Title: Potential health risks of occupational exposure to microbiological contaminants in recycled water destined for non-potable reuse

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Abstract

Introduction

In the face of growing water scarcity, recycled water (RW) is increasingly used for non-potable purposes including irrigation, to ease the pressure on freshwater resources. Despite treatment, RW can present health risks to end-users due to potential microbiological contamination.

Aim and Objectives

This study aimed to evaluate potential health risks from occupational exposure to microbial contaminants during RW non-potable reuse, focusing on microbial quality changes from discharge to point of use (PoU).

Materials and Methods

An exploratory study was conducted at four wastewater treatment plants (WWTPs) and one site receiving RW from one of WWTPs for non-crop irrigation in Tshwane Municipality. In total, 503 water samples were collected over 12 months from discharge points, ponds and tanks, and PoU. Samples were analysed for total coliforms (TCs) and *Escherichia coli*, *Enterococcus* spp., and *Legionella pneumophila* using IDEXX Colilert-18/2000, Enterolert-E, and Legiolert kits, respectively. Samples were also

analysed for *Salmonella* spp. presence/absence and identification using culture and the InvA gene real-time PCR.

Results and Discussion

The microbiological quality of RW was benchmarked against Department of Water and Sanitation (DWS) and World Health Organization (WHO) guidelines for safe RW reuse involving human exposure which are <1000 MPN/100mL for TCs, *E. coli*, and *Enterococci*, and undetectable for *Salmonella* and *L. pneumophila*. Total coliforms (683333–4840000 MPN/100ml), *E.* coli (648000–3596800 MPN/100ml), and *Enterococci* spp. (1600–28000 MPN/100ml) levels consistently exceeded DWS and WHO limits at several points, including PoU, across all sites. Similarly, *L. pneumophila* concentrations (1767–25800 MPN/100ml) were out of specification and *Salmonella* was detected by culture at several points including PoU, at four of five sites.

Conclusions

The study reveals persistently high microbial levels in RW probably due to systemic operational inefficiencies like chlorine shortages and cable theft. Therefore, workers involved at the studied sites face increased risks of gastrointestinal and respiratory infections, if control measures are not in place.