

Health Risk Modeling and Biomarker of Fluorosis in the Fluoride Endemic Village of Maharashtra: A Cross-Sectional Study

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Abstract

Introduction: Fluorosis, a debilitating disease, causes dental mottling and bone deformities among other adverse health effects. The current epidemiological study focused on the status and markers of fluorosis in a fluoride endemic village of Maharashtra.

Material and Methods: The research conducted include fluoride determination in all water sources and urine samples, followed by a medical examination of dental and skeletal manifestations of fluorosis. Sampling was conducted annually across all three seasons. Exposure and bone fluoride uptake modeling was performed with estimated daily fluoride ingestion and urinary excretion levels.

Results: The medical examination of subjects showed 96.5% prevalence of dental fluorosis with high community fluorosis index of 1.18, while radiological findings revealed 63.15% prevalence of skeletal fluorosis. Duration of exposure, age of subjects and physiological symptoms like chronic joint pain were found to be significantly correlated with skeletal fluorosis ($p < 0.05$). No significant correlation with dental fluorosis was observed. Fluoride in drinking water showed seasonal variation with highest level in winter (6.54 mg/L) and lowest level in monsoon (0.54 mg/L). Consequently, the mean urinary fluoride concentration was highest in winter (9.37 mg/L) and lowest in monsoon (3.88 mg/L). Health risk assessment using EPA model revealed hazard quotient of 2, indicating high probability of adverse health effects. Multilogit regression demonstrated that subjects excreting urinary fluoride above 4 mg/L had 7.25 times higher odds of having skeletal fluorosis ($p < 0.05$). Exposure and bone fluoride uptake modeling based on estimated daily fluoride ingestion of 9.61 mg and urinary excretion of 7.18 suggested that the predicted mean fluoride concentrations in bone ash of subjects with and without skeletal fluorosis were found to be significantly different ($p < 0.05$).

Conclusion: The comprehensive risk evaluation in the study clearly brings out the high risk of fluoride exposure and adverse effects in Dongargaon village for the first time. Further, urinary fluoride was shown to be a significant biological marker for skeletal fluorosis. The study warrants implementation of immediate control measures at the study site. The fluoride exposure and uptake modeling will help in predicting prospective risk of fluorosis.