

Prioritizing hazardous pollutants in two Nigerian water supply schemes: a risk-based approach

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Objective To rank pollutants in two Nigerian water supply schemes according to their effect on human health using a risk-based approach.

Methods Hazardous pollutants in drinking-water in the study area were identified from a literature search and selected pollutants were monitored from April 2010 to December 2011 in catchments, treatment works and consumer taps. The disease burden due to each pollutant was estimated in disability-adjusted life years (DALYs) using data on the pollutant's concentration, exposure to the pollutant, the severity of its health effects and the consumer population.

Findings The pollutants identified were microbial organisms, cadmium, cobalt, chromium, copper, iron, manganese, nickel, lead and zinc. All were detected in the catchments but only cadmium, cobalt, chromium, manganese and lead exceeded World Health Organization (WHO) guideline values after water treatment. Post-treatment contamination was observed. The estimated disease burden was greatest for chromium in both schemes, followed in decreasing order by cadmium, lead, manganese and cobalt. The total disease burden of all pollutants in the two schemes was 46 000 and 9500 DALYs per year or 0.14 and 0.088 DALYs per person per year, respectively, much higher than the WHO reference level of 1×10^{-6} DALYs per person per year. For each metal, the disease burden exceeded the reference level and was comparable with that due to microbial contamination reported elsewhere in Africa.

Conclusion The estimated disease burden of metal contamination of two Nigerian water supply systems was high. It could best be reduced by protection of water catchment and pretreatment by electrocoagulation.

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Introduction

In the fourth edition of the *Guidelines for drinking-water quality*, the World Health Organization (WHO) reiterates that a risk-based approach should be used to inform management decisions on the safety of drinking-water supplies.¹ This approach entails the comprehensive assessment of both the risk to health and risk management and should encompass all stages of the water supply system, from water catchment to human consumption.¹⁻³ In contrast, the concentration-based approach relies solely on determining whether the end product complies with standards that ensure consumer safety.² Nevertheless, even with the risk-based approach, the concentration of contaminants in water ultimately determines the level of risk. However, in addition to concentration, the risk-based approach also takes into account parameters such as the level and duration of exposure to contaminants, their toxicity and the severity of the diseases they produce in assessing the need for mitigation. Furthermore, since this approach involves estimating the number of disability-adjusted life years (DALYs), it provides a framework for systematically comparing the disease burden associated with different pollutants,⁴ whether microbial, chemical or radiological.¹

In this paper, we used a risk-based approach to identify the pollutants that posed the greatest risk to human health in two Nigerian water supply schemes and which should, therefore, be prioritized for removal.

Methods

Two water supply schemes in Nigeria were investigated: the Asejire and Eleyele schemes in Oyo State, which was included in "hydrological area 6" in the WHO and United Nations Children's Fund (UNICEF) country report for Nigeria.⁵ The Asejire scheme, which was commissioned in 1972, is located in a suburb of the metropolis of Ibadan, about 30 km east of the city centre; the Eleyele scheme, which was commissioned in 1942, is situated within the metropolis. Ibadan is the capital of Oyo State and covers the largest area of any city in any country in tropical Africa.⁶ It is also the third most populous city in Nigeria: in 2010, the population was 2 893 137.⁶

The two water supply schemes are managed by the Water Corporation of Oyo State and together provide an urban piped water supply to around 25% of the people in Ibadan.^{7,8} Water for the Asejire scheme is collected by a dam on the River Osun and the level is maintained at about 81 m⁷ throughout the year, thereby ensuring a regular supply. Farming is prohibited in the catchment area⁷ and trees were planted on the banks of the dam to prevent soil erosion and silting. The Eleyele scheme's dam collects water from two major rivers: the Ona and Ogunpa, which pass through Ibadan and are often polluted with effluent from unregulated industrial, commercial and residential quarters.⁷ Water for the treatment works is abstracted using a low-lift pump in the Asejire scheme and by gravity in the Eleyele scheme. Water purification is carried out using the conventional techniques of screening, aeration, coagulation, flocculation, sedimentation, filtration and chlorination. Treated water is delivered to consumers by tankers and through a pipe distribution system, which includes high-lift

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