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Osteoporosis and Epidemiology of Fractures in Croatia†

An international comparison

Velimir Matkovic, MD, PhD,* Marija Ciganovic,* Cedomil Tominac,* and Krista Kostial, MD, PhD†

We examined the epidemiology of osteoporotic fractures in Croatia and correlated the results with data from other countries. We analyzed annual rates of wrist fractures in the large urban community of Zagreb and hip fractures in the Republic of Croatia. In addition, we determined mortality data and measured metacarpal bone mass in patients with hip fractures. There were age and sex differences in the incidence of both types of fracture. The incidence of wrist fractures is the same as in some Northwestern European countries, but the incidence of hip fractures is much lower.

With increases in life expectancy and in the number of elderly people, bone loss and fractures are becoming more common in Croatia (Yugoslavia), as they are elsewhere (Fig. 1). Problems associated with bone loss and aging are not only medical; there are also social, cultural, and economic ramifications that affect the life of a community or a nation. In 1970, the number of people in the world aged 60 years and above was estimated at 291 million, or 8% of the world’s population. By the year 2000 this number is expected to reach 585 million, increasing the proportion of old people in the world to 9% (1). As a consequence, we should expect an epidemic of bone fractures among the elderly. In many countries, most orthopaedic beds are occupied by hip fracture patients (2,3), and the total expenses for the community are enormous. A ten-day period in the hospital for each such patient in the United States would cost about $1 billion a year.

The scientific study of bone loss and fractures began long ago with the classical work of Astley Cooper (4) and was continued more than 100 years later by many others (5-10). The epidemiologic work of Richmond Smith contributed much to the proper understanding of the problem (11-14).

We now recognize three main sites of fracture associated with bone loss—wrist, spine, and hip (15). The epidemiology of spinal osteoporosis is difficult, because vertebral fractures can occur without symptoms (16), but about 8% of women will be affected by age 80. The incidence of wrist fractures starts to rise immediately after the menopause with a cumulative prevalence of about 15% by age 80. Hip fractures tend to occur later with a cumulative prevalence of about 6% by age 80 (17). Most reports of hip fractures come from northern European countries where osteomalacia due to vitamin D deficiency could be a contributory factor (18). Preliminary data on hip fracture epidemiology in Croatia (19) and a nutritional survey in two small regions in Croatia (20) indicate that the incidence of those fractures tends to be lower in Croatia, which has a higher daily exposure to sunshine than elsewhere in Europe (21). We extended our study to wrist as well as to hip fractures over several years and determined metacarpal bone mass in patients with hip fracture. Death rates were also recorded.

Materials and Methods

Fracture rates

We recorded forearm fractures over a period of five years in an urban population of Zagreb, the capital of Croatia, with about one million inhabitants. Fractures of the lower end of the radius, with or without the ulna, up to 3 cm above the wrist joint (wrist or Colles fracture) were in-
eluded. Data were obtained from surgical records of outpatient at six main hospitals in Zagreb.

Hip fractures and associated mortality data were recorded in the Republic of Croatia (part of Yugoslavia, with about 4.5 million inhabitants) over a four-year period. Hip fractures were defined as fractures of the upper end of the femur from the head to the subtrochanteric level. Data were obtained from the Institute of Public Health of Croatia and were based on centralized inpatient statistics.

For each fracture case we recorded the age, sex, home address, date of accident, site of fracture, and type of trauma. Age and sex-specific rates were calculated from the corresponding population figures (Census of Population of Yugoslavia, 1971) and expressed as fractures per 10,000 per year for each sex and five-year age groups. International comparison was based on available publications.

Bone morphometry

Metacarpal bone mass was determined in more than 2,000 normal people living in Croatia (1,023 men and 1,152 women of different ages) and in 200 patients with hip fractures (92 men and 118 women). The number of subjects in each five-year age group ranged from about 30 to 100 for normal subjects and from 3 to 30 in the fracture cases. Hand radiographs (postero-anterior) and morphometric measurements were made as described by Barnett and Nordin (22). The hands were placed over a film cassette containing Sanix 210-420 film (Fotokemika, Zagreb). The film was exposed at a distance of 100 cm and processed in the standard way.

At the midpoint of the second metacarpal of the left hand, external diameter (T) and internal diameter (M) were measured with a needle-tipped caliper (John Bull, British Indicators, Ltd) on films placed on a standard viewing box. Each caliper reading was rounded to 0.01 mm. From these primary measurements, we made the following calculations: cortical area (CA) given by π/4 (T²-M²), total area (TA) given by π/4 T², and the ratio between these areas (CA/TA) given by (T²-M²)/T², representing cortical bone mass corrected for external bone volume (bone "density") as an indicator of osteoporosis (23,24). All measurements were conducted by the same observer in a short time (25). The differences between the groups were tested by means of student's t test.

Results

Wrist fractures

The total number of fractures recorded in Zagreb from 1968 to 1972 was 6,865. Over two-thirds (4,803) occurred in women and one-third (2,062) in men. The distribution of fractures according to age, sex, and type of trauma is presented in Fig. 2. Over 90% of the fractures were the result of moderate trauma according to the Alffram classification (26). The calculated age-specific fracture rate shows a drastic increase in women after the age of 45 but very little change in men (Fig. 3). For women, Zagreb has almost the same annual wrist fracture rate as Malmo (9), Dundee, and Oxford (10) (Table I, Fig. 4).

Discussion

Our data show an earlier onset in the rise of wrist fractures than in hip fractures and a higher incidence of both fractures in women than in men. This is in general agreement with studies in other countries. Only two other epidemiologic studies in urban communities, one in Sweden (9,26) and one in Great Britain (10), analyzed wrist and hip
fracture rates in the same population groups. Hip fractures in Croatia show a much lower incidence than in Malmo (26) and in Dundee-Oxford (10), while wrist fracture incidence shows no difference, surprisingly. This finding indicates that factors influencing wrist and hip fractures are probably not the same.

Postmenopausal bone loss may be the most important factor influencing wrist fracture rates. During the first few years after the menopause women undergo a phase of rapid cortical bone loss (31), best demonstrated with artificially induced menopause due to oophorectomy (32). This change could be a critical factor that causes bone fragility and leads to fracture. If menopausal bone loss occurring at about the same age in all women is the dominant reason for the acute rise of wrist fractures, the lack of difference in forearm fracture rates between various countries would be expected. However, the wrist fracture rate in the urban population of Zagreb was about twice as high as in two small rural population groups in Croatia (20), although there was the same drastic increase in wrist fracture at menopause as in the urban populations. Other factors such as the soft tissues around the forearm might influence the wrist fracture rate; but further studies are necessary.

In contrast to patients with wrist fractures, those with hip fractures tend to have a greater degree of generalized osteoporosis than their age-matched controls, in this as well as in other studies of peripheral cortical bone (33,35). Patients with hip fractures also have a significant degree of axial osteoporosis based on spinal height measurements (36), x-rays of the spine (37,38) and iliac crest bone biopsy (18,33). Bone histology of women with hip fractures in England revealed a very high incidence of osteomalacia and severe osteoporosis with evidence of secondary hyperparathyroidism (18). Plasma levels of 25-hydroxy vitamin D were significantly reduced, which would indicate vitamin D deficiency more from inadequate exposure to the sun than from low dietary intake of vitamin D (39,40). Some years ago, Richmond Smith and his co-workers proposed the same explanation for the low serum antirachitic activity found in patients with spinal osteoporosis living in Michigan (41). Vitamin D stimulates muscle metabolism (42), and the proximal myopathy of vitamin D deficiency (43) could increase the risk of falls in the elderly (44,45), an additional factor in the etiology of hip fractures besides bone mass.

The occurrence of hip fractures in Croatia probably reflects the normal process of bone loss with age. The rate in women starts to rise 25 years after the increase in wrist fractures, compared with the 15-year time interval in Swe-
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Fig. 2
Distribution of wrist fractures according to age, sex, and type of trauma in Zagreb (1968-1972).

The authors thank Prof. B.E.C. Nordin, MRC Mineral Metabolism Unit, Leeds, England, and Dr. W. Mertz, Nutrition Institute, U.S. Department of Agriculture, Beltsville, Maryland, for their continued interest and help in this work.
Fig. 3

Fig. 4
International comparison of age-specific wrist fracture rates in women.

Fig. 5
Comparison of age-specific wrist and hip fracture rates in women from Croatia (semilogarithmic plot).
Fig. 6
Distribution of hip fractures according to age, sex, and type of trauma in Croatia (1969).
Comparison of age-specific hip fracture rate and death rate from these fractures in women from Croatia.

Fig. 7

Metacarpal cortical/total area ratio (MCA/MTA) of men with a hip fracture after moderate and severe trauma (expressed in relation to the mean ± 2SD of MCA/MTA values of control group).

Fig. 8
Osteoporosis in Croatia

### TABLE II
International Comparison of Age-specific Hip Fracture Rates in Women*

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*Annual fracture rate per 10,000

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**Fig. 9**
International comparison of age-specific hip fracture rates in women.

**Fig. 10**
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### TABLE III

International Comparison of the Age-specific Hip Fracture Rates in Men*

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*Annual fracture rate per 10,000

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**Fig. 11**

Metacarpal cortical/total area ratio (MCA/MTA) of women with hip fractures in relation to controls.

**Fig. 12**

Metacarpal cortical/total area ratio (MCA/MTA) of men with hip fractures in relation to controls.
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References


