



Occurrence, Human Health Risks, and Public Awareness Level of Pharmaceuticals in Tap Water from Putrajaya (Malaysia)

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Abstract

Pharmaceutical residue pollution remains as an underexplored issue, especially in Asian countries. Along with that line, the purpose of this study was to investigate the occurrence of pharmaceutical residues in tap water and its associated potential health risks, involving a total of 80 Putrajaya residents. Besides, this study also aimed to evaluate public awareness (knowledge, attitude, and practice) levels with regards to pharmaceutical handling. The highest pharmaceutical residue occurrence was caffeine (0.38 ng/L) while the lowest was diclofenac (0.14 ng/L). These pharmaceutical residue occurrences in tap water were linked with rapid urbanization and industrialization in river water, poor removal efficiencies in wastewater and drinking water treatment plants as well as improper pharmaceutical waste handling and disposal from the general public. The potential health risks (RQ_T) indicated residents in Putrajaya with ages between 61 and 75 were exposed to the highest health risks caused by the pharmaceutical residues in tap water. In general, low public awareness (knowledge, attitude, and practice) levels were identified with only 44.5% of Putrajaya population having good knowledge, 27.5% having good attitude and 1.6% having good practice related to pharmaceutical handling and its effect to tap water quality. Findings of this study reflected the importance of public awareness program to educate the general public on proper unused/expired handling and disposal to minimize pharmaceutical pollution.

Keywords Pharmaceuticals · Tap water · Potential risks · Public awareness

Introduction

In southeast Asia, the urbanization rate is estimated at 41.8%, and about 245 million people are living in the urban areas (OECD Rights and Translation Unit 2008). Rapid

urbanization rate can be associated with elevated anthropogenic pollutants via point and non-point sources. Along this line, occurrence of emerging pollutants such as pharmaceuticals, phthalate esters, pesticides, and steroid hormones have been detected in river water (Huo et al. 2007; Kasprzyk-Hordern et al. 2007; Archana et al. 2017; Praveena et al. 2018), wastewater (Fang et al. 2019) and even in drinking water (Wen et al. 2014; Yang et al. 2014) as a results of urbanization. Currently, occurrence and impacts of emerging pollutants in an environment are not well understood as emerging pollutants are not included in routine monitoring program although these pollutants have been released for a long time (Klumpp et al. 2015). Over the last 15 years, pharmaceuticals have received growing interest due to pharmaceuticals and associated excretion by human and inefficient removal by sewage treatment plants (Kaushik et al. 2016; Kaushik and Thomas 2019). Pharmaceutical residues have been detected in the environment of river water (Chen and Zhou 2014; Matongo et al. 2015), groundwater (Clara et al. 2004; Bottoni et al. 2010) and wastewater (Niazay et al.

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