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Map Distribution of Factors Affecting Stunting in East Nusa Tenggara

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Abstract

Stunting is chronic malnutrition in children under five years of age, which results in disturbances in the growth and development of children. Several factors, such as economic, health, and environmental factors, can influence stunting. In this study, a distribution map of the factors influencing stunting in East Nusa Tenggara districts/cities will be formed using Geographically Weighted Regression with a Spatial Lag of X. The variables used are the percentage of infants under two years who are breastfed, the percentage of toddlers who receive complete immunization, the percentage of households that do not use defecation facilities, the percentage of mothers who do not attend formal education, the GRDP growth rate, actual expenditure per capita, and the newly formed variable, namely GRDP growth rate around the i-th observation locations. From the results, it can be concluded that the western part of East Nusa Tenggara has unaffected economic factors, and the eastern part is an area where almost all variables are influential. Only the percentage of mothers who do not attend formal education has no effect, and the northern part is an area with economic factors which has an effect. The southern part is an area with child health factors that have no effect.

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INTRODUCTION

Malnutrition is a condition with deficiencies, excesses, or imbalances in a person's energy and nutrient needs. Malnutrition is generally divided into a person's undernutrition and micronutrient deficiencies. Conditions of undernutrition can be in the form of stunting (height for age), wasting (weight for height), and underweight (weight for age). At the same time, micronutrient deficiencies can be in the form of deficiencies of essential vitamins and minerals the body needs.

According to Uddoh (1980), malnutrition can be caused by a lack of food production due to the movement of people from villages to cities in search of jobs with higher salaries. Many people are illiterate and know little about nutrition, food transportation errors, and food storage methods. Many poor people can not buy proper food. Many households do not use their money wisely, such as buying fashionable clothes at high prices with the consequence of buying food of the cheapest and poor quality to meet their family's food needs (Ogunrinade, 2014).

Stunting (height for age) is a problem caused by chronic malnutrition in children under five, especially during the first 1000 days of life. Chronic malnutrition results in disturbances in the growth and development of children. Stunted toddlers usually have abnormal heights or are too short compared to other toddlers their age. Stunting in infancy is an indicator of children's well-being and an accurate reflection of social inequality. The World Health Organization (WHO) targets that by 2025 the number of children under five years of age who are stunted will decrease by 40%. The stunting target is based on analyzing time series data from 148 countries (Onis & Branca, 2016).

WHO states that Indonesia has a malnutrition status because it exceeds the maximum standard limit for stunting, which is 20% (Ministry of Health, 2021). The high number of stunting cases in Indonesia can hamper economic growth and social life (Permana & Wijaya, 2020). The possibility that Indonesia will experience economic losses caused by stunting is enormous. This situation is evidenced by a report from the World Bank in 2018 which stated that Indonesia has the potential to lose 2% to 3% of its Gross Domestic Product (GDP) due to high cases of stunting (World Bank, 2018). The Central Bureau of Statistics records that the GDP figure in Indonesia in 2021 will reach IDR 16,970.8 trillion, meaning that losses experienced by Indonesia caused by stunting are estimated to reach IDR 339 trillion to IDR 509 trillion per year.

Much research is being carried out regarding the factors and impacts resulting from the incident stunting. The research conducted by Nirmalasari (2020) identified causal factors stunting in Indonesia, which come from mother, child, and environmental factors. Other research about stunting has been carried out by Wulandari & Kusumastuti (2020), who concluded that the mother's motivation variable is the variable that most dominantly influences stunting. So that the midwives and cadres need to counsel mothers to increase their insight and increase the mothers' motivation. Research on stunting has also been studied at one of the Community Health Centres (Puskesmas) in East Nusa Tenggara, conducted by Raga & Silitonga (2022). However, the five variables used in the study concluded that none had a significant effect.

Several studies from overseas countries on stunting were conducted by Seboka et al. (2022). Researchers analyzed stunting in children under five in Ethiopia from 2011 to 2019. They concluded that stunting among children was significantly correlated with poor sanitation, poor wealth index, inadequate diet, place of residence, and mother's education. In addition, another study was conducted by Muche et al. (2021), which analyzed stunting using the Geographically Weighted Regression method and obtained the results that families who have poor toilet facilities for wasting and underweight, fathers who have primary education for stunting and wasting, fathers who have secondary education for stunting and underweight, mothers aged 35 – 49 years for wasting and underweight, having daughters for stunting, having children

eight years and over for wasting, and mothers who have primary education for waste are some of the significant research variables on (p-value<0,001).

Another study was conducted by Quamme & Iversen (2022) in Sub-Saharan Africa, where stunting is very rampant in that location. This study stated that stunting was significantly higher in boys aged > 1 year with low birth weight. Nasrin et al. (2023) conducted a study on moderate to high diarrhea with stunting in children under five years which was associated with diarrhea. They concluded that the strategy that needs to be implemented to reduce stunting in 3 Sub-Saharan African countries is to control diarrhea at moderate to high levels. High level so that stunting does not increase.

High-incidence stunting is caused by two factors, namely direct factors and indirect factors. Examples of direct influencing factors stunting in toddlers are food and health status. In contrast, examples of indirect factors that influence stunting in toddlers are toddler parenting, health services obtained, maternal factors, and the environment where toddlers live (Permana & Wijaya, 2020). Another root cause that makes up the numbers stunting being high is the low economic status of the family.

The impact of stunting on the individual includes increased morbidity and mortality, increased health costs incurred, and decreased learning capacity, which can reduce the ability and capacity to work. Some of these things will have an impact on the development of the nation and state (Wardani et al., 2020). Permana and Wijaya (2020) also mention the impact of stunting in an area, namely the inhibition of economic growth and social life. Nirmalasari (2020) in her research stated that there were many influencing factors of stunting in addition to providing poor nutrition, such as maternal factors, child factors, and environmental factors. All three are suspected to be very influential on the growth of children.

Maternal factors can be: mothers who are pregnant in their teens, namely aged less than 20 years, or pregnant women who are more than 35 years old, the mother's upper arm circumference during pregnancy is 23.5 cm, the mother's height is less for mothers who do not give exclusive breastfeeding to babies, early complementary feeding, namely when the baby is not yet six months old. The child factor can be: children at birth have a history of low birth weight or premature, children who are not fully immunized, often experience diarrhea and recur, have a history of infectious diseases in newborns (neonatal), and there is a history of infectious diseases. Environmental factors can be: low social and economic status of the family, low family income, lack of family (especially mother) education, the habit of defecating in inappropriate places, such as in rivers or inadequate latrines, use of untreated drinking water

Based on the three influencing factors stunting, this study will use six predictor variables, namely the percentage of infants under two years who are breastfed, the percentage of toddlers who receive complete immunization, the percentage of households that do not use defecation facilities, the percentage of mothers who do not attend formal education, percentage growth rate of Gross Regional Domestic Product, and per capita actual spending.

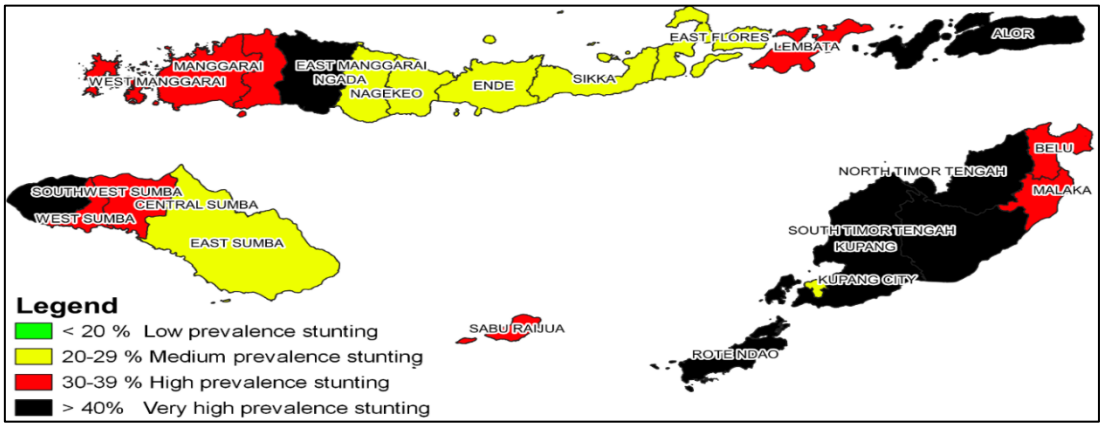

Figure 1. Map of the District/City Stunting Prevalence Distribution in East Nusa Tenggara, 2021
Source: Data Processed, 2023

The National Population and Family Planning Agency stated that several provinces in Indonesia had high stunting rates in 2021, including East Nusa Tenggara, West Sulawesi, Aceh, West Nusa Tenggara, Southeast Sulawesi, and South Kalimantan (Ministry of Health, 2021). The six provinces have a stunting toddler prevalence of more than 30%. Based on Figure 1, East Nusa Tenggara Province is divided into 21 districts and one city with a condition of 6 districts and one city colored yellow, meaning it has a moderate prevalence of stunting, between 20% to 29%. There are eight districts colored red, meaning it has a high prevalence of stunting, which is between 30% to 39%, and there are seven districts colored black, meaning that they have a very high prevalence of stunting, which is more than 40%.

Based on Figure 1, it can be concluded that all districts/cities in East Nusa Tenggara have a stunting prevalence of more than 20%. The high prevalence of stunting in East Nusa Tenggara can have a long-term impact on preparing superior Human Resources. Each district and city in East Nusa Tenggara Province has differences in economic, social, and cultural conditions and the quality of human and natural resources. Case stunting assumes that it is influenced not only by health and economic factors in one location but also by health and economic factors in neighboring locations (spillover effect), so it can lead to spatial dependence. Figure 1 shows a spatial effect of prevalence stunting between one location and the surrounding locations.

In this study, will be tested with the null hypothesis is: "the percentage of infants under two years who are breastfed, the percentage of children under five who receive complete immunization, the percentage of households that do not use defecation facilities, the percentage of mothers who do not attend formal education, the Gross Regional Domestic Product growth rate, actual expenditure per capita, and the new variable that is formed, namely GRDP growth rate around the observation locations that have been weighted Queen Contiguity have an effect on the prevalence of stunting in every district/city in East Nusa Tenggara" against the alternative hypothesis is: "the percentage of infants under two years who are breastfed, the percentage of children under five who receive complete immunization, the percentage of households that do not use defecation facilities, the percentage of mothers who do not attend formal education, the Gross Regional Domestic Product growth rate, actual expenditure per capita, and the new variable that is formed, namely GRDP growth rate around the observation locations that have been weighted Queen Contiguity have no effect on the prevalence of stunting in every district/city in East Nusa Tenggara".

So far, there has been no research that has modeled the prevalence of stunting in East Nusa Tenggara Province using a modified Geographically Weighted Regression model with a Spatial Lag of X. Therefore, in this study, a modification of GWR with SLX will be

modeled on stunting prevalence in East Nusa Tenggara, which is then carried out the formation of a distribution map based on the results of the modelling.

RESEARCH METHODS

Geographically Weighted Regression (GWR) is a method in statistics that is used to analyze the presence of spatial heterogeneity in the data being analyzed (Fotheringham et al., 2002). In modeling using the GWR method, model parameters will be obtained that have local characteristics at each point or each location observed. The parameter estimation used in the GWR analysis is the Weighted Least Square (WLS) method by giving different weights at each observation location. Guo et al. (2008) stated that the Fixed Gaussian Kernel weighting function produces a smoother spatial distribution than the Adaptive Gaussian Kernel function. Therefore, this study will use the Fixed Gaussian Kernel weighting function to estimate Geographically Weighted Regression parameters. The general model of Geographically Weighted Regression is as follows:

$$Y_i = \beta_0(u_i, v_i) + \beta_1(u_i, v_i)X_{1i} + \beta_2(u_i, v_i)X_{2i} + \ldots + \beta_k(u_i, v_i)X_{ki} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$Y_i = \beta_0(u_i, v_i) + \sum_{k=1}^{p} \beta_k\,(u_i, v_i)X_{ki} + \varepsilon_i \quad \ldots\ldots (2)$$

Spatial lag of X (SLX) is a spatial econometric model that develops a spatial regression model involving exogenous interaction effects. The exogenous interaction effect occurs when the predictor variable at the i-th location depends on the predictor variable at the j-th location. So that this exogenous interaction is indicated by the presence of terms WX on modeling (Elhorst & Vega, 2017), SLX in this study will only be carried out on the Gross Regional Domestic Product variable growth rate with the consideration that GRDP growth rate at the i-th location is affected by GRDP growth rate at neighboring locations. The purpose of forming a new variable using SLX is to handle the spatial dependency of the i-th observation location with the j-th observation location. The general model of the Spatial Lag of X is:

$$Y_i = \beta_0 + \left(\beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_p X_{pi}\right) + \left(\theta_1 \sum_{j=1}^{n} W_{1j}X_{1j} + \theta_2 \sum_{j=1}^{n} W_{2j}X_{2j} + \cdots + \theta_p \sum_{j=1}^{n} W_{nj}X_{pj}\right) + \varepsilon_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$Y_i = \beta_0 + \sum_{k=1}^{p} \beta_k X_{ki} + \sum_{k=1}^{p} \theta_k \sum_{j=1}^{n} W_{ij}\,X_{kj} + \varepsilon_i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Thus, it is necessary to model the prevalence of stunting based on economic, health, and environmental variables that aim to see each predictor variable's effect on each observation location. This research uses the modified Geographically Weighted Regression with Spatial Lag of X models to overcome the problem of spatial heterogeneity and spatial autocorrelation in the data.

The variables used in this study were the percentage of infants under two years who are breastfed, the percentage of children under five who received complete immunization, the percentage of households that do not use defecation facilities, the percentage of mothers who do not attend formal education, the Gross Regional Domestic Product growth rate, and the actual expenditure per capita. There is also an additional variable, namely the GRDP growth rate around the i-th observation location, which has been given a Queen Contiguity weight. The Queen Contiguity weighting matrix is a distance matrix determined based on the intersection of the side (Rook Contiguity) and the intersection of the corner points (Bishop Contiguity) of one location to another. This newly formed variable is called the Spatial Lag of X. When a suitable model has been formed, it forms a distribution map based on the parameter significance test obtained.

The data used in this study is secondary data sourced from the Buku Saku Studi Status Gizi Indonesia 2021 (Ministry of Health, 2021) and the Central Bureau of Statistics (Central Bureau of Statistics East Nusa Tenggara, 2022). The data used is stunting prevalence data and influencing factors based on 21 districts and one city in East Nusa Tenggara in 2021, with the variables presented in Table 1.

Table 1. Variables Description and Source

Variable	Definition	Unit	Data Source
$stun$	Stunting prevalence	Percent (%)	Ministry of Health, 2021
$brfed$	Percentage of infants under two years who are breastfed	Percent (%)	Central Bureau of Statistics, 2022
$immun$	Percentage of children under five who received complete immunization	Percent (%)	Central Bureau of Statistics, 2022
$defec$	Percentage of households that do not use defecation facilities	Percent (%)	Central Bureau of Statistics, 2022
$formedu$	Percentage of mothers who do not attend formal education	Percent (%)	Central Bureau of Statistics, 2022
$GRDP$	Gross Regional Domestic Product growth rate	Percent (%)	Central Bureau of Statistics, 2022
$expen$	Real expenditure per capita	Thousand rupiah (IDR)	Central Bureau of Statistics, 2022

Source: Data Processed, 2023

The first step is to form a modified GWR SLX from model 1 and model 2 with the following models:

$$stun_i = \beta_0(u_i, v_i) + \beta_1(u_i, v_i)brfed_i + \beta_2(u_i, v_i)immun_i + \beta_3(u_i, v_i)defec_i + \beta_4(u_i, v_i)formedu_i + \beta_5(u_i, v_i)GRDP_i + \beta_6(u_i, v_i)expen_i + \theta(u_i, v_i)\sum_{j=1}^{n} W_{ij}GRDP_j + \varepsilon_i \quad \text{.....(5)}$$

Where, $\beta_0(u_i, v_i)$ is the intercept coefficient for the i-th observation location, $\beta_k(u_i, v_i)$ is slope coefficient of the k-th predictor variable at the i-th observation location with $k = 1,2, \dots ,6$, $\theta(u_i, v_i)$ is the spatial coefficient for the lag of the predictor variable, $W_{ij}GRDP_j$ is GRDP around the i-th observation, which has been weighted Queen Contiguity, and ε_i is the error model for the i-th observation.

After forming the modified GWR SLX model, the parameters' significance was tested at all observation locations. Then form a distribution map based on variables that significantly affect each observation location, and interpret the analysis results obtained.

RESULTS AND DISCUSSION

In this study, because there were no significant variables at the 5% significance level, a 10% significance level was used. In addition, this research is econometric research that does not require a small error rate.

Several assumptions must be met in forming the model so that the model formed is a Best Linear Unbiased Estimator, one of which is non-multicollinearity.

Multicollinearity is a situation with a linear relationship or high correlation between predictor variables (Gujarati, 2003). In GWR modeling, the multicollinearity assumption is the existence of local multicollinearity from each observation location. One way that can be used to detect the presence of local multicollinearity from each observation location is to use the Variance Inflation Factor (VIF) locally (Gujarati, 2003). The formula used to see the magnitude of the local VIF can be calculated using equation (6).

$$VIF_k(u_i, v_i) = \frac{1}{1 - R_k^2(u_i, v_i)} \quad \text{..... (6)}$$

Where, $VIF_k(u_i, v_i)$ is VIF of the k-th predictor variable at the i-th observation location, and $R_k^2(u_i, v_i)$ is the coefficient of local determination (between the k-th predictor variables with other predictor variables at the i-th observation location).

Table 2. VIF of Each Observation Location

Districts/Cities	$brfed$	$immun$	$defec$	$formedu$	GDP	$expen$
West Sumba	1,484	2,473	9,597	8,273	1,492	1,635
East Sumba	1,336	2,216	6,959	6,268	1,556	1,633
Kupang	1,808	1,253	2,899	4,491	1,740	3,190
South Timor Tengah	1,910	1,236	2,943	4,666	1,797	3,665
North Timor Tengah	1,874	1,225	2,742	4,223	1,796	3,374
Belu	1,920	1,261	2,700	4,160	1,868	3,553
Alor	1,794	1,214	2,333	3,238	1,798	2,482
Lembata	1,541	1,204	2,347	2,914	1,575	1,937
East Flores	1,426	1,291	2,460	2,790	1,494	1,725
Sikka	1,356	1,469	2,870	3,020	1,480	1,664
Ende	1,330	1,678	3,486	3,387	1,487	1,625
Ngada	1,357	1,974	4,763	4,243	1,498	1,634
Manggarai	1,431	2,199	6,266	5,336	1,493	1,677
Rote Ndao	1,796	1,470	3,386	5,344	1,824	3,209
West Manggarai	1,493	2,329	7,581	6,373	1,487	1,695
Central Sumba	1,442	2,393	8,671	7,480	1,500	1,633
Southwest Sumba	1,537	2,534	9,343	8,872	1,486	1,643
Nagekeo	1,338	1,864	4,222	3,872	1,496	1,624
East Manggarai	1,394	2,096	5,469	4,733	1,494	1,657
Sabu Raijua	1,414	1,781	4,209	5,141	1,769	2,122
Malaka	1,943	1,258	2,878	4,530	1,856	3,872
Kupang City	1,804	1,307	3,034	4,741	1,755	3,211

Source: Data Processed, 2023

Based on Table 2, the VIF of each observation location produces a value that is less than 10 for all observation locations. It means there is no multicollinearity in each predictor variable at each observation location in East Nusa Tenggara districts/cities, so that modeling can be done.

After obtaining the GWR SLX modified model at each observation location, testing the residual model's normality assumption using the Jarque Bera Test with the following hypothesis (Gujarati, 2003).

H_0 : the residuals are normally distributed vs

H_1 : the residuals are not normally distributed

The formula used to see the statistical value of the Jarque Bera test can be calculated using equation (7).

$$JB = n\left[\frac{S^2}{6} + \frac{(K-3)^2}{24}\right] \sim \chi^2_{(2)} \quad \text{.....(7)}$$

Where JB is the statistics of the Jarque Bera test, n is the number of observations, S is the skewness coefficient, and K is the kurtosis coefficient.

From the VIF estimation result, obtained p-value of 0.898 which means the p-value is more than α (0,1), so it can be concluded that the residuals of GWR SLX are normally distributed. Fotheringham et al. (2002) state that spatial heterogeneity can be overcome by using Geographically Weighted Regression. Therefore, it is necessary to carry out a spatial heterogeneity test to prove whether there is still spatial heterogeneity after modeling using the GWR SLX. Spatial heterogeneity in this study was tested using the Breusch Pagan Test with the following hypothesis.

$H_0 : \sigma_1^2 = \sigma_2^2 = \cdots = \sigma_n^2 = \sigma^2$ (the residuals of variance are homogeneous) vs

H_1 : there is at least one $\sigma_i^2 \neq \sigma^2$ with $i = 1,2, \ldots, n$ (the residuals of variance are heterogeneous)

The formula used to see the statistical value of the Breusch Pagan test can be calculated using equation (4).

$$BP = \frac{1}{2} f'Z(Z'Z)^{-1}Z'f + \frac{1}{T}\left[\frac{e'We}{\sigma^2}\right]^2 \sim \chi^2_{(k+1)} \quad ....(8)$$

Where BP is statistics of Breusch Pagan test, $\boldsymbol{f}$ is vector sized $n \times 1$, $\boldsymbol{Z}$ is matrix sized $n \times (p+1)$ with element matrix is the vector of X with standardized observations, $\boldsymbol{e}$ is the vector of the error model, and σ^2 is a variance of error.

Obtained a p-value of 0.653 which means the p-value is more than α (0,1), so it can be concluded that the variance error of the GWR SLX modification model is homogeneous. It means characteristic similarities exist between one observation location and another after modeling using the modified GWR SLX model.

Geographical similarities between the observed locations and neighboring locations can cause dependence between locations. Therefore it is necessary to test the assumption of spatial autocorrelation (spatial dependency) using Moran's I test from the residuals of the GWR SLX modified model with the following hypothesis.

$H_0 : I = 0$ (no spatial autocorrelation) vs

$H_1 : I \neq 0$ (there is spatial autocorrelation)

The formula used to test the hypothesis and see the statistical value of Moran's I test can use equation (8).

$$I = \frac{\sum_{j=1}^{n}\sum_{i=1}^{n} w_{ij}(X_i - \bar{X})(X_j - \bar{X})}{\sum_{j=1}^{n}(X_i - \bar{X})^2} \quad .....(8)$$

Where I is a statistic of Moran's I test, w_{ij} is spatial weighting on the matrix element of the ij-th, X_i is observational data at the i-th location, $i = 1,2,\dots,n$, X_j is observational data at the j-th location, $j = 1,2,\dots,n$, $\bar{X}$ is the average of observations, and n is the number of observation locations.

Obtained a p-value of 0.116 which means the p-value is more than α (0,1), so it can be concluded that there is no spatial autocorrelation in the district/city stunting prevalence data in East Nusa Tenggara after being modeled with the modified GWR SLX model.

After checking the assumptions, it has been proven that the model formed does not have local multicollinearity, the residuals of the GWR SLX model are normally distributed, the variance of the residuals of the GWR SLX model is homogeneous, and there is no spatial autocorrelation. It means that the model formed is BLUE (Best Linear Unbiased Estimator).

Table 3 presents the estimated value of the model parameters from each observation location to see whether the k-th parameter significantly affects the stunting prevalence of each district/city in East Nusa Tenggara. In this study, the estimation of the coefficients of the GWR modification model parameters with SLX was carried out using the Weighted Least Square (WLS) method, which refers to research by Leung et al. (2000)

Table 3. Parameter Estimator Values from Each Observation Location

Districts/Cities	$\widehat{\boldsymbol{\beta}}_{int}$	$\widehat{\boldsymbol{\beta}}_{brfed}$	$\widehat{\boldsymbol{\beta}}_{immun}$	$\widehat{\boldsymbol{\beta}}_{defec}$	$\widehat{\boldsymbol{\beta}}_{formedu}$	$\widehat{\boldsymbol{\beta}}_{GDP}$	$\widehat{\boldsymbol{\beta}}_{expen}$	$\widehat{\boldsymbol{\theta}}_{WGDP}$
West Sumba	44,016	0,222	-0,192	0,788	-0,651	0,720	-0,002	0,259
East Sumba	50,509	0,137	-0,159	0,840	-0,693	1,561	-0,002	0,561
Kupang	143,347	-0,860	-0,091	-0,815	-0,207	6,886	-0,003	2,292
South Timor Tengah	207,499	-1,458	-0,177	-1,599	0,046	6,418	-0,003	2,850
North Timor Tengah	225,359	-1,574	-0,243	-1,920	0,069	6,548	-0,004	3,014
Belu	269,814	-1,953	-0,323	-2,463	0,189	6,194	-0,004	3,502
Alor	200,025	-1,225	-0,323	-2,036	-0,047	7,442	-0,004	2,883
Lembata	120,958	-0,545	-0,107	-0,480	-0,498	7,189	-0,004	1,293
East Flores	96,861	-0,369	0,004	0,272	-0,694	6,474	-0,003	0,589
Sikka	77,762	-0,218	0,039	0,716	-0,779	5,601	-0,003	0,449
Ende	66,896	-0,102	0,003	0,877	-0,793	4,589	-0,003	0,474

Districts/Cities	$\widehat{\beta}_{int}$	$\widehat{\beta}_{brfed}$	$\widehat{\beta}_{immun}$	$\widehat{\beta}_{defec}$	$\widehat{\beta}_{formedu}$	$\widehat{\beta}_{GDP}$	$\widehat{\beta}_{expen}$	$\widehat{\theta}_{WGDP}$
Ngada	55,050	0,049	-0,073	0,925	-0,776	3,187	-0,002	0,545
Manggarai	47,361	0,152	-0,124	0,911	-0,754	2,250	-0,002	0,583
Rote Ndao	85,428	-0,338	-0,014	0,128	-0,454	6,795	-0,003	2,455
West Manggarai	44,292	0,197	-0,151	0,884	-0,731	1,719	-0,002	0,576
Central Sumba	44,893	0,207	-0,182	0,814	-0,672	0,988	-0,002	0,354
Southwest Sumba	43,389	0,231	-0,196	0,776	-0,642	0,618	-0,002	0,208
Nagekeo	59,255	-0,006	-0,045	0,919	-0,784	3,695	-0,002	0,526
East Manggarai	50,544	0,108	-0,101	0,922	-0,767	2,678	-0,002	0,553
Sabu Raijua	63,344	-0,075	-0,028	0,847	-0,741	5,199	-0,003	2,152
Malaka	267,437	-1,971	-0,282	-2,323	0,203	5,960	-0,004	3,429
Kupang City	118,949	-0,647	-0,049	-0,448	-0,298	6,895	-0,003	2,228

Note: significant at α = 10%

Source: Data Processed, 2023

Modeling using Geographically Weighted Regression with Spatial Lags of X produces different models for each observation location. Not all predictor variables significantly affect the prevalence of stunting in all locations.

The percentage of infants under two years who are breastfed is only significant for the prevalence of stunting in the districts of South Timor Tengah, North Timor Tengah, Belu, Alor, and Malaka. The five districts have negative estimators, meaning that every increase in the percentage of breastfed babies under two years will decrease the prevalence of stunting in the five districts. This aligns with research conducted by Windasari et al. (2020), which states that a significant relationship exists between breastfeeding and the incidence of stunting in toddlers. Breastfeeding for children is very much needed during the growth period to help maintain a child's nutritional balance and achieve physical growth, mental health, and good child health status. WHO and UNICEF advise mothers to give exclusive breastfeeding to babies until the baby is six months old and continue to give breast milk until the baby is two years old to meet the baby's nutritional needs.

Complete immunization is one of the efforts aimed at preventing disease. This must be done with the right time of administration and dosage (Najikhah et al., 2021). Complete immunization in toddlers is related to parental education. Parents who understand the importance of primary immunization will always register their toddlers for immunization (Noh et al., 2018). The percentage of children under five who received complete immunization was only significant in Belu, Alor, and Malaka. The three districts have negative estimators, meaning that every increase in the percentage of children under five who receive complete immunization will decrease the prevalence of stunting in these three districts. This is in line with research previously conducted by Nursyamsiyah et al. (2021), which stated that a history of complete primary immunization has a relationship with the incidence of stunting. Based on this study, it was concluded that toddlers who do not have a complete history of primary immunization are at risk of 3,5 times experiencing stunting. Providing immunization is one way that can be done to prevent malnutrition in children through health services in the local environment. Providing complete basic immunization to toddlers is expected to have a positive impact on children's nutritional status so that the prevalence of stunting does not continue to increase.

Communities with poor access to water and sanitation facilities are one of the causes of growth and development failure in children (Sahiledengle et al., 2022). In almost all observation locations, the percentage of households that do not use defecation facilities was significant for the prevalence of stunting. The 18 observation locations did not have the

same effect; some had a negative effect, and some had a positive effect. In Kupang, South Timor Tengah, Belu, and Alor, the higher percentage of households that do not use defecation facilities, the lower prevalence of stunting. This is not in line with research conducted by Djara et al. (2022), which concluded that any increase in households with proper defecation behavior could reduce the prevalence of stunting. It is possible that this could happen because the four locations already have public facilities that can be used together for bathing, washing, and defecating so that the people in the four observation locations do not defecate indiscriminately. In West Sumba, East Sumba, Central Sumba, Southwest Sumba, Sikka, Ende, Ngada, Manggarai, West Manggarai, East Manggarai, Nagekeo, Sabu Raijua, and Malaka, the higher percentage of households that do not use defecation facilities, the higher prevalence of stunting. There is a positive effect between the percentage of households that do not use defecation facilities and an increase in the prevalence of stunting at the 13 observation locations, which aligns with research conducted by Djara et al. (2022). Households that do not have defecation facilities may defecate openly, resulting in a risk of stunting physical growth in children, such as toddlers, who are susceptible to diarrhea and pneumonia through air pollution. According to the Ministry of Health (2021) in the *Buku Saku Studi Status Gizi Indonesia 2021*, toddlers who are diagnosed with or experience symptoms of diarrhea and pneumonia are the cause of stunting in children.

The percentage of mothers who do not attend formal education was significant for the prevalence of stunting in the 15 observation locations. The 15 observation locations had the same effect on the prevalence of stunting. That is, the higher percentage of mothers who do not attend formal education, the lower prevalence of stunting in these locations. This is in contrast to research conducted by Azis et al. (2021) which showed that risk factors for maternal education affect the incidence of stunting with a risk of 5,5 times. Tatu et al. (2021) also analyzed the risk factors associated with the incidence of stunting, and the researchers stated that the higher the education level of parents, especially mothers, the greater their ability to absorb the information obtained, especially regarding nutrition in children. Low maternal education will have an impact on providing nutritional food standards for their children, so there is a possibility that toddlers will stunted. There are several determinants of stunting in developing countries such as Nigeria, namely wealth and mother's education. This happens because those who provide nutrition service facilities are mainly the role of a mother and wealth in the family. Apart from that, there are also other factors that affect stunting, namely, access to health services and families who program family planning (Adeyemi et al., 2022). The results of this study stated that the higher percentage of mothers who do not attend formal education, the lower prevalence of stunting. This is expected to occur because mothers who attend formal education can work outside the home, so they do not have time that can be used to check the womb during pregnancy. When the baby is born, it is possible that the mother does not have time that can be used to check the toddler at the health services.

There are several observation locations with GRDP growth rates, which significantly affect the prevalence of stunting. The 15 observation locations have the same effect, namely a positive effect on the prevalence of stunting, meaning that any increase in the GRDP growth rate will increase the prevalence. This is not in line with the theory presented by Nasrun & Rahmania (2018), which states that if GRDP increases, income will also increase. There is a related adverse relationship due to chronic malnutrition in children. Chronic malnutrition can interfere with brain development, leading to decreased cognitive and socio-emotional skills, low educational achievement, and low income due to chronic malnutrition (Galasso & Wagstaff, 2019). Another study by Kusumawardhani & Martianto (2011) concluded a negative relationship between GRDP and the prevalence of malnutrition. Stunting is a disorder of growth and development in children that occurs due to malnutrition in children since

childhood. Therefore, an increase in the GRDP growth rate should be able to reduce the prevalence of stunting. However, the results of this study prove that the GRDP growth rate positively affects the prevalence of stunting in several districts/cities of East Nusa Tenggara. It may happen because 2021 Covid-19 is high, so maybe the government spending on the health sector is more directed toward dealing with Covid-19 cases than stunting cases.

In almost all observation locations, actual expenditure per capita significantly affects the prevalence of stunting. The 18 observation locations have the same effect, namely a negative effect. This means that every increase in actual expenditure per capita will decrease the prevalence of stunting in these locations. This aligns with research conducted by Djara et al. (2022). Actual expenditure per capita indicates the decent living dimension to measure the Human Development Index.

The more significant actual expenditure per capita or the more significant the people's purchasing power, the more capable people are of achieving a decent life. One of the causes of stunting is the inability of households to meet the needs of toddlers, such as eating nutritious food and providing health services for toddlers. WHO states that stunting is caused by the inability of households to meet food needs adequately in terms of quality and quantity as well as health services (Batubara & Juwarni, 2018).

The newly formed variable, namely GRDP growth rate around the i-th observation location, which has been given a Queen Contiguity weighting, is significant for the prevalence of stunting, namely in the districts of Kupang, South Timor Tengah, North Timor Tengah, Belu, Alor, Rote Ndao, Sabu Raijua, Malaka, and Kupang City. These nine locations have a positive effect, meaning that any increase in GRDP growth rate around the i-th observation location will increase the prevalence of stunting in the i-th observation location. Just as the GRDP growth rate, the GRDP growth rate around the i-th observation location should also be able to reduce the prevalence of stunting, but the results of this study prove that the GRDP growth rate around the i-th observation location has a positive effect on the prevalence of stunting in East Nusa Tenggara. This happens because the GRDP growth rate positively affects the prevalence of stunting, so the new variable, namely the GRDP growth rate weighted with Queen Contiguity, positively affects the prevalence of stunting.

Based on Table 3, there are several significant predictor variables, where the significant predictor variables in each district/city in East Nusa Tenggara will be used to create a map of the distribution of factors that influence stunting prevalence. Figure 2 shows the results of the distribution map obtained.

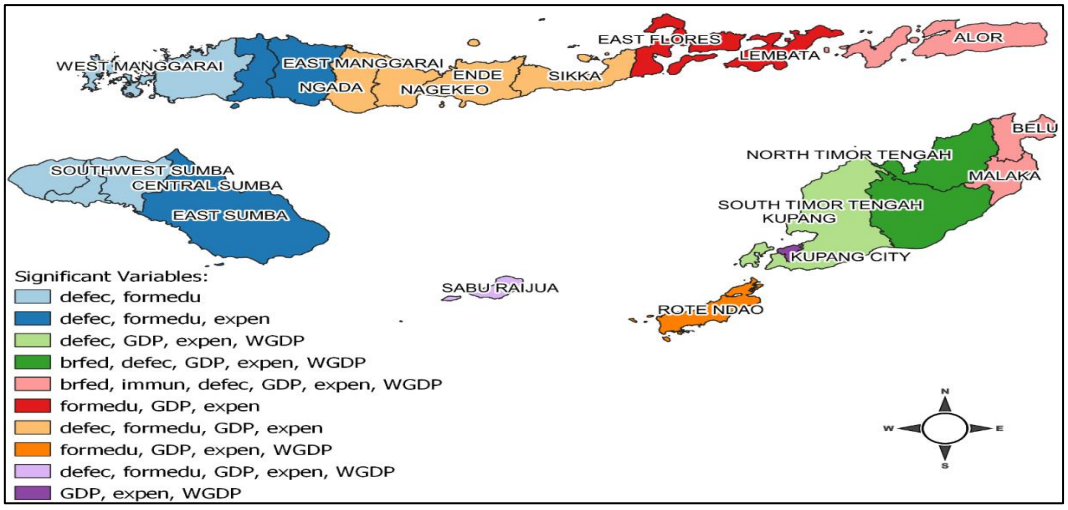

Figure 2. Map Distribution of Factors Affecting Stunting Prevalence in East Nusa Tenggara
Source: Data Processed, 2023

The western part of East Nusa Tenggara Province, namely the areas colored light blue (West Sumba, Central Sumba, Southwest Sumba, and West Manggarai) variables that tend to influence the prevalence of stunting are the variable percentage of households that do not use defecation facilities and the percentage of mothers who do not attend formal education. At this westernmost location, economic variables such as GRDP growth rate, actual expenditure per capita, and GRDP growth rate around the i-th observation location do not affect the prevalence of stunting.

However, the further east the economic variables are, the more significant the prevalence of stunting, such as the actual expenditure per capita that has an effect is marked with dark blue locations (East Sumba, Manggarai, and East Manggarai). The central part of East Nusa Tenggara Province, namely the orange observation locations (Sikka, Ende, Ngada, Rote Ndao, and Nagekeo) variables originating from environmental factors such as the variable percentage of households that do not use defecation facilities, the percentage of mothers who do not attend education formal, GRDP growth rate, and actual expenditure per capita has a significant effect on the prevalence of stunting.

Still the same as the locations in orange, the locations in red (Lembata and East Flores), significant variables come from environmental factors such as the percentage of mothers who do not attend formal education, GRDP growth rate, and actual expenditure per capita has a significant effect on prevalence stunting. The eastern part of East Nusa Tenggara Province, namely locations that are light green (Kupang Regency), dark green (South Timor Tengah and North Timor Tengah), pink (Belu, Alor, Malaka), and purple (Kupang City) indicate that the variable percentage of mothers who do not attend formal education has no significant effect on the prevalence of stunting. However, economic variables such as GRDP growth rate, actual expenditure per capita, and GRDP growth rate around the i-th observation location have a significant effect on the prevalence of stunting.

CONCLUSION

The resulting modification model between Geographically Weighted Regression and Spatial Lag of X differs for each observation location, so not all predictor variables used in this study have the same effect for all observation locations. In the western part of East Nusa Tenggara Province, such as West Sumba, East Sumba, Central Sumba, Southwest Sumba, Manggarai, West Manggarai, and East Manggarai are regions with insignificant economic variables.

Almost all research variables in the eastern part of East Nusa Tenggara Province, such as Alor, Belu, and Malaka, affect the prevalence of stunting. Only the percentage of mothers who do not attend formal education has no significant effect on the three locations.

In the northern part of East Nusa Tenggara, such as the districts of Kupang, South Timor Tengah, North Timor Tengah, Rote Ndao, Sabu Raijua, and Kupang City are regencies and cities with variables that influence the prevalence of stunting are economic variables, namely GRDP growth rate, actual expenditure per capita, and GRDP growth rate around the i-th observation location which has been given a Queen Contiguity weight.

In the southern part of East Nusa Tenggara, such as Lembata, East Flores, Sikka, Ende, Ngada, and Nagekeo districts, the location is characterized by health factors that have no effect, namely the variable percentage of infants under two years of age who are breastfed and the percentage of children under five who receive complete immunization does not affect the prevalence of stunting in the five locations.

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