

# Characteristics of Neonates and Child Health Outcomes after the Mamuju Earthquake Disaster

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**Abstract**—A six-point-two-magnitude earthquake rocked Mamuju District, West Sulawesi Province, Indonesia, on 15 January 2021, causing significant health issues for the affected community, particularly among vulnerable populations such as neonates and children. The aim of this study is to examine and describe the diseases diagnosed in the pediatric population in Mamuju 14 days after the earthquake. This study uses a prospective observational study of the pediatric population presenting at West Sulawesi Regional Hospital, Mamuju Regional Public Hospital, and Bhayangkara Hospital for the period of 14 days after the earthquake. Demographic and clinical information was recorded. 153 children were admitted to the health center. Children younger than six years old were the highest proportion (78%). Out of 153 children, 82 of them were male (54%). The most frequently diagnosed disease during the first and second weeks after the earthquake was respiratory problems, followed by gastrointestinal problems that showed an increase in incidence in the second week. This study found that age has a correlation with common disease in children after an earthquake. Respiratory and gastrointestinal problems were found to be the most common diseases among the pediatric population in Mamuju after the earthquake.

**Keywords**—Health outcomes, pediatric population, earthquake, Mamuju.

## I. INTRODUCTION

INDONESIA is a disaster-prone country based on its geographic, geological, and demographic conditions [1]. Indonesia has a wide continental shelf area, the highest mountains in the tropics (the Central Highlands of Papua), and the only one in the world where there is a sea between islands (Banda Sea). Some of the world's mountain folds also intersect in Indonesia. This condition is the meeting point of three large tectonic plates, namely the Indo-Australian, Euro-Asian, and Pacific plates. The Pacific plate is the most active tectonic plate in the world and contributes nearly 90% of earthquakes. The three plates are moving into each other, the Indo-Australian plate pushes into the Euro-Asian plate. This occurrence creates a seismic line and ring of active volcanoes along Sumatra, Jawa, Bali, Nusa Tenggara, and Sulawesi parallel with the subduction zones of the two plates. Areas that are prone to earthquake are close to subduction zones and nearby active faults. Sulawesi Island is one of the areas situated near active fault lines [2], [3].

On 15 January 2021, there was a 6.2 magnitude earthquake that rocks Mamuju District, West Sulawesi Province, Indonesia. It was preceded by a 5.9 magnitude earthquake that happened the same day earlier which caused some minor damage and landslides on roads. Numerous aftershocks

occurred until 20 January 2021 that did not cause any further damage or tsunami [4]-[6]. Reports from National Agency for Disaster Management (BNPB) on 24 January 2021 said the earthquake caused damages to 1159 houses, six places of worship, 11 healthcare facilities, 103 educational units, five Government offices, and a hotel, bridge, and port. There were 81 casualties, 426 people with serious injuries, 240 people with moderate injuries, and 2703 people with minor injuries. The earthquake also caused the disruption of electricity, communication, water supply, and transportation access. The availability of a clean water supply for bathing and defecating is limited [5], [6].

Natural disasters, including earthquakes, can have serious health, social and economic consequences that affect the lives of billions of people. As a result of a disaster, it will cause health problems, including disabled health services, death and injured victims, nutritional problems, environmental sanitation, infectious disease, and mental disorders [7]. The risk of communicable disease is very high which follows natural disasters [8]. Diseases can be distinguished as water-borne (e.g., diarrhea, Hepatitis A and E, leptospirosis), air-borne/droplet (e.g., measles, acute respiratory infections (ARI)), or vector-borne (e.g., malaria, dengue), and contamination from wounded injuries (e.g., tetanus) [8], [9]. The most common diseases following the earthquake were respiratory tract infections, skin diseases, and diarrhea [10]. Infectious diseases may be reported after the earthquake as the result of unplanned and overcrowded shelters and limited access to food and clean water [11].

The disaster caused various potential health problems for the affected community, even felt more severely by vulnerable population groups. As stated in Article 55 of the Law of the Republic of Indonesia No. 24 of 2007 concerning Disaster Management, neonates and children are vulnerable to health problems [12]. This study aims to describe the diseases that are diagnosed in the pediatric population at Mamuju 14 days after the last earthquake.

## II. RESEARCH METHODOLOGY

This study used a prospective observational approach following the course of disease for 14 days after West Sulawesi, Mamuju earthquake on 15 January 2021. The sample involved 153 subjects. The study used purposive sampling based on inclusion criteria, i.e., every child aged 0-18 years old who was admitted at West Sulawesi Regional Hospital, Mamuju

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Regional Public Hospital, and Bhayangkara Hospital. Data collection was conducted through simple medical records which consisted of name, age, sex, and diagnosis. All patients were grouped according to the diagnosis. The data were

analyzed using Statistical Package for the Social Sciences (SPSS) ver. 22. Mann–Whitney test and Kruskal-Wallis test was used to analyze the data.

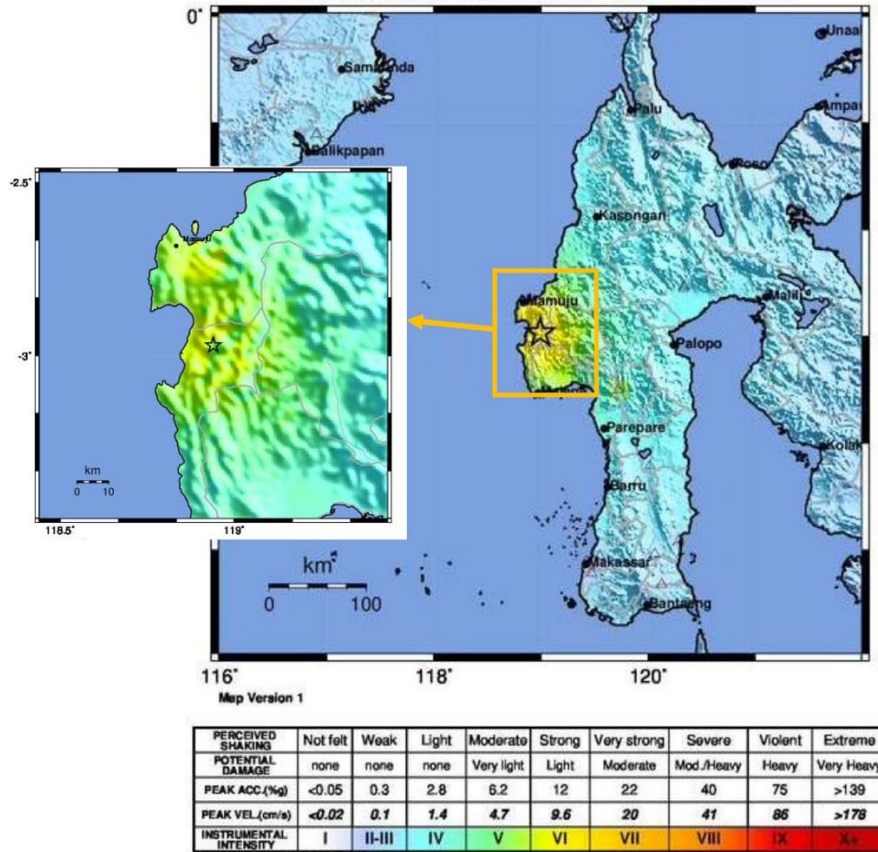


Fig. 1 The shake map of Mamuju earthquake on 15 January 2021 [4]



Fig. 2 (a) Damage to a building (*Hotel Maleo Mamuju*) due to the Mamuju earthquake on 15 January 2021 [4]



Fig. 2 (b) Damage to a building (*Asrama Polsek Mamuju*) due to the Mamuju earthquake on 15 January 2021 [4]

### III. RESULTS

In 14 days after the earthquake on January 15, 2021, 153 children were admitted to the health center. Out of 153 children, 82 (54%) of them were male and 71 (46%) were female. Half of the admitted children were in the 1-5 years age group 83 (54%) followed by children older than 5 years old and under 1 year old both in the same number respectively 35 (23%).

TABLE I  
CHILDREN CHARACTERISTICS

Characteristics	1 <sup>st</sup> week n (%)	2 <sup>nd</sup> week n (%)
Gender		
Male	54 (56%)	28 (50%)
Female	43 (44%)	28 (50%)
Age (years)		
<1	14 (14%)	21 (38%)
1-5	62 (64%)	21 (38%)
6-18	21 (22%)	14 (24%)

There were 58 children (37.9%) diagnosed with respiratory problems, 25 children (16.3%) diagnosed with gastrointestinal

problems, 16 children (10.5%) with skin problems, eight children (5.2%) with ear, throat, and neck problems, seven children (4.6%) with nutritional problems and 39 children with other health problems which do not have specific diagnoses (i.e., fever, general weakness, primary headache, etc.). In the first and second weeks, the respiratory problem was the most frequent-occurring disease. Gastrointestinal problem was the second most frequent-occurring disease and increased in the second week, unlike the respiratory problem which decreased in the second week.

TABLE II  
TOTAL NUMBERS FREQUENCY PER WEEK OF DIAGNOSES CATEGORIES

Characteristics	1 <sup>st</sup> week n (%)	2 <sup>nd</sup> week n (%)
Respiratory problem	34 (35%)	24 (43%)
Gastrointestinal problem	12 (13%)	13 (23%)
Skin problem	10 (10%)	6 (11%)
Nutritional problem	7 (7%)	0 (0%)
Ear, throat, and neck problem	6 (6%)	2 (3%)
Other	28 (29%)	11 (20%)

TABLE III  
CROSSTABS BETWEEN AGE AND DISEASE

	Diseases						p
	Gastrointestinal problem	Respiratory problem	Ear, throat, and neck problem	Nutritional problem	Skin problem	Other	
< 1 years	6	22	1	2	1	3	0.001*
Age 1-5 years	15	28	6	3	9	22	
6-18 years	4	8	1	2	6	14	

\*Kruskal Wallis test (p < 0.005)

Based on SPSS Kruskal-Wallis, the study found a correlation between age and disease appearing after the earthquake. Based on SPSS Mann-Whitney, the study found a correlation between age under-5 years old and disease but no correlation between gender and disease appearing after the earthquake with the Mann-Whitney test.

### IV. DISCUSSION

Indonesia is prone to earthquakes because many areas are close to subduction zones and nearby active faults. Sulawesi Island is one of the areas situated near active fault lines. Earthquakes can have serious health, social, and economic consequences that affect the lives of billions of people. In this study, more than half of the admitted child patients were under six (78%), followed by patients older than 5 years old (22%). Several assessments showed no correlation between gender and disaster. All gender has the same risk of impact from the earthquake.

Our study found a correlation between age under 5 years old and disease. Children, especially the youngest, have fewer resources to cope with disasters because of their characteristics; hence, they are especially sensitive to the positive and negative aspects of their environment. This pediatric patient is likely to present with a unique array of diseases and injury patterns, secondary to differences in physiology and anatomy. Injury patterns in the pediatric population by Jacquet et al. demonstrated a high incidence of fracture-related injuries

(30.6%) and wounds [13]. Head injury and spinal injury were reported in 18.4% and 6.5%. Crush injury and crush syndrome are frequently observed injury patterns following earthquakes. A crush injury occurs when there's compression applied to limbs and body regions, leading to muscle swelling or neurological disruptions in the impacted areas of the body [14]. Typically affected body parts include lower extremities (74%) and upper extremities (10%) [13].

The character of diseases faced in 1st week the most are respiratory problem diseases, gastrointestinal problem diseases, and others. Respiratory problem is common cold and acute respiratory tract infection (ARTI). Gastrointestinal problem is diarrhea, worms' infection, and typhoid, while other problems or diseases are fever, general weakness, and primary headache. The study found that fever, general weakness, and primary headache decreased in the second week, while gastrointestinal infection increased. Following the concept of the three stages that follow a disaster, this occurrence takes place during the second phase known as the post-impact phase (from the fourth day to the fourth week after the disaster). During this period, the emergence of infectious diseases becomes evident. Water and food-borne infectious diseases such as cholera, bacterial dysentery, cryptosporidiosis, rotavirus, norovirus, salmonella, typhoid, paratyphoid, and giardiasis become prevalent [15].

In the second week, respiratory infections were also the main health problem. Respiration tract infection was the highest disease in the first and second weeks. The study by D'Aloisio et al. shows that the short-term period after the earthquake

showed a visible increase in Crater admissions for respiratory diseases [16]. A study carried out by Motamedi et al., examining earthquakes that took place in the last ten years in Iran, China, Haiti, Pakistan, and Peru, revealed that respiratory infections affecting both the upper and lower respiratory tracts, notably bronchitis and pneumonia, were the most common health issues observed [17].

In a study conducted by Tan et al. it was discovered that following the Sumatra earthquake in 2009, the medical team from the Singapore Armed Forces observed that pneumonia or upper respiratory tract infection (URTI) affected as many as 47% of patients treated in their mobile clinic [18]. Another problem to be considered is the air quality and the massive exposure to air pollution, smoke, and dust over a long period because of the collapse of many buildings. Infectious diseases may be reported after an earthquake because of unplanned and overcrowded shelters and limited access to food and clean water [9], [16].

In this study, a total of 13 patients with gastrointestinal issues were admitted. Gastrointestinal tract infection became the highest disease in the third and fourth weeks. Giardiasis, caused by a flagellated enteric protozoan *Giardia lamblia*, is a common cause of endemic and epidemic diarrhea. *G. lamblia* is found worldwide, particularly in temperate and tropical locations. Farthing et al. reported that it is particularly seen in water-borne outbreaks of diarrhea and increasingly in foodborne outbreaks [19].

Gillin et al. reported that *G. lamblia* is distributed throughout the world both in developed and developing countries. Acquisition of the parasite requires oral ingestion of *Giardia* cysts [20]. Although this usually occurs after the ingestion of contaminated water, person-to-person and food-borne transmissions are also important. Marshall et al. and LeChevallier et al. pointed out that surface water can easily become contaminated by human or animal sources, and *Giardia* cysts survive well in the environment, particularly in cold water [21], [22]. Most water-borne outbreaks occur because of the use of untreated surface water, or water treated by a faulty purification system or by inadequate chlorination, and not subjected to flocculation, sedimentation, and filtration, such as is seen in disaster conditions. Pickering et al. observed that person-to-person transmission is now the second most identified mode of acquisition and occurs in groups with poor fecal-oral hygiene [23].

Results of Ozturk et al. show that in the group living and studying in crowded conditions because of an earthquake, hygiene conditions including the number of toilets shared by the students, location of the toilets (outside the school), and frequency of handwashing were found to be poor, and the rates of Giardiasis and Enterobiasis was significantly high in this group [24]. The high level of infection in this group was thought to be correlated with these parameters because other hygienic conditions we investigated such as garbage disposal service, the sewer system, and source of drinkable water were found to be well-organized in both groups [24].

Giri et al. observed that diarrheal diseases accounted for more than 40% of deaths in camps during the acute phase of an

emergency, with over 80% of these deaths occurring among children less than two years old [25]. The World Health Organization (WHO) estimated that about 2.8 million people were displaced following the Nepal earthquake and warned of possible outbreaks of waterborne diseases, vector-borne diseases, and ARI. The organization also warned of the worsening of child nutrition status. The risk of epidemics of infectious diseases following earthquakes has been mentioned with suggestions for investing in sanitation, hygiene, and vaccination. Outbreaks of diarrhea, cholera, hepatitis E, ARI, influenza, measles, meningitis, and tetanus have been reported following major earthquakes during the last decade [25].

According to the report by Benedict and Park [26], in the aftermath of a disaster, if wounds come into contact with organic materials, it can trigger fungal infections of the skin and soft tissues, particularly mucormycosis. When a catastrophe occurs, harmful fungi might be displaced from their usual environments. This could elevate their presence in the surroundings or introduce them to locations where they would not typically thrive. Consequently, these fungi might come into contact with injured individuals, potentially leading to fungal infections. The predominant bacteria causing infection in earthquakes were *Acinetobacter baumannii*, *Escherichia coli*, and *Staphylococcus aureus* [26].

This study found that 7% of child patients have nutritional problems. According to a report by the United National International Children's Emergency Fund (UNICEF), in some areas children were immunized against measles, polio, and rubella; they were screened for acute malnutrition. Children from affected families may have more severe illness at presentation possibly because of the impact of the earthquake on the family/caregivers and/or diverted attention of the family toward the task of finding shelter and necessities [25].

## V. CONCLUSION

Our findings show that age has a correlation with frequent disease in children after an earthquake, but no correlation between gender and disaster. Respiration and gastrointestinal problem became the most-occurring disease in the pediatric population after an earthquake in Mamuju.

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