Human Development Index, Geographic Disparities and Strategies to Reduce Maternal Mortality in Indonesia

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ABSTRACT

Recent data shows disparities and setbacks in maternal health services. In Indonesia, there was an increase in maternal mortality in 2020 compared to 2019. Inequality is a powerful predictor of maternal mortality. The aim of this study is to find whether inequality indicators, namely the Human Development Index and Geographic Units, can be predictors of maternal mortality.This research uses an ecological study design with a unit of analysis in 34 provinces in Indonesia. The data used in this study is secondary data from the Ministry of Health and BPS. Descriptive analysis and Poisson regression were used to determine whether the Human Development Index and geographic units could be predictors of maternal mortality. The increase in maternal mortality occurred in 21 (61%) provinces in Indonesia. The province's lowest maternal mortality rate was 48, and the highest was 565 per 100,000 live births. The Human Development Index and geographic units can significantly predict maternal mortality (P < 0.05). Human development indices and geographic units are significant predictors of maternal mortality. Strategies that can be done to reducematernal mortality are improved education, health services, and specific and collaborative interventions according to provincial needs.

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INTRODUCTION

Maternal mortality is a major global health concern and is one of the Sustainable Development Goals (SDGs). SDG 3.1 aims to reduce global maternal mortality to fewer than 70 per 100,000 live births by 2030 (1,2). Recent data shows disparities and deterioration in maternal health services in some countries around the world, this target is difficult to achieve (2–4). According to a report published in a study by UN agencies, every two minutes, awoman dies during her pregnancy or childbirth. According to this report, there has been an increase in maternal mortality in almost all parts of the world over the past few years (1,3).

This upward trend in maternal mortality is a worrying setback for pregnant women's health services (1,3). Whereas previously, a number of studies showed a positive trend in reducing maternal mortality between 2000 and 2015, after this period, the downward trend did not occur again and even in some cases there was a trend reversal. Maternal mortality

rates increased between 2016 and 2020 in two of the eight UN regions — Latin America and the Caribbean and Europe and North America — at 17% and 15%, respectively (1).

In Indonesia, according to Indonesia's health profile in 2020, there was an increase in maternal mortality in 2020, namely 4,627 maternal deaths compared to 2019 of 4,197 maternal deaths. An increase in the number of maternal deaths occurred in 21 (61%) provinces in Indonesia (5,6). The maternal mortality rate in Indonesia is 189 per 100,000 live births. The lowest provincial maternal mortality rate is DKI Jakarta at 48 per 100,000 live births and the highest is Papua at 565 per 100,000 live births (7).

The Human Development Index (HDI) introduced by the United Nations Development Programme (UNDP) in 1990 is a composite measure that evaluates countries' performance in providing all necessary facilities to their citizens. HDI is formed by three basic dimensions: longevity and healthy life, knowledge, and decent living standards. At the community and policy level, the Index reflects the effectiveness of Health Policy, Education Policy, and Access to Knowledge and Economic Policy and Living Standards (11). Geographic disparities, on the other hand, are differences in health outcomes, access to health services, and quality of health care between geographic locations.

Despite global efforts and various Indonesian government programs to improve maternal health and reduce maternal mortality, the fact is that the reduction in maternal mortality is not as expected. Strong suspicion of this is because there is still high inequality in various countries and geographical regions. Some studies show that there is a relationship between HDI, geographical location and its components, and maternal mortality rates. For example, an ecological study in West and South Asian countries in 1980–2010 found that there is a negative relationship between HDI and maternal mortality (r = -0,7, P < 0,001), this shows that when HDI increases (improves), then maternal mortality decreases (improves). In another study using maternal mortality and HDI data from 188 countries in 2014 in the world, a significant negative correlation was found between HDI and maternal mortality rates (r = -0.807, 95% CI: -0.853, -0.747, P = 0.001) (12,13). In a study of 54 African countries, the findings of this study showed clusters (hotspots) very high maternal mortality rates occurred in the Central and West Africa region (14).

Existing research, especially in Indonesia, is still sparse to address this issue of inequality and its relationship to maternal mortality. The research we conducted was predictive, using regression analysis. Compared to previous studies, our study was able to assess the strength of the relationship between maternal mortality and its predictors. Understanding the relationship between HDI, geographic disparity and MMR in Indonesia can provide useful insights on policymaking to develop intervention strategies to reduce maternal mortality. Therefore, the purpose of this study is to determine whether the Human Development Index (HDI) and geographical units can be predictors of predictive models of the Maternal Mortality Rate (MMR) in Indonesia.

METHOD

The research conducted was quantitative research with an ecological study design. Ecological studies are a type of observational epidemiological study in which the unit of analysis is a population or group, not individuals. It is used to understand the relationship between outcomes and exposure at the population level. A population represents a group of individuals with shared characteristics such as geography, ethnicity, socioeconomic status, or occupation (15).

The target population and unit of analysis in this study are 34 provinces in Indonesia, namely Aceh, North Sumatra, West Sumatra, Riau, Riau Islands, Jambi, Bengkulu, South Sumatra, Bangka Belitung Islands, Lampung, Banten, Java, West, DKI Jakarta, Central Java, Yogyakarta, East Java, Bali, West Nusa Tenggara, East Nusa Tenggara, North Kalimantan, West Kalimantan, Central Kalimantan, South Kalimantan, East Kalimantan,

Provinces on the island of Sulawesi, Gorontalo, North Sulawesi, West Sulawesi, Central Sulawesi, South Sulawesi, Southeast Sulawesi, North Maluku, Maluku, Papua, West Papua. The 34 provinces are grouped into Provinces on the Island of Sumatra, Provinces on the Island of Java, Provinces on the Island of Bali and Nusa Tenggara Islands, Provinces on the Island of Kalimantan, Provinces on the Island of Sulawesi and Provinces in the Maluku Islands and Papua.

The variables used in this study are Province, Maternal Mortality Rate (MMR), Human Development Index (HDI), Poverty, Geographical Unit, and Service Quality. To determine the spatial trend of MMR, provincial and MMR variables are used. To find out and create predictive models, dependent variables MMR and independent variables Human Development Index (HDI), Poverty, Geographical Unit, and Service Quality are used.

The data used in this study is secondary data from credible institutions or organizations, publicly accessible and intended for the public. Provincial data based on the number of provinces in 2020, MMR and Poverty data using data from the Central Bureau of Statistics in 2020 (5,7,16), Service quality data using data from the percentage of the number of puskesmas without doctors in each province comes from the 2020 health profile published by the Ministry of Health of the Republic Indonesia and geographical variables are geographical units of Indonesia according to ISO_3166-2: ID, ISO 3166-2: ID is an ISO standard that defines international codes: this code is part of ISO 3166-2 addressed to the country of Indonesia (5).

Data analysis includes a descriptive analysis of variables such as maternal mortality rate (MMR), Human Development Index (HDI), poverty, geography, and service quality. Bivariate analysis between dependent variables (MMR) with independent variables (Human Development Index (HDI) or Poverty or Geographic or Service Quality using correlation tests. Parametric correlation tests are used for normally distributed data and nonparametric tests for normally undistributed data. For the formation of predictive models using Poisson regression analysis. The results of data analysis are presented in descriptive tables, graphs, and tables of Poisson regression analysis results. Data processing and analysis using Microsoft Excel, RStudio, and Stata 16.

RESULTS

Based on Indonesia's health profile in 2020, the number of maternal deaths in Indonesia in 2020 was 4.627, an increase compared to 2019 of 4.197 or an increase of 10.24%. An increase in the number of maternal deaths occurred in 21 (61%) provinces in Indonesia (5). Based on BPS data, the maternal mortality rate in Indonesia is 189 per 100,000 live births. The lowest provincial maternal mortality rate is DKI Jakarta at 48 per 100,000 live births and the highest is Papua at 565 per 100,000 live births (7).
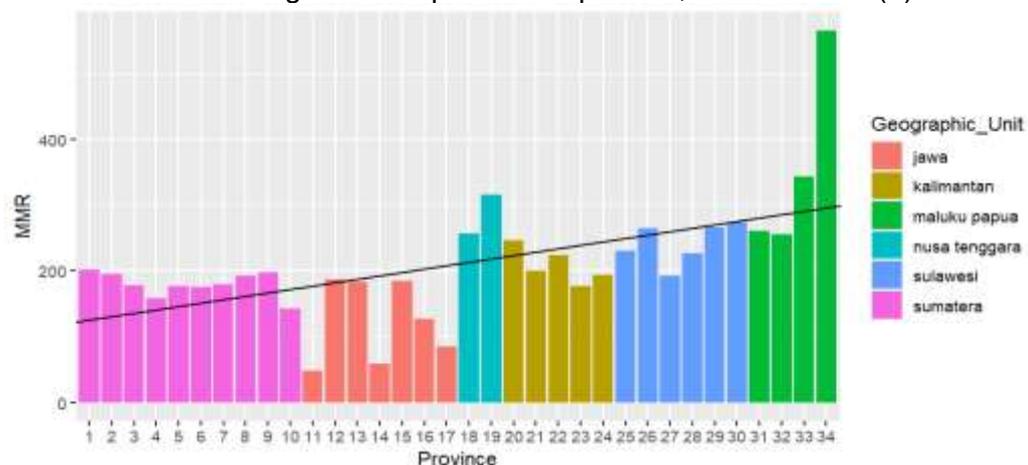
Figure 1. Spatial Trends in Maternal Mortality Rate in Indonesia

In Figure 1, it can be seen that there is a spatial trend of maternal mortality rates in Indonesia. It can be seen that the distribution of maternal mortality rates in Indonesia varies greatly. The eastern region of Indonesia has a high maternal mortality rate compared to the western part of Indonesia. Provinces located in eastern Indonesia such as North Maluku, Maluku, Papua, West Papua have high maternal mortality rates, exceeding maternal mortality rates in Indonesia. Provinces located in the geographical unit of Java island have a lower maternal mortality rate than maternal mortality rates in Indonesia.

Descriptive statistics of research variables can be seen in Table 1. The mean maternal mortality of all provinces in Indonesia is 210.5 per 100,000 live births, and more than 50% of provinces in Indonesia have maternal mortality rates above 194.5 per 100,000 live births. The provincial human development index in Indonesia ranges from 60.04 to 80.77 with 50% of provinces having a human development index below 71.42. Inequality seems to occur in the quality of health services where there are provinces where almost 50% of Puskesmas do not have doctors but there are provinces where all Puskesmas have doctors.

Table 1. Descriptive Statistics of Research Variables

Variable	N	mean	median	min	max
Maternal Mortality Rate	34	210,5	194,5	48	565
Human Development Index	34	71,07	71,42	60,04	80,77
Poverty (%)	34	10,42	8,73	3,78	26,64
Quality of Service (%)	34	7,65	2,85	0	48,2
Geographic Unit	6				

Predictive Model of Maternal Mortality

Initial stage Before the analysis of model formation, a correlation test was carried out to determine the relationship between MMR variables and independent variables. Test selection is based on whether the data is normally distributed or not. The results of the data normality test, show that the data is not normal distribution. The correlation test used in this study is the sparman rank test, the results of the correlation test can be seen in Table 2.

Table 2. Relationship of Maternal Mortality Rate with Predictor Variables

Variable		Correlation coefficients	P-value
HDI	MMR	-0,82	0,000
Poverty	MMR	0,54	0,001
Quality of Service	MMR	0,72	0,000
Geographic Unit	MMR	0,37	0,03

Table 2 shows that there is a mortality relationship with all predictor variables, and a strong negative correlation between maternal mortality and human development index (HDI), meaning that the lower the human development index of a province the higher the number of maternal deaths. A strong positive correlation occurred between the maternal mortality variable and the percentage of the number of puskesmas without doctors, the higher the proportion of puskesmas without doctors showed the higher the maternal mortality rate in the province.

Predictive modeling of maternal mortality using Poisson regression analysis with robust error standards. The predictive model variables consist of MMR response variables and predictor variables namely HDI, Poverty, Quality and Geographic Unit. The method used for model formation is the backward method, where all variables are entered into the model. Evaluation and selection of models based on Prob > chi2 values and Log pseudolikelihood. The results of Poisson regression analysis using stata obtained the best

model as shown in table 3. Prob values > chi2 = 0.0000 (P<0.05) and Log pseudolikelihood = -170.21109 show that the model can significantly predict maternal mortality (MMR).

Table 3. Predictive Model of Maternal Mortality Rate

Number of obs = 34				Wald chi2(8) = 582.03		
				Prob > chi2 = 0.0000		
Log pseudolikelihood = -170.21109				Pseudo R2 = 0.7578		
MMR2020	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
HDI	-.0731438	.0130572	-5.60	0.000	-.0987355	-.0475521
Poverty	.008595	.0072115	1.19	0.233	-.0055392	.0227293
Quality	-.0018927	.003411	-0.55	0.579	-.0085782	.0047927
Geographic Unit						
Sumatera	.1596659	.0921335	1.73	0.083	-.0209125	.3402442
Kalimantan	.2932179	.1156776	2.53	0.011	.0664939	.5199419
Nusa Tenggara	.204317	.1003599	2.04	0.042	.0076152	.4010187
Sulawesi	.3224696	.1009814	3.19	0.001	.1245497	.5203895
Maluku Papua	.3463019	.1051826	3.29	0.001	.1401477	.552456
_cons	10.19953	.9881374	10.32	0.000	8.262812	12.13624

The From the predictive model in Table 3, we can evaluate that the predictor variables that can significantly predict maternal mortality are the human development index (HDI) P< 0.05 and the geographical regions of Kalimantan, Sulawesi, Nusa Tenggara and Maluku Papua P< 0.05. The geographical position on the island of Sumatra is not significantly different from the island of Java in the prediction of maternal mortality rate P>0.05. The poverty variable (P value 0.233) and the Quality variable (P value 0.579) could not predict maternal mortality significantly (P>0.05).
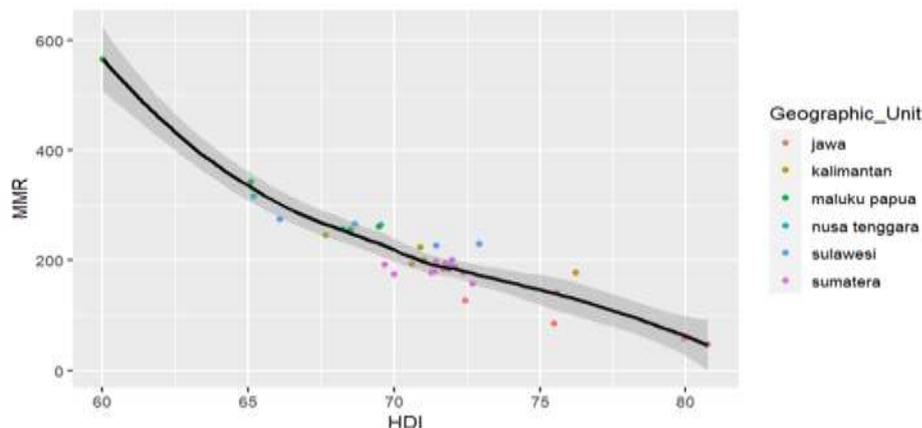

Figure 2. MMR's relationship with HDI and Geographic Unit

A visualization of the relationship between maternal mortality and significant predictors can be seen in Figure 3. The negative coefficient value on the human development index shows an increase of 1 point in the human development index resulting in a decrease of -.0731438 log maternal mortality rate (MMR). Geographical posis that is very risky in increasing maternal mortality is in the Maluku and Papua regions with a coefficient of 0.3463019 and P value < 0.05, followed by the geographical region of Sulawesi with a coefficient of .3224696 and P value < 0.05.

DISCUSSION

Indonesia is an archipelagic country located in the Southeast Asian region and is part of the ASEAN community. Characteristically it is the largest archipelagic country in the world, with a total land area of 1,904,569 square kilometers and has the 4th largest population in the world with a population of 277,749,853 people (18). With a large area and a large population, it is very possible for development inequality to occur, especially the health sector in Indonesia. Sustainable Development Goals (SDGs) 3.1 sets a target to reduce global maternal mortality to less than 70 per 100,000 live births by 2030 (1,2).

The high maternal mortality rate in Indonesia at 189 per 100,000 live births and the trend of increasing maternal mortality in Indonesia in 2020 compared to 2019 make it difficult for Indonesia to achieve this target. However, a number of regions such as DKI Jakarta Province have achieved the SDGs target with a maternal mortality rate of 48 per 100,000 live births. With optimal interventions on factors that contribute to high maternal mortality, it is hoped that more provinces in Indonesia will be able to achieve the targets set by the SDGs.

Our results show that significant factors as predictors of maternal mortality in Indonesia are the human development index and the geographical unit of a province. The Human Development Index (HDI) is a statistical index that combines data on life expectancy, education level, and per capita income. The human development index (HDI) can describe and represent several aspects of the social determinants of health (SDOH). The results of maternal mortality modeling that can be seen in table 3 show the human development index as a significant predictor ($p < 0.05$) of maternal mortality. The negative value of the human development index regression coefficient can be interpreted as an increase in the human development index will significantly reduce maternal mortality.

The results of this study, which show the human development index is a significant factor in maternal mortality, are consistent with a systematic review of individual and ecological causes of maternal mortality worldwide. This systematic review study explains the human development index as a significant factor to maternal mortality (8). So, any attempt to improve the human development index is a systematic effort that can be made to reduce maternal mortality. Improving the human development index (HDI) can be done strategic planning in several main areas, namely education and health. Improving the quality and accessibility of education at all levels can significantly improve a country's HDI (21). Improving healthcare, especially in terms of accessibility and quality, can lead to better health outcomes and higher HDI (11,22).

Geographical units are variables that represent the existence of geographical disparities. Geographic disparities indicate differences in health outcomes, access to health services, and quality of health care between geographic locations (23, 24). As a result of our research, the geographical units of Kalimantan, Nusa Tenggara, Sulawesi and Maluku Papua are significantly ($p < 0,05$) associated with maternal mortality (table 3). A positive value in the regression coefficient in the geographical unit can be interpreted as there is a geographical disparity in the region compared to the geographical unit of Java. This geographical disparity has caused an increase in maternal mortality rates in Kalimantan, Nusa Tenggara, Sulawesi and Maluku Papua. The high maternal mortality rate in eastern Indonesia shows the low access to maternal health services in the region.

The results of this study which show geographical disparities between regions in Indonesia are consistent with a study published in 2022 showing that there are differences in the use of hospital health facilities between regions in Indonesia. Maluku has the lowest hospital usage rate, followed by Papua, Sulawesi, Java-Bali, Sumatra, Nusa Tenggara, and Kalimantan (20). The occurrence of geographical disparities between regions in Indonesia is caused by the large area and population and the existence of several regions or districts fail to encourage growth and end up with stagnation or slowdown in development (19).

Several studies have shown that geographic disparities contribute to high maternal mortality rates. In a study of 54 African countries, the findings of this study showed that MMR clusters (hotspots) occurred in Central and West Africa (14). Some of the causes of geographic disparities include limited access to health services, differences in demographics, attitudes, lifestyle factors, and cultural practices, variations in the resources and quality of health services and inequalities in health policies and programs (9,14,19,25,26). Addressing geographic disparities can be done through context-specific interventions and collaborations with the specific needs, challenges, and opportunities of a particular region or location. California, for example, has made great progress in lowering its maternal death rate. Identify the most common and preventable causes of maternal death in California, such as obstetric bleeding and preeclampsia, and collaborate among various stakeholders to implement effective interventions. These strategies have successfully decreased the rate of maternal death. California's success can serve as a model for other states and nations looking to enhance their own maternal health results (27).

The findings of our study can be evidence and guidelines for formulating policies to reduce maternal mortality. To reduce maternal mortality can be done by making policies that can improve the human development index. Interventions are also directed at reducing geographic disparities in health services between regions in Indonesia. Some efforts that can be made to improve the human development index and reduce geographical disparities in provinces in Indonesia are by improving the quality and accessibility of education at all levels, improving health services, especially in terms of accessibility and quality, and improving health infrastructure, distribution of health workers, and Specific interventions according to regional needs especially in eastern Indonesia (5,11,21,22).

Our ecological research has limitations. The aggregate data available in a province may not be sufficient to describe variations in a variable's local character. This study uses a small amount of data, but there is a similarity between the results of past studies that could serve as a guideline for the strength of the conclusions.

CONCLUSION

Human development index and geographic units can be significant predictors of maternal mortality. There was a geographical disparity in terms of maternal services, this is reflected in the increasing trend of maternal mortality rates to the east of Indonesia. Strategies that can be done to reduce maternal mortality are through improving education, health services, and specific and collaborative interventions according to the context of the needs of each province. Further research needs to be done using panel data with more data series so that the validity and precision of the study are better.

AUTHOR CREDIT STATEMENT
R came up with the idea, wrote the article, and gave the data, while TYMW reviewed it.

DECLARATION OF COMPETING INTEREST
The authors state that the performance described in this manuscript was not influenced by any substantial conflicting financial, professional, or personal interests.

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