

**Artikel Penelitian**

***Diving Frequency Increase the Risk Barotrauma in Traditional Fisherman-Divers***

**Pengaruh Frekuensi Menyelam Meningkatkan Risiko Kejadian Barotrauma pada Nelayan Penyelam Tradisional**

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**ABSTRACT**

*Barotrauma is a problem caused by differences between air pressures inside the body and in the environment. This condition causes damage to many organs and body tissues. Many factors influence the occurrence of barotrauma. However, the two factors that are not obviously influencing the incidence of barotrauma are the diving frequency and the diving resting time. This study aimed to identify the effect of diving frequency and resting time on barotrauma. This study used an observational analytic design through a case-control approach of 174 respondents. The results show p-value=0.000 and OR=5.48 that indicate an effect of diving frequency on barotrauma. The diving resting time does not influence barotrauma with p-value=0.621. The diving frequency is a factor that affects the incidence of barotrauma.*

**Keywords:** Barotrauma, diving frequency, resting time

**ABSTRAK**

Barotrauma adalah masalah yang disebabkan oleh perbedaan tekanan udara dalam tubuh dengan lingkungan. Kondisi ini menyebabkan kerusakan pada banyak organ dan jaringan tubuh. Dari banyak faktor yang mempengaruhi barotrauma, terdapat 2 faktor yang belum jelas mempengaruhi terjadinya barotrauma adalah frekuensi menyelam dan waktu istirahat menyelam. Tujuan dari penelitian ini adalah untuk mengetahui pengaruh frekuensi menyelam dan waktu istirahat pada barotrauma. Penelitian ini menggunakan desain observasional analitik melalui pendekatan *case control* dengan 174 responden. Hasil penelitian ini menunjukkan p-value=0,000 dan OR=5,48 yang menyatakan ada pengaruh frekuensi penyelaman pada barotrauma. Waktu istirahat menyelam tidak berpengaruh pada barotrauma dengan p-value=0,621. Frekuensi menyelam adalah faktor yang berpengaruh terhadap kejadian barotrauma.

**Kata Kunci:** Barotrauma, frekuensi menyelam, waktu istirahat

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DOI: <http://dx.doi.org/10.21776/ub.jkb.2019.030.04.9>

## INTRODUCTION

Barotrauma is an injury caused by the physiological air pressure in the body with environmental pressure and causes damage to organs and body tissues. The damage to body tissues can include the lungs, abdomen, and others. Barotrauma occurs in many divers in the world. The prevalence of barotrauma reached 0.35% of 10,000 dives carried out, and the mortality reached 1.3% of 10,000 divers (1,2). Barotrauma incidence is quite high in Indonesia. The incidence of ear barotrauma reached 11.3% in Bungin island, and lung barotrauma reached 6.91% in the Seribu Islands (3).

Many factors influence the incidence of barotrauma such as the diving frequency, diving resting time, weight, diving experience, diving length, speed of ascending, history of disease, and diving time (4-6). However, the two factors that are not obviously influencing the occurrence of barotrauma are the diving frequency and the diving resting time. The diving frequency is related to barotrauma in which divers who have a high diving frequency are at risk of experiencing barotrauma. The maximum limit of diving is twice a day (5). Previous research explained that the diving frequency correlates with the occurrence of barotrauma (7-10). Conversely, other studies previously also stated that the diving frequency does not correlate with the occurrence of barotrauma (11,12). Diving resting time was recommended at least 4 hours/diving (5,6). However, previous research explained that divers who have adequate rest periods experience barotrauma, and there is no correlation of diving resting time with the occurrence of barotrauma (7,8,12).

Tasipi Island is one of the seven islands in the North Tiworo District, West Muna Regency, Southeast Sulawesi. Most of the population is the Bajo tribe. The phenomenon of the occurrence of barotrauma found on Tasipi Island is very high. Based on data in 2017 from the department of marine and fisheries statistics, Tasipi Island is one of the islands which has the highest number of traditional fishermen-diver among the other six islands in the North Tiworo sub-district, West Muna Regency. A number of 87 traditional active fishermen-divers experience barotrauma and have suffered from paralysis.

Based on the results of preliminary studies, fishermen carried out diving on an average of more than three times a day and the diving resting time was less than 4 hours/diving. After diving, fishermen experience ear pain like deafness. The report from the West Muna district health office states that Tasipi Island does not have adequate health facilities and diving facilities. Only one health provider is available, that is a nurse who has been responsible for the three other islands in the North Tiworo sub-district. The position of this health provider was never settled on one island, so the community had difficulty getting the health services.

In our preliminary study, the nurse on the Tasipi island stated that the health problem often found in the Tasipi islands was ear barotrauma. However, when we interviewed ten people who experienced barotrauma, the fishers in the fishing communities in the islands considered that the case of barotrauma was common after diving. Therefore, they considered this condition did not require further treatment. In barotrauma conditions, the fishermen continue to dive as usual. The aim of the

study was the relationship of the effect of diving frequency and diving resting time on the incidence of barotrauma.

## METHODS

This study used observational analytic design with a case-control approach. The research respondents were 174 traditional fishermen-divers obtained using a total sampling method on Tasipi Island (23 November-5 December 2018). The research instrument was an observation sheet. Bivariate analysis was using chi-square and Fisher tests to identify the effect of diving frequency and diving resting time on barotrauma. The criteria of respondents who experienced barotrauma were joint pain, ear disorders such as deafness, urine retention, paralysis, itchiness, dizziness, vertigo, and ataxia (13). This research was conducted after obtaining approval from the ethics committee of LPPM UHO number 2504/UN29.20/PPM/2018.

## RESULTS

Table 1 showed that the most dominant education level of respondents was primary school, as many as 147 respondents (84.5%). The most dominant diving frequency of respondents was more than two dives a day, as many as 100 respondents (57.4%). The most dominant diving resting time of respondents was less than 4 hours/dive as many as 170 respondents (97.7%). The respondents who experienced barotrauma were 87 respondents (50%).

**Table 1. Characteristics of respondents based on education level, diving frequency, diving resting time, and**

Variables	Category	F	%
Education Level	Primary School	147	84.5
	Junior High School	22	12.6
	Senior High School	5	0.29
Diving Frequency	>2 dives/day	100	57.4
	≤2 dives/day	74	42.6
Diving Resting time	<4 Hours/dive	170	97.7
	≥4 Hours/dive	4	2.3
Barotrauma	Barotrauma	87	50
	Non-Barotrauma	87	50

Table 2 shows that there is a significant difference in the effect of diving frequency on barotrauma (p-value=0.000). Odd ratio value (OR=5.48) explained that fishermen who were diving more than twice a day had a 5.48-times higher risk to suffer barotrauma than fishermen who were diving less than twice a day. Table 2 also shows that diving resting time does not influence barotrauma (p-value=0.621).

**Table 2. Distribution frequency and resting time of diving**

Variables		Groups				OR	p
		Barotrauma		Non - Barotrauma			
		N	%	N	%		
Diving Frequency	>2 dive/day	67	38.5	33	19	5.48	0.000
	≤2 dive/day	20	11.5	54	31		
Diving Resting time	<4 hour/dive	86	49.4	84	48.3	3.071	0.621
	≥4Hour/dive	1	0.6	3	1.7		

## DISCUSSION

In this study, the education level of the respondents was dominated by primary school (84.5%) than junior high school (12.6%) and senior high school (0.29%). The results were similar to the previous study that the level of education of the respondents was more on primary school than junior high school and senior high school. Almost all the fishermen did not finish their primary school and focused on their works. For the diving frequency, fishermen who dived more than twice a day (57.4) were higher in number than those who dived than less than twice a day (42.6). The results were similar to the previous study that the frequency of fishermen who dived twice or more a day was higher than those who dived less than twice a day (8). Most fishermen had less than 4 hours/dive resting time. The results were similar to the previous study that the majority of fishermen had less than 1 hour/dive resting time (8).

The results of this study indicate that diving frequency factor influences the incidence of barotrauma in traditional fishermen-diver who dive more than twice a day yield 5.48-times higher risk to suffer barotrauma than fishermen who dive less than twice on Tasipi island, West Muna Regency, Southeast Sulawesi.

This study was similar with Cialoni *et al.*, (5) and Navisah *et al.*, (12) who stated that divers who have more than 100 times diving experience and more than two dives on one day have a high risk of experiencing barotrauma. However, this also depends on the depth of the diving, the physical condition, and the equipment used in the diving process.

The regular diving frequency and more than twice a day increase the risk of barotrauma. The diving frequency more than twice a day increases the pressure on the lungs. This condition causes excessive consumption of oxygen and nitrogen in the body. In this condition, divers are at risk of suffering from nitrogen narcosis and oxygen toxicity which result in an increased risk of barotrauma through organ tissue damage that is supported by a diving speed of 9 meters/minute (5,14).

Nitrogen narcosis is caused by a lack of neuron stimulation due to the high solubility of nitrogen in body fat. Diving more than twice a day at a depth of up to 150 feet can consume a large amount of nitrogen that is five times higher due to the increase in pressure reaching 5 atm. Oxygen toxicity also arises from the amount of oxygen consumption that is five times higher when there was an increase of 5 atm (4,15,16).

Another result in this study explained that the diving resting time did not influence the incidence of barotrauma in traditional diver-fishermen on Tasipi island, West Muna

Regency, Southeast Sulawesi (p-value=0.621). In this study, respondents who had less resting time and experienced barotrauma were 86 respondents (50%), and non-barotrauma was 84 respondents (50%). Based on these results, it can be concluded that less diving resting time does not dominantly affect the incidence of barotrauma in which the cases of non-barotrauma are similar to the number of barotrauma cases.

Respondents in this study were traditional divers who chose this activity as a livelihood for the people of Tasipi Island. This of course significantly affects the diving frequency and the diving resting time performed by divers. Fishermen from the island of Tasipi, on average, dive more than three times a day with a resting period of around 30 minutes. The diving duration depends on the equipment used and the diving targets that respondents want to achieve.

The average respondents there used a compressor to find sea cucumbers with an average diving time of 30 minutes on single diving. However, some fishermen did not use compressors to find fish with an average duration of 3-5 minutes. Because diving is the fisherman's livelihood, the time to spend was at least 4 hours in a single dive but still did not support the financial condition of the fishermen. Still, many fishermen who lack time to rest but did not experience barotrauma were certainly influenced by other factors such as the use of diving equipment, length of diving, depth of diving, and others.

Cialoni *et al.*, (5), Jansen *et al.*, (14,17) and Navisah *et al.*, (12) stated that diver's resting time was recommended to be a minimum of 4 hours to return diving. This resting time is very much related to the diving frequency. When the number of diving frequencies is more than twice a day with a resting period of fewer than 4 hours, it could increase the risk of barotrauma. However, this risk is also influenced by the depth, length and, the speed of diving, and the use of diving equipment.

Based on the results of this study, it can be concluded that diving frequency increases the risk of barotrauma incident. Diving resting time does not influence barotrauma. Diving frequency is an influencing factor on barotrauma. Therefore, nurses need to provide the fishermen about diving safety by using standard diving equipment, give information about barotrauma, and advise the fishermen to use health facility when they experience the symptoms of barotrauma.

## ACKNOWLEDGEMENT

Thank you to the Ministry of Maritime and Fisheries Affairs and the Chief of Tasipi Island to support this research.

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