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Original Article

Epidemiology of Vertebral Fractures

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Abstract

Vertebral fractures are one of the most common fractures associated with skeletal fragility and can cause as much morbidity as hip fractures. However, the epidemiology of vertebral fractures differs from that of osteoporotic fractures at other skeletal sites in important ways, largely because only one quarter to one-third of vertebral fractures are recognized clinically at the time of their occurrence and otherwise require lateral spine imaging to be recognized. This article first reviews the prevalence and incidence of clinical and radiographic vertebral fractures in populations across the globe and secular trends in the incidence of vertebral fracture over time. Next, associations of vertebral fractures with measures of bone mineral density and bone microarchitecture are reviewed followed by associations of vertebral fracture with various textural measures of trabecular bone, including trabecular bone score. Finally, the article reviews clinical risk factors for vertebral fracture and the association of vertebral fractures with morbidity, mortality, and other subsequent adverse health outcomes.

Key Words: Vertebral fractures; prevalence; incidence; epidemiology.

Introduction

Vertebral fractures are one of the most common skeletal fractures associated with low bone mass and other causes of skeletal fragility. However, in contrast to fractures occurring at other skeletal sites, two-thirds to three-quarters of vertebral fractures are not recognized at the time of their clinical occurrence and require spine imaging to be detected *(1,2)*. Epidemiologic studies of vertebral fractures have focused primarily on radiographic vertebral fractures, with fewer studies of the epidemiology specifically of that subset of vertebral fractures that are clinically recognized. Delineating the prevalence, incidence, causative factors, and clinical consequences of vertebral fractures is complicated further by the lack of consensus as to exactly what changes within a vertebra on spine imaging warrant a diagnosis of vertebral fracture *(3−5)*, such that some aspects of the epidemiology of vertebral fractures may depend somewhat on the chosen definition of vertebral fracture.

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In this article, we will describe in detail the prevalence and incidence of vertebral fractures in the general population as a function of age, sex, and ethnicity; causation of vertebral fracture; and clinical consequences of vertebral fracture. In each of these sections, we will highlight what aspects of vertebral fracture epidemiology may differ for clinical compared with radiographic (but clinically unapparent) vertebral fractures, and where the prevalence, incidence, and clinical consequences of vertebral fractures may depend on the definition of radiographic vertebral fracture that is used.

Prevalence and Incidence of Vertebral Fractures

There are few population-based comprehensive studies of the incidence of clinically recognized vertebral fractures (defined as patients presenting with acute or subacute symptoms suggestive of a recent vertebral fracture, with radiographic confirmation of the event). For example, in the European Union (EU), good reliable population-based estimates of the incidence of clinical vertebral fracture have been established only in Malmö, Sweden; for the rest of the EU, the incidence of clinical vertebral fractures in each country has been estimated by the incidence of hip fracture and the

ratio of clinical vertebral to hip fractures for each 5-yr age group noted in Sweden *(6,7)*.

Studies that include men and women at least as young as 50 yr show that the incidence of clinical vertebral fracture is actually higher in men than women under the age of 50−55 yr *(8,9)* but that the risk rises in women after the age of 60 yr and substantially so after 70 yr of age (Fig. 1) *(7,9−12)*. Among men, the incidence of clinical vertebral fracture rises somewhat after the age of 70 yr, and markedly so after the age of 80 yr. Figure. 1 shows that the age-adjusted incidence may vary substantially from country to country, but some of these differences may be due to different patterns of clinical presentation and differences in vertebral fracture ascertainment rather than true differences in fracture incidence. Clinical vertebral fracture rates may be particularly high in the United States (Fig. 1), but the population-based empirical study on which these estimates are based included vertebral fractures discovered incidentally on lateral spine imaging obtained for other clinical reasons *(11)*. The age-specific incidence of radiographic vertebral fracture (whether clinically apparent or not) is 2−2.5-fold higher in women than in men *(13,14)* and is significantly higher in Scandinavia than in eastern or southern Europe *(14)*. The skeletal location of incident vertebral fractures is highest at T12 and L1, second highest at L2 and L3, and third highest at T7 through T9 and at L4 *(13)*.

No consistent trends in the incidence of vertebral fracture over the past 20 yr have been evident in studies done to date. Although the incidence in Iceland decreased from 1989 to 2008 *(10)*, no change in age-specific incidence in men or women in Manitoba occurred between 1986 and 2006 *(15)*, and the incidence appeared to increase in Olmstead County, Minnesota, between 1989 and 2009 *(11)*. Some of the increase in Minnesota may be due to more incidental identification of vertebral fractures on lateral spine imaging obtained for other clinical reasons *(11)*.

Several large population-based cohort studies, using spine radiographs of all participants, have estimated the prevalence of radiographic vertebral fractures as a function of age and sex, in Canada *(16)*, Hawaii *(17)*, Spain *(18)*, mainland China *(19)*, Taiwan *(20)*, Hong Kong *(21)*, Korea *(22)*, India *(23)*, Denmark *(24)*, Vietnam *(25)*, Japan *(17)*, 5 Latin American countries *(26)*, Europe *(27)*, and the United States *(28−30)*. Considering those studies that are both truly population-based and used very similar fully quantitative morphometric methods to define vertebral fracture (Fig. 2), the prevalence of radiographic vertebral fracture clearly rises with age across the globe. Age-specific prevalence rates tend to be highest in countries with largely Caucasian populations, and lower in Latin American and Asian populations (Fig. 2), but not uniformly so; a recent study has shown a relatively high prevalence of vertebral fracture in Vietnam, and a direct comparison of population-based estimates of radiographic vertebral fracture found little difference between residents of Hiroshima, Japan, and both Caucasian and Japanese-Americans residing in Hawaii *(17)*. There are no reliable population-based estimates of incidence or prevalent vertebral fractures from any African countries. In the Study of Osteoporotic Fractures, the age-adjusted incidence of radiographic vertebral fracture in African Americans was one-third that of Caucasians *(30)*, but these findings cannot be extrapolated to current African populations.

Importantly, the definition of radiographic vertebral fractures has a substantial influence on their apparent incidence and prevalence. In the European Vertebral Osteoporosis Study, the apparent prevalence of radiographic vertebral fracture was reduced nearly by half when using the McCloskey-Kanis morphometric definition of vertebral fracture instead of the more liberal modified Eastell definition *(27)*. The prevalence of radiographic vertebral fractures is also somewhat higher when using the Genant semiquantitative (SQ) method compared with the algorithm-based qualitative method (particularly in the midthoracic spine) *(31,32)* and compared to most fully quantitative morphometric methods *(3)*.

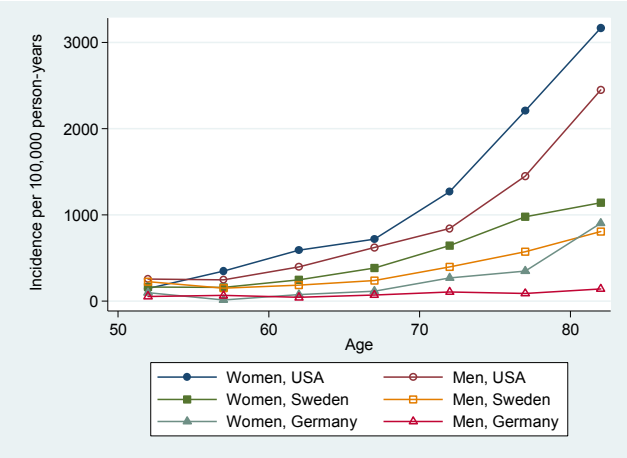

Fig. 1. Incidence of clinical vertebral fracture by age and sex.

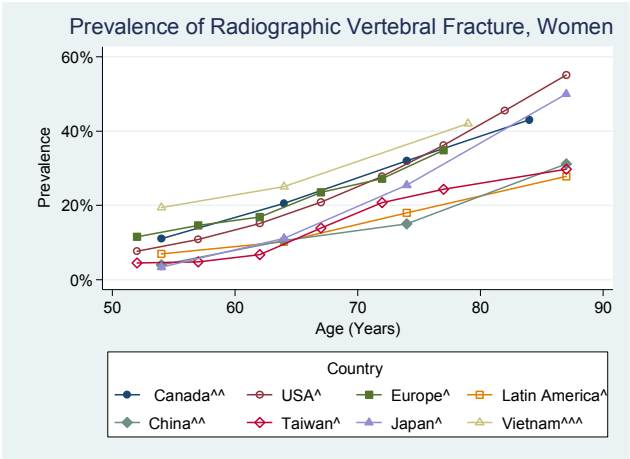

Fig. 2. Prevalent radiographic vertebral fracture by age and country (women). Morphometric vertebral fracture definition method. ^Eastell et al. *(227)*, ^^Black et al. *(228)*, ^^^Ross et al. *(229)*.