

Improving water quality communications at beaches: input from stakeholders

Preethi L. Pratap, Sarah Redman, Michael C. Fagen and Samuel Dorevitch

ABSTRACT

Objectives: Water quality communication practices vary widely and stakeholder input has not played a role in defining acceptable levels of risk. Although the 2012 Recreational Water Quality Criteria (RWQC) emphasize the importance of promptly notifying the public about hazardous conditions, little is known about the public's understanding of notifications, or about levels of risk deemed acceptable. We sought to address these gaps.

Methods: A mixed methods approach was used. Focus groups (FGs) provided qualitative data regarding the understanding of surface water quality, awareness, and use, of currently available water quality information, and acceptability of risk. Intercept interviews (INTs) at recreation sites provided quantitative data.

Results: INTs of 374 people and 15 FG sessions were conducted. Participants had limited awareness about water quality information posted at beaches, even during swim bans and advisories. Participants indicated that communication content should be current, from a trusted source, and describe health consequences. Communicating via mobile electronics should be useful for segments of the population. Risk acceptability is lower with greater outcome severity, or if children are impacted.

Conclusions: Current water quality communications approaches must be enhanced to make notification programs more effective. Further work should build on this initial effort to evaluate risk acceptability among US beachgoers.

Key words | acceptable risk, beach water quality, communications, public input

Preethi L. Pratap (corresponding author)
Samuel Dorevitch
Division of Environmental and Occupational Health Sciences,
University of Illinois Chicago School of Public Health,
2121 W Taylor, MC 922,
Chicago, Illinois 60612,
USA
E-mail: plakshmi@uic.edu

Sarah Redman
Michael C. Fagen
Division of Community Health Sciences,
University of Illinois Chicago School of Public Health,
1603 W Taylor, MC 923,
Chicago, Illinois 60612,
USA

INTRODUCTION

Gastrointestinal illness (GI) attributable to water recreation impacts 2–3% of swimmers at US marine (Wade *et al.* 2010) and Great Lakes (Wade *et al.* 2008) beaches. Much effort goes into monitoring fecal indicator bacteria – *Escherichia coli* and enterococci – at US recreational waters. Since its inception, the United States Environmental Protection Agency (EPA) Beach Program (USEPA 2000) has made available nearly \$111 million to states and local authorities to monitor beach water quality and notify the public of conditions that may be unsafe for swimming (USEPA 2012a). The agency allocated approximately \$10 million in 2012, and launched an improved website for beach advisories and closings which allows the public to more quickly, and easily access the most current water quality and pollution testing

information for more than 6,000 US beaches (USEPA 2012b). A variety of beach notification systems have been developed through this program, including the use of colored flags at beaches, websites, and social networking sites with the ultimate goal of preventing recreational waterborne illness. However, notification systems vary across jurisdictions and few have undergone evaluations of their content, delivery methods, or effectiveness (Pratap *et al.* 2011; USEPA 2011).

A number of reports from government agencies and non-profit organizations have described a low level of awareness of water quality information at beaches and even lower reports of adherence to beach notifications (Wisconsin Department of Natural Resources 2002; Heal the Bay 2008; Indiana Department of Environmental Management

2007; USEPA 2011). World Health Organization (WHO) research on risk communication suggests that an audience-centered approach to communicating risk is critical, as an individual's experiences and perceptions can affect receptiveness to certain messages (WHO 2001). Little is known about the receptiveness of US beachgoers to public health messages at beaches and what they perceive as elevated risk while making decisions.

The EPA recently updated its 1986 ambient water quality criteria (USEPA 1986). These criteria were developed by applying relationships between concentrations of indicator bacteria and the probability of GI to estimate the concentration of indicator bacteria that would result in what has been called 'acceptable risk'. Under the new 2012 Recreational Beach Water Quality Criteria (RWQC) (USEPA 2012c) states now have an option of determining the indicator concentration based on illness rate that they consider acceptable (such as 32 or 36 cases of acute GI for every 1,000 recreators). These illness rates, or levels of risk deemed to be acceptable, were not defined by relevant stakeholders (i.e. those who use surface waters for recreation). Additionally, the 2012 Criteria include the option of using quantitative polymerase chain reaction (qPCR) methods for rapidly measuring water quality at beaches. Having such data available within hours of water sample collection is of limited value if the information is not communicated effectively to the public.

In order to enhance the impact of water quality communications for beachgoers, we sought to: (1) describe the awareness, understanding, and use of water quality information by beachgoers; (2) identify stakeholder suggestions for improving public health communications at beaches, so that use of the water on high-risk days can be reduced; and (3) begin characterizing stakeholder perceptions of acceptable risk.

METHODS

Overview

Both quantitative and qualitative methods were used to explore perceptions and knowledge of recreational water quality in Chicago. Three topic areas were the subject of inquiry in both the intercept interviews (INTs) and focus group (FG) understanding of water quality, water quality

communications, and perceptions of risk. These topic areas were thought *a priori* to be critical in the linkage between the availability of water quality information and consequent risk reduction behaviors at beaches. INTs were used to quantitatively evaluate the current awareness and use of beach notifications at water recreation locations in the Chicago area. FGs were conducted to better understand the limitations of current approaches and to develop an understanding of how stakeholders believe such approaches can be improved. FG discussions were conducted at the University of Illinois at Chicago. Children 12–17 years of age and adults (18 years or older) were eligible to participate. Data were collected between August 1 and October 15, 2009.

Focus group discussions

Participant recruitment: Swimmers at Lake Michigan beaches were recruited using flyers. Spanish-speaking swimmers were also recruited through ads in a Spanish-language newspaper. In addition, participants in a study of limited contact water recreation and health – the Chicago Health, Environmental Exposure, and Recreation Study (CHEERS) – were contacted after completing their final CHEERS interviews (Dorevitch et al. 2012).

Focus groups: Separate FGs were held for nine categories of participants: English-speaking swimmers (two groups), Spanish-speaking swimmers (two groups), boaters, fishers (two groups), kayakers and canoers (two groups), rowing teams (adult and youth), coaches, and vendors/event organizers. The last two groups were (1) Lake Michigan life guards, and (2) employees of local, state, and federal governmental agencies in Chicago that are responsible for managing surface water quality. Groups had six to 10 participants.

FG organization: Two experienced FG interviewers (one native English speaker, and one native Spanish speaker) moderated the sessions. Participants first discussed (1) what water quality meant to them and (2) what they perceive as risks/hazards associated with water recreation. In order to gain insight into factors that promote, or hamper, the understanding of beach notifications, posters with examples of specific communication systems currently used at Chicago-area waterways were presented and discussed. Next, participants discussed acceptable risk and

compared that level to the targeted risk levels that are the basis of the EPA's 1986 recreational water quality criteria.

A separate discussion guide was used for the lifeguards and Chicago-area non-profit/government employees responsible for recreational water quality decisions. The discussion for life guards focused on questions regarding: (1) awareness about water quality testing, (2) notifying the public regarding water quality, (3) training, and (4) barriers to enforcing swim advisories/bans. The goal of the session with decision making agencies was to share the key outcomes/suggestions/concerns related to recreational water quality communications in the Chicago area as described by the various user groups, and discuss potential ways they could include these suggestions to improve current communication methods and content. This included feedback on specific brochures, websites, and signs developed by the concerned agencies.

Coding guides are used to categorize information obtained in FG interviews. The coding for this study was based on a conceptual model developed to describe the use of information by the public to use or not use surface waters for recreation, and to identify opportunities to promote healthy behaviors (Figure 1). The model differentiates between the time periods before, during, and after water use. Within each time period, factors that may promote, or counter, the choice of avoiding water recreation are identified, so that interventions can be developed with a goal of preventing recreational waterborne illness. For example, communicating poor water quality to the public who have not yet arrived at the beach may require different approaches and may need to address different motivations than an intervention designed at altering the behavior of those who have already arrived at the beach.

In total, 49 codes spanning eight categories, or 'families', of codes were created. Families were also defined by the conceptual model and are in bold in Figure 1. FG transcripts were coded using the qualitative data analysis package Atlas.ti (Muhr 2009) by a primary coder and reviewed by a content area expert to ensure accuracy and consistency, as well as fidelity with the coding guide. Data were analyzed through a four-step process: (1) identifying broad themes while coding transcripts, (2) examining code families to identify subtopics and key points within groups of codes, (3) exploring family level concepts and comparing them

between families, and (4) characterizing the behaviors of each user group based on family level concepts.

Intercept interviews (INTs)

Staff approached swimmers at Lake Michigan beaches in Chicago. At the time the study was conducted, 'swim advisories' were issued at Chicago beaches if a water sample collected the previous day had an *E. coli* density of ≥ 235 most probable number (MPN)/100 mL, and a 'swim ban' was issued for *E. coli* of $\geq 1,000$ MPN/100 mL. Beaches remain open during swim bans. Recruiting took place on days of swim bans, days of swim advisories, and days without beach notification. We use the term 'beach notification' to include both advisories and swim bans. Participants were asked if they were aware of signs currently posted at access points, what the signs conveyed, and how (if at all) they used the posted information. Participants were also asked whether and in what ways they changed their activities or plans based on information available at beaches. INTs were conducted in English only and data were analyzed using the SPSS Inc., statistical software (IBM, USA).

Although some FG participants were primarily users of the Chicago River system, an engineered urban waterway not used for swimming, this report is based only on information obtained regarding Chicago's Lake Michigan beaches.

Human Research Subjects: The protocol was approved by the University of Illinois at Chicago Institutional Review Board. We obtained written documentation of informed consent from adults and parental consent for children.

RESULTS

Participants

A total of 492 people participated in the FGs and the INTs.

FGs: 118 water recreators participated in the 13 FG sessions (plus two additional sessions for lifeguards and environmental/health officials). Participants were predominantly female (67.8%) and adult (97.4%). More than half of the participants had a college degree.

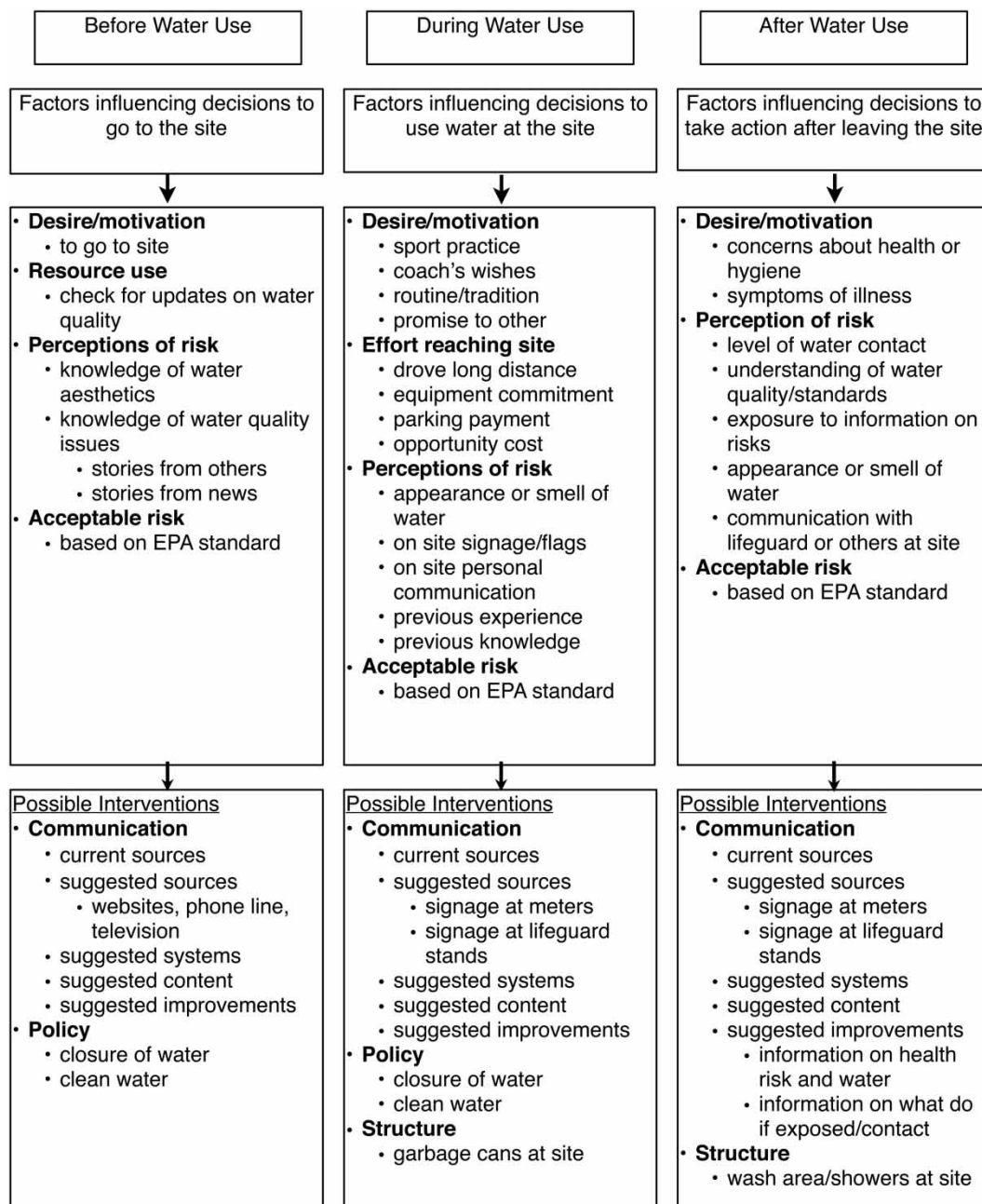


Figure 1 | Conceptual model of factors influencing water use decision-making.

INTs: At eight Lake Michigan beaches 374 people participated, 288 of whom (77%) were recruited at beaches that had no notification in effect on the day of the interview. Over 12 days, 30 (8.02%) participants were recruited at beaches during swim bans, and an additional 56 (14.9%) at beaches during swim

advisories (seven days of advisories and/or bans at various beaches). The majority of the participants were female (66.6%) and 95% were adults (mean age 37.3, range 12–89 years).

The following broad themes were identified in the FGs and INTs.

Awareness of water quality information

Searching on Google was the most commonly mentioned approach to obtaining water quality information among participants in all 13 FGs. However, INT data indicate that few people interviewed at beaches sought water quality information before coming to the beach: five of 86 beachgoers (6%) on days with a swim ban/advisory, and none of 288 at beaches when no advisory/ban was in place. In 10 of 13 FGs, television was mentioned as a source of information used prior to the beach visit; newspapers, and marine radio were popular among fisherman and boater FGs. Internet and TV were also the most popular sources for information prior to arrival at the beach among INTs. Lake Michigan beach users (both FGs and INTs) were largely unaware of the Chicago Park District (CPD) website for beach water quality (www.chicagoparkdistrict.com/resources/beaches/) and the Illinois Department of Public Health (IDPH) website about beach water quality (<http://app.idph.state.il.us/envhealth/ilbeaches/public/>). FG participants found the Park District website very attractive and user-friendly, although they liked the idea of having access to the testing data in the IDPH website. Participants expressed interest in using both these websites in future. Overall, Spanish-speaking swimmers in general indicated that they were not aware of any official website or sign in Spanish that provided water quality information at Lake Michigan; they did not comment on the content of brochures, websites, or current signage, which were only in English. They relied mostly on Spanish TV channels or the community newspaper (La Raza) for any information on Michigan beach closures or swim bans. As one participant summed it up, 'Yes, it's a question of the internet. Many Hispanics don't have access to this information. Let's keep in mind many people don't use the internet.'

Several Spanish-speaking swimmers reported going to the beach only to realize that the beach was closed for swimming. As one participant reported, 'I was really frustrated not long ago just because we biked over and there were no lifeguards and no flags ... but someone told us the beach was closed.'

Participants in all 13 FGs mentioned that signs/flags were the most significant source of water quality information when at Lake Michigan beaches. However, English

speaking FG swimmers rarely mentioned noticing any signs or colored flags upon arrival at Lake Michigan beaches. This is consistent with the observations of INT participants: only 17.3% ($n = 65$) of whom mentioned seeing any signs/flags the day of their interview. On days of swim ban/advisory only 13 of 86 (15%) INT participants reported seeing any sign or an advisory flag.

Speaking to lifeguards was considered important among FG swimmers, especially during an advisory or swim ban. However, in their FG session, lifeguards said they were largely unaware and untrained regarding current water quality testing procedures at beaches, which limited their ability to communicate with beachgoers. As one life guard said, 'Yeah, they usually tell us whether it's clear, we have a green flag, if there's some *E. coli*, but it can't affect you, it's yellow, or if there's too much, then a red flag. We would wanna know how it's caused, 'cause when somebody asks you, Do you know how it's causing? You say, I don't know. It feels dumb if you're telling them to stay out because of it.'

Preferred sources/systems for beach water quality information

For FG participants, 'not knowing where to look' was the biggest limitation to finding water quality information. A single website containing all local recreational water quality information was recommended. In general, FG participants were excited about the possibility of receiving beach notification information using social media, particularly via Facebook, and to a lesser degree, via Twitter. When asked what would be a desired source of water quality communications for future use, participants in 10 of 13 FGs wanted water quality information about a specific beach through the weather report – either on television, online, on the radio or in the newspapers. As one participant said, 'If we're thinking of going to the beach for a family trip, we'll go to weather.com or whatever. So, if you had an ad there that was just like, thinking about going to the beach today? Look here to see which ones are safe or not, I would like, click on that 'cause we've been thinking about going to the beach.' Participants in eight of 13 groups mentioned TV news channels as a good source for this information without having to go online. 'Now, because of

television, cable and all that other things ... the news comes up and they say whatever beach is closed and why. I definitely want warning alerts put on the news, radio and television. It's probably what most people would get, that kind of instantaneous news.' Similarly, 70% ($n = 264$) of the INT respondents recommended using the internet and TV for providing the public with beach water quality information.

INT respondents wanted to see more prominent signage in parking lots, or at the beach entrance (before they paid for parking), in restrooms, and at the lifeguard stands. This was also suggested by FGs to prevent the frustration of paying for parking, only to find out that a swim ban is in place.

Participants in 11 of the 13 FGs suggested that a color-coded system of flags or signs worked best, but they wanted to know how color categories are defined. Participants in nine of 13 FGs felt that a rating system (numeric scale, percent of the permissible concentration of bacteria, or the probability of getting sick) may also work, although they acknowledged that this may be too much information for a sign. FG swimmers felt that lifeguards should be able to explain the reasons for swim bans or advisories.

Understanding health risk information contained in beach notification

Participants in all four swimmer FGs wanted to know what an 'advisory' or 'yellow flag' meant. The connection between beach notification and microbial measures of water quality was generally not apparent; many participants were unsure about whether posted advisories were for elevated bacteria levels, chemicals in the water, or because of wave conditions. Among participants interviewed at beaches while a swim ban/advisory was in place, only 13 of 86 noted a sign or flag, of whom only five reported knowing what the flag or sign meant.

FG participants described their own ways for evaluating risk that were unrelated to signage or flags at beaches. Good water quality was generally described in terms of the absence of negative aesthetics: foul smells, floating debris, or cloudy water. The presence of animals in the water was cited as evidence of good water quality in 10 of 13 FGs. Some participants were interested in knowing more than *E. coli* concentrations. 'I'm not sure if bacteria count only would give me any information that I could use. You

know, and also what type of illness it might be likely to cause if I were to ingest it or if I were to get it on my skin ... I need to know.' Participants in all 13 groups felt they need more specific information to make an 'informed decision'.

Swimmers at Lake Michigan beaches wanted to know the difference between an advisory and closure, or swim ban: 'understanding the reasons behind why the beaches were closed on any given day' was important to them. They felt this will help them decide if they want their children to play in the water. Parents of small children and those who had had (or knew of) episodes of gastrointestinal symptoms following water recreation were unique among FG participants in that they did perceive a risk of GI as a result of swimming at the beach.

FG participants provided insights into aspects of beach water testing and reporting that resulted in a low level of concern regarding health risk at beaches. Participants in five of 13 FGs described a lack of trust for government agencies responsible for water quality testing (at Lake Michigan beaches and elsewhere). Participants in 11 of 13 FGs indicated that they would pay more attention to notifications if they knew when the information was 'last updated' and 'what was tested'. One participant said, 'I don't know if the information is still valid and applicable. I just have noticed that the signs are old and so I wonder sometimes the water quality could be better now. Hey, it could be worse. Who really knows?'

Participants in most groups wanted more information about four topics: water quality, water monitoring, health outcomes, and recommendations for safe use of recreational waters. Nine of the 13 FGs wanted to know 'who tests the waters' and felt that having information about 'the type of illness or consequence'; 'what am I exposed to today'; and 'the odds of the consequences' were important factors in adhering to a sign/flag. This, as well as details about why an advisory was issued on a given day, were noted by some FG participants as information they would like to use in deciding whether to allow their children to play in the water. A question asked infrequently was, 'Is it ok for my child to swim on during an advisory?' Several groups raised specific concerns about recreational safety and health, typically framed in general terms, such as requests for information about the 'do's and don'ts' of safe recreation.

For example, 'That sign didn't give me any information about why that water wasn't suitable. What I was getting exposed to and what their potential consequence could be? What would be the odds of those consequences?' said one fisherman.

Perceptions of risk and behaviors influenced by many factors

When asked about recreational water quality in Chicago, one club leader said, 'It's in such an interesting setting of the lake and the river (in Chicago) that paddlers are willing to put up with it to access some really incredible recreational paddling opportunities.' Perceptions varied by the type of user, for example, rowers were the most risk averse of all the groups in most categories, and believed that '... signs were important to people who had no experience'. Rowers noted that they '... would swim in Lake Michigan beaches regardless of the signs or what a lifeguard says because they see it as vastly cleaner than other waterways (in Chicago)'. Spanish speaking swimmers are often unable to make use of signs that are in English. They follow the lifeguard advice, however they feel that '... if Americans are in the water it's safe to go'.

Any previous illness or knowledge of illness, or having children (especially swimmers with families), and influence of peers, especially among fishermen, were also some other factors taken into consideration while making a decision to use a waterway.

Although one or two participants mentioned previous illness or knowledge of someone falling sick after spending time in a Chicago waterway, none discussed any specifics. Participants across all 13 groups mentioned concern about 'bacteria' or '*E. coli*'; however, none of them discussed any symptoms related to exposure, or knew exactly how it could make them sick.

Among beach users interviewed, 42.8% mentioned having any health concerns related to water quality at Chicago beaches. Presence of bacteria or *E. coli* in the water was the primary concern cited by over 58% of these participants. Other concerns included 'dumping', 'presence of chemicals', 'sewage discharge from the river', 'invasive species such as zebra mussels and fish', and 'floating trash/garbage'.

FG participants generally were not aware of the existence of federal, state, or local water quality standards, though in the majority of groups some participants were aware that *E. coli* is monitored at beaches, and that public notification regarding *E. coli* takes place. Nine of the 13 groups also wanted to know more about the values of pollutants that trigger advisories or swim bans at beaches. 'They'll out a little snip at the end of the 10:00 news that 10 second thing ... when they tell you on TV not go in Lake Michigan by the beaches. There's a level there. That's the only standard I ever heard of.'

Although a general mistrust of government agencies posting water quality information was mentioned among participants in 5 of 13 FGs, when asked about the importance of health and safety messages posted by government agencies at water recreation spots, over 78% of the intercept interviewees felt such messages were important to them. Less than 10% thought that such messages were never helpful. The rest thought that they 'did not care' about such health and safety messages or that they were 'not at all important'. When beachgoers were asked about their awareness regarding specific health and safety messages posted by the CPD at Chicago beaches, over 54% were aware of the general rules about littering the beaches, however awareness about specific rules regarding 'feeding the birds', 'disposal of diapers' or 'not swimming when ill' was lower (less than 40%). Five participants mentioned that they did not understand the 'do not feed the birds' rule.

Acceptability of risk

FG participants were asked, 'If 1,000 people go swimming at a beach, how many cases of GI are acceptable: 1, 5, 10, 25, or 100 cases?' Responses were typically 5 or 10 cases of GI illness per 1,000 people; at least one participant in eight of the groups considered 25 cases to be acceptable. However, most fishermen and Spanish-speaking swimmers thought the risk should be zero. Outside the context of swimming at beaches, competitive rowers were comfortable with higher levels of risk (100 cases per 1,000). Participants in eight of 13 FGs noted that the targeted risk level should be lower for children, the elderly, and those with limited immune systems. 'If I saw a sign that said eight per thousand in this beach and it meets Federal Standards and I had a three year old, I

would think twice about all of a sudden letting them into that water. So there needs to be some context.'

Participants in all 13 FGs thought that the targeted risk level should be lower if the outcome is severe illness. As one participant mentioned, 'If it were like, incredibly serious, especially missing practice or school, then one of a thousand because I think, I wanna higher standard if I'm gonna be sick for two days.' Most FG participants felt that information such as the expected cases of illness per 1,000 users need to be provided along with, or instead of, the bacteria levels themselves.

DISCUSSION

As noted by Covello (1998), the overall goal of risk communication should not be to diffuse public concerns but rather to produce an informed public that is involved, interested, reasonable, thoughtful, solution-oriented, and collaborative. Figure 2 outlines the key steps that we *a priori* assumed may be significant in the process of translating water quality notification to behavior change.

Users of recreational waters identified, through FGs and INTs, several gaps in the steps that we assumed may be important to translating existing water quality communication messages into behavior change. As outlined in Figure 1, opportunities to prevent recreational waterborne illness differ before, during, and after water recreation. Water quality or beach notification information is rarely sought before a beach visit, and once at the beach, few swimmers were aware of signs or flags. Only 6% (5/86) of beachgoers interviewed at beaches with a swim

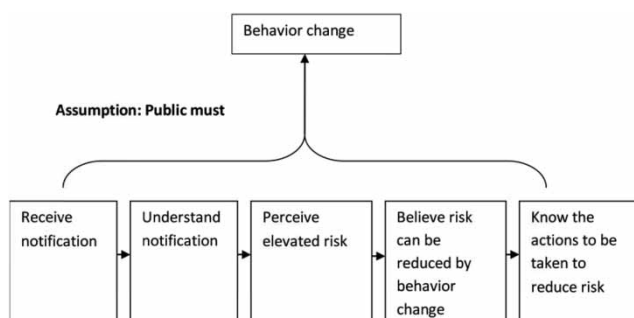


Figure 2 | Assumption on how notifications can translate to behavior change and risk reduction.

ban/advisory had sought information prior to coming to the beach that day, indicating a need to educate the public about the availability of information that may help them avoid the frustration of traveling to the beach during a swim ban. There is much room for improvement regarding on-site signage or flags as only 15% reported seeing any sign or an advisory flag that day. None of 288 interviewees at open beaches mentioned looking for any information. Lake Michigan beach users (both FG and INT participants) were largely unaware of the currently available beach water quality websites.

Among the subset that saw flags, many did not know what they meant. Only 5/13 (38%) participants who observed a flag or sign at beaches during a swim ban/advisory reported knowing what the flag or sign meant. Given that all four swimmer FGs wanted to know what an 'advisory' or 'yellow flag' meant, the concept of 'advisory' should be better explained, or potentially, eliminated. Among the subset who reported seeing signs at beaches, many were suspicious of posted information because it did not state when the information was posted or what triggered a beach advisory. Participants in nine of 13 FGs wanted to know 'who tests the waters' and felt that having information about 'the type of illness or consequence', 'what am I exposed to today', and 'the odds of the consequences' were important factors in adhering to a sign/flag.

A perception of risk in relation to water quality appears to be driven by the absence of negative aesthetics, rather than by information in signage, which generally lacks specific information about bacteria levels, adverse health outcomes, or estimates of risk for those outcomes. Perceptions varied by the type of user and their motivation to use the waterways. Given that the perceived risk of illness was generally not related to water quality information, the idea of reducing risk through behavior change was rarely mentioned. The course of action to take in response to an 'advisory' (yellow flag) was not clear. Knowing proper actions to take in order to reduce risk was clear when life-guards communicated directly with study participants, even in the absence of any prior awareness of water quality or any perceived risk of swimming.

Access to information, use of notification systems and perceptions of risk are strongly influenced by the type of audience (user) and therefore need to be considered to

enhance receptiveness, access and content of public health messages and delivery methods.

Based on FG/INT findings, several recommendations for improving the content of beach water communications messages and message delivery can be offered (Table 1). Website postings and social networking outlets were of interest to FG participants. Making the public aware of these communication methods should be prioritized, as this information could be used to prevent the frustration of traveling to a beach where a swim ban or advisory is in effect. Given that only 17.3% ($n = 65$) of participants surveyed at all the beaches mentioned seeing any signs/flags on the day of the INT (including on the days of advisories and swim bans), information should be easy to find and include large signs and/or flags posted prominently at numerous locations, including parking lots. The timeliness of the information, both online and at beaches, should be noted (e.g. 'today's water quality is ...'). Some locations in the USA, and elsewhere, now use social media to disseminate the most recent measures of water quality at a beach (SCCWRP 2013; SEPA 2013).

Participants were generally not aware about available sources of local water quality information – online or at the beach. For those who were aware of the signs/flags, message content was not specific enough for them to

appreciate. For example, most participants felt that the color-coded flags that were used as part of the beach advisory system need to be supplemented with information about bacterial counts or outcomes of exposure. In order to perceive the level of risk, message content must include: up to date information (for example, date and time of testing), from trusted sources (such as a federal agency versus a local agency), with some health outcome information (how sick can I get? who is at risk?). The cause for beach notifications should be presented, perhaps in relation to the relevant standard, along with information about potential health outcomes (e.g. 'Levels of bacteria were about double the standard today. This may increase the risk of vomiting and diarrhea'). The degree of risk considered acceptable varied across groups, and was also dependent on the severity of expected outcomes, as well as who might be impacted (children, the elderly). Rowers were the most risk averse, indicating that educating the public about federal standards and the severity of outcomes may be important in dispelling myths about water quality.

A study supported by the Centers for Disease Control and Prevention (CDC) found that the public will respond to a threat situation by seeking protective information and taking self-protective action, underlining the critical role of effective communication in public health emergencies (Wray et al. 2008). While recreational water quality related illnesses are not public health emergencies, they are public health problems that can be prevented via effective communication. Our study participants also desired more information on how to protect themselves, for example, over 65% of beachgoers said they value hygiene messages posted at beaches, but many still do not understand why they should not feed the birds (which is part of an initiative to reduce the number of gulls at beaches).

Similar to prior studies about perceptions of water quality and health risk at beaches, our research identified media reports about beach closures, seeing signs advising not to swim, and prior bouts of illness following swimming as factors that negatively impact the perception of water quality at beaches (Pendleton et al. 2001). We also found that an individual's initial perception of water quality is often based on the color, clarity, odor, and visible debris in the water (Canter et al. 1993; House 1996; Jensen & McLellan 2005). Like previous studies, our results suggested that perception

Table 1 | Recommendations for improving beach communications, improving access to information and educating the public

Desired message content

When was sampling and analysis performed
 Agency or laboratory that performed the testing
 Anticipated or potential health outcomes
 Groups at higher risk for illness or for more severe illness
 Reason for beach notification: bacteria level with context (relative to an EPA standard)

Strategies for improving communications

Involve local user groups as stakeholders in message development
 Educate lifeguards about recreational water testing and how to effectively communicate reasons for a given beach notification
 Educate beachgoers about what they can do to improve and protect their recreational waters
 Use the weather channel or website to post beach water quality status
 Post signs and flags at more access points such as parking lots and vendor stalls
 Avoid the current ambiguity of 'advisory' or 'yellow flag' status

of risk was influenced by the individual evaluating the risk, their fears, and sensitivity to risk (Sjoberg 2000; Wakefield & Elliot 2003). For example, collegiate rowers were the most risk averse. Similarly, personal use of water ways, historical changes in the water, knowledge of contaminants and water quality issues, trust in public officials (Canter *et al.* 1993) and information from the media (Wakefield & Elliot 2003; Jensen & McLellan 2005) were key factors in how the users perceived risk. Pendleton *et al.* (2001) found that media played a very important role in public perception of bathing health risks and that media sources of information about ocean water quality contributed to an elevated sense of risk among study participants.

The information provided by FG and INT participants was in some cases contradictory. Although FG participants noted wanting much more information than is currently available, INT participants were generally not aware of posted information, even during advisories and swim bans. This suggests a need to improve awareness of current signage and flags, and to improve understanding of that information.

The final FG was conducted to engage employees of local, state, and federal governmental agencies in Chicago that manage surface water quality. We shared user concerns related to water quality communication content and current delivery methods used by these agencies, and discussed possible solutions. Since this research was conducted, the CPD initiated a campaign to educate beach visitors and lifeguards about water quality and available online resources (CPD 2012). A texting service, beach hotline phone number, website, as well as Facebook and Twitter now provide the swim status at each beach, while Beach ambassadors continue to educate beach goers about what they can do to help keep Chicago beaches clean.

Summary of findings regarding targeted risk levels

The EPA's 1986 Ambient Water Quality Criteria (USEPA 1986) were based on what is referred to as 'acceptable risk', though in the absence of input from communities that use public beaches, 'targeted risk' is a more appropriate term. The new 2012 RWQC refers to 'estimated illness rates' that would be expected if states establish specific water quality standards; however, the issue of acceptability of specific

estimated illness rates by users of recreational waters was not addressed. To the best of our knowledge, this is the first description of stakeholder perspectives on the acceptability of risk. Many FG participants identified 10 cases of illness per 1,000 swimmers as acceptable, lower than the examples of 32 and 36 cases of gastrointestinal illness per 1,000 swimmers used in the 2012 RWQC. However, there is nuance to acceptability, and based on our findings, the acceptability of risks specifically to children are lower than risks acceptable for adults. This suggests that microbial standards established by states may need to be lower than the beach action values noted in the RWQC in order to account for the public's acceptance of risk. Future work to further define the acceptability of risk by the public could include the 'willingness to pay' and other approaches used in economic research.

No more than a few prior studies evaluated beach notification practices and their impacts on the public (Wisconsin Department of Natural Resources 2002; Indiana Department of Environmental Management 2007; Heal the Bay 2008). These reports also highlight a generally low level of awareness of water quality information at beaches and even lower reports of adherence to beach notifications, along with some insights regarding why beachgoers may not adhere to advisories. Two recent studies attempted to evaluate the notification methods currently used as part of the USEPA Beach Program in various states (Pratap *et al.* 2011; USEPA 2011). Both studies interviewed local and state beach program managers and reviewed existing reports of beach user surveys and beach notification studies. The present study is the first systematic effort to bring user groups, non-profit/government agencies and lifeguards together for FG discussions specifically to evaluate local recreational water quality communications.

Strengths of this research include the application of quantitative methods to evaluate shortcomings of current beach communications practices, while qualitative methods were used to gain insight into the roots of these shortcomings and to identify, based on beachgoer input, suggestions for improvement. Limitations of the study include representativeness: although we sought representation from diverse stakeholders, we are unable to estimate the degree to which our findings apply to other groups in other locations. Outside of extreme storm events, Chicago beaches are not

impacted by point sources of pollution; perceptions of risk and information desired by the public may be different in areas impacted by wastewater or industrial pollution. Recent growth of social media is not uniformly distributed across age groups; therefore, health communication programs utilizing social media must first consider the age of the targeted population to help ensure that messages reach the intended audience (Chou *et al.* 2009). Had the FGs included more people in the teens and twenties, perhaps we would have observed greater use of smart phones and other approaches to obtaining water quality prior to a beach visit. While 'acceptable risk' appears to be within the range upon which current US recreational water quality criteria are based, a more complete picture would be obtained using relative valuation approaches and by conducting FGs in other parts of the USA. Additionally, had we varied elements of the definition of gastrointestinal illness (such as the presence or absence of vomiting or fever; or the need to miss school/work), more specific information about acceptability would have been gleaned.

CONCLUSIONS

Despite the substantial commitment of resources to water quality monitoring, there is much room for improving the communication of test results to the public in a way that promotes behavior change (avoidance of swimming when bacteria levels are thought to be elevated). The public's need for accurate, accessible, timely, and concrete sources of beach water quality information, and guidance on actions needed for protection of self and family, are areas in which current messaging can be improved. While direct communications with lifeguards appear to be understood, signs at beaches are generally not noticed and when they are, they are often not understood. The suggestions for improved message content and delivery should be implemented and evaluated. The internet, smart phones, and social media are opportunities for effective communications, and health promotion. Educating lifeguards and the public about current testing criteria, information sources, and how they can contribute may be good initial approaches. Greater consideration of disease severity and additional evaluations of risk acceptability are important

steps that would be useful in establishing water quality standards. In this preliminary assessment, the degree of risk acceptable to the public appears to be lower than those presented in the US EPA's 2012 Recreational Water Quality Criteria.

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