

Investigations on the Occurrence of Osteoarthritis in Middle-aged and Elderly Persons in Fluorosis-Afflicted Regions of Gaomi City with High Fluoride Concentration in Drinking Water

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Abstract: [Objective] To explore the relationship between fluoride concentration in drinking water and osteoarthritis in populations to provide a scientific basis for prevention and control of endemic skeletal fluorosis. [Methods] From 2003 to 2004, we investigated the occurrence of osteoarthritis in middle-aged and elderly persons over the age of 50 permanently residing in fluorosis-afflicted regions of Gaomi City, where fluoride concentration in drinking water ranged between 0.25 and 7.97 mg/L. [Results]: A total of 7,876 persons were investigated; the frequency of occurrence of arthritic symptoms within the most recent one month for the regions with higher fluoride concentration in drinking water was higher than that for the regions with lower fluoride concentration in drinking water; the incidence of rigidity of joints (knee, hip and vertebra) after waking up in the morning was 50.96%, and the incidence of pain in knee joints, hip joints and vertebra within the most recent one month was 49.23%; these indicators are all higher for the population with higher fluoride concentration in drinking water than those for the population with lower fluoride concentration in drinking water. [Conclusions] Excessive intake of fluoride may lead to a higher incidence of osteoarthritis in populations, and the populations' response to osteoarthritis should be regarded as an important indication in the study of endemic fluorosis.

Key words: Drinking water, fluorosis, middle-aged persons, elderly persons, osteoarthritis

In order to explore the relationship between fluoride concentration in drinking water and the incidence of osteoarthritis in populations to provide a scientific basis for prevention and control of endemic skeletal fluorosis, we carried out investigations between 2003 and 2004 on the occurrence of osteoarthritis in middle-aged and elderly persons permanently residing in the fluorosis-afflicted regions of Gaomi City, with different fluoride concentrations in drinking water.

1 Subjects and methods

1.1 Subjects From October 2003 to April 2004, based on reexamining the background data offered by the 1982 investigation on the baseline water fluoride concentration in Gaomi City, we selected the following towns for investigation: Lijiaying Town, Chaigou Town, Yaogezhuang Town, Zhugou Town, Heya Town and Damoujia Town. Five villages were chosen from each town; in total, 30 villages were selected as investigational sites. Investigations were conducted on persons over the age of 50 who had permanently resided in the aforesaid villages since their birth or marriage. The persons under investigation were divided into six groups based on the fluoride concentration in drinking water (0.25–7.97 mg/L) after retesting in October 2003; the number of persons under investigation was basically similar among all groups, the ratio of males to females was about 1:1.2, and the age distribution was consistent. As to the water quality indexes at the investigational sites, all indicators except fluoride concentration were similar, and environmental factors and dietary habits were generally identical.

1.2 Methods The investigation team consisted of professionals from the Institute for Environmental Hygiene and

Hygienic Engineering of the Chinese Academy for Preventive Medicine Science, Shandong Provincial Institute for Prevention and Control of Endemic Diseases, and Gaomi Sanitary and Anti-epidemic Station; after being trained in uniform investigational criteria, team members went to the home of each person under investigation, who were queried about joint rigidity and joint pain within the most recent one month. The arthritic symptoms were mainly those of primary osteoarthritis lesions, and did not include secondary joint pain and rigidity induced by muscular causes or other causes. In October 2003, five water samples were collected in each village under investigation from well water that had been utilized for drinking for over 20 years; the fluoride concentration was determined with fluorine ion-selective electrodes.

Comparison of mean values between multiple groups used the F test, and comparison of the incidence of osteoarthritis between multiple groups used the χ^2 test.

2 Results

2.1 Occurrence of osteoarthritis symptoms A total of 7,876 persons were investigated for the frequency of occurrence of osteoarthritis symptoms within the most recent one month; this frequency for the population with higher fluoride concentration in drinking water was higher than that of the population with lower fluoride concentration in drinking water, and the differences among these six groups was statistically significant ($F = 10.65, P < 0.01$), as shown in Table 1.

Table 1 Occurrence of arthritic symptoms in middle-aged and elderly persons permanently residing in villages in Gaomi City with different fluoride concentrations in drinking water

| Group | Number of water samples | Fluoride concentration in drinking water (mg/L) | | | Number of persons investigated | | | Frequency of occurrence of arthritic symptoms | | |
|-------|-------------------------|---|----------|-----------|--------------------------------|---------|-------|---|----------|----------|
| | | <i>x</i> | <i>s</i> | Range | Males | Females | Total | Total | <i>x</i> | <i>s</i> |
| 1 | 5 | 0.30 | 0.03 | 0.25–0.34 | 751 | 612 | 1,363 | 359 | 0.26 | 0.28 |
| 2 | 5 | 0.64 | 0.05 | 0.58–0.73 | 803 | 664 | 1,467 | 693 | 0.47 | 0.56 |
| 3 | 5 | 1.03 | 0.02 | 1.00–1.06 | 755 | 615 | 1,370 | 349 | 0.25 | 0.32 |
| 4 | 5 | 1.69 | 0.23 | 1.45–3.56 | 857 | 717 | 1,574 | 1,384 | 0.88 | 0.97 |
| 5 | 5 | 3.18 | 0.74 | 2.62–3.56 | 590 | 461 | 1,051 | 1,133 | 1.08 | 1.21 |
| 6 | 5 | 6.92 | 1.04 | 4.32–7.97 | 588 | 463 | 1,051 | 3,973 | 3.78 | 2.89 |

2.2 Occurrence of joint rigidity after waking up in the morning Of all 7,876 persons investigated, 4,014 persons experienced rigidity in knee joints, hip joints and vertebrae after waking up in the morning, with incidence of 50.96%. The incidence for the population with higher fluoride concentration in drinking water was higher than that for the population with lower fluoride concentration in drinking water, and the difference was of statistical significance ($\chi^2 = 1399.33, P < 0.01$); regarding the incidence of joint rigidity, that for knee joints was 25.89% (2,039 persons), that for vertebrae was 16.23% (1,278 persons), and that for hip joints was 8.85% (697 persons), as shown in Table 2.

3 Discussion

In recent years, injuries of bone joints caused by fluoride have attracted a greater level of attention; some scholars observed injuries to joints in young rabbits caused by high fluoride in animal experiments [1], and other scholars found that the incidence of joint injury reached up to 73% when they performed X-ray radiography of bone joints on patients with skeletal fluorosis [2]. The current investigations were focused on the occurrence of osteoarthritis symptoms in middle-aged and elderly persons, as well as the rigidity of knee joints, hip joints and vertebrae, which are apt to fluorosis-associated injury after waking up in the morning, and the pain in the aforesaid joints within the most recent one month; these troubles were easily recalled by the persons investigated, and in the meantime the effects of secondary arthritis were ruled out as much as possible in our investigation. The result of our investigations demonstrated the following: For middle-aged and elderly persons permanently residing in villages with different fluoride concentrations in drinking water, the per-capita frequency of occurrence of osteoarthritis symptoms rose along with the elevation of fluoride concentration in drinking water; the incidence of joint rigidity after waking up in the morning and the incidence of [joint] pain within the most recent month was 50.96% and 49.23% respectively, and both of these indicators rose along with the elevation of fluoride concentration in drinking water.

Table 2 Occurrence of partial joint rigidity after waking up in the morning in middle-aged and elderly persons permanently residing in villages in Gaomi City with different fluoride concentrations in drinking water

| Group | Number of persons investigated | Number of persons having joint rigidity | | | | Incidence of joint rigidity (%) | | | |
|-------|--------------------------------|---|------------|-----------|-------|---------------------------------|------------|-----------|--------|
| | | Knee joints | Hip joints | Vertebrae | Total | Knee joints | Hip joints | Vertebrae | Total |
| 1 | 1,363 | 97 | 19 | 43 | 159 | 7.11 | 1.39 | 3.15 | 11.67 |
| 2 | 1,467 | 209 | 53 | 91 | 353 | 14.86 | 3.76 | 6.47 | 24.06 |
| 3 | 1,370 | 124 | 16 | 43 | 183 | 9.05 | 1.16 | 3.14 | 13.36 |
| 4 | 1,574 | 336 | 134 | 272 | 742 | 21.35 | 8.52 | 17.28 | 47.14 |
| 5 | 1,051 | 315 | 73 | 210 | 598 | 29.97 | 9.65 | 19.98 | 56.90 |
| 6 | 1,051 | 958 | 402 | 619 | 1,979 | 91.15 | 38.25 | 58.90 | 188.30 |

2.3 Occurrence of pain in partial major joints within the most recent one month Of all 7,876 persons investigated, 3,877 persons experienced pain in knee joints, hip joints and vertebrae within the most recent one month, with incidence of 49.23%. The incidence for the population with higher fluoride concentration in drinking water was higher than that for the population with lower fluoride concentration in drinking water, and the difference was of statistical significance ($\chi^2 = 1,409.19, P < 0.01$); 2,015, 654 and 1,208 persons experienced pain in knee joints, hip joints and vertebrae respectively, and the incidence was 25.58%, 8.30% and 15.34% respectively, as shown in Table 3.

The results of the current investigations demonstrate that the excessive intake of fluoride may lead to a higher incidence of osteoarthritis in the affected populations. Therefore, the response to osteoarthritis in the affected populations should be regarded as an important indication in the study of endemic fluorosis.

Table 3 Occurrence of pain in partial joints within the most recent one month in middle-aged and elderly persons permanently residing in villages in Gaomi City with different fluoride concentrations in drinking water

| Group | Number of persons investigated | Number of persons having joint pain | | | | Incidence of joint pain (%) | | | |
|-------|--------------------------------|-------------------------------------|------------|-----------|-------|-----------------------------|------------|-----------|--------|
| | | Knee joints | Hip joints | Vertebrae | Total | Knee joints | Hip joints | Vertebrae | Total |
| 1 | 1,363 | 118 | 24 | 58 | 200 | 8.67 | 1.76 | 4.26 | 14.67 |
| 2 | 1,467 | 201 | 50 | 89 | 340 | 14.29 | 3.55 | 6.33 | 23.18 |
| 3 | 1,370 | 295 | 65 | 175 | 535 | 8.32 | 0.94 | 2.85 | 12.70 |
| 4 | 1,574 | 114 | 13 | 39 | 166 | 20.20 | 6.55 | 14.04 | 40.79 |
| 5 | 1,051 | 318 | 103 | 221 | 642 | 28.07 | 6.18 | 16.65 | 50.90 |
| 6 | 1,051 | 969 | 399 | 626 | 1,994 | 64.56 | 26.58 | 41.71 | 189.72 |

References:

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 [2] WANG Yunzhao, BAI Shicheng. *Skeletal Fluorosis Caused by Coal Flue Gas in Three Gorges Region* [J]. Chinese Journal of Endemiology, 1989, 8(6): 386-391.

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