

Is the Public Aware of Water Quality Monitoring and Safety Notifications on Beaches?

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ABSTRACT

Recreational water-related activities have important public health benefits, however, pollution at beaches may have serious health risks. Although there is a substantial amount of research and policies in place at federal and state levels, oftentimes these efforts may not be well translated to the public. This paper evaluates the effectiveness of routine water quality monitoring and warning systems in Georgia, USA. A survey was conducted among 238 beachgoers in Georgia, asking about awareness of water quality monitoring and warning signs for beach advisories. Surveys were collected directly at beaches as well as through an online questionnaire. Results show that more than a third of the respondents (36.1%) are unaware that Georgia beaches are monitored for water quality and public health with nearly two-thirds (64.7%) feeling current signage is inadequate. Most (89.9%) want signs to report the sources of pollution. Residents (compared to visitors), older, White, wealthier, and college-educated respondents are more likely to be aware of water monitoring. In terms of having ever read a water quality advisory, residents and older respondents are more likely to have read a warning. While most respondents have read such warning signs, a large percentage, 41.2%, have never read any beach advisory. Public health and environmental agencies must improve communications about polluted waters to the public using symbols and campaigns with a special emphasis on visitors and younger beachgoers.

Keywords: Beaches, water quality, pollution, warnings, signage, signs, Georgia

INTRODUCTION

With an estimated 90 million illnesses (DeFlorio-Barker et al. 2018) annually related to water-borne pathogens, public warnings to beachgoers provide important safety information, but does the public pay attention to these warnings? Is the public even aware that US beaches are monitored for water quality and safety? This study focuses on exploring beachgoers' knowledge and perception of water quality testing and warning systems.

Every year, the United States' coastal recreational waters and interior Great Lakes are visited approximately 900 million times by residents and tourists (USEPA, 2018a). Many people use these waters primarily for swimming, surfing, fishing or boating purposes. Ensuring the safety of these beaches becomes particularly important during the swimming season (sometimes year-round depending on the geographical location) as these water bodies may be contaminated with sewage leaks (Lee et al., 2014; Aslan et al., 2018), stormwater runoff (Brownell et al., 2007; He and He, 2008), animal waste (Converse et al., 2012; Fogarty et al., 2003; Wright et al., 2009), and wastes from boats (Ho et al., 2011). These pollution sources may carry pathogens and cause waterborne diseases particularly among vulnerable populations such as young children (Arnold et al., 2016). The Centers for Diseases Control reported a significant increase in recreational water disease outbreaks in the last decade (Hlavsa et al., 2015), and a recent study by DeFlorio-Barker et al. (2018) estimated 4 billion water recreation events resulting 90 million recreational water-related illnesses occurring in the USA. These illnesses are calculated to have an economic burden of

\$2.2-3.7 billion annually. Therefore, it is essential to routinely monitor recreational waters for public health safety.

The Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000 (USEPA, 2000) funds states, territories, and tribes to perform beach monitoring programs and notify the public about water quality at the Great Lakes and marine coastal beaches. With the aid of these funds, beach water quality has been routinely monitored at the state level by beach managers and local health departments to protect swimmers from potential health risks associated with high levels of waterborne pathogens. The program also led to the development of a national database where all the water quality information from all monitored beaches could be stored (USEPA, 2018b). When high levels of bacteria are detected, states are given the authority to issue a water quality advisory or beach closure until these levels decrease to acceptable limits. These decisions are mainly communicated to the public via installing signs on the beach. Some states use additional methods of risk communication, such as virtual media, as well to reach out to as many users as possible. Regardless, current methods of beach safety communication may not be effective, and many visitors may not be aware of these warnings.

While posting signs about threats to recreational beach waters is the primary method of alerting visitors to potential public health risks, relatively little research has been done into whether the public reads these signs. One study from Australia showed that only 45% of 472 beachgoers reported

observing any warning signage (Matthews et al., 2014), even while individuals often define a beach's quality as acceptable based on the water quality, amount of litter, and beach safety (Vaz et al., 2009). The perceptions of beach quality and expectations for such beaches also vary between residents and visitors. In one study, residents wanted to avoid overpopulation of beaches and keep their local beaches in a more natural state. Non-resident visitors, however, do not mind the crowds, and they are more interested in better parking and amenities at the beaches (Roca et al., 2009).

This particular study expands the limited research into the effectiveness of beach water safety notifications. Individuals visiting beaches along the coastal islands of Georgia were asked about their knowledge and awareness of water quality surveillance and warning signs to identify how well such safety warnings are working to protect public health.

Study area

Coastal Georgia has 3,400 miles of tidal shoreline with 14 barrier islands and 100 miles of sand beaches. The Sea Islands, the state's barrier islands, separate the Georgia mainland from the Atlantic Ocean. The Sea Islands' beaches help attract 102 million visitors to the state and generate \$61 billion in tourism dollars annually. The state's strong tourism economy also supports nearly half a million jobs for Georgians (Georgia Department of Economic Development, 2017). Georgia is actively monitoring water quality and routinely issuing water advisories on public beaches.

Tybee Island, for example, serves as a popular tourist destination for beachgoers. In 2015 the island's government completed an economic study that highlights the impact of beaches on the regional economy. This report finds that Tybee Island draws more than 1 million visitors annually and generates \$93 million in revenues directly produced on the island. The island also produces \$8.7 million for local governments through parking fees, hotel taxes, and sales taxes.

The state of Georgia, the location of this study, has been extensively monitoring the state's beaches for microbiological safety since 2002 -including Tybee Island. Typically, beach advisory warnings in Georgia are posted when the recreational water quality criteria for bacteria (70 CFU/100 ml) is exceeded (USEPA, 2012). These warnings involve issuing a press release and activating the on-site advisory signs at the affected beach. Beach water samples are collected on Tuesdays, and the bacteriological test results are released on Wednesdays. When a beach sample exceeds the criteria, water quality sampling is repeated on Thursdays, and the results are re-posted on Fridays.

Recent studies on the water quality of this area showed that, as the state adopted the new USEPA Recreational Water Quality Criteria (RWQC) for bacteriological safety (guideline value decreased from 104 CFU/100 ml to 70 CFU/100 ml), the number of advisories doubled at Tybee

Island, indicating a health concern (Aslan and Benevente, 2016).

Jekyll Island is another popular recreational area in Georgia, and according to routine beach monitoring data, two out of seven beaches (St. Andrews and Clam Creek beaches) have been frequently reported as "under advisory" in the past decade. Approximately 45% of the St. Andrews and 22% of the Clam Creek beach water samples were not in compliance with the RWQC. In 2014, St. Andrews was under advisory for 207 days and Clam Creek 92 days due to high bacterial levels, which led these beaches to be issued under "permanent advisor" after this year (Aslan and Jones, 2017).

METHODS

This study analyzes quantitative results collected from a survey of beachgoers who have visited a Georgia beach in the past three years. Data were collected from participants at two heavily visited beaches (Tybee Island and Jekyll Island) in the summer of 2017 as well as through an online survey distributed via social media. Participation was voluntary, and respondents did not receive any incentives or compensation to complete the survey. The survey instrument was approved by the Georgia Southern University Institutional Review Board. Data were analyzed using IBM SPSS 23 (IBM, Armonk, NY). Analyses were conducted using Chi-square, t-test, and simple linear regression procedures.

RESULTS

Participant demographics

Among 238 participants involved in the study, the majority were female (73.7%), non-Hispanic (96.6%), not active duty military (100.0%), and white (90.0%). Compared to Americans as a whole, respondents are older (mean and median ages are 46 years), disproportionately highly educated (74% having a Bachelor's degree or higher), and wealthier (median household incomes of \$80,000 to \$89,999). The majority (76.6%) lives more than three miles from a Georgia beach but reside in Georgia (79.0%). Only 13% of respondents were visitors from other states.

Awareness of water quality surveillance

Participants report Tybee Island (45.7%) and Jekyll Island (44.8%) as their most visited beaches in the last three years with more than a third (36.1%) of the respondents are unaware that these and other Georgia beaches are monitored for water quality and public health.

Using Chi-square and Phi procedures, differences among sub-populations were examined with the data revealing statistically significant differences in awareness of water quality monitoring of Georgia beaches (see Table 1). Overall, there is a moderately strong association between education and awareness of water quality surveillance ($\phi = 0.291$, $p = .000$) with college graduates are more likely to be

aware of water quality surveillance (X2 (1, n = 238) = 20.137, p = .000). There is also a weak association between race and awareness of water quality surveillance (ϕ = -0.203, p = .002). White respondents are more likely to be aware of water quality surveillance than the analytic sample's relatively small aggregate of all other races (X2 (1, n = 238) = 9.774, p = .002). Additionally, there is a weak association between income and awareness of water quality surveillance (ϕ = 0.160, p = .016) with respondents with household incomes of \$50,000 or more are more likely to be aware of water quality surveillance (X2 (1, n = 227) = 5.809, p = .016). Finally, there is a moderately strong association between residence and awareness of water quality surveillance (ϕ = -0.286, p = .000) with year-round beach residents reporting greater awareness of water quality surveillance than visitors (X2 (1, n = 235) = 19.284, p = .000). An independent samples t-test was also conducted and determined that age is also statistically significant. Older respondents are more likely to report being aware of water quality monitoring (95% CI, -11.920 to -3.871), t(234) = -3.865, p = .000). Analyses found no statistically significant differences in terms of sex or ethnicity.

Awareness of warning signs

Most respondents (58.8%) report having read at some point in their lives a sign at a beach with a warning about water quality, swimming, or consuming any seafood caught at the beach. More than a third of respondents, however, report having never read such a sign. Nearly two-thirds of respondents (64.7%) believe current signage on Georgia beaches does not provide enough information with 89.9%

wanting signage to report the sources and health risks of waterborne pathogens.

There is also a moderately strong association between residence and having read a water quality sign (ϕ = -0.264, p = .000). Year-round beach residents are more likely to have read a warning sign than visitors (X2 (1, n = 235) = 16.339, p = .000). Indeed, while 81.8% of year-round residents have read a warning sign, only 51.1% of visitors report having ever read one. Analysis using an independent t-test also determined that older respondents were more likely to have read a warning sign (95% CI, -9.083 to -1.090), t(234) = -2.508, p = .013). While education does not meet the threshold for significance, it comes close to significance (p = .052). Sex, race, ethnicity, income, and education were not significant.

Awareness of pollution sources other than sewage

Most respondents (89.5%) report being aware that unsafe levels of bacteria in beach water can originate from sources other than human sewage. Men are also more likely than women to know this fact (X2 (1, n = 236) = 4.819, p = .028) though the strength of association is weak (ϕ = 0.143, p = .028). College graduates compared to respondents without a college degree are also more aware of this fact (X2 (1, n = 238) = 6.986, p = .008) and again the strength of association is weak (ϕ = 0.171, p = .008). An independent samples t-test also finds that older respondents are more likely to be aware that sources other than human sewage can pollute coastal waters (95% CI, -14.895 to -2.132), t(234) = -2.628, p = .009). There are no statistically significant differences for race, ethnicity, income, and residence.

Table 1

Awareness of Water Quality Monitoring of Georgia Beaches

| | Percent Responding YES |
|--------------------------------------|------------------------|
| Overall | 63.9 |
| College graduates | 72.2 |
| Respondents without a college degree | 40.3 |
| Whites | 67.6 |
| All other races combined | 38.7 |
| Income of \$50,000 or more | 68.7 |
| Incomes of \$49,999 or less | 50.0 |
| Year-round residents | 89.1 |
| Visitors | 56.7 |

Conclusions

Beaches are major economic engines for many communities. It is estimated that recreational activities in the coastal USA and the Great Lakes contribute \$6 trillion to the national economy every year (USEPA, 2018a). Georgia has been extensively monitoring their beaches since 2002, in order to meet the BEACH Act requirements. Even though Georgia has been one of the states that use various communication sources, more than a third of the participants in the survey stated that have never read a water quality sign, meaning that the beach signs used to notify the public about microbiological water quality have not been completely effective. These results indicate that preventing exposure to contaminated waters and the associated health risks for beachgoers may be limited by the lack of awareness of such notification systems. The participants also state that the current signage is inadequate and would prefer to have more information on the sources and health risks of waterborne pathogen exposure.

Our study shows that visitors (compared to year-round residents), racial minorities, younger beachgoers, and lower educated individuals report lower awareness of authorities' work to actively monitor beach water quality. Younger beachgoers and visitors are also less likely to have ever read a warning sign. The discrepancy between what the public knows and what the monitoring efforts have been reporting needs to be overcome by better communication. Health communication strategies must be guided by evidence-based strategies and our study provides a unique data set for developing a targeted program for individuals who are not aware of the beach notification signs for water quality. Therefore, there is a need for better designs targeted for specific communities to deliver the information.

Pratap et al., (2011) summarized 35 beach programs nationwide for their method of water quality notification. According to their dataset, all (100%) of the programs use communication methods such as posting the results on signs and displaying on a website. Most states (82.8%) publish press releases. In Georgia, beach notifications are communicated to the public through i) posting signs on the beach, ii) notifying the public through the Georgia Department of Natural Resources website, iii) issuing press releases, iv) posting email alerts to subscribers, and v) sending out alerts through social media. Regardless, our results showed that even though many means of communications have been used -and the majority of the participants were educated- more than a third of beachgoers were still not aware of the availability of this information. These results show that the transmission of information did not translate into an effective communication for these individuals.

A couple of reasons for the lack of public awareness can be related to the mechanics of the communication tools. The content of the message on the signs consists of the bacterial levels. The size of these signs is too small to be recognized,

the design features may not be as attractive to younger individuals, and the location of the signs may not be visible from all angles. A study from Australia showed that among those who did notice some aspect of the sign, the majority only noticed the hazard symbols rather than any wording (Matthews et al., 2014). These limitations can be prevented by revisiting the design of these signs and how the message is delivered at the beach site.

One possible strategy to disseminate water quality safety to diverse populations uses a strategic design of communication components targeted for communities who are currently unaware of these signs. The message needs to be clear and attractive to the targeted audiences. Research suggests beachgoers, in general, are most likely to identify a symbol or set of symbols than a text-heavy health notice. Future research in this area may well seek to identify what type of mixture of symbology and text is most effective with different audiences such as the younger, minority, and non-residential visitors which this study finds are less informed by current signage.

Even when the signs are noticed, however, it may not necessarily change the behavior; people may continue using the beach during a beach advisory. A study conducted after Hurricane Katrina showed that minority communities were more vulnerable to health outcomes than others before and after the disaster because of culture and language barriers, lower perceived risk, and distrust of notifications (Andrulis et al., 2007). Therefore, the message needs to be informative and multicultural to educate the public on health outcomes. Additional communication tools, such as information hotlines offered in multiple languages, can increase the number of individual notified through effective communication. Similar to some countries in Europe under the Blue Flag campaign, electronic signage systems that display user friendly notifications of real-time daily predictions based on the hydrology, water quality, and rainfall predictions, can also be installed on beaches (McPhail and Stidson, 2009). These tools can be combined with beach water quality educational materials and regularly updated depending on the need. Regardless, a pretesting of new communication tools to evaluate the behavioral changes will also be needed before full-scale implementation.

Adequate evaluation tools should be selected to measure the impact of these communication methods on improved awareness on beach notifications and a decreased rate of swimmer-associated illnesses. Since communicating through media outlets seems to be missing a significant portion of the population, a multicomponent approach to reach out to targeted audiences is needed. Based on our findings, we believe that a health communication campaign that involves a broad set of culturally diverse communication strategies and activities focusing on the beach monitoring and health will not only prevent more

swimmer-associated illness but also deliver a strong message to beachgoers coming to this area that their health is protected by a well-designed beach monitoring program. Our findings demonstrate the importance of developing better communication tools to notify the public about the safety of beach water. Educated individuals who live by the coast are more aware of surveillance and safety signage. The signs on the beaches need to thoroughly explain the sources and health risks of waterborne pathogens. Such signage also needs a clear and eye-catching format/symbology that alerts the third of the public who are unaware of or disinterested in current signage. Efforts should be intentional in including short-term visitors who are less aware of signage than residents. Water quality and beach safety due to recreational water use should be clearly communicated to the public so that the link between monitoring efforts and the effectiveness of the notifications can be improved.

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Conflicts of interest

None to declare.

Ethical approval

This study was approved by the Georgia Southern University Office of Research Services and Sponsored Programs.

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