

## GASTRIC DISCOMFORTS FROM FLUORIDE IN DRINKING WATER IN SANGANER TEHSIL, RAJASTHAN, INDIA

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**SUMMARY:** A health survey of 1135 children and 1475 adults living in Sanganer Tehsil, Rajasthan, India, revealed a wide range of gastrointestinal (GI) discomforts associated with fluoride (F) in the groundwater in over 30 village areas. Complaints of abdominal pain including stomach ache, a bloated feeling, nausea, diarrhea, and constipation were recorded by questionnaires and interviews in low (<0.5 ppm F), medium (1.0-1.5 ppm), and high (>1.5 ppm) F water areas. Although the survey did not disclose GI discomfort among 360 children in the low nor among 375 children in the medium F areas, 8.50% of the 400 children (mainly 12 to 18 years old) in the high F area were suffering from stomach ache, 3.25% from a bloated feeling, 4.75% from nausea, 0.25% from diarrhea, and 0.25% from constipation. Among 458 adults in the low F village areas, 8.30%, 3.49%, 6.11%, 5.24%, and 0.87%, respectively, complained of stomach ache, a bloated feeling, nausea, diarrhea, and constipation, while among 489 adults in the medium F areas the percentages were 12.07%, 4.29%, 9.20%, 4.50%, and 1.64%, and among 528 adults in the high F areas they increased to 39.20%, 11.17%, 17.61%, and 18.94%, and 1.89%, respectively. The main complaint of children and adults was stomach ache, followed by nausea and a bloated feeling, with males more prone to these effects than females. Possible reasons for the prevalence of gastric distress in these F areas are poor nutritional and socio-economic conditions exacerbated by ingestion of F through drinking water and dietary habits.

Keywords: Constipation; Diarrhea; Gastrointestinal discomfort; Groundwater fluoride; Nausea; Rajasthan, India; Sanganer Tehsil; Stomach ache.

### INTRODUCTION

Fluoride (F) ingested in food and water is absorbed through the gastric and duodenal mucosa, thereby entering the circulatory system.<sup>1</sup> Acute and chronic studies in animals and humans have shown that F causes gastrointestinal (GI) damage.<sup>2-6</sup> In cases of osteofluorosis, intestinal disorders have been reported.<sup>7</sup> In rabbits, histopathological changes<sup>8</sup> and cell degeneration in duodenal mucosa<sup>4</sup> from F have also been observed.

The present study was conducted to evaluate GI effects of F in drinking water on children and adults residing in village areas of Sanganer Tehsil, Rajasthan, India.

### MATERIALS AND METHODS

On the basis of the F concentration in the groundwater, villages of Sanganer Tehsil were divided into two groups: F non-endemic group (low F group having F in drinking water below 1 ppm or medium F group having F in the range of 1.0-1.5 ppm) and a high F-endemic group (F in drinking water more than 1.5 ppm).

A minimum of 10 villages was selected from each group for the study. A human health survey was carried out with a questionnaire prepared with the help of

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physicians for interrogation purposes and investigation of the health problems of children (<6 to 18 years) and adults of the various villages.

### RESULTS

The villagers of the F-endemic study areas were found to be suffering from GI discomforts including stomach ache, a bloated feeling (gas), nausea (vomiting), intermittent diarrhea, repeated constipation, and abdominal tenderness.

As seen in Table 1, among children in the low and medium F areas, no cases of GI discomfort were observed. In the high F village areas, stomach ache followed by nausea and a bloated feeling were the most common complaints among the children. Only a few children in the high F areas reported having intermittent diarrhea or repeated constipation.

**Table 1.** Gastrointestinal discomforts among children in low, medium, and high fluoride village areas of Sanganer Tehsil

Area	Sex <sup>a</sup>	Total no. of children surveyed	Gastrointestinal discomforts (percentages in parenthesis)				
			Stomach ache	Bloated feeling	Nausea	Diarrhea	Constipation
Low F (<1.0 ppm)	Total	360	0	0	0	0	0
	M	177	0	0	0	0	0
	F	183	0	0	0	0	0
Medium F (1.0-1.5 ppm)	Total	375	0	0	0	0	0
	M	193	0	0	0	0	0
	F	182	0	0	0	0	0
High F (>1.5 ppm)	Total	400	34 (8.50) <sup>b</sup>	13 (3.25)	19 (4.75)	1 (0.25)	1 (0.25)
	M	203	19 (9.36)	7 (3.45)	10 (4.93)	0 (0.00)	1 (0.49)
	F	197	15 (7.61)	6 (3.05)	9 (4.57)	1 (0.51)	0 (0.00)

<sup>a</sup>M = male; F = female.

As seen in Table 2, GI distress with stomach ache followed by nausea, diarrhea, and a bloated feeling, were the most common complaints among adults living in the low F areas. Similar findings were seen in the medium F areas. In the high fluoride areas, the highest numbers of cases GI discomfort were observed; stomach ache being the most frequent, followed by diarrhea, nausea, and a bloated feeling. Constipation was also found but to a comparatively low extent. Moreover, males appeared to be more susceptible to GI discomforts compared to females.

**Table 2.** Gastrointestinal discomforts among adults in low, medium, and high fluoride village areas of Sanganer Tehsil

Area	Sex <sup>a</sup>	Total no. of adults surveyed	Gastrointestinal discomforts (percentages in parenthesis)				
			Stomach ache	Bloated feeling	Nausea	Diarrhea	Constipation
Low F (<1.0 ppm)	Total	458	38 (8.30) <sup>b</sup>	16 (3.49)	28 (6.11)	24 (5.24)	4 (0.87)
	M	226	23 (10.18)	9 (3.98)	16 (7.08)	14 (6.19)	2 (0.88)
	F	232	15 (6.47)	7 (3.02)	12 (5.17)	10 (4.31)	2 (0.86)
Medium F (1.0-1.5 ppm)	Total	489	59 (12.07)	21 (4.29)	45 (9.20)	22 (4.50)	8 (1.64)
	M	241	30 (12.45)	11 (4.56)	22 (9.13)	11 (4.56)	4 (1.66)
	F	248	29 (11.69)	10 (4.03)	23 (9.27)	11 (4.44)	4 (1.61)
High F (>1.5 ppm)	Total	528	207 (39.20)	59 (11.17)	93 (17.61)	100 (18.94)	10 (1.89)
	M	263	104 (39.54)	28 (10.65)	49 (18.63)	52 (19.77)	5 (1.90)
	F	265	103 (38.87)	31 (11.70)	44 (16.60)	48 (18.11)	5 (1.89)

<sup>a</sup>M= male; F= female.

Finally, as seen in Table 3, stomach ache was the most common GI discomfort among children as well as adults, followed by nausea and a bloated feeling in children, while the trend among adults was stomach ache followed by nausea and diarrhea. Only a few children were found to be suffering from constipation and intermittent diarrhea, while among adults these ailments were more common. The highest numbers of GI disorders were observed among adults of 60 years or older, followed by those in the 41-to-60 year age group.

**Table 3.** Gastrointestinal discomforts among inhabitants of different age groups and sex in villages of Sanganer Tehsil

Age range (Years)	Sex <sup>a</sup>	Total no. of people surveyed	Gastrointestinal discomforts (percentages in parenthesis)				
			Stomach ache	Bloated feeling	Nausea	Diarrhea	Constipation
<6	Total	145	0	0	0	0	0
	M	77	0	0	0	0	0
	F	68	0	0	0	0	0
6-12	Total	266	0	0	0	0	0
	M	134	0	0	0	0	0
	F	132	0	0	0	0	0

<sup>a</sup>M = male; F= female.

**Table 3 continued.** Gastrointestinal discomforts among inhabitants of different age groups and sex in villages of Sanganer Tehsil

Age range (Years)	Sex <sup>a</sup>	Total no. of people surveyed	Gastrointestinal discomforts (percentages in parenthesis)				
			Stomach ache	Bloated feeling	Nausea	Diarrhea	Constipation
12-18	Total	724	34 (4.70) <sup>b</sup>	13 (2.62)	19 (2.62)	1 (0.14)	1 (0.14)
	M	362	19 (5.25)	7 (1.93)	10 (2.76)	0 (0.00)	1 (0.28)
	F	362	15 (4.14)	6 (1.66)	9 (2.49)	1 (0.28)	0 (0.00)
19-40	Total	818	137 (16.75)	33 (4.03)	64 (7.82)	62 (7.58)	8 (0.98)
	M	412	75 (18.20)	18 (4.37)	36 (8.74)	32 (7.77)	4 (0.97)
	F	406	62 (15.27)	15 (3.69)	28 (6.90)	220630 (7.39)	4 (0.99)
41-60	Total	513	116 (22.61)	36 (7.02)	66 (12.87)	56 (10.92)	8 (1.56)
	M	252	58 (23.02)	17 (6.75)	32 (12.70)	31 (12.30)	6 (2.38)
	F	261	58 (22.22)	19 (7.28)	34 (13.03)	25 (9.58)	2 (0.77)
>60	Total	144	51 (35.42)	27 (18.75)	36 (25.00)	28 (19.44)	10 (6.94)
	M	66	24 (36.36)	13 (19.70)	19 (28.79)	14 (21.21)	4 (6.06)
	F	78	27 (34.62)	14 (17.95)	17 (21.79)	14 (17.95)	6 (7.69)
Children	Total	1135	34 (3.00)	13 (1.15)	19 (1.67)	1 (0.09)	1 (0.09)
	M	573	19 (3.32)	7 (1.22)	10 (1.75)	0 (0.00)	1 (0.17)
	F	562	15 (2.67) <sup>b</sup>	6 (1.07)	9 (1.60)	1 (0.18)	0 (0.00)
Adults	Total	1475	304 (20.61)	96 (6.51)	166 (11.25)	146 (9.90)	26 (1.76)
	M	730	157 (21.51)	48 (6.58)	87 (11.92)	77 (10.55)	14 (1.92)
	F	745	147 (19.73)	48 (6.44)	79 (10.60)	69 (9.26)	12 (1.61)
Grand Total	Total	2610	338 (12.95)	109 (4.18)	185 (7.09)	147 (5.63)	27 (1.03)
	M	1303	176 (13.51)	55 (4.22)	97 (7.44)	77 (5.91)	15 (1.15)
	F	1307	162 (12.39)	54 (4.13)	88 (6.73)	70 (5.36)	12 (0.92)

<sup>a</sup>M = male; F= female.

## DISCUSSION

GI complaints in endemic F areas are early warning signs of F toxicity, and in this report they were fairly frequent in the F areas. Generally, they may be attributed to the formation of hydrofluoric acid in the gut<sup>9</sup> resulting from reaction of F anions with gastric hydrochloric acid. Owing to the presence of un-ionized HF, hydrofluoric acid has tissue-penetrating and corrosive properties that can cause inflammation, petechiae, ulceration, and other mucosal abnormalities in the small and proximal intestine. Moreover, the stomach and intestinal lining (mucosa) are destroyed with loss of microvilli.<sup>10-11</sup>

In his book on *Health Effects of Environmental Pollutants*, Waldbott<sup>12</sup> noted that 47% of fluorosis patients in Sicily were affected with GI problems. The extent of F absorption from the stomach has implications in that gastric acidity enhances both the absorption and the toxicity of F. In rabbits administered 10 mg NaF/kg bw for 24 months, the GI mucosa was severely damaged with loss of microvilli and mucus along with surface abrasions from epithelial cell degeneration.<sup>4</sup>

In early F treatment of patients for osteoporosis, GI discomfort in the form of epigastric pain, nausea, vomiting, and diarrhea was reported.<sup>13</sup> Similarly, loss of appetite, nausea, abdominal pain, constipation, and intermittent diarrhea were observed by Susheela et al. in patients of the Faridabad district, in northern India who were afflicted with dental and skeletal fluorosis.<sup>14</sup> Further research by this group verified these GI symptoms in patients with osteofluorosis.<sup>15</sup> After acute F exposure, various GI and other discomforts including salivation, nausea, vomiting, abdominal pain, diarrhea, cramps, cardiac arrhythmia, and coma have been reported.<sup>16</sup>

In previous work, we also observed GI symptoms in patients with skeletal fluorosis.<sup>17</sup> The main complaint was a bloated feeling followed by stomach ache and nausea. In a recent report, bloated bellies of caimans and alligators from exposure to silicofluoridated water were described.<sup>18</sup> The possible role of enzyme inhibition by F in GI discomfort has also been suggested.<sup>19-20</sup> Recently, Spittle<sup>21</sup> has reported dyspepsia in a woman associated with fluoridated water intake.

## CONCLUSION

In the village study areas the most prevalent GI discomforts were stomach ache, a bloated feeling, and nausea. The maximum number of cases of gastric discomfort were observed in the high-F areas, which may therefore be correlated with high F concentrations in the groundwater used for drinking and cooking as well as poor nutrition among the inhabitants.

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