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Modeling Cases of Stunting Toddler in Indonesia using the Conway Maxwell Poisson Regression Method

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***Abstract*— 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. According to the results of the Indonesia Nutrition Status Study (SSGI) of the Ministry of Health (Kemenkes), the prevalence of toddlers experiencing stunting in Indonesia in 2022 will reach 21.6 percent. Based on data from the Asian Development Bank, in 2022, the percentage of stunting prevalence in Indonesia will be 31.8 percent, putting Indonesia in 10th place in the Southeast Asia region. Stunting can be caused by various factors, including health factors and social factors. One way to find out is by modeling stunting in toddlers based on the factors that influence it. This research aims to determine the factors that influence stunting among toddlers in Indonesia in 2022 using the Conway Maxwell Poisson (CMP) regression method. This method is an extension of Poisson regression, which analyzes the relationship between independent variables (discrete or continuous) and dependent variables (count data) under the assumption of equidispersion. However, in analyzing data with the Poisson regression model, there can be violations of the equidispersion assumption, namely overdispersion or underdispersion. Therefore, a CMP model is required to address equidispersion violations in Poisson regression. The results obtained show that using this method can overcome overdispersion, so that the factors influencing stunting in toddlers in Indonesia in 2022 will be exclusive breastfeeding, complete immunization, provision of vitamin A, low birth weight, poor nutrition, and diarrhea.**

Keywords*— *Stunting, Poisson Regression, Overdispersion, Conway Maxwell Poisson Regression

I. INTRODUCTION

Stunting is the impaired growth and development of children due to chronic malnutrition and recurrent infections, characterized by below-standard length or height. Malnutrition occurs in the womb and early life after birth but only becomes apparent after the child is 2 years old. Stunting is also a condition where a person's height is shorter than the height of other people of the same age. Stunting is a global problem and does not only occur in Indonesia [1].

According to the results of the Indonesian Nutrition Status Study "Studi Status Gizi Indonesia (SSGI)" of the Ministry of Health (Kementerian Kesehatan Republik Indonesia), the prevalence of stunted toddlers in Indonesia in 2022 reached 21.6 percent, this figure decreased by 2.8 percent from the previous year. In 2021, the prevalence of stunting in Indonesia was 24.4 percent. The percentage of stunting in Indonesia has decreased compared to the previous few years. Although declining, this figure is still high because the target stunting prevalence in Indonesia in 2024 is 14 percent and the WHO standard is below 20 percent. Cases of stunting can be caused by a variety of factors including health and social factors. One way to find out is by modeling stunting toddlers based on influencing factors. An analysis of the factors that influence stunting is an important step in the fight against this health problem. This helps in designing a more effective strategy that focuses on factors that have a significant impact on reducing stunting among children under five [2].

Poisson regression consists of several assumptions that need to be met, one of which is that there is equidispersion or the variance value is similar to the average value. If there is a violation of the equidispersion assumption that results in a high increase in the standard error and reduces the efficiency of parameter estimation, the conclusion obtained becomes invalid. This invalid conclusion indicates that the explanatory variables tend to be considered influential but in reality the explanatory variables are not necessarily influential [3]. In situations like this, a model is needed that can overcome these problems, one of which uses 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 regression parameters and dispersion parameters. The advantage of Conway Maxwell Poisson Regression is that it has the flexibility to model various cases of overdispersion and underdispersion data and has properties that make it methodologically interesting and useful in practice [4]. Based on this background, this study will model and determine the factors that affect stunting toddlers using the Conway Maxwell Poisson Regression method in Indonesia.

II. MATERIALS

A. Conway Maxwell Poisson Regression

The Conway Maxwell Poisson Regression model is an analysis of the relationship between response random variables in the form of discrete data with one or more predictor variables. The relationship between response variables and predictor variables in Conway Maxwell Poisson Regression can be expressed through expectation values [5].

By using $\beta_0, \beta_1, \beta_2, \dots, \beta_p$ as unknown parameters and with the help of iterative calculations using software the estimated value of β can be obtained. Here is the Conway Maxwell Poisson Regression model:

$$\mu_i(x_{1i},x_{2i},\dots,x_{pi}) = \exp\left(\frac{\beta_0+\beta_1 x_{1i}+\beta_2 x_{2i}+\dots+\beta_p x_{pi}}{\phi}\right) - \frac{\phi-1}{2\phi}$$

$$= \exp\left(\frac{x_i\beta}{\phi}\right) - \frac{\phi-1}{2\phi} \quad (1)$$

III. METHODS

A. Data and Research Variables

The data used in this study are secondary data sourced from the 2021 Indonesian Health Profile. The population in this study is stunting toddlers by province in Indonesia. The sample used in this study is stunting toddlers by province in Indonesia in 2022. With the variables used in this study are response variables in the form of the number of cases of stunting toddlers in 34 provinces in Indonesia and predictor variables in the form of exclusive breastfeeding in infants, complete immunization in infants, vitamin A administration in toddlers, low birth weight in infants, malnutrition in toddlers and diarrheal diseases in toddlers.

B. Data Analysis Steps

Data analysis in this study used the Conway Maxwell Poisson Regression method assisted by RStudio software. The following are the stages of analysis carried out in this study, namely (1) Conducting a multicollinearity test by looking at the Variance Inflation Factor (VIF) value. (2) Conduct a Poisson distribution test, in this test using the Kolmogorov-Smirnov test. (3) Test the assumption of equidispersion by looking at the dispersion value whether the data is in a state of overdispersion or underdispersion. (4) Determine the Conway Maxwell Poisson Regression model and (5) Perform parameter significance testing. Parameter significance testing to see significant variables using simultaneous test (likelihood ratio test) and partial test (wald test).

IV. RESULTS AND FINDINGS

A. Multicollinearity Test

Tabel 1. Variance Inflation Factor (VIF) Values

Variance Inflation Factor (VIF) Values Table	
Predictor Variables	***VIF***
X_1	7,13
X_2	4,36
X_3	1,68
X_4	7,15
X_5	1,80
X_6	1,12

Table 1 shows that the VIF values of all predictor variables have values smaller than 10, which means that there is no multicollinearity problem 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

Tabel 2. Kolmogorov-smirnov Test

Kolmogorov-smirnov Test Table	
p-value	***Description***
0,1624	Sample is Poisson distributed

Based on Table 2 for the Kolmogorov-smirnov test results, the p-value = 0.1624 which means the p-value (0.1624) > α (0.05) Which means that the sample comes from a Poisson-distributed population.

C. Equidispersion Assumption Test

Tabel 3. Estimated Value of Dispersion

Estimated Value of Dispersion Table		
Deviance	***df***	***Estimated Dispersion***
2068361	27	76605,96

Based on Table 3, it can be seen that the estimated dispersion value obtained from the deviance value divided by the free degree is 76605.96 where the estimated dispersion value is more than 1, meaning that the data is overdispersed or the response variable data has a variance value greater than the average value. In resolving the violated assumptions, one alternative is to use the Conway Maxwell Poisson regression model.

D. Conway Maxwell Poisson Regression Model

Tabel 4. Parameter Estimation Values

Parameter Estimation Values Table	
Parameter	***Estimate***
β_0	-188100
β_1	0,6171
β_2	3,999
β_3	1966
β_4	-9,761
β_5	38590
β_6	338,3

Based on Table 4, it can be seen that the conway maxwell poisson regression model formed is as follows:

$$E(Y_i) = \exp\left(\frac{-188100 + 0{,}6171x_1 + 3{,}999x_2 + 1966x_3 - 9{,}761x_4 + 38590x_5 + 338{,}3x_6}{76605{,}96}\right) - \frac{(76605{,}96 - 1)}{2(76605{,}96)}$$

$$E(Y_i) = \exp(-2{,}455 + 0{,}0000081x_1 + 0{,}0000522x_2 + 0{,}0257x_3 - 0{,}00013x_4 + 0{,}5037x_5 + 0{,}00442x_6) - 0{,}4999 \quad (2)$$

E. Parameter Testing of Conway Maxwell Poisson Regression Model

The simultaneous test is carried out with the aim of identifying the effect of predictor variables on the response variable simultaneously or simultaneously. To conduct the test, the likelihood ratio test method is required, the results of which can be seen in Table 5 as follows:

Tabel 5. Ratio Likelihood Test Result

Ratio Likelihood Test Result Table	
Conway Maxwell Poisson Criterion	***Value***
$\ln \boldsymbol{L}(\widehat{\boldsymbol{\Omega}})$	-214096
$\ln \boldsymbol{L}(\widehat{\boldsymbol{\omega}})$	-10227505

Based on Table 5, it is obtained:

$$G = -2 \ln \left(\frac{L(\hat{\omega})}{L(\hat{\Omega})}\right) = 20026817 \quad (3)$$

Based on the results of the likelihood ratio test, the value of $G = 20026817$ is obtained while for the value $\chi^2_{0,05;34-6-1} = 40{,}1133$ which means the value of $G > \chi^2_{0,05;34-6-1}$. So it can be concluded with a significant level of 0.05 that there is at least one predictor variable that simultaneously affects the response variable.

Then, conduct a partial test. Partial tests have the aim of knowing the effect of each predictor variable individually on the response variable. The test method used in this case is the wald test which can be seen as follows:

Tabel 6. Wald Test Result

Wald Test Result Table		
Parameter	***Wald***	***Decisions***
β_0	121696,43	Significant
β_1	23102,51	Significant
β_2	27534	Significant
β_3	138538,43	Significant
β_4	18533,20	Significant
β_5	85338,29	Significant
β_6	2344,35	Significant

Table 6 can be seen with a significant level of 0.05 so that it can be decided that there are 6 variables that have a significant effect on stunting cases in children under five, namely exclusive breastfeeding, complete immunization, vitamin administration, low birth weight, malnutrition and diarrhea.

V. CONCLUSIONS

Based on the results and discussions that have been carried out previously, it can be concluded as follows:

1. The model obtained from the case of stunting in Indonesia in 2022 using Conway Maxwell Poisson Regression is as follows:

$$E(Y_i) = \exp(-2{,}455 + 0{,}0000081x_1 + 0{,}0000522x_2 + 0{,}0257x_3 - 0{,}00013x_4 + 0{,}5037x_5 + 0{,}00442x_6) - 0{,}4999$$

2. Factors that significantly influence stunting among children under five years of age, namely exclusive breastfeeding, complete immunization, vitamin administration, low birth weight, malnutrition and diarrhea.

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