VIA MEDICA

ORIGINAL ARTICLE

Int Marit Health
2019; 70, 1: 11–16
DOI: 10.5603/IMH.2019.0002
www.intmarhealth.pl

ISSN 1641–9251

A survey of jellyfish sting knowledge among Thai divers in Thailand

Sukati Suriyan[1], Kanlaya Haruethaikan[2], Roopngam Evelyn Piyachat[3]

[1]School of Allied Health Sciences, Walailak University, Nakhon Si Thammarat, Thailand
[2]Maha Chakri Sirindhorn Clinical Research Centre Under the Royal Patronage, Faculty of Medicine, Chulalongkorn University, Thailand
[3]Department of Clinical Immunology, Faculty of Medical Technology, Western University, Kanchanaburi, Thailand

ABSTRACT

Background: *In tropical regions, jellyfish envenomation is a persistent hazard for people who spend time in the sea. Jellyfish stings can be dangerous, and among the people who face the greatest risk are scuba divers. This study therefore sought to determine the level of knowledge divers in Thailand have about the threat of jellyfish envenomation.*

Materials and methods: *In April 2018, a total of 238 divers responded to a questionnaire, thereby providing data for further statistical analysis.*

Results: *The findings revealed that 31.91% of the study participants cited jellyfish stings as their most frequently encountered injury, with 68.09% having personal experience of the problem, or having seen others injured by jellyfish. However, 34.03% of the sample respondents believed their own level of knowledge to be "low" or "none". The mean score was 71%, which can be considered satisfactory, but the scores for items concerning the recognition of signs of envenomation and items about first aid responses (52.74% and 59.13%, respectively) were not acceptable.*

Conclusions: *Divers frequently experience jellyfish stings, and diving personnel were highly rated for their knowledge in this area. However, very few were fully confident in their first aid capabilities, and therefore it can be argued that it is necessary to improve the level of medical education and to provide training to eliminate this weakness.*

(Int Marit Health 2019; 70, 1: 11–16)

Key words: divers, jellyfish sting, knowledge, medical education

INTRODUCTION

Jellyfish are a type of marine invertebrate which can be found worldwide. Both venomous and harmless species exist, including some which pose a serious threat to humans who come into contact with them. Most jellyfish have dome-shaped bodies and are easily recognised by their tentacles which hang below. These tentacles house the cnidocytes, which are cells that can be activated by stimulation, which can take both chemical and mechanical forms. The cnidocytes contain organelles known as nematocysts, which are responsible for the delivery of venom into the target when they are triggered [1, 2]. Not only is the sting very rapid, but it can be delivered even when the tentacles are separated from the jellyfish, or when the jellyfish is already dead [3].

Different species will produce different symptoms when they envenomate their victims. Another factor affecting the severity of an attack is the amount of bare skin exposed to the jellyfish. While some cases are relatively mild and do not lead to permanent sequelae, others can be much more serious, causing constant pain, vesicular formations, urticaria, superficial necrosis [4], eye injuries [5], cardiovascular problems [6], Irukandji syndrome [7], multiple organ dysfunction [8], and sometimes death [9]. It can be difficult to find accurate data concerning the incidence of

Dr. Piyachat Evelyn Roopngam, Head of Clinical Immunology Department, Faculty of Medical Technology, Western University, T. Sralongrua, A. Huay Kra Chao, Kanchanaburi, Thailand, 71170, e-mail: pyachat@live.com, Piyachat.ro@western.ac.th

jellyfish envenomation because stings are rarely reported. It can be estimated that the number of cases could be as high as 150 million per year [10]. Research carried out in Italy revealed that medical services provided to jellyfish victims in Italian waters cost around €400,000 over a period of 5 years. This represents a significant burden for public health care providers [11]. In tropical or subtropical regions, jellyfish enjoy conditions which are even more conducive to growth and procreation, and the past 10 years has seen jellyfish blooms become increasingly common, especially in Thailand, possibly as a consequence of overfishing, global warming, and of activities which place excessive nutrient levels in the water, thus boosting plant growth while contributing to lower oxygen levels [12, 13].

In the tropical seas of the Asia-Pacific region, the major jellyfish types include *Chironex fleckeri*, *Aurelia aurita*, and *Chrysaora chinensis*. *Aurelia aurita*, also known as the moon jellyfish, can be found all over the world, and had long been considered harmless. However, toxicology tests along medical reports have since confirmed that it is in fact a species which is venomous to humans [14]. Among the other types of jellyfish known to be venomous are *Cyanea capillata* and *Chrysaora chinensis* which appear predominantly in the seas around East Asia, including Thailand, Japan, and Korea [15]. In other parts of the world, especially the North Atlantic, North Pacific, and Arctic Oceans, *Cyanea capillata*, also known as the lion's mane jellyfish poses a potential threat [15]. Meanwhile, blooms of *Cyanea nozakii* have been seen in the Yellow Sea, the Bohai Sea, and the waters around Thailand [16]. In addition, the dangers posed by box jellyfish are relatively well-known since it has a reputation as one of the world's most venomous marine creatures [9]. The most dangerous of all these species is *Chironex fleckeri*, which is capable of causing rapid cardiorespiratory depression when it strikes, with the potential to kill within minutes when the dose received is high [17]. One problem is that many doctors and nurses do not have the requisite knowledge concerning box jellyfish, and are therefore not able to offer the best possible assistance to victims of envenomation. This situation persists despite a number of box jellyfish attacks occurring in Thai waters. The symptoms caused by box jellyfish envenomation, such as Irukandji syndrome, which is linked to carybdeid stings, and other envenomation sequelae are thus rarely diagnosed by Thai physicians [9, 17].

Since these dangerous species are becoming more abundant, they pose an increasingly significant risk to divers and other tourists, especially when it is taken into account that they are almost invisible in the water. Divers are particularly threatened since they spend more time in the water in close proximity to jellyfish. In this study, the researchers therefore carried out a survey to assess the level of knowledge of Thai divers concerning jellyfish. This survey made use of a number of sub-questionnaires in order to gather the data. In this report, the findings concerning the section of the study which addressed the topic of jellyfish stings will be reported.

MATERIALS AND METHODS

STUDY DESIGN AND SAMPLING

The study involved an investigation into the levels of knowledge held by divers about health, and hence the researchers visited a number of diving schools and participated on diving trips in order to gather data during May 2017. The study used a cross-sectional design to examine the divers' knowledge on the subject of jellyfish envenomation. The study population therefore comprised Thai scuba divers who attended the diving schools or joined the diving trips. The study participants were chosen through a convenience sampling approach with the exclusion criteria ensuring that divers who had previously worked in health care environments were not selected.

COLLECTION OF DATA

To gather data, a questionnaire was used. This instrument was written in Thai and was developed in accordance with the Cochrane Systematic Review and 2014 Expert Consensus with the approval of the Chinese Society of Toxicology [18]. Certain alterations were made to fit the purposes of this study. The instrument comprised two parts: the first covered demographic data through items involving gender, age, diving experience, education, and health and medical details, while the second emphasized knowledge concerning jellyfish envenomation and included items asking about sources of this knowledge, personal experience with jellyfish stings, knowledge of emergency first response, general knowledge about recognising and treating jellyfish stings, and also knowledge about the dangers and consequences of envenomation. The questions in the knowledge component included both multiple choice items and items requiring a true/false response [18]. For the purposes of this study, the term 'jellyfish' refers to the *Chironex fleckeri*, *Aurelia aurita*, *Scyphozoans* and *Chrysaora chinensis* species. Correct responses were therefore indicative of knowledge related to first aid, venomous species and body parts, and periods of increased incidence of attack in the context of the species mentioned.

DATA ANALYSIS

The data underwent analysis using SurveyMonkey® (San Mateo, California, USA), while counts and percentages were to describe the categorical variables. Correct answers were awarded one point, and other answers received zero in

the case of single-answer items. For multiple choice items which listed more than one correct answer, one point was awarded for each correct answer identified, but the selection of a single wrong answer would result in a score of zero for that item. The total scores were then presented in the form of median ± standard deviation. Scores exceeding 60% were deemed satisfactory. Univariate analyses were performed for each of the factors which influence the knowledge score in order to determine the links between the total score and the variables involved. The results from the knowledge score were not normally distributed, and hence it was necessary to employ non-parametric tests for the purpose of performing the univariate analyses.

ETHICAL CONCERNS

The researchers received ethical approval from the Ethics Committee of Walailak University, Nakhon Si Thammarat, Thailand (WUEC-18-015-01); the study was carried out following the guidelines set out by the Declaration of Helsinki, and the participants completed the questionnaire in anonymity. Confidentiality was maintained at all times for the data collected.

RESULTS

The study used data gathered from 238 Thai divers. Table 1 presents the socio-demographic data about the respondents, of whom 54.62% were male while 45.38% were female. In the age category, 86.14% were aged 18–35 years. A majority attended diving schools on the island of Koh Tao in Surat Thani province, Thailand (78.90%) and 65.22% held PADI certification (Professional Association of Diving Instructors) while 89.50% had less than 5 years' diving experience. Around 85% had attained at least a bachelor's degree level of education.

A total of 32% of the respondents (n = 75) stated that either they personally, or a diving colleague, had been stung by a jellyfish. A majority of the respondents (65.97%, n = 157) had some knowledge about jellyfish stings, while the remainder had no such knowledge. Medical education concerning jellyfish stings was typically obtained through online sources (43.27%, n = 90), while other sources of information included television (16.35%, n = 34), friends or family (12.5%, n = 26), and the diving schools (27.88%, n = 58).

In Table 2, the general knowledge levels of divers with regard to jellyfish envenomation are presented. The mean scores for knowledge were shown to be 71 ± 18%, or the equivalent of 6.4 out of 9 points.

In Table 3, participants were asked about the symptoms and consequences of jellyfish envenomation. The highest score recorded was 100%, but the mean was 0.8 ± 0.36 or around 85%.

Table 1. Participants' socio-demographic data (n = 238)

Characteristics	N (%)
Gender:	
Male	130 (54.62)
Female	108 (45.38)
Age [years]:	
18–25	77 (33.33)
26–35	122 (52.81)
36–45	26 (11.26)
< 45	6 (2.60)
Did not answer	7
Diving experience [years]:	
0	111 (46.64)
< 2	64 (26.89)
2–5	38 (15.97)
> 5	25 (10.50)
Education level:	
Lower than bachelor's degree	34 (14.72)
Bachelor's degree	166 (71.86)
Higher than bachelor's degree	31 (13.42)
Did not answer	7
Diving certificate::	
PADI	135 (65.22)
NAUI	8 (3.86)
Other	3 (1.45)
No certificate	61 (29.47)
Did not answer	31
Friends or relatives working in health care:	
Yes	45 (19.15)
No	190 (80.85)
Did not answer	2

In Table 4, the respondents' knowledge of appropriate first aid responses to jellyfish envenomation is presented. For the first item, the mean score was 0.5/1.0 ± 0.50 while for the second it was 0.8/1.0 ± 0.36.

DISCUSSION

The researchers believe this is the first research study to examine knowledge about jellyfish envenomation among a particular population. The study involved divers in Thailand, and it was found that while jellyfish injuries were common, fewer than half of the participants who had personally experienced a jellyfish attack had the necessary knowledge to intervene safely or effectively. While a majority knew something about jellyfish stings, few had sufficient knowledge of first aid

Table 2. General knowledge concerning jellyfish envenomation (n = 238)

Questions	N (%)
1. Which part of the jellyfish is responsible for envenomation?	
1. Body	25 (10.59)
2. Tentacles	200 (84.75)
3. Head	11 (4.66)
Did not answer	2
The correct response: 2	200 (84.75)
2. Which jellyfish species has a potentially fatal sting?	
1. Box jellyfish	148 (62.45)
2. Moon jellyfish	15 (6.33)
3. True jellyfish	6 (2.53)
4. Chrysaora jellyfish	68 (28.69)
Did not answer	1
The correct response: 1	148 (62.45)
3. Dismembered or dead jellyfish can still envenomate victims	
1. True	188 (80.00)
2. False	47 (20.00)
Did not answer	3
The correct response: 1	188 (80.00)
4. Jellyfish do not make unprovoked attacks on humans	
1. True	157 (67.97)
2. False	74 (32.03)
Did not answer	7
The correct response: 1	157 (67.97)
5. In which of the periods below are jellyfish stings most likely?	
1. Noon	22 (9.24)
2. Morning	16 (6.72)
3. Night	37 (15.55)
4. Rainy season	151 (63.45)
5. Winter	12 (5.04)
The correct response: 4	151 (63.45)

Table 3. Knowledge of the symptoms and consequences of envenomation (n = 238)

Questions	N (%)
1. What symptoms result from mild envenomation?	
1. Itchiness	125 (52.74)
2. Burning pain	109 (45.99)
3. Hoarseness	3 (1.27)
4. Chest pain	0 (0.0)
Did not answer	1
The correct response: 1	125 (52.74)
2. In which of the circumstances below should an envenomated patient be taken immediately to hospital?	
1. Obesity	6 (12.53)
2. Allergy or heart disease	219 (92.41)
3. Having a cold	4 (1.69)
4. Alcoholism	7 (0.42)
Did not answer	2
The correct response: 2	219 (92.41)

Table 4. Knowledge of first aid and treatment aid (n = 238)

Questions	N (%)
1. How should you treat the wound if someone is stung by a jellyfish?	
1. Leave the sea and clean the wound with sea water	125 (53.19)
2. Leave the sea and clean the wound with fresh water	110 (46.81)
Did not answer	2
The correct response: 1	125 (53.19)
2. You should pull out any remaining nematocyst from the skin with your bare hands	
1. True	36 (15.19)
2. False	201 (84.81)
Did not answer	1
The correct response: 2	201 (84.81)

to react correctly to envenomation. To address this problem, further training and medical education would be required.

GENERAL KNOWLEDGE CONCERNING JELLYFISH ENVENOMATION

Jellyfish which are dead or tentacles which have separated from the body are still able to envenomate a victim if they have not yet dried out. Therefore, divers should take care not to touch dead jellyfish with their exposed skin. Jellyfish do not actively seek to attack humans, and will only sting after the provocation of coming into close proximity with a swimmer. It is therefore important for swimmers to avoid jellyfish whenever possible. Another way to reduce the incidence of jellyfish envenomation would be for divers to avoid the sea during the rainy season when the probability of an attack is greatest. In terms of knowledge about the dangers of different species, most participants were aware

that box jellyfish stings can be fatal. This is important since box jellyfish have been reported in Thai waters. The level of general knowledge shown by the respondents overall was satisfactory, while two questions were successfully answered by more than 60% of the participants. More than half of the divers knew that the rainy season in the most dangerous period in Thailand for jellyfish stings. The reason for this is that when it rains, the presence of fresh water attracts jellyfish to move towards the shore [18].

RECOGNITION OF SYMPTOMS

First aid is most effective when delivered early, accurately, and correctly. This requires immediate recognition that a problem exists. The first sign of mild envenomation is usually an itchy skin. If this is accompanied by hoarseness, burning pain, or chest pain, this is indicative of an allergic reaction to the sting. In some cases, this can quickly turn to acute pulmonary oedema and allergic shock within a period ranging from a few minutes up to six hours. Death is a potential outcome should this happen [19]. Accordingly, it is vital to be able to identify the symptoms quickly so that severe cases can be sent immediately to hospital. In particular, victims who have allergies, heart disease, a temperature exceeding 38°C, are aged above 65, or have been extensively stung across a large expanse of skin should be hospitalized as soon as possible [18]. The findings in this research suggest that a majority of divers have some knowledge of the signs of jellyfish envenomation, since more than half knew that itchiness would result in mild cases. However, 45% identified burning pain, chest pain, or hoarseness as signs of a mild case; this is potentially dangerous since any of these symptoms can be followed by allergic shock and death if immediate medical help is not sought. It would therefore be helpful if educational efforts could focus on this particular misconception so that divers will in future be aware of this potential danger.

FIRST AID KNOWLEDGE

When a jellyfish sting occurs, the victim should promptly leave the sea and have the wound cleaned in seawater. It is inadvisable to use fresh water since fresh water has low osmotic pressure which allows the remaining nematocysts to break apart and release further toxins [20]. Once the wound has been cleaned, the tentacles and any observable nematocysts should be removed carefully from the skin. It is advisable to use a seawater paste to cover the injured skin. Dry sand can also be used for this purpose. It is then possible to extract the jellyfish tentacles with tweezers or a knife. This can also be done by hand as long as protection is used to prevent the bare hands from suffering envenomation [21]. The knowledge of the divers was shown to be good in this section. However, it is a matter for concern that 47% of the respondents believed fresh water to be the better choice for cleaning the wound, since the use of fresh water would lead to a worsening of the injury. The divers were also shown to be generally well aware that they should not attempt to remove nematocysts with their bare hands.

MEDICAL EDUCATION AND FURTHER TRAINING

The respondents cited the internet as their main source of medical education about jellyfish envenomation. This suggests that there is a need for better-designed and more accessible medical training and education to raise knowledge standards. Since many divers also obtained information from television or the diving schools, it might be argued that brochures could be used effectively to deliver this education. The diving schools themselves must also seek to increase the knowledge levels in first aid practices and skills along with appropriate responses to jellyfish envenomation. One useful aid to learning about symptoms would be photographs of typical skin reactions which could be used for comparison. The validity of this particular finding could be verified through future studies involving other seaside populations, such as fishermen and tourists. It may also be helpful to design educational materials which could extend this knowledge base to the general population.

LIMITATIONS OF THE STUDY

This study has a number of limitations. The problem of selection bias may be present since the sample size was small. Furthermore, the sample might not be fully representative of the population because a convenience sampling approach was employed. In addition, recruitment of the participants solely from diving schools means that it is difficult to make generalizations from the findings which extend beyond the diving fraternity. It cannot be inferred that the general population of Thailand, for example, would be similarly knowledgeable about jellyfish envenomation. Further studies would be required to shed light in this area.

CONCLUSIONS

This study may be the first to investigate knowledge levels about jellyfish envenomation among members of a particular population who are most at risk. Within this naval unit based in northeastern Thailand, jellyfish stings are frequently encountered, yet personnel scored badly in their knowledge of risk factors, symptoms, and appropriate first aid responses to jellyfish stings. From this it can be inferred that medical education and further training might be useful in order to improve this situation, offering divers better protection from the dangers of jellyfish attacks in the future.

ACKNOWLEDGEMENTS

The researchers would like to extend sincere thanks to all the study participants and the diving schools involved,

without whose contribution this study would not have been possible.

REFERENCES

1. Tibballs J. Australian venomous jellyfish, envenomation syndromes, toxins and therapy. Toxicon. 2006; 48(7): 830–859, doi:10.1016/j.toxicon.2006.07.020, indexed in Pubmed: 16928389.
2. Di Costanzo L, Balato N, Zagaria O, et al. Successful management of a delayed and persistent cutaneous reaction to jellyfish with pimecrolimus. J Dermatolog Treat. 2009; 20(3): 179–180, doi: 10.1080/09546630802562443, indexed in Pubmed: 19016374.
3. Haddad Junior V, Silveira FL, Migotto AE. Skin lesions in envenoming by cnidarians (Portuguese man-of-war and jellyfish): etiology and severity of accidents on the Brazilian coast. Rev Inst Med Trop Sao Paulo. 2010; 52(1): 47–50, indexed in Pubmed: 20305955.
4. Winter KL, Fernando R, Ramasamy S, et al. The in vitro vascular effects of two chirodropid (Chironex fleckeri and Chiropsella bronzie) venoms. Toxicol Lett. 2007; 168(1): 13–20, doi: 10.1016/j.toxlet.2006.10.011, indexed in Pubmed: 17141433.
5. Winkel KD, Hawdon GM, Ashby K, et al. Eye injury after jellyfish sting in temperate Australia. Wilderness Environ Med. 2002; 13(3): 203–205, indexed in Pubmed: 12353597.
6. Nagai H, Takuwa K, Nakao M, et al. Isolation and characterization of a novel protein toxin from the Hawaiian box jellyfish (sea wasp) Carybdea alata. Biochem Biophys Res Commun. 2000; 275(2): 589–594, doi: 10.1006/bbrc.2000.3352, indexed in Pubmed: 10964708.
7. McIver LJ, Tjhung IG, Parish ST, et al. Irukandji sydrome in the Torres Strait: a series of 8 cases. Wilderness Environ Med. 2011; 22(4): 338–342, doi:10.1016/j.wem.2011.08.002, indexed in Pubmed: 22000547.
8. Wang B, Zhang L, Zheng J, et al. Multiple organ dysfunction: a delayed envenomation syndrome caused by tentacle extract from the jellyfish Cyanea capillata. Toxicon. 2013; 61: 54–61, doi: 10.1016/j.toxicon.2012.11.003.
9. Lippmann JM, Fenner PJ, Winkel K, et al. Fatal and severe box jellyfish stings, including Irukandji stings, in Malaysia, 2000––2010. J Travel Med. 2011; 18(4): 275–281, doi: 10.1111/j.1708-8305.2011.00531.x, indexed in Pubmed: 21722240.
10. Boulware DR. A randomized, controlled field trial for the prevention of jellyfish stings with a topical sting inhibitor. J Travel Med. 2006; 13(3): 166–171, doi: 10.1111/j.1708-8305.2006.00036.x, indexed in Pubmed: 16706948.
11. De Donno A, Idolo A, Bagordo F, et al. Impact of stinging jellyfish proliferations along south Italian coasts: human health hazards, treatment and social costs. Int J Environ Res Public Health. 2014; 11(3): 2488–2503, doi: 10.3390/ijerph110302488, indexed in Pubmed: 24583831.
12. Xian W, Kang B, Liu R. Jellyfish blooms in the Yangtze Estuary. Science. 2005; 307(5706): 41, doi: 10.1126/science.307.5706.41c, indexed in Pubmed:15637253.
13. Richardson AJ, Bakun A, Hays GC, et al. The jellyfish joyride: causes, consequences and management responses to a more gelatinous future. Trends Ecol Evol. 2009; 24(6): 312–322, doi: 10.1016/j.tree.2009.01.010, indexed in Pubmed: 19324452.
14. Rastogi A, Biswas S, Sarkar A, et al. Anticoagulant activity of Moon jellyfish (Aurelia aurita) tentacle extract. Toxicon. 2012; 60(5): 719–723, doi:10.1016/j.toxicon.2012.05.008, indexed in Pubmed: 22652129.
15. Li Li, McGee RG, Isbister G, et al. Interventions for the symptoms and signs resulting from jellyfish stings. Cochrane Database Syst Rev. 2013(12): CD009688, doi: 10.1002/14651858.CD009688.pub2, indexed in Pubmed: 24318773.
16. Dong Z, Liu D, Keesing JK. Jellyfish blooms in China: Dominant species, causes and consequences. Mar Pollut Bull. 2010; 60(7): 954–963, doi:10.1016/j.marpolbul.2010.04.022, indexed in Pubmed: 20553695.
17. Thaikruea L, Siriariyaporn P. The magnitude of severe box jellyfish cases on Koh Samui and Koh Pha-ngan in the Gulf of Thailand. BMC Res Notes. 2016; 9: 108, doi: 10.1186/s13104-016-1931-8, indexed in Pubmed: 26888067.
18. Kan T, Gui Li, Shi W, et al. A survey of jellyfish sting knowledge among naval personnel in Northeast China. Int J Environ Res Public Health. 2016; 13(7), doi: 10.3390/ijerph13070725, indexed in Pubmed: 27447652.
19. Li R, Yu H, Yue Y, et al. In depth analysis of the in vivo toxicity of venom from the jellyfish Stomolophus meleagris. Toxicon. 2014; 92: 60–65, doi:10.1016/j.toxicon.2014.10.002, indexed in Pubmed: 25305553.
20. Queiroz Mda C, Caldas JN. Comparative dermatology: skin lesion produced by attack of jellyfishes (Physalia physalis). An Bras Dermatol. 2011; 86(3): 611–612, indexed in Pubmed: 21738993.
21. Lakkis NA, Maalouf GJ, Mahmassani DM. Jellyfish stings: a practical approach. Wilderness Environ Med. 2015; 26(3): 422–429, doi:10.1016/j.wem.2015.01.003, indexed in Pubmed: 25935311.