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Estimating the economic burden from illnesses associated with recreational coastal water pollution—a case study in Orange County, California

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Abstract

A cost-of-illness framework was applied to health and income data to quantify the health burden from illnesses associated with exposure to polluted recreational marine waters. Using data on illness severity due to exposure to polluted coastal water and estimates of mean annual salaries and medical costs (adjusted to 2001 values) for residents of Orange County, California, we estimated that the economic burden per gastrointestinal illness (GI) amounts to $36.58, the burden per acute respiratory disease is $76.76, the burden per ear ailment is $37.86, and the burden per eye ailment is $27.31. These costs can become a substantial public health burden when millions of exposures per year to polluted coastal waters result in hundreds of thousands of illnesses. For example, exposures to polluted waters at Orange County's Newport and Huntington Beaches were estimated to generate an average of 36,778 GI episodes per year. At this GI illness rate, one can also expect that approximately 38,000 more illness episodes occurred per year of other types, including respiratory, eye, and ear infections. The combination of excess illnesses associated with coastal water pollution resulted in a cumulative public health burden of $3.3 million per year for these two beaches. This paper introduces a public health cost variable that can be applied in cost-benefit analyses when evaluating pollution abatement strategies.
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1. Introduction

A large body of epidemiological research has shown that exposure to recreational waters contaminated with human and animal waste can result in several types of illnesses including gastroenteritis (GI), acute respiratory disease (ARD), and eye, ear and skin infections (Saliba and Helmer, 1990; Prüss, 1998; Haile et al., 1999; Dwight et al., 2004). These illnesses are caused by enteric bacteria, viruses and protozoa that are found primarily in human wastewater, and are not endemic to recreational waters. The majority of these illnesses are self-limiting and place little demand on the health care system, and yet they are debilitating to various degrees, which can result in associated costs. Several researchers have suggested that illnesses associated with coastal water pollution can have significant health and economic impacts on society (Fleisher et al., 1998; Gerba et al., 1996; Henrickson et al., 2001; Saliba and Helmer, 1990; Corbett et al., 1993; Haile et al., 1999). A recent study estimated that globally polluted coastal waters generate 120 million excess GI episodes and 50 million ARD episodes every year, resulting in $12 billion per year in public health costs (Shuval, 2003).

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Domestic sewage discharged along coastlines has historically been the primary source of marine coastal water pollution for recreational bathing beaches in the USA. However, with few exceptions, most sanitation facilities across the United States have been upgraded to comply with USA federal law. The attention of policy makers is now being focused on the potentially larger problem of untreated urban runoff. Urban runoff contains a mixture of non-point source pollutants that are suspended in water from irrigation runoff, households, and storm events, as well as contributions of raw sewage from degrading infrastructure and accidental spills. Research of high density urban and industrial landscapes show infectious and toxic pollutants are routinely released into runoff waters (Bay and Greenstein, 1996; Gold et al., 1991; Field et al., 1993).

Urban runoff is of particular concern in the Southern California region of the USA where the large population and vast expanse of impermeable surfaces generates large volumes of polluted runoff water that can discharge onto popular coastal beaches. Untreated urban runoff is considered the most significant source of water pollution impacting Southern California's coastal waters, estuaries and bays (Southern California Coastal Water Research Project, 1991; California Resource Agency, 1997; Schafer and Gossett, 1998; Noble et al., 2000; Dwight et al., 2002).

In one large-scale epidemiological study of illnesses associated with polluted recreational marine waters, researchers measured the severity of the resulting illnesses by evaluating length of illness, and whether or not the subjects had to see a doctor (Fleisher et al., 1998). Values were collected for four illness types (GI, ARD, eye and ear infections), and the data were used to ascertain the severity of the water-associated illnesses. The researchers concluded that excess illnesses associated with recreational waters have a significant impact on public health.

Understanding the severity of symptoms and estimating the economic impact from recreational water-related illnesses is important because the information can aid the decision making process related to pollution abatement strategies. To illustrate the utility of this approach, we estimated the economic impact on public health from exposure to polluted coastal water at two popular beaches.

2. Methods

In order to quantify the health costs per water associated illness, we applied the 'cost-of-illness' framework to health data on illness-related lost activity days and medical care use generated from an epidemiological study of recreational coastal water users (Fleisher et al., 1998), and to annual income data and medical care costs for residents of Orange County, California (USDC, 2004; Nichol, 2001). We then show in an example how these results can be used to estimate the annual public health burden for recreational beaches by combining our cost per illness results with published results of a model that estimated the number of water associated GI illnesses for a specific site (Turbow et al., 2003).

To calculate the cost per water-associated illness, we used the cost-of-illness approach which focuses on health damages, or costs following the onset of illness (Berger et al., 1994). This is an attractive method for estimating economic values for morbidity effects because it uses actual data of financial costs directly measured in a market setting, such as lost earnings and medical services from illness (Kenkel, 1994).

The variables in the model include estimates of illness severity (proportion of persons with lost normal-activity-days, and proportion requiring a medical visit per illness episode) for each type of illness; the average annual salary of the population; the proportion of illnesses that require professional medical attention; and the medical costs associated with an illness.

2.1. Data

Data on illness severity came from the only published measures of illness severity for illnesses associated with contaminated recreational water (Fleisher et al., 1998). The values were collected during randomized intervention follow-up epidemiological studies conducted at four beaches in the United Kingdom. For our cost-of-illness valuation, we only used health data from subjects classified as bathers, and censored data from non-bathers. Subjects were adult volunteers (>18 years) and the final cohort ($n=548$) had a mean age of 32 years; 54% were male. Although several types of illnesses have been associated with exposure to waterborne pathogens, including some rare but severe illness (Saliba and Helmer, 1990; Prüss, 1998), the current study was restricted to GI, ARD, ear and eye ailment illness outcomes as a conservative estimate of the total burden of illness.

Subjects in the study by Fleisher et al. (1998) were considered to have an illness only if they reported a composite of certain symptoms known to be associated with a particular illness lasting for over 24 h, or if there was clinical confirmation of symptoms. Subjects were classified as having GI if they reported experiencing vomiting or diarrhea, or all cases of nausea, indigestion, diarrhea or vomiting that were accompanied by a fever. Subjects were classified as having ARD if they reported experiencing at least one symptom from each of the following three categories: (1) fever; (2) headache and/or body-aches and/or unusual fatigue and/or anorexia; and (3) sore throat and/or runny nose and/or dry or productive cough. Subjects were classified as having an ear ailment if they showed clinical evidence of ear infection or inflammation by medical examination, or if the subject reported ear pain with or without discharge. Subjects were classified as having an eye ailment if they reported incidence of sore, red, eyes with or without discharge.

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