Nutritional Status Measurement Using CIAF in Flood-Affected Toddlers in Sidomulyo Village, Bumiaji, Batu

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Abstract

Background: Flooding often leads to malnutrition among children under five, driven by limited access to nutritious food and unsanitary conditions. Sidomulyo Village in Batu City, prone to flooding due to the Paron River overflow, has faced challenges affecting the nutritional status of children. **Objective:** this research aims to analyze the nutritional status and its determinants using the CIAF Index for children under 5 years old affected by flooding in Sidomulyo Village, Bumiaji District, Batu City, Indonesia. **Methods:** This analytical observational study involved 20 pairs of mothers and children under five residing in Sidomulyo Village. Anthropometric measurements were conducted by calculating their z-scores, and classifying their nutritional status using the Composite Index of Anthropometric Failure (CIAF). Interviews were conducted to gather data on maternal, child, and sanitation characteristics. Data analysis was performed using SPSS version 23.0, including descriptive analysis and Chi-square tests to examine relationships ($P < 0.05$). **Results:** The findings revealed that 68.75% of toddlers in Sidomulyo had a normal nutritional status. Factors influencing nutritional status included maternal characteristics (maternal height, education level, and family income) and child-related factors (frequency of food consumption). **Conclusion:** The study concluded that most toddlers affected by flooding in Sidomulyo have normal nutritional status. Also the determining factors of children's nutritional status are maternal height, education level, family income and frequency of food consumption. The results of the study can be used as a reference for further research with the aim of maintaining children's nutritional status in this area.

Keywords: anthropometric failure, flood, maternal, toddler, sanitation

Original Research Article

INTRODUCTION

Indonesia is a country located in the Asia-Pacific region, which makes it highly prone to various natural disasters. The nation consists of numerous islands, resulting in a complex geological and geographical structure that increases its vulnerability to natural hazards (Hadi et al., 2019). Geographically, Indonesia is situated at the convergence of three tectonic plates: the Indo-Australian, Eurasian, and Pacific plates. Consequently, the country frequently experiences significant seismic activity, including earthquakes, volcanic eruptions, landslides, and other natural disasters (Lestari et al., 2021). Additionally, Indonesia lies along the Pacific Ring of Fire, making it home to some of the most active volcanoes in the world and placing it at high risk of volcanic disasters. These factors collectively classify Indonesia as a disaster-prone region. The most frequent natural disasters include floods (1,070 incidents), tornadoes (879 incidents), and landslides (575 incidents) (Arifin et al., 2021).

Floods are phenomena that occur when rivers or other bodies of water overflow or submerge surrounding areas due to heavy rainfall or tidal waves, leading to widespread inundation (Muliaty, 2021). Indonesia is known for its high annual rainfall, ranging from 2,000 to 3,000 mm, making floods more likely during the rainy season, which typically spans from October to January. The presence of approximately 600 major rivers across the country, many of which are poorly maintained and inadequately managed, further exacerbates the risk of flooding (Findayani, 2015). In addition to riverine floods, coastal flooding caused by seawater inundation also occurs. This is primarily driven by land subsidence and rising sea levels due to global warming. Flood disasters lead to various losses, including damage to infrastructure, the destruction of valuable possessions, and disruptions to daily activities for affected communities (Nadya & Salim, 2023). From a health perspective, floods contribute to the spread of diseases such as dengue fever, malaria, cholera, diarrhea, dysentery, tuberculosis, skin infections, respiratory tract infections, and leptospirosis. These health impacts are worsened by unhealthy environmental conditions, which can promote the emergence of dangerous acute infectious diseases. The occurrence of these diseases is closely linked to predisposing factors that arise during flooding events (Sitorus et al., 2023).

One of the most vulnerable groups in the face of natural disasters is children, as they are still in their developmental stages both physically and mentally and remain dependent on adults. Experiencing traumatic and distressing events caused by disasters can lead to significant stress and deep psychological trauma in children, as well as in adults (Peni et al., 2020). Flooding has severe implications for children, affecting their health, nutrition, education, and overall well-being. Exposure to floodwaters increases the risk of waterborne diseases such as diarrhea, cholera, and skin infections, which can lead to dehydration and malnutrition (Gallego et al., 2025). Poor sanitation and contaminated water sources further compromise children's immune systems, making them more vulnerable to infections (Shrestha et al., 2022). Additionally, floods often disrupt food supply chains and displace families, leading to food insecurity and inadequate nutrient intake, which can hinder children's physical and cognitive development (Ghimire et al., 2023). The destruction of homes and schools also affects children's sense of security and access to education, causing emotional distress and long-term psychological effects (Afriyanti et al., 2024).

One of the regions in Indonesia frequently affected by flooding is Batu City. As Batu City continues to develop as an agricultural and tourism hub, the demand for infrastructure and facilities has increased significantly over the years. One of the major challenges faced by the city is the reduction of water catchment areas due to population growth and development demands. This has led to an increase in surface runoff during the rainy season, resulting in flooding (Marzuqi et al., 2016). Sidomulyo Village, located in Batu City, Malang, East Java, is renowned for its ornamental and cut flowers, which serve as the village's signature product. Situated on the southern slopes of Mount Arjuno at an altitude of 800–850 meters above sea level, the village experiences temperatures ranging from 15 to 17 degrees Celsius. Sidomulyo Village is bordered by the following administrative areas: to

the north by Bumiaji District, to the south by Kesisir Subdistrict, to the east by Bumiaji District, and to the west by Bumiaji District and Sumberejo Village (Rahma & Aldila, 2016). According to Media Posko Malang (January 8, 2024), Sidomulyo Village in Bumiaji District experienced flooding after heavy rainfall lasting three hours. This area is prone to flooding due to the overflow of the Paron River. Sidomulyo Village frequently experiences flooding due to the overflow of the Paron River, causing water to spread onto roads and affecting some residents. However, the recent flooding was not as severe as previous events (Malang Poscomedia, 2024). In contrast, in 2021, Sidomulyo Village experienced a severe flood that resulted in casualties, swept away vehicles, and submerged houses (CNN, 2021).

Flooding significantly impacts the nutritional status of toddlers by disrupting food security, increasing disease risks, and limiting access to healthcare, making proper nutritional assessment essential (Ghimire et al., 2023). During floods, food shortages and economic hardships often force families to rely on inadequate diets, leading to insufficient energy and nutrient intake in toddlers. Contaminated water sources and poor sanitation expose children to waterborne diseases such as diarrhea, which further exacerbates malnutrition by causing dehydration and nutrient loss (Aborode et al., 2025). Given these challenges, analyzing the nutritional status of toddlers in flood-affected areas is crucial to identifying the true extent of malnutrition to toddlers. In this study, the nutritional status of flood-affected children was analyzed using a combined method, the Composite Index of Anthropometric Failure (CIAF). This approach classifies children into seven categories such as no failure; wasting only; wasting and underweight; wasting, underweight, and stunting; underweight and stunting; stunting only; and underweight only (Kuiti et al., 2022).

The advantage of this method is that unlike conventional methods that assess wasting, stunting, or underweight separately**,** CIAF identifies children experiencing multiple forms of malnutrition simultaneously. Traditional indicators may underestimate the true extent of child malnutrition by classifying children into isolated categories. CIAF captures all forms of anthropometric failure, ensuring no undernourished child is overlooked (Permatasari & Chadirin, 2022). Thus, measuring nutritional status with CIAF offers a more comprehensive solution, allowing for targeted prevention based on the type of malnutrition experienced by children. Research analyzing children's nutritional status using the CIAF method in children affected by disasters has never been conducted. Previous research was only conducted using conventional methods. Previous studies, such as one conducted by (Nurulfuadi et al., 2021), analyzed the nutritional status of children under five following the earthquake in Palu, Sigi, and Donggala using conventional methods. Similarly, another study by (Nasrul et al., 2019) on children in Buluri Subdistrict, Palu, also relied on conventional methods. Based on the aforementioned considerations, this study aims to analyze the nutritional status and its determinants using the CIAF index for children affected by flooding in Sidomulyo Village, Bumiaji District, Batu City. This study is urgently needed to bridge this research gap by using the CIAF method to assess the comprehensive nutritional status of flood-affected toddlers. The findings will provide valuable insights for local health authorities and policymakers to develop targeted interventions and nutritional support programs for disaster-affected communities.

MATERIALS AND METHODS

Research Design

This study is an analytical observational study. The research was conducted in August 2024 in Sidomulyo Village, Bumiaji District, Batu City, East Java Province, Indonesia.

Population and Sample

The population in this study comprises children under five years old and their mothers in Sidomulyo Village. The sample consists of 20 pairs of mothers and children under 5 years from Sidomulyo Village. The inclusion criteria for this study are children aged 0–59 months who have lived in Sidomulyo Village since birth, have no physical or mental disabilities, and whose parents or guardians have provided informed consent for participation. The exclusion criteria include children with chronic diseases that

interfere with nutritional status, such as tuberculosis, nephrotic syndrome, heart disease, and respiratory infections.

Measurement and Data Collection

Weight Measurement

Body weight was measured using a digital weighing scale. For children under 2 years of age, weight was measured using a digital baby scale with light clothing and without a diaper. For children older than 2 years, weight was measured using a digital floor scale. Before weighing, shoes, accessories such as hats, and other items were removed, and the clothing was not excessively thick.

Height Measurement

Height was measured using an infantometer or stature meter. For children under 2 years or those unable to stand, height was measured using a length board with a measurement range of 10-99 cm. The child's feet were placed close together, with the knees pressed straight and the soles of the feet aligned. For children over 2 years old or those able to stand, height was measured using a stature meter. The child was required to stand upright with arms relaxed at their sides.

Anthropometric Measurement

Anthropometric measurements were performed using the CIAF index, which combines three indices: weight-for-age, length/height-for-age, and weight-for-length/height to assess the nutritional status of children under five. The child's age was obtained from the information provided by the mother, including the child's birth date, month, and year, and then the age was calculated in months.

Table 1. CIAF Index Classification for Children Under Five Years

CIAF Classification	Description	Wasting	Stunting	Underweight
No failure	Normal WAZ, HAZ and WHZ	-	-	-
Wasting only	WAZ < - 2 SD, but normal HAZ and WHZ	V	-	-
Wasting and underweight	WAZ and WHZ < - 2 SD, but HAZ normal	V	-	V
Wasting, underweight, and stunting	WAZ, WHZ and HAZ < - 2 SD	V	V	V
Stunting and underweight	HAZ and WHZ < - 2 SD, but WAZ normal	-	V	V
Stunting only	HAZ < - 2 SD, but normal WAZ and WHZ	-	V	-
Underweight only	WHZ < - 2 SD, but normal HAZ and WAZ	-	-	V

Mother and Child Characteristics

The characteristics of mothers and children were assessed through direct interviews. Maternal characteristics include age (under 25 years or over 25 years), height (short if less than 150 cm or tall if 150 cm or more), maternal education level (low if no schooling or only elementary/middle school education, high if at least high school education), employment status (unemployed or employed), family income was classified as low if it was below the regional minimum wage or high if it exceeded the regional minimum wage. Child characteristics include gender (male or female), age (under 24 months or 24 months or older), The frequency of food source consumption (low if less than 3 times a day, high if 3 or more times a day).

Sanitation

Sanitation was assessed through direct interviews. Water source (protected or unprotected), and handwashing habits (yes or no, using running water and soap).

Data Analysis

The data were analyzed using SPSS version 23.0 software. Descriptive statistics, including mean, standard deviation, and percentage, were analyzed using univariate analysis to obtain a distribution of the frequency for each variable. Bivariate analysis was conducted using the chi-square test to determine the relationships between variables with a 95% confidence level.

Ethical Statement

This study was approved by the ethics committee of Faculty of Medicine, Wijaya Kusuma University, Indonesia (certificate number 41/SLE/FK/UWKS/2025).

RESULTS

The nutritional status assessment based on the CIAF (Composite Index of Anthropometric Failure) index for children under five is presented in **Table 2**. In Sidomulyo Village, most children under five are classified as having normal nutritional status or no failure (68.75%). However, some children exhibit various forms of nutritional deficiencies, including wasting only (6.25%), wasting and underweight (6.25%), stunting and underweight (3.13%), stunting only (9.37%), and underweight only (6.25%). When analyzed by age groups, children aged 0–24 months mostly categorized into the no failure category (83.4%), with some categorized as wasting only (8.3%) and stunting only (8.3%). In contrast, children aged 25–60 months show a distribution of no failure (60%), wasting only (5%), wasting and underweight (10%), stunting and underweight (5%), stunting only (10%), and underweight only (10%). Regarding nutritional status based on gender, boys are classified as normal (65%), wasting only (5%), wasting and underweight (10%), stunting and underweight (5%), stunting only (5%), and underweight only (10%). Meanwhile, girls are predominantly classified as normal (75%), wasting only (8.4%), and stunting only (16.6%).

Table 2. Classification of Nutritional Status Based on CIAF Index in Children Under 5 Years

Categories	Aged (0-24 Months)		Aged (25-60 Months)		Male		Female		Total	
	n	%	n	%	n	%	n	%	n	%
No failure	10	83,4%	12	60%	13	65%	9	75%	22	68,75%
Wasting only	1	8,3%	1	5%	1	5%	1	8,4%	2	6,25%
Wasting & underweight	0	0	2	10%	2	10%	0	0	2	6,25%
Wasting, underweight, & stunting	0	0	0	0	0	0	0	0	0	0
Stunting & underweight	0	0	1	5%	1	5%	0	0	1	3,13%
Stunting only	1	8,3%	2	10%	1	5%	2	16,6%	3	9,37%
Underweight only	0	0	2	10%	2	10%	0	0	2	6,25%

The maternal and child characteristics are summarized in Table 3. Based on maternal characteristics, the majority were older than 25 years (95%), had a height of more than 150 cm (95%), were unemployed (70%), and had a high income (80%). Regarding child characteristics, most were boys (20%), with 12 children (37.5%) aged 0–24 months and 20 children (62.5%) aged 25–60 months. Additionally, the frequency of children's food consumption was generally more than three times per day. Among maternal factors, anthropometric failure was predominantly associated with maternal age

over 25 years (90%), height above 150 cm (80%), low educational attainment (70%), unemployment (90%), and high family income exceeding the regional minimum wage (60%). Regarding child-related factors, boys (70%) exhibited a higher prevalence of anthropometric failure compared to girls (30%). Children aged 25–60 months (80%) had a greater likelihood of anthropometric failure than those under 25 months (20%). Furthermore, all children experiencing anthropometric failure (100%) consumed meals less than three times per day, had access to protected water sources, and practiced regular handwashing. The Chi-square analysis identified significant determinants of anthropometric failure, including maternal factors such as age (*P* = 0.001), education level (*P* = 0.000), and family income (*P* = 0.000), as well as child-related factors such as meal frequency of less than three times per day (*P* = 0.000).

Table 3. Maternal and Child Characteristics Based on CIAF Index

Characteristics	n(%)	Anthropometric Failure using CIAF Index n(%)	*P-value*
Maternal Characteristics			
Age			
< 25 years	1 (5%)	1 (10%)	**0.0016**
> 25 years	19 (95%)	9 (90%)	
Height			
Short (< 150 cm)	1 (5%)	2 (20%)	**0.000**
Height (> 150 cm)	19 (95%)	8 (80%)	
Education			
Low	7 (35%)	7 (70%)	**0.000**
High	13 (65%)	3 (30%)	
Working Status			
Unemployed	14 (70%)	9 (90%)	**0.0418**
Employed	6 (30%)	1 (10%)	
Family Income			
Low	4 (20%)	4 (40%)	**0.0126**
High	16 (80%)	6 (60%)	
Child Characteristics			
Sex			
Male	20 (62.5%)	7 (70%)	0.572
Female	12 (37.5%)	3 (30%)	
Age			
0-24 Months	12 (37.5%)	2 (20%)	0.290
25-60 Months	20 (62.5%)	8 (80%)	
Frequency Consumption of Food			
Low (< 3x/day)	10 (31.25%)	10 (100%)	**0.000**
High (> 3x/day)	22 (68.75%)	0	
Sanitation			
Water Source			
Unprotected	0	0	1.225
Protected	32 (100%)	10 (100%)	
Handwashing Habit			
Not good	0	0	1.225
Good	32 (100%)	10 (100%)	

*Statistically significant at *p*=0.05

DISCUSSION

Based on Table 2, most children experiencing anthropometric failure are those aged 25–60 months, with categories including wasting only (5%), wasting & underweight (10%), stunting & underweight (5%), stunting only (10%), and underweight only (10%). This finding aligns with a study by Andini et al. (2020), which reported that malnourished children are more commonly found among those aged 7–23 months. This occurs due to a gap between the body's energy and nutrient needs and the actual

intake. As children grow older, their nutritional and energy needs increase. However, these needs are also influenced by family characteristics such as socioeconomic status, parenting patterns, and parental knowledge about children's nutritional requirements. Additionally, in this study, boys were more likely to experience anthropometric failure, with categories including wasting only (5%), wasting & underweight (10%), stunting & underweight (5%), stunting only (5%), and underweight only (10%). This is consistent with research by Ariawan *et a*l (2021), which showed that boys are more likely to experience malnutrition and undernutrition than girls. This difference is attributed to the higher physical activity levels of boys compared to girls, leading to greater energy expenditure, while their nutritional intake may be insufficient to meet their body's needs.

Based on the results shown in table 3, maternal age (*P* = 0.0016), maternal height (*P* = 0.000) and work status (*P* = 0.0418) influence children's nutritional status. The results indicate that maternal height significantly influences the nutritional status of children. Children born to mothers with a height of ≤150 cm have a 30.8% higher risk of stunting compared to those born to mothers taller than 150 cm, who have a lower risk of stunting. Genetically, parents with short stature are more likely to pass this trait to their children. Parental height impacts a child's growth, and if one parent has less-than-ideal height, the child is likely to inherit a similar stature (Baidho et al., 2021). This genetic predisposition is due to the inheritance of short-stature traits through chromosomes carrying specific genes from parents. Maternal height, in particular, plays a critical role in determining a child's stature, as mothers with shorter heights may increase the risk of intrauterine growth restriction (Ramadhan et al., 2020). Apart from genetic factors, other factors related to a child's nutritional status include socioeconomic status and parenting patterns. Mothers with shorter stature may have more limited access to nutritious food and healthcare services, which can further exacerbate the risk of malnutrition in children (Yuwanti et al., 2021).

The mother's age greatly influences the nutritional status of the child. In this study, most mothers were classified as having a young maternal age, which may be associated with a lack of knowledge about nutrition. Age is an important factor influencing a mother's level of nutritional knowledge. Younger mothers may have insufficient knowledge about proper nutrition, both during pregnancy and after childbirth, which can impact the nutritional status of their children (…). The ideal age for pregnancy is between 20–35 years. However, in reality, many women give birth before the age of 20 while still having children with normal nutritional status. This can be attributed to the mother's dedication in caring for, nurturing, and raising her child. A positive attitude and adequate knowledge about child nutrition significantly impact feeding practices, which in turn influence the nutritional status of young children (Yunus, 2018). The mother's occupation also affects the child's nutritional status. Based on the results of the study, mothers who do not work have children with poor nutritional status. Soleha & Zelharsandy (2023) reported that working mothers have sufficient income to meet their children's needs, so that the mother's working conditions have an impact on the child's nutritional status. However, a working mother must pay attention to her child's eating patterns so that the child does not experience malnutrition (Mustika, 2015).

The results showed that anthropometric failure was influenced by education level (*P* = 0.000), family income (*P* = 0.000), and child habit such as meal frequency of less than three times per day (*P* = 0.000). Kasumayanti & Zurrahmi (2020) reported that low household income can affect various aspects, including poor dietary habits, limited healthcare maintenance, and overall family well-being. Income level is a crucial determinant of the quality and quantity of food consumed. A family's ability to purchase nutritious food depends on income, and families with limited income are less likely to meet their dietary needs, particularly essential nutrients. However, in this study, respondents with income levels above the regional minimum wage (UMR) were found to have children with anthropometric failure. This anomaly may result from improper parenting practices, where parents fail to monitor meal times or the quality of food consumed by their children. Adequate attention and proper caregiving practices significantly influence improving a child's nutritional status (Sudarsih & Wijayanti, 2013).

Apart from family income level, it turns out that in this study, maternal education is also related to the child's nutritional status. Maternal education plays a crucial role in determining the nutritional status of children. Higher maternal education levels are associated with better human capital investment, as improved maternal education contributes to enhanced child nutrition (Tazinya et al., 2018). Educated mothers are more likely to adopt effective parenting practices, including making informed dietary choices for their children. Maternal education is strongly linked to an individual's knowledge. Education level, both directly and indirectly, is a fundamental factor influencing nutritional issues among young children. A mother's educational attainment impacts her understanding and ability to access critical information about optimal childcare practices, which are vital for improving child nutrition (Shaputri & Dewanto, 2023). Children's eating frequency habits also affect their nutritional status. Dietary patterns in early childhood are also essential for growth and development, as food is a primary source of nutrients. Proper nutrition is integral to physical growth, health, and cognitive development. A poor diet during early childhood can disrupt growth, leading to conditions such as underweight, stunted growth, or even severe malnutrition (Petralina, 2020).

CONCLUSION

The conclusion of this study is that most toddlers affected by flooding in Sidomulyo Village have normal nutritional status or no failure. Maternal characteristics, including maternal height, education, family income, and the frequency of daily food consumption, significantly influence the nutritional status of toddlers in Sidomulyo Village. This study has several limitations that can serve as points of evaluation and guidance for future research on the same topic. Future studies could benefit from a larger sample size to obtain more accurate statistical results. And also the inclusion of additional relevant questions to find out other factors that influence nutritional status so that it is more comprehensive. This findings can be reference for intervention research to maintain or improve the nutritional status of toodler in Sidomulyo Village and be a reference for local health workers to make policies.

CONFLICT OF INTEREST

The authors declared that there is no conflict of interest.

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