Health risks associated with recreational water activities

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Abstract. Recreational water activities are becoming increasingly popular among travelers, especially for adventurous people who like to try something new in their life. The aquatic environment can provide enjoyment as well as health hazards to someone who involve in it. In particular, adventure travel and water sports are considered high-risk activities. Most of water activities are tightly regulated to ensure safety, but accidents and other risk do occur. Health risks during activities in fresh water or ocean water vary from infectious disease and drowning to marine envenomation, decompression sickness, and hypothermia. Most of the risks are highly preventable with proper planning and preparation. Travel medicine physicians need to understand the scope of the problem and provide individualized travel advice during a pre-travel consultation visit.

1. Introduction
Water recreation is one of the most popular activities during holiday. Recreational water includes fresh and coastal waters (natural water) as well as artificial waters like pools and spas. The use of recreational has health benefits but also poses health risks and physical risks such as drowning and injury. Water use for recreational purposes may be exposed to pathogen and cause infectious disease. Most common diseases associated with contact to recreational water are acute gastroenteritis and respiratory infections.

In a broader sense, water recreation include all activities in which the whole body or face are in contact with water, either natural or artificial waters. However, this article will only include recreational activities associated with natural water, both fresh water (whitewater) and coastal water (ocean sea water). Natural water for recreational activities usually is found at beach or ocean, rivers, lakes, waterfall, and hot springs.

There are many recreational water activities that can be grouped as primary and secondary contact recreation (table 1). In primary contact, the person has direct contact with the water, can be fully immersed and can possibly swallow waters. Secondary contact recreations involved direct contact with the water but are unlikely to swallow it. In addition, there are another group of people that enjoying the water from a distance or the scenic view around it without having direct contact with the water, such picnicking around the water.
Table 1. Type of recreational natural water activities.

| Primary contact          | Secondary contact          |
|--------------------------|---------------------------|
| Bathing                  | Jet skiing and waterskiing|
| Swimming                 | Canoeing and kayaking     |
| Snorkeling               | Kite surfing              |
| Surfing and body boarding| Rafting and tubing        |
| Diving                   | Parasailing               |
|                          | Wakeboarding              |
|                          | Submarine trip            |
|                          | Fishing                   |
|                          | Boating, yachting, sailing|

2. Infectious Diseases

2.1. Recreational water-related illness
Recreational exposures to pathogens in the water environment may cause infectious disease, which are collectively called recreational water illnesses (RWI). The illness can be foodborne, airborne, or direct contact with contaminated water from artificial (e.g. swimming pool, spa, water fountain) or natural waters (e.g. river, lake, ocean). The most common RWI is gastrointestinal infection manifested as diarrhea. Common pathogens are Campylobacter, Salmonella, Shigella, entero-pathogenic Escherichia coli, Cryptosporidium, giardia, norovirus, rotavirus, and adenovirus [1].

Other definition found in the literature regarding water-associated infectious disease is acute gastrointestinal illness (AGI) [2]. Clinically, AGI is manifested as diarrhea, vomiting, nausea, or stomach cramps. Diagnosis criteria were 1) diarrhea at least three loose stools in a 24-hour period; 2) vomiting; 3) nausea with stomachache; or 4) nausea or stomachache that interfere with daily activity [3]. The symptoms usually occur within 1 to 3 days [4]. Swimmers with body immersion, head immersion, or who swallowed water were at higher risk of water-related illness compared with non-swimmers [3].

Other illnesses associated with recreational water are upper respiratory illness (2 of the following: sore throat, cough, runny nose, cold, or fever); rash; eye irritation (eye infection or watery eye); and earache, ear infection or runny ears, skin and soft tissue infection, and central nervous system infections [3,5].

2.2. Schistosomiasis
Schistosomiasis is a parasitic disease caused by blood flukes (trematode worm) from the genus Schistosoma, e.g. Schistosoma mansoni, Schistosoma haematobium, and Schistosoma japonicum. Acute schistosomiasis is an important febrile illness among European travelers who were mostly returning from Africa [6,7]. River rafting in Ethiopia is one of the most common water activities associated with Schistosomiasis [8].

2.3. Legionnaires’ disease (legionellosis)
Legionnaires’ disease is a severe bacterial infection that presenting with pneumonia-like symptoms. The pathogen responsible is bacteria of Legionella genus. Transmission occurs by inhalation of a water aerosol containing the pathogen. Cases of travel-associated Legionnaires’ disease have been reported and were caused by contaminated water in hotels or cruise ships [9,10]. This pathogen can be found in fresh water, either natural water or artificial water systems (e.g. water tanks, spas, cooling towers, hot-water systems, swimming pools, fountains).

Most cases of legionellosis are caused by Legionella pneumophila serogroup 1. Rare serogroups of L. pneumophila can also be found among travelers visiting an area where water hygiene is severely bad during war [11]. A recent study from Greece found that among hotels associated with TALD, positive
Legionella was also found in samples from decorative fountain ponds, showers near pools and spas, garden sprinklers, drip irrigation systems and soil. *Legionella pneumophila* from several serogroups and other Legionella species were found [12].

### 2.4. Leptospirosis

Water recreation is an emerging risk factor for leptospirosis [13]. Delayed diagnosis may occur since the incubation period of leptospirosis may reach 21 days [14]. Several outbreaks occur after exposure to contaminated water and soil during water rafting and swimming [15]. Most cases get infected when travel to an endemic regions, especially in Southeast Asia regions [16, 17]. Several fatal cases of leptospirosis associated with river swimming or rafting has been reported in Malaysia [18].

### 3. Accident and Injuries Related to Water Recreation

#### 3.1. Drowning

Definition of drowning provided by The World Congress on Drowning is the process of experiencing respiratory impairment from submersion/immersion in liquid [19]. Drowning is among the top causes of death worldwide. Children under 5 years old are at risk and more than half of casualties are under 25 years old [20]. Lack of children supervision, distraction and insufficient planning were reported as risk factors of drowning among travelers [21]. Travel on overcrowded or small boats were also identified as risk factors. Another important risk factor for drowning is alcohol drinking. Alcohol can be detected in 30%-70% of the victims’ blood [22].

Risk of drowning may happen with water travel, either with large vessels or small boats. Boat accidents often occur with migrants, refugees and asylum seekers who make unauthorized travel without proper safety equipment. However, people on holiday may also end up with a tragedy. Study showed that drowning occurs three times more likely among travelers while abroad than within the home country [23]. Boating incidents were among the most important cause of death due to drowning; most of the casualties were not wearing life jackets [24].

Drowning may occur during swimming or surfing. Rarely, drowning occur when diving. Recreational swimmers in open seawater and recreational diver may be at risk of drowning if they suddenly panic after experiencing the sensation of cold water, rip currents, encounter with unexpected marine objects (large fish or venomous creature), spatial disorientation, or experience trouble with breathing apparatus (e.g. when water flooding the dive mask).

#### 3.2. Marine envenomation

Marine environment is really fascinating; it can attract many people to come and explore. However, some marine creatures are venomous and are hazardous to divers, swimmers, surfers, and also fishermen. Envenomation by marine creatures is a process by which venom or toxin is injected into another creature, including human, by means of a bite, puncture or sting. This behavior is usually a form of defense mechanism. It is important for every diver to remember the fundamental rule of diving: look, but don’t touch (figure 1).

Animal bite with envenomation involved sea snakes and octopi (e.g. blue ringed octopus). Puncture wound is caused by many creatures e.g. bony fish (scorpion fish, lion fish), sea urchins, starfish (crown-of-thorns), cone shells, and stingrays. Stings usually occur by skin contact with animals in the phylum Cnidaria e.g. hydrozoans (e.g. fire corals, Portuguese man-o-war), scyphozoans (true jellyfish), anthozoans (soft corals and anemons), and cubozoans (e.g. box jellyfish, irukandji) [25].
3.3. Decompression illness
The term decompression illness (DCI) comprised of decompression sickness (DCS) and arterial gas embolism (AGE) [26]. Formerly known as bend, DCS occurs when microbubbles are formed in the tissues and then released into the tissue uncontrollably during or after ascend to the sea surface without proper time for equilibration (decompression). A similar phenomenon could be seen when a soda bottle is opened; this is known as the effect of Boyle’s Law. Similarly, AGE is the release of gas into the systemic arterial circulation, typically after a pulmonary barotrauma.

There are two types of DCS, i.e. type 1 and type 2. Type 1 DCS is usually mild and typically manifest as musculoskeletal pain and mild cutaneous symptoms. Type 2 DCS is more severe and involve the cardiovascular system, lungs, or central nervous system. Clinical manifestations of DCS can be grouped as neurologic, inner ear, and cardiopulmonary. Symptoms of neurologic DCS include numbness, paresthesia muscle weakness, paralysis, etc. Inner ear DCS could be manifested as tinnitus, hearing loss, vertigo, nausea, vomiting and imbalance. The symptoms of cardiopulmonary DCS could be a dry cough, retrosternal pain, or dyspnea. Fortunately, DCS is a rare event when the divers follow the safe diving behavior. The incidence rate of DCI in recreational divers was estimated from 2.0 to 4.0 per 10,000 person dives. The lifetime incidence of DCI was increased in divers with less diving experience [27]. Recent report from the Diving Alert Network (DAN) showed that DCS was the second most common reason for calls to their medical center after ear and sinus barotrauma. The incidence of AGE is much lower than DCS [28].

3.4. Traumatic (Mechanical) Injuries
Traumatic injuries and deaths due to water-related accidents are much less frequent compared to road traffic accidents and drowning [29]. All watercrafts (boats, jet skis, yacht, etc.) can threat the rider’s and also other people in the water near these vessels while they are swimming, surfing, or even diving. Sudden maneuvers may result in serious collisions and cause fractures, soft tissue injuries or even drowning if passengers are ejected from the boat.

Acute injuries that may occur among recreational surfers are lacerations, contusions, sprains/strains, and fractures. Most of the injuries were caused by a collision with a surfboard, either with ones own board or another surfer’s board, or with the sea floor [30]. Risk of acute injuries increased during competitive surfing. Shoulder, ankle, head, and face are the most common site of injuries, affecting muscular, joint and skin tissue. Direct trauma may cause skin injuries, while maneuvers performed and repetitive actions may result in joint and muscular injuries [31].
Paddling is an activity that requires the use of a paddle to move a vessel through the water. This includes kayaking, canoeing, and rafting. Both arms and certain level of physical fitness are needed to do this recreational sport. Injuries that potentially occur when paddling include musculoskeletal injuries (sprain/strain, dislocations, fractures) and soft tissue injuries (lacerations, abrasions, contusions). The common site of injuries were head, neck, shoulders, lower extremities (foot, ankle, leg, knee, hip), and upper extremities (hand, wrist, arm) [32]. Knowing the risk factors and proper preparation may minimize the risk of injury and death [33].

Kite surfing is a new water sport, which combines the skill of wind surfing and water-skiing while hanging on a flying kite (figure 3). The kitesurfer is standing on a small surfboard and controlling the kite by using a control bar. The kite is connected to the kitesurfer by a harness and conveys wind energy to move the surfboard [34]. Most injuries involve the musculoskeletal system, ranging from ankle sprain to major bone fractures. Fractures of the upper and lower extremities may occur after hitting the kite boards [35]. Spinal and chest injuries can occur as well as shoulder dislocation and back pain when the kite surfer falls and hit the waves. Other injuries are skin lacerations, sunburn, and cranio-facial wound [36].

Another rare form of acute injuries is non-venomous animal attacks or bites. Shark can attack human when they are provoked or feel threatened by a swimmer. Shark attacks is increasing and coincide with increasing people using the ocean [37]. Attack by a moray eel has also been reported [38]. Other animals that could be dangerous include barracuda fish, electric fish, seals and sea lions, hippopotami, crocodiles and alligators, and piranhas.

3.5. Hypothermia
Immersion into the cold water (<10 °C) poses a life-threatening risk of cold-shock response and hypothermia. This could be the early process of drowning. When the body accidently falls into water colder than thermoneutral temperature (35 ± 0.5 °C), the initial physiological responses are skin cooling, followed by cooling of superficial nerves and limb muscles, and then cooling of deep tissues (hypothermia). Accidental hypothermia should be considered when a person has a history of cold exposure and an unintentional drop of core body temperature of less than 35 °C [39].

Hypothermia can occur in several occasions, like swimmers who are not wearing appropriate garment with heat insulation or boaters accidentally fall into cold water for a prolonged period of time. Hypothermia may cause loss of consciousness when deep body cooling continues and might be fatal. The signs and symptoms progressively occur from shivering, confusion, disorientation, introversion, amnesia, arrhythmias, cloud consciousness, loss of consciousness, ventricular fibrillation and death [40].

4. Risk Assessment and Pre-Travel Advice
Many travelers do not aware that water recreation may be risky and harmful. In addition, adventure activities are often take place in remote areas with minimal or no medical facility. Therefore, a pre-
travel visit with risk assessment is strongly advised to ensure safety and prevent health risks. An effective pre-travel consultation is a skill that one should master when communicating risks, offering advice and expect good outcomes (adherence) from the traveler [41]. Health risks can be further elaborated as absolute risk (baseline risk in average) and specific (individual risk factors). Risk assessment then should be followed with risk reduction strategy (any intervention, prophylaxis, and potential side effects). However, the final decision to accept the advice and other preventive measures depends on the traveler’s risk perception and tolerance [42].

Travel medicine physicians need to have proper knowledge about medical geography and skill to construct pre-travel advice. General assessment should consist of current medical problem (diabetes, hypertension, coronary heart disease, immunodeficiency, etc.), past illnesses, vaccination history, any allergy, any medication, and also a possibility of pregnancy or be pregnant for a woman during the trip. Risk assessment during pre-travel visit should include disease epidemiology, policy, medical condition, and travelers’ preferences [43]. A complete and accurate itinerary and activities should be obtained from the travelers. These include:

- A complete itinerary (countries, cities, specific places);
- Length of trip and length of stay in each city or place;
- Type of accommodation (luxury vs. budget hotel, camp, etc.);
- Type of activities (swimming, boating, scuba diving, etc.);
- Season, climate and weather forecast at the destinations.

Recommendations for water safety should be tailored according to the water-related destinations and the planned activities [21]. General message like avoiding any freshwater contact to prevent schistosomiasis should not be given. Swimming should only be done in the designated areas. Appropriate footwear should be advised while swimming in the sea or on the beach [44]. Pre-travel assessment is also best time to review vaccination history and booster. In particular, travelers should have adequate tetanus vaccination before departure.

Wearing personal floatation device (PFD) when playing in the water could prevent the incidence of drowning, especially in young children. Adult supervision is required and preferably is not done with alcohol consuming. Personal flotation device consists of lifejackets and other buoyancy devices that are designed to keep the wearer afloat. Children, recreational boaters, and water-sports participants who do activities in calm waters or near the seashore should use a PFD. The use of PFDs has been associated with reduce risk of drowning among boaters although the exact data may be difficult to obtain [45]. When the trip includes travels by boat, ensure that the company have enough PFDs in the vessel and has adequate communication tools whenever an emergency occurs. Do not travel in an overcrowded or undersized watercraft.

All divers should have adequate training and license from a well-recognized diving organization, such as Professional Association of Diving Instructors (PADI), Scuba Schools International (SSI), the National Association of Underwater Instructors (NAUI), Confédération Mondiale des Activités Subaquatiques (CMAS), Persatuan Olahraga Selam Seluruh Indonesia (POSSI) or Indonesian Subaquatic Sport Association, and so on. To prevent decompression illness, a recreational diver should dive conservatively, either using dive tables or computer. Insurance and safety information for divers can be found in the Diving Alert Network (DAN) website (www.diversalertnetwork.org). Divers with chronic diseases (such as hypertension or diabetes) should be check routinely cardiovascular fitness and other risk factors.

Proper training and education may well reduce the risks associated with adventure travel and water activities [46]. Swimming skill and paddling technique is needed in water sports. First aid kit or a personalized travel medical kit or should be considered consisting essential tool for treating illnesses and injuries [47]. People planning to do recreational water sports should also check their vessels and equipment, whether they are properly working and no damage. Lifejackets and helmets should be
provided. Weather should also be considered; operator may cancel all activities if water condition is dangerous.

5. Conclusion
Water recreation during holiday is increasingly common in our population. Activities within natural water environment, either freshwater or ocean water, may associated with environmental risk, infectious pathogens and traumatic injuries. Drowning, marine envenomation, and decompression sickness are the most common risks found during water recreational activities. Recreational activities involving water should be well planned before traveling and should not be a spontaneous action. Consuming alcohol beverages or narcotics before doing water activities should be strongly discouraged. A complete cardiovascular and pulmonary assessment may be required for people at risk of cardiovascular event. A personalized travel advice, appropriate training and education should be given to prevent morbidities and mortalities, especially when trying a new or unfamiliar type of water activity.

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