ELSEVIER

Mortality in the Presence of a Vertebral Fracture, Scoliosis, or Scheuermann's Disease in the Thoracic Spine

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PURPOSE: Vertebral fractures and scoliosis, unlike Scheuermann's disease, have been associated with increased mortality. Total and cause-specific mortalities of these spinal deformities were studied to produce epidemiologic knowledge.
METHODS: A population of 16,010 Finnish men and women 20 to 92 years of age participated in a health examination from 1973-1976. Their spinal deformities were assessed from chest radiographs by two radiologists. Logistic regression and Cox's model were used to estimate risk ratios and to control confounding. The follow-up period was 30 years.
RESULTS: Vertebral fracture significantly predicted total mortality, and this increase in mortality was due to an excess of cancer and respiratory deaths. The increased risk of cancer death persisted even when those subjects with a history of cancer and the first 5 years of follow-up were excluded to avoid the effect of metastatic fractures, and when confounding was controlled. In this analysis the relative risk of cancer death in subjects with a baseline vertebral fracture was 2.02 (95% confidence interval: 1.23–3.31).
CONCLUSION: Vertebral fracture significantly predicted increased mortality from cancer. To clarify the mechanism, the fractures should be studied further for their associations with defined and site-specific cancer types.
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KEY WORDS: Vertebra, Fracture, Scoliosis, Scheuermann's Disease, Mortality, Cancer.

INTRODUCTION

Osteoporosis-related vertebral fractures have important health consequences, including increased mortality (1–9). While these fractures show associations with increased mortality, there is no evidence that the excess deaths are due to any particular disease (1–6, 9). However, severe vertebral deformities and kyphosis are known to predict mortality in women (1). The follow-up periods in previous studies have been relatively short. In a 10-year population-based follow-up study, vertebral deformities were associated with cancer deaths in women and with pulmonary and cardiovascular deaths in men (7). Low bone mineral density has also been associated with increased risk of nontrauma mortality (10).

Idiopathic scoliosis is a structural lateral curvature of the spine arising in otherwise healthy children, usually during puberty, and it represents the most common form of spinal deformity in childhood (11). The diagnosis is made when other causes of scoliosis, such as vertebral anomalies, are ruled out. The male-female ratio for small curves in the range of 10 degrees is 1:1. In curves of larger magnitude, however, female dominance may grow as high as 1:10 (11). Epidemiologic studies in Finnish pubertal and prepubertal schoolchildren indicate that the prevalence of scoliosis is 4%–9% (12, 13). Scoliosis with curvature over 60 degrees is commonly associated with restrictive lung disease (14). Previous findings regarding mortality in subjects with scoliosis are contradictory. Increased mortality has been reported in subjects with untreated scoliosis (15) and in subjects with untreated infantile, juvenile, or severe (>70 degrees) scoliosis (16). In a natural history study of adults with adolescent idiopathic scoliosis, subjects were productive and functional at a high level at 50-year follow-up and mortality was not increased (17). Although the follow-up period in this study was 50 years, the small number of cases and the use of hospital-based control subjects restrict evaluation of mortality.

Scheuermann's disease is characterized by a fixed thoracic kyphosis with wedged thoracic vertebrae and endplate changes (11). It affects 0.5%–8% of healthy subjects, with prevalence in the male population (18, 19). The cause of this condition remains unclear. Scheuermann's disease is not known to increase mortality, although long-term prognostic studies are few. Murray et al. (19) followed up 67

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Selected Abbreviations and Acronyms

OR = odds ratio
CI = confidence interval
RR = risk ratio
ICD = *International Classification of Diseases*

patients with Scheuermann's disease for 32 years. Mortality was not increased, although patients with kyphosis of over 100 degrees had a restrictive lung disease.

Limited knowledge of mortality regarding these spinal deformities encouraged us to analyze their total and cause-specific mortality in a population sample of 16,010 Finnish men and women during a 30-year follow-up. The aim was to produce epidemiologic knowledge and to create hypothesis for further studies.

METHODS

Study Population And Baseline Examination

The Finnish Social Insurance Institution carried out a multiphase screening examination from 1973-1976. Altogether, 16,010 men and women 20–92 years of age (83% of those invited) from 12 populations in four regions of Finland were examined. The groups examined constituted either the entire population of a community or a random sample of it. The mean age of subjects was 45.0 years.

The baseline examinations included a medical examination and chest radiographs (posteroanterior and lateral). Background information was collected with a premailed questionnaire, which included questions about medical history. The answers were checked and, when necessary, completed by a nurse at the examinations.

Definition of Variables

Subjects were asked to categorize their general health as good, moderate, rather poor, or poor. Categories of smoking history were as follows: newer smoked; ex-smoker; current smoker of cigars, pipe, or fewer than 10 cigarettes per day; current smoker of 10–19 cigarettes per day; and current smoker of 20 or more cigarettes per day. Standing height and weight were measured at the examination in light indoor clothing without shoes. Body mass index (weight [in kilograms]/height [in square meters]) was used as a measure of relative weight. Education was used as a measure of socioeconomic status and was classified as follows: lower education (i.e., completion of an 8-year period of comprehensive schooling), or less; intermediate education (i.e., lower or upper secondary schooling of 9–13 years); and higher education, including studies or degrees taken at universities or other higher education establishments (>13 years). The subjects were asked to classify their leisure-time physical activity during the usual week into one of four categories: none or little; walking, cycling or related light activities at least 4 hours per week; ball games, jogging, or related activities at least 3 hours per week; and regular vigorous exercise. For data analyses the two higher categories were combined because of the small number of subjects.

Radiographic Evaluation

Chest radiographs were viewed by two trained radiologists who studied every picture independently from 100- × 100-mm photofluorograms. Wedge-shaped and collapsed vertebrae were identified from the Th1 to the Th12 level (20). Scoliosis was diagnosed in patients with Cobb angle of at least 10 degrees (21) in the thoracic spine. Diagnosis of Scheuermann's disease was based on Sørensen's radiographic criteria (22) of three adjacent wedged vertebrae, angled at least 5 degrees.

In this study vertebral fracture, Scheuermann's disease, and scoliosis were considered to be present if either one of the radiologists registered that finding. In most data analyses a hierarchic classification was used: vertebral fracture, Scheuermann's disease (in the absence of vertebral fracture), and scoliosis (in the absence of vertebral fracture and Scheuermann's disease).

The kappa coefficient was used to assess diagnostic agreement by the two radiologists (23). Systematic differences between the radiologists were tested by the McNemar test, and expressed as exact p values. These results are presented in Table 1.

Follow-up

The mortality of the study population was monitored continuously. The information, including the cause of death using *International Classification of Diseases* (ICD) codes, was obtained from Statistics Finland. Altogether 7,830 deaths were identified among the study population by the end of 2005. There were 277 subjects with a history of cancer at baseline and 809 of the cohort's subjects had died during

TABLE 1. Diagnostic agreement of the two radiologists in the hierarchic classification of the deformities: No deformity, vertebral fracture, Scheuermann (no vertebral fracture), and scoliosis (no vertebral fracture, no Scheuermann's disease)

	Radiologist 2			
Radiologist 1	No deformity	Vertebral fracture	Scheuermann	Scoliosis
No deformity	15,338	26	21	84
Vertebral fracture	22	27	8	3
Scheuermann	22	0	37	6
Scoliosis	79	4	5	133

No deformity: kappa 0.48; McNemar test $p < 0.001$. Vertebral fracture: kappa 0.46, McNemar test, $p = 0.71$. Scoliosis: kappa 0.45, McNemar test, $p < 0.001$. Scheuermann: kappa 0.38, McNemar test, $p < 0.001$. Overall: kappa 0.46, test for symmetry, $p < 0.0001$.