



The model of prevention decompression sickness occurrence on traditional divers around the island of Makassar[☆]



Atjo Wahyu^{a,*}, Furqaan Naiem^a, A. Ummu Salmah^b, Yahya Thamrin^a, Tahir Abdullah^b

^a Department of Occupational Health and Safety Public Health Faculty, Hasanuddin University, Indonesia

^b Department of Biostatistics and Family Planning-Health Public Health Faculty, Hasanuddin University, Indonesia

Received 2 October 2019; accepted 17 October 2019

KEYWORDS

Occupational diseases;
OHS of Marine;
Diving

Abstract

Objective: This study aims to find models of the occurrence of occupational diseases prevention dives with control variables simultaneously confounding factors include (working period, diving frequency, duration, age, nutritional status, warming up before diving, smoking habits and alcohol consumption).

Method: This research is a cross-sectional study design that with 120 people as sample taken by random sampling from some island in Makassar. The study conducted by questionnaire, which competent doctor's diagnosis, timer/stopwatch, meter, scales and microtoice.

Results: There is no direct influence between variables nutritional status, working lives, age and decompression sickness.

Conclusion: Behaviors have influence, either directly or indirectly to decompress but through the intervening variable depth, frequency and duration.

© 2020 Elsevier España, S.L.U. All rights reserved.

Introduction

Indonesia is an archipelago with two-thirds of the sea area larger than the land. This can be seen by the shoreline in almost every island in Indonesia ($\pm 81,000$ km), which makes Indonesia ranks second only to Canada as a country that has the longest coastline in the world.^{1,2}

This condition is exacerbated by a lack of attention and government support in terms of anticipating and preventing

[☆] Peer-review under responsibility of the scientific committee of the 1st International Conference on Nutrition and Public Health (ICNPH 2019). Full-text and the content of it is under responsibility of authors of the article.

* Corresponding author.

E-mail address: atjowahyu.2006@gmail.com (A. Wahyu).

Table 1 Distribution of respondents by age, last education, depth, work period, diving duration, nutritional status, smoking and alcohol habit and complaints decompression on traditional divers around the island makassar 2018.

Independent variables	Decompression (n = 120)				Total	
	Low		High		n	%
	n	%	n	%		
<i>Age</i>						
≤35 years	14	18.2	63	81.8	77	100
>35 years	12	27.9	31	72.1	43	100
<i>Working period</i>						
New (≤5th)	5	13.9	31	86.15	36	100
Prolonged (>5 years)	21	25.0	63	75.0	84	100
<i>Nutritional status</i>						
Malnutrition	7	36.8	12	63.2	19	100
Normal	17	19.1	72	80.9	89	100
More	2	16.7	10	83.3	12	100
<i>Behavior</i>						
Not	10	23.8	32	76.2	42	100
Risky	16	20.5	62	79.5	78	100

the risk of diving in the non-formal sector workers are still relatively underserved working population is a population that has not received adequate medical care. Likewise, the problem is closely related to the health status of traditional divers are divers behavior when doing his job, the average in terms of divers who follow no formal education or training, while the training that has been there still unreached in accordance of ability.³

Developed countries, like the United States, cases of accidents caused by diving is still very high and estimated at 3 to 4 cases per 10,000 divers, on average each year are 1000 cases. While in the Asia-Pacific region ranging between 500–600 cases excluding Japan.⁴

Diseases caused by a dive that had recorded as many as 560 cases in the Naval Hospital (AL) Muntohardjo from 2007 to 2009, 20 people were paralyzed and 15 died after Paralyzed. Presumably, because the divers do not pay attention to the depth and diving duration.^{5,6}

Small islands around the city of Makassar, it was found that the prevalence of traditional divers accidents in 2011–2014, the victim paralyzed 85 people, the death toll of 50 people a total number of victims of 135 people. As for the island Lae-Lae obtained 40% experiencing DCS, and 60% traditional divers dive to a depth of over 19 meters past the allowable threshold value which is 10 meters.⁷⁻⁹

The unavailability of a watch or a pointing device which is a standard tool depth dive diver worsen conditions in Makassar. Plus the lack of adequate training dives healthy and safe, among other things how to plan dives and do stop to prevent the occurrence of decompression in traditional divers.¹⁰

Methods

This research is observational analytic research with a cross-sectional study design that with a sample size of 120 people taken at random from some island in Makassar,

from a population of 259 divers with research instrument was a questionnaire, which competent doctor's diagnosis, timer/stopwatch, meter, scales and microtoice. The statistical test used to analyze and determine the model of prevention of occurrence DCS to control the confounding factor is the regression test logistics, while the statistical tests were used to assess the effect of length of service, age, nutritional status and behavior of the decompression by means of variable intervening depth, frequency and duration are used path analysis (path analysis) using Amos application.

Result

Descriptive data

The study lasted nearly two months, namely from the date of 2 August to 24 September on divers in Makassar, based on Table 1 showed that Age with a high risk of decompression >35 years. However, the results in Table 1 showed that most respondents aged ≤35 years and most experienced decompression with a complaint that is 63 (81.8%) ≤35 years and 31 (72.1%) in those aged >35 years. As well as shows that most respondents are divers with a long working life and high incidence of decompression complaints that 63 (75%), and as many as 31 respondents (86.15%) of the new working life categories.

Table 2 showed that most respondents diving with unsafe category or more than 30 meters and 52 (72.2%) underwent decompression with the high complaint. Some have maintained great diving frequency still normal but still decompressing with a high complaint by 60 (80%) of a total of 75. For the duration of the majority of respondents diving <30 min and 85 (81.7%) of them experienced decompression with the high complaint.

Table 2 Cross-tabulation distribution intervening variable proportion of decompression based on traditional divers around the island Makassar 2018.

Intervening variable	Decompression (<i>n</i> = 120)				Total	
	Low		High		<i>n</i>	%
	<i>n</i>	%	<i>n</i>	%		
<i>Depth</i>						
Secure	6	12.5	42	87.5	48	100
Not safe	20	27.8	52	72.2	77	100
<i>Frequency</i>						
Normal	15	20.0	60	80.0	75	100
Often	11	24.4	34	75.6	35	100
<i>Duration</i>						
<30 min	19	18.3	85	81.7	104	100
>30 min	7	43.8	9	56.2	16	100

Source: Primary Data, 2018.

Table 3 Influence coefficient relation with path analysis and research hypothesis indirect effect.

Hypothesis (Path)	Indirect effect	Total effect
Nutritional status → Depth → DCS	.000	.040
Nutritional status → Frequency → DCS	.000	.181
Working period → Depth → DCS	.002	.086
Working period → Frequency → DCS	.002	.256
Age → Depth → DCS	.002	.017
Age → Frequency → DCS	.002	-.138
Behavior → Depth → DCS	.037	.000
Behavior → Frequency → DCS	.037	.141
Behavior → duration → DCS	.037	.087

Multivariate analysis

Table 3 is a hypothesis testing see *p*-value less than 0.05 then the relationship between significant variables. The test results are presented in the following table:

Simultaneously, Fig. 1 and Table 3 showed that on influence coefficient path analysis and hypothesis of the indirect influence between variables showed that all independent variables have an indirect relation to the incidence of decompression influence value (total effect) is the largest effect of working period on the incidence of decompression through frequency dive is equal to 0.256 and influence behavior toward decompression through diving depth has influence smallest value of 0000. In addition, there is a negative influence between age and incidence of decompression through the diving frequency of -0138.

Discussion

The results showed that most of the divers on the island of Makassar in 2018 had a normal nutritional status of as many as 87 (72.5%) the rest is not normal to severe underweight category 4 (3.3%) of the respondents, skinny with 17 (14.2%) lightly grease 3 (2.5%) and fat weight 9 (7.5%).

The results are consistent with research Sabrina (2007) and Amir (2015) which states that there is an association between nutritional status and decompression, this is due to less variation nutritional status of the respondent where the majority of nutritional status to normal as many as 89 (74.1%) respondents.⁹⁻¹¹ While the existing theory and research results in Mendez-Dominguez (2018) differ from the results of this study, where the divers in Mexico there is influence between nutritional status and the incidence of decompression.¹²

This is in line with research Sukmajaya (2010) on factors related to decompression in professional divers and traditional divers in Gili Matra North Lombok NTB that where respondents are comprised of 80 professional divers and 69 traditional divers shows that the frequency of dives associated with the incidence of decompression at professional divers.¹³⁻¹⁵ Logistic regression variable working period in the table shows that the factors most associated with decompression with *p*-value 0.001, with a value of Wald against decompression, is 10,235, which means that the service life of 10,235 times associated with the incidence of decompression. Value OR (exp1) of 6748 is the strength of the relationship between working life and the incidence of decompression. While the path analysis results obtained *p*-value 0.104 which shows that there is no direct influence between the working period with decompression.

Although the working period cannot directly influence the decompression, indirectly through intervening variable depth and frequency has an influence on decompression. Because divers with long working lives feel more experienced and dive deeper and more frequent the risk of decompression will be even greater. As the results Suzuki et al. that the depth of influence decompression.

Changes in bodily functions, cardiovascular and hormonal systems as part of the process of becoming parents will lead to a lack of ability to work. In the world of diving itself, the ideal age limit is 16–35 years old, with a note that if forced to dive with over 35 years of age then the diver should be in a state of physical and mental health through electrocardiographic examination for the presence of heart disease.

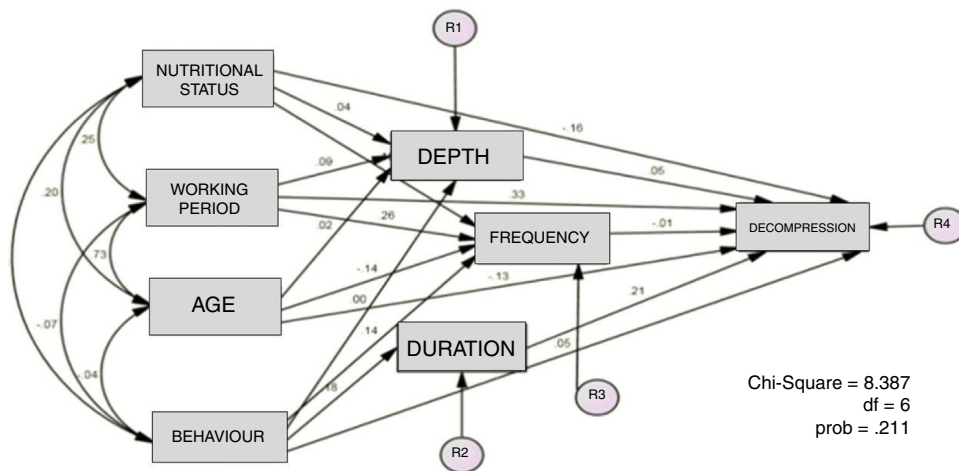


Figure 1 Path analysis of model decompression on traditional divers around the Island Makassar.

The test results obtained direct path analysis for the p-value 0.106 which shows that there is no direct effect between age and incidence of decompression.

Conclusion

Nutritional status has no direct influence by decompression, but it has an indirect influence on decompression through intervening variable depth and frequency. Working lives do not have direct influence with decompression, but it has an indirect influence on decompression through intervening variable depth and frequency. Age does not have direct influence with decompression, but it has an indirect influence on decompression through intervening variable depth and frequency. The behavior has an influence either directly or indirectly to decompress but through the intervening variable depth, frequency and duration.

Conflict of interest

The authors declare no conflict of interest.

References

- Hardiana I, Trixie B. Potensi Indonesia sebagai Negara Maritim [Internet], vol. 21. Indonesia: Perikanan Indonesia. Sekretariat Kabinet RI; 2014. Available from: <http://www.perumperindo.co.id/publikasi/artikel/21-potensi-indonesia-sebagai-negara-maritim> [cited 03.11.19].
- Widodo J. Indonesia Sebagai Poros Maritim Dunia [Internet]. Indonesia: Portal Informasi Indonesia. Kebijakan Nasional; 2019. Available from: <https://www.indonesia.go.id/narasi/indonesia-dalam-angka/ekonomi/indonesia-poros-maritim-dunia> [cited 04.11.19].
- Hammade AG. Hubungan Persepsi Risiko, Cara Menyelam dan Keluhan Dekompresi pada Penyelam Tradisional di Pulau Pasi, Kecamatan Bonto Mate'ne. Makassar: Kabupaten Selayar Tahun 2008. Universitas Hasanuddin; 2008.
- Eric M. The bends – decompression syndrome. Emed Health. 2012. Available from: http://www.emedicinehealth.com/decompression_syndromes_the_bends/article_em.html [cited 15.03.19].
- Alaydrus MA, Usbud M, Yulianto A, Julianto GE. Study of general paralysis in fishermen divers barrang lombo island land districts of Ujung Tanah Makassar City. Age. 2014;15:25–34.
- Jusmawati J, Arsin AA, Naiem F. Faktor Risiko Kejadian Decompression Sickness Pada Masyarakat Nelayan Peselam Tradisional Pulau Saponda. Media Kesehatan Masyarakat Indonesia. 2016;12:63–9.
- Pahri R. Hubungan Karakteristik Individu Dengan Kapasitas Paru Pada Penyelam Tradisional di Pulau Lae-Lae Kota Makassar. Makassar: Fakultas Kesehatan Masyarakat: Universitas Hasanuddin; 2015.
- Parasetiyo. Hubungan Perilaku Menyelam Dengan Kejadian Penyakit Dekompresi Pada Penyelam Tradisional di Pulau Lae-Lae Kota Makassar. Makassar: Universitas Hasanuddin; 2015.
- Amir P. Faktor yang Berhubungan Dengan Kejadian Penyakit Dekompresi Pada Penyelam Tradisional di Pulau Lae-Lae Kota Makassar Tahun 2015 (Skripsi). Makassar: Fakultas Kesehatan Masyarakat: Universitas Hasanuddin; 2015.
- Kartono SA. Prevalensi dan Faktor Risiko Kejadian Penyakit Dekompresi dan Barotrauma Pada Nelayan Penyelam di Kecamatan Karimun Jawa Kabupaten Jepara (Tesis). Program Studi Ilmu Kesehatan Masyarakat Minat Utama Epidemiologi Lapangan. Yogyakarta: Universitas Gajah Mada; 2007.
- Sabrina. Faktor-faktor yang Berhubungan dengan Kejadian Keluhan Dekompresi pada Penyelam Tradisional Pulau Karang Kec. Liukang Tupabbiring Kab. Pangkajene dan Kepulauan (Skripsi). Makassar: Universitas Hasanuddin; 2007.
- Mendez-Dominguez N, Huchim-Lara O, Chin W, Carrillo-Arceo L, Camara-Koyoc I, Cárdenas-Dajdaj R, et al. Body mass index in association with decompression sickness events: cross-sectional study among small-scale fishermen-divers in Southeast Mexico. Undersea Hyperbaric Med: J Undersea Hyperbaric Med Soc Inc. 2018;45:445–51.
- Sukmajaya A, Wijayanti Y. Faktor yang Berhubungan dengan Penyakit Dekompresi Pada Penyelam Profesional Dan Penyelam Tradisional di Gili Matra Kabupaten Lombok Utara Propinsi NTB (Skripsi). Yogyakarta: Universitas Gajah Mada; 2010.
- Mallongi A, Ane RL, Birawida AB. Ecological risks of contaminated lead and the potential health risks among school children in Makassar Coastal Area, Indonesia. J Environ Sci Technol. 2017;10:283–9.
- Wahyu A. Higiene Perusahaan. Makassar: Jurusan Kesehatan Kerja Fakultas Kesehatan Masyarakat. Universitas Hasanuddin; 2003.