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Analyzing the Influence of Demographic Factors on the Level of Community Preparedness for Tsunami Disaster in Bengkulu City

Zulfia Memi Mayasari[1,*], Yudhi Harini Bertham[2], M. Farid[3], Arif Ismul Hadi[3]
[1,2]Study Program of Natural Resources Management, Faculty of Agriculture, University of Bengkulu, 38122, Indonesia
[1]Department of Mathematics, Faculty of Mathematics and Natural Sciences, University of Bengkulu, Bengkulu, 38122, Indonesia
[3]Department of Physics, Faculty of Mathematics and Natural Sciences, University of Bengkulu, Bengkulu, 38122, Indonesia.

Corresponding author*
editor@sunankalijaga.org

Abstract: Bengkulu is one of the cities in Indonesia that has a high level of vulnerability to tsunamis. This high level of vulnerability will have a huge impact on the tsunami threat. One of the mitigation efforts that can be taken to minimize the effects of a tsunami disaster is to increase preparedness in facing the disaster. This study aims to analyze the influence of demographic factors on the level of community preparedness in Bengkulu City towards the tsunami disaster through an ordinal logistic approach. Data collection was carried out by distributing questionnaires to 400 selected respondents who were selected using the stratified random sampling method in nine sub-districts in Bengkulu City. In this study, the level of community preparedness was determined using an index analysis categorized into three levels: not ready, moderate, and ready. Determination of the level of community preparedness considers five key parameters: knowledge and attitudes, family policies, emergency response plans, early warning systems, and resource mobilization. The influence of demographic factors, including age, gender, occupation, education level, and length of stay, on the level of community preparedness was processed with the help of R software using a bivariate test with Spearman's rank. The results of the study show that age, occupation, and length of stay, with a significance level of 10%, have a significant influence on the level of preparedness of the Bengkulu City community for the tsunami disaster, while gender and education levels do not have a significant influence on the level of preparedness of the Bengkulu City community for the tsunami disaster. The results of this study are expected to provide important information for the Bengkulu City government and related agencies in designing more effective and targeted disaster mitigation programs, as well as increasing community capacity in dealing with the threat of tsunamis.

Keywords: Bengkulu, Community, Demographic Factor, Ordinal Logistic Regression, Preparedness.

Introduction

Bengkulu City is located on the west coast of Sumatra Island, directly facing the Indian Ocean and close to a subduction zone. This positioning makes Bengkulu City vulnerable to the threat of tsunamis (BNPB, 2016; Fathiyah et al., 2024). This vulnerability is further exacerbated by the high population density in Bengkulu's coastal areas. Therefore, an effective strategy is needed to address this threat, namely by increasing community preparedness. Preparedness refers to actions taken in advance to anticipate potential disasters, to prevent loss of life, reduce property damage, and minimize future disruptions to community life (Hargono et al., 2023; Langshiang, 2023; Ryan et al, 2020). Preparedness is a key part of disaster management and plays a crucial role in disaster risk reduction activities (Paton, 2018). Preparedness aims to reduce hazards' impacts through effective, timely, adequate, and efficient preventive measures for emergency response and disaster relief (Fhathird and Desfandi, 2022). According to Adiyoso (2018), other objectives of disaster preparedness include (1) handling threats more quickly and accurately, (2) managing vulnerabilities more effectively, (3) enhancing disaster management capacity, and (4) reducing

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casualties and damage. When communities are highly prepared, they are better able to reduce the negative impacts that disasters may bring (Rangarirai et al., 2023; Suwaryo et al., 2021). Communities with a high level of preparedness are more capable of mitigating disaster risks (Asih et al., 2023; Bogdan et al., 2021; Bronfman et al., 2019). While preparedness is the most effective strategy for minimizing casualties and damage, its success varies among populations, often depending on socio-demographic factors such as gender, age, education, occupation, and length of stay (Addiarto and Kusyairi, 2025; Tiwi et al., 2025).

Previous studies on tsunami preparedness have employed a variety of methods. Research on environmental behavior and mobility highlights that factors such as the built environment, route conditions, and travel patterns play a major role in evacuation readiness, while mobility-focused analyses indicate inequalities that stem from socio-economic differences (Leon et al, 2022; Aksa et al, 2024). Many studies on disaster preparedness primarily use descriptive surveys or indices, which, while valuable, may not adequately reflect the ordered levels of preparedness (not ready, moderate, ready). Some recent research has employed regression models; however, these often do not account for the ordinal nature of the data (Fazeli et al., 2024; Xenidis and Kaltsidi, 2022; Ma et al., 2024). As a result, the combined effects of various demographic factors on different levels of preparedness have not been thoroughly investigated in tsunami contexts, particularly in Indonesia (Miyazaki, 2022; Nugraha et al., 2016).

In this study, we used ordinal logistic regression (OLR) to examine how demographic factors shape tsunami preparedness levels among residents of Bengkulu City. OLR is particularly useful for analyzing cumulative probabilities across ordered categories and has been widely applied in disaster preparedness research (Qing et al., 2021; Nugraha et al., 2016). This method helps untangle the combined effects of various sociodemographic factors while keeping the results clear and practical for policymakers.

This research investigates how demographic factors such as gender, age, occupation, education, and length of stay affect tsunami preparedness levels in Bengkulu City through the use of OLR. Unlike earlier studies that examined environmental or psychosocial factors separately, or that relied on methods less suited to ordinal preparedness data, this study brings multiple socio-demographic variables together within an OLR framework. This approach delivers robust statistical evidence and practical guidance for policymakers by identifying which groups are less likely to reach higher levels of preparedness, offering a fresh contribution to efforts in reducing tsunami disaster risk in Indonesia (Fazeli et al., 2024; Sakya et al., 2023).

Materials And Methods

Study area

This research was conducted in Bengkulu City, Indonesia. The research location can be seen in Figure 1.

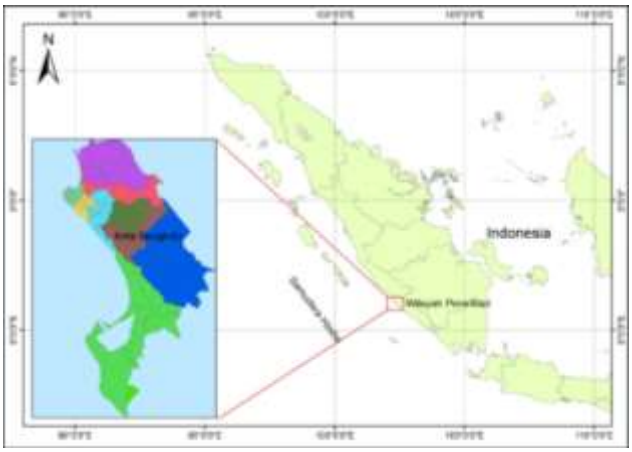

Figure 1. Research Location

Materials

This study uses primary data collected through questionnaires. The sample size calculated using the Slovin formula in Equation (1) (Fauzy, 2019), is 400 samples from a population of 390,060 people (BPS, 2024). This study utilizes *R* software for data processing.

$$n = \frac{N}{1 + N.e^2} \quad (1)$$

Information:
n: Sample size

N: Population size
e: Error tolerance (in this study, $e = 5\%$)

The data collected is divided into two parts, namely: (1) Data to determine the level of preparedness, and (2) Data to determine the relationship between demographic factors and the level of community preparedness.

Methods

This study is divided into two parts: (1) Determining the level of community preparedness, and (2) Determining the influence of demographic factors on the level of community preparedness for tsunami disasters. The research area was divided into several groups (based on sub-districts), and the determination of the sample size in each group used the proportional stratified random sampling technique as in Equation (2).

$$s = \frac{Subpopulation\ size}{Population\ size} \times n \quad (2)$$

Information:
s: Sample size in each sub-district
Subpopulation size: Population size in the sub-district
n: Sample size

Determining the level of community preparedness

The steps taken to determine the level of community preparedness for a tsunami disaster are:

1. An initial survey aimed at understanding the real conditions in the field
2. Conducting validity and reliability tests on the questionnaires to be distributed. Validity testing was conducted using the Pearson product-moment correlation coefficient in Equation (3). In this case, the Pearson product-moment correlation coefficient, typically denoted by r, is sought, which measures the strength of the linear relationship between two variables. The results of the validity test are considered valid if $r_{count} > r_{table}$ where r_{count} denoted by r_{xy}.

$$r_{xy} = \frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{(N\sum x^2 - (\sum x)^2)(N\sum y^2 - (\sum y)^2)}} \quad (3)$$

Information:
r_{xy} : Product-moment correlation coefficient
$\sum xy$: The sum of the results of multiplying the scores for each item (X) by the total score (Y) for each respondent
$\sum x$: Sum of all item scores
$\sum y$: Sum of total scores
N : Number of respondents

The reliability test uses the Cronbach's Alpha value in Equation (4).

$$\alpha = \left(\frac{n}{n-1}\right)\left(1 - \frac{\sum \sigma_b^2}{\sigma_t^2}\right) \quad (4)$$

Information:
α : Reliability value
n : Number of questions
σ_t^2: Total score variance
σ_b^2: Variance of question items

3. Determine the index of each parameter

Parameters used to measure the level of preparedness include knowledge and attitudes, family policies, emergency response plans, early warning systems, and resource mobilization (BNPB, 2012; Kusumastuti et al, 2021; Nuryana et al, 2023. Analysis of the collected questionnaire results was carried out using index analysis. The index assessment is carried out in several stages: measuring the index of each parameter from each respondent using Equation (5), determining the weight of each parameter using Equation (6), and calculating the total index of each respondent using Equation (7).

$$Index = \frac{Total\ real\ scores\ parameter}{Maximum\ scores\ of\ the\ parameter} \times 100 \quad (5)$$

$$W_{p_i} = \frac{T_{p_i}}{T} \quad (6)$$

Information:
W_{p_i} : Weight of parameter i
T_{p_i} : Number of questions of parameter i
T : Number of questions

$$Total\ Index = K\ weight * K\ Index + P\ weight * P\ Index + E\ weight * E\ Index + W\ weight * W\ Index + M\ weight * M\ Index \quad (7)$$

Information:

K : Knowledge and attitudes parameter
P : Family policies parameter
E : Emergency response plans parameter
W : Early warning systems parameter
M : Resource mobilization parameter

Determining the influence of demographic factors on the level of community preparedness for tsunami disasters

The steps taken to determine the influence of demographic factors on the level of community preparedness for tsunami disasters are:

1. Defining the variables used
2. Calculate the frequency distribution for each variable and coding.
3. Determine the initial ordinal logistic regression model
   The initial model was designed to provide a baseline probability of a person being in a particular preparedness category without taking demographic factors into account.
4. Determine the final ordinal logistic regression model
   The final model was formed to show how much influence demographic factors have on the level of preparedness and to identify which variables significantly influence preparedness.

Results And Discussion

Level of Preparedness

Bengkulu City consists of nine sub-districts, seven of which are located in coastal areas. Coastal areas generally have large populations and high population densities. This is one of the factors that makes Bengkulu City vulnerable to the danger of tsunamis. Figure 1 shows the geographical position of Bengkulu City. The distribution of the population and population density in the sub-districts in Bengkulu City are shown in Figures 2 and 3.

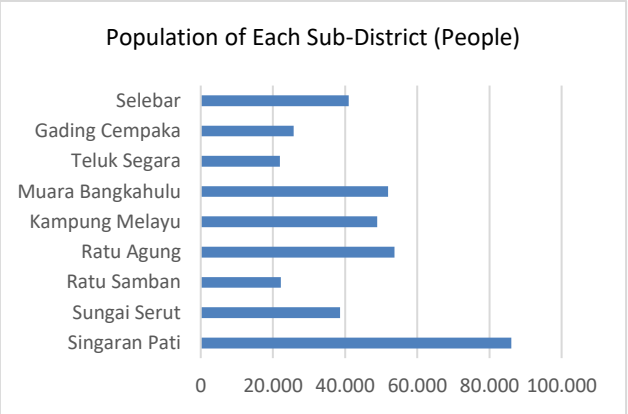

Figure 2. Distribution of the Population in Bengkulu City

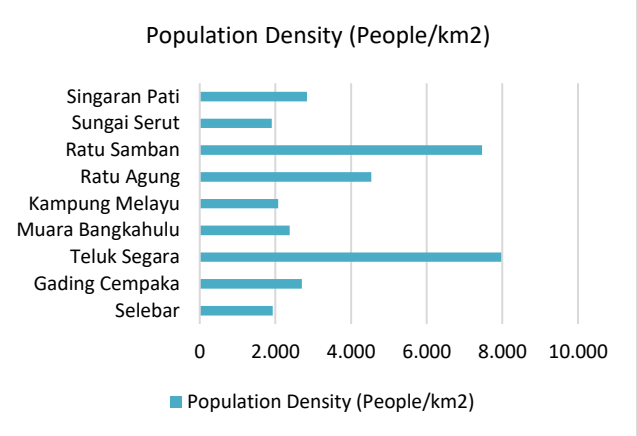

Figure 3. Population Density in Bengkulu City

Based on Figure 2, it can be seen that the population in each sub-district ranges from 20,000 to 80,000. The largest population is in Selebar Sub-District, with a population of 86,103 people, while the smallest population is in Ratu Samban Sub-District, with a population of 21,975 people. Based on Figure 3, the population density in each sub-district is relatively high, with a population exceeding 1,000 people/km2. The highest population density is in Teluk Segara Sub-District, with a density of 7,972 people/km2.

The results of the validity test on the questionnaire, consisting of 31 questions to determine the level of community preparedness, with an error tolerance 5%, showed that the questionnaire was valid and reliable with a Cronbach's alpha value of 0.83. Determination of the level of preparedness based on the total index value is classified into three levels: not ready, moderate, and ready, as shown in Table 1.

Table 1. Category of Community Preparedness Level.

No	Index Score	Category
1	80,000 – 100,000	Ready
2	55,000 – < 80,000	Moderate
3	<= 55,000	Not Ready

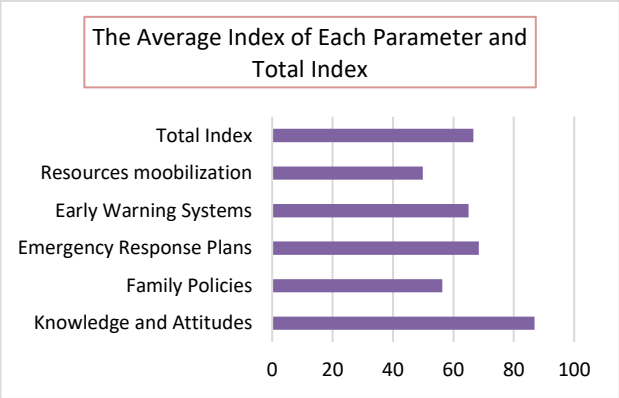

Figure 4. The Average Index of Each Parameter and Total Index

The average index of each parameter and the total index are shown in Figure 4. Based on Figure 4, the knowledge and attitude parameter is the parameter with the highest average index, followed by the emergency response plans, early warning systems, family policies, and resources mobilization parameters, with index values of 86.83, 68.40, 65.00, 56.30, and 49.90, respectively. This means that the average knowledge and attitude of the Bengkulu City community in preparedness for the tsunami disaster is ready. Based on the emergency response plans, early warning systems, and family policies parameters, the level of preparedness of the Bengkulu City community for the tsunami disaster is at a moderate level, while based on the resources mobilization parameter, the level of preparedness of the Bengkulu City community for the tsunami disaster is at the not ready level. Overall, the average total index of the Bengkulu City community is at a moderate level with a total index value of 66.59.

The influence of demographic factors on the level of community preparedness for tsunami disasters

The variables used in this study are shown in Table 2. Based on the results of the questionnaire distributed to 400 respondents across nine sub-districts in Bengkulu City, the results are presented in Table 3. Based on Table 3, it can be seen the frequency distribution of each research variable including: 1) the gender, dominated by male (55.25%), 2) the age, dominated by respondents is over 30 years old (60%), 3) the occupation, dominated by private employees (38%), 4) the education, dominate by respondents who had a minimum education of high school (91.25%), and 5) the level of preparedness, dominate by respondents who is at a moderate level of preparedness for a tsunami disaster.

Table 2. Variables, Categories, and Data Types

Variable /Symbol/Type	Category	Data type
Preparedness/Y/ Dependent	Ready Moderate Not Ready	Ordinal qualitative
Gender/ $X1$/ Independent	Male Female	Nominal qualitative
Age/ $X2$/ Independent	≤ 30 > 30	Ordinal qualitative
Occupation/ $X3$/Independent	Civil Servant Private employee Students Other	Nominal qualitative
Education Level/ $X4$/Independent	High school, Diploma, Bachelor, Postgraduate No schooling, elementary school, junior high school	Ordinal qualitative
Length of stay/ $X5$/Independent	Continuous (Quantitative ratio)	

Table 3. Profile of the Respondents' Socio-Demographic Characteristics and Code

Variables	Frequency	%	Code
Gender			
- Male	221	55.25	0
- Female	179	44.75	1
Age			
- <=30 years old	160	40.00	0
- >30 years old	240	60.00	1
Occupation			
- Civil Servant	71	17.75	3
- Private Employee	152	38.00	2
- Students	43	10.75	1
- Other	134	33.50	0
Education Level			
- High school, Diploma, Bachelor, Postgraduate	365	91.25	1
- No schooling, Elementary School, Junior High School	35	8.75	0

Length of Stay	Continue		
Level Preparedness			
- Ready	26	6.50	3
- Moderate	210	52.50	2
- Not Ready	164	41.00	1

The analysis of how demographic variables affect the preparedness level of the Bengkulu City community in facing the tsunami disaster was conducted using a statistical modeling process. Since the dependent variable, the preparedness level, has three ordinal categories: not ready, moderate, and ready, the method employed was ordinal logistic regression. This model estimates the likelihood of respondents being at a certain preparedness level or higher, based on their demographic features, such as gender, age, occupation, education, and length of stay. With this approach, it is possible to identify which variables significantly influence preparedness levels and whether their effects are positive or negative.

Ordinal Logistic Regression Modeling

The modeling stages include model identification, parameter estimation, significance testing, and interpretation of the model results. The resulting model is expected to provide a deeper understanding of the demographic factors that influence community preparedness for tsunami disasters and can serve as a basis for formulating more targeted disaster mitigation policies. The initial model for ordinal regression can be seen in Table 4.

Table 4. Initial Model of Ordinal Logistic Regression

Variable	Coefficient	Std. Error	t value	p value
$X1$ (Female)	0.510	0.197	2.589	0.005*
$X2$ (>30 y.o)	-0.428	0.241	-1.772	0.038*
$X3$_Civil Servant	-0.804	0.373	-2.155	0.016*
$X3$_Pprivate Employee	-0.107	0.232	-0.461	0.322
$X3$_Student	-0.029	0.310	-0.094	0.463
$X4$ (High school, Diploma, Bachelor, Postgraduate)	0.374	0.347	1.078	0.141
$X5$ (Length of Stay)	-0.002	0.007	-0.285	0.388
1|2	-0.856	0.441	-1.940	0.026*
2|3	1.288	0.444	2.898	0.002*

Note: * Significant variables at the 5% significance level

The ordinal regression model at this stage is the initial model that includes all demographic variables as predictors; gender ($X1$), age ($X2$), occupation ($X3$), education level ($X4$), and length of stay ($X5$). Based on the results of the parameter significance test, it is known that not all variables have a significant effect on the level of community preparedness. The variables that show a significant effect at the 5% significance level are: gender (female/ $X1$), age (>30 years old/ $X2$), and occupation (civil servant/ $X3$).

Final Ordinal Logistic Regression Model

The final model was constructed by including only variables that were proven to be statistically significant to obtain a simpler and more efficient model without compromising the model's explanatory power. Table 5 shows a test of the final ordinal logistic regression model. Based on the results of parameter significance testing in the initial ordinal logistic regression model, it was found that not all variables had a significant influence on the level of community preparedness. Significance testing was performed by examining the p-value, where a parameter is considered significant if the p-value is < 0.05 (5% significance level).

Table 5. Final Ordinal Logistic Regression Model

Variable	Coefficient	Std. Error	t value	p value
$X1$ (Female)	0.500	0.197	2.545	0.006*
$X2$ (>30 years old)	-0.488	0.227	-2.148	0.016*
$X3$_Civil Servant	-0.761	0.370	-2.060	0.020*
$X3$_Private Employee	-0.079	0.230	-0.345	0.365
$X3$_Student	0.036	0.304	0.118	0.453
1|2	-1.170	0.271	-4.313	0.000*
2|3	0.968	0.269	3.599	0.000*

Note: * Significant variables at the 5% significance level

The final ordinal logistic regression model is shown in Equations (8) and (9).

- For category $Y \leq 1$ (Not Ready)

$$\log\left(\frac{P(Y \leq 1)}{P(Y > 1)}\right) = -1.170 - (0.500 \times Gender = 1) - (-0.488 \times Age = 1) - (-0.761 \times Occupation = 3) \quad (8)$$

- For category $Y \leq 2$ (Moderate or Not Ready)

$$\log\left(\frac{P(Y \leq 2)}{P(Y > 2)}\right) = 0.968 - (0.500 \times Gender = 1) - (-0.488 \times Age = 1) - (-0.761 \times Occupation = 3) \quad (9)$$

Interpretation of the final ordinal logistic regression model

1. $\frac{P(Y \leq 1)}{P(Y > 1)}$ (Ready vs. Not ready atau Moderate)
   - Intercept (-1.170): This is the logit value when all independent variables are 0. That is, when gender is male (0), age ≤ 30 years old (0), and occupation not civil servant (0), the logit for P(Y ≤ 1) compared to P(Y > 1) is -1.170.
     - Interpretation: Negative values indicate that the "Ready" category is less likely than the "Not Ready or Moderate" category in the baseline state (without the influence of the independent variable).
   - Gender = 1 (Female), Coefficient 0.500:
     - Interpretation: If an individual is female (Gender = 1), then the logit for P(Y ≤ 1) compared to P(Y > 1) increases by 0.500.
     - This means that females are more likely to be in the Ready category compared to the Not Ready or average category compared to males (Gender = 0).
   - Age = 1 (Age > 30 years old) Coefficient -0.488:
     - Interpretation: If an individual is over 30 years old, then the logit for P(Y ≤ 1) compared to P(Y > 1) decreases by 0.488.
     - This means that Age > 30 years old reduces the likelihood of someone being in the Ready category compared to the Not Ready or average category, compared to individuals aged <= 30 years old
   - Occupation = 3 (Civil Servant), Coefficient -0.761:
     - Interpretation: If an individual is a civil servant, then the logit for P(Y ≤ 1) compared to P(Y > 1) will decrease by 0.761.
     - This means that individuals who a civil servants are less likely to be in the Ready category compared to the Not Ready or Moderate categories, when compared to those who are not civil servants.
2. $\frac{P(Y \leq 2)}{P(Y > 2)}$ (Moderate or Not Ready vs. Not Ready)
   - Intercept (0.968): This is the logit value when all independent variables are 0. That is, when gender is male (0), age ≤ 30 years old (0), and occupation is not a civil servant (0), the logit for P(Y ≤ 2) compared to P(Y > 2) is 0.968.
     - Interpretation: This positive value indicates that without other factors, a person is more likely to be in the Moderate or Not Ready category than in the Not Ready category (more likely to be "Moderate" or "Ready" than "Not Ready").
   - Gender = 1 (Female), Coefficient 0.500:
     - Interpretation: If the individual is female (Gender = 1), then the logit for P(Y ≤ 2) compared to P(Y > 2) increases by 0.500.
     - This shows that women are more likely to be in the Moderate or Not Ready category compared to the Not Ready category when compared to men.
   - Age = 1 (Age > 30 years old), Coefficient -0.488:
     - Interpretation: If the individual is older than 30 years old, then the logit for P(Y ≤ 2) compared to P(Y > 2) will decrease by 0.488.
     - This shows that Age > 30 years old reduces the likelihood of someone being in the Moderate or Not Ready category compared to the Not Ready category, when compared to individuals aged <= 30 years old.
   - Occupation = 3 (Civil Servant), Coefficient -0.761:
     - Interpretation: If an individual works as a civil servant, then the logit for P(Y ≤ 2)

compared to P(Y > 2) will decrease by 0.761.

This means that civil servants are less likely to be in the Moderate or Not Ready category compared to the Not Ready category, when compared to individuals who are not civil servants.

Discussion

This study indicates that the level of community preparedness for tsunami hazards in Bengkulu City is generally moderate. Despite the community demonstrating strong knowledge and positive attitudes, shortcomings remain in areas such as emergency planning and, in particular, resource mobilization. This gap suggests that awareness has not yet fully translated into effective preparedness actions. Similar trends have been observed in other coastal regions, where understanding disaster risks does not always result in proactive behavior (Bronfman et al., 2019; Bogdan et al., 2021).

Among the demographic variables examined, gender, age, and occupation showed significant influences on preparedness. Women tended to have higher preparedness levels, supporting previous findings that they are often more cautious and more involved in family safety measures (Addiarto & Kusyairi, 2025). Conversely, respondents aged over 30 showed lower preparedness, which may reflect the greater exposure of younger individuals to disaster education and their confidence during evacuation situations.

Preparedness levels were also lower among civil servants compared to other occupational groups. One possible explanation is their dependence on institutional protocols, which may limit personal initiative in preparing individual or household emergency plans. Similar patterns have been noted in other studies involving workers in the formal sector within hazard-prone environments (Qing et al., 2021).

On the other hand, education level and duration of residence did not show significant effects on preparedness. This indicates that general academic achievement and long-term living experience do not necessarily lead to better disaster readiness. Instead, focused disaster education, active community participation, and practical training appear to be more influential factors (Paton, 2019; Sakya et al., 2023).

Overall, these findings emphasize the need for more targeted efforts to strengthen tsunami preparedness in Bengkulu City, particularly for adults over 30 years old and civil servants. Enhancing community-based capacity building, improving preparedness programs in workplaces, and increasing access to necessary resources will be key steps in building stronger and more resilient coastal communities.

Conclusions

The research results show that the level of preparedness for a tsunami in Bengkulu City is mostly moderate, while others are either ready or not ready. This indicates that community preparedness is still less than optimal. Based on the ordinal logistic regression analysis, not all demographic factors significantly influenced preparedness levels. Of the five variables analyzed (gender, age, occupation, education, and length of stay), only gender, age, and occupation as a civil servant were shown to have a significant influence. Gender had a positive effect, meaning women tended to be more prepared for disasters than men. Age had a negative effect, meaning respondents aged 30 and over tended to be less prepared than those aged 30 and under. Employment as a civil servant also had a negative effect, meaning civil servants were less likely to be in the prepared category compared to other occupational groups. Meanwhile, education and length of stay in coastal areas did not significantly influence preparedness.

In general, this study confirms that certain demographic characteristics do play a role in determining community preparedness, but not all factors have a significant impact. Therefore, efforts to improve tsunami disaster preparedness in Bengkulu City should be more directed at the adult age group (over 30 years old) and civil servants, with more intensive education and training programs, so that their level of preparedness can be improved. The results of this study can be a basis for local governments and related institutions

to design more targeted tsunami disaster mitigation programs, so that the preparedness of the Bengkulu community, especially in coastal areas, can be increased evenly.

Conflict of Interest: The authors declare that there are no conflicts of interest concerning the publication of this article.

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