

The Role of Fluoride, Cadmium and Water Hardness in Drinking Water: A Critical Study of Potential Factors of Chronic Kidney Disease of Unknown Etiology (CKDu) in the Prevalence Area, Sri Lanka

W.S.M. Botheju¹, J.A. Liyanage²

Chronic Kidney Disease of unknown etiology (CKDu) is a major public health problem in North Central Region in Sri Lanka, and it is receiving global attention due to the absence of clear evidence to determine the causative factors. Although indisputable epidemiological data are lacking, high concentrations of water hardness, fluoride, cadmium, and other heavy metals in drinking water could be major causes for the prevalence of CKDu. Therefore, the present investigation was carried out to assess the role of fluoride (F), cadmium (Cd) and water hardness in drinking water sources as potential risk factors for CKDu in a prevailing area of Sri Lanka. Drinking water samples were randomly collected from 30 dug wells in Girandurukotte Grama Niladhari Division (GND), Badulla District and Buddhangala GND in Ampara District (as reference sampling site) in the dry season (June 2019), Sri Lanka. Cd and F contents of the collected drinking water samples were analyzed using Inductive Coupled Plasma Mass Spectrometry and Fluoride meter respectively according to the standard procedures. Total water hardness values were calculated based on calcium and magnesium contents which were analyzed using Atomic Absorption Spectrometry. Each analysis was performed in triplicates. Results were statistically analyzed using MINITAB 17 software. Inverse distance weight (IDW) and spatial autocorrelation (Moran's Index - MI) tools in ArcMap 10.2.2 software were used to interpolate the spatial distribution patterns of F, Cd and total hardness in collected water samples. According to the results, mean F, Cd, and total hardness values of analyzed water samples in Girandurukotte GND were 1.64 ± 0.04 mg/L, 0.124 ± 0.074 μ g/L and 83.60 ± 4.02 mg/L respectively. Mean F content of the analyzed water samples in the CKDu prevalence area exceeded the maximum permissible levels of SLS standards (SLS 614: 2013, F - 1.0 mg/L) whereas the total water hardness values indicated the 'moderately hard water' (60 to 120 mg/L). As per the results, mean Cd concentration in Girandurukotte GND consented with SLS standard limits (Cd - 3.00 μ g/L). Furthermore, mean F, Cd and total hardness values in reference sampling site were 0.504778 ± 0.076 mg/L, 0.018 ± 0.006 μ g/L and 30.76 ± 8.06 mg/L respectively and those results complied with SLS standard limits. Mean water hardness values in the reference sampling site indicated the 'soft water' (0 to 60 mg/L). According to the statistical analysis, F, Cd and total hardness values in Girandurukotte GND were significantly higher compared to the reference site ($P < 0.05$). Moran's indices of F, Cd and total hardness in Girandurukotte GND were -0.013, -0.006, and -0.011 respectively as per the Moran's Index Tool. Based on the results, it can be concluded that high concentrations of fluoride, water hardness and long term exposure to heavy metals such as cadmium can lead to the occurrence of CKDu prevalence. Therefore, utilization of treated water can be recommended as a preventive measure of CKDu in the study area and these findings can be used as a benchmark in the water supply design processes in CKDu affected areas.

Keywords: CKDu; Fluoride; Cadmium; Water hardness; Drinking water

¹ Department of Chemistry, University of Kelaniya, Kelaniya, Sri Lanka, shermilambotheju@gmail.com

² Department of Chemistry, University of Kelaniya, Kelaniya, Sri Lanka