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Risk Factors of Flood-related Mortality in Phichit Province, Thailand

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Abstract

In July 2011, catastrophic flooding occurred in 65 out of 77 provinces in Thailand, affecting 9.5 million and caused 813 deaths. The highest number of death due to floodwater was found in Phichit Province. An investigation was conducted to identify risk factors for flood-related mortality. A matched case-control study was performed. A case was defined as a flood-related death and the matched control was a person residing in the same neighborhood within five years age range. Data on cases were gathered by interview with family members and witnesses while information on controls was obtained through a structured questionnaire. Total 50 flood-related deaths and 100 controls were enrolled. Majority of deaths (56%) were 31-60 years old. About 87% of deaths were males and the cause of all deaths was drowning (100%). Health problems such as central nervous system disorder, psychosis and epilepsy were observed among 34% of the deaths. A common activity at the time of death was fishing (44%). Having health problem (adjusted OR=17.3, 95% CI=1.1-275.5) and male gender (adjusted OR=14.6, 95% CI=1.4-154.2) were identified as independent risk factors of flood-related deaths. Risk communication was initiated with the related ministries and high risk activities in the floodwater were prohibited by the responsible ministries.

Keywords: disasters, drowning, floods, mortality, risk factors, Thailand

Introduction

Flooding is the most common natural disaster globally and causes devastating effects on the environment, society, economic and health.[1] Direct physical and mental impacts fall on people in the path of flooding, particularly the vulnerable groups. Physical health consequences include infections, injuries and deaths while severity depends on individual's vulnerability, characteristics of floodwater and surrounding environmental conditions. Common causes of flood-related deaths are drowning, physical injuries and diarrheal diseases.[2]

From 2001 to 2011, eight out of 10 largest natural disasters in Thailand were flooding according to the Department of Disaster Prevention and Mitigation. In the 2011-Thailand floods, 9.5 million people were affected, thousands of people were injured and 813 died from flood-related incidents.[3] The estimated economic lost was about 45.7 billion USD and ranked as the fourth costliest disaster in the world.[4]

The Bureau of Epidemiology, Department of Disease Control, Ministry of Public Health, established a flood-related mortality surveillance system in August 2011 to monitor the magnitude of flood-related deaths and verify the cause of deaths. In September 2011, a sharply increasing trend of flood-related deaths was observed in Phichit Province and risk factors of deaths were not well understood. Therefore, an investigation was conducted to identify the risk factors, with a goal to prevent future deaths.

Methods

The national flood-related mortality surveillance system routinely collected data on flood-related cases notified from the provincial health offices (Figure 1). Drowning was defined as a process of experiencing respiratory impairment from submersion or

immersion in water.[2] Physical trauma was defined as a flood-related incident of being hit by an object in the water, collapse of a building or a vehicle crash.[3]

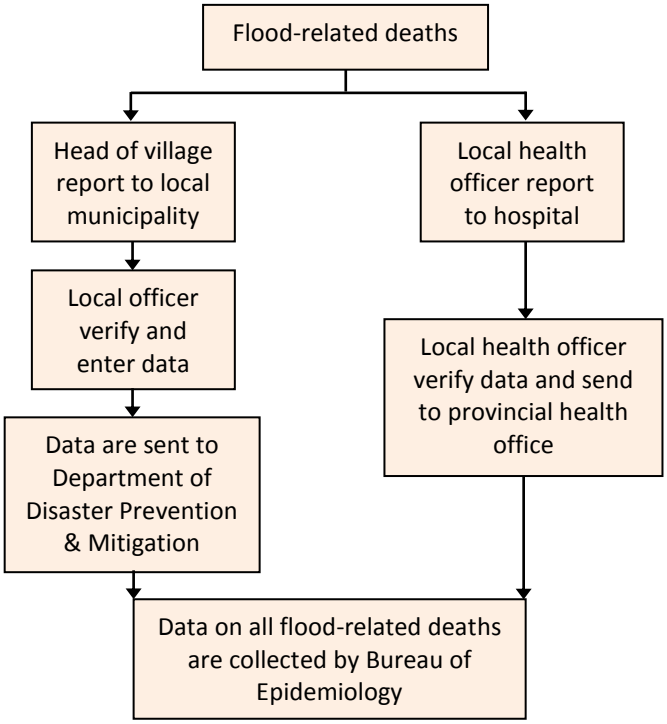

Figure 1. Flood-related mortality surveillance system of Thailand, 2011

All 77 provinces in Thailand were affected by flooding, and flood-related deaths were reported from 65 provinces, with the highest number of flood-related deaths in Phichit Province. Thus, the study was carried out in all flood-related deaths from Phichit Province. A matched case-control design was employed for different lifestyle among specific age-groups and various types of floodwater exposure in different areas. A case and two controls were matched by age and living area. Case definition of a flood-related death was obtained from the national flood-related mortality surveillance system by the Bureau of Epidemiology. A case was a resident in Phichit Province who lost the life in floodwater between July and October 2011 whereas a control was a person currently residing in the same neighborhood (left-hand side of the case's house while facing towards the house) and matched with the individual death by age (± five years range). People who mismatched or did not respond were excluded.

A structured questionnaire was developed to collect data on demographic information (age, gender, address and occupation), activities leading to death (walking, riding, driving and fishing), risk factors and surrounding circumstances (alcohol drinking, high water level and dangerous current exposure). A similar questionnaire was used to collect data from the controls as well. The standardized interview was conducted by the trained epidemiologists and public health professionals. Witnesses, family members and investigating policemen were also interviewed to obtain more information of the deaths. To compare risk factors exposed by the cases and the controls, odds ratios (OR) with 95% confidence Interval (95% CI) were calculated to examine the association between a possible risk factor and flood-related mortality. Univariated analysis by matched analysis was conducted to acquire crude OR. Variables with p-value less than 0.1 were included in multivariated analysis by conditional logistic regression. All statistical tests for this study were performed using Epi Info version 3.5.3.[5]

Results

All 12 districts in Phichit Province were affected by flooding since 31 Jul 2011. The flooding was river floods which rose slowly and stagnated for about three months and greatly impacted the living condition, economy and health. There were total 54 flood-related deaths, with crude mortality rate of 9.8 per 100,000 population during August and October 2011. The highest number of death was observed in September 2011, with 25 cases, and reduced to 16 cases in October 2011 (Figure 2).

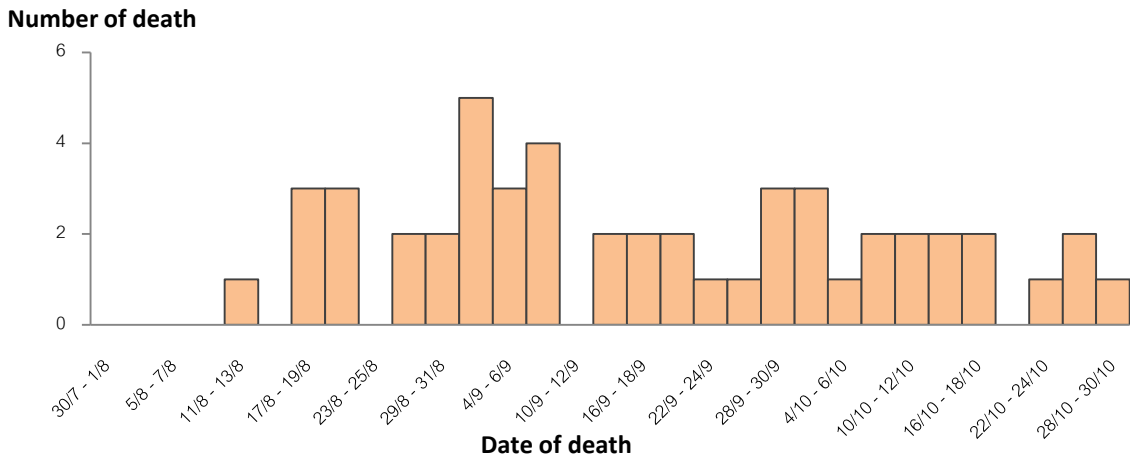

Figure 2. Distribution of flood-related deaths by date of death in Phichit Province, Thailand, July to October 2011

Deaths were reported in all districts, clustering mostly (22.2%) in Muang District which was at the center of the province.

Overall fifty decedents were included in the study, as four had incomplete data. Majority of deaths were males (88.0%). Median age was 42 years old, ranged from 3 to 88 years. Mortality proportion was the highest among working age group (31-60 years, 55.6%), followed by children <15 years (18.6%) and elderly >60 years (14.8%). Occupational status of the decedents included employee (52.0%), no occupation (18.0%) and student (14.0%). About 32% of the dead cases could not swim and 48% could swim with limited skills. The fatal cases confronted various types of currents, with mostly (47.8%) in still current. Activities related to death included mostly 44.0% fishing and 42.0% walking through floodwater. Most (81.8%) flood-related mortality events occurred in daytime (Table 1).

Having health problem at the time of death was observed in 34.0% of cases, including 9.3% with cramps or syncope and 3.7% with seizure or psychotic problems. Among the children under 15 years, 90.0% were school-aged, 60.0% had no experience of flooding and none of them could swim.

There were 33.3% of deaths in flooded man-made water reservoir, 18.5% in flooded natural water reservoir and 11.1% in the house (Table 2). All deaths occurred in floodwater and their autopsy reported as death due to asphyxia. The primary cause of all deaths was drowning.

With respect to the activities during death, more males went for fishing (87.5%) and fell into the water (71.4%) while those walked through the water were all males (100%). Overall, the remaining 50 cases and 100 controls were similar in age, living area and exposure of flooding.

The multivariate analysis revealed two potential risk factors of flood-related death, which included having health problem during flooding such as hypertension, epilepsy and mental retardation (Adjusted OR = 17.3, 95% CI = 1.1-275.5) and male gender (Adjusted OR = 14.6, 95% CI = 1.4-154.2) (Table 3).

Discussion

Phichit Province had the highest number of flood-related deaths due to geographical plains, long duration of flood and high density of population (3 times higher than the national population density)[4]. As people in the province had experienced flooding in the past, built houses to prepare for flooding such as no electricity outlet at the basement, strong structure, high ceiling on the first floor and toilet placed on the second floor. Hence, there was no electrocution or trapping in collapsed buildings and drowning was the only cause of death in the province. Nevertheless, as one of the drawbacks for the people who experienced flood frequently, the local people had low awareness on floodwater threats despite the unusual big flooding in that year, leading to risky behaviors, lack of self-protection and even death. Moreover, the flooding was caused by river flood which had low violence, yet stagnated for long duration. This could render people to expose to floodwater for months and might be relevant to high mortality as well.

The peak of flood-related death in the province was in September, which could be related to the common period for tropical storms in Thailand. In contrast to flood deaths in the United States where 75% of flash flood deaths occurred during the hours of twilight and darkness, the mortality mostly occurred during daytime in Thailand due to the water-related activities[6].

The strongest association of flood-related death as having health problems during flooding suggested that there might be a pre-existing condition causing death such as physical inability or impaired consciousness. Many people in the province were inevitably living with the floodwater and carrying out normal activities due to long duration of flooding. A study reported that population at risk of flood-related deaths included people with disabilities or illness, children, elderly and people confined in the prisons[7], which complied with the findings from this study.

Majority of flood-related deaths were in working age (31-60 years) since elderly and children stayed in the house while adults had to go out and expose to floodwater during their daily activities. The same result was observed in studies from Europe and United States[3]. However, the finding differed from the situations in Nepal[8] and Bangladesh[9] where the most affected population was children under 10 years. Children in Phichit Province died as they played or walked in floodwater and the strong current swept those vulnerabilities away.

Males were significantly at increased risk of death due to water-related activities and high risk behaviors such as fishing, traveling and walking through floodwater. Male gender was also risk factor in United States, yet with different related activities such as driving or working for emergency and supporting services[3]. A study in South Korea reported that most males died from drowning while females mostly died from structural collapse.[7] Similarly in

Nepal[8] and Bangladesh[9], as houses were destroyed by flash flood, females were more likely to be affected.

Water-related activities in Phichit Province were high risk since people did not recognize the danger of floodwater. Fishing in deep water without life-saving equipment could lead to death. Fishing and walking through floodwater were related to deaths in this study while in Australia, mostly were died from using motor vehicle during flooding (48.5%). About 26.5% of mortalities went swimming or surfing in the floodwater[10].

Table 1. Characteristics of flood-related deaths (cases) and controls in Phichit Province, Thailand, September to December 2011

Variable	Number of case (Percent) n=50	Number of control (Percent) n=100
Demographic data		
Male	44 (88.0)	33 (33)
Median age (range)	42 (3-88)	43 (4-86)
Occupation		
Employee	26 (52.0)	18 (18.0)
Student	7 (14.0)	17 (17.0)
Farmer	6 (12.0)	35 (35.0)
No	9 (18.0)	8 (8.0)
Personal information		
Able to swim	34 (68.0)	70 (70.0)
Habit of drinking alcohol	33 (66.0)	25 (25.0)
Characteristic of flooding		
Flood at home	34 (68.0)	60 (60.0)
Median flood duration (days)	28.5	21.0
Median water height in meter (range)	2.0 (0.1-5.0)	1.5 (0.1-3.0)
Flood at home last year	10 (20.0)	17 (17.0)
Water current	(n=46)	(n=70)
Still	22 (47.8)	45 (64.3)
Moderate	13 (28.3)	16 (22.9)
Rapid	11 (23.9)	9 (12.9)
Activity during flooding		
Fishing	22 (44.0)	31 (31.0)
Walking through water	21 (42.0)	71 (71.0)
Playing in water	5 (10.0)	6 (6.0)
Boating	4 (8.0)	20 (20.0)
Riding	2 (4.0)	16 (16.0)
Swimming	1 (2.0)	2 (2.0)
Fishing activity	n = 22	n = 30
Place		
Rice field	12 (54.5)	20 (66.7)
Canal	5 (22.7)	2 (6.7)
Human built resource	3 (13.6)	1 (3.3)
Side road	2 (9.1)	1 (3.3)
Method		
Walking	13 (59.1)	16 (53.3)
Boating	6 (27.3)	11 (36.7)
Riverside	2 (9.1)	3 (10.0)
Equipment		
Net	10 (45.5)	18 (60.0)
Hooking	5 (22.7)	12 (40.0)
Time		
Day	18 (81.8)	26 (86.7)
Night	4 (18.2)	2 (6.7)
Physical status		
Having health problem	17 (34.0)	2 (2.0)
Getting drunk	13 (26.0)	12 (12.0)

Table 2. Activities and circumstances of flood-related mortality in Phichit Province, Thailand, September-December 2011 (n=52)

Surrounding circumstances	Activity	Total deaths (Percent)
Flooded man-made water reservoir		18 (34.6)
	Fishing	8 (15.4)
	Playing	6 (11.5)
	Falling into	2 (3.8)
	Walking through	1 (1.9)
	Boating	1 (1.9)
Flooded natural water reservoir		10 (19.2)
	Fishing	6 (11.5)
	Walking	2 (3.8)
	Falling into	1 (1.9)
	Boating	1 (1.9)
Floodwater in the house		6 (11.5)
	Walking through	4 (7.7)
	Falling into	2 (3.8)
Floodwater near the house		5 (9.6)
	Walking through	3 (5.8)
	Falling into	1 (1.9)
	Fishing	1 (1.9)
Floodwater in rice field		3 (5.8)
	Fishing	1 (1.9)
	Walking through	1 (1.9)
	Falling into	1 (1.9)
Floodwater on the road/roadside		9 (17.3)
	Riding	4 (7.7)
	Boating	3 (5.8)
	Walking through	2 (3.8)
Driving in a vehicle		1 (1.9)

Table 3. Factors associated with flood-related mortality in Phichit Province, Thailand, September to December 2011

Factor	Crude odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Having health problem during flooding vs. healthy	88.0 (13.3-580.3)	17.3 (1.1-275.5)
Male vs. female	34.5 (9.7-122.6)	14.6 (1.4-154.2)
Walking through floodwater vs. other activities	12.7 (1.3-120.0)	14.6 (0.5-439.5)
Getting drunk during flooding vs. not getting drunk	16.3 (2.2-121.4)	1.8 (0.02-143)
Exposing floodwater level >1.5 vs. <1.5 meters	3.3 (1.3-8.3)	1.0 (0.2-4.6)
Alcohol drinking habit vs. no alcohol drinking	42.0 (8.9-197.7)	0.9 (0.1-7.7)
Exposing strong and whirl current vs. still current of floodwater	4.6 (1.59-13.1)	0.9 (0.1-6.5)

Other risk-taking behaviors like walking, boating, playing and attempting to rescue reported in this study were similar to those in Australia[10]. Most deaths related to risky activities in this study were preventable. The pattern emerged as being close to Reimer's descriptions in which mortalities occurred when residents entered their flooded homes to fetch belongings, boating and driving across flood[11]. Coates's study showed that 5.7% mortalities were due to recreational pursuits[12].

Various immediate control measures such as risk communication with the related ministries and prohibiting school-age children from playing in floodwater by the responsible ministries were launched. In addition, water-related entertainment

activities were forbidden by the municipal government. High risk population was closely monitored and if needed, immediate responses were undertaken. Warning signs for people who go fishing in the dangerous or strong current places were installed in the province.

Limitation

The coverage of morbidity surveillance might not be completed and under-reported as the province staff might be exhausted with flood responses at that time. Information bias might exist in this study as data on flood-related death were derived indirectly from proxy of cases. Some quantitative data obtained may have some errors in terms of measurement of floodwater depth, velocity and alcohol level in blood. However, it was minimized by interviewing family members for personal data, and utilizing information on witness and police investigation for death scenes. The selection bias might occur in the control selection process as well, though mortality and morbidity related to physical trauma were observed.

Recommendations

To prevent flood-related mortalities, awareness on flood-related threats should be thoroughly raised among the affected population and sustained for many years, including providing health education and swimming class in schools. Early warning for detailed information of flooding such as the time of flooding and depth of floodwater must be undertaken well before the flooding began. Monitors to measure floodwater level should be installed in the flood prone areas. People with chronic diseases must be evacuated before flooding.

High risk activities in floodwater such as walking, playing and boating should be discouraged while fishing in rice-field or deep water should be forbidden. Proper risk communication and education on specific target population should be implemented as well. In the long term, sustainable education programs on flood-related threats, including locating safe places for fishing and distributing life protective equipment, should be established in the province.

In conclusion, male gender and having health problem during flooding were potential risk factors of flood-related mortality. Most of flood-related mortalities were preventable. Proper interventions in target population must be implemented before the flooding season. Some findings were specified in context of the rural of Thailand and this might be applied to the rural areas of other developing countries.

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