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Drinking water consumption and association between actual and perceived risks of endocrine disrupting compounds

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Drinking water contains emerging contaminants, i.e., endocrine disrupting compounds (EDCs). However, the extent to which it is publicly viewed as a potential risk that requires attention (public awareness, political obligation, and regulatory efforts) is substantially underrated. Thus, this study investigated drinking water consumption patterns among consumers of different life stages, evaluated household practices using tap water as daily drinking water, and examined the actual risk as well as consumers' perception of tap water quality for drinking with the potential EDCs contamination. Collectively, the present study is of great concern for regional database profiling and supporting human health risk assessment in regulating contamination and exposure of EDCs. It also provides an empirical and theoretical contribution to current public risk perception of EDCs in tap water, and promoted the formulation of risk communication and governance strategies for the development of risk behaviors in adopting public participation in the drinking water supply system monitoring and management framework.

INTRODUCTION

The principal chemical constituent of the human body, water controls biochemical reactions within cells, acts as a material transport medium, and maintains adequate blood volumes[1]. Water is also influential in human health, comfort, and performance, as body water regulates human thermal environments (human thermoregulation), thereby controlling physiological and psychological responses[2]. Dehydration of body mass (≥2%) can cause impaired thermoregulatory function and elevated cardiovascular strain, also taking time to accumulate[3]. Thus, drinking enough water is essential to restore the large quantity of water lost daily.

While drinking water is mandatory to maintain life for survival, there is little consensus on safe drinking water access for consumption. Over the past few decades, the concerns about quality of drinking water supply were limited to (i) microbial contamination, (ii) aesthetic problems, and (iii) chemical contents[4–8]. The chemical contaminants were mostly disinfectants, disinfection by-products, nutrients, metals, and major ions. Water contamination and the subsequent health issues were due to both natural processes and anthropogenic activities originating primarily from the industrial revolution[9]. To date, threats to the global drinking water supply system (i.e., water source pollution, incomplete removal, and water supply insecurity) and insufficient regulatory frameworks have prompted human exposure to emerging organic pollutants, especially endocrine disrupting compounds (EDCs) via daily consumption of drinking water, especially tap water. Trace concentrations of EDCs such as pharmaceuticals, drugs, personal care products, hormones, plasticizers, and pesticides were detected in global drinking water[10]. The broad scopes of EDCs are reviewed for having endocrine disrupting effects through a variety of modes of action and mechanisms, thus causing health effects in exposed individuals and populations in the form of acute and chronic diseases.

EDCs are released from point and non-point sources. Many hydrophilic and persistent EDCs are able to penetrate through water utility systems that were designed to remove only traditional pollutants and contamination is released, even with advanced treatment technology, due to the various physicochemical properties, transport pathways, and fates of the EDCs[10]. Thus, the presence of EDCs in the drinking water supply (tap water) was mainly due to the inadequate remediation technologies in drinking water treatment plants, other than the influences of land use on the pollution in the drinking water sources (surface water). Meanwhile, variation in treatment efficiency of EDCs is potentially impacted by their corresponding pollution levels in raw water[11]. Further, the dynamics and partitioning of EDCs in the distribution network depend upon varying design and operation of the system[12].

Alternatively, the use of additional household water utility systems (e.g., filtration and purification devices) at home or other point of use is commonly practiced, especially in developing countries whose drinking water is of uncertain quality. To date, membrane processes such as reverse osmosis and nanofiltration have been promoted as more capable of remediating EDCs[13]. Further, water purification requires membranes with improved selectivity relative to permeability[14]. Replacing conventional polymers with emerging materials, ultrafast molecular separation membranes are highly selective towards emerging organic pollutants[15]. However, water purifiers have recently been highlighted as a source of contamination of EDCs in drinking water, particularly of organophosphate flame retardants[16]. Consequently, the concerns about removal efficiency, cost effectiveness, and sustainable use remain while households are trying to reduce the risk of contaminants exposure and waterborne disease arising from contamination during water supply distribution and storage.

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