Health Effects Associated With Recreational Coastal Water Use: Urban Versus Rural California

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We compared rates of reported health symptoms among surfers in urban North Orange County (NOC) and rural Santa Cruz County (SCC), California, during 2 winters (1998 and 1999) to determine whether symptoms were associated with exposure to urban runoff. NOC participants reported almost twice as many symptoms as SCC participants during the 1998 winter. In both study years, risk increased across symptom categories by an average of 10% for each 2.5 hours of weekly water exposure. Our findings suggest that discharging untreated urban runoff onto public beaches can pose health risks. (*Am J Public Health*. 2004;94:565–567)

Coastal waters along public beaches can be polluted by urban runoff, which is water that carries non–point-source pollution via surface waterways to the ocean.[1] A variety of illnesses have been associated with exposure to polluted recreational coastal waters.[2–4] In this study, which involved 2 geographic watersheds differing in terms of urbanization, we measured reported health effects on individuals with high levels of exposure to coastal waters.

METHODS

North Orange County (NOC), California, was the "urban" site because its watershed is 1 of the most developed areas in the world and generates highly polluted runoff waters.[5–9] We selected Santa Cruz County (SCC), California, as the comparison "rural" site because of its coastal water quality indicators (Figure 1) and watershed characteristics.

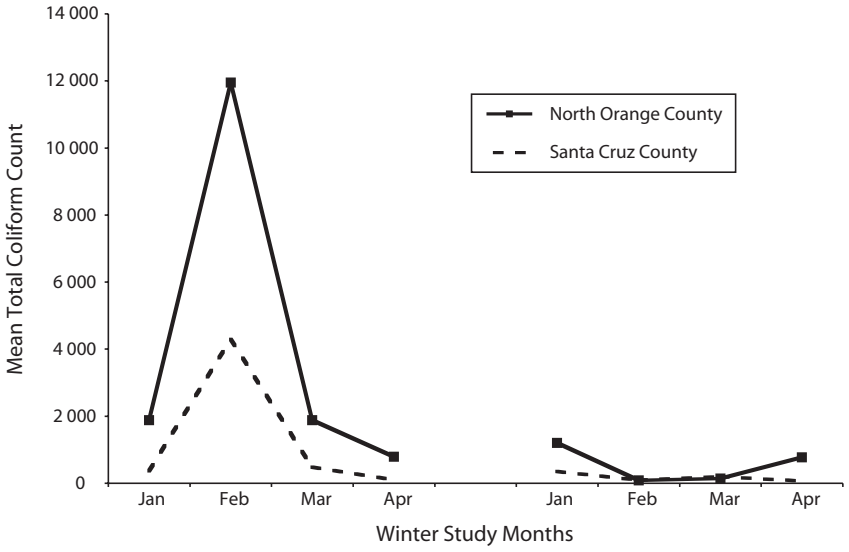

FIGURE 1—Mean monthly total coliform counts (per 100 mL) during 1998 El Niño and 1999 La Niña winters: North Orange County and Santz Cruz County coastal waters (data provided by Orange County Health Care Agency and Santa Cruz Health Agency).

We conducted 2 cross-sectional surveys of surfers from NOC and SCC, 1 in April 1998 and 1 in April 1999, and gathered data on reported health symptoms (e.g., vomiting, diarrhea, sore throat) experienced during the previous 3 months. The 1998 El Niño winter had led to record high precipitation throughout California, while the 1999 La Niña winter had led to record low precipitation in NOC. NOC had lower total rainfall than SCC in both years, yet the former had higher coastal water coliform (a water quality measure of pollution) levels (Figure 1).

Surfers were selected as the study population because of their regular exposure to coastal waters. Interviewers at surfing beaches recruited participants by approaching all individuals who had wetsuits and surfboards. Those who reported surfing at least once a week and were 18 years or older were eligible to be interviewed. Demographic information was collected, as well as information on symptoms experienced during the previous 3-month period. Participants also reported the amount of time they were exposed to coastal waters.

Multiple reports of 1 symptom were combined, allowing only 1 symptom report per participant, equivalent to a 3-month period prevalence. Logistic regression analysis was used to estimate adjusted odds ratios (ORs) comparing symptom reporting rates between the 2 counties, stratified by year. The final logistic model included the following variables: county, water exposure, gender, age, occupation, educational level, annual income, political outlook, and level of concern about water quality. The latter 2 variables were included to control for potential reporting bias associated with perspectives about the potential health effects of environmental pollution and water quality.

RESULTS

In 1998, investigators interviewed 479 participants in NOC and 374 in SCC. In 1999, investigators interviewed 662 participants in NOC and 358 in SCC. At each site, response rates were above 80% in both 1998 and 1999. The mean age of the participants was 30 years, and 93% were male.

The urban versus rural analysis showed that NOC participants reported almost twice

TABLE 1—Odds Ratios for Reported Symptoms: North Orange County and Santa Cruz County, 1998 and 1999

	1998 (El Niño Winter)		1999 (La Niña Winter)	
	OR	95% CI	OR	95% CI
Any symptom	1.85	1.36, 2.52	1.17	0.87, 1.57
SRD	1.29	0.91, 1.82	0.75	0.53, 1.05
HCGI	2.32	1.27, 4.25	0.97	0.62, 1.51
Fever	1.63	1.08, 2.44	0.89	0.61, 1.28
Nausea	1.18	0.74, 1.90	0.89	0.58, 1.36
Stomach pain	2.51	1.45, 4.32	0.90	0.60, 1.37
Vomiting	2.13	0.95, 4.78	0.84	0.46, 1.53
Diarrhea	2.10	1.33, 3.31	1.06	0.69, 1.63
Sinus problems	1.41	1.05, 1.91	1.25	0.93, 1.68
Cough	1.36	0.96, 1.91	1.10	0.80, 1.51
Phlegm	1.33	0.92, 1.92	0.52	0.35, 0.76
Sore throat	1.96	1.42, 2.70	1.55	1.13, 2.14
Eye redness	2.44	1.20, 4.93	1.42	0.60, 3.33
Ear pain	1.36	0.89, 2.09	1.55	0.98, 2.46
Skin infection	1.93	1.12, 3.33	0.71	0.42, 1.21

Note. Odds ratios (ORs) were adjusted for water exposure, gender, age, occupation, education, income, political outlook, and level of concern about coastal water quality. CI = confidence interval; SRD = significant respiratory disease (fever and sinus problems, fever and sore throat, or cough and phlegm); HCGI = highly credible gastrointestinal illness (vomiting, diarrhea and fever, or stomach pain and fever).

as many symptoms overall as SCC participants (OR=1.85; 95% confidence interval [CI]=1.4, 2.5) during the 1998 El Niño winter (Table 1). In that year, NOC participants reported higher rates of every symptom. During the 1999 La Niña winter, NOC participants reported only slightly more symptoms than SCC participants (OR=1.17; 95% CI=0.9, 1.6) and reported slightly higher frequencies in regard to 6 of the 12 symptoms. Odds ratios decreased consistently across all symptoms between the 2 winters. In both study years, risk increased across almost every symptom category by an average of about 10% (OR=1.1) for each additional 2.5 hours of water exposure per week.

DISCUSSION

Results from this investigation and other studies[9,10] suggest that discharging untreated urban runoff onto public beaches can pose health risks. This conclusion is supported by the higher reporting rates of symptoms among urban NOC participants during the rainy 1998 El Niño winter, after controling for possible confounding (due to demographic characteristics) and reporting bias (due to concern about coastal water quality). The exposure–response relationship demonstrated for most of the symptoms further supports this conclusion. Direct associations have been reported between pollution levels in runoff waters and urban land use, population levels, and amount of impervious surface area in the watershed.[11–15]

Research on the health consequences of urban runoff represents a relatively new area of investigation, despite decades of urban runoff contaminating coastal waters.[7,12] Most previous epidemiological studies focused on waters contaminated with domestic sewage, and the majority found associations between water pollution levels and incidence levels of symptoms.[2–4,16–21] Most epidemiological studies of recreational water use have focused on single exposure events rather than exposure over time.[2,3] Our study assessed 3-month prevalence rates of symptoms and demonstrated that average symptom prevalence was associated with different levels of water pollution.

To reduce the potential for confounding, we sampled from the same source population during both years and used comparable groups of surfers with relatively similar social characteristics. The high participation rates (above 80%) lowered potential bias due to selective participation. The study was cross sectional, which represents a limitation in terms of assessment of symptoms over a 3-month period, but any recall bias was likely to be nondifferential and toward the null. To reduce potential differential reporting bias, we adjusted for participants' level of concern about coastal water quality. Another limitation is that we did not measure water quality at the sites, so we were unable to determine the specific nature of the pollutants associated with symptoms.

In summary, this study suggests that discharging untreated urban runoff onto public beaches can pose health risks. These potential health risks warrant greater public health surveillance, as well as greater efforts to reduce pollutants discharged onto public beaches. Large-scale prospective investigations are needed to further characterize the health risks of people exposed to untreated urban runoff in coastal waters. ■

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Contributors

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Human Participant Protection

The use of human participants in this study was approved by the institutional review board of the Univer-

sity of California at Irvine. The participants provided verbal informed consent.

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