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ORIGINAL ARTICLE

Untreated Scheuermann's disease: a 37-year follow-up study

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Abstract
Introduction There are only a few follow-up studies of untreated Scheuermann's disease. The aim of this study was to investigate the relationship between vertebral changes, back pain, and disability in patients with untreated Scheuermann's disease after a 37-year follow-up.
Materials and methods Eighty patients responded to a postal questionnaire concerning back pain and disability and 49 of them had classic Scheuermann's disease. Degree of kyphosis, lordosis, scoliosis, the number of affected vertebrae, and mean and maximum wedge angles were measured from radiographs. Back pain and disability scores were compared to a sample of the general Finnish population (n = 3,835).
Results At follow-up, the patients were on average 59 (SD 8) years old (range 44–79 years), and the mean follow-up time was 37 (SD 7) years (26–54 years). The patients comprised more males than females (3.1:1). At follow-up, male patients were on average 3 cm taller than controls ($p = 0.007$). At age 20, female patients compared to controls were on average 6 kg heavier ($p = 0.016$) and had higher body mass index (BMI) (mean 23.9 kg/m^2 vs. 20.8 kg/m^2, $p = 0.001$). Scheuermann's patients had 2.5-fold [odds ratio (OR); 95% confidence interval (CI); 1.4–4.5, $p = 0.003$] increased risk for constant back pain compared to controls. The risk for disability because of back pain during the past 5 years (OR 2.6; 95% CI 1.4–4.7, $p = 0.002$), risk for back pain during the past 30 days (OR 3.7; 95% CI 1.9–7.0, $p < 0.001$) and risk for sciatic pain (OR 2.3; 95% CI 1.3–4.3, $p = 0.005$) were higher compared to controls. Scheuermann's patients had higher risk for difficulties in mounting stairs (OR 5.4; 95% CI 2.8–10.3, $p < 0.001$) and in carrying a 5 kg load for at least 100 m (OR 7.2; 95% CI 3.9–13.3, $p < 0.001$).
Conclusion Scheuermann's patients had a higher risk for back pain and disabilities during activities of daily living than controls. However, the degree of thoracic kyphosis among Scheuermann's patients was not related to back pain, quality of life, or general health.

Keywords Scheuermann's · Thoracic hyperkyphosis · Juvenile osteochondrosis · Natural history

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Introduction

Scheuermann's disease was originally defined as a growth disturbance of the thoracic spine, characterised by a rigid hyperkyphosis due to wedge-shaped vertebral bodies [19]. According to the generally accepted definition published later by Sørensen [21], at least three consecutive vertebral bodies with a minimum of 5° of wedging have to be present to justify the diagnosis. Besides vertebral wedging, typical radiographic findings are: irregularities of the vertebral

endplates, disc material herniation through the endplates (Schmorl's nodes), narrowing of the disc spaces, and lengthening of the vertebral bodies [3, 23]. The apex of the "classic" Scheuermann's is found at the mid-thoracic spine, the lower thoracic spine or at the thoracolumbar junction [11]. Similar vertebral changes may occur also in the lumbar spine (atypical Scheuermann's, lumbar Scheuermann's), as first described by Edgren and Vainio [7]. Our study deals exclusively with the "classic" thoracic Scheuermann's, with at least three consecutive 5° wedge-shaped vertebrae. Because sometimes only one or two vertebrae may be affected [23], we also included cases of a single vertebra with over 10° of wedging in the thoracic spine.

The incidence of Scheuermann's has been reported to range from 0.4 to 8% [13, 16, 22]. According to earlier studies [14, 15, 18], the prevalence of Scheuermann's has been closely similar between the genders. However, some studies have found Scheuermann's in the thoracic spine to be more prevalent among boys than girls [8, 17], whereas other studies have reported kyphosis to be prominent in females than males (1.9:1) [4].

The specific aetiology of the Scheuermann's is unknown. Different theories have been reported, such as a development error in collagen aggregation leading to failure of vertebral endplate ossification [2]. Genetic aetiology has also been discussed [6, 10]. Hormonal factors, such as increased growth hormone, have also been proposed [2]. This may explain the connections between increased body height and Scheuermann's [9]. Some studies have reported that mechanical factors play a role in the pathogenesis of the disease. There are reasons to assume that Scheuermann's may be a multifactorial skeletal deformity [9].

The long-term prognosis of patients with Scheuermann's is largely unknown. Murray et al. [15] reported in their 32-year follow-up study that patients with Scheuermann's had more pain than those of a control group. The pain symptoms, however, did not interfere with activities of daily living or employment.

The aim of this study was to investigate the relationship between vertebral changes, back pain, and disability in patients with untreated Scheuermann's after at least 26 years of follow-up and to compare their back pain symptoms, quality of life, and possible disability to those of a representative sample of the Finnish population.

Materials and methods

All patients referred to outpatient clinics between 1950 and 1990 with suspected Scheuermann's ($n = 255$) were identified from the patient registry of the authors' institution. Baseline spinal radiographs (standing p.a. and lateral films of the thoracolumbar spine) and present addresses were obtained for 136 patients (53% of the cohort).

A follow-up questionnaire, based on the Finnish Population Study (Health 2000), was mailed to all 136 patients and included anthropometric data, and questions concerning back pain and disability at work and during activities of daily living, quantified using the VAS scale (0–10, 0 means no pain at all and 10 means the worst possible pain; in other items 0 means the worst and 10 means the best health/quality of life and disability). It also included questions on present general state of health and quality of life. Patients were asked about their ability to walk up one floor without resting and to carry a 5 kg shopping bag at least 100 m. In addition, patients were asked to complete a pain drawing showing the location of their back pain during the past 7 days. A reminder was sent to patients who did not respond to the first mailing after 1 month. In total, 80 patients completed the questionnaire (59%, 80/136).

The baseline spinal radiographs of these 80 patients were assessed by two of the authors in detail. Nine cases were excluded because of the poor quality of the X-rays. Thus, the final study group consisted of 71 patients. Thoracic kyphosis, the number of affected vertebrae, the number of vertebrae with wedging greater than 5°, the mean and maximum degrees of wedging of vertebrae, lumbar lordosis and scoliosis were assessed by Cobb's method [5]. The criteria for Scheuermann's were the presence of a minimum of three vertebra with wedging greater than 5° or at least one vertebra with over 10° of wedging. The apex of the kyphosis had to be in the thoracic spine, the lowest being at Th11. According to this radiographic evaluation, 49 patients (12 females and 37 males) met the inclusion criteria. Their mean age at follow-up ($n = 49$) was 59 (SD 8) years.

A representative sample of the Finnish adult population [$n = 3{,}835$, 1,851 males (48%) and 1,984 females (52%)] drawn from the Health 2000 study served as a control group (http://www.terveys2000.fi/indexe.html).

Statistical analysis

Statistical analyses were performed with PASW (version 18.0; SPSS Inc., Chicago, IL, USA). *T* tests and analysis of variance were applied to calculate statistical differences in distributions between the sub-groups of patients with Scheuermann's or between the Scheuermann's patients and the control group. $p < 0.05$ (two-tailed) was accepted as a statistically significant threshold. Pearson's correlation coefficient was used to investigate the association between anatomical variables and back symptoms in patients with Scheuermann's. Because the control subjects were slightly younger than the Scheuermann's patients, the

Table 1 The differences between Scheuermann's and controls (Health 2000) in age and anthropometrics at age 20 and at follow-up

	Female			Male		
	Mean (95% CI)		p^b	Mean (95% CI)		p^b
	Scheuermann's $n = 12$	Reference group $n = 1{,}984$		Scheuermann's $n = 37$	Reference group $n = 1{,}851$	
Follow-up age (years)	58.7 (54.2–63.2)	55.8 (55.5–56.2)	0.210	58.8 (56.4–61.3)	55.3 (54.9–55.6)	0.005
Height at 20 years (cm)	164.3 (160.7–167.8)	163.1 (162.9–163.4)	0.542	178.2 (176.1–180.3)	176.2 (175.9–176.5)	0.069
Follow-up height (cm)[a]	163.8 (160.3–167.3)	161.8 (161.5–162.0)	0.248	178.3 (176.2–180.4)	175.4 (175.1–175.7)	0.007
Weight at 20 years (kg)	61.2 (56.6–65.8)	55.5 (55.2–55.9)	0.016	71.5 (68.6–74.4)	70.0 (69.5–70.49)	0.291
Follow-up weight (kg)[a]	67.6 (60.0–75.2)	70.4 (69.8–71.0)	0.467	86.0 (81.5–90.5)	83.9 (83.3–84.6)	0.385
BMI at 20 years (kg/m^2)	23.9 (22.1–25.6)	20.8 (20.7–21.0)	0.001	22.5 (21.7–23.3)	22.5 (22.4–22.6)	0.950
Follow-up BMI (kg/m^2)[a]	25.0 (22.2–27.9)	26.9 (26.7–27.1)	0.193	27.0 (25.7–28.4)	27.2 (27.0–27.4)	0.836

95% CI 95% confidence interval

[a] Age adjusted

[b] ANCOVA

anthropometric comparisons between Scheuermann's patients and the Health 2000 controls were adjusted by age (Table 1). Age and gender-adjusted odds ratios (ORs) with 95% confidence intervals (CIs) for different risk factors for patients compared to controls were calculated.

Results

The specific anthropometric characteristics of the Scheuermann's patients and the Health 2000 sample are shown in Table 1. The mean follow-up time of the Scheuermann's patients was 37 (SD 7) years (range 26–54 years). Thirty-seven (76%) of the patients were male and 12 (24%) of the patients were female. Nearly 80% (38/49) of the patients were at working age at the time of follow-up, and 66% (25/38) of them were employed either full time or part-time. There were no differences between Scheuermann's patients and the control group in employment status (51 vs. 54%, $p = 0.723$). Thirty of the 38 employed patients reported absences from work. Only five of them (17%) reported back pain as a reason for this.

Baseline radiographs

Mean kyphosis in the thoracic spine among the Scheuermann's patients was 45° (range 20°–78°) (Table 2). The apex of the kyphosis was located between the Th7 and Th9 vertebrae in two-thirds of cases (71%). Over 80% of the patients (84%) had five or more damaged vertebrae. Five males and one female of the 49 patients had changes both in the thoracic spine and in the lumbar spine. Half of the patients ($n = 25$) also had thoracic scoliosis (mean 15°). Lumbar lordosis varied from 11 to 60° (mean 35°). Degree of thoracic kyphosis correlated with that of lumbar lordosis ($r = 0.622$, $p < 0.001$). There were no differences in any of the anatomic variables between the genders. Baseline radiographic data by gender are shown in Table 2. Patients who had difficulties in walking up one floor without resting had on average more damaged vertebral bodies than

Table 2 Baseline radiograph data on Scheuermann's patients

	Scheuermann's			
	Female $n = 12$ Mean (SD)	Male $n = 37$ Mean (SD)	All $n = 49$ Mean (SD)	p between genders
Kyphosis (°)	51.7 (16.9)	43.2 (15.3)	45.2 (16.0)	0.109
Vertebra with changes (*n*)	5.8 (1.7)	6.2 (2.0)	6.1 (2.0)	0.480
Wedging over 5° (*n*)	5.1 (1.7)	4.8 (1.9)	4.9 (1.8)	0.659
Mean wedge (°)	10.6 (2.6)	8.8 (3.2)	9.2 (3.1)	0.081
Maximum wedge (°)	13.5 (2.8)	12.0 (4.6)	12.4 (4.2)	0.281
Lumbar lordosis (°), (11/26)[a]	36.2 (8.8)	34.3 (12.8)	34.9 (11.6)	0.661
Scoliosis (°), (5/20)[b]	16.4 (8.1)	14.6 (7.4)	14.9 (7.4)	0.626

[a] Lumbar lordosis: female patients $n = 11$ and male patients $n = 26$

[b] Scoliosis: female patients $n = 5$ and male patients $n = 20$

Table 3 Back pain and disabilities in activities of daily living in Scheuermann's patients and the control group (Health 2000)

	Scheuermann's patients $n = 49$ % (n)	Health 2000 $n = 3,835$ % (n)	p between groups[a]	Scheuermann's patients[b] OR 95% CI
Constant back pain	37.5 (18)	19.6 (549)	0.002	2.5 (1.4–4.5)
Disability because of back pain during last 5 years	53.3 (24)	31.1 (871)	0.001	2.6 (1.4–4.7)
Back pain during last 30 days	71.1 (32)	43.0 (1,205)	<0.001	3.7 (1.3–4.3)
Sciatic	64.6 (31)	46.1 (1,622)	0.011	2.3 (1.3–4.3)
Difficulties carrying 5-kg load at least 100 m	44.9 (22)	12.4 (476)	<0.001	5.4 (2.8–10.3)
Difficulties in walking up one floor without resting	32.7 (16)	7.8 (299)	<0.001	7.2 (3.9–13.3)

[a] Based on Pearson chi-squared test

[b] Age- and gender-adjusted odds ratios (OR) and their 95% confidence intervals (95% CI) for back symptoms and activities of daily living in Scheuermann's patients ($n = 49$) compared to control subjects ($n = 3,835$)

patients who did not have difficulties in this activity (6.9 vs. 5.7, $p = 0.036$).

Follow-up questionnaires

According to self-reported height, the male Scheuermann's patients were on average 3 cm taller than controls ($p = 0.007$) and at age 20 had been slightly taller than controls ($p = 0.069$; Table 1). Female patients had been heavier at age 20 ($p = 0.016$) and had a higher body mass index (BMI) ($p = 0.001$) than controls (Table 1).

The Scheuermann's patients reported mean back pain intensity of 3.8 on the VAS scale (0–10) during the past 7 days. Twenty-five percent (12/49) of the patients did not report any back pain. Sixteen percent of the patients had pain in the thoracic spine, 31% in the lumbar spine and 29% in the whole spine. There were no gender differences in reported back pain in any of the back pain items. There was also no difference in back pain and disability between patients with thoracic kyphosis less than 40° and those with thoracic kyphosis more than 60°.

The prevalence of different types of back pain was higher in the Scheuermann's patients compared to controls (Table 3). The Scheuermann's patients had a 2.5-fold ($p = 0.003$) increased risk for constant back pain. The patients also had a higher risk for back pain-related disability during the past 5 years ($p = 0.002$), for back pain during the past 30 days ($p < 0.001$) and for sciatic pain ($p = 0.005$; Table 3). There were no differences between the Scheuermann's patients and controls in disability caused by back pain either at work ($p = 0.994$), during leisure time ($p = 0.203$) or in performing domestic tasks ($p = 0.528$).

A higher number of Scheuermann's patients reported difficulties climbing one floor without resting compared to controls (Table 3). Adjusted for age and gender, the Scheuermann's patients had over fivefold risk for difficulties in mounting stairs compared to controls ($p < 0.001$) (Table 3). Carrying a 5-kg load (e.g. shopping bag) at least 100 m was more difficult for the Scheuermann's patients than controls (Table 3). Adjusted for age and gender, the risk for experiencing difficulties in carrying a 5-kg load was 7.2-fold in the Scheuermann's patients compared to controls ($p < 0.001$) (Table 3). No gender differences were observed between the Scheuermann's patients in mounting stairs ($p = 0.515$) or carrying a 5-kg load ($p = 0.282$).

Scheuermann's patients reported lower quality of life than controls (age-adjusted 6.4 vs. 7.6 in VAS scale, $p < 0.001$) and lower general health status than controls (age-adjusted 6.4 vs. 7.3 in VAS scale, $p < 0.001$).

Discussion

Scheuermann's patients had higher risk for back pain than controls. Patients had nearly fourfold higher risk for back pain during the past 30 days, and nearly threefold higher risk for continuing back pain than controls. Disabilities related to activities of daily living, such as carrying a 5-kg load at least 100 m and walking up one floor without resting, were more frequently reported by the Scheuermann's patients compared to controls.

Murray et al. [15] found no differences between Scheuermann's patients and controls in activities of daily living or use of medication because of low back pain. However, the Scheuermann's patients had more intense back pain than controls. We found that Scheuermann's patients more commonly reported back pain than controls. Our Scheuermann's patients also reported more inconvenience in relation to their health and quality of life compared to controls. Although the difference was statistically significant, it was not as obvious clinically. Among the Scheuermann's patients poorer self-reported health and quality of life and disabilities in performing activities of daily life,

such as walking up stairs or carrying a load, may be influenced also by other diseases, e.g. heart disease. Although the increase in thoracic kyphosis of our patients was not so severe (58° in the highest quartile), they nevertheless reported a lot of back problems. It may be that patients with Scheuermann's changes in the thoracic spine may also have secondary degenerative changes in the lumbar spine owing to compensatory increase in lumbar lordosis.

In the earlier study by Murray et al. [15], 60% of patients were working, which resembles the proportion in our study. However, only a few patients in our study reported absence from work due to back pain. Despite the vertebral changes in our Scheuermann's patients, they were able to work with minimal sick leaves and were not different in this respect from controls. A similar trend was reported by Murray et al. [15].

In our study, at age 20, the female patients were heavier and had higher BMI, and at follow-up the male patients were taller than controls, which is in line with Fotiadis et al. [9], who found children with Scheuermann's to be taller and heavier than healthy controls. They proposed that increased height and weight may be a secondary result of other spine disturbances. Lonner et al. [12] also found that among 36 Scheuermann's patients, the mean BMI in the kyphosis group (24.5 kg/m^2) was significantly higher than in the adolescent idiopathic scoliosis group. Scoles et al. [20], in turn, found no differences between the mean height of normal and Scheuermann's patients, but weight differed slightly between the groups.

Various earlier studies have found higher prevalence of Scheuermann's in men [6, 8, 15, 17], which is in line with our finding. However, in their sample, Bradford et al. [4] and Ascani et al. [1] reported that girls had Scheuermann's more often than boys. Ascani et al. [1] found kyphosis in 3% of 16,000 Italian school children. However, in their study they included both scoliosis and kyphosis and they found no gender differences between scoliosis and kyphosis. In the study by Bradford et al. [4], data on patients with juvenile kyphosis were collected from hospital records.

This study has some limitations. First, it was a retrospective study. Also, the response rate was relatively low, but this is a common problem in long-term follow-up studies. No specific clinical baseline data were available on our patients, and our group included no cases of extreme hyperkyphosis. Also, we had no radiological follow-up data, and hence can draw no conclusions about the progression of kyphosis; however, on average the patients did not lose body height during the follow-up. Therefore, we assume that kyphotic deformities of this magnitude do not progress.

Conclusion

The present Scheuermann's patients had higher risk for back pain compared to controls. In addition, the Scheuermann's patients reported lower quality of the life and reported poorer general health than controls. Risk for disabilities in the activities of the daily living was more prevalent in the Scheuermann's patients than controls. However, among the patients there was no correlation between the degree of kyphosis and self-reported quality of life or health or back pain.

Conflict of interest None.

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