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Beachgoers' responses to beach health advisories

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ABSTRACT

Drawing on responses from 238 beachgoers who have visited a Georgia (U.S. state) beach in the past three years, this study asks respondents about their knowledge of beach water quality monitoring, awareness of beach health advisories, perception of water quality, and expected responses upon learning of a beach's water pollution advisory. Binomial logistic regression finds that the only demographic predictor of respondents who would completely stop visiting a beach with an advisory is whether the respondent is a visitor or resident (year-round or part-time). Nearly 40% of visitors would not come to a beach with an advisory compared to 13.4% of residents. Most respondents report they would continue to visit a beach but would stay out of the water and stop harvesting seafood from the beach's waters. More than a third (36.1%), however, are unaware Georgia regularly monitors beach water for water quality, and 41.2% have never read a beach sign warning of contaminated water or seafood. Alarmingly, just over half view aesthetic factors such as no litter, no odor, and clear water as criteria for defining whether beach water is safe.

Key words: advisories, beaches, Georgia, pollution, warnings

HIGHLIGHTS

- Will help in designing more effective health communications about environmental health dangers to the public.
- Provides analysis of the different ways that residents and visitors respond to beach water pollution advisories.
- While most beachgoers have read a beach water advisory at some point, the majority reported they did not know the state routinely tests beach water for unsafe levels of pathogens.

1. INTRODUCTION

The U.S. Environmental Protection Agency (EPA) requires under the BEACH ACT that states monitor beach water quality. When water pathogens exceed the EPA's acceptable standards, the state monitoring agencies must notify local coastal governments and the public about possible health risks (National Science Center for Environmental Publications (NSCEP) & U.S. EPA 2016). Relatively little studied, however, is the response of beachgoers to notifications of unsafe beach waters. This study of beachgoers visiting popular Georgia (U.S. state) beaches examines how individuals report they would respond to a health warning.

1.1. Location and economic impact

Georgia's Sea Islands extend down the state's entire coast and attract more than 100 million domestic tourists and another million international tourists annually. Generating over $60 billion in revenue and employing 450,000 Georgians, the coastal hospitality industry serves as a major economic engine for the state (Georgia Department of Economic Development 2017). The Port of Savannah also now serves as the third largest port in the United States (Schenker 2019), and the coast is also a popular film location for Georgia's growing film industry (Hensley 2016).

In 2015, Tybee Island, a popular beach resort close to Savannah, commissioned an economic study that found the island's 1,044,000 annual visitors generated almost $9 million in taxes and fees for the local government as well as $93 million in business revenues. Georgians visiting from other parts of the state had the highest per capita spending. Significantly, when

questioned about their response if Tybee's beaches eroded or became unusable, most Georgia visitors and half of out-of-state visitors said they would respond by vacationing at beaches in other states (Barber *et al.* 2015). Coastal beaches and recreational waters serve as major economic engines that would seriously harm local communities and tax bases if deemed polluted or unappealing.

1.2. Existing research on responses to beach advisories

Beach water quality research largely focuses on testing. Several studies indicate that more rapid means of testing are better at measuring water pathogens and accurately alerting officials to the need to close beaches or issue advisories (Wade *et al.* 2006). Children under the age of 10 especially have been found sensitive to gastrointestinal illnesses after exposure to beaches in the Great Lakes (Wade *et al.* 2008). Another prominent area of research in beach water quality focuses on the incidence and types of human illnesses associated with contaminated water (Wade *et al.* 2006; Corbett *et al.* 2008; Yau *et al.* 2009; Schiff *et al.* 2016). These studies find that beachgoers who swim while at a beach report significantly more respiratory, skin, ear, and gastrointestinal illnesses than non-swimmers. A 1996 study from the United Kingdom found that bather exposures above 60 fecal streptococci per 100 mL of water were associated with acute febrile respiratory illness. A similar threshold of 100 fecal coliform was associated with earaches (Fleisher *et al.* 1996). Earlier French studies also identified that swimmers are more at risk of illnesses than non-swimmers with fecal streptococci levels correlating to gastrointestinal illnesses more than fecal coliforms (Ferley *et al.* 1989; Zmirou *et al.* 1990). French researchers also quantified the risk of illness to swimmers based on times swimming and different levels of waterborne pathogens (Zmirou *et al.* 2003). Yet, a 2012 study by Greek researchers found similar elevated risks for bathers vs. non-bathers even when recreational waters met clean water standards for excellence (Papastergiou *et al.* 2012). Also of particular note is the 3-year Surfer Health Study that validated the '72-h rule' whereby surfers and swimmers who did not get in beach water for 72 h after a rain storm reported fewer illnesses associated with contaminated water than those who ignored this rule (Schiff *et al.* 2016).

Thus, testing and health outcomes from contaminated water have a significant presence in the scholarly literature. Data on the public's perception and response to water advisories, however, are less common. In the broader context of warning signs in general, Quarantelli (1983) finds that people are more responsive to short-term warnings of immediate danger than longer-term warnings such as one finds with periodic water advisories. Other studies find that many or even most beachgoers do not notice advisories (Matthews *et al.* 2014), do not understand advisories using symbols such as flags (Lucrezi & van der Merwe 2014), or evaluate advisories against current conditions visible to the beachgoer (Busch 2009; Brannstrom *et al.* 2015). An Australian study also finds that beachgoers evaluate riptide current warnings more seriously if they have children with them or are elderly (Sherker *et al.* 2010). While these studies look at beachgoers' behaviors and perceptions, a 2011 paper that surveyed 37 states and 18 municipalities reports wide variety in how water advisories are communicated to the public as well as the general lack of evaluation of the efficacy of these advisory systems (Pratap *et al.* 2011). An earlier article echoes the need for evaluating warning systems and utilizing a variety of pictures, symbols, and colors to create more effective warning (Young 1991).

Finally, another thread of beach advisory research focuses on quantifying the economic impact of beach closures and erroneous warnings (Murray *et al.* 2001; Rabinovici *et al.* 2007). Largely missing from the literature are studies that ask beachgoers how they would respond to water contamination warnings. This particular study details survey results asking beachgoers how they would respond to such water quality advisories.

2. MATERIALS AND METHODS

Researchers collected data in June and July 2017's summer swimming season using both an online survey and direct paper surveys distributed at two major resort island beaches (Tybee Island and Jekyll Island). Respondents completed a survey asking about their demographics, perceptions of water quality, and potential responses to advisories of polluted beach waters. Respondents did not receive any incentives. Online surveys were distributed through social media (Facebook) groups that focus on coastal Georgia living. The Georgia Southern University Institutional Review Board approved this study. Results and analyses were generated using IBM SPSS 23 (IBM, Armonk, NY) and ArcMap 10.4.1 (Esri, Redlands, CA).

3. RESULTS

3.1. Participants' demographics

Eligible respondents must have visited a Georgia beach in the past three years. This criterion resulted in 238 respondents who consisted of mostly non-Hispanic (96.6%), White (90.0%), and women (73.7%), with a median age of 46. This convenience samples of beachgoers are wealthier and more educated (74.0% with a college degree) than the U.S. population as a whole. Most of the respondents are visitors (65.1%) with about a third residing within 3 miles (4.8 km) of a Georgia beach (see Table 1).

3.2. Responses to a sign warning of unsafe levels of bacteria in beach water

While almost all respondents (98.3%) perceive polluted beach water as posing health risks, over a third (36.1%) do not know that the state routinely monitors beach water quality and posts beach advisories when levels of pathogens exceed safe levels.

Table 1 | Survey participants' demographics and responses

	Percentage	Number
Total	100	238
Sex		
Female	73.7	175
Male	26.3	63
Race		
White	90.0	214
All other races combined	10.0	24
Ethnicity		
Non-Hispanic	96.6	230
Hispanic	3.4	8
Income		
Incomes of $50,000 or more	68.7	164
Incomes of $49,999 or less	31.3	74
Education		
Have a college degree	74.0	176
Do not have a college degree	26.0	62
Residence		
Visitors	65.1	155
Residents	34.9	83
How completed survey		
Paper survey at beach	82.7	197
Online	17.3	41
Responses to Survey Questions		
TRUE: Polluted beach waters pose health risks.	98.3	234
TRUE: State of Georgia routinely monitors beach water quality and warns of unsafe pathogen levels.	36.1	86
YES: Have ever read a beach water quality advisory.	58.8	140
Yes, I would personally stop using a beach in the same way if there was an advisory.	94.1	224
Yes, I would completely stop using a beach if there was an advisory.	29.8	71
Yes, I would completely stop bringing family to a beach if there was an advisory.	39.5	94
Yes, I would stop catching seafood at a beach with an advisory.	99.2	236
Yes, I would stop family from catching seafood at a beach with an advisory.	99.6	237
Yes, I would continue to use the beach personally but stay out of the water.	65.1	155
Yes, I would continue to use the beach with family but stay out of the water.	54.6	130

While Tybee Island, Jekyll Island, and other Georgia beach resorts regularly post such advisories on local beaches about water pathogens affecting swimmers and locally caught seafood, 41.2% of respondents have never read one of these advisories (58.8% have).

If respondents did notice or hear of a beach advisory, a small number (5.9%) would continue personally to use the beach as if there was no such advisory. When asked the same question but when making a decision about bringing their families to the beach, 5.0% said they would still not make any changes to their use of the beach.

Relatively few respondents report catching seafood at the beach: 12.2% (fish), 4.2% (crabs), 2.5% (shrimp), and 0.8% (other seafood). If they encountered a beach health advisory, only a handful of respondents said they would continue to catch seafood at the beach (0.8%) or allow their family to continue catching seafood (0.4%).

Most respondents reported they were drawn to the beach for swimming, sunbathing, and walking in the surf, and 29.8% report they would completely stop coming to any beach with an advisory warning. If asked the same question in regard to bringing family members to such a beach, 39.5% said they would completely avoid this beach. The majority, however, would continue to use such a beach personally (65.1%) or with their families (54.6%) but would avoid getting in the water.

3.3. Comparing visitors and residents

There are some key differences in how local residents and visitors say they would respond in terms of their own personal beach use in the event of a beach advisory. There are no statistically significant differences between residents and visitors in some areas: Both groups would make changes to their beach use, and both visitors and residents would stop crabbing, fishing, or shrimping (see Table 2).

Visitors are more likely, however, to completely stop coming to a beach if there is an advisory (38.9% of visitors compared to 13.4% of residents) (X^2 (1, $n = 226$) = 16.256, $p = 0.000$). While three out of four residents (76.8%), however, report they would continue to use a beach but stay out of the water, only 59.0% of visitors would do so (X^2 (1, $n = 226$) = 7.326 $p = 0.007$).

When asked how they would respond to a beach advisory and their families' use of a beach, similar patterns exist. Visitors are statistically more likely to stop bringing their families to a beach with a water advisory (50.7% of visitors would stop coming to a beach compared to 22.0% of residents) (X^2 (1, $n = 226$) = 17.947, $p = 0.000$). Both groups show no statistical differences in stopping to fish, crab, or shrimp: both groups overwhelming said they would stop.

3.4. Binomial logistic regression

After finding no multicollinearity among the predictive variables, researchers conducted a binomial logistic regression analysis of the ability of (a) demographic characteristics, (b) awareness of water testing, and (c) reported beach activities to predict whether a beachgoer would stop using a beach if a water quality advisory was posted. The logistic regression model was statistically significant ($X^2(19) = 39.012$, $p = 0.004$). The model explained 23.6% (Nagelkerke R^2) of the variance in stopping use of a beach and correctly predicted 91.9% of cases. Sensitivity was 35.4%, specificity was 91.9%, the positive predictive value was 65.7%, and the negative predictive value was 76.5%. Of the predictive variables, five were statistically significant: whether the individual is a visitor or resident, whether they use the beach to swim, whether they use the beach to walk a pet, whether the beachgoer is aware of water pollution from non-human sources, and whether they use the beach to picnic. Respondents who use a beach to walk a pet had 2.94 times higher odds of stopping use of a beach because of a water advisory. Likewise, people who use a beach to swim had 3.31 times higher odds of stopping use of a beach. On the contrary, residents (compared to visitors), beachgoers aware that pollution can come from non-human sources, and people who report using a beach for a picnic are less likely to stop using a beach altogether (see Table 3).

To better understand this model and whether visitors use beaches differently than residents, Chi-square analyses compared beach activities based on whether the respondent was a visitor or resident. For most activities, there were no statistically

Table 2 | Statistically significant differences between visitors and residents

	Visitors (%)	Residents (%)
Yes, I would completely stop using a beach if there was an advisory.	38.9	13.4
Yes, I would completely stop bringing family to a beach if there was an advisory.	50.7	22.0
Yes, I would continue to use the beach personally but stay out of the water.	59.0	76.8

Table 3 | Variables in the equation

							95% CI for Exp(*B*)	
	B	**SE**	**Wald**	**df**	**Sig.**	**Exp (*B*)**	**Lower**	**Upper**
Swimming	0.958	0.409	5.492	1	**0.019**	2.606	1.17	5.804
Walked in the surf	0.623	0.554	1.263	1	0.261	1.864	0.629	5.525
Walked but not in the surf	0.163	0.371	0.193	1	0.661	1.177	0.569	2.435
Picnicking	−0.882	0.45	3.841	1	**0.05**	0.414	0.172	1
Sunbathing	−0.398	0.451	0.779	1	0.377	0.672	0.277	1.626
Used the public restroom	−0.716	0.371	3.72	1	0.054	0.489	0.236	1.012
Horse riding	−17.901	24,554.727	0	1	0.999	0	0	.
Walked a pet	1.447	0.565	6.549	1	**0.01**	4.251	1.403	12.875
Fishing	−0.415	0.606	0.47	1	0.493	0.66	0.201	2.165
Shrimping	−1.144	2.313	0.244	1	0.621	0.319	0.003	29.65
Crabbing	0.982	1.153	0.725	1	0.394	2.67	0.279	25.585
Catching other seafood	−17.825	24,554.727	0	1	0.999	0	0	.
Biking	−0.031	0.477	0.004	1	0.949	0.97	0.381	2.469
Kayaking	0.527	0.67	0.62	1	0.431	1.694	0.456	6.298
Paddle boarding	−21.378	12,018.533	0	1	0.999	0	0	
White or minority	0.602	0.573	1.104	1	0.293	1.827	0.594	5.621
Above national median income	−0.286	0.359	0.634	1	0.426	0.751	0.372	1.518
4-year college degree or not	−0.557	0.38	2.145	1	0.143	0.573	0.272	1.207
Sex	−0.411	0.43	0.916	1	0.339	0.663	0.286	1.539
Resident or visitor	−1.422	0.467	9.285	1	**0.002**	0.241	0.097	0.602
Constant	−0.327	0.664	0.242	1	0.622	0.721		

Bold values are those that are statistically significant.

significant differences; however, visitors are statistically more likely to swim and sunbathe at a beach. Residents are statistically more likely to bike, kayak, and paddleboard at a beach.

4. DISCUSSION

This study finds that the vast majority (95%+) of respondents say they would change how they use a beach in the event of a water quality advisory. Most visitors and local residents alike would stop catching local seafood at that beach (fishing, crabbing, shrimping, and other seafood). Visitors report swimming and sunbathing more at a beach than residents, and if that beach has a water advisory, visitors are more likely to say they would completely stop coming to that beach. Residents, on the other hand, say they would continue coming to the beach but avoid getting into the water.

The binominal logistic regression model predicts 23.6% of the variance in whether respondents say they will stop using a beach. Perhaps fearful that a pet will jump into polluted water, respondents who report walking a pet along the beach are 2.94 times more likely to stop using a beach with a water advisory. Swimmers also understandably are more likely to find another beach without an advisory.

On the other hand, the model finds that residents are less likely to stop using their local beach in case of an advisory. Similarly, people who use the beach for picnics and those who are aware that polluted waters may be the result of non-human sources also are less likely to completely stop using a beach.

Other studies find differences in how residents and visitors see and use beaches. This study shows differences extend to how these two groups report they would respond to a potential water advisory. For communities which depend on beach recreation and visitors economically, this study underscores the fears and risks that visitors and their money will seek alternatives when faced with water quality advisories. While respondents – including visitors – say they want more detailed information

from water advisories, more than a third report not knowing the state routinely monitors water quality at Georgia beaches. A large minority, 41%, have never read or seen a beach advisory.

4.1. Limitations

This survey relies upon a convenience sample of beachgoers drawn from respondents visiting two particular Georgia beaches in the summer of 2017 and respondents willing to voluntarily complete an online questionnaire. Participants are older, better educated, wealthier, more female, and more non-Hispanic white than the population in general and thus lack the diversity of the population in general. Studies on risk aversion do find that women are more risk adverse than men (Hahn *et al.* 2000; Rosen *et al.* 2003), but studies offer mixed results about whether more education increases or decreases risk aversion (Hahn *et al.* 2000; Rosen *et al.* 2003; Jung 2015; Chong & Martínez 2021). Thus, this study cannot answer if results are biased toward greater risk aversion to beach warnings because of the higher proportion of college educated women among participants. Researchers also surveyed beachgoers only in the summer months, and there may be seasonal variations in the demographics and perspectives of beachgoers not captured in these data. Results may, therefore, not be representative of the population of Georgia beach visitors in general or beachgoers who visit Georgia beaches in seasons other than summer.

5. CONCLUSIONS

Living along a beach for all or part of a year influences residents to perceive clean beach water as pathogen-free water. Short-term visitors, however, rate aesthetic factors such as smell and the absence of litter above health risks. Higher educated individuals among residents and visitors alike, however, rate pathogen-free water as more important than aesthetics. Beach managers and local health departments need to invest in ways to educate the public – especially short-term visitors – about routine testing, health risks, beach notifications, and the importance of pathogen-free waters.

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DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

CONFLICT OF INTEREST

The authors declare there is no conflict.

REFERENCES

Barber, D., Beck, J., Mangee, N., Saadatmand, Y. & Toma, M. 2015 *Tybee Island Tourism Study*. Available from: http://www.cityoftybee.org/DocumentCenter/View/139.

Brannstrom, C., Lee Brown, H., Houser, C., Trimble, S. & Santos, A. 2015 'You can't see them from sitting here': Evaluating beach user understanding of a rip current warning sign. *Applied Geography* **56**, 61–70. https://doi.org/10.1016/j.apgeog.2014.10.011.

Busch, J. 2009 Surfer and beachgoer responsiveness to coastal water quality warnings. *Coastal Management* **37** (6), 529–549. https://doi.org/10.1080/08920750903044865.

Chong, A. & Martínez, J. J. 2021 Does education increase risk aversion in households? Some evidence using artefactual experiments in Peru. *Latin American Economic Review* **30**, 1–19. https://doi.org/10.47872/LAER.V30.22.

Corbett, S. J., Rubin, G. L., Curry, G. K. & Kleinbaum, D. G. 2008 The health effects of swimming at Sydney beaches. The Sydney beach users study advisory group. *American Journal of Public Health* **83** (12), 1701–1706. https://doi.org/10.2105/ajph.83.12.1701.

Ferley, J. P., Zmirou, D., Balducci, F., Baleux, B., Fera, P., Larbaigt, G. & Boudot, J. 1989 Epidemiological significance of microbiological pollution criteria for river recreational waters. *International Journal of Epidemiology* **18** (1), 198–205. https://doi.org/10.1093/IJE/18.1.198.

Fleisher, J. M., Kay, D., Salmon, R. L., Jones, F., Wyer, M. & Godfree, A. F. 1996 Marine waters contaminated with domestic sewage: Nonenteric illnesses associated with bather exposure in the United Kingdom. *American Journal of Public Health* **86** (9), 1228–1234. https://doi.org/10.2105/AJPH.86.9.1228.

Georgia Department of Economic Development 2017 Tourism. Available from: http://www.georgia.org/industries/georgia-tourism/ (accessed 29 September 2017).

Hahn, R., Vesely, S. & Chang, M. H. 2000 Health risk aversion, health risk affinity, and socio-economic position in the USA: The demographics of multiple risk. *Health, Risk & Society* **2** (3), 295–314. https://doi.org/10.1080/713670164.

Hensley, E. 2016 *Georgia now Tied for No. 3 in Worldwide Film Production – Atlanta Business Chronicle*. Available from: https://www.bizjournals.com/atlanta/morning_call/2016/06/georgia-now-tied-for-no-3-in-worldwide-film.html (accessed 29 September 2017).

Jung, S. 2015 Does education affect risk aversion? Evidence from the British education reform. *Applied Economics* **47** (28), 2924–2938. https://doi.org/10.1080/00036846.2015.1011313.

Lucrezi, S. & van der Merwe, P. 2014 Beachgoers' awareness and evaluation of the Blue Flag Award in South Africa. *Journal of Coastal Research* **315**, 1129–1140. https://doi.org/10.2112/jcoastres-d-13-00159.1.

Matthews, B., Andronaco, R. & Adams, A. 2014 Warning signs at beaches: Do they work? *Safety Science* **62**, 312–318. https://doi.org/10.1016/j.ssci.2013.09.003.

Murray, C., Sohngen, B. & Pendleton, L. 2001 Valuing water quality advisories and beach amenities in the Great Lakes. *Water Resources Research* **37** (10), 2583–2590. https://doi.org/10.1029/2001WR000409.

National Science Center for Environmental Publications (NSCEP) & U.S. EPA 2016 Document Display | NEPIS | U.S. EPA. Available from: https://nepis.epa.gov/Exe/ZyNET.exe/P100599B.TXT?ZyActionD=ZyDocument&Client=EPA&Index=2006+Thru+2010&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=.

Papastergiou, P., Mouchtouri, V., Pinaka, O., Katsiaflaka, A., Rachiotis, G. & Hadjichristodoulou, C. 2012 Elevated bathing-associated disease risks despite certified water quality: A cohort study. *International Journal of Environmental Research and Public Health* **9**, 1548–1565. https://doi.org/10.3390/ijerph9051548.

Pratap, P. L., Desai, P. & Dorevitch, S. 2011 Beach communications: A need for evaluation of current approaches. *Journal of Water and Health* **9** (3), 556–568. https://doi.org/10.2166/wh.2011.171.

Quarantelli, E. L. 1983 *People's Reactions To Emergency Warnings*. Available from: http://dspace.udel.edu/handle/19716/1118.

Rabinovici, S. J. M., Bernknopf, R. L., Wein, A. M., Coursey, D. L. & Whitman, R. L. 2007 Economic and health risk trade-offs of swim closures at a Lake Michigan Beach. *Environmental Science & Technology* **38** (10), 2737–2745. https://doi.org/10.1021/es034905z.

Rosen, A. B., Tsai, J. S. & Downs, S. M. 2003 Variations in risk attitude across race, gender, and education. **23** (6), 511–517. https://doi.org/10.1177/0272989X03258431.

Schenker, D. B. 2019 *Top 15 Ports in The Americas – DB Schenker*. Available from: https://nowthatslogistics.com/top-15-ports-in-the-americas/ (accessed 1 June 2019).

Schiff, K., Griffith, J., Steele, J., Arnold, B., Ercumen, A., Benjamin-Chung, J. & Mcgee, C. 2016 *The Surfer Health Study: A Three-Year Study Examining Illness Rates Associated with Surfing During Wet Weather*. Available from: http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/943_SurferHealthStudy.pdf.

Sherker, S., Williamson, A., Hatfield, J., Brander, R. & Hayen, A. 2010 Beachgoers' beliefs and behaviours in relation to beach flags and rip currents. *Accident Analysis & Prevention* **42** (6), 1785–1804. https://doi.org/10.1016/J.AAP.2010.04.020.

Wade, T. J., Calderon, R. L., Brenner, K. P., Sams, E., Beach, M., Haugland, R. & Dufour, A. P. 2008 High sensitivity of children to swimming-associated gastrointestinal illness: Results using a rapid assay of recreational water quality. *Epidemiology* **19** (3), 375–383. https://doi.org/10.1097/EDE.0b013e318169cc87.

Wade, T. J., Calderon, R. L., Sams, E., Beach, M., Brenner, K. P., Williams, A. H. & Dufour, A. P. 2006 Rapidly measured indicators of recreational water quality are predictive of swimming-associated gastrointestinal illness. *Environmental Health Perspectives* **114** (1), 24–28. https://doi.org/10.1289/ehp.8273.

Yau, V., Wade, T. J., de Wilde, C. K. & Colford Jr, J. M. 2009 Skin-related symptoms following exposure to recreational water: A systematic review and meta-analysis. *Water Quality, Exposure and Health* **1** (2), 79–103. https://doi.org/10.1007/s12403-009-0012-9.

Young, S. L. 1991 Increasing the noticeability of warnings: Effects of pictorial, color, signal icon and border.Proceedings of the Human Factors Society Annual Meeting **35** (9), 580–584. https://doi.org/10.1518/107118191786754662.

Zmirou, D., Ferley, J. P., Balducci, F., Baleux, B., Fera, P., Larba igt, G. & Boudot, J. 1990 [Evaluation of microbial indicators of health risk related to river swimming places]. *Revue D'epidemiologie et de Sante Publique* **38** (2), 101–110. Available from: https://europepmc.org/article/med/2115683.

Zmirou, D., Pena, L., Ledrans, M. & Letertre, A. 2003 Risks associated with the microbiological quality of bodies of fresh and marine water used for recreational purposes: Summary estimates based on published epidemiological studies. *Archives of Environmental Health* **58** (11), 703–711. https://doi.org/10.3200/AEOH.58.11.703-711.

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