



Nutritional status of children in Central Sulawesi post-earthquake and tsunami: A study based on e-PPGBM data

Status gizi pada anak di Sulawesi Tengah pasca-gempa bumi dan tsunami: Studi berdasarkan data e-PPGBM

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Abstract

The September 28, 2018, earthquake and tsunami in Central Sulawesi had a severe impact on children's health and nutrition, particularly in relation to malnutrition and micronutrient deficiencies. This study aimed to compare the nutritional status of children living in disaster-affected and non-disaster-affected areas. The research method used a cross-sectional design, conducted in Sigi Regency in April 2024. Samples were children aged 6-23 months taken from the e-PPGBM System data. The study analyzed data from three periods: before and after the disaster, with data from 10,894 children and 10,894 children. Statistical tests were used to identify the changes in stunting, underweight, and wasting. The results showed that after the disaster, the average Z-scores of Height-for-Age (HAZ) and Weight-for-Height (WHZ) was significantly lower in the disaster-affected areas than in the unaffected areas ($p = 0.000$), indicating a sustainable impact on the growth and nutritional status of children. In conclusion, there was a significant decrease in the nutritional status of children in disaster-affected areas compared with that in non-disaster-affected areas. Rapid action and sustained recovery efforts are essential to address the long-term effects on children's growth and nutrition.

Keywords: e-PPGBM, post-disaster nutrition, stunting, wasting

Abstrak

Gempa bumi dan tsunami pada 28 September 2018 di Sulawesi Tengah berdampak berat pada kesehatan dan gizi anak-anak, terutama terkait dengan malnutrisi dan kekurangan mikronutrien. Penelitian bertujuan untuk membandingkan status gizi anak-anak di daerah yang terkena bencana dan daerah yang tidak terkena bencana. Metode penelitian menggunakan desain cross sectional, dilakukan di Kabupaten Sigi, pada April 2024. Sampel merupakan anak usia 6-23 bulan diambil dari data Sistem e-PPGBM. Data yang dianalisis mencakup tiga periode: sebelum dan setelah bencana, dengan data dari 10.894 anak. Uji statistik menunjukkan perubahan pada stunting, berat badan kurang, dan wasting. Hasil penelitian menunjukkan bahwa setelah bencana, rata-rata Z-Score TB/U dan BB/TB secara signifikan lebih rendah di daerah yang terkena bencana dibandingkan dengan daerah yang tidak terkena bencana ($p = 0,000$), menunjukkan dampak yang berkelanjutan pada pertumbuhan dan status gizi anak-anak. Kesimpulan, terdapat penurunan signifikan dalam status gizi anak-anak di daerah yang terkena bencana dibandingkan dengan daerah yang tidak terkena bencana. Tindakan cepat dan upaya pemulihan yang berkelanjutan sangat penting untuk mengatasi dampak jangka panjang pada pertumbuhan dan gizi anak-anak.

Kata Kunci: e-PPGBM, gizi pasca-bencana, stunting, wasting

Introduction

Natural disasters have a significant impact on the nutritional status of children both globally and nationally. Globally, over 149 million children under the age of five experienced stunting due to chronic malnutrition in 2023 (UNICEF, 2023); In Indonesia, the prevalence of stunting is 24.4% in 2023, particularly in areas frequently affected by disasters such as earthquakes and floods (Ministry of Health of the Republic of Indonesia, 2023), and recent trends indicate that nutritional management in disaster-affected areas increasingly involves a multi-sectoral approach, including economic recovery and nutrition education.

However, challenges, such as inter-agency coordination and program sustainability, still need to be addressed (WFP, 2024). September 28, 2018 (Polcari et al., 2019; Syifa et al., 2019) An earthquake with a magnitude of 7.7 on the Richter scale hit Central Sulawesi Province, especially Donggala district, Parigi Moutong district and Palu city. Fifteen minutes later, the tsunami hit Palu City. The estimated affected population is more than 310,000 people in Donggala County, near the epicenter of the earthquake. The nearest major city is Palu, which has a maximum population of over 350,000 (WHO, 2018). A State of Emergency was declared for a national response, which demonstrated an inability to cope with the local capacity (Yew et al., 2020).

Expert attention related to children's nutritional status is an indicator of the importance of assessing the welfare of a population in a certain area (Al Rahmad et al., 2023; Arbie & Labatjo, 2019; Hulu et al., 2022; Zamzamy et al., 2024). It can be accessed through health cards or surveys (Al Rahmad, 2018).

The combination of health surveys and disaster data offers an easily accessible and accurate method to determine the long-term public health consequences of natural disasters. Rydberg et al.'s study shows that the comparison of stunting before and after an earthquake is an important indicator of community welfare, as is the comparison between populations and different levels of earthquake exposure (Rydberg et al., 2015). Most children in disaster-affected areas continue to experience various forms of malnutrition including stunting, emaciation, and

wasting. The prevalence rates of stunting in children aged 6-23 months are 10.8%, 4.9%, and 2.8%, respectively (Sun et al., 2013). Children in the disaster-exposed group had a higher body mass index and a higher proportion of overweight after the earthquake than those in the control group (Zheng et al., 2017). Another study in Japan showed that children affected by the disaster in Fukushima Prefecture at an early age had an increased proportion of overweight children (Ono et al., 2018). Previous health examination data are useful for investigating the physical growth of the affected children.

In this context, the combination of data from the Integrated Nutrition Information System (SIGIZI) and the e-PPGBM allows for a comprehensive analysis of the nutritional status of children in disaster-affected and unaffected areas. This study aimed to compare the nutritional status of children in disaster-affected areas with that in non-disaster-affected areas using e-PPGBM data. This study identified the long-term impact of disasters on children's nutritional health and highlighted the uniqueness of using e-PPGBM data as an added value in this analysis.

Methods

The type of research used in this study was cross-sectional, with a comparative design that aimed to compare the nutritional status of children in disaster-affected areas and those not affected by disasters. This research was carried out in April 2024 using electronic secondary data-Community-Based Nutrition Recording and Reporting (e-PPGBM). This research has undergone an ethics test conducted at the Ethics Commission of the Poltekkes of the Ministry of Health of Surabaya, and has been declared to have met ethical principles and can be carried out with the ethical number EA/2209.1/KEPK-Poltekkes_Sby/V/2024.

The Ministry of Health (Kemenkes) launched the Integrated Nutrition Information System (SIGIZI Terpadu), which is a national nutritional information system that records and reports community-based nutritional data. With a special focus on adolescents, pregnant women, and children under the age of five years, this system is used to track the implementation of various nutrition programs

in Indonesia. One of the main modules of the SIGIZI platform is e-PPGBM.

Using eppgm data from Sigi Regency. Covering 15 sub-districts: Dolo, West Dolo, South Dolo, Gumbasa, Kinovaro, Kulawi, South Kulawi, Lindu, Marawola, West Marawola, Nokilalaki, Palolo, Pipikoro, Sigi Biromaru, and Tanambulava. The measurement time was divided into three: 12 months before the disaster on September 28, 2017, and September 28, 2018 which obtained 2840 children's data. The first six months after the disaster (September 29, 2018–March 28, 2019) obtained data from 7248 and the second six months after the disaster (March 29, 2019–September 29, 2019) obtained data on 10,894 children.

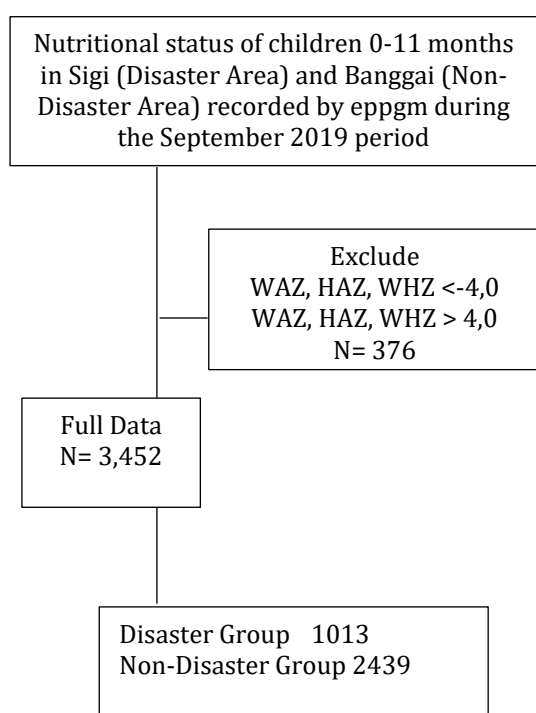


Image 1. Research sample

The collected data were processed using statistical software, focusing on anthropometric indicators, such as Weight-for-Age Z-score (WAZ), Height-for-Age Z-score (HAZ), and Weight-for-Height Z-score (WHZ). A comparative analysis was conducted to assess the differences in nutritional status between disaster-affected and unaffected areas. Statistical tests, such as Chi-square, independent t-tests, and ANOVA, were used to evaluate the significance of the differences in nutritional status between the groups. Statistical significance was set at $p < 0.05$.

Result and Discussion

Data from the three tables highlight the impact of the earthquake and tsunami in Central Sulawesi on the children's overall nutritional condition. Table 1 shows the significant variations in the number of affected children in different districts, with Palolo and Sigi Biromu showing marked changes in the percentage of children registered in the e-PPGBM system before and after the disaster.

Table 2 shows the differences in the prevalence of nutritional problems between affected and unaffected areas before the disaster. In the affected areas, the prevalence of underweight, stunting, and wasting among children was lower than in the unaffected areas, whereas in the unaffected areas, the prevalence of nutritional problems was higher.

Table 3 shows a comparison of the average Z-scores for the anthropometric indicators in the affected and unaffected areas after the disaster. The results indicated that the average Z-scores for height-for-age (HAZ) and weight-for-height (WHZ) were significantly lower in the affected areas than in the unaffected areas, highlighting the ongoing impact on children's growth and nutritional status.

The data showed significant variations in the number of children affected by the earthquake and tsunami in Central Sulawesi. Palolo District recorded the highest percentage of affected children (20.3%) before the disaster, which dropped to 10.6% at 0-6 months post-disaster and rose to 16.6% after 7-12 months. Sigi Biromu showed that 10.6% of children were affected after the disaster, but this increased to 14.5% after 7-12 months. This highlights the dynamic change in the distribution of disaster impacts on the number of children recorded in the e-PPGBM system in the various affected districts.

The initial decline in the percentage of affected children in Palolo after the disaster may be due to the movement of the population to other areas or disruptions to the recording system, whereas the increase again after 7-12 months indicates the partial recovery of the population returning to their home areas or an increase in recording accuracy. In Sigi Biromu, an increase in the percentage of affected

children after 7-12 months can reflect a slow recovery or decline in socioeconomic conditions that affect the nutritional status of children.

Table 1. Number of children recorded in e-PPGBM in areas affected by natural disasters such as earthquake and tsunami in Central Sulawesi

District	Types of Disasters		Child n (%)		
	Earthquake	Liquefaction	1 year prior (n=2.355)	After 0-6 months (n=6.457)	After 7-12 months (n=10.239)
Dolo	Yes	No	336 (14.3)	720 (11.2)	389 (3.8)
Dolo Barat	Yes	No	148 (6.3)	462 (7.2)	585 (5.7)
Dolo Selatan	Yes	No	191 (8.1)	80 (1.2)	980 (9.6)
Gumbasa	Yes	No	60 (2.5)	396 (6.1)	186 (1.8)
Kinovaro	Yes	No	122 (5.2)	428 (6.6)	918 (9.0)
Kulawi	Yes	No	186 (7.9)	327 (5.1)	761 (7.4)
Kulawi Selatan	Yes	No	76 (3.2)	373 (5.8)	718 (7.0)
Lindu	Yes	No	83 (3.5)	32 (0.5)	139 (1.4)
Marawola	Yes	No	309 (13.1)	1169 (18.1)	1013 (9.9)
Marawola Barat	Yes	No	14 (0.6)	206 (3.2)	274 (2.7)
Nokilalaki	Yes	No	46 (2.0)	141 (2.2)	319 (3.1)
Palolo	Yes	No	479 (20.3)	685 (10.6)	1702 (16.6)
Pipikoro	Yes	No	27 (1.1)	320 (5.0)	463 (4.5)
Sigi Biromu	Yes	Yes	249 (10.6)	762 (11.8)	1486 (14.5)
Tanambulava	Yes	No	29 (1.2)	356 (5.5)	306 (3.0)

Table 2. Comparison of the prevalence of nutritional problems based on anthropometric indicators before the natural disasters of earthquake and tsunami in Central Sulawesi

Anthropometric Indicator	Mean ± SD Z-Score		p-value
	Disaster Areas n=1.013	Non-Disaster Areas n=2.439	
Weight for Age Z-score (WAZ)			
Underweight	215 (9.1)	1053 (16.3)	<0.001
Normal	2137 (90.7)	5372 (83.2)	
Overweight	3 (0.1)	32 (0.5)	
Height For Age Z-score (HAZ)			
Stunting	215 (9.1)	1655 (25.6)	<0.001
Normal	2140 (90.9)	4802 (74.4)	
Weight For Height Z-score (WHZ)			
Wasted	223 (9.5)	764 (11.8)	<0.001
Normal	2107 (89.5)	5531 (85.7)	
Overweight	25 (1.1)	162 (2.5)	

The data showed a significant difference in the prevalence of nutritional problems between the affected and unaffected areas of Central Sulawesi before the disaster. In disaster areas, the prevalence of underweight (9.1%), stunting (9.1%), and underweight (9.5%) was lower than in non-disaster areas (16.3%, 25.6%, and 11.8%, respectively). In contrast, the problems of good and fat were higher in non-disaster

areas. The p values for all indicators showed significant differences ($p < 0.001$), highlighting the potential impact of pre-disaster conditions on children's nutritional status. This indicates that, before the disaster occurred, the affected areas may have had more effective nutritional intervention programs or better socioeconomic support. This also indicates that more stable environmental and resource conditions in the

affected areas before the disaster contribute to better nutritional status.

Table 3. Average comparison of Z Score of three anthropometric indicators After the natural disaster earthquake and tsunami in Central Sulawesi

Indicator Anthropometry	Disaster Areas n=1.013	Non-Disaster Areas n=2.439	p-value*
Weight for Age Z-Score	-0.78 ± 1.07	-0.59 ± 1.06	0.182
Height For Age Z-Score	-0.80 ± 1.33	-0.74 ± 1.15	0.000
Weight For Height Z-Score	-0.27 ± 1.42	-0.10 ± 1.29	0.000

*Statistical significance was assessed using Anova Test

The data showed a significant difference in the average anthropometric Z-scores after the earthquake and tsunami in Central Sulawesi. In disaster areas, the average Z-score for height for age (-0.80) and weight for height (-0.27) were lower than those in non-disaster areas (-0.74 and -0.10, respectively), with $p=0.000$ values for these two indicators showing significant differences. Although the analysis results showed that the difference in WAZ Z-scores between the disaster-affected and non-affected areas was not significant ($p=0.182$), several factors may explain why this result was not statistically significant. First, the sample size may not be large enough to detect small differences in the Z-scores. Second, high data variability or other confounding factors may have influenced the results. Additionally, the effects of the disaster on the WAZ parameters may take longer to become significantly visible. This discussion aims to provide an additional context for the obtained results and to consider the factors that may contribute to the non-significance of the findings.

A study in Japan found that of 236 disaster evacuees, as many as 23% lost weight and 28% reported a decrease in food intake one month after the earthquake. A total of 25% of the refugees reported gastrointestinal symptoms, including constipation (10%), loss of appetite (6.4%), vomiting (6.4%), and nausea (2.1%). Although 44% of the victims preferred more vegetables (33%), most of the food aids received, such as rice balls or bread, were carbohydrate-based, probably because of the easy and abundant provision of emergency food pans. The consumption of an unbalanced diet may cause more gastrointestinal symptoms in survivors (Inoue et al., 2014). It is feasible to provide micronutrients as part of emergency relief and transition programs such as those recommended by the World Health

Organization/UNICEF/World Food Program. The nutritional status of the population affected by an emergency is critical because malnutrition increases the risk of infection and is associated with more than 50% child mortality in developing countries (de Pee et al., 2007). The study results indicated significant differences in HAZ and WHZ Z-scores between the disaster-affected and unaffected areas. The significant decrease in HAZ Z-scores in disaster-affected areas suggests a delay in children's height growth, which may be related to disruptions in nutritional intake or general health conditions after a disaster. A decrease in WHZ Z-scores indicates issues with weight relative to height, which also points to negative impacts on children's nutritional status, possibly owing to changes in dietary patterns or limited access to nutritious food. The implications of these results highlight the need for more targeted nutritional interventions to support the recovery of the growth and health of children in disaster-affected areas.

However, the differences in the WAZ Z-scores were not significant. This may be due to several factors, such as sample size, which may not be large enough to detect small differences or high variability in the data. Additionally, the effects of the disaster on weight may take longer to significantly impact the WAZ Z-scores. This discussion aims to provide additional insights into the obtained results and consider the factors influencing the analysis outcomes.

The nutritional management of children under five years of age in shelters has not been handled optimally, so it is necessary to carry out special and integrated nutrition management. Nutrition programs in shelters include nutritional services, counseling, and food provision (Laili et al., 2022). Several recent studies have supported the importance of a holistic approach to nutritional management in

shelters. Children under five who live in shelters or in emergency situations often face a higher risk of malnutrition than children under five in more stable environments (Al Rahmad et al., 2024).

Therefore, it is important to implement nutrition programs that include nutrition services, such as routine checks on the nutritional status of children under five years, growth monitoring, and the provision of nutritional supplements when needed (Akinyode Obembe et al., 2024; Behanan et al., 2023; Choedon et al., 2024; Sobngwi-Tambekou et al., 2024). Nutrition counseling for parents or caregivers in shelters is very important for providing an understanding of the importance of balanced nutrition (Limauro et al., 2024), preparation of nutritious food with limited resources (Sato et al., 2024; Siva & Anderson, 2023; Tokumaru et al., 2022), and dealing with common nutritional problems in children under five. Nutritionists in shelters are urgently needed to provide direct consultations, prepare appropriate meal plans, and provide education and training for shelter staff and caregivers of children under five years of age (Abimibayo Adeoya et al., 2022; Vaiciurgis et al., 2022). Food Provision must include the distribution of nutritious and balanced food, paying attention to the calorie and nutritional needs of children under five years of age, and ensuring consistent food availability (Retondario et al., 2022).

The availability of consistent food is very important so that children under five years of age receive adequate nutritional intake at all times. This is reinforced by research that states that lack of access to nutritious food can negatively impact the health and development of children under five years of age (Boulehatt, 2023; Gedeon et al., 2022; Makoukji et al., 2024).

Therefore, a comprehensive approach involving various aspects of nutrition management is essential to ensure that children under five in shelters receive optimal nutritional intake to support their overall growth and development.

This study had several limitations. First, the data used only came from the Sigi Regency, which may not represent the full impact of the disaster in other regions. Therefore, the findings may not be fully generalizable to areas outside of Sigi. Second, the study's measurement period was limited to a specific time after the disaster;

therefore, it could not comprehensively capture the long-term impact of the disaster. Further research with a longer measurement period would provide more comprehensive insight. Additionally, this study relied on secondary data from the e-PPGBM system, which may have limitations in terms of data accuracy and completeness. Finally, some variables that could affect children's nutritional status, such as socioeconomic factors and access to health care services, may not have been fully considered in this analysis.

Conclusion

Research in Central Sulawesi has shown that earthquake and tsunami disasters significantly increase the prevalence of stunting, being underweight, and wasting in children. Dramatic changes in nutritional status, particularly in Z-scores for height-for-age and weight-for-height, were evident between the disaster-affected and non-disaster-affected areas. Interventions such as nutrition services, nutritional counselling, the presence of dietitians, and consistent food provision are crucial.

This study has limitations, including the small sample size and the short observation period. Therefore, further longitudinal studies are needed to determine the long-term effects and additional factors affecting the nutritional status of children. These findings highlight the need for a rapid and effective post-disaster nutritional response and long-term efforts to restore children's nutritional health and reduce impacts on vulnerable communities.

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Conflict of Interest Declaration

The authors declare that they have no affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

Author Contributions

AB and MJ contributed to the design and conduct of the study, analyzed the results, and wrote the manuscript. They also organized and supervised the project.

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