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The Relationship between Hip Fracture and Water Fluoridation: An Analysis of National Data

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Abstract: Data from the 1973–1977 National Health Interview Surveys were used to determine whether water fluoridation prevents hip fractures related to osteoporosis. No protective effect was found for fluoride levels of 0.7 ppm, the level recommended for the prevention of dental caries. There are some indications that higher concentrations of fluoride might have a protective effect for groups with a high incidence of osteoporosis. However, no determination of the actual levels needed or the possible adverse effects of high water fluoride levels could be made. (*Am J Public Health* 1983; 73:296–298.)

Over 500,000 people aged 45 and older are hospitalized for fractures each year.[1] Many of these fractures are related to osteoporosis. Since sodium fluoride has been used in the treatment of osteoporosis,[2,3] it has been suggested that the ingestion of fluoridated water might act to prevent this condition. This paper examines whether water fluoridated to the extent recommended for prevention of dental caries (0.7 ppm) has the added benefit of preventing fractures related to osteoporosis.

The relationship between fluoride exposure and osteoporosis is of particular interest to public health workers. Since water fluoridation has been used to prevent tooth decay, many public health workers are familiar with implementing water fluoridation systems. If fluoride is protective against osteoporosis as well as dental caries, the universal fluoridation of public water supplies could result in a reduction in the incidence of osteoporotic fractures and the death, disability, and cost associated with them. Water fluoridation would then provide a relatively inexpensive way to reduce the risk of disease for a large part of the population.

Protective effects of water fluoridation on osteoporosis[2] and death rates from falls[4] were found in areas with high levels of naturally-occurring fluoride. One study has suggested some protective effect of exposure to the lower levels of fluoride recommended for the prevention of dental caries[5] while other studies show no effect.[6,7] Most of the studies that have explored the relationship between water fluoridation and osteoporosis have been based on comparisons of only a few areas. This analysis extends previous research by utilizing national data from a multi-stage probability sample. The analysis is based on a representative sample of the US population and therefore covers a broader range of environmental conditions. Unfortunately, it is not possible to directly address some of the pertinent questions raised by prior research. Direct measures of length of exposure and actual level of water fluoridation are not available and therefore it will not be possible to determine the precise level at which water fluoridation is most effective, the age at which exposure should begin, or the optimal duration of that exposure.

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TABLE 1—Hip Fracture Hospitalization Rates for White Adults by Sex and Age, NHIS Data, 1973–77

Sex and Age	Number of Respondents with Hip Fracture	Total Number of Respondents	Rate per 1,000 Population
Females			
Less than 25 years	2	113,470	.02
25–44 years	4	66,167	.14
45 years or over	207	87,637	2.36
45–64 years	40	56,775	.70
65 years or over	167	30,860	5.41
Males			
Less than 25 years	5	113,530	.04
25–44 years	11	61,148	.18
45 years or over	80	74,040	1.08
45–64 years	17	51,571	.33
65 years or over	63	22,469	2.80

Methods

The data used in this analysis are from the National Health Interview Surveys (NHIS) of 1973–1977. Since NHIS has no direct measure of osteoporosis, hip fracture was used as an indicator of this condition. From a policy point of view, fracture is of major concern since it is this manifestation of osteoporosis and not the underlying condition which causes disability. Any protective effect of fluoride on osteoporosis that is not translated into a reduction in fractures is of less interest from a practical standpoint.

Determination of hip fracture status is based on the NHIS hospital episode record. White persons hospitalized at least once in the last 12 months for whom hip fracture was the reason for hospitalization comprise the population of cases. Blacks were omitted since their hip fracture rates are different from those of Whites and there were too few Blacks to permit a separate analysis.

Since a direct measure of fluoride exposure is not available from the NHIS, an ecological measure of water fluoridation was used. The Centers for Disease Control (CDC)[8] provide information on the per cent of the population in each US county served with water having a natural or adjusted fluoride content of at least 0.7 ppm. The data are reported to the CDC by State Health Departments and reflect the situation as of 1973. Unfortunately, the validity of these measures is not known.* Each NHIS respondent in our study was categorized according to the proportion of the population served by fluoridated water in the county where he/she resided. This value is then interpreted as the probability that the respondent was exposed to a water fluoride content of at least 0.7 ppm.

There are several problems with this approach. First, it is ecological. We would prefer to know whether an individual drinks fluoridated water rather than the probability that he/she lives in an area with a fluoridated water supply. The probability of exposure will be a poor indication of actual exposure if within-county fluoridation levels are heterogeneous. The extent to which this is true cannot be determined for these data. In order to minimize this source of error, we compare respondents with high probabilities of exposure (above .8) to those with low probabilities (below .2). There are 104 counties in the high-fluoride group and 284 counties in the low-fluoride group.

The NHIS sample is used because it includes a large number of respondents and geographic areas rather than for the purpose of providing national estimates. Since this study is exploratory the analysis is based on unweighted data and variances are calculated as if the rates were based on a simple random sample. Under this assumption the numbers of respondents available in high and low fluoride areas were sufficient to detect a twofold difference in rates at the 5 per cent significance level.

Results

Table 1 shows the rate of hospitalization for hip fracture by age and sex. Fracture rates increase substantially with age. Among adults 45 years of age and over the rates for females are about twice as high as those for males. Fractures among women in this age group are most likely to be associated with osteoporosis.[9,10]

Hip fracture rates for adults 45 years of age and over are presented by fluoride exposure in Table 2. Females over age 45 living in low fluoride areas had 9 per cent more hip fractures over the five-year period than did those living in high fluoride areas. The small differential found for males is in the opposite direction. These differences are not statistically significant.

*However, a comparison of the CDC fluoride data with household water samples from the National Health and Nutrition Examination Augmentation Survey (1974–1975) indicated a high level of agreement.

TABLE 2—Hip Fracture Hospitalization Rates per 1,000 Population Aged 45 and Over by Sex and Fluoride Exposure Status: NHIS 1973–77, Whites

	Females		Males	
Fluoride Exposure*	Rate per 1,000 Population	Number of Respondents	Rate per 1,000 Population	Number of Respondents
Less than 20 per cent	2.4	30,473	1.0	25,997
At least 80 per cent	2.2	21,810	1.1	18,034

*Exposure refers to the per cent of the population in the respondent's county of residence served by water supplies having at least 0.7 parts per million fluoride.

Discussion

The data in Table 2 suggest that fluoride levels which protect against dental caries (0.7 ppm) are not sufficient to prevent osteoporotic hip fractures. However, higher levels of water fluoridation may be protective. While it is not possible to directly test the hypothesis, a preliminary assessment can be made by investigating hospitalization rates for hip fracture in areas where most of the population has naturally fluoridated water. Areas with naturally occurring water fluoride levels of 0.7 ppm or more can be identified in the CDC data. There were nine counties in the NHIS sample where at least 80 per cent of the population have naturally fluoridated water, yielding 1,242 women and 1,111 men 45 years of age or over. Thus, these respondents will have been exposed to fluoride levels higher than 0.7 ppm (although to an unknown degree).

Among the men, there was one hip fracture, which was consistent with the rates in Table 2. Among the women, where the incidence of osteoporotic fracture is higher, there were no hospitalizations for hip fracture. If we assume that hip fractures follow a Poisson distribution at the rate of 2 per 1,000 (as in Table 2) then the probability of observing no fractures among the 1,242 women is .083. Although the numbers involved here are quite small, the calculation suggests that the hypothesis of a protective effect at higher fluoride levels among women should not be ignored.

On the basis of these results it appears that if water fluoridation can protect against osteoporotic fractures, fluoride levels would have to exceed 0.7 ppm. Research to determine the optimal dosage and length of exposure needed to demonstrate a protective effect would be necessary. Of equal importance is determining whether this higher level has any adverse effects, especially for those who are not at high risk of osteoporosis. If a much higher level of fluoride is necessary for the prevention of osteoporosis than for prevention of dental caries, it may be more feasible for fluoride to be administered on an individual basis to those at high risk.

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