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Enteric pathogens in stool samples of Chicago-area water recreators with new-onset gastrointestinal symptoms☆

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ABSTRACT

Background: Characterizing pathogens responsible for recreational waterborne gastrointestinal illness is important in estimating risk and developing management strategies to prevent infection. Although water recreation is associated with sporadic cases of gastrointestinal illness, pathogens responsible for such illness are not well characterized.

Methods: A prospective cohort study was conducted enrolling non-water recreators (such as cyclists and joggers) and two groups of limited-contact waters recreators (such as boaters and kayakers): those on an effluent-dominated urban waterway and those on general use waters. Stool samples were collected from participants who developed gastrointestinal symptoms during a three-week follow-up period. Samples were analyzed for bacterial, viral, and protozoan pathogens. Logistic regression models were used to identify associations between water recreation and the presence of pathogens in stool samples.

Results: Among 10,998 participants without gastrointestinal symptoms at baseline, 2,429 (22.1%) developed at least one symptom during 21 days of follow-up. Of those, 740 (30.5%) provided at least one stool sample, of which 76 (10.3%) were positive for a pathogen. Rotavirus, found primarily among adults, accounted for 53 of the 76 (70%) infections. Among participants with symptoms, pathogen presence was not associated with water

Abbreviation: AGI, Acute gastrointestinal illness; CAWS, Chicago Area Waterways; CDC, Centers for Disease Control and Prevention; CHEERS, Chicago Health, Environmental Exposure, and Recreation Study; CLIA, Clinical Laboratory Improvement Amendments; GI, Gastrointestinal; GUW, General Use Water; IDPH, Illinois Department of Public Health; NEEAR, National Epidemiological and Environmental Assessment of Recreation Water; OR, Odds Ratio; PCR, Polymerase Chain Reaction; RWGI, Recreational waterborne gastrointestinal; STEC, Shigatoxin producing *E. coli*; UIC, University of Illinois at Chicago; UIMC, University of Illinois Medical Center; UNX, Unexposed; WBDOSS, Waterborne Disease Outbreak Surveillance System.

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recreation or the extent of water exposure. The range of pathogens that could be identified and sample size limitations may have contributed to this lack of association.
Conclusions: We did not find specific pathogens or groups of pathogens associated with recreational waterborne gastrointestinal illness. Although pathogens responsible for outbreaks of waterborne gastrointestinal illness have been described, microbes that cause sporadic cases remain poorly defined.

1. Introduction

The US Centers for Disease Control and Prevention (CDC) Waterborne Disease Outbreak Surveillance System (WBDOSS) summarizes and evaluates reported outbreaks of recreational waterborne illness. From 2003 to 2008 39 outbreaks of gastrointestinal involving 559 people on untreated waters (lakes, rivers, beaches) were reported (Yoder et al., 2004, 2008a; Dziuban et al., 2006; Hlavsa et al., 2011). Etiologic agents in the outbreaks of recreational waterborne gastrointestinal illness (RWGI) were bacteria (including *Escherichia coli* O157:H7, *Shigella* spp., *Plesiomonas* spp.), viruses (norovirus), and protozoa (*Cryptosporidium*). Additionally, case-control studies have identified associations between water recreation and outbreaks of gastrointestinal (GI) illness caused by *E. coli* O157:H7 (Ackman et al., 1997; Bruce et al., 2003; Keene et al., 1994) and norovirus (Baron et al., 1982; Sartorius et al., 2007). Outbreaks generally occurred in inland waters, locations that are thought to present a unique risk to water recreators due their limited capacity to dilute pathogens (relative to coastal waters), as well as the proximity of inland waters to fecal pollution sources (Dorevitch et al., 2010).

Cohort studies of water recreation have identified cases of RWGI that have not been part of recognized outbreaks of disease. The US National Epidemiological and Environmental Assessment of Recreation Water (NEEAR) study found that RWGI attributable to swimming is fairly common. Compared to non-swimmers, approximately 25–35 more cases of gastrointestinal illness occurred per 1000 swimmers at marine (Wade et al., 2010) and freshwater (Wade et al., 2008) beaches. Although these studies involved a combined total of 13,070 swimmers (participants who underwent body immersion), no outbreaks were reported in the literature or identified by WBDOSS at the times and locations of NEEAR data collection in marine or freshwater. Sporadic cases of RWGI (those that occur outside of the setting of recognized outbreaks) have also been reported among swimmers in US inland waters (Marion et al., 2010) and following head immersion in several European inland waters (Wiedenmann et al., 2006). We recently described findings of the Chicago Health, Environmental Exposure, and Recreation Study (CHEERS), a cohort study of limited contact water recreation (canoeing, kayaking, boating, fishing, and rowing) in Chicago area waters. The risk of gastrointestinal illness attributable to water recreation was approximately 15 per 1000 people (Dorevitch et al., 2012). More than 7700 water recreators participated in the study; again, outbreaks of RWGI were not identified by public health surveillance systems.

Given that sporadic cases of RWGI appears to be fairly common (unlike recognized outbreaks of relatively severe infections), characterizing the pathogens responsible for such illnesses may be valuable. If it were known which microbes cause sporadic cases of RWGI, measured concentrations of those microbes could be useful for estimating health risks using quantitative microbial risk assessment methods. Determining whether pathogens responsible for sporadic cases of recreational waterborne illness are bacterial, viral, or protozoan could also be useful in identifying pathogen sources and developing strategies to reduce pathogen loads in recreational surface waters. As presented in Fig. 1, individuals without water exposure are at risk for developing gastrointestinal symptoms due to "background factors" that may be caused by infectious agents (foodborne or via person-to-person transmission) or may be caused by factors other than infection (medication side effects, lactose intolerance, etc.). Those with

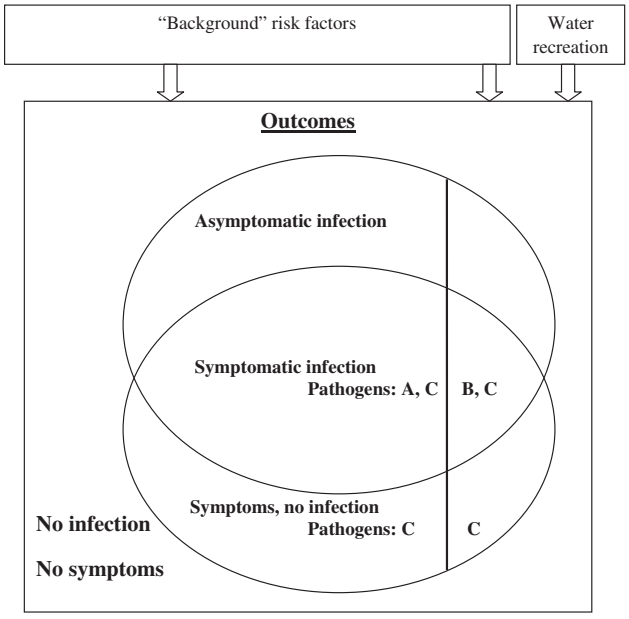

Fig. 1 – A conceptual model for this study. All participants have background risk factors for developing gastrointestinal symptoms, which include infectious and non-infectious causes. Symptoms and infections among water recreators have additional risk factors, including infectious hazards (right side of the vertical line). Study participants may develop symptoms, infection, both, or neither. Stool samples were requested from study participants with symptoms, some of whom had infections. Letters A–C refer to the (potentially overlapping) sets of pathogens that cause infection unrelated to water recreation (A), waterborne pathogens acquired during water recreation (B), and those causing asymptomatic infection (C).