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# Assessment of Risk Factors for Injuries on Beaches

**J. Arturo Abraldes and Jorge Pérez-Gómez**

The purpose of this study was to examine the risk factors for injuries on a beach. It is important to know all the risk factors for injuries that can happen in a beach to prevent accidents. Risk factors were grouped in four main categories: beach morphology (BM), beach equipment (BE), lifeguard service (LS), and miscellaneous aspects (MA). All of them were evaluated according to their importance using a survey by Spanish and International experts. Descriptive analysis showed that LS is the main mechanism by which to reduce injuries on a beach. Lifeguard service in-service training is very important as are the affluence and activities developed by the beach patrons, the influences of weather and climate on the beach, and other infrastructures as risk factors for dangers on beaches. **Keywords:** prevention, security, aquatic activities, swimming.

The interest in aquatic activities is a social phenomenon that has increased in recent years, due to the increases in leisure time, according to the Spanish National Statistics Institute (2004). Over the last 10 years, Spanish people have spent around 48 min per day in sport practice or physical activities. During that same period, the number of people involved in the national federation of aquatic activities increased from 194,013 in 1993 to 267,125 in 2003.

The leisure time increases during holidays lead to a higher involvement in aquatic activities, especially during the summer and spring seasons due to the favorable climate conditions in Spain. This same increase in aquatic participation also can explain the increase in aquatic accidents (American Red Cross, 1995; Branche & Stewart, 2001; Brewster, 1995; Edmonds & Walker, 1999; Graver, 2004; Grenfell, 2002; Thanel, 1998; YMCA, 2001). An accident is defined as an important damage or injury to humans that is associated with high economic costs in some cases and that could have been prevented (Girsek, 1999; Langley, 2004; Saluja et al., 2004). According to the World Health Organization (2003), the most negative effects on health associated with the practice of aquatic activities are eye injury, lacerations, slipping and falling injuries, spinal cord injuries leading to paralysis, head injuries, and drowning.

Drowning, defined as the impossibility to breathe due to immersion in water, is the most serious problem related to beach and water use (Bierens, 2005; OMS,

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2003). Drowning is considered the second major cause of death around the world, with approximately 409,272 victims per year. It is second behind automobile accidents. In Europe annually there are a total of 30,322 drowning accidents, while there are 588 in Spain. These are the 4th leading cause of death and the 2nd most frequent cause in children from 1 to 4 years old (OMS, 2000; Peden & McGee, 2003).

These aquatic accidents are associated with a high economic cost, according to the United States Centers for Disease Control and Prevention (USCDCP). Each death has an estimated cost ranging from \$2,790,000 to \$3,610,000 USA dollars as a result of medical care, administrative cost, lost of productivity, and lost of quality of life to the victim. The cost of a disability associated with nonfatal aquatic accidents is between \$138,000 and \$181,000 USA dollars, plus \$15,000 US dollars per month for taking care of the person (Branche & Stewart, 2001; Mael, Seck, & Russell, 1998; National Safety Council, 2004). To our knowledge, there are no studies in Spain that had evaluated the economic cost of these aquatic accidents.

There is overwhelming agreement that active prevention measures are the far superior option for reducing accidents that occur in aquatic activities than rescues and responding to their occurrence (Bennett, Cummings, Quan, & Lewis, 1999; Bhide, Edmonds, & Tator, 2000; Bierens, 2005; Branche & Stewart, 2001; Brewster, 1995; Cohen & Swift, 1999; Hooper, Coggan, & Adams, 2003; Mael, Seck, & Russell, 1998; OMS, 2003; Palacios, 1998, 2000; Quan, Bennett, Cummings, Henderson, & Del Beccaro, 2001; Royal Life Saving Society Canada, 2003; Saluja et al., 2004; Thanel, 1998; Towner & Ward, 1998). There is insufficient evidence to show clear results (Pitt & Cass, 2001; Quan, Bennett, Cummings, Trusty, & Treser, 1998) because most of the studies are experimental approaches that have not included the majority of the critical variables, so the studies are not able to offer definitive or conclusive results (Dannenberg & Fowler, 1998).

The term "prevention" is understood as education and information to avoid accidents (Cohen & Swift, 1999). According to Haddon (1970), the prevention of an accident needs to include several actions and strategies that are oriented to the people, the reason for the accident, the physical and social environment just before, during, and after the accident occurred. For Runyan (1998), it is important to take into account some criteria related to the prevention of accidents like the effectiveness of the preventive measures adopted, the economic cost, and the preference of the community and the viability of the program. Cohen and Swift (1999), Haddon (1970), and Runyan (1998), understand "prevention" as the decisions, measurements, and preparations that are taken in a preventive way for avoiding an accident, and if an accident does happen, how to reduce its consequences.

There are no studies that have included all the events associated with accidents before, during, and after their occurrence. Palacios' definition (1998) discussed decisions that should be made before an accident to avoid it; however, this definition does not include the decisions that have to be made during or after the accident.

The preventive actions to avoid an accident can be grouped in three major groups: education, ambient modification, and legislation, according to Towner and Ward (1998). In the aquatic environment, Brewster (1995) differentiated six

major areas: preventive actions, special ways of operation, rules and regulations, maintenance of the installations, design of the infrastructures, and public education. The last item is considered the most important and all the campaigns of prevention described in the scientific literature consulted talk about it (Azeredo & Stephens-Stidham, 2003; Bennett, Cummings, Quand, & Lewis, 1999; Bhide, Edmonds, & Tator, 2000; Frederick, Bixby, Orzel, Stewart-Brown, & Willet, 2000; Green & Hart, 1998; Mitchell & Haddrill, 2004; O'Flaherty & Pirie, 1997; Quan et al., 2001; Sznajder et al., 2003).

The signs and the boards of information are a form of education in situ to the public. They are considered as an extremely valuable measure, since many bathers are tourists who are not familiar with the environment, because they come from places where there are no beaches or because the characteristics of the beaches are different and maybe the panels are the only way to get information about the private dangers of the beach (Brewster, 1995). For that reason, signs have to be there showing clearly the main rules, recommendations, and dangers.

One of the key means to diminish the risk of accidents at beaches is to take into account the environment in which they happen, because aquatic environments are constantly changing (Short & Hogan, 1994). In Table 1, it is possible to observe the specificity of risks at beaches compared with other aquatic environments (Brewster, 1995).

According to Short (2001), the term "risk factors" refers to ambient elements present at a beach that expose people to dangerous situations or risk (Table 2). To analyze the danger and risk factors at a beach, we have designed a data collection instrument that consists of some systematized registration records (Anguera et al., 1998). These records are complimented by direct observation in situ by a couple

**Table 1 Comparison Between Beaches and Other Aquatic Sport Facilities (Brewster, 1995)**

| Variables                      | Swimming Pools/Aquatic Parks  | Beaches  |
|--------------------------------|---|--|
| Water temperature              | It could be controlled  | Depending of natural conditions                            |
| Water transparency             | Controlled  | Depending of natural conditions                            |
| Difficulty of saving           | There is contact with the subject immediately entering the water or swimming short distance | It could require long distances and in adverse conditions  |
| Natural dangers                | None  | They could be large ones and, sometimes, not visible       |
| Water currents and wave action | None or predictable and completely controllable   | The waves and current are frequent, and could be the major |
| Level and hours of occupation  | It could be controlled  | Generally, it could not be controlled                      |
| Atmospheric conditions         | Low effect  | Possible severe effect                                     |

of experts with experience in the area. This instrument has been adapted from others that already were validated (Palacios, 1998; Palacios, Abalades, Sánchez, & Barbeito, 2005; Palacios et al., 2004), enlarging the contents to evaluate from the diverse information that we found in the international literature (Brewster, 1995; Graver, 2004; Méndez, 2000; Royal Life Saving Society Canada, 2003; Short, 1993, 2001). The document of registration is divided into five large blocks: demographic information, beach morphology, beach facilities and equipment, lifeguarding services, and miscellaneous aspects.

General demographic information about the beach includes the province, the municipality, the name of the beach, if it possessed any distinctive or idiosyncratic qualities, as well as the exact date and hour of the start of the observation. Beach morphology (Table 3) involves all the aspects related to morphology and beach physical factors. This category is divided in three subcategories: dry zone, water zone, and common criteria. Beach facilities and equipment (Table 4) involves all the points in relation to the infrastructure (e.g., access, parking, supply of water, water, and tidal characteristics) and the utilities (e.g., bar, sailing clubs, tourist information). Lifeguarding services (Table 5) includes all the aspects in relation to the lifeguarding services of the beach and is divided in three categories: human resources, material resources, and evacuation plans. With miscellaneous aspects (Table 6), we grouped several miscellaneous elements such as weather conditions and beachgoers activities. Because no existing consensus existed among the important factors in relation to their effect on dangers and risks at a beach, we suggest the need to evaluate these factors as a mechanism for determining the dangers and risks associated with specific beaches.

## Method

The explanation for the risk factors related to injuries at a beach was carried out by the administration of a survey to Spanish and foreign experts in this area. The experts were selected based on several factors that included type of doctoral degrees, certification in rescue and life-saving for three years, or experience as coordinator of lifesaving for an aquatic facility.

The evaluation sheet quantified, with a rating from one to five, the blocks and variables indicating their incidence on the risks at the beach. Thirty-one experts participated in the study, 24 Spanish and 7 internationals. The statistic analysis done was descriptive (averages, frequencies, and percentages of each one of the variables and blocks). We sent the project by mail and e-mail with a page in which the experts should evaluate each variable included in the project by rating them

**Table 2 Relative Ratings of Environmental Risk Factors of Beaches**

| Risk factors             | Ratings |
|--------------------------|---------|
| 1. Beach Morphology      | 28.79%  |
| 2. Beach Equipment       | 15.15%  |
| 3. Lifeguarding service  | 31.82%  |
| 4. Miscellaneous aspects | 24.24%  |

**Table 3 Resources Available as Components of Beach Morphology**

|                            |        |        |
|----------------------------|--------|--------|
| (a) Dry Zone               |        | 27.27% |
| sand                       | 37.04% |        |
| rock                       | 62.96% |        |
| (b) Water Zone             |        | 48.48% |
| surface                    | 23.53% |        |
| sea floor                  | 29.41% |        |
| currents, waves, and tides | 47.06% |        |
| (c) Common criteria        |        | 24.24% |
| fauna                      | 30.00% |        |
| flora                      | 23.33% |        |
| recreational equipment     | 46.67% |        |

**Table 4 Resources Related to Beach Equipment**

|                     |        |        |
|---------------------|--------|--------|
| (a) Infrastructure  |        | 43.75% |
| access              | 35.71% |        |
| supplies            | 25.00% |        |
| hygiene             | 39.29% |        |
| (b) Utilities       |        | 56.25% |
| hotel business      | 12.28% |        |
| nautical activities | 26.32% |        |
| tourist information | 19.30% |        |
| cleaning utilities  | 22.81% |        |
| public security     | 19.30% |        |

from 1 to 5. After getting an evaluation from the experts, we combined the ratings and established a risk rating for each variable analyzed.

The data were analyzed with the software package Microsoft Excel 2003 for Windows, version XP. The descriptive analysis was done on each variable in the study, so we identified the important risks and/or dangers associated with each variable.

## Results

A survey of data (Survey 1) was used to obtain the results.

## Discussion and Conclusion

We had located very few studies in the literature that related to valid and reliable tools for assessing the risk factors for injuries on beaches. Therefore it was important to develop a tool that can be applied to evaluate different beach environments.

**Table 5 Relative Resources Related to Beach Lifeguarding Services**

|                        |        |        |
|------------------------|--------|--------|
| (a) Human resources    |        | 36.84% |
| professional training  | 37.74% |        |
| experience             | 30.19% |        |
| job conditions         | 32.08% |        |
| (b) Material Resources |        | 31.58% |
| prevention material    | 24.24% |        |
| scanning materials     | 24.24% |        |
| rescue materials       | 25.76% |        |
| first aid materials    | 25.76% |        |
| (c) Planning           |        | 31.58% |
| action protocol        | 54.29% |        |
| evacuation resources   | 45.76% |        |

**Table 6 Relative Resources Related to Miscellaneous Aspects**

|                              |        |        |
|------------------------------|--------|--------|
| (a) Weather conditions       |        | 40.74% |
| temperature                  | 37.84% |        |
| wind                         | 35.14% |        |
| other atmospheric conditions | 27.03% |        |
| (b) Beachgoers               |        | 59.26% |
| flow                         | 51.61% |        |
| activities                   | 48.39% |        |

The tool that we developed mainly assessed the structural risk factors on beaches using 4 main components: beach morphology, beach equipment, lifeguarding service, and miscellaneous aspects.

According to the experts we surveyed, the lifeguard service was the single most important component on a beach that could prevent injuries and accidents, slightly followed by beach morphology, miscellaneous aspects, and beach equipment. In the beach morphology, not surprisingly, the water area was considered more dangerous than the dry area. Related to the beach equipment, the available utilities were considered more important than the other aspects of infrastructure. Within the elements related to the lifeguard service, the human resources and its formation were considered the most important elements as a proactive means to decrease the dangers and risks at beaches. In the miscellaneous aspects, the characteristics of beachgoers were rated as more important than weather conditions.

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## Appendix

### Survey 1

#### Evaluation of the Beach Risk Factors by Experts

The present document tries to evaluate the factors that affect beach hazards. These factors can contribute to the danger of a beach by being present (for example, the presence of rip currents) or by being absent (for example, the absence of lifeguards in a beach). Because there are a lot of factors to consider, we have classified them in four categories of information:

1. **Beach Morphology:** This category involves all the aspects related with morphology and beach physical factors. This category is divided in three points: dry zone, water zone, and common criteria.
2. **Beach Equipment:** This category involves all the points in relation to the infrastructure (access, parking, supply of water, water closed) and the utilities (bar, sailing clubs, tourist information).
3. **Lifeguarding service:** Here are included all the aspects related to the lifeguarding service of the beach. Its analysis is divided in three blocks: human resources, material resources, and evacuation plans.
4. **Miscellaneous aspects:** In this point, we group several aspects based on weather conditions and beachgoers' activities.

Regarding this information, please value every one of these points in relation to the importance to you on the risk of injury on a beach. You should fill in the boxes with a number between one and five (1–5). Don't forget that one means very low danger and five means very high danger.

Going deeply in each one of the categories previously discussed, please indicate your valuation about the criteria of every one of the categories/

**Beach Morphology:** This point involves all the angles in relation with the relief and the orography. We divide its analysis in three great blocks:

(a) **Dry zone:** It includes all the factors of the part of the beach that is not covered by water. Principally sand and rocks. In this point we center in texture, thickness, the presence of cliffs, etc.

(b) **Water zone:** It involves all the points of the part of the beach covered by the sea. We distinguish three zones: surface, sea floor and waves, currents and tides.

(c) **Common criteria:** In this point all the elements that could be find in the two zones are analyzed. These are fauna, flora, and recreational equipment.

Please indicate in the box the level of danger that have for you the presence of the criteria cited and also the relevant points of each one of them. A value of 1 means very low danger and 5 means very high danger.

- a) Dry Zone .....
- sand .....
- rock .....
- b) Water Zone .....
- surface .....
- sea floor .....
- currents, waves, and tides .....
- c) Common criteria .....
- fauna .....
- flora .....
- recreational equipment .....

**Beach Equipment:** In this point, all the criteria in relation with the infrastructure (access, parking, water supply, water closed) and utilities (bar, nautical clubs, tourists information) that can be found in a beach are included.

(a) Infrastructure: It involves all these resources built in a beach by human to secure better conditions of accessibility (promenades, beach access, parking), supplies (water, public telephones), and hygiene (water closed, bins).

(b) Utilities: Here there are included all the complements that a beach should have. In these we include hotel business, nautical activities, tourist information, cleaning utilities, and public security.

Please evaluate in the boxes below the influence that the absence of these aspects have in the danger of a beach by the same way that previous point. Remember that 1 means very low danger and 5 means very high danger.

- a) Infrastructure .....
- access .....
- supplies .....
- hygiene .....
- b) Utilities .....
- hotel business .....
- nautical activities .....
- tourist information .....
- cleaning utilities .....
- public security .....

**Lifeguarding Service:** Included are all the elements that are a part of the lifeguarding service.

(a) Human resources: Included are the elements in relation to the staff of the lifeguarding service: professional training, experience, and job conditions.

(b) Material resources: Included are all the materials related to the lifeguarding service. These are grouped in relation to their function:

• Prevention materials: items for the purpose of informing, warning, and providing the characteristics, hazards, and rules of behavior to avoid accidents and injuries.

• Scanning materials: Here are included all the materials that have the purpose of assisting the lifeguard with scanning of the beach.

• Rescue materials: Here we analyze all the materials used for undertaking an aquatic rescue.

• First aid materials: Here we analyze all the materials that are used for providing first aid.

(c) Planning: Included here are all items considered in the organization of a rescue. Principally this analysis centers on the action protocol and the evacuation resources of the lifeguarding service.

Please evaluate the absence of these factors with a number between 1 and 5, where one means very low danger and 5 means very high danger.

- a) Human resources . . . . .
- professional training . . . . .
- experience . . . . .
- job conditions . . . . .
- b) Material resources . . . . .
- prevention material . . . . .
- scanning materials . . . . .
- rescue materials . . . . .
- first aid materials . . . . .
- c) Planning . . . . .
- action protocol . . . . .
- evacuation resources . . . . .

(d) Miscellaneous aspects: In this point we consider all the elements of the beach that are punctual and change depending of a serial of circumstances that could increase or decrease the danger of the beach:

**Weather conditions:** This involves the atmospherics conditions of the zone. We emphasize environment and aquatic temperature, wind, and also other atmospheric conditions that affect the risk of injury in the beach (humidity, rain, fog).

**Beachgoers:** Here is registered all the variables related to beachgoers. We analyze principally the number of beachgoers and their activities at the beach.

Please evaluate these points in the same way as in previous points: 1 means very low danger and 5 means very high danger.

- a) Weather conditions . . . . .
- temperature . . . . .
- wind . . . . .
- other atmospheric conditions . . . . .
- b) Beachgoers . . . . .

- flow .....
- activities .....

Remarks:

Other Experts: (If you know another expert in this topic, who could contribute to this, please give us his address in the blank below).