PUBLIC UNDERSTANDING OF RIP CURRENT AND BEACH SAFETY AT TELUK CEMPEDAK RECREATIONAL BEACH IN PAHANG, MALAYSIA

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Abstract

Rip currents are known to be a global public health issue and have been extensively contributed to the coastguard rescues and drowning cases at recreational beaches. Most studies in Malaysia have focused on the physical control of rip currents, with little emphasis on social factors. This study aims to assess the public knowledge of rip currents and beach safety at Teluk Cempedak Recreational Beach (TRCB) in Pahang, Malaysia. A convenience sampling technique was used to conduct a cross-sectional study among 300 beachgoers in TCRB. All data was collected using a self-administered questionnaire. Bivariable and multivariable logistic analyses were computed to identify factors associated with satisfactory knowledge of rip current and beach safety. More than half of the respondents were females (51%) and residents of Kuantan (62%). Out of 300 respondents, 160 (53.3%) had a satisfactory knowledge of rip currents, while a higher number of respondents (n = 221, 73.7%) had an unsatisfactory knowledge of beach safety. Those aged 35 and up, females, and those who had never had difficulty with water activities at the beach were more likely to have satisfactory knowledge of rip

currents. The only factor found to be significantly related to satisfactory beach safety knowledge was age (35 years old). In conclusion, the respondents were concerned about rip currents, but they had inadequate knowledge of beach safety. Therefore, the development of effective beach safety education programmes is needed in Malaysia.

Keywords: beach safety, coastal hazards, drowning, public knowledge, rip currents

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. According to Ariffin et al., (2019), a beach is defined as depositional units formed by the influence of waves, winds, and tides and is predominantly made up of pebbles or sand, especially in the area between the low water line and the high-water line. In general, beaches provide an enticing and relaxing environment that adds meaning to leisure and recreational activities. In this respect, these activities allow the beach area to expand and eventually make a huge contribution towards the tourism industry in Malaysia, which attracts millions of local and foreign visitors from all around the world (Hirschmann, 2020). However, despite these robust activities at the beach, the number of drowning cases that occur at the beach is disturbingly high. The World Health Organization (WHO) reported that approximately 40 people are involved in drowning accidents each hour worldwide, which equates to 372,000 cases annually (Dermawan, 2017). The Australian Water Safety Council claims that drowning is a main public health issue and was ranked as the 4th leading cause of accidental injury death in Australia (Peden et al., 2021). In Peninsular Malaysia, recent incidences of beach drowning, inclusive of fatal and non-fatal accidents, have tended to increase. Malaysia had as many as 700 drowning accidents every year, and 500 of the people who died were children younger than 18 (Dermawan, 2017).

Drownings at the beach areas along Malaysia's coastlines are generally associated with rip currents (Mohammed Isa et al., 2021; Hamsan and Ramli, 2021). Statistically, rip currents are one of the deadliest hazards to beachgoers globally at both patrolled and unpatrolled beaches. A rip current is a type of wave-inducing current that forms nearshore and flows towards the sea (Dalrymple et al., 2011). Originating within the surf zone, the rips tend to flow in the seaward direction of the breaking zone and can move at a relatively high speed (Cervantes et al., 2015). They could occur on beaches with either rocky or soft sand (silt), and the scale is largely influenced by the type of beach they encounter. Castelle et al., (2016) distinguished the types of rip currents based on three different generating mechanisms, which are rips influenced by hydrodynamics, bathymetric rips, and boundary rips. Rip current formations at the recreational beaches along the east coast of Malaysia are mostly controlled

by bathymetrical and boundary factors, which include channel rip currents that usually occur at beaches of intermediate beach state and natural features (headland, rock patches, and coastal structures). Rip currents would then drag bathers from the surf zone into deeper water, which would later result in fatigue and panic (Brander et al., 2011; Drozdzewski et al., 2012; Mohammed Isa et al., 2021).

The United States Lifesaving Association reported that rip currents were responsible for 80% of its rescues (Carey and Rogers, 2005; Gensini and Ashley, 2010). They are also responsible for 68% of all the reported lifeguard rescues in the United Kingdom. Drowning accidents associated with rip currents have been reported more in Australia than other risks, such as floods, shark attacks, and bushfires (Brander et al., 2013), with an average of 21 people drowned annually (Brighton et al., 2013). In India, drownings due to rips kill 39 people annually (Arun Kumar and Prasad, 2014). 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 (Mohammed Isa et al., 2021). Other data from the media showed evidence that this value is much higher. However, it is unclear whether the incidents were related to the rips (Houser et al., 2019).

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 (Azhary et al., 2016; Hamsan and Ramli, 2020). However, the problems associated with rip currents have been exacerbated by their complexity (Shaw et al., 2014). This is because some bathers may consider the rip currents dangerous, while others may not feel the same. 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 (Azhary et al., 2016; Hamsan and Ramli, 2020). However, the problems associated with rip currents have been exacerbated by their complexity (Shaw et al., 2014). This is because some bathers may consider the rip currents dangerous, while others may not feel the same.Less danger can be exerted on those who have a better understanding of the rips as well as the ability to easily recognise the rip currents. There was a strong need in the efforts for intervention programmes and modules to assess the beachgoers' knowledge and behaviour of beach hazards. Therefore, in more recent years, studies in other countries, notably Japan, the United Kingdom, Australia, and the United States (US), have been more emphasised in the social science of rips (Brannstrom et al., 2015; Woodward et al., 2015; Fallon et al., 2018; Silva-Cavalcanti et al., 2020). The difference in terms of acceptance of the bathers towards the rip currents is seen to cause most of the rip current fatalities to be preventable.

A study by Woodward et al., (2015) shows that beachgoers who have been taught about rip currents have a better understanding of them and that lifeguards are the most effective method for intervention in beach safety and awareness. Meanwhile, Sherker et al., (2010) highlighted the important role of parents in recognising the beach flag and swimming in the designated safe area. However, in the case of heavily visited beaches that include larger areas, such as in Texas, almost half of beachgoers were not aware of the existence of beach safety features (lifeguards, flags, and signboards) when approaching the beach area. Many people claimed they had difficulty translating the rips image on the warning sign into a feature observable at the shore (Brannstrom et al., 2015). Fallon et al., (2018) in their study on Miami Beach did mention the capability to swim and the frequency of beach visits as the two factors that could affect the rip current knowledge. The frequency with which beachgoers visit the beach environment is one of the primary contributors to the high level of rip current knowledge from the other proportion of respondents. All of these studies eventually lead to efforts to measure the effectiveness of beach lifeguard services, public rip current educational programs, rip hazard mitigations, and general trends of rips in Malaysia's poorly documented areas becoming more assessable, as in other developed countries (Brander et al., 2011; Gallop et al., 2016; Fallon et al., 2018). Thus, this study aims to determine the level of public understanding of rip currents and beach safety at TCRB in East Coast Peninsular Malaysia. A modified questionnaire, which has been validated and tested for reliability, was used to assess the attitudes, thoughts, and perceptions of the public on rip risks. This study sought to initiate efforts towards developing rip current intervention programmes 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 is located at the north-eastern tip of Pahang, Malaysia (Figure 1). The location is approximately 5 km from Kuantan, the capital city of Pahang. Topographically, TCRB consists 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. TCRB is physically steeper than other beaches in Pahang, with a width of roughly 57.3 m and a slope of 3.28° (Hamsan et al., 2019). According to Hamsan and Ramli (2020), TCRB is classified as an intermediate beach with a low tide bar rip beach state, which is prone to the occurrence of rip currents. Its coastline is exposed and subjected to tidal actions from the South China Sea. TCRB is

characterized by a mixed tide of diurnal and semidiurnal tides with mean tidal ranges of less than 2 m (Yaacob et al., 1995; Mohd et al., 2018; 2019).

The meteorological environment of the Pahang coastline is 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 are also two brief inter-monsoons, one in October and the other in April. During NEM, the east coast of Peninsular Malaysia is exposed to strong wave conditions, which lead to the occurrence of higher wave heights of 1.5 m up to 2.7 m (Mohd et al., 2018). The average annual rainfall amounted to 2,400 mm, and the average temperature was 28 °C. The maximum and lowest rainfall intensity usually occur in December and January, respectively. The average wind speed is around 8 km/h with a relative humidity of 85% (Zulfakar et al., 2020; Hamsan and Ramli, 2020). Over the years, TCRB has become one of the most popular destinations for both international and domestic tourism and recreation in Pahang (Bhuiyan et al., 2011; Agita, 2019). Attractions, including the availability of many accommodations, such as hotels, restaurants, and proximity to the capital city of Pahang, are some of the factors that led TCRB to become the most frequently visited beach in Pahang. However, TCRB has recorded a significant number of fatal drowning cases, i.e., substantially higher than other beaches (Mohammed Isa et al., 2021; Hamsan and Ramli, 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 (Muaz, 2014). Figure 2 depicts the beach signage and facilities available at TCRB during the study period.

2.2 Study Design and Data Collection

A cross-sectional survey with 300 respondents was conducted from November 2020 until March 2021 using a self-administered questionnaire. Data was collected via convenient sampling. A temporary booth was set up near an open area closer to the beach with welcoming posters and refreshments, while respondents that were on the beach were approached directly to participate. A face-to-face survey following the technique by Sherker et al., (2010) was then conducted after the respondents agreed to take part in the study. The respondents then completed the questionnaire in approximately 5 to 10 minutes. As the goal was to also recruit respondents from a wider range of age groups and demographics, conducting the survey during weekends and public holidays was highly prioritised. The sampling time was carried out in a few sessions considered to be “high use” from 2 pm in the afternoon until 7 pm to increase the survey reliability. The booth was also adjusted and moved to two areas during the sampling, one of which was closer to the beach area with restaurants and the other closer to

the coastal guard area. 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).

A validated questionnaire adapted from a preliminary study conducted at TCRB by Mohammed Isa (2021) was used in this study. The questionnaire is available in both Malay and English. The questionnaire comprises of 24 questions with five sections: socio-demographic background, frequency of visiting the beach, swimming ability, knowledge of rip currents, and knowledge of beach safety. The five-item questions (14–18) were used to measure respondents' knowledge of rip current. Satisfactory knowledge was determined based on the correct answer to question 18's rip current image identification. There are eight items used to examine the beach's safety knowledge. Based on all the right answers to questions 19 through 22, the respondents were deemed to have satisfactory knowledge about beach safety. The survey was administered, and sometimes explanations were given for each question in Malay. All comments from the respondents were recorded to help identify which questions required further explanation to facilitate the understanding of beachgoers. The survey was carried out in printed colour hard copy and respondents were allowed to observe the beach facilities while answering the survey. Respondents were offered refreshment during the survey to reduce any external pressure and fatigue, especially at noon when the temperature can reach up to 32 degrees Celsius. Upon completion of the survey, respondents were briefed on how to identify safe areas for bathing and what beach safety features are available in the area. Respondents that voluntarily shared their contact information are willing to be involved again in future projects or intervention programs.

2.3 Statistical Analysis

Descriptive statistics were analysed using the software Statistical Package for Social Sciences (SPSS), version 26 (IBM). Inferential analysis on bivariable analysis of categorical variables using the Chi-square test was used to determine the association between the independent variables (sociodemographic, frequency of visiting the beach, and swimming ability) and the outcome of the study (knowledge of rip current and beach safety). A possible contributory factor was identified in each of the independent variables with a p value less than 0.05, and these variables were included in the multiple logistic regression models. The adjusted odds ratio (AOR) was calculated at a 95% confidence interval (CI) to identify the determinant for satisfactory knowledge of rip currents and beach safety. A p-value of less than 0.05 is considered statistically significant.

3.0 Results

3.1 Sociodemographic, visitation frequency and swimming ability

Table 1 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 over 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 group. Overall, approximately 62% (186 of the respondents) were local, while the remaining 38% (114 of the respondents) were non-local. From the table, the frequency of beachgoers visiting TCRB, more than half (58.3%) of the respondents visited this beach more than five times. Nearly half of the respondents reported visiting the beach all year round, regardless of the monsoonal season. Beachgoers went to TCRB for various reasons, including safety (48%), proximity (34.7%), and moderate wave conditions (11.3%). Although beach safety was the dominant factor that prompted beachgoers to visit the beach, more than 70% of the beachgoers would not hesitate to visit the beach without any coastguard supervision. Respondents were then asked to evaluate their swimming ability, and nearly 93% of the respondents stated that they could only swim 50 m or less without stopping. They also acknowledged the risk of drowning while swimming (63%), and that they did not know how to escape violent waves while swimming (52.3%). This is further supported when nearly two thirds of the respondents reported having experienced encountering difficulty with water activities at the beach, which included cramp, panic, and being caught in rips (76.7%). Numerous beachgoers, low tide conditions, and no company were the principal variables that attracted the respondents to visit the beach (Figure 3). By contrast, high tide conditions, no lifeguards, storms, and closed beach areas were the main factors that hindered the presence of beachgoers.

3.2 Knowledge of Rip Current

In section D of the survey, respondents were asked about their knowledge of rip currents. Rip currents have several different names locally depending on the nature of work and educational background. Therefore, questions 14 to 17 were designed to facilitate visitors in recognising the mechanism or foundation of rip current. Five local names of rip currents in Malay were also provided in the questionnaire. Overall, 53.3% had a satisfactory level of rip current knowledge based on their ability to recognise the existence of rip currents in the image provided to them in question 18 of the questionnaire, where A and B are the safer bathing areas. Most of them (86.3%) had heard of the occurrence of currents on the beach but not about the presence of rip currents (61.3%). However, most of them believed that rip currents were generated by wind (86.7%). When asked about swimming direction when trapped in rip currents, 42% of respondents were unaware that they should swim parallel to the shore rather than in the direction of the flow (Table 2).

3.3 Knowledge of beach safety

In section E, respondents were asked to identify several safety features available in TCRB from the figures provided in the questionnaire. The result shows that there is a high, unsatisfactory level of beach safety knowledge (73.7%) among the respondents by knowing the function of the beach safety flag at the beach. Even though most of the respondents reported recognising the function of the lifeguard tower located at the beach and responding well to the function of flags, they failed to answer correctly for the yellow-red flag function (56%). The yellow-red flag indicates the safest zone for water activities and bathing following the recommendation from the International Life Saving Federation (ILSF) as implemented in other countries such as Australia and Japan (Woodward et al., 2015). However, almost all of them (93.7%) could understand the function of a red flag (Table 3). Additionally, each respondent was given three photos adopted from Sherker et al., (2010) to evaluate their ability to identify the presence of rip currents that depicted different beach conditions with different flag systems (Question 23). More than half of the respondents (53%) would swim in the rip and only 46% would consider bathing between the flags, just slightly lower than results by Sherker et al., (2010) in New South Wales beaches. However, nearly 81% of the respondents correctly answered Question 24 on the identification of the red beach safety flag.

3.4 Factors associated with satisfactory knowledge of rip Current and beach safety

Knowledge of rip currents was found to be significantly linked to four factors, as shown in Table 4. Those who were older (≥ 35 years old), females, lived in Kuantan, and had never experienced water activity problems at the beach were more knowledgeable about rip currents than their counterparts. The adjusted logistic regression models showed that age (AOR = 1.97, 95% CI = 1.19 – 3.23), gender (AOR = 2.73, 95% CI = 1.58 – 4.71), and never having experienced water activity difficulty at the beach (AOR = 7.79, 95% CI = 3.79 – 15.99) remained significant, but not on the locality variable (AOR = 1.36, 95% CI = 0.79 – 2.32) (Table 5). Using the Wald estimator, never having trouble in the water at the beach was found to be the most important factor in having good rip current knowledge, followed by gender and age. The only determinant significantly related to satisfactory knowledge of beach safety was age. Those who were younger than 35 years old had better knowledge compared to the older respondents (Table 4).

4.0 Discussion

4.1 Knowledge of rip current and beach safety

To assess the knowledge of rip currents among beachgoers, respondents were asked to choose which area they would conduct water activities. Although two thirds of the areas are safe, 39% (n = 117) of

the respondents incorrectly picked area C (a rip channel) as the safer area to swim. The reason is mostly due to the absence of waves, which most consider as a calmer area than the breaking wave zone (Ballantyne et al., 2005; Caldwell et al., 2013). Similar patterns of responses were also recorded by Gallop et al., (2016), where 40% of the respondents chose rip channels as the most suitable area to bathe. In Australia, although most of the respondents thought they had the right understanding to identify a rip, nearly half of the respondents were not able to determine a safer bathing area (Ballantyne et al., 2005; Sharker et al., 2010). TCRB was equipped with warning signs and coastal guards as part of the beach safety management. The implemented beach flag system follows the guidelines set by ILSF and is used by other countries such as Australia, New Zealand, and the UK. The flag colours that are available in TCRB are red as a warning "no swimming zone" and a combination of red and yellow as a safe area patrolled by the coastguards.

Most respondents (73%) in TCRB expressed a good understanding of flag functions, which is better than people on the central south coast of England (66%) (Woodward et al., 2015; Gallop et al., 2016). In contrast, a proper response to the flag warning is considered poor among beachgoers when most of them still swim outside the designated area. A similar trend was reported by Surf Life Saving Australia in their survey (Australia, 2017). Menard et al., (2018) found that the flag system should be monitored simultaneously with the presence of coastguards to increase awareness of rip risks. This was proven true when most people in TCRB were observed to swim outside the flagged area further away from the coastguard supervision. Improvement in the number of coastguards patrolling and interaction with beachgoers could become an effective solution to reduce drowning cases (Brander et al., 2011; Drozdzewski et al., 2015; Gilchrist and Branche, 2018).

4.2 Factors associated with satisfactory knowledge of rip current and beach safety

Respondents over 36 years old held a better awareness of beach safety knowledge as shown in Table 5. Compared to respondents below 36 years old, they gave the correct answer to the beach conditions based on the flags shown to them. This older group of respondents provides an indication of the frequency of use with regard to beach 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 and beach safety (Table 4). 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 male subjects answered correctly on the knowledge of beach safety as males are more likely to accompany their children swimming, underestimating risks or engaging in high-risk beach activities. Local respondents (Kuantan) revealed a better understanding 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 areas, who have more access to nearby beaches, were likely to have a better understanding of the rip currents. Rip current knowledge does correlate with beach safety knowledge, where more than 54% (162) of the local respondents were able to provide a greater level of awareness and understanding of beach hazards.

These findings suggest 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 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. With nearly 90% of respondents did not possess strong swimming ability, chances to escape rip current will be extremely low (Brander et al., 2011; Drozdzewski et al., 2015). These findings were also consistent with the results of other studies, i.e., beachgoers had difficulties recognising rip currents (Ballantyne et al., 2005; Sherker et al., 2010; Brannstrom et al., 2015; Gallop et al., 2016). In Malaysia, initiatives to raise awareness among local communities of the dangers posed by rip currents are very scarce. Warning signage on rip currents along TCRB was not visible, and lifeguards are often patrolled only during the weekends. This study provides suggestions on the matter of the importance of education on beach safety, particularly on rip currents, which will empower beachgoers to adopt the safest measures while visiting the beach (Silva-Cavalcanti et al., 2018).

No significant association was linked between the respondents' swimming ability and their knowledge of rip currents and beach safety. 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 due to the fact that 81% of the respondents in this study are poor swimmers. On a side note, swimming and surfing are not the primary activities 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 the factor of respondents' having problems during water activity is significantly correlated with the knowledge of rip currents but not with the knowledge of beach safety. These problems generally comprise cramps and panic resulting from being dragged by the rip currents or waves. The finding also matches 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 them. However, the association between the respondents' experience and the knowledge of beach safety remains unclear. As this study only focuses on a single recreational beach and the respondents were recruited through convenient sampling, the findings may not be generalizable to another recreational beach in Malaysia.

5.0 Conclusion

A set of questionnaires were given to 300 beach visitors at TCRB to assess the public's understanding of rip currents and beach safety. Findings from the study demonstrate that beachgoers at TCRB had satisfactory knowledge of rip currents with a lack of awareness of beach safety knowledge. Only 38.7% of the respondents knew about the term rip currents, and nearly 60% did not know the correct strategy to escape rip currents. Most beachgoers recognised the coastguard facility and were even aware of the designated area marked by a pair of red or yellow-red beach flags. However, most respondents had difficulties indicating a safe bathing area in a photograph of a combined rip current formation and flags, where nearly 53% chose to swim in rip currents and outside the flags. Variables such as age, gender, and the respondents' experience of problems during water activities show significant association ($p < 0.05$) with the knowledge of rip currents. Those who had never experienced panic or difficulties in the water knew more about rip currents than those who had. However, age showed significant associations with knowledge of beach safety. Further analysis revealed that respondents' swimming ability had no significant effect on both the knowledge of rip currents and beach safety, probably because most of the respondents (93%) were poor swimmers. It can be fairly concluded that there are still a lot of misconceptions surrounding rip currents in Malaysia, and that these problems need to be seriously addressed. Coastal guards and warning signage need to be further revised and improved. Intervention programmes such as campaigns and training are also needed to mitigate rip risks.

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