SKELETAL FLUOROSIS AMONG RETIRING EMPLOYEES OF WONJI SHOA SUGAR FACTORY

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SUMMARY: A retrospective study was done involving 263 retiring employees of Wonji Shoa Sugar Factory, an estate located in the Ethiopian Rift Valley and which is known for the high fluoride levels in its domestic water supplies. The radiological prevalence of skeletal fluorosis in the study sample was found to be 70.3 %. Skeletal fluorosis was associated with male gender ($p<0.05$) and also the prevalence was higher among factory and agricultural workers than among administrative workers ($p<0.05$). The association between male gender and fluorosis persisted within strata of occupation, indicating that the association was not mediated by occupation. The prevalence of clinical signs suggestive of skeletal fluorosis was markedly lower than the radiological prevalence and raged between 20.6 % and 40.2 % for the whole sample, indicating that many cases were asymptomatic. Further clinical epidemiological studies are suggested and strengthening of the existing defluoridation program is recommended.

Key words: Skeletal fluorosis; Occupational factors; Gender factors; Rift Valley; Ethiopia.

INTRODUCTION

Individuals depending on water supplies with fluoride levels greater than 3-6 mg/L or ingesting more than 10-20 mg fluoride daily are likely to develop skeletal fluorosis after 10-20 years of exposure.[1,2] Early skeletal involvement by fluorosis is not clinically obvious even though radiological changes are discernible in the skeleton at early stages.[3] In later stages skeletal fluorosis is manifest with restriction of movement of the spine and of the joints of the limbs and with neurological complications. Radiologically, skeletal fluorosis is characterised by increased radiodensity, by osteophyte formation, and by calcification of ligaments, tendons and interosseous membranes. The most obvious changes are seen in the spine and pelvis.[4,5] Although the entire spine may be affected, pronounced changes occur in the lumbar spine.[5]

Endemic skeletal fluorosis is widespread in the East African Rift Valley due to high levels of fluoride in the water sources.[6] Wonji Shoa Sugar Factory (WSSF) is an agro-industrial estate of 5000 hectares in central Ethiopia located in the Rift Valley. It was established in 1954. The estate presently has about 8000 employees working in three sectors-factory, agriculture, and administrative office. Most of the factory and administrations workers live in the two factory villages and most of the agricultural workers reside in the 14 plantation villages. The community of the estate has depended on well water, which has been known to have high fluoride levels. It has a dual water supply of raw water for washing purposes and defluoridated water for drinking and cooking purposes. Defluoridated water was made available to the factory villages since 1962 and to all plantation villages since 1976.

In 1972, the existence of spinal fluorosis among the workers of the estate was discovered. Between 1976 and 1984, 244 workers retired before reaching the official

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age of retirement, i.e. 55 years, due to disable spinal fluorosis.[6] At the time of retirement the employees of WSSF are required to undergo radiological examinations of the lumbar spine, and estimation of fluorosis-related disability is made by an independent medical board based on clinical and radiological findings. The purpose of the present survey is to estimate the present prevalence of skeletal fluorosis among the adult population of the estate by retrospectively examining the data of employees who had retired over a two year period.

MATERIALS AND METHODS

The survey was conducted in October 1997 and involved all employees of WSSF who retired between January 1, 1995 and December 31, 1996. Demographic and clinical data were obtained from the report forms of the examining medical board. The X-rays of the lumbar spine (PA and lateral view) were blindly examined by a radiologist (one of the investigators) and graded according to Roholm's classification which identifies three stages of skeletal fluorosis; Stage I, II, and III.[7] A total of 308 workers retired during the two year period. Completed medical board report forms and X-rays of the lumbar spine were available for 263 (85.4%) of the retirees and all of these were included in the survey.

RESULTS

Demographic data. Only one person (0.4 % of the sample) was aged 50 years, all the rest being 55 years old at the time of retirement. Of the sample, only 13 subjects (4.9 %) were females. The duration service in the estate was above 20 years for 261 retirees (99.2 % of the total) and was 16-20 years for the remaining 2 retirees (0.8 %). Among the study subjects, 106 individuals (40.3 %) worked in the factory sector, 125 individuals (47.5 %) worked in the agricultural sector and 32 individuals (12.2 %) worked in the administration sector. The last one included the workers who worked in personnel, finance, material supply, medical, etc. departments.

Clinical data. According to the fluorosis-related disability estimation made by the examining medical board, 146 individuals (55.5 % of the sample) were found to have no disability. The remaining 117 individuals (44.5 % of the sample) were assessed as having some degree of disability. The prevalence of five clinical signs that may be related to skeletal fluorosis and which were looked for by the medical board is presented in Table 1. The prevalence of those clinical signs in the whole sample ranged between 20.6 % and 40.2 %.

TABLE 1. Prevalence of five clinical signs among employees of Wonji Shoa Sugar Factory who retired during 1995 and 1996.

Clinical Signs	Present		Absent		Total	
	No	%	No	%	No	%
Kyphosis	54	20.6	208	79.4	262	100.0
Impaired walking	62	23.9	197	76.1	259	100.0
Impaired squatting	101	39.1	157	60.9	258	100.0
Impaired neck mobility	77	30.0	180	70.0	257	100.0
Impaired lumbar mobility	105	40.2	156	59.8	261	100.0

Radiological findings. Of the 263 subjects studied, 185 individuals (70.3 % of the total) had radiological signs of spinal fluorosis. Among those affected, 113 individuals (61.1 %) had stage I fluorosis, 42 individuals (22.7 %) had stage II fluorosis and 30 individuals (16.2 %) had stage III fluorosis. The only individuals who retired at the stage of less than 55 years had stage II fluorosis. Of the two individuals who had served in the estate for less than 20 years, one was radiologically free of skeletal fluorosis but the other one had stage III fluorosis.

The distribution of the three stages of skeletal fluorosis among the study subjects by sex is shown in Table 2. The radiological prevalence of all the stages of skeletal fluorosis was 72.0 % (180 individuals out of 250) among the men. The radiological prevalence of all stages of skeletal fluorosis was 38.5 % (5 individuals out of 13) among the women. The difference in the prevalence of skeletal fluorosis between the two sexes was statistically significant (p=0.02, Fisher's exact test). Furthermore, all women who were found to have fluorosis had stage I fluorosis.

TABLE 2. Distribution by sex of the three stages of skeletal fluorosis among employees of Wonji Shoa Sugar Factory who retired during 1995 and 1996. (figures in parentheses represent percentages of the row totals).

Sex	Radiologically fluorotic				Radiologically non-fluorotic	Total (%)
	Stage I	Stage II	Stage III	All stages		
Male	108	42	30	180 (72.0)	70 (28.0)	250 (100)
Female	5	0	0	5 (38.5)	8 (61.5)	13 (100)
Total	113	42	30	185 (70.3)	78 (29.7)	263 (100)

The distribution of the three stages of skeletal fluorosis among the study subjects by work is shown in Table 3. It can be seen that the prevalence of all stages of skeletal fluorosis was 77.4 % among the factory workers, 72.0 % among agricultural workers and 40.6 % among administration workers. The difference was statistically significant (Chi-square test; p=0.0003). Among the 13 administration workers who were found to have skeletal fluorosis, 12 had stage I fluorosis while only one had stage II fluorosis, none having stage III fluorosis.

TABLE 3. Distribution by work place of the three stages of skeletal fluorosis among employees of Wonji Shoa Sugar Factory who retired during 1995 and 1996 (figures in parentheses represent percentages of row totals).

Work Place	**Radiologically Fluorotic**				**Radiologically non-fluorotic**	**Total (%)**
	Stage I	**Stage II**	**Stage III**	**All stages**		
Factory	37	25	20	82 (77.4)	24 (22.6)	106 (100)
Agriculture	64	16	10	90 (72.0)	35 (28.0)	125 (100)
Administration	12	1	0	13 (40.6)	19 (59.4)	32 (100)
Total	113	42	30	185 (70.3)	78 (29.7)	263 (100)

The occurrence of four clinical signs and of fluorosis-related disability in accordance with the existence of fluorosis among the study subjects is shown in Table 4. Among the fluorotic individuals, the prevalence of four clinical signs that could be related to skeletal fluorosis (kyphosis, impaired neck mobility, impaired squatting and impaired lumbar mobility), ranged between 23.4 % and 47.3 %.

TABLE 4. Occurrence of four clinical signs and of disability among fluorotic and non-fluorotic individuals who retired from Wonji Shoa Sugar Factory during 1995 and 1996.

Clinical sign		Radiologically fluorotic		Radiologically non-fluorotic	
		No	%	No	%
Kyphosis	Present	43	23.4	11	14.1
	Absent	141	76.6	67	85.9
	Total	184	100.0	78	100.0
Impaired Squatting	Present	82	45.3	19	24.7
	Absent	99	54.7	58	75.6
	Total	181	100.0	77	100.0
Impaired neck mobility	Present	67	36.8	10	13.3
	Absent	115	63.2	65	86.7
	Total	182	100.0	75	100.0
Impaired lumbar mobility	Present	87	47.3	18	23.4
	Absent	97	52.7	59	76.6
	Total	184	100.0	77	100.0
Disability	Present	87	47.0	59	75.6
	Absent	98	53.0	19	24.4
	Total	185	100.0	78	100.0

DISCUSSION

The high radiological prevalence of skeletal fluorosis in the sample (70.3 %) suggests that the condition is prevalent among the adults residents of the estate. About three-fifth of those affected had stage I fluorosis, the rest having the more severe stages of fluorosis. A survey conducted in 1979-80 and involving 530 workers aged 45-55 years found radiological evident skeletal fluorosis in 46 % of them (personal communication, Wonji Hospital). The lower prevalence in that survey could be due to differing criteria of radiological classification and to difference in duration of residence in the estate of the study subjects.

In the present study skeletal fluorosis was associated with male gender. This association persisted within strata occupation (administrative and non-administrative), indicating that the association between male gender and fluorosis was not mediated by occupation. The number of women in the survey was very small to make sound conclusions but the lower prevalence of fluorosis among the women studied was not because of engagement in administrative work. Lower prevalence of skeletal fluorosis in females than in males was previously reported by a study in India.[3]

The higher prevalence of skeletal fluorosis among factory and agricultural workers than among administrative workers could be due to agronomic factors which predispose workers to varying amounts of water ingestion. This might also explain the lower prevalence of the more severe stages of fluorosis among administrative workers.

The prevalence of certain clinical signs suggestive to skeletal fluorosis was low in the present study as compared to the radiological prevalence, and ranged between 20.6 % and 40.2 % for the whole sample, and between 23.4 % and 47.3 % among the fluorotic subjects. This suggests that many individuals had asymptomatic skeletal fluorosis. A survey conducted in 1990 and involving 328 adults had found physical

impairments indicative of skeletal fluorosis in 63 % of those who resided in the area for greater than 20 years.[8]

It is suggested that elaborate clinical and epidemiological surveys be carried out to better understand the exact magnitude and nature if the problem and potential risk factors that may predispose to the development of skeletal fluorosis. It is recommended that revival and strengthening of the existing defluoridation program of drinking water supplies of the estate be undertaken urgently.

ACKNOWLEDGEMENTS

We are grateful to Wosen Gebreab, Abdella Unsa and Wonji Shewaye for their support in retrieving the X-ray films and medical board report forms of the study subjects. The help of Dr. Arnaud Fontanet in performing the statistical tests is highly appreciated. We also would like to thank Kibinesh Abebe for her typing service.

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