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Literacy of Coastal Communities on the Ciguatera Phenomenon and its Impact on Economic Activities: Case Study in Gili Matra, Indonesia

Literasi Masyarakat Pesisir Terhadap Fenomena Ciguatera dan Dampaknya terhadap Kegiatan Ekonomi: Studi Kasus di Gili Matra, Nusa Tenggara Barat Indonesia

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ABSTRAK

Keracunan ciguatera mempunyai dampak yang signifikan, memengaruhi kesehatan fisik individu, dan memberikan pengaruh terhadap kesejahteraan ekonomi dan sosial penduduk yang tinggal di daerah yang terkena dampak. Tujuan dari penelitian ini adalah untuk mengevaluasi tingkat literasi masyarakat pesisir di Gili Matra, Indonesia, sehubungan dengan pemahaman mereka tentang fenomena Ciguatera dan potensi dampaknya terhadap kegiatan ekonomi lokal. Melalui penggunaan pendekatan penelitian kualitatif, penelitian ini menemukan bahwa sebagian besar penduduk yang tinggal di kawasan pesisir Gili Matra memiliki pemahaman yang terbatas terhadap fenomena Ciguatera. Meskipun dampak ekonomi langsung terhadap masyarakat lokal mungkin terbatas, namun penting untuk mengedukasi masyarakat mengenai fenomena ini guna meningkatkan kesadaran masyarakat, khususnya dalam hal pencegahan terjadinya keracunan ciguatera.

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ABSTRACT

Ciguatera poisoning has significant implications, affecting both the physical health of individuals and exerting influence on the economic and social well-being of populations living in affected areas. This study aims to evaluate the level of literacy proficiency among coastal populations in Gili Matra, Indonesia, in connection to their understanding of the Ciguatera phenomena and its potential impact on local economic activities. Through the utilization of a qualitative research approach, the present study discovered that a significant proportion of residents living in the coastal area of Gili Matra had a restricted understanding of the Ciguatera phenomena. Although the immediate economic effects on the local community may be limited, it is crucial to educate the public about this phenomenon to increase public awareness, particularly in terms of preventing the occurrence of CFP.

1. INTRODUCTION

1.1 Background

The sea and its riches have served as the primary foundation for an archipelago nation like Indonesia (Rochwulaningsih *et al*., 2019). According to Gasco *et al*. (2020), fish has emerged as a significant protein source, with a substantial proportion of those residing on islands consuming more than 100 grams of fish protein per capita daily. Nevertheless, the overreliance on fish as a primary source of sustenance can have severe consequences for inhabitants of islands in instances where this valuable resource becomes contaminated with hazardous substances, such as elevated levels of ciguatoxin (Mudge *et al*., 2023). Ciguatera Fish Poisoning (CFP), or Ciguatera, is a type of *Ichthyosarcotoxism* that arises due to the consumption of reef fish that have been contaminated by a high concentration of ciguatoxin (CTX), a potent neurotoxin synthesized by benthic dinoflagellates, specifically *Gambierdiscus toxicus.* The ciguatoxin producer dinoflagellates were often found abundant and associated with the macroalgae, damaged corals, and seagrass that serve as the primary food source for herbivorous fish (Sims, 2023). Ciguatoxin could cause neurological, gastrointestinal, and even cardiac symptoms in humans who consume ciguatoxin-contaminated fish, which could be fatal in some rare cases (Friedman *et al*., 2017). The symptoms commonly manifested within 6-12 hours from ingestion of CTX-contaminated fish containing CTX at concentrations above 0.08 or 0.1 μg/kg fish (Friedman *et al*., 2017). The clinical symptoms of CFP are often complex, and about 175 different symptoms related to CFP have been recorded so far (Chinain *et al*., 2021). However, CFP commonly manifests in the form of nausea, diarrhea, vomiting, abdominal pain, tingling in the extremities, such as hands, feet, and/or mouth, muscle weakness, and reversal of hot-cold sensation. The duration of symptoms might range from a few weeks to multiple years in some uncommon chronic and relapsing CFP cases (Lehane & Lewis, 2000; Lewis, 2006; Friedman *et al*., 2017; Chinain *et al*., 2021).

In addition to its effects on human health, ciguatera poisoning also carries substantial socio-economic ramifications, both in developing and developed countries, mainly in the Pacific Ocean and the Caribbean Sea (Trick *et al*., 2020). For example, the estimated economic loss caused by CFP cases during 1998 in Puerto Rico could reach between 8-10 million USD per year (Chinain *et al*., 2021). These implications encompass several significant effects. Initially, it is essential to note that ciguatera poisoning has the potential to result in escalated expenditures associated with health problems. When an individual becomes infected, it is often necessary for them to seek medical attention and treatment, thus imposing a strain on the healthcare system (Murray *et al*., 2021). Furthermore, it has been observed that patients afflicted with ciguatera poisoning frequently encounter severe symptoms, particularly neurological complications, that may lead to a decline in their ability to engage in productive work (Chinain *et al*., 2021). Furthermore, the presence of ciguatoxin in reef fish can lead to the depletion of a significant dietary resource, particularly in societies that heavily depend on fish as a primary protein source (Holmes & Lewis, 2023). Also, the adverse impact of ciguatera on fish originating from impacted areas is likely to lead to a reduction in the demand for reef fish in both local and worldwide markets. Consequently, this fall in sales might have detrimental effects on the local economy (Perilli *et al*., 2023).

Likewise, the tourism sector, particularly in coastal regions, could potentially have repercussions due to the occurrence of ciguatera poisoning. The potential threat of poisoning can lead to a decline in tourist arrivals, which then affects the financial earnings of the local community (Holmes & Lewis, 2023). Ciguatera poisoning possesses extensive ramifications, impacting not only the physical well-being of individuals but also exerting influence on the economic and social welfare of populations residing in impacted areas. Ciguatera poisoning is a naturally occurring phenomenon that has a disruptive impact on the economic operations of coastal communities.

Previously, there have been many studies discussing the impact of natural phenomena that disrupt the economic activities of communities in coastal areas (such as tidal floods, abrasion, environmental exploitation, the COVID-19 pandemic, and drought) on the economic activities of coastal communities in various regions. The results of these studies provide an in-depth understanding of how the impact of natural phenomena, such as natural disasters (such as tidal floods, abrasion, and environmental exploitation) and humanitarian disasters (the COVID-19 pandemic), affect the economic activities of coastal communities. For example, research by Khaqiqi and Syamsuddin (2021) highlights the negative impact of tidal floods on tourism at Blendung Beach, with a reduction in the number of visitors, damage to stalls and damage to trees, as well as disruption to the village economy. Rudiarto *et al*. (2016) emphasized that the behavior of coastal communities has a significant impact on environmental damage, which can threaten the sustainability of the Kuwaru Beach area from an economic, social, and environmental perspective. Ismiyanti and Buchori (2021) discusses the social and economic impacts of abrasion, including increased anxiety and economic vulnerability of coastal communities.

According to Ervianto (2021), the occurrence of natural phenomena, such as abrasion, can have a disruptive impact on the economic activities of coastal communities. The observed shifts in livelihood patterns evidence this, as individuals within these communities have been observed transitioning towards engagement in the service sector. This finding aligns with the research findings of Suryani *et al*. (2019), which indicate that the physical consequences of abrasion encompass harm to residential structures and infrastructure. Furthermore, the socio-economic repercussions encompass a reduction in income and alterations in occupational patterns, particularly within the trade industry. Furthermore, Hamid *et al*. (2023) underscored the significance of community empowerment and disaster mitigation in addressing the socio-economic consequences associated with the adverse effects of abrasion on socio-economic situations.

Pinto (2015) pointed out that there is a significant connection between human behavior and environmental

degradation, particularly in the context of coastal tourism operations. This connection poses a potential threat to the sustainability of the Kuwaru Beach area, encompassing economic, social, and environmental dimensions. In addition to this, the depletion of the shrimp cypress tree ecosystem also yields consequences in terms of heightened coastal erosion, thus diminishing the earnings of individuals employed within the tourism services industry. According to Mustika (2017), the depletion of mangrove forests and subsequent environmental degradation can lead to a decline in individuals' income, alterations in occupational patterns, and shifts in property ownership. Budhiawan *et al*. (2022) and Sulistiani (2022) provide a comprehensive analysis of the effects of water and land pollution, as well as the exploitation of mangrove forests, on the environmental and economic circumstances of coastal populations. In their respective studies, Nurfadilah and Bulan (2021) and Sulistio (2022) critically examine the notable economic ramifications of the COVID-19 pandemic on individuals engaged in fishing activities and residing in coastal areas. These consequences encompass a discernible decline in the market value of fish catches. In the study conducted by Daris *et al*. (2023), an analysis is undertaken to investigate the economic ramifications associated with the practice of sea sand mining. Specifically, the study focuses on the adverse effects that this activity has on the livelihoods of fishermen. Yongki (2022) elucidated the positive and negative ramifications of sea sand mining on the local economy, whereas Devi (2018) ascertained that fishing communities employed three survival strategies, namely active strategies, passive strategies, and network strategies, which encompassed engaging in additional employment, adopting frugal lifestyles, and leveraging social networks.

There is a scarcity of research investigating the socio-economic repercussions of the Ciguatera crisis on coastal communities despite the existence of several studies examining the influence of marine disasters on these communities' socio-economic status. Consequently, this study addresses the existing gap in the literature. The present research exhibits notable distinctions in comparison to the investigations. The primary objective of this study is to examine the ciguatera phenomenon and its potential impact on the economic activities of coastal communities in Gili Matra, North Lombok Regency, Indonesia.

Gili Matra, situated in the coastal region of eastern Indonesia, has marine conditions that significantly contribute to the sustenance of the residents' economic endeavors. The marine environment surrounding this island presents vital assets with significant economic prospects for its inhabitants. The traditional fishing industry is a prominent sector wherein people rely on fish catches for both economic sustenance and nutritional needs. Furthermore, the growth of seaweed on Gili Matra offers supplementary economic prospects through seaweed production, which is utilized in diverse businesses. Moreover, Gili Matra, being renowned as a prominent tourism hotspot, draws a considerable number of visitors who are captivated by its remarkable underwater allure and ecological variety. This, in turn, leads to substantial financial gains through various recreational activities such as snorkeling, diving, and boat excursions. Hence, the preservation of robust and sustainable marine environments plays a pivotal role in ensuring the long-term viability of economic endeavors among the coastal populations residing in Gili Matra.

1.2 Research Objective

The objective of this study is to assess the literacy proficiency of coastal communities about the ciguatera phenomena and its implications for the economic activities of communities residing in Gili Matra. This study aims to comprehend the extent to which coastal communities rely on marine resources and the consequential implications of ciguatera poisoning on their economic viability. Like numerous other island villages, Gili Matra is primarily dependent on fish as a primary source of revenue, sustenance, and tourist attraction.

2. METHODS

This study employs a descriptive qualitative technique. According to Nazir (2014), descriptive research involves examining the existing state of human groups, objects, circumstances, systems of thought, or events to generate methodical, factual, and precise descriptions of the things being investigated. Sukmadinata (2011) asserts that the qualitative descriptive approach is employed to provide a detailed account of prevailing occurrences, encompassing both natural and human-engineered aspects. The data and information utilized in this study were derived from a survey conducted in May 2022 among a sample of 100 individuals residing in the Gili Matra region, Indonesia (please see Figure 1 for details location). The data that was gathered was subsequently subjected to descriptive qualitative analysis.

Source: Google Map, 2023.

Figure 1. Map of Gili Matra

3. RESULTS AND DISCUSSION

This section explains the result of this study, which started with a description of the respondent's characteristics, followed by qualitatitve analysis, and closed with a discussion of the result.

3.1 Results

This section presents respondent's characteristics, People Literacy Regarding the Ciguatera Phenomenon, The Possible Effect of CFP on the Economy, and Education on Ciguatera for Local People in Gili Matra.

3.1.1 Respondent's Characteristics

Respondent's Characteristics in this study consider Demography, Occupation, and Income of the respondents.

3.1.1.1 Demography

The study sample consisted of 100 individuals residing in the surrounding area of Gili Matra, comprising 95% males and 5% females. According to the respondents' educational attainment, a significant majority (89%) possess a low degree of education, expressly limited to elementary school. In contrast, a mere 8% of individuals possessed a senior high school education, while a mere 3% had attained only a junior high school level of education. Regarding age, the minimum age reported by the respondents was 19 years, while the maximum age recorded was 72 years.

3.1.1.2 Occupation

Most respondents (82%) were engaged in fishing activities, while a smaller proportion (8%) were employed in private firms, primarily within the tourism service sector. A minor fraction of the remaining respondents were involved in trading or non-fishery business sectors (see Figure 2).

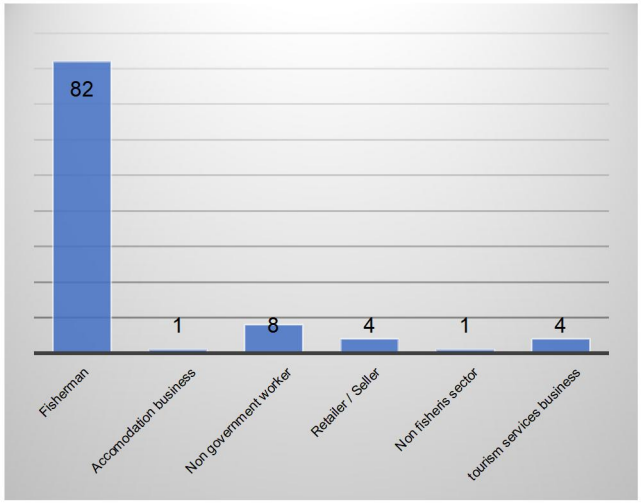

Figure 2. Respondent's Occupation

3.1.1.3 Income

From an economic standpoint, it is evident that a significant majority of the respondents (87%) own relatively modest salaries, amounting to less than 1 million rupiah each month. Only a minority of the remaining individuals own an income of over 1 million rupiah (see Figure 3 for further elaboration).

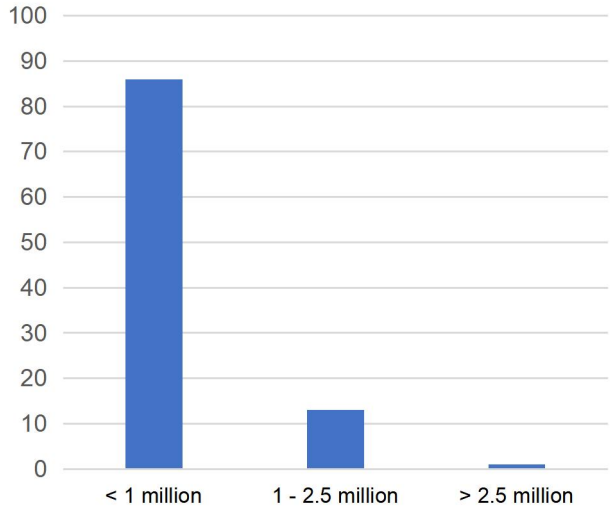

Figure 3. Respondents' Family Income

3.1.2 People Literacy Regarding the Ciguatera Phenomenon

For the emergence of the CFP phenomena, the study inquired about the attributes of CFP that may have been encountered by individuals residing in the vicinity of Gili Matra.

3.1.2.1 Experiencing Sea Color Change

One notable trait associated with the appearance of the CFP phenomena is the alteration in the color of oceanic waters. The participants were queried regarding their prior observations of the sea color fluctuations on Gili Matra. Approximately 69% of the participants indicated that they had not observed any alteration in the color of seawater. In the study, it was found that 31% of the respondents reported observing a change in the color of seawater to brown during rainfall (refer to Figure 4). These alterations often transpire within the estuarine region of the river when the amalgamation of seawater and river water takes place. The duration of the alteration in seawater color persists for a period ranging from 24 to 36 hours.

3.1.2.2 Experience on Sudden Massive Death Fish

The second characteristic of the CFP phenomenon pertains to the abrupt death of substantial quantities of fish. Out of the sample size of 100 participants, an overwhelming majority of 97% reported no prior observation or awareness of the occurrence commonly referred to as sudden deaths of fish. In contrast, a mere 3% of individuals had encountered this occurrence, which transpired during the 1900s because of the use of potassium by unscrupulous fishermen to capture fish unlawfully (see Figure 5).

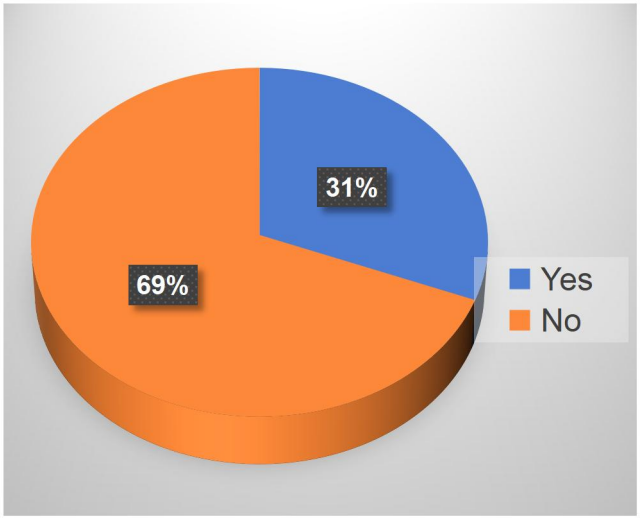

Figure 4. People's experience on sea color change

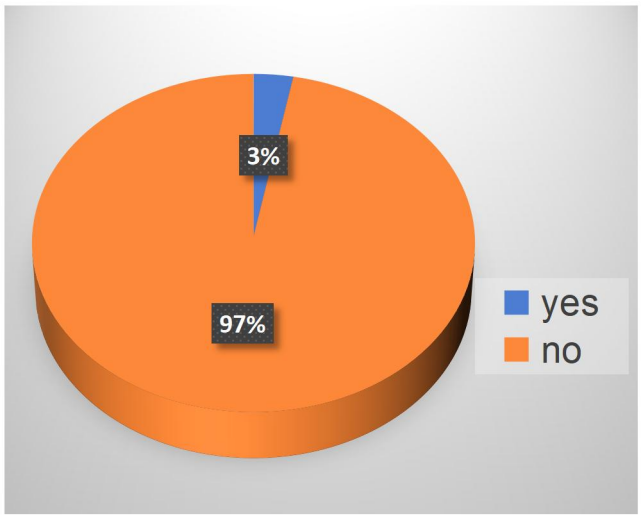

Figure 5. People's experience on massive dead fish

3.1.3 The Possible Effect of CFP on the Economy

In the event of the CFP phenomenon, it is anticipated that the marine and fisheries industry will see consequential effects, particularly in relation to employment opportunities. Paradoxically, the findings of the study conducted on Gili Matra revealed that a significant proportion of participants (82%) expressed a preference for maintaining their employment despite the occurrence of CFP. In contrast, a mere 2% of the participants indicated their intention to abstain from any form of employment. Approximately 12% of respondents expressed their intention to pursue employment in sectors other than fisheries. In comparison, 3% indicated their preference to remain within the fisheries sector but not engage in sea-based work (see Figure 6 for further elaboration).

This finding indicates that most individuals do not exhibit fear towards the CFP phenomenon, and also, it does not exert a substantial influence on community engagement efforts. Therefore, the CFP is not expected to have a substantial influence on the economic conditions of the fishing community residing in Gili Matra.

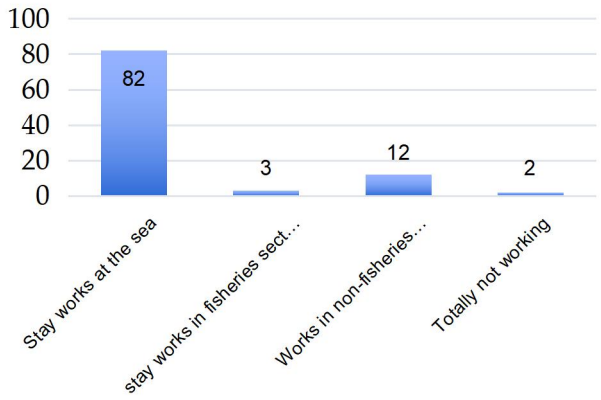

Figure 6. Action related to the existence of CFP

3.1.4 Education on Ciguatera for Local People in Gili Matra

Based on the findings of this study, it is evident that the community acknowledges a lack of information about Ciguatera Fish Poisoning (CFP). The lack of public awareness of CFP and appropriate response measures in the event of a sudden alteration in seawater conditions leading to extensive death of fish is evident among the community. Based on the data obtained from the community, it was found that 65% of individuals expressed a need for information on the cause of Ciguatera Fish Poisoning (CFP). Additionally, 16% of respondents sought knowledge regarding the symptoms or distinguishing features associated with CFP. Furthermore, 11% of participants expressed a desire for information on strategies to manage CFP, while a mere 1% expressed interest in understanding the broader impact of CFP (see Figure 7).

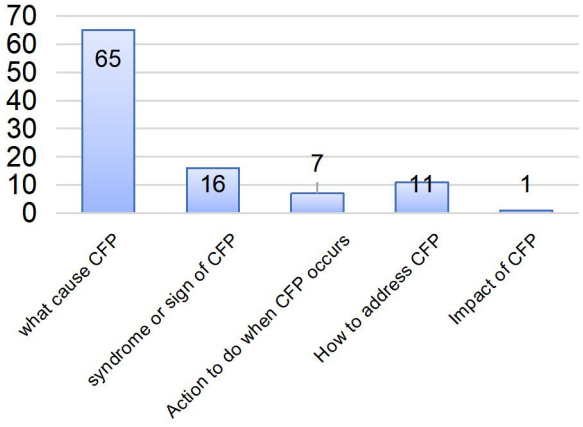

Figure 7. Things that people want to know related to CFP

Ninety percent of the general population considers knowledge regarding CFP to be highly significant, while 8% perceive it as vital. Conversely, a minority expressed the view that information about CFP carries little importance (see Figure 8). The introduction and dissemination of the CFP phenomena throughout diverse target groups is crucial. The present study identified fishermen, households, religious leaders, and village government as the key stakeholders to be targeted in the program, as described in Figure 9.

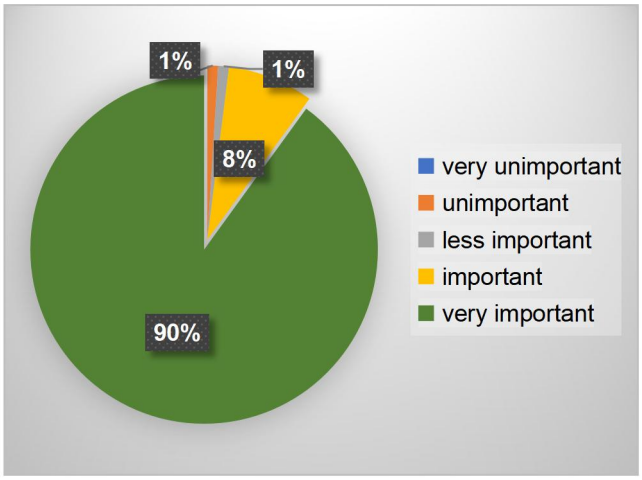

Figure 8. How important of the CFP

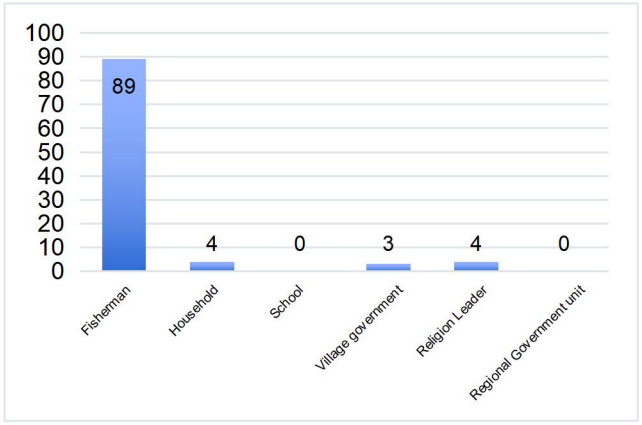

Figure 9. Targeted group for CFP introduction

3.2 Discussion

This study presents findings on the level of public literacy about the Ciguatera phenomena. The majority of individuals residing in the coastal region of Gili Matra had a limited comprehension of the Ciguatera phenomenon, which might also indicate their vulnerability towards the Ciguatera cases. This might be because signs of harmful algal blooms (HABs), such as ocean discoloration or mass fish mortality, might never occurred in Gili Matra. Thus, the coastal communities in Gili Matra need to made aware of the natural phenomena related to the occurrence of Ciguatera and or HABs in general. That condition was in contrast with another coastal area of Indonesia with frequent occurrences of HABs, such as Lampung Bay, in which 40.5% of local respondents were generally aware of the HAB signs and impacts in their area (Aditya *et al*., 2013). Being a disaster, ciguatera can also exert influence on the socio-economic circumstances of a given human community. The findings of this study are consistent with prior research conducted by Mustika (2017), Daris *et al*. (2023), Suryani *et al*. (2019), Ismiyanti and Buchori (2021), which have demonstrated that disasters, particularly those transpiring in coastal regions, possess the capacity to engender a reduction in societal well-being. According to previous studies conducted by Ervianto (2021) and Suryani *et al*. (2019), it has been observed that certain community groups may opt to transition to alternative means of sustenance. The absence of a major impact on human reactions can be attributed to the non-occurrence of the ciguatera phenomenon.

This research makes a valuable contribution to the existing body of knowledge by enhancing comprehension of public literacy concerning ciguatera. It underscores the necessity for policymakers to undertake educational initiatives aimed at raising public awareness about the hazards associated with ciguatera. Consequently, prevention efforts can be effectively implemented through educational campaigns and by fostering greater community involvement in the conservation of coastal ecosystems, as emphasized by Rudiarto *et al*. (2016), Devi (2018), and Hamid *et al*. (2023).

4. CONCLUSION

According to the findings of this study, the community residing in nearby areas of the Gili Matra area has not reported any incidences that can be attributed to the presence of Ciguatera Fish Poisoning (CFG) in the region. While the direct economic impact on the surrounding community may be minimal, it is imperative to disseminate knowledge to the public regarding this phenomenon to enhance public awareness, particularly in terms of preventing the onset of CFP. This proactive approach is essential to mitigate the socio-economic consequences associated with the occurrence of CFP.

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