Acta orthop. Scandinav. *40*, 137–142, 1969

From The Department of Orthopaedic Surgery (Head: Anders Hulth, M.D.), Malmö General Hospital, University of Lund, Malmö, Sweden.

THE INFLUENCE OF A HIGH FLUORIDE CONTENT IN THE DRINKING WATER ON THE BONE MINERAL MASS IN MAN

By

P. A. ALFFRAM, J. HERNBORG & B. E. R. NILSSON

Received 7.xi.67

In recent years numerous studies have indicated a beneficial effect of fluoride administration on the bone mineral mass in man. *Berstein et al.* (1966) demonstrated, in a large population study, an increased bone density in subjects from areas with a high fluoride content in the drinking water.

The objective of the present study was to evaluate the influence of a high fluoride intake with the drinking water on the bone mass of the peripheral skeleton in healthy women.

MATERIAL AND METHODS

In the city of Malmö in southern Sweden the fluoride content of the drinking water is 0.2–0.4 ppm.[1] Sixty-two healthy women, forty-five to seventy-two years old were selected from the population of Malmö (Control Group).

In the town of Billesholm, located less than fifty miles from Malmö, the fluoride content of the drinking water is 4.0–6.8 ppm. Forty-seven healthy women were selected from the population of Billesholm (Fluoride Group).

None of the subjects selected had a history of fracture of the measured limb, of endocrinous disease, back-ache or deformity. There were no racial or ethnical differences between the two populations, nor were there any obvious differences in the dietary habits. The average time elapsed after menopause was slightly but not significantly longer in the Fluoride Group. To qualify for this study at least twenty years of residency in the area was required. One third of the Fluoride Group were born and raised in the town of Billesholm; another third had spent forty years or more in the area.

The evaluation of the bone mass was based on three measurements; 1) The com-

[1] Parts per million.

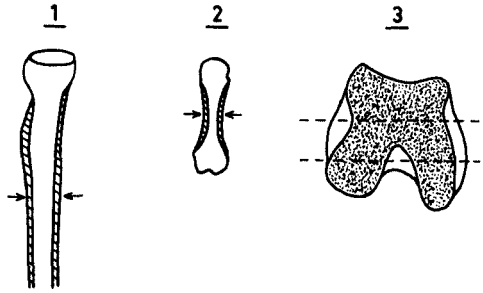

Figure 1. Evaluation of bone mass:
1. *The combined cortical thickness of the radius.*
2. *The combined cortical thickness of the second metacarpal.*
3. *The mineral content of the distal end of femur.*

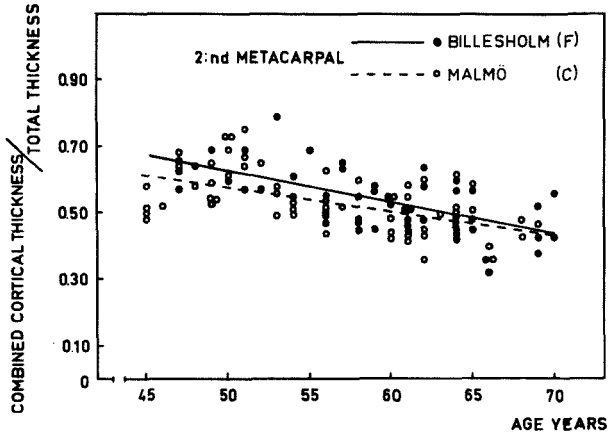

Figure 2. The relationship of combined cortical thickness of the second metacarpal and age.

bined thickness of the two cortici measured with a caliper on antero-posterior radiograms of the second metacarpal (Figure 1:2) (*Nordin* 1961). The values were expressed as fractions of the total thickness of the metacarpal. 2) The combined thickness of the cortici on antero-posterior radiograms of the proximal end of the radius (*Meema* 1963) (Figure 1:1). The values were expressed as fractions of the total thickness of the radius. 3) The density of the distal end of the femur was evaluated from the attenuation of a photon-beam passing through the femur laterally in the epicondylar area. The method has been described by *Nilsson* (1966) (Figure 1:3).

The exposure of the radiograms, the measurements of the cortical thicknesses and the measurements of the femur densities were all performed in a standardised way in the same hospital. The film-object distance was about sixty-four cm.

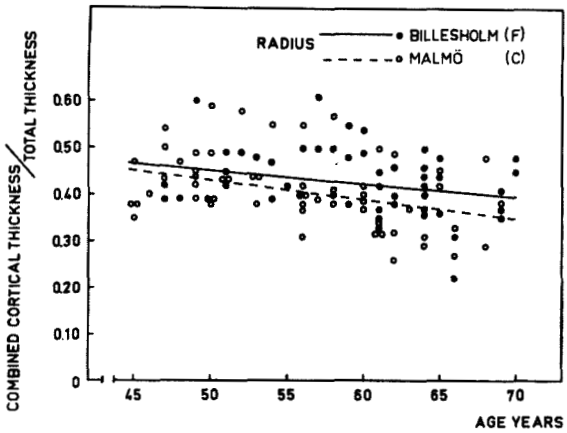

Figure 3. The relationship of combined cortical thickness of the radius and age.

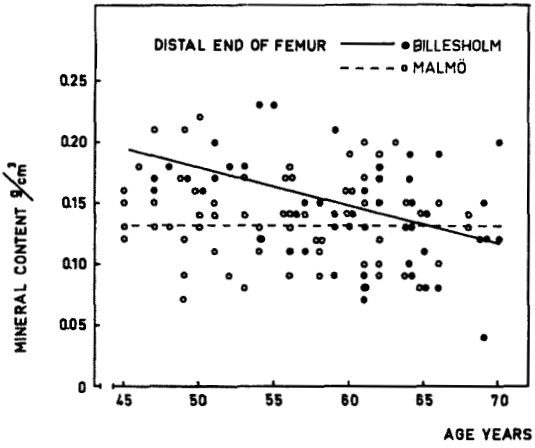

Figure 4. The relationship of the mineral content of the distal end of the femur and age.

RESULTS

The various parameters of skeletal mass were more or less dependent on age in both groups (Figures 2, 3 and 4). The regressions of age and bone mineral mass were compared by covariance analysis (Table). In none of the comparisons were very high levels of probability obtained. All the parameters do, however, indicate the same tendency and if the data are taken together it may be concluded that the bone density was greater in subjects from the area with a high water fluoride content.

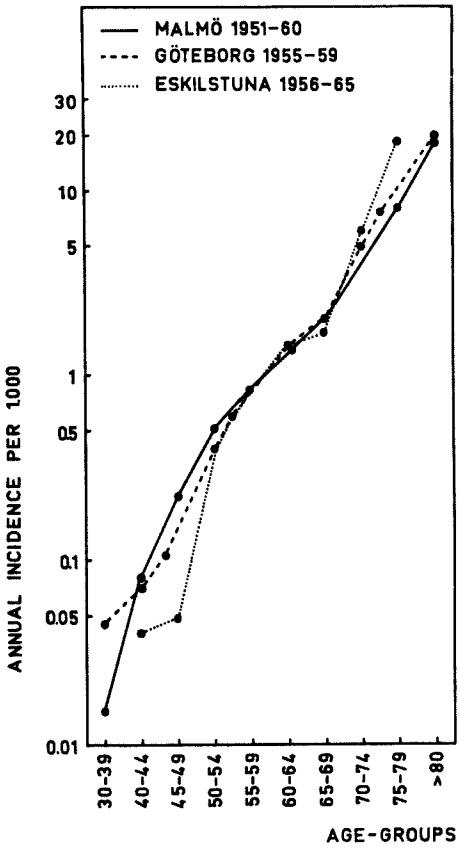

Figure 5. Incidence of fracture of the upper end of femur in three Swedish cities with varying fluoride concentrations in the drinking water.

Table. Analysis of covariance, levels of probability.

Treatment	Scatter	Slope	Intercept
Age *vs.* Bone Mass Radius	$P > 0.2$	$P > 0.2$	$0.05 > P > 0.01$
Age *vs.* Bone Mass 2. Metacarp.	$P > 0.2$	$P > 0.2$	$0.2 > P > 0.1$
Age *vs.* Bone Mass Distal Femur	$0.2 > P > 0.1$	$0.1 > P > 0.05$	$0.2 > P > 0.1$

There was no relationship between the time of residency in Billesholm and the bone density of the fluoride group.

DISCUSSION

It has previously been demonstrated (*Bernstein et al.* 1966) that the incidence of radiologically decreased density of the lumbar vertebrae is lower in a population with an increased intake of fluoride with the drinking water. The findings in the present study indicate a similar difference in the bone mineral mass of the peripheral skeleton of healthy women.

From the two studies it should be possible to conclude more definitely that a high fluoride concentration in the drinking water is associated with an increase of the skeletal mass and that this increase is not likely to be confined to certain geographical regions or anatomical locations. *Bernstein et al.* (1966) also demonstrated a decreased incidence of vertebral compression fractures in their population with a high fluoride intake. In epidemiological studies of the incidence of fracture of the upper end of the femur in three cities in Sweden: by *Alffram* (1964) in Malmö (0.2–0.4 ppm), by *Mårtensson* (1962) in Gothenburg (<0.1 ppm), and by this group (1967) in Eskilstuna (0.8–1.2 ppm) (Figure 5), no significant differences could be demonstrated. Thus the water fluoridation level usually recommended for the prevention of dental caries (1 ppm) does not to a significant degree influence the incidence of fracture of the upper end of the femur.

SUMMARY

The bone mass was evaluated in sixty-two female residents in an area with a low fluoride content in the drinking water and in forty-seven female residents of an area with a high water fluoride content. The measurements represented the skeletal mass of the limbs. The skeletal mass was demonstrated to be greater in residents of the high fluoride area.

REFERENCES

Alffram, P.-A. (1964) An epidemiologic study of cervical and trochanteric fractures of the femur in an urban population. *Acta orthop. scand.* Suppl. 65.

Barnett, E. & Nordin, B. E. C. (1961) The clinical and radiological problem of thin bones. *Brit. J. Radiol.* **34**, 683.

Bernstein, D. S., Sadowsky, N., Hegsted, D. M., Guri, C. D. & Slare, F. S. (1966) Prevalence of osteoporosis in high- and low-fluoride areas in North Dakota. *J. Amer. Med. Ass.* **198**, 499.

Meema, H. E. (1963) Cortical bone atrophy and osteoporosis as a manifestation of aging. *Amer. J. Roentgenol.* **89**, 1287.

Mårtensson, L. (1962) Är svensk sjukhusplanering ändamålsenlig? Statistiska undersökningar rörande collumfrakturens frekvens. *Sv. Läk.-Tidn.* **59**, 3185.

Nilsson, B. E. R. (1966) Post-traumatic osteopenia. A quantitative study of the bone mineral mass in the femur following fracture of the tibia in man using Americium-241 as a photon source. *Acta orthop. scand.* Suppl. 91.