

Quantitative microbial risk assessment (QMRA) shows increased public health risk associated with exposure to river water under conditions of riverbed sediment resuspension

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Abstract

Although higher microbial concentrations have been reported in sediments than in the overlying water column, most quantitative microbial risk assessment (QMRA) studies have not clearly indicated the contribution of sediment-borne pathogens to estimated risks. Thus, the present study aimed at determining the public health risk associated with exposure to pathogenic bacteria in polluted river water under undisturbed conditions and conditions of sediment resuspension in the Apies River, Gauteng, South Africa. Microbial pathogens were isolated and identified using culture and molecular methods. The beta-Poisson dose-response model was used to estimate the probability of infection (Pi) with the various pathogens, following accidental/intentional ingestion of 1 mL or 100 mL (or 50 mL) of untreated river water. Mean wet season *Escherichia coli* counts ranged between $5.8E + 01$ and $8.8E + 04$ MPN/100 mL (water column) and between $2.40E + 03$ and $1.28E + 05$ MPN/100 mL (sediments). Mean dry season *E. coli* counts ranged between $5.11E + 00$ and $3.40E + 03$ MPN/100 mL (water column) and between $5.09E + 00$ and $6.30E + 03$ MPN/100 mL (sediments). Overall (water and sediments) *Vibrio cholerae* was the most detected pathogen (58.8%) followed by *Salmonella* spp. (23.9%) and *Shigella* (10.1%). Ingestion of 1 mL of river water could lead to 0%–4% and 1%–74% Pi with *E. coli* during the dry and wet season, respectively. During the dry season, the Pi with *V. cholerae*, *Salmonella* spp. and *Shigella* spp. were 0%–1.39%, 0%–4.11% and 0%–0.16% respectively, depending on volume of water ingested. The risks of infections with all microorganisms increased during the wet season. A 2-log increase in water *E. coli* count following sediments disturbance led to approximately 10 times higher Pi with *E. coli* than when sediments were undisturbed. Therefore, the use of the untreated water from the Apies River for drinking, household purposes or recreational activities poses a potential health risk to the users of the river.