Public Understanding on Rip Currents and Beach Safety at Teluk Cempedak Recreational Beach of Pahang, Malaysia

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Abstract

A cross-sectional study was conducted to examine the public understanding of rips currents at Teluk Cempedak Recreational Beach of Pahang, Malaysia, from November 2020 to March 2021 via a questionnaire survey. Convenient sampling was used to collect data from 300 respondents. The questionnaire consisted of 24 questions, encompassing five sections, i.e., the demographic background, frequency of visiting the beach, swimming ability, their knowledge of rip currents, and understanding of beach safety. Associations between the study variables and the knowledge of both rip currents and beach safety were evaluated using the independent sample t-test, Chi-square test, and multiple logistic regressions at the confidence level of 0.05. In general, only 86% of the respondent knew about the rip currents. For beach safety knowledge, 83% of the respondents on the lifeguard facilities, 44% for the yellow red-flag and 93.7% for the red flag. Variables such as gender (knowledge of rip currents: Adjusted Odds Ratio (AOR) = 0.647, 95% confidence interval (CI) = 0.487 - 0.60, p = 0.003; beach safety: AOR = 0.665, 95% CI = 1.14 - 5.02, p = 0.021), locality (knowledge of rip currents: AOR = 2.482, 95% CI = 1.407 - 4.380, p = 0.002, beach safety: AOR = 1.821, 95% CI = 1.022 - 3.245, p = 0.042), and respondents' experience of having problems in water activities (knowledge of rip currents: AOR = 0.170, 95% CI = 0.635 - 6.379, p = 0.000) were significantly associated with the knowledge of both rip currents and beach safety. Further studies are essential to enhance public understanding of rip currents and hence the beach safety in Malaysia.

1.0 Introduction

Coastal areas, notably beaches, offer several useful functions, such as buffer zones for tidal waves and flooding, sources of seafood, and recreational activities. A beach refers to an extensive area of sand or small stones neighbouring the sea. In general, beaches provide an enticing and relaxing environment that adds meaning to leisure and tourism. In this respect, beaches in Malaysia have attracted millions of local and foreign visitors from all around the world. However, beaches own many hidden hazards that potentially place beachgoers in a risky environment.

Drownings at the beach areas along Malaysia coastlines are generally associated with rip currents. Rip currents are strong flows of water that run from ashore back to the open sea, with breaking waves. Indeed, rip currents are one of the most deadly hazards to beachgoers globally at both patrolled and unpatrolled beaches, often present at high frequency and low intensity in dynamic and swell-dominated beaches (Castelle et al., 2016). The formation of rip currents also depends on the beach topography. They could occur on beaches with either rocky or soft (sand or silt). In general, the rips are divisible into shore-normal, narrow, and seaward streaming currents (Dalrymple et al., 2011). Rip currents usually flow towards the breaking waves, moving at a relatively high speed. They could drag the swimmers from surf zone into deeper water, which later resulting in fatigue and panic (Mohammed Isa et al., 2021).

The United States Lifesaving Association reported that rip currents are responsible for 80% of its rescues. They are also responsible for 68% of all the reported lifeguard rescues in the United Kingdom. They killed

more people in Australia than other risks, such as floods, shark attacks, and bushfires (Brander and Dominey-Howes, 2014), with an average of 21 people drowned annually in rip currents (Brighton et al., 2013). In India, drowning due to rips killed 39 people annually (Arun Kumar and Prasad, 2014). In Peninsular Malaysia, recent incidences of beach drowning, inclusive of fatal and non-fatal accidents, tended to increase. Between 2006 and 2018, in Pahang state, 31 cases regarding rip current fatalities were reported as mentioned in Hamsan and Ramli (2020). In particular, Teluk Cempedak Recreational Beach (TCRB) had the highest number of drownings with eight deaths (38.8%) compared to other beaches along the shoreline of Pahang. Other data from media showed evidence that this value is much higher, however, it is unclear whether the incidents were related to the rips.

To date, studies on rip currents in Malaysia have been focusing on the physical aspects, such as the existence, mechanisms, and effects of the rips, along with methods for escaping (Mohammed Isa et al., 2021). By contrast, in more recent years, studies in other countries, notably Japan, Australia and the United State (US), were more emphasized in the social science of rips (Brannstrom et al., 2015; Woodward et al., 2015; Fallon et al., 2017; Llopis et al., 2018; Silva-Cavalcanti et al., 2020; Mohammed Isa et al. 2021). With more than 100 people have drowned annually in the US by rips (Carey and Rogers, 2005; Gensini and Ashley, 2009), there was a strong need in the efforts for intervention programs and modules to assess the beachgoers knowledge and behaviours of beach hazards.

Through this study, the level of public understanding of rip currents and beach safety at TCRB in Kuantan, Pahang will be determined. Understanding the attitudes, thoughts, and perceptions of human beings on rips better would help mitigate the adverse effects of such natural coastal hazards. In addition, this study sought to initiate efforts in developing rip current intervention program to create greater public awareness in Malaysia about the beach safety measures when encountering rip currents.

2.0 Materials And Methods

2.1 Study Site

This study focused on TCRB (3°48'43.50” N, 103°22'21.41” E), which was located at the north-eastern tip of Pahang, Malaysia (Figure 1). It was approximately 5 km from Kuantan, the capital city of Pahang. Topographically, TCRB consisted of a long, protruding dynamic headland at the southern end and a narrower one at the northern tip, creating a bay with a shallow embayment indentation in between. Hence, TCRB experienced rip currents due to morphodynamic changes as described by in Hamsan and Ramli (2020). In general, TCRB was physically narrower and steeper than other beaches in Pahang, with a width of roughly 57.3 m and a slope of 3.28° (Hamsan et al., 2019). Its coastline was exposed and subjected to tidal actions from the South China Sea.

The meteorological environment of Pahang coastline was primarily affected by two monsoons, i.e., the northeast monsoon (NEM) or the wet season from November to March, and the southwest monsoon (SWM) or the dry season from May to September. There were also two brief inter-monsoons, one in

October and the other in April. The average annual rainfall was 2,400 mm, and the average temperature was 28°C. The maximum and lowest rainfall intensity usually happened in December and January, respectively, and the average wind speed was 8 km/h with an 85% relative humidity (Tukimat et al., 2018; Hamsan and Ramli, 2020). Over the years, TCRB has become one of the most popular destinations for tourism and recreation in Pahang. Attractions, including the availability of many accommodations, such as hotels, restaurants, and proximity to the capital city of Pahang, were some of the factors that led TCRB to become the most frequently visited beach in Pahang. However, it had recorded a significant number of fatal drowning cases, i.e., substantially higher than other beaches (Mohammed Isa et al., 2021). The lack of warning signage on rip currents along the bay rendered it necessary to create greater awareness among the public on the importance of understanding beach safety. Figure 2 depicts the beach signage and facilities available at TCRB during the study period.

2.2 Recruitment Procedures and Ethical Consideration

A cross-sectional survey was conducted from November 2020 until March 2021 via questionnaire with the participation of 300 respondents. Data were collected via convenient sampling. Respondents of different age groups and gender were approached to participate. A face-to-face survey was conducted after the respondents agreed to take part in the study. The respondents then completed the questionnaire in approximately 5 to 10 minutes. The Kuantan Municipal Council granted permission to conduct the survey, and the International Islamic University Malaysia Research Ethics Committee (IREC) approved the study protocol, procedure, information sheet, and consent declaration (IREC 2020-134).

2.3 Study Design and Instrument

The questionnaire was adapted from a preliminary study conducted at TCRB by Mohammed Isa (2021) with modifications. This modified questionnaire comprised 24 questions denoted by Q1 to Q24 with five sections: socio-demographic background, frequency of visiting the beach, swimming ability, knowledge of rip currents, and knowledge of beach safety. The questionnaire was offered in the Malay language.

2.4 Statistical Analysis

The outcome for the analysis address rip identification, flags risk, swimming ability and safety knowledge as described above. All sections provide an overall insight that result in the knowledge of rip currents and beach safety. The internal consistency of the questionnaire and variables was evaluated using the Cronbach alpha reliability test. Descriptive statistics emphasising frequencies and percentages were analysed using the software Statistical Package for Social Sciences (SPSS), version 26 (IBM). Besides, bivariable analysis of categorical variables was performed using the Chi-square and Independent sample *t* test. In the bivariate analysis, independent variables significantly associated ($p < 0.05$) with the outcome factors were evaluated in the regression models. Finally, the associated factors related to beach safety and rip currents knowledge in the multiple logistic regression models were estimated using the Enter method. The adjusted odds ratio (AOR) was calculated at a 95% confidence interval (CI) to determine the probability of reporting beach safety and knowledge of rip currents.

3.0 Results

3.1 Reliability of the Questionnaire

Table 1 shows the Cronbach's alpha value for Section C (visiting factors and swimming ability), Section D (knowledge of rip currents), and Section E (knowledge of beach safety). Due to different answer scheme used for every question, each question was analysed in separate grouping for consistency and to yield higher score in the scale reliability coefficient. In Section C, Q11(A) in the questionnaire was grouped as Part 1 and Q11(B) was grouped by Part 2, respectively. The Cronbach's alpha for Section C (Part 1) was 0.54, and 0.727 for part 2. As Q12 to Q14 have a yes and no options, they were grouped in Part 1 while Q15 and Q16 were in the Part 2 for Section D. The Cronbach's alpha value for these Part 1 and Part 2 was 0.362 and 0.322, respectively. Meanwhile, for Section E, the Cronbach's alpha of Part 1 (Q17 to Q21) and Part 2 (Q23 and Q24) was 0.270 and 0.545, respectively.

3.2 Demographic Information of the Respondents

Table 2 shows the demographic information for 147 males (49%) and 153 females (51%) respondents. Respondents were arbitrarily divided into four age groups, i.e., from 18 to 29 years old, 30 to 39 years old, 40 to 49 years old, and above 50 years old. Altogether, there were 83 respondents in the first group, 117 in the second, 75 in the third, and 25 in the last. Overall, approximately 62% (186) of the respondents) were local people from Kuantan, while 38% (114) came from elsewhere. Table 3 shows the frequency of beachgoers visiting TCRB, more than half (58.3%) of the respondents had visited this beach more than five times. In the study area, only 8% of the respondents came to this beach for swimming. Visitors went to TCRB for various reasons, including safety, near the city, and moderate wave conditions. Beach safety was the dominant factor that prompted visitors to visit the beach and followed its proximity to a city, suitable waves, and patrolled by lifeguards.

3.4 Visitors' Swimming Ability

Visitors' swimming ability was subdivided into two categories, i.e., one on the variables that influenced the respondents' decision to visit or not to visit the beach and the other on the respondents' swimming ability. For the first category, numerous visitors, low tide conditions, and no companion were the principal variables that attracted the respondents to visit the beach (Figure 3). By contrast, high tide conditions, no lifeguard, storms, and closed beach areas were the main factors that hindered the presence of visitors. Figure 4 shows the swimming ability of the respondents. Only 19% (57) of the respondents swam well, while 81% (243) of them were poor swimmers, i.e., they could not swim more than 25 m. Overall, the likelihood of the respondents drowning at the beach was moderate, and their capability of escaping from the rips was at the lowest level (Figure 4).

3.5 Knowledge of Rip Current and Beach Safety

Figure 4 shows that 61.30% of the respondents were knowledgeable about the currents, while 38.70% were aware of the existence of rips. Most respondents (86%) incorrectly believed that rip currents were generated by wind with only 13.3% of the respondents answered it correctly. Besides, when asked on the question about the swimming direction when trapped in the rip currents, 39% of the respondents indicated that they would swim in parallel with the current flow, 42% would swim with the direction of the flow, and 19% would swim against the rip current (Figure 5).

Meanwhile, each respondent was given three photos to evaluate their ability to identify the presence of rip currents in Q21. Photo in Q21(A) andQ21 (B) showed the occurrence of the rip currents in the water. For Q21(A), 74% of the respondents could not identify the rip currents. Meanwhile, only 27.3% of the respondents answered correctly for Q21 (B), suggesting that more than half of the respondents could not recognise the rip currents regardless the gender and age. The flag system used along the beach can be an indicator to assess the beach safety knowledge. Respondents were presented with a yes and no knowledge scale that depicting different beach conditions with different flag system. On the swimming response to beach flags, 46.7% of the respondents chose to swim within the area marked with flags, and 53.3% of them incorrectly opted to swim outside the flags, i.e., in the rips.

Figure 6(A) shows that 83.3% of the respondents recognised the function of the lifeguard tower located at the beach. Majority of the visitor responded well to the function of flags with 44% answered correctly for yellow-red flag and more than 90% for red flag (Figure 6(B) and 6(C)). Overall, respondents showed a satisfactory and fair awareness and understanding of both the yellow-red and red flags. The number of patrolling lifeguard patrols along the beach was sufficiently abundant owing to the high-risk rating of TCRB and its attractiveness as a tourist hotspot. The presence of patrolling lifeguards and red flags might enhance the awareness of the beachgoers in choosing the safety area for their activity (Woodward et al., 2015). Those beachgoers that decided to take their own risk swimming beyond the designated area are mostly experienced swimmer. 23.7% of them share their experience being trapped in waves while only 2% did notice the encounter with rip current. Failing to identify the rip currents led respondents to swim in the rips, and hence also the low proportion of rip currents as the primary challenge.

3.7 Association between the Study Variables and Knowledge of Rip Current and Beach Safety

Table 4 shows the association between the study variables and the awareness of the rip currents. These variables included the socio-demographic characteristics of the respondents, their swimming ability, and their experience during water activities. The respondents' awareness of the current was determined by their ability to spot the occurrence of rips in the water. Table 5 shows the multiple regression analysis between the study variables with the awareness of the rip currents. Variables such as gender (AOR = 0.647, 95% CI = 0.487 - 0.60, ρ = 0.003), locality (AOR = 2.482, 95% CI = 1.407 - 4.380, ρ = 0.002) and the

respondents' experiencing problems (AOR = 0.170, 95% CI = 0.635 - 6.379, ρ = 0.000) in the water activity showed significant associations with the rip currents.

Table 6 shows the association between the age group and the knowledge of beach safety. Respondents older than 36 years old tended to have a better understanding of beach safety. Variables such as gender, locality, frequency of visits, and swimming ability were significantly associated ($\rho < 0.05$) with the knowledge of beach safety. The knowledge of beach safety was determined based on the respondents' ability to identify whether the beach condition was safe to swim when they were picture given in the questionnaire. Table 8 shows the multiple logistic regressions between the study variables and the respondents' knowledge of beach safety. Only gender (AOR = 0.665, 95% CI = 1.14 - 5.02, ρ = 0.021) and locality (AOR = 1.821, 95% CI = 1.022 - 3.245, ρ = 0.042) were significantly associated with the knowledge of beach safety

4.0 Discussion

4.1 Reliability of the Questionnaire

No reliability test was necessary for Section A as the questionnaire recorded the respondents' demographic information. Previous works done in Mohammed Isa et al., (2021) was continued in improving the reliability of the instruments for larger scale assessments. The internal consistency of section B (frequency of visiting TCRB) was deemed acceptable with a Cronbach's alpha coefficient of 0.6 (Griethuijsen et al., 2014). In comparison with findings by Mohammed Isa et al., (2021), the Cronbach's alpha of Part 1 in Section C have been improved from 0.422 to 0.545 following the revision and removal of some questions in this section after the first pilot project. Meanwhile, the consistency of Part 2 (the respondents' swimming ability) also improved from -0.3 to 0.72. For Section D (knowledge of rips), the Cronbach's alpha coefficient remained low at 0.362 and 0.322. The low reliability of the questions is an indicator of how most respondents having difficulty to comprehend the term of rip current and were not expose to the knowledge of identifying beach hazards. This statement is further supported by limited literatures and research conducted in Malaysia to assess the level of knowledge of visitors despite most beaches receiving thousands of visitors annually. Further improvement should be done after intervention programs to give preliminary exposure on beach safety to the public before assessment being made.

4.2 Association between the Study Variables and Knowledge of the Rip Currents and Beach Safety

Respondents over 36 years old held a better awareness of beach safety knowledge (Table 6). Compared to respondents below 36 years old, they gave a correct answer on the beach conditions based on the flags shown to them. This older group of respondents provide an indication of the relationship with frequency to beach on the safety knowledge. This finding agreed with the results reported by Woodward et al., (2015).Variables such as gender and locality were significantly associated with knowledge of rip currents (Table 4) and beach safety (Table 6). This study found that males had better knowledge of rip

currents than females in identifying the occurrence of rip currents. Consistent with the findings by Fallon et al., (2018), more males gave correct answers on the knowledge of beach safety as males more likely to accompany their children swimming, underestimation of risks or involved in high-risk beach activities.

Overall, local respondents (Kuantan) had better understand of rip currents and beach safety than outsiders; 32.7% (98) of the local respondents identified the rip currents while only 14.0% of the non-local respondents gave the correct answer. Respondents residing near the coastal area which have more access to nearby beaches were likely to have a better understanding of the rip currents. Rip current knowledge does correlate with the beach safety knowledge where more than 54% (162) of the local respondents were able to provides greater level of awareness and understanding of beach hazards.

These findings suggested that respondents generally were not well versed in the rip currents since most of them could not spot the rips accurately. Although the respondents had heard of rip currents before, they were unaware of the impact of the rip currents. Also, most of them were ignorant about the strategy to survive in the rips, i.e., swimming in parallel with the flow of currents. These findings were consistent with the results of other studies, i.e., beachgoers had difficulties recognising rip currents (Ballantyne et al., 2005; Sherker et al., 2010; Brannstorm et al., 2015). In Malaysia, initiatives to raise awareness among local communities about the dangers posed by rip currents are very scarce. Warning signages on rip currents along TCRB were not visible and lifeguards are often patrol only during weekend. This study provides suggestion on the matter of the importance of education on beach safety, particularly on rip currents, which will empower beachgoers to adopt the safest measure while visiting the beach (Woodward et al., 2015).

No significant association was detected between the respondents' swimming ability and the knowledge of rip currents and beach safety in this study. However, other studies reported that good swimmers tended to have more knowledge about rip currents and beach safety (Hatfield et al., 2012; Drozdzewski et al., 2015; Fallon et al., 2018;). This inconsistency might be because most respondents (81%) in this study were poor swimmers, and swimming and surfing were not the primary activity at TCRB. A previous study reported that less than 40% of beachgoers at TCRB went there for swimming (Mohammed Isa et al. 2021).

It is important to note that factor of respondents having problems during water activity was significantly associated with the knowledge of rip currents, but not with the knowledge of beach safety. These problems generally comprised cramps and panics as a result of being dragged by the rip currents or waves. This finding was consistent with a study in the United Kingdom (Woodward et al., 2015), whereby respondents caught in rips before described the rip currents better than those who had never experienced it. However, the association between the respondents' experience with the knowledge of beach safety remains unclear.

5.0 Conclusion

A set of questionnaires was given to 300 beach visitors at TCRB to assess the public understanding on knowledge of rip currents and beach safety. Only 38.7% of the respondents knew about the term rip currents 22.3% of them correctly the occurrence of rip currents in the water. By contrast, the respondents had a better knowledge of beach safety; 44% of them correctly interpreted the implication of the yellow-red safety flag and 93% gave the correct answer for the red safety flags. Variables such as gender, locality, and the respondents' experience of having problems during water activities were significantly ($p < 0.05$) associated with the knowledge of rip currents. Respondents who experienced cramps and panic because of being caught in the rip currents had a better knowledge of the rip currents than those who had never had it before. However, only two variables, i.e., gender and locality, showed significant associations with knowledge of beach safety. Meanwhile, respondents' swimming ability was not significantly associated with both the knowledge of rip currents and beach safety, probably because most of the respondents (81%) were poor swimmers. Further studies, notably on the good swimmers' behaviour would be essential to enhance the safety of beaches with rip currents.

Declarations

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Tables

Table 1

Reliability Statistic of the Questionnaire

Reliability Statistic			
Section in Questionnaire		**Cronbach's Alpha**	**N of Items**
Section C	Part 1	.545	8
	Part 2	.727	2
Section D	Part 1	.362	3
	Part 2	.322	2
Section E	Part 1	.270	4
	Part 2	.545	4

Table 2

Respondents' demographic information.

Label	Categories	Number of respondents, n	Percentage (%)
Age	18-29	83	27.7
	30-39	117	39.0
	40-49	75	25.0
	>50	25	8.5
Gender	Male	147	49.0
	Female	153	51.0
Locality	Kuantan	186	62.0
	Outside Kuantan	114	38.0

Table 3

Frequency of visiting Teluk Cempedak.

Category	Items	Number of respondents, n	Percentage (%)
Frequently visit beach	> 5 times	175	58.3
	< 5 times	125	41.7

Table 4

Association between the study variables with rip currents awareness.

Variables		Rip Currents knowledge			
		n	%		
Gender	Male	35	(11.7)	10.171	0.006*
	Female	32	(10.7)		
Locality	Local	98	(32.7)	10.021	0.007*
	Non-local	42	(14.0)		
Frequency visiting	> 5 times	83	(27.7)	1.274	0.503
	< 5 times	57	(19.0)		
Swimming ability	Good	52	(17.3)	5.265	0.076
	Poor	19	(6.3)		
Having problem with water activity	Yes	58	(82.9)	31.0986	0.000*
	No	102	(44.3)		

Chi-square * < 0.05 have association

Table 5

Multiple logistic regression to determine the factors associated with rip currents awareness.

Variables	Rip currents knowledge				
	B	Wald	AOR	95% CI	
Gender	-0.435	8.985	0.647	0.487-0.60	0.003
Locality	0.909	9.848	2.482	1.407-4.380	0.002
Having problems with water activity	-1.769	17.756	0.170	0.075-0.388	<0.001

< 0.05 is significant

Table 6

Association between study variables with beach safety knowledge.

Variables		Beach safety knowledge				
		n	%		t	
Age mean (standard deviation)		36.3 (9.1)			2.082	0.038*
Gender	Male	133	(44.3)	10.558		0.001*
	Female	117	(39.0)			
Locality	Local	162	(54.0)	4.992		0.025*
	Non-local	88	(29.3)			
Frequency visiting	>5 times	156	(52.0)	10.206		0.001*
	<5 times	94	(31.3)			
Swimming ability	Good	52	(73.2)	0.705		0.401
	Poor	88	(29.3)			
Having problem with water activity	Yes	66	(94.3)	6.203		0.013*
	No	184	(80.0)			

Chi-square * < 0.05 have association

Table 7

Multiple logistic regression to determine the factors associated with beach safety knowledge.

Variables	Beach safety knowledge				
	B	Wald	AOR	95% CI	
Gender	-0.41	0.143	0.665	1.14-5.02	0.021*
Locality	0.600	4.140	1.821	1.022-3.245	0.042*
Frequency	0.628	3.195	1.874	0.941-3.733	0.074
Having problems with water activity	0.699	1.411	2.021	0.635-6.379	0.235

< 0.005 is significant

Figures

Figure 1

Study Area (Teluk Cempedak, Pahang, Malaysia)

Figure 2

Available beach safety signs and facilities; beach flags, lifeguard tower, basic beach safety signage at Teluk Cempedak Beach. No rips-related information board can be found (Muhamad Isa et al., 2021).

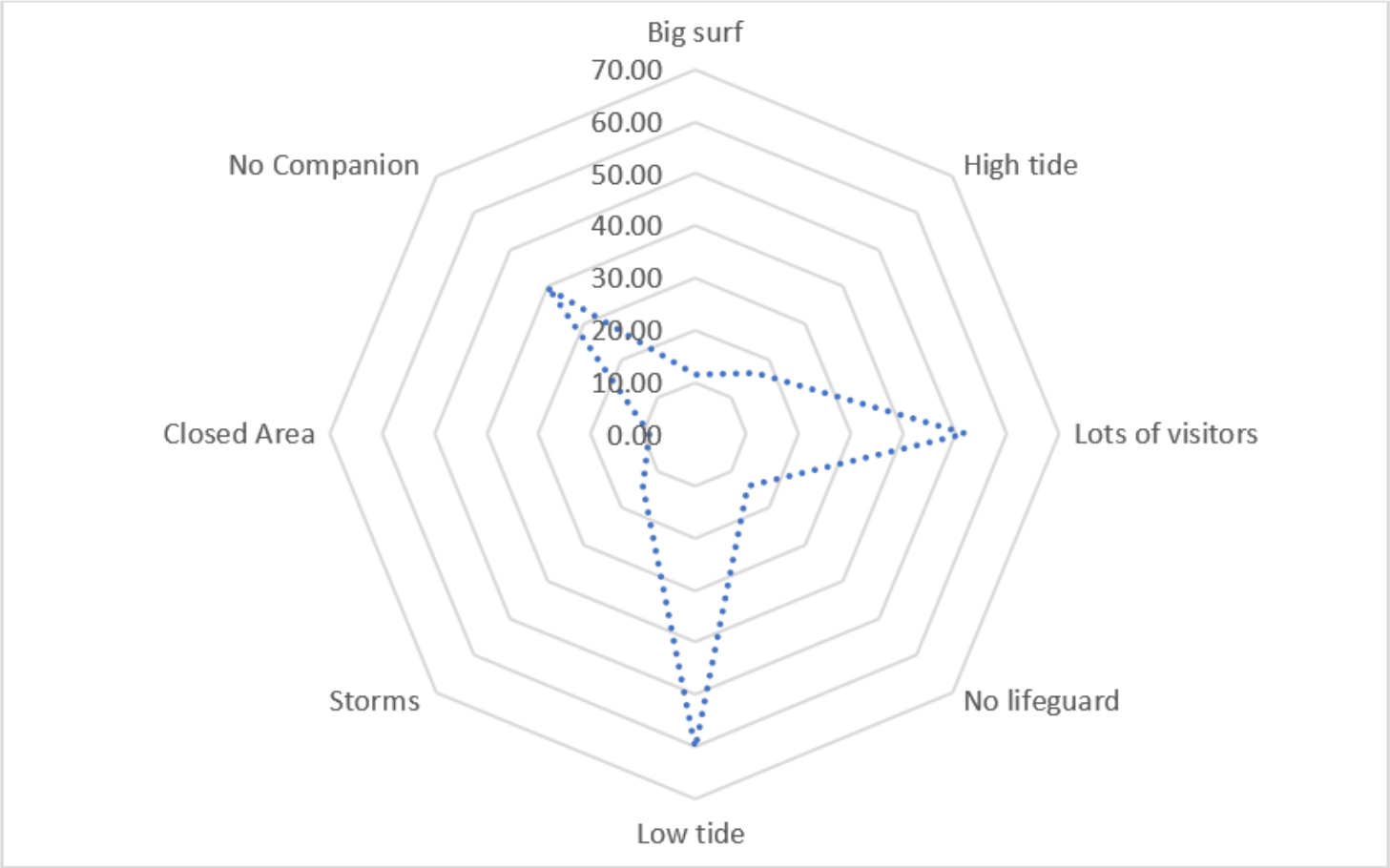

Figure 3

Factors Whether to Visit or Not to Visit the Beach

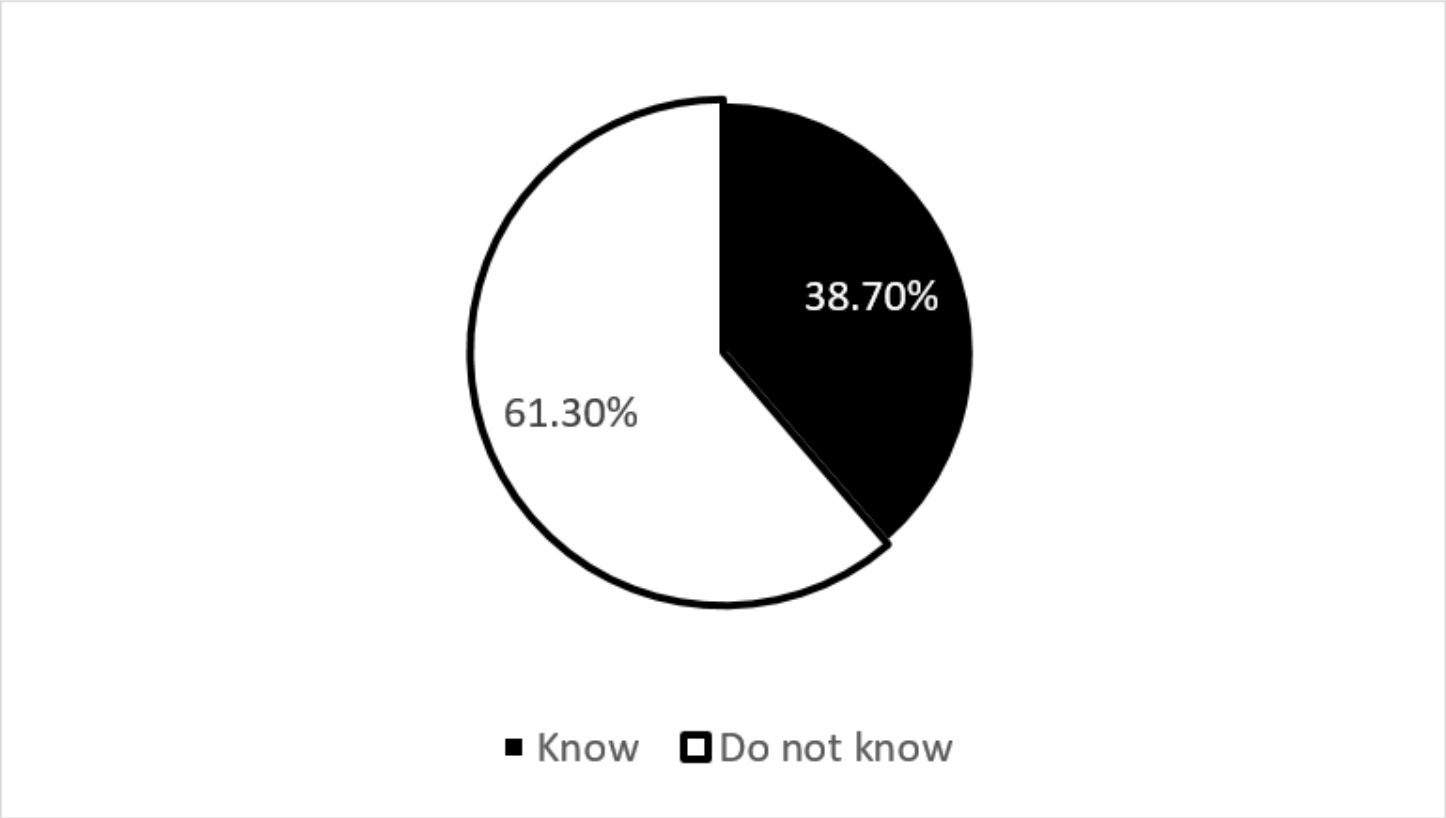

Figure 4

Existence of Rips

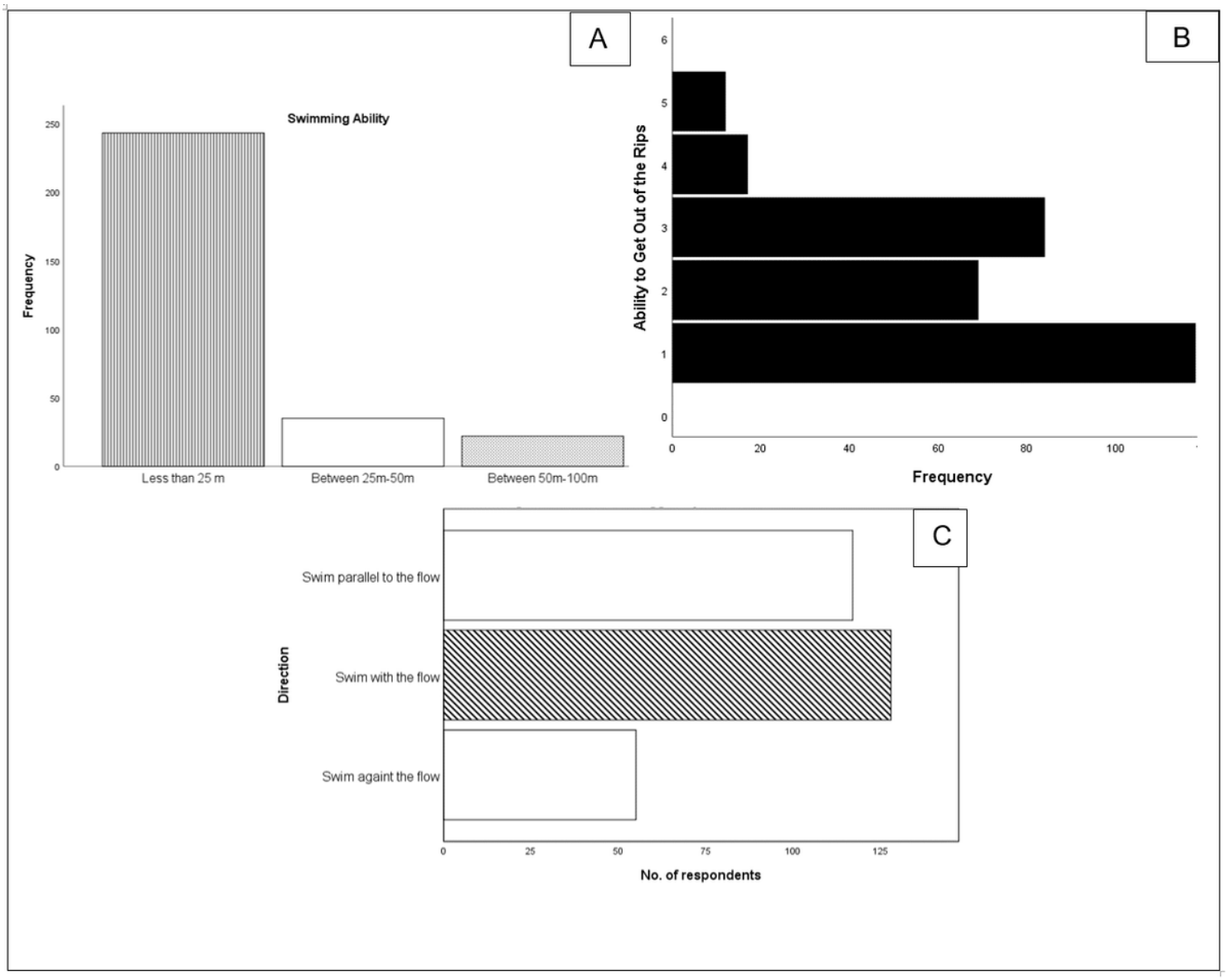

Figure 5

Respondents' swimming ability (A), Ability to get out of the rips (B), Swimming direction when dragged by the current (C)

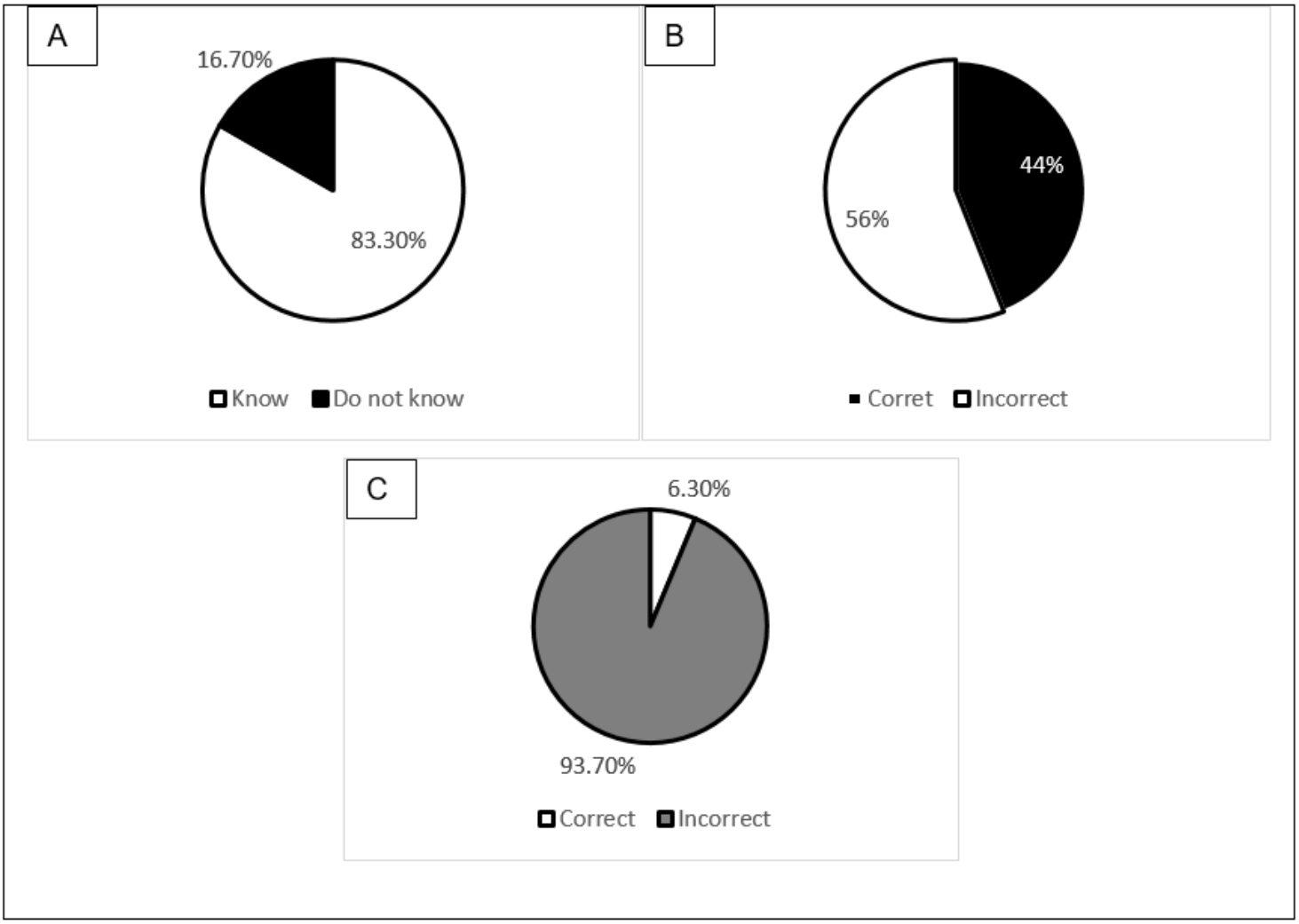

Figure 6

The percentage of respondents who are aware of the function of lifeguard (A), The percentage of respondents who are aware of the Yellow-Red flag (B), The percentage of respondents who are aware of the Red flag function (C)

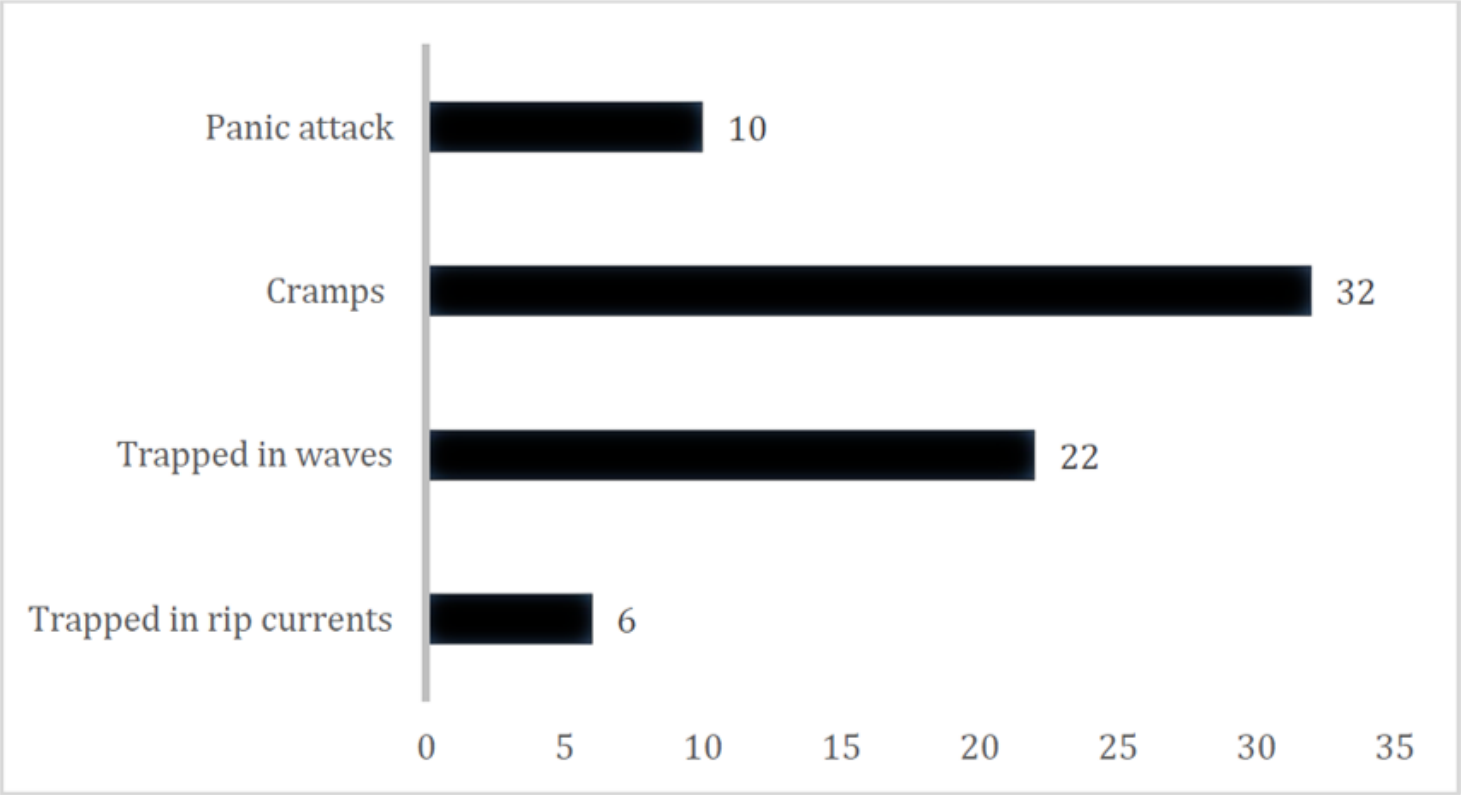

Figure 7

Problems Faced by the Respondents

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Questionnaire13thVersion.pdf