Modeling Factors Affecting Stunting in Indonesia using the Conway Maxwell Poisson Regression Method

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Abstract. Stunting is a global problem due to chronic malnutrition and recurrent infections in children, characterized by below standard height. This problem does not only occur in Indonesia and can be caused by various health and social factors. Modeling toddler stunting based on factors is an important step in overcoming this problem, because it can help design more effective strategies to reduce stunting rates in Indonesia. This research aims to obtain a model and factors that influence stunting of toddlers in Indonesia in 2021 using the Conway Maxwell Poisson Regression (CMPR) method. CMPR was used in this research because the data experienced overdispersion problems. One alternative model that can overcome this is to use CMPR. The results of this research show that the use of the CMPR method can overcome overdispersion, so that the factors influencing the occurrence of stunting in children under five in Indonesia in 2021 are early initiation of breastfeeding, complete basic immunization, poor people, pneumonia cough, poor nutrition and diarrhea.

Keywords: Stunting, Poisson Regression, Overdispersion, Conway Maxwell Poissson Regression.

1 Introduction

Stunting is a disruption in the growth and development of children due to chronic malnutrition and recurrent infections, which is characterized by their length or height being below standard [1]. According to the results of the Indonesian Nutrition Status Study (SSGI) of the Ministry of Health, the prevalence of toddlers experiencing stunting in Indonesia in 2021 reached 24.4 percent, this figure decreased by 2.5 percent from the previous year. In 2020, the prevalence of stunting in Indonesia was 26.9 percent. The percentage of stunting in Indonesia has decreased compared to previous years. Even though it is decreasing, this figure is still high because the stunting prevalence target in Indonesia in 2024 is 14 percent and the WHO standard is below 20 percent [2].

One alternative model that can be used on data with overdispersion conditions is the Conway Maxwell Poisson Regression model. Conway Maxwell Poisson Regression is an extension of the Poisson regression model. The process of forming the Conway Maxwell Poisson Regression model is based on the Conway Maxwell Poisson distribution. The Conway Maxwell Poisson Regression model has two parameters, namely the regression parameter and the dispersion parameter. The advantage of Conway Maxwell Poisson Regression is that it has flexibility in modeling various cases of overdispersion

Y. Yuyun et al. (eds.), *Proceedings of the 5th International Seminar on Science and Technology (ISST 2023)*, Advances in Physics Research 10,
https://doi.org/10.2991/978-94-6463-520-1_16

and underdispersion data and has properties that make it methodologically interesting and useful in practice [3]. Based on this background, this research will model and determine the factors that influence stunting in toddlers using the Conway Maxwell Poisson Regression method in Indonesia.

2 Data and Method

The Conway Maxwell Poisson Regression model is an analysis of the relationship between random response variables in the form of discrete data with a Conway Maxwell Poisson distribution and one or more predictor variables [4].

The data used in this research is secondary data sourced from the 2021 Indonesian Health Profile. The population in this study is stunted toddlers according to provinces in Indonesia. The sample used in this research is stunted toddlers according to 34 provinces in Indonesia in 2021. With the variable used being stunted toddlers as the response variable and the predictor variable consisting of Early Breastfeeding Initiation (X_1), Complete Basic Immunization (X_2), Poor Population (X_3), Pneumonia Cough (X_4), Malnutrition (X_5) and Diarrhea (X_6).

3 Results and Discussion

a) Multicollinearity Test

Table 1. Variance Inflation Factor (VIF) Value

Predictor Variables	VIF
X_1	1,24
X_2	1,07
X_3	1,16
X_4	1,34
X_5	1,22
X_6	1,25

Based on Table 1, it can be seen that the VIF value of all predictor variables has a value smaller than 10, which means that there are no multicollinearity problems found in the data or there is no relationship between each predictor variable and the assumption of non-multicollinearity between predictor variables has been fulfilled.

b) Poisson Distribution Test

Table 2. Kolmogorov-Smirnov Test

p-value	Decision	Information
0,5136	Accept H_0	The Sample has a Poisson Distribution

Based on Table 2, the Kolmogorov-Smirnov test results show p-value = 0.5136, which means p-value (0.5136) > α (0.05), so accept H_0. Which means that the sample comes from a population with a Poisson distribution.

c) Equidispersion Assumption Test

Table 3. Estimated Value of Dispersion

Deviance	df	Estimated Dispersion (ϕ)
422651,8	27	15653,77

Based on Table 3, it can be seen that the estimated dispersion value is obtained from the deviance value divided by the degrees of freedom, namely 15653,77, where the estimated dispersion value is more than 1, meaning that the data experiences overdispersion or the response variable data has a variance value greater than the average value. In resolving violated assumptions, one alternative is to use the Conway Maxwell Poisson Regression model.

d) Conway Maxwell Poisson Regression Model

Table 4. Conway Maxwell Poisson Regression Parameter Estimation Values

Parameter	Estimate
β_0	$-2{,}326 \times 10^4$
β_1	$-4{,}040 \times 10^1$
β_2	$3{,}593 \times 10^{-1}$
β_3	$1{,}624 \times 10^2$
β_4	$3{,}428 \times 10^3$
β_5	$3{,}762 \times 10^3$
β_6	$3{,}297 \times 10^2$

Based on Table 4, it can be seen that the Conway Maxwell Poisson Regression model formed is as follows:

$$\hat{\mu} = exp(-1{,}4859 - 0{,}00258085x_1 + 0{,}0000229529x_2 + 0{,}0103745x_3 + 0{,}218989x_4 + 0{,}240325x_5 + 0{,}021062x_6) - 0{,}499968$$

e) Simultaneous Test

Table 5. Likelihood Ratio Test Results

Conway Maxwell Poisson Regression Criteria	Value
$\ln L(\hat{\Omega})$	-128585
$\ln L(\hat{\omega})$	-1057649

Based on Table 5, it is obtained:

$$G = -2 \ln\left(\frac{L(\hat{\omega})}{L(\hat{\Omega})}\right)$$
$$= 2\left(\ln L(\hat{\Omega}) - \ln L(\hat{\omega})\right)$$
$$= 2\,(-128585 - (-1057649))$$
$$= 1858128$$

Based on the results of the likelihood ratio test, a value is obtained $G = 1858128$ as for value $\chi^2_{0,05;34-6-1} = 40{,}1133$ which means value $G > \chi^2_{0,05;34-6-1}$ and for p-value = <

$2,2 \times 10^{-16} < \alpha = 0,05$ then reject H_0. So it can be concluded with a significance level of 0.05 that there is at least one predictor variable that simultaneously influences the response variable.

f) Partial Test

Table 6. Wald Test Results

Parameter	Estimate	Standard Error	Wald	Table χ^2	Decision
β_0	-23260	161,6	20717,47	3,841	Reject H_0
β_1	-40,40	2,595	242,38	3,841	Reject H_0
β_2	0,3593	0,000403	797653,68	3,841	Reject H_0
β_3	162,4	2,238	5265,65	3,841	Reject H_0
β_4	3428	20,43	28154,32	3,841	Reject H_0
β_5	3762	39,33	9149,34	3,841	Reject H_0
β_6	329,7	2,036	26222,99	3,841	Reject H_0

Table 6 can be seen with a significance level of 0.05 so that a decision can be made that there are 6 variables that have a significant influence on stunting cases in toddlers, namely Early Breastfeeding Initiation (X_1), Complete Basic Immunization (X_2), Poor Population (X_3), Pneumonia Cough (X_4), Malnutrition (X_5) and Diarrhea (X_6).

4 Conclusion

Based on the results and discussion, it can be concluded as follows: Factors that significantly influence the number of cases of stunting under five in Indonesia are Early Breastfeeding Initiation (X_1), Complete Basic Immunization (X_2), Poor Population (X_3), Pneumonia Cough (X_4), Malnutrition (X_5) and Diarrhea (X_6).

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