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Judul	: The Impact of Frequency and Duration of Diving Activitieson the Occurrence of Decompressive Sickness
No. Pemeriksaan	: 2645474684.2025. 04. 14
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The Impact of Frequency and Duration of Diving Activitieson the Occurrence of Decompressive Sickness

by Perpustakaan STIKES HANG TUAH SURABAYA

MJN

Original Article

doi:10.31674/mjn.2022.v14i02.013

The Impact of Frequency and Duration of Diving Activities on the Occurrence of Decompressive Sickness

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ABSTRACT

Background: Diving activities have a risk of disease due to difference of pressure that may cause to decompression sickness. Studies showed that the risks for the incidence of decompression sickness is the number of hours of diving and diving experience. This study aims to analyze the number and duration of diving and its factors associated with occurrence of decompression sickness experience by divers. **Methods:** The study used a cross-sectional approach with an modified questionnaire and observational checklist from underwater and hyperbaric medicine. Total of 66 divers were recruited by simple random sampling. Data were analyzed using logistic regression with a significance value of $P<0.05$. **Results:** The results showed that the number of hours of diving in one week and diving experience influenced the incidence of decompression sickness experienced by divers ($p<0.05$). The results of the regression test showed an Exp (B) value of 10.540 for the number of dives in a week, which means that the value of the number of dives in a week >10.5 hours tended to experience decompression compared to those with a number of dives <10.5 hours, and the Exp (B) value of 2.645 during the working period of a long dive. This means that diving experience >2.6 years is more likely to experience decompression compared to those with experience <2.6 years. **Conclusion:** Monitoring diving activities and the complaints felt by divers after diving is needed as early detection of decompression sickness, providing appropriate activities, and reducing the impact of decompression sickness on divers.

Keywords: Diving Activity; Health Status; Decompression Sickness

INTRODUCTION

Diving is an activity carried out under surface water with or without used equipment, to achieve a specific purpose (Rusoke-Dierich, 2018). The Dive environment has various potential dangers for both physics and biology (Rahman, Kurniawati, & Apriani, 2020). Anatomically the human body consists of 3 elements, namely solid, liquid and hollow. Dense body tissues are bones, muscles, heart, liver (Saklani, George, & Nadiya, 2021). Relatively do not carry pressure, while the liquid can continue the pressure, and the hollow such as the ears, sinuses, stomach, intestines, lungs, and airways are strongly influenced by changes in pressure (Di Muro *et al.*, 2020). Accidents and diseases due to diving are usually caused by 3 closely related factors, namely the diver's factor, the dive environment, and the diving technique or diving equipment used (Campos *et al.*, 2018). The preparation of a mature dive plan will determine the success and safety of diving activity (Koesdianasari, 2018). Many factors must be taken into account in the preparation of a dive plan, including the purpose of the dive, the situation and conditions of the dive environment, diving equipment and the ability of the diver (Hidayat & Febriyanto, 2021). In Indonesia divers traditional generally still apply traditional method and with limited equipment. This traditional dive method is often called the fisherman compressor (Putra, Karwur, Hidayati, 2020). Traditional fishermen to catch fish, one of the ways they do it is by diving, which is commonly known as traditional divers (Rahman, Kurniawati & Apriani, 2020). Activities carried out by traditional divers are catching fish, lobster, sea cucumbers, abalone, shellfish, pearls etc., which have high economic value (Winda, 2020). Traditional diving

Received June 30, 2022; Received in revised form September 26, 2022; Accepted October 1, 2022

activities with all the limitations of equipment and knowledge about diving can affect the condition of the diver, and pose a high risk to health such as pain, paralysis, disability, and death (Oetama, Luhulima & Mainase, 2019). The risks experienced are not only caused by the divers themselves but are also influenced by the underwater environment, the diving techniques used, and the mental and physical conditions of the divers (Mirza & Rodriguez, 2018). Proper diving techniques, safety equipment can improve the quality of life. Quality of life is described as a way of self-reflection so that it can function physically, emotionally, mentally and socially (El-Soud *et al.*, 2020). It is further described as living without functional limitations, a breakdown (D'Souza *et al.*, 2018). The low quality of life of traditional divers begins with injuries experienced work, for example experiencing decompression. Decompression sickness is a disease caused by the formation and increase of bubble size when the partial pressure of the inert gas in the blood and tissues exceeds the ambient pressure (Duke *et al.,* 2017). The formation of air bubbles will block blood flow and the nervous system so that it will cause symptoms such as pain in the joints, headaches, itching, numbness or numbness and paralysis (paralysis) and can even cause death (Mirza & Rodriguez, 2018). Decompression sickness is a collection of symptoms that occur in a person exposed to pressure drops (Edward *et al.*, 2021). Decompression sickness is a disease caused by the release and expansion of gas bubbles from the soluble phase in the blood or tissue due to a rapid decrease in pressure around it (Di Muro *et al.*, 2020).

Data from the Ministry of Health, according to a survey of 251 diver respondents in 9 provinces in Indonesia, the diving technique used is 56.6% of breath-holding divers, 33.9% of compressor divers and 9.6% of divers with SCUBA. Common complaints from the 251 respondents included 21.2% dizziness/headache, 12.6% fatigue, 12.5% decreased hearing, 10.8% joint pain, 10.2% nosebleed, 9.7% chest pain/tightness, 6.4% reduced vision, 6.0% red patches on the skin, 5.6% animal bites, 3.2% paralysis and 1.7% loss of consciousness.

The body is supposed to adapt to stress along with a rapid increase in height when diving. This is a problem in diving and a nuisance due to air pressure (Howle *et al.*, 2017). Decompression sickness is a risk of occupational disease, especially among divers or fishermen (Russeng *et al.* 2020a). Many diving activities in the waters are carried out by professional divers, military divers, recreational divers, traditional compressor divers, and breath-holding divers. Traditional divers and breath-hold divers usually pay less attention to safety and health so they are potentially exposed to decompression sickness (Kovačević & Franinović Marković, 2018). The diver's blood and tissue absorb additional nitrogen or helium from the lungs while inside (Javed, Javed, & Khalid, 2022). A diver ascends to fast, this excess gas will separate from the solution and bubbles (Russeng *et al.,* 2020b). These bubbles produce mechanical and biochemical effects that lead to a condition known as decompression sickness (Widyastuti, Hadisaputro, & Munasik, 2019). The risk factors that influence the occurrence of decompression sickness are environmental factors, namely sea water temperature, dive depth, host factors, namely age, duration of diving, frequency of dives, tools used, years of service as a diver, asthma, smoking, obesity and alcohol consumption (Rusoke-Dierich, 2018).

Studies on the effect of diving activities which include length of dive time and diving experience on the incidence of decompression in divers still need to be investigated, in this study, it will be proven the magnitude of the effect of length of time diving and diving experience on the incidence of decompression in divers.

METHODOLOGY

This research is an observational analytic study with a cross sectional approach to analyze the effect of dive time and diving experience on the incidence of decompression in divers. Respondents in this study were divers who carried out diving activities on the white sandy coast of Situbondo, East Java, Indonesia. The population was taken randomly over a period of 1 month so as to get as many as 66 respondents. The variables in this study were the length of the dive in a week (in hours), diving experience (in years) and the incidence of decompression (yes and no categories). Questionnaire and observation checklist modified from underwater and hyperbaric medicine (Lee & Ye, 2013). Data were obtained using direct interviews with respondents and direct observation of respondents to determine the presence of decompression sickness in respondents. The data is taken after the diver has done the diving activity

and the maximum is 24 hours after the last dive activity. Analysis of research data was carried out by logistic regression test. This research has been submitted for ethical approval on JanuariJanuary,, 26 2021 and has been approved by the Health Research Ethics Commission (KEPK) Stikes Hang Tuah Surabaya. The research ethic certificate was published on March 16, 2021 and the end on March 16, 2022. The number ethic certificate of the research is PE/94/XII/2021/KEPK/SHT.

RESULTS

General Data

Univariate analysis showed in table 1 that the age of the respondents ranged from 19 to 58 years with the highest frequency being 41 years old, as many as 12 respondents (18.2%). The education category of respondents with the highest number of graduates is elementary school, which is 28 respondents (42.4%). The occupation of the respondent with the highest frequency is as a laborer, which is 46 respondents (69.7%) and the average respondent is in the middle to lower socioeconomic level. The research data shows that 42 respondents (63.6%) dive for more than 60 minutes each time with the number of dives for a week ranging from 10 to 30 hours with the highest frequency for 10 hours, namely in 20 respondents (30.3%). The number of diving activities during the week, most of the respondents, as many as 46 (69.7%) admitted to diving more than 3 times a week. Meanwhile, the majority of divers experience or work period, as many as 49 respondents (74.2%) said that they had been doing diving activities for more than 6 years.

Table 1: General Research Data

No	Data	Frequency	Percentage (%)
1	Age		
	a. 19 – 28 years	5	7.58
	b. 29 – 38 years old	18	27.27
	c. 39 – 49 years old	27	40.91
	d. 49 – 58 years old	16	24.24
2	Education		
	a. Did not finish elementary school	12	18.2
	b. Finished elementary school	28	42.4
	c. Finished junior high school	14	21.2
	d. Finished high school	9	23.6
	e. Diploma/bachelor	3	4.5
3	Work		
	a. Businessman	6	9.1
	b. Private	3	4.5
	c. Labourer	3	4.5
	d. Fisherman	8	12.12
	e. Laborer	46	69.7
4	Dive time		
	a. Less than 60 minutes once dive	24	36.4
	b. Over 60 minutes per dive	42	63.6
5	Number of diving activities/week		
	a. Less than 3 times	20	30.3
	b. More than 3 times	46	69.7
6	Diving Working Period		
	a. Less than 6 years	17	25.8
	b. More than 6 years	49	74.2
7	Smoke		
	a. Yes	48	72.7
	b. Not	18	27.3

The association between frequency and duration of Diving Activities on the Occurrence of Decompressive Sickness

The results of the multivariate analysis in this study showed that there was an effect between the number of dives and the duration of work diving on the occurrence of decompression, which was indicated by a significance value of <0.05. With an Exp (B) value of 10.540 on the number of dives in one week, which means that the value of the number of dives for a week >10.5 hours tends to experience decompression compared to the number of dives <10.5 hours. And the value of Exp (B) is 2.645 on experience or length of service diving, which means that the value of working diving >2.6 years tends to experience decompression compared to those with a working period of <2.6 years.

Table 2: Results Analysis Regression Logistics the Impact of Frequency and Duration of Diving Activities on the Occurrence of Decompressive Sickness

Variables in the Equation									
								95% CI for EXP(B)	
		B	SE	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1 [a]	Diving (weekly)	2,355	0.707	11.111	1	0.001	10.540	2.639	42.098
	Constant	-7.164	2.501	8.202	1	0.004	0.001		
Step 2 [b]	Diving (weekly)	24.466	2113.882	0.000	1	0.991	42203495143.440	0.000	.
	Working Period Dive	6.158	529.297	0.000	1	0.991	472.317	0.000	.
	Constant	-113.144	9793.690	0.000	1	0.991	0.000		
Step 3 [b]	Working Period Dive	0.973	0.337	8.357	1	0.004	2.645	1.368	5.116
	Constant	-4.790	1.775	7.280	1	0.007	0.008		
a. Variable(s) entered on step 1: Amount Diving (per week).									
b. Variable(s) entered on step 2: Working Period Diving.									

DISCUSSION

The results of the multivariate analysis showed that there was an influence between the number of dives and the duration of the dive work that affected the occurrence of decompression, which was indicated by a significance value of < 0.05. With an Exp (B) value of 10.540 on the number of dives in one week, which means that the value of the number of dives for a week> 10.5 hours tends to experience decompression compared to the number of dives <10.5 hours. And the value of Exp (B) is 2.645 on experience or length of service diving, which means that the value of working diving >2.6 years tends to experience decompression compared to those with a working period of <2.6 years.

The results showed that there was an influence between the number of dives and the working period of the dive, which had an effect on the occurrence of decompression, which was indicated by a significance value of <0.05. With an Exp (B) value of 10.540 on the number of dives in one week, which means that the value of the number of dives for a week> 10.5 hours tends to experience decompression compared to the number of dives <10.5 hours. The results of interviews with respondents also showed that the duration or length of the respondents diving was 42 respondents (63.5%) diving for more than 60 minutes with the frequency or number of diving more than 3 times a week as many as 46 respondents (69.7%). The accumulated length of time diving for a week ranges from 10 to 30 hours a week with the highest frequency being 10 hours p7 week according to 20 respondents (30.3%). This is in line with the results of the study that the longer the diving time, the higher the tendency to experience decompression (Jain, 2017). Nitrogen levels contained in the blood are not normal but must be re-exposed to nitrogen. The more often someone dives, the condition of the body will also decrease because the human body

isn't be in the water continuously. When diving, the blood and rescue tissues absorb additional nitrogen or helium from the lungs. If a rescuer rises too fast, this excess gas will separate from the solution and bubbles. These bubbles produce mechanical and biochemical effects that lead to a state of decompression. The findings of Widyastuti, Hadisaputro & Munasik (2019) also show that the frequency of diving per day is a risk factor for paralysis due to diving. The frequency of diving is also related to the condition of the diver's body, if the body is in good condition it is possible to dive with more frequency, but if the body is in an unhealthy condition then don't force it to dive. However, the reality is that many divers experience health problems if they dive more than 2 times a day (Duke *et al.* 2017). Therefore, divers should not dive more than 2 times a day. Nitrogen levels in the blood that have not been completely removed from the body will be piled up again because the diver is doing diving again because of the demands of the work that must be done to pursue the target from the place of work.

The frequency of dive fishermen who dive > 2 times a day is due to the lack of catches in the previous location so that divers rise again to the surface to move locations to places where there are suspected to be many catches. According to Astari, Fatimah, & Andarini (2021) a diver who often dives will experience repeated pressure trauma more often. This will cause disruption of the balance system in the body because it is more and more frequent to equalize the pressure in the body with the pressure of the surrounding water. This is in accordance with the theory that the more often a person re-dives, the more nitrogen is trapped in the body. When a diver descends to the seabed and rises back to the surface and then down again to the seabed, the nitrogen in his body also does not get a chance to come out completely (Widyastuti, Hadisaputro & Munasik, 2019). Theoretically, the nitrogen contained in the blood due to diving will return to normal 24 hours after diving. If nitrogen is not normal in the body and must be exposed again, it will cause Chokes or Bends which will have severe consequences (Bibiano-Guillen *et al.* 2021).

The duration of the dive of each individual is different depending on his ability to dive in the water. The longer a person dives, meaning that the more often the pressure equalizes, the more likely it is to fail to equalize the pressure. So that every diver should have a previous plan regarding the duration or length of diving (Tetzlaff & Thomas, 2017). Research conducted by Widyastuti, Hadisaputro & Munasik, (2019) found that resting time was significantly associated with the incidence of decompression. Rest time is needed by divers to normalize nitrogen. The longer the rest time taken by the diver, the more nitrogen gas can be released to reduce the occurrence of gas bubbles in the blood which can cause decompression sickness. The rest time required by divers depends on the depth of the dive reached.

The results of the study related to the experience or years of work of divers in diving activities showed that most of the respondents, as many as 49 respondents (74.2%) had diving experience for more than 20 years. The results of the logistic regression test showed an Exp (B) value of 2.645 in experience or length of work diving, which means that the value of working diving >2.6 years tends to experience decompression compared to those with a working period of <2.6 years.

The period of work can determine the length of time a person is exposed to risk factors in the workplace. The longer the diver works, the greater the exposure to the environment that can cause health problems, paralysis and even death (Widyastuti, Hadisaputro & Munasik, 2019). The results of the study found that years of service were a risk factor for the incidence of decompression sickness. This research is in line with that conducted by Russeng et al., (2020b) that the longer a person works as a diver fisherman, the greater the risk of experiencing decompression sickness. In addition to the two factors previously described, the diver's physical condition also affects diving activities and decompression events. Diving health, especially in the respiratory system, nerves as well as the circulatory system also affects the physical condition of the diver. The results of this study also showed that most of the respondents had a smoking habit, as many as 48 (72.7%) respondents. Smoking can cause changes in the structure and function of the respiratory tract and lung tissue. Smoking habits will accelerate the decline in lung function. The reduction in forced expiratory volume per year was 28.7 mL for non-smokers, 38.4 mL for former smokers and 41.7 mL for current smokers (Rusoke-Dierich, 2018). The effect of cigarette smoke can be greater than the effect of narcosis due to the condition of 8 dives which is only about a third of the bad effect of cigarettes (Jain & Baydin, 2017). Smoking habits can cause changes in the structure and function of the airways and lung tissue (Sriwahyuni, Merianti & Amelia, 2018). As a result of changes in the anatomy of the airways in smokers, it will cause a decrease in lung function and this will directly affect the

physical condition of the diver and will have an impact on the incidence of decompression sickness.

The limitations of this study include the bias that comes from the subject because the data obtained comes from the subject's recall. Another limitation is interview bias, namely bias that comes from the interviewer caused by the interviewer's knowledge or belief of a risk factor that is being proven.

CONCLUSION

The results of this study indicate that the length of time diving and experience or working period of diving have an effect on the incidence of decompression sickness. The longer the time of diving and the longer the working period of diving, the tendency of decompression sicknes will increase.

Conflict of Interest

The authors declare that they have no conflict of interests.

ACKNOWLEDGMENT

This research obtained funding through an internal research grant from the Hang Tuah School of Health, Surabaya and there was no conflict of interest with the overall results of the study.

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