

COMPARISON OF SERUM AND URINARY FLUORIDE LEVELS AMONG FERTILIZER AND WOOD INDUSTRY WORKERS IN MANGALORE CITY, INDIA

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SUMMARY: Serum and urinary fluoride (F) concentrations are reported for 34 workers from the fertilizer industry and 55 workers from the wood industry in Mangalore City, India. Convenience sampling was employed to determine the F concentration in serum and urine using the ion selective electrode method. Workers employed in the fertilizer industry had higher serum F (0.077 ± 0.027 ppm) and urinary F (3.85 ± 1.66 ppm) than workers employed in the wood industry (0.037 ± 0.009 ppm and 0.97 ± 0.37 ppm). As expected, the serum and urinary F levels among exposed workers showed a strong correlation ($r = +0.81$). These findings indicate that phosphate fertilizer workers in India are at high risk of exposure to excessive amounts of F. Implementation of effective protective and regulatory measures confirming the Occupational Safety and Health Hazards (OSHA) standards or the Environmental Health & Safety (EHS) guidelines are recommended for phosphate fertilizer plants of India.

Keywords: Industrial fluoride exposure; Phosphate fertilizer workers; Serum fluoride; Urinary fluoride.

INTRODUCTION

Anthropogenic fluoride (F) is released into the environment from exhaust fumes and waste generated during various industrial procedures. The principal industries that release significant amounts of F include coal burning, the production of aluminum, steel, and phosphate fertilizers, and the manufacture of glass, ceramic, and brick products.^{1,2} Continual exposure to F-containing compounds often occurs in workers in these industries. In particular, workers employed in phosphate fertilizer industries have been found to have significantly high F concentrations in their bodies.^{3,4} Exposure to F can be through inhalation of gaseous F compounds released during processing and handling of fertilizer in the industry and through direct dermal contact. Since very little literature is available regarding the F level in body fluids of phosphate fertilizer industry workers in India,⁵ the aim of the present study was to evaluate the occupational risk of exposure to F among these workers in India.

MATERIALS AND METHODS

A cross-sectional comparative study was designed involving 34 male laborers working in an industrial phosphate fertilizer plant and 55 male laborers employed in the wood working industry in Mangalore city, India. Before beginning the study, the design of the project was approved by the local ethics committee. Participants in the study were in the 35–50 age group. Except for the risk of exposure to occupational F, both groups also shared the same characteristics with respect to socioeconomic status and food habits. A convenience sampling was employed

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with the informed consent of all the participants. Blood and urine samples were collected over a two-week period at the end of working hours (post-shift samples). After dilution with equal volumes of TISAB buffer, F levels in serum and urine were determined directly using an Orion F ion-specific electrode against a Ag/AgCl reference electrode. Data were recorded as parts per million (ppm) of F. The concentration of F in the drinking water in the region ranged from 0.5 to 1 mg/L.

RESULTS AND DISCUSSION

Table 1 gives the mean age and the mean period of employment of the male workers in the phosphate fertilizer plant and in the wood working industry.

Table 1. Mean age and period of employment of the male workers

Group	Mean age of the workers (yr)	Mean period of employment (yr)
Phosphate fertilizer workers	43.14	6.47
Wood workers	41.56	8.16

Table 2 shows the mean serum and urinary F concentrations of these two groups of workers. The differences in the F concentrations between the phosphate and wood working groups are statistically very highly significant.

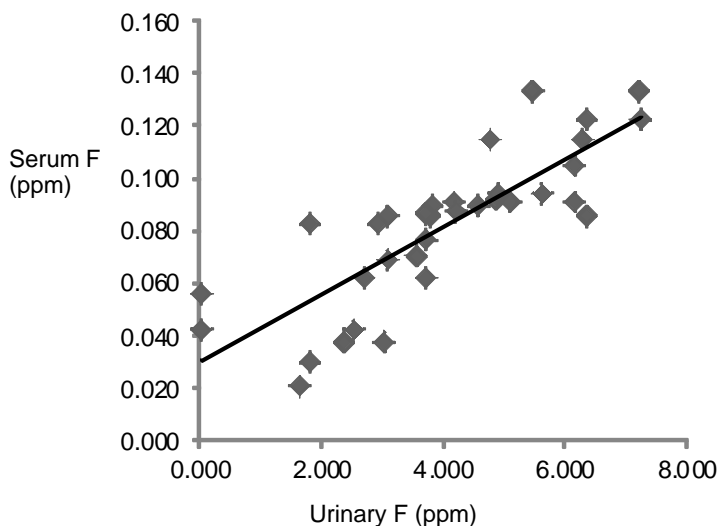
Table 2. Serum and urinary F of workers (mean±SD)

Group	n	Serum F (ppm)	Urinary F (ppm)
Phosphate fertilizer workers	34	0.077±0.027*	3.85±1.66*
Wood workers	55	0.037±0.009	0.97±0.37

*p<0.0001 compared with wood workers as controls.

The Figure shows that the relationship between the serum and urinary F concentrations of the F exposed workers is a good linear correlation ($r = 0.81$; $p < 0.01$).

Figure. Relationship between serum and urinary F in F-exposed phosphate fertilizer workers.



Past studies have shown that urinary F and serum F levels are valid biomarkers for estimating the levels of occupational exposure to F.^{3,6,7} In the present study the serum and urinary F levels of exposed workers were found to be more than twice as high as those in the wood worker controls. This finding is authenticated by some earlier studies conducted among fertilizer industry workers exposed to excessive amounts of F.^{8,9} Moreover, there was a strong positive correlation between the serum F and urinary F levels of workers employed in the fertilizer plant, indicating that the fertilizer industry workers are exposed to excessive amounts of F.

Several studies and reviews throw light on the hazardous effects of chronic occupational exposure to excessive amounts of F.¹⁰⁻¹³ The findings call for immediate implementation of regulatory and protective measures such as the OSHA standards,¹⁴ or the EHS guidelines,¹⁵ in the risk-prone occupational workspace, so that the health of the workers can be safeguarded as much as possible. These measure should especially apply in a developing country like India, where the “occupational safety and health (OSH) scenario is complex” owing to the “large unorganized work force, the availability of cheap labor, meager public spending on health, inadequate implementation of existing legislation, lack of reliable OSH data, shortage of OSH professionals, multiplicity of statutory controls, apathy of stakeholders, and infrastructure problems.”¹⁶

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