The Association of Food Insecurity and Chronic Diarrhea on the Prevalence of Stunting in Children under 2-5 Years of Age

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Abstract. Stunting is associated with food insecurity and diarrheal infections. Age under five years is a golden age, which is very important for optimizing growth and development in the future. This study aimed to investigate the association between food insecurity and diarrhea and the prevalence of stunting in toddlers aged 2-5 years. Analytical observations using cross-sectional design. The study sample comprised 140 children aged 2-5 years. The sample was selected by simple random sampling. Data analysis was performed using univariate, chi-squared, Kruskal-Wallis, and multivariate tests. A total of 18.6% of the toddlers were stunted, 66 families were food insecure, and 31 toddlers had diarrhea. There was a relationship between chronic diarrhea and short nutritional status (p<0.001), and there was a significant relationship between food insecurity and the incidence of stunting (p=0.001). Results of the multivariate analysis using logistic regression. The final modal formula was log p (stunting) = -2.549 + 1.808 (parental income < minimum wage) + 6.098 (history of diarrhea) + 1.396 (food insecurity). Diarrhea is the dominant factor that most influences the incidence of stunting.

1. Introduction

Malnutrition is the most common cause of childhood morbidity and mortality in many developing countries [1]. Each year one-third of child deaths are due to acute and chronic malnutrition [2]. Chronic malnutrition often includes wasting, stunting, vitamin and mineral deficiencies, and underweight status. Stunting is the most common and contributes significantly to the nation's poverty rate [3]. Stunting is the result of chronic malnutrition, which leads to impaired growth, impaired development, recurrent infections, and psychosocial disorders [4] Stunting is defined as an indicator of chronic malnutrition (z-score height for age, or HAZ). Children whose WHO curve point based on HAZ is <-2SD are defined as stunted [5]. The global prevalence of stunting in children under five years old reached 22% in 2020 [6]. In Indonesia, the prevalence of stunting in 2020 reached 26.92%, decreased in 2021 to 24.4%, and decreased in 2024 to 19,8% [7].

Among households with high levels of poverty, low levels of parental education, poor diets, and household food insecurity, stunted children are more likely to be found [6]. Children raised by families with low incomes are 2.1 times more likely to be stunted [8]. The long-term impact of stunting is the inhibition of physical, mental, intellectual, and cognitive development. Toddlers who experience stunting until the age of five will find it difficult to recover, and the condition may persist into adulthood, reducing their quality of life [8]. Children and adolescents from developing countries are at a higher risk of stunting. This is because economic development is an important factor in the influence of food insecurity on the risk of stunting [9].

Diarrhea is the occurrence of defecation with a liquid stool texture with an incidence of >3 times a day [10]. The incidence of diarrhea is one of the health problems in Central Java with a diarrhea morbidity rate of 843 toddlers per 1000 population and a mortality rate due to diarrhea of 39.0% in 2019 [11,12]. Previous studies link stunting with recurrent diarrhea and food insecurity. In Indonesia, diarrhea prevalence among children under five was 9.8% in 2021, while in Central Java it was higher at 13.2%, alongside a stunting rate of 20.8% [13]. According to the 2022 Indonesian Nutrition Status Survey (SSGI), the prevalence of stunting in Central Java was 20.8%. This figure is slightly lower than the national prevalence of 21.6%, but it still indicates a significant public health concern.

The Sayung sub-district was selected for sampling in this study. Sayung Sub-district's coastal position and harsh meteorological and geographic factors influence the frequency of tidal floods in a number of its settlements. The incidence of environmental enteric dysfunction, which leads to infectious disorders such as diarrhea and is one of the triggers

of food insecurity resulting from natural disasters, is hypothesized to be influenced by tidal and flooding conditions. Diarrhea is not a direct trigger of food insecurity, but both often arise from the same environmental factors such as flooding and poor sanitation, which disrupt food access and impair nutrient absorption. Therefore, it is important to examine the influence of infectious diseases such as diarrhea and food insecurity on the incidence of stunting in the Sayung Sub-district in order to prevent and improve the quality of life of the community. The age range of 24-59 months was chosen since it had the highest prevalence of stunting according to the SSGI in 2021 [13].

2. Methodology

2.1. Study design, data collection, and participants

This study employed a multivariate analytical observational research design with a cross-sectional design. This study used a cross-sectional design with simple random sampling of 140 households in the coastal area of Sayung Subdistrict, Demak Regency Central Java. The population in this study consisted of all households with toddlers aged 2–5 years residing in the working areas of the Sayung I and Sayung II Community Health Centers in Demak Regency, Central Java. The selected households were located in coastal villages directly impacted by extreme weather caused by climate change. Data was collected in Demak Regency, Central Java, Indonesia, between April and July 2022.The inclusion criteria in this study were children aged 2-5 years who lived in the Sayung District, Demak Regency. The exclusion criteria were as follows: sick or resigned toddlers, children with short stature parents, children with a history of hormonal disorders, and children with a history of metabolic syndrome disorders. Subjects were randomly selected using a simple random sampling method. Data were obtained by direct measurement and direct interviews with parents and caregivers of children under five. The data collected were in the form of toddler identity, family characteristics, family food security measured using the US-HFSSM questionnaire, diarrheal disease measured based on a history of diarrhea periods of more than 14 weeks in the past year, and the nutritional status of children based on height per day. The instrument is based on the United States Household Food Security Survey Module (US-HFSSM), which has been widely used and validated internationally to measure household food insecurity. The US-HFSSM questionnaire was translated into Indonesian and confirmed to be valid and reliable.

Degree of food security (HFS) was obtained using Household Food Security Survey Module (HFSSM) Questionnaire. The determination of food security is based on the maximum total score of 18 questions that describe household food security in the last 12 months. Negative responses are given a score of 0 and positive responses are given a score of 1. The total score is then categorized into 2 categories of food security, namely food secure if the score is 0 and food insecure if the score is 1-18. More specifically, the HFS score categories are: Score 0 = food secure; Score 1-2 = food insecure without hunger; Score 3-7 = food insecure with moderate hunger; Score 8-18 = food insecure with severe hunger.

2.2. Statistical analysis

The data obtained will be processed and analyzed using the IBM statistical package for social science (SPSS) computer program version 25.0. The Kolmogorov-Smirnov test was used solely to check data normality as a prerequisite for statistical analysis, so its results were not presented in the findings. Univariate, bivariate, and multivariate logistic regression analyses were conducted to identify the associations between stunting, food security, and

diarrhea. Univariate analysis described each variable, bivariate logistic regression examined crude associations, and multivariate logistic regression assessed adjusted associations while controlling for confounders. The Kruskal–Wallis test was applied to assess the relationship between household food security status and child nutritional status.

2.3. Ethical approval

This study was approved by the Health Research Ethics Commission of the Faculty of Medicine of Diponegoro University (certificate no. 221/EC/KEPK/FK-UNDIP/VII/2022.

3. Results and Discussions

The results showed that more than half of the data were taken from males, which amounted to 75 children (53.57% of the total children), while the remaining 46.43% were female, totaling 65 individuals. The toddlers with normal nutritional status had the highest frequency, accounting for 101 children (72.14% of the total population). Children with an extremely short nutritional status had the lowest frequency, accounting for nine children (6.43 %). The results suggest that although most children had normal nutritional status, the presence of extremely short cases highlights the need for attention to vulnerable groups.

Table 1: Characteristics of children and families, incidence of diarrhea, stunting status and household food insecurity

Variable		n	%
Father's educational level	Not yet graduated elementary school	1	0.72
	Has graduated elementary school	30	21.58
	Has graduated junior high school	33	23.74
	Has graduated senior high school	69	49.64
	Diploma's degree	1	0.72
	Bachelor's degree	5	3.60
Mother's educational level	Has graduated elementary school	30	21.43
	Has graduated junior high school	34	24.29
	Has graduated senior high school	63	45.00
	Diploma's degree	3	2.14
	Bachelor's degree	10	7.14
Family income	≥ Minimum wage	74	52.86
	< Minimum wage	66	47.14
Child's sex	Girl	65	46.43
	Boy	75	53.57
Diarrhea history	Yes	31	22.14
	No	109	77.86
Household food security	Food secure	74	52.86
	Food insecure without hunger	39	27.86
	Food insecure with moderate hunger	22	15.71
	Food insecure with severe hunger	5	3.57
Stunting status	Severely stunted (HAZ ≤-3)	9	6.43
	Stunted (HAZ <-2)	17	12.14
	Normal (-2≤ HAZ <2)	101	72.14
	Tall (HAZ ≥ 2)	13	9.29

The average annual income of parents based on the data collected was IDR 2.98, which shows that the average income of parents is above the minimum wage. Based on the data obtained, 74 households (52.86%) had income above the minimum wage. However, 66 households (47.14%) still have an income below the minimum wage in the Demak Regency. Parental education data show that fathers' education is dominated by senior high school, namely 69 people (49.64%), and the lowest data are obtained in the last education not graduating from elementary school and graduating from D3. The average total monthly household income is stated in rupiah obtained through interviews with the category Low if ≤ Demak Regency Minimum Wage and High if > Demak Regency Minimum Wage.

Household food security status showed that they were food secure, but 47% of the families were food insecure. Regarding the incidence of diarrhea, the results showed that most of the toddlers, namely a total of 109 children (77.86 %), did not experience diarrhea during the week, one year before the interview. However, 31 children (22.14 %) had experienced diarrhea for more than equal to one week for one year before data collection.

The results of nutritional status data showed that 26 children (18.6 %) still suffered from stunting. Analysis of the relationship between family food security status and nutritional status of toddlers according to HAZ with data processing using the Kruskal–Wallis test showed that the p-value significance value was 0.001 (p <0.05), which indicates that there is a significant relationship between the two variables. The results show that despite more than half of households having income above the minimum wage and fathers mostly educated at the senior high school level, nearly half of families were still food insecure. Diarrhea affected over one-fifth of children, and 18.6% were stunted. A significant association between food security and child nutritional status (p = 0.001) indicates that improving household food security is essential to reducing stunting, alongside addressing health and environmental factors.

Table 2: The relationship between family food security status and nutritional status based on HAZ

Variable		Nutritional status								*p*
		Severely stunted		Stunted		Normal		Tall		
		n	%	n	%	n	%	n	%	
Household food security	Food secure	2	2.70%	8	10.81%	52	70.27%	12	16.22%	
	Food insecure without hunger	1	2.56%	7	17.95%	30	76.92%	1	2.56%	0.001
	Food insecure with moderate hunger	3	13.64%	2	9.09%	17	77.27%	0	0.00%	
	Food insecure with severe hunger	3	60.00%	0	0.00%	2	40.00%	0	0.00%	

Analysis of the relationship between diarrheal infectious diseases and nutritional status of children under five according to HAZ with data processing using the Kruskal–Wallis test showed that the p-value was 0.001 (<0.05), which indicates a significant relationship between the two variables. The data showed that most children who had experienced chronic diarrhea in the past year had a normal nutritional status.

Multivariate analysis was carried out to determine how much correlation and the extent of the significance of the correlation between the terms of the variables included in the multivariate analysis if p < 0.25 in the bivariate analysis results. The assumption required in the multivariate logistic regression analysis was multicollinearity. Multicollinearity indicates a strong relationship between independent variables. Using a chi square 2 × 2 table and an expected count of <20%. The results show strong multicollinearity between variables, as evidenced by the ROC curve area value of 0.695, which meets the requirements of above 0.5. The logistic equation model obtained was log p (stunting) = -2.549 + 1.808 (parental income < minimum wage) + 6.098 (history of diarrhea) + 1.396 (food insecurity). Based on the independent variable equation,, with the dependent variable. This study examined the relationship between the incidence of chronic diarrhea, stunting, and food insecurity on the incidence of stunting.

Table 3: The relationship between diarrheal disease and nutritional status based on HAZ

Variable		Nutritional status								*p*
		Severely stunted		Stunted		Normal		Tall		
		n	%	n	%	n	%	n	%	
Diarrhea history	Yes	7	22.58%	7	22.58%	15	48.39%	2	6.45%	<0.001
	No	2	1.83%	10	9.17%	86	78.90%	11	10.09%	

Stunting in this study was thought to be caused by environmental factors and poor nutritional status. Environmental conditions that are risk factors are related to stunting, such as water conditions, sanitation, and hygiene [14]. Based on the Central Bureau of Statistics of Sayung Subdistrict in 2021, figures show that most people use drilled wells / pumps and plumbing with meters as a source of water [15]. The condition of the water consumed by this community may not have been cooked properly or the storage is not good.

A previous study explained that the causes of wasting, stunting, and anemia in children under five years old are childbirth weight, child health and nutritional status, parenting practices, maternal nutrition and health status, household water source, and sanitation conditions. In addition, there are social and economic factors that affect the nutritional status of children, namely the education level of parents, especially mothers, the health and nutritional status of mothers during pregnancy and lactation, the immunization status of children, and the wealth status of families and the current political system. The prevalence of stunting in children in Indonesia is approximately 37%. The main determinants of stunting, which have been identified in Indonesian children are premature birth, short birth length, non-exclusive breastfeeding, low maternal height and education level, inadequate latrines, untreated drinking water, poor surplus health care and poor household socioeconomic status [16].

The minimum wage policy is used as a benchmark because in its stipulation, the central government sets this policy as an effort to realize workers' rights to a decent livelihood for humanity, as stipulated in Article 4 of CHAPTER II of Government Regulation Number 36 of 2021 [17]. Income below the minimum wage is considered an inadequate household income. As many as 47.14% of households had inadequate income. At the time of data collection, many people claimed to have experienced the impact of the pandemic and the occurrence of natural disasters, such as floods and tidal floods, the timing of which was increasingly difficult to predict, making it an obstacle for the community to be active. This has an impact on the income value of families who have jobs with irregular salaries, and the impact of layoffs on some families.

The relationship between food security status and the degree of under-five nutritional status based on HAZ is shown with a p-value of 0.001. There are difficulties when food insecurity measures are associated with households, because the measures do not always include the same food security status for all children in the household. Younger children are often prioritized and protected more than older children and parents [18]. Previous research has shown a significant relationship between the socioeconomic status of children living in developing countries. Social inequality significantly affects the incidence of stunting among children. Children living in rural areas with low income have a higher prevalence of stunting than those living in urban areas [16].

A previous study that conducted a household survey with a cross-sectional research design showed that there is a significant relationship between the incidence of food insecurity and chronic malnutrition that results in stunting (P < 0.003). This study also compared the locations where the respondents lived. There was a stronger association between food insecurity and stunting in children living in urban areas (P < 0.001) than in rural households (P < 0.019). The study also concluded that interventions to improve food security are needed to reduce the incidence of malnutrition by considering the location, climate, and household environment [19]. Most children under five did not experience diarrhea and their nutritional status based on HAZ was normal. The results of statistical tests using the chi-square correlation test showed a p-value of <0.001 which indicates that diarrhea infection is related to the nutritional status of toddlers based on TB / U.

Acutely and chronically malnourished children are at an increased risk of morbidity and mortality following an episode of diarrhea. A previous cross-sectional study of Kenyan children aged 6-59 months with acute diarrhea revealed that stunting was not associated with the severity of clinical conditions or presence of specific pathogens. Children who wasted with diarrhea experienced more severe illnesses than those without malnutrition. This is due to delays in care-seeking or reduced immune response to infection [20].

Both studies conducted in Demak's coastal area highlight how sociodemographic factors, such as parental education, household income, and family type, play a crucial role in shaping food security and dietary diversity among vulnerable populations [21]. These findings emphasize that improving household food security and children's nutritional status requires integrated interventions that address education, income, and health-related determinants in disaster-prone coastal communities [22].

The limitations of this study include the assessment of chronic diarrhea, which still has high bias. In addition, the data were collected during the pandemic two years earlier, so many households were affected by the economy and the number of households experiencing food insecurity was quite high. Other limitations that affect the results of the study include genetic factors, child nutritional status, hormonal factors, maternal nutritional

status, household water source, child birth weight, and delivery complications.

4. Conclusions

This study concludes that there is a significant relationship between food insecurity and diarrhea on stunting in children aged 2-5 years with diarrhea as the variable that most influences the incidence of stunting. For further research, it is necessary to consider the genetic, hormonal, and complications of disorders. In addition, to assess diarrheal disease, which still has high bias, it is necessary to conduct research on measuring diarrheal disease using more objective biomarkers to minimize bias. Further research is needed to determine the conditions of food insecurity in the Sayung sub-district community after the Covid-19 pandemic which may experience changes in economic levels and food insecurity conditions.

5. Sources of funding

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