

III.2.2 Selected Recreational Water Epidemiology Studies Based on Nonwastewater Effluent Sources of Fecal Contamination

United States (Calderon et al., 1991)

Calderon et al. (1991) followed the health status and swimming activities of volunteer participants. This study is included in the meta-analysis of Wade et al. (2003). The study site was a small pond (3 ac) located in a semirural and largely forested community in Connecticut. An intense sanitary survey of the surrounding watershed indicated that no human sources of fecal contamination impacted the stream that fed the pond, and there were no point sources of microbial pollution.

Water samples were analyzed for *E. coli*, enterococci, fecal coliforms, *P. aeruginosa*, and staphylococci. A total of 104 families participated in the study. Swimming was defined as a day in which an individual swam in the pond, and during swimming activity, completely submerged their head and body beneath the surface of the water. There were 1,310 exposure-days accumulated by swimmers and 8,356 person-days for nonswimmers.

Water quality data were collected on 49 days of the study. The geometric mean *E. coli* density was 51 CFU/100 mL. Rain occurred on 16 of the 49 days of the study. The geometric mean densities of *E. coli* and fecal coliforms were determined to be over two times greater on rainy days than on dry days; levels of enterococci were four times higher on rain days than dry days. The densities of staphylococci and *Pseudomonas* were about the same during rainy and dry periods.

The symptomatic GI illness rate in swimmers was 22.9 per 1,000 person-days, whereas, in nonswimmers, the rate was 2.6 per 1,000 person-days. Gastrointestinal illness was also strongly associated with swimming when adjusted for age. However, no association was found between high fecal indicator bacteria densities and GI illness in swimmers or between swimmer illness and high-volume rain days. The authors suggested that swimming-associated illness may have been due to etiological agents that were transmitted from swimmer-to-swimmer via bathing water.

The data from this study indicate that illness in swimmers was not statistically associated with densities of commonly used fecal indicator bacteria in a recreational water whose source was rainwater runoff from a forested watershed. These results led the authors to conclude that currently recommended bacterial indicators (i.e., *E. coli* and enterococci for fresh recreational waters per USEPA, 1986) are "...ineffective for predicting potential health effects associated with water contaminated by nonpoint sources of fecal pollution."

Hong Kong (Cheung et al., 1990; Holmes, 1989)

Cheung et al. (1990) and Holmes (1989) described a prospective cohort study that was conducted in two phases in the summers of 1986 and 1987. The first phase involved four popular beaches and tested the epidemiological techniques used in the second phase (main study) that incorporated results from nine beaches. The main study was undertaken to provide data for deriving health-related bathing water quality standard specific to the conditions of Hong Kong. Six of the beaches in the main study were predominately impacted by human sewage, two were