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# Surf Bather Drowning Risk and Exposure-Related Factors Identified by an Expert Panel

**Damian Morgan and Joan Ozanne-Smith**

In the absence of an established literature, identifying and quantifying surf bather drowning risk factors requires a clearly defined problem-focused research strategy. To initiate this strategy, nominal group technique (NGT) was used to identify and rank risk and water exposure-related factors based on consensus of an expert panel. The results identified, in order, level of experience (encompassing swimming ability in surf conditions), lack of local knowledge (encompassing awareness of surf hazards, including rip currents), and surf conditions (encompassing prevailing wave height and rip currents) as the three most influential surf bather drowning risk factors. Factors most influential on exposure to water were identified and ranked as prevailing weather geographic location (encompassing bather accessibility to the beach), and infrastructure (encompassing the presence of artificial beach amenities). This study provides direction for future analytic epidemiological research and complementary studies on drowning at surf beaches and other locations.

**Keywords:** drowning, beach, risk factors, water exposure, nominal group technique.

Surf bather drowning is a significant injury problem for many countries with wave-dominated beaches and amenable swimming conditions (e.g., Blay, 2011; Hartmann, 2006; Klein, Santana, Diehl, & de Menezes, 2003; Lushine, Fletemeyer, & Dean, 1999; Morgan, Ozanne-Smith, & Triggs, 2008). Specific presumed risk factors associated with surf bather drowning include exposure to rip currents, limited surf-swimming experience, fitness for bathing, and contemporaneous intake of alcohol with swimming (e.g., Gensini & Ashley, 2010; Harada, Goto, & Nathanson, 2011; McCool, Moran, Ameratunga, & Robinson 2008; Morgan, Ozanne-Smith, & Triggs, 2009a); however, evidence substantiating the risk contributions made by these and other surf bather drowning-associated factors is limited or absent.

Studies of rip currents conducted by surf beach drowning researchers highlight the availability of important but limited evidence. The environmental phenomena of rip currents form in the presence of breaking waves (Short, 1996). Smith and Largier (1995, p. 10974) define rip currents as episodic events characterized by

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“intense, narrow, seaward flow of water from the surf zone.” Anecdotal evidence, reported as observations from ecological studies, intimate that rip currents present a drowning hazard for surf bathers by moving them involuntarily to deeper water farther from shore (Blay, 2011; Gensini & Ashley, 2010; Harada et al., 2011; Houser, Barrett, & Labude, 2011; Morgan et al., 2008).

Although knowledge of surf bather hazards such as rip currents has obvious value for drowning prevention, their identification fails to establish or quantify drowning risk at the individual, group, or population levels. Moreover, it is not clear whether the presence of person or situational factors alters the risk posed by the hazard (e.g., a strong swimmer caught in a rip current or CPR availability upon rescue). More precise information is required to better understand this injury problem by identification of candidate factors associated with surf bather drowning risk and water exposure. Hence, the objective of this study was to generate a list of factors, ranked by influence, associated with surf bather drowning. Data were generated from an expert panel with the intention to inform future analytic studies. The study is set in Victoria, Australia. Victoria’s coastline extends some 1,230 km, 66% of which comprises 588 ocean beaches (Short, 1996). Eleven coastal drownings were reported in Victoria for the year ending 30 June 2011 (Surf Life Saving Australia, 2011).

## **Methodological Issues Associated With Identifying Surf Bather Drowning Risk**

Identifying and quantifying surf bather drowning risk requires clearly defined problem-focused research. The approach is ideally based on rigorous scientific methods that establish the roles played by hypothesized factors associated with the injury problem. Improved theoretical understanding should, in turn, provide the opportunity to propose, develop, and assess targeted surf bather drowning countermeasures. The inherent complexity of this research problem is demonstrated by the application of accident causation models. Such models may be used to identify possible factors relevant to surf bather drowning events.

An accident (injury) causation model described by Segui-Gomez and Baker (2009, p. 639) can be used to explain surf bather drowning as the outcome following a sequence of events. The event sequence is: exposure→event→injury→death. Each step in the sequence involves risk factors. For example, an exposure risk factor may be accessibility to water, an event risk factor may be wave conditions, an injury risk factor may be swimming ability, and a death risk factor may be absence of rescue services. Meeuwisse (1994) proposed a similar framework for sport injury where outcome-distant intrinsic risk factors (i.e., associated with the individual) predispose the athlete to injury. Exposure to extrinsic risk factors (i.e., associated with the environment) are sequenced closer to the event. Meeuwisse (p. 168) states the following:

The presence of both intrinsic and extrinsic factors may render the athlete susceptible to injury but . . . are not usually sufficient for injury to occur. Rather, these factors sum or interact effectively to make the athlete “an accident waiting to happen.”

Meeuwisse (1994) refers to these factors as part of the web of causation, the end result being an event causing injury. When analyzing sports injury, Meeuwisse (pp. 168–169) argued that too often, the focus falls on the event and injury mechanism but “little attention tends to be paid to the other factors that are distant from the outcome and preceded the inciting event.”

Analytic epidemiological research designs have the capacity to identify and quantify drowning risk from intrinsic and extrinsic factors (e.g., Brenner et al., 2009). Applying analytic studies to investigate surf bather drowning, however, presents several difficulties. First, the researcher must determine candidate factors to investigate and confounding factors to control. With limited descriptive research available for the at-risk population, this selection is not clear. Moreover, research effort may be wasted where uncontrolled or unknown factors confound results. For example, assessing the role of swimming ability in surf bather drowning against a nondrowning control group should logically account for factors such as gender, confidence, health status, water conditions, or bathing in supervised zones. Without control of confounding variables, findings will be open to competing explanations with little substantial knowledge gain.

Second, securing internal validity through control of numerous variables requires substantial study size and research effort. Even where a risk factor is established, further research would likely be required to develop and test an effective countermeasure (e.g., suitability of training type to increase swimming ability). This point emphasizes the need for cost effective research methods to identify injury risk factors to better target more costly, resource intensive epidemiological research.

A third research difficulty is associated with defining exposure to situational risk factors. For example, a study may compare beach drowning risk for bather groups aged below 30 years and 30 years and over for a defined period. Assume that both groups sustained identical drowning frequencies. If the younger aged group had double the frequency of immersions, then, based on this exposure measure, the older group would be judged to have twice the risk of drowning. But if exposure was defined by duration, and the older group spent on average four times longer in the water (compared with the younger group) per immersion, then the older bathers would be judged as having relatively lower drowning risk. As a further complication, studies may require risk exposure precision by accounting for location factors (e.g., deep water or shallow) or prevailing sea and water conditions. Therefore, before determining the most suitable definition for exposure, it may be beneficial to better understand situational factors that influence bathing at the population level, particularly where they may be associated directly with drowning risk (e.g., wave size).

The fourth difficulty surrounds whether the factor of interest is a drowning cause or simply marks an underlying cause. For example, the finding that recreational drowning appears to be more frequent over summer months is probably explained by more frequent exposure to water rather than air temperature being a causal factor (Dwight, Brinks, SharavanaKumar, & Semenza, 2007). Alternatively, persons from specific ethnic background may be marked as having higher drowning risk whereas the causal factor may be related to surf swimming familiarity or swimming ability. Both causal factors and markers may provide suitable targets for intervention (Morgan, 2006a).

## Method

The study method followed the nominal group technique (NGT). NGT provides for a structured meeting to identify, group and evaluate relevant facts, opinions, and ideas (Delbecq, Van de Ven, & Gustafson, 1975). Known also as an expert panel, the method is an appropriate source of health-related information where statistical data or controlled studies are limited or inadequate for meta-analysis (Jones & Hunter, 1995).

The chief advantage of the NGT method resides in the facilitation of structured outcomes with control of panel bias (Delbecq et al., 1975). The method is similar to the better known Delphi technique, the primary difference being that the NGT involves face-to-face interaction. Although panel member anonymity provided by Delphi is designed to improve judgment accuracy, possible disadvantages include a loss of flexibility, problem insight, and direct feedback provided by panel members' face-to-face communication of ideas, inconsistent interpretation of questions, panel members' feelings of limited responsibility for the end result, and bias introduced through low compliance or withdrawal of panel members (Murray, 1979; Woudenberg, 1991). In this study, potential bias in the method that results from nonanonymity was counteracted, at least partially, through use of specialized recording equipment known as the Zing group-computer software system. This system links all panel participants via individual key boards connected to a common work space (split into a panel space and consensus space) appearing on a projected computer screen. Computer assisted data collection allows participant responses to be listed anonymously, reduces substantially the time required for the NGT process, and provides for more intensive panel interaction (Dowling & St. Louis, 2000; Willcox & Zuber-Skerritt, 2003).

Eight representatives from selected Victorian organizations comprised the expert panel. All were involved directly in beach safety and beach management or had relevant expertise and experience in related areas including injury prevention. Panel members were seated around a large table facing a computer projected screen.

Each panel member had a keyboard for submitting typed responses. Following a general explanation of the research investigation, the panel provided responses to three questions on local beaches, beach attributes, and characteristics of users. These questions were intended to focus panel members' attention on the research topic (surf beaches and their users), to promote panel interaction, and to allow time for familiarization with the computer system. The remainder of the session (approximately two hours) was used to focus on two research questions (listed in the next section), following the five stage process proscribed by the NGT method for each question.

Stage 1: The research question was presented and explained. Clarification of the research question was provided to the panel by the moderator (first listed author). All panel members were required to indicate that they understood the research question.

Stage 2: Following a short period of reflection on the question, panel members submitted individual responses (no limit) via their keyboard. Responses from all panel members were collated in the panel space on the projected screen.

Stage 3: In turn, panel members read aloud each individual response listed in the panel space. A brief explanation of the response was provided by someone within the panel to ensure all panel members were clear on the meaning. The moderator then discussed suitable expressions that encapsulated the individual response (termed a “panel response”). When the panel reached consensus on a suitable panel response, this was listed in the consensus space of the projected screen. The panel then determined by discussion whether listed panel responses sufficiently overlapped or subsumed subsequent individual responses. Individual responses considered to differ from panel responses by any panel member were listed as a separate panel response. Following categorization of all individual responses into panel responses, the moderator requested further relevant responses not covered in the listed panel responses (which may have come to mind during this stage).

Stage 4: The panel response list was read aloud to the panel. Following this, panel members individually ranked the panel responses according to their strength of influence with respect to the question (detailed next section). Panel members completed this task firstly on paper (to provide a record in case of technical problems) and then via the keyboard using the Zing group-computer.

Stage 5: The moderator summed ranks for each panel response using the Zing group-computer inbuilt software. The lowest score was considered by panel consensus as the most influential element with respect to the research question, the second lowest the next most influential, and so on. The moderator presented results to the panel. Standard deviations of ranked scores were calculated manually following the session.

## Research Questions Put to the Expert Panel

The expert panel responded to two questions in turn. The first elicited information on factors associated with exposure to surf bathing and the second on factors associated with the risk of surf bather drowning.

1. What factors influence the level of surf beach use by swimmers, surfers, and other water users?
2. What factors influence swimmers, surfers, and other water users' risk of drowning at surf beaches?

## Panel Category Ranking

In stage 4 of the NGT process, panel members ranked the panel response according to the criteria listed below:

Study question 1—a rank of 1 was given to the panel response considered to provide the strongest influence on the level of surf beach use along the Victorian coastline by swimmers, surfers, and other water users, followed by a rank of 2 for the second strongest influence and so on until all panel responses were ranked.

Study question 2—a rank of 1 was given to the panel response considered to present the greatest influence on drowning risk to swimmers, surfers, and other water

users at surf beaches along the Victorian coastline, followed by a rank of 2 for the second greatest influence to drowning risk and so on until all panel responses were ranked.

## Results

Tables 1 and 2 present the overall panel response rank, mean rank score, standard deviation score, panel response, and individual responses subsumed by panel responses for questions 1 and 2, respectively. Panel responses without corresponding individual responses were added in stage 3 of the NGT process.

Research question 1 generated 130 individual responses. Individual responses were subsequently grouped into 19 panel responses plus 1 addition (information) in stage 3. Following ranking, the weather was deemed by panel consensus to be the most influential factor on the level of use by surf beach bathers. This panel response included individual responses for temperature and weather forecasts. The next ranked panel responses in order were the geographic location of the beach (linked to proximity of users and accessibility), infrastructure available at the beach (referring to artificial amenities), and surf conditions (pertaining to hydrological features including swell characteristics). Standard deviations provide an indication of rank agreements among the panel, though these scores should be treated with caution due to the small sample size. The lowest standard deviations and hence highest rank agreement were found on the first two ranked factors, weather and geographic location.

For research question 2, 85 individual responses were grouped into 17 panel responses plus 1 addition (gender) in stage 3. The panel response term level of experience was ranked as the most influential on drowning risk to swimmers, surfers, and other water users. This term was associated largely with individual responses related to swimming ability and water competence. The term was followed in rank order by lack of local knowledge (which encompassed limited levels of surf experience, awareness of surf beach hazards and water safety knowledge), surf conditions (e.g., wave height, dumping waves, rips), and no life saving services. As for Table 1, the lowest standard deviations and hence highest rank agreement listed in Table 2 were for the first two ranked factors, level of experience and lack of local knowledge.

## Discussion

The results provide consensus lists of factors considered by an expert panel to influence surf beach use and drowning risk for surf bathers at Victorian surf beaches. Identified factors that influence beach use by surf bathers broadly equate with variables identified by previous beach use studies in Australia and other countries (e.g., De Ruyck, Soares, & McLachlan, 1997; Micallef & Williams, 2004; Mercer, 1972; Morgan, 1999; Wolch & Zhang, 2004). The influence of weather on bathing is supported by Dwight et al.'s (2007) report of life guard visitation estimates for two beaches in Southern California. Bathing rates (the number of water exposure events) for a five-year period ranged from 26% in winter (January) to 54% in summer (August). Beach accessibility and amenities can be assumed to motivate or

**Table 1 Panel Ranking of Factors That Influence Surf Beach Use by Surf Bathers in Victoria**

<b>Rank (Mean/ SD)</b>	<b>Panel Response</b>	<b>Individual Responses—130—(Multiple Responses in Parentheses)</b>
1 (2.9/2.6)	Weather	weather (5); temperature; weather forecasts.
2 (4.5/2.6)	Geographic location	proximity to Melbourne; remoteness (2); proximity to home; accessible; travel time to the beach; distance from home or accommodation.
3 (6.3/4.6)	Infrastructure	facilities; site development; toilets (4); car parks (4); available facilities; coffee shop close-by (2); conditions of toilets; amenities; parking (2); parking costs; showers; food; change rooms (3); public transport; kiosk facilities; public telephone or mobile phone access.
4 (7.1/3.3)	Surf conditions	surf conditions; swell direction; good surf (2); tide; type of surf; ocean characteristics; wave type; big waves; good surf; knowledge of changes; type of surf; good wave.
5 (7.9/3.6)	Familiarity with beaches	knowledge of venue; fishing experience.
<b>6 equal</b> (8.6/5.5)	Physical beach characteristics	beach space; type of surfers (short boards/long boards); good beach; water conditions suitable for planned activity; clean water; shade; EPA beach reports; clean; attractive/scenic; sandy; beach suitable for a number of ages; absence of rips; good for children; how well beach is managed; amenity of beach; type of beach.
<b>6 equal</b> (8.6/6.0)	Life saving services	life saving services; patrolled beach (3); rescue facilities; rescue services; presences of lifesavers.
8 (10.3/3.1)	Social reasons	friends; visiting with friends; group consensus.
9 (10.5/6.2)	Physical safety characteristics	dangerous rips; beach safety; safe (2); no needles on beach; danger/ hazard rating; dangerous currents; signage; regular beach cleaning.

*(continued)*



**Table 1 (continued)**

<b>Rank (Mean/ SD)</b>	<b>Panel Response</b>	<b>Individual Responses—130—(Multiple Responses in Parentheses)</b>
<b>10</b> (11.5/5.5)	Day of week	day of week; holidays/weekends; weekend vs. weekday.
<b>11</b> (11.6/5.1)	Psychological motivation	excitement of surfing experience; popularity/ image of the beach; getting away from city; reputation; advertising; pleasant memories from previous visits; Internet information—e.g., surfshop.com; reputation; tourist information.
<b>12</b> (12.0/4.4)	Number of people at beach	crowds; population usage; popularity; not crowded; amount of other users; no swimmers; number of other users; number of swimmers present (not crowded).
<b>13 equal</b> (12.1/7.2)	Accommodation	holiday homes; proximity to accommodation; close to residence or holiday residence; camping holiday; traditional holiday site; holiday site.
<b>13 equal</b> (12.1/5.6)	Time of day	time of day.
<b>15</b> (12.4/5.7)	Activities allowable	recreation; range of activities offered; use of surf riding equipment; boat ramp; activities; boat and surf equipment hire.
<b>16</b> (12.5/3.6)	Wind direction	wind direction; protection from prevailing winds.
<b>17</b> (12.6/5.9)	Road infrastructure	accessibility; easy access (2).
<b>18</b> (14.0/3.2)	Demographics of surrounding area	demographics of area.
<b>19</b> (16.0/4.9)	Experience level	experience of user.
<b>20</b> (16.5/6.3)	Information available	

*Note:* *SD*—standard deviation; 1 = strongest influence to 20 = weakest influence.

**Table 2 Panel Ranking of Factors Influencing the Drowning Risk for Surf Bathers at Victorian Beaches**

<b>Rank (Mean/ SD)</b>	<b>Panel Response</b>	<b>Individual Responses—85—(Multiple Responses in Parentheses)</b>
<b>1</b> (2.1/2.0)	Level of experience	swimming experience; level of experience; lack of swimming experience; ability to swim (3); skill level of user; overestimation of own ability; not understanding the weather; hitting submerged reef or sandbank; personal skill level; experience in surf conditions; think they can swim; lack of understanding of rips; person not brought up in beach culture; person used to swimming in rivers; knowledge of correct use and competence in using craft.
<b>2</b> (3.0/2.5)	Lack of local knowledge	lack of local knowledge; ignorance of dangers/ hazards; lack of information about danger zones (rips etc); knowledge of location; level of knowledge of water safety; being unfamiliar at the beach; no understanding of water conditions; knowledge of water safety; ability to find a patrolled location; not familiar with the beach; being a tourist.
<b>3</b> (7.1/5.0)	Surf conditions	size of waves; rips; surf conditions; weather (2); dangerous conditions; height of waves; off-shore wind; dumping waves
<b>4</b> (7.6/4.8)	No life saving services	nonpatrolled area; availability of life saving services (3); lack of patrols; lack of emergency rescue services; not enough lifeguards.
<b>5</b> (8.5/4.3)	Swimming alone	swimming alone; swimming with a friend.
<b>6</b> (9.0/4.4)	Physical beach characteristics	reef break or beach break; submerged objects; amount of rips/ dangerous currents; conflicting activities; relative safety of water environment at venue; amount and intensity of rips; hazards.
<b>7</b> (9.8/3.3)	Signage	poor signage; lack of safety signs; bad signage; signage (2).
<b>8</b> (9.8/4.8)	Alcohol and other drugs	drinking; alcohol (2); drinking alcohol; influence of alcohol/ drugs.

*(continued)*

**Table 2 (continued)**

<b>Rank (Mean/SD)</b>	<b>Panel Response</b>	<b>Individual Responses—85—(Multiple Responses in Parentheses)</b>
<b>9</b> (9.9/4.9)	Social behaviors	hoolligan behavior; parental supervision.
<b>10</b> (10.5/5.0)	Equipment	surfer has helmet or not; faulty equipment; equipment (leg rope); loss of leg rope; lack of swimming aids; equipment being used; no PFDs; lack of personal alerting devices; no life jacket on board.
<b>11</b> (10.6/6.0)	Gender	
<b>12</b> (10.9/7.8)	Distance from shore	distance from shore.
<b>13 equal</b> (11.3/4.9)	Personal fitness	fitness of the surfer; health of swimmer;
<b>14 equal</b> (11.3/3.8)	Proximity to other users	swimmers feel safer when other surfers around.
<b>15</b> (11.4/4.2)	Warning information	lack or warnings
<b>16</b> (12.3/3.9)	Conflict among activities	swimmers being hit by surfboards
<b>17</b> (12.8/4.1)	Infrastructure	inappropriately placed car parks; car park near rip.
<b>18</b> (13.4/3.5)	Crowding	number of surfers in the water; amount of other users; risk of being hit by other surfboards.

*Note:* SD—standard deviation; 1 = greatest influence to 18 = weakest influence.

enable bathing at beach locations. It follows that increased beach bather visitation facilitated by warm temperatures, improved beach access, or new facilities raise implications for safety service resourcing.

Factors specified to influence the risk of drowning correspond to those commonly listed in safety messages or open water drowning prevention guidelines provided by life saving agencies or identified by research (Moran, Quan, Franklin, & Bennett, 2011; Morgan, 2006a; Quan, Bennett, Moran, & Bierens, 2012). Further, identified factors including level of experience (encompassing swimming ability), lack of local knowledge (encompassing surf hazard awareness), no lifesaving services (i.e., drowning risk posed by bathing in unpatrolled areas or times) and use of alcohol have been studied in surf bather populations, for the most part by self-report (e.g., Ballantyne, Carr, & Hughes, 2005; Manolios & Mackie, 1988; McCool, Moran, Ameratunga, & Robinson, 2008; Mitchell & Haddrill, 2004; Morgan et al., 2009a; Sherker, Williamson, Hatfield, Brander, & Hayen, 2010; White & Hyde, 2010). However, the majority of relevant studies have not assessed or controlled for bather responses across varying sea or water conditions (e.g., wave height). Hence, the validity of previous study results should be considered in light of prevailing surf conditions being ranked in the current study as the third greatest influence on drowning risk (Table 2).

## Implications for Research

Factors influencing beach use (Table 1) shape the bather population size and composition exposed to causal risk factors. Future studies may need to account for these exposure components to capture the heterogeneity of users within the surf bather population. Surf bather research should also consider whether causal risk factors are modifiable and how they may interact. For example, the interaction between prevailing surf conditions and swimming ability may be necessary to cause drowning, but only the latter factor is modifiable through training or by locating bathers within supervised zones (Morgan, 2006b).

This study has more specific implications for future research. Analytic epidemiological studies could be used to determine the contributions of the three highest candidate drowning risk factors (encompassing, respectively, surf swimming ability, hazard awareness, and surf conditions) to surf bather drowning events. Ideally, the remaining factors would be accounted for or controlled either a priori or by direct measurement. Research design options may include controlled experiments in wave pools or case-control studies possibly using rescues as a proxy drowning measure. The difficulty here for the latter design is identifying and recruiting suitable controls. Although challenging to implement, these studies would provide evidence for risk factor contributions to surf bather drowning to facilitate better targeted countermeasures.

As suggested earlier, measuring exposure to water in epidemiological research is more complex. The identified factors may indicate influences at the population levels but further research is required to determine and measure specific bathing behaviors of individuals and groups within the at-risk population (Morgan, Ozanne-Smith, & Triggs, 2009b). Nevertheless, factors identified in this study provide a guide to general influence on exposure to water and subsequent drowning risk.

## Limitations

The validity and reliability of the study results are contextualized by potential limitations. Firstly, the study results provide subjective data from eight persons. The small sample size may have limited the potential scope of responses. Secondly, individual judgments within the panel had a relatively large influence on overall factor ranking. Thirdly, an alternate expert panel may conceivably have produced a different set of individual responses, panel responses, or ranking outcomes. In any case, results are only applicable to Victorian surf beaches. Fourthly, respondents may have differed in their understanding of panel responses or their agreement on the applicability of individual responses. Lastly, the moderator or vocal individuals may have biased the panel, particularly during the process of suggesting representative panel terms appropriate to individual responses.

## Conclusion

The study identified potential factors associated with surf beach use and surf bather drowning based on a consensus of expert opinion. The findings provide direction to future analytical studies of candidate surf bather drowning risk factors and variables presumably associated with bathing exposure. Results from epidemiological studies, combined with complementary biomechanical and other disciplinary studies, should provide pertinent information for developing and testing suitable surf bather drowning countermeasures (Finch, 2006; Miloslis & Stephenson, 2011). As the method for gathering preliminary information reported here proved expeditious and relatively inexpensive, it may also be suitable to explore risk factors operating in other open water drowning locations such as lakes and rivers.

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