THE CONTRIBUTION OF DRINKING WATER TOWARDS DENTAL FLUOROSIS: A CASE STUDY OF NJORO DIVISION, NAKURU DISTRICT, KENYA

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Abstract. This study was carried out to measure the fluoride levels of water consumed in the Njoro division of Nakuru district, Kenya. The sources of drinking water, methods of water storage and utilisation, as well as the perceptions of the local community towards dental fluorosis and the percentage of children with moderate to severe dental fluorosis were also determined. Rainwater had mean fluoride levels of 0.5 mg L\(^{-1}\), dams 2.4 mg L\(^{-1}\), wells 4.1 mg L\(^{-1}\), springs 5.5 mg L\(^{-1}\), and boreholes 6.6 mg L\(^{-1}\). Water stored in plastic and cement containers did not show appreciable reduction in fluoride content with storage time; water stored in metal containers reduced fluoride by up to 8.2%; water stored in clay pots had the highest reduction in fluoride content, ranging between 34.3 and 64.7%. Forty eight point three percent of children observed in the area had moderate to severe dental fluorosis, even though most people in the area did not know the cause of the problem. There is need to educate the community on the causes of fluorosis, and to lay strategies for addressing the issue, such as encouraging more rainwater harvesting, treating drinking water with alum, or using clay pots for storage of drinking water.

Key words: boreholes, drinking water, fluoride, fluorosis, rivers, storage, wells

1. Introduction

Fluoride is found in rocks, plants, animals, air, and water in varying concentrations. Because it is highly reactive, fluoride commonly exists in the ionic form as fluoride, and enters the human body by ingestion, inhalation, and, in extreme cases, through the skin. Water borne fluoride is absorbed more rapidly than food borne fluoride (Låg, 1990). The fluoride absorbed by the body, if not excreted, can cause teeth and nail striations (Hui, 1985), dental fluorosis, or on prolonged exposure to high levels of fluoride, skeletal fluorosis.

In its mild form, mottled teeth have little public health significance, apart from causing embarrassment to the affected. However, it may bring about excessive wear of the teeth, and mastication can be affected (Hui, 1985). Severe fluorosis makes teeth more susceptible to dental caries. In skeletal fluorosis, the skeleton increases in density, and osteophytic outgrowths appear on the long bones, vertebrae, and ribs.

The East African Rift Valley is a known high fluoride zone (Nanyaro et al., 1984), and health problems associated with high fluoride ingested by humans are
prevalent. ‘Unmodified’ waters in the Rift Valley were defined by Clarke et al. (1990) as waters whose chemical composition is derived from normal water–rock interaction at moderate temperatures. These waters show relatively high fluoride concentrations (up to 180 mg L$^{-1}$), signifying that the leaching of the Rift Valley volcanic rocks is an important contributor to fluoride levels in the waters. Rift Valley volcanics exhibit high alkalinity (pH > 7); and are high in sodium, potassium, bicarbonate, as well, as chloride and fluoride (Gaciri and Davies, 1993). Calcium and magnesium are low as they are precipitated, largely as carbonates. Williamson (1953) found the highest levels of fluoride in groundwaters in the Rift Valley to be 39.0 mg L$^{-1}$ from wells, and 43.5 mg L$^{-1}$ in boreholes.

The majority of foodstuffs in Kenya contain less than 1 mg kg$^{-1}$ fluoride, but tea and lake fish are notable exceptions (Njenga, 1982). Given the various possible sources of fluoride in Kenya, it is important to evaluate the amounts of fluoride ingested by people in various parts of the country. This study was conducted to assess the contribution of drinking water to fluoride intake by the residents of Njoro in Nakuru district in the Kenya Rift Valley.

The specific objectives of the study were the following.

(i) To determine the fluoride levels of different water sources in the region, to identify sources with the lowest levels.
(ii) Determine the water storage methods in use, and how they affect the levels of fluoride ingested.
(iii) Determine how different water treatment methods used by households affect fluoride levels.
(iv) Determine water utilisation patterns, and how they affect fluoride ingestion.
(v) Investigate the rates of teeth mottling among children born and raised in the region.
(vi) Determine the attitudes towards dental fluorosis by various households in the region.

2. The study area

The study area (Figure 1) is located in the Kenya Rift Valley, and comprises the Njoro division of Nakuru district, and covers an area of 774 km$^2$. The population of Njoro is approximately 167,860, with approximately 23,975 households. The altitude varies from 1600 to 3050 m above sea level. Two permanent rivers, the Njoro (Ndarugu) River, originating from the Mau Hills, and Mbagaria River, originating from the Teret forest, occur in the division and drain into Lake Nakuru. The total annual rainfall ranges from 500 mm in the low lands to 1800 mm in the highlands falling during two seasons; the long rains from March to April, and the short rains from October to December.