examine the multicollinearity between variables.

Heteroscedasticity

Table 2, proved that heteroscedasticity was absent in this study and met the assumption. The Glasjer test by regressing residual values and absolute values on all independent variables obtained the *p value* of all independent variables >0.05.

Table 1. Results of Multicollinearity Test

Variable	X1	X2	X3
X1	1.000000	0.590544	-0.018814
X2	0.590544	1.000000	-0.006665
X3	-0.018814	-0.006665	1.000000

Table 2. Results of Heteroscedasticity Test

Variable	Probability Value	Explanation
X1	0,700	Heteroscedasticity does not occur
X2	0,380	Heteroscedasticity does not occur
X3	0,770	Heteroscedasticity does not occur

Autocorrelation

The autocorrelation was tested by the Durbin-Watson test. Durbin Watson's value in this study is 1.689 and the value is close to 2, so it can be said that there is no autocorrelation problem in all data and the classical assumption of autocorrelation is met.

Panel Regression Modeling

Random Effect Model was the best model and become the final model for this investigation. Table 3 describes the results of the panel regression using the Random Effect estimation model

.**Table 3.** Results of Regression Panel Using *Random Effect Model*

Variable	Coefficient	Probability Value	Explanation
X1	-1.919457	0.020*	Significant
X2	0.597788	0.660	Not Significant
X3	-0.231486	0.610	Not Significant
Constant	**225.7721**	**0.050***	Significant

Table 3 shows that the only significant variable was the giving blood-supplement tablets by probability value of 0.020 (p<0.05). It means that the percentage of women receiving blood supplement tablets has a significant effect on reducing MMR. The

estimation of model parameters using the Random Effect Model for MMR modeling in East Java is as follows:

$Y_{it} = 225{,}7721 - 1{,}919457\ X_{1it}$

The symbol *i* stands for the district/city index and *t* stands for time period in years. The model equation shows that the coefficient of the percent of women receive blood supplement tablets is 1.919457. It means that with every 10% increase in the number of pregnant women who receive blood supplement tablets, it will reduce the MMR by 19%. Therefore, the finding was in tune with the goals of the community and the government in tackling the high MMR in East Java.

DISCUSSION

The most significant influential variable was the administration of blood supplement tablets. This variable wax selected through Random Effect Model after panel data regression. The coefficient of that variable is 1.919457. It concluded that every unit of blood-added tablets obtained by pregnant women will reduce the MMR by 1.919457 according to the coefficient value. Providing pregnant women blood-added pills can boost their nutrient intake, which tends to lower the maternal death rate. During pregnancy, the need for nutritional intake increases, because it does not only need to meet the needs of the mother, but also the nutritional needs of the fetus in the mother's stomach. If the nutritional intake needed is still low, it can cause health problems, one of which often occurs is the problem of anemia.

Anemia in pregnancy is defined as the mother's hemoglobin level below 11.6 g/dl, 9.7 g/dl, 9.5 g/dl in the first, second, and third trimester, respectively (13). Decreased iron stores in the body of pregnant women and low iron absorption can cause anemia (14–16).

More iron intake is needed by pregnant women because the fetus experiences faster growth, causing Hb levels to decrease (17). The mother's body during the third trimester of pregnancy requires more iron intake because the fetus is in a faster growth period, causing Hb levels to decrease (18). The government program of giving blood-added tablets had a significant effect on MMR in East Java Province from 2014-2018 (12). Studies agreed that a pregnant woman should only consume 60 mg of iron, in the form of ferrous sulfate, ferrous fumarate, or iron gluconate and 0.400 mg of folic acid (19). The 2018 Indonesian Basic Health Research shows that around 61.9% of pregnant women consume approximately 90 mg iron supplements (20).

The study of iron tablet intake adherence of 10 pregnant women during second trimester showed that knowledge affects the behavior. If the woman is at least moderately knowledgeable (two women of high and three women of moderate knowledge), they will obediently take the iron tablet. Contrary, if the woman is less knowledgeable (five women), she will be less likely to take the iron tablet (21). The adherence affected by predisposing, driving, and environmental factors. (i) The predisposing factors consisted of age, level of education, salary, awareness of pregnancy danger signs, especially about anemia; supporting factors were such as distribution of iron tablets, reception of iron tablets, and side effects. (ii) The driving factors were such as frequency of antenatal care, alarm for the tablet, and family support. (iii) The environmental factors were such as availability and access to ANC.

Awareness about anemia for pregnant women includes understanding the causes, signs and symptoms, and consequences of no iron tablet; the benefits and instructions of the iron tablet; and iron-rich foods options (22). The level of knowledge possessed by pregnant women is influenced by several factors, including education, age, occupation and income, experience, and socio-culture (23). Therefore, the government has developed a program of blood supplement tablets to prevent anemia in pregnant women. Every pregnant woman is recommended at least 90 tablets. This effort is a government program that is expected to make MMR in East Java Province experience a downward trend in the coming year.

There are two variables in this study that do not significantly affect MMR in East Java Province, the first is childbirth assisted by health personnel and the second is family planning history factors. The factor of childbirth assisted by health is one of the factors that affect MMR (10). This contrasts with other studies which explain that most maternal deaths occur during childbirth, so the government provides quality health facilities with trained health workers (24). Maternal death often results from complications during labor. If the delivery is assisted by non-trained health

workers, it will have an impact on the health of the mother and baby to be born and cause death. One of the obstacles to the high MMR in Indonesia is that many births are assisted by either trained or untrained traditional birth attendants (25).

The limited knowledge of birth attendants if not from health workers and the unavailability of adequate delivery aids will increase the risk of bleeding and infection (26). Minister of Health Regulation No. 43 of 2016 explains the standards of maternal health services, which contain every maternity mother gets services according to standards. The definition of service according to standards is delivery carried out by a midwife and/or doctor and/or midwifery specialist working in a government or private health service facility who has a Registered Certificate (Surat Tanda Registrasi/STR) both normal delivery and/or delivery with complications (27). According to these standards, traditional birth attendants are not allowed to give birth, even delivery must be done at a health service place that already has a permit, which means that pregnant women are prohibited from giving birth at home. Therefore, the government provides quality health facilities with trained health workers.

Based on the results of statistical analysis, family planning history did not significantly affect MMR in East Java Province. Other studies complement this finding. The history of maternal participation in the family planning program has no significant effect on MMR in East Java Province (28,29). When compared to mothers without family planning, those with family planning resulted in a lower risk obstetric-related death because the pregnancy is scheduled and resulted in less labor (30,31). The family planning program is one solution that mothers can choose to limit the number of children they have in order to minimize maternal mortality.

Looking at the various events that affect maternal mortality, strategies to reduce maternal mortality has been made by a global consensus consisting of (i) family planning in connection with services for reproductive health, (ii) specialized care for expectant mothers and new mothers, (iii) quick emergency obstetric treatment, and (iv) prompt postpartum care. The increase in contraceptive prevalence among married women was from 8% to 60% from 1970 to 2002. This is in line with the decrease in fertility rates from 5.0 to 2.6 (32,33). The Central Bureau of Statistics explained that the growth in contraceptive use has decreased from the beginning of 2000. Meanwhile, in 2017, CPR increased by 63%, and TFR fell to 2.3 (34).

CONCLUSIONS AND SUGGESTIONS

Conclusions

The Random Effect Model was the best panel data regression model based on the appropriate estimation method. The analysis on the Random Effect Model showed that the variable giving blood-added tablets significantly affected the MMR in East Java Province.

Suggestions

The model equation Y_{it} = 225,7721– 1,919457 X_{1it} is recommended as an appropriate estimation method to reduce MMR according to national targets. According to the results of this study, it is indicated the need for educational efforts, especially regarding the side effects of blood-added pills for pregnant women in East Java Province, Indonesia. Health workers are also expected to deliver better counselling related to blood supplement tablet for pregnant women. Furthermore, efforts are needed to correct the misunderstanding that circulating in the community about the benefits. This will increase the consumption ratio in pregnant women.

Counseling can be in the form of recommendations that it is better to take blood supplement tablets at night before going to bed to reduce nausea. The thing to avoid is taking blood supplement tablets with tea, coffee, milk, ulcer medicine and calc tablets, because they will inhibit iron absorption. Together with the primary healthcare system and obstetricians, an integrative approach and counseling among pregnant women and their partners will increase awareness of maternity health and birth management.

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