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Cervical, Dorsal and Lumbar Spinal Syndromes

A field investigation of a non-selected material of 1200 workers in different occupations with special reference to disc degeneration and so-called muscular rheumatism

By

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Lennart Hult.

I. Introduction

Pain and ache in the low back and in the neck and shoulders, often known as muscular rheumatism, are very common. These symptoms cause so much sick-absenteeism that they represent a real social problem.

Since Friberg (1941) published his work, "Low Back and Sciatic Pain Caused by Intervertebral Disk Herniation", he has directed extensive research at the Orthopedic Department of *Karolinska Institutet* on the causes and treatment of low back pain. As a result, a number of papers have been published on the clinical diagnosis (roentgen examination, myelography, and disk puncture) of these conditions, on the results of conservative treatment and of various operative methods, and on the morbid anatomy of the intervertebral disks and their microscopic, electron-microscopic and biochemical structure. All these reports have contributed greatly to our understanding of the various aspects of the signs and symptoms in question.

In 1949, Dr. Elof Edlund, Physician-in-Chief of the Province of Värmland, approached Professor Friberg with a request for assistance in an investigation to determine the extent to which postural faults of childhood and adolescence are of functional significance in the adult, with particular reference to spinal conditions. Friberg, who grasped the importance of an investigation of this kind, realizing that it would also yield information of the frequency in a "normal" material of degenerative changes in the various joint systems, including the intervertebral disks, planned the orthopedic section of the study. The roentgenographic section was planned by Professor Eric Lindgren, *Serafimerlasarettet.*

The investigation, which was entrusted to me as orthopedist and to Dr. S. E. Sjögren as roentgenologist, was carried out at the end of 1949. On the initiative of Dr. Edlund, the study was made in the community of Munkfors, which has a population of about 4000. In Munkfors the Uddeholm Company employs 1200 men in the production of sheet iron, as well as several hundred forest workers. The population of Munkfors is stable, and the chances of finding employment except in

heavy occupations in the iron-works or in the forests are small. Furthermore, the Uddeholm Company endeavors to transfer men who cannot do heavy work to lighter jobs, which means that very few laborers leave the community. The material covered 100 boys of 8 to 11 years, 100 apprentices of 15 to 20 years, and 277 industrial and forest workers of 35 to 49 years. The results of the study, which were published earlier this year under the title, "The Munkfors Investigation", revealed that roentgenographic signs of disk degeneration in the cervical, dorsal and lumbar spines were very common, that symptoms of the lumbago-sciatica type had been experienced by almost 80 per cent of the industrial and forest workers examined, and that the stiff neck – brachialgia symptoms were equally frequent. The high incidence of stiff neck – brachialgia gave us a new perspective on the heterogeneous nature of this syndrome. It was found that 1.25 to 1.5 per cent of the approximately 1200 workers employed by the Uddeholm iron-works had been transferred to lighter work because of backache. In contrast with the high frequency of the symptoms mentioned above, symptoms from the joints of the upper and lower extremities were rare.

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Numerous occupational groups, particularly in the heavy categories, have claimed that back trouble or "rheumatism" represents their own special occupational disease. The Swedish Confederation of Trade Unions (LO) therefore raised the question whether these symptoms are genuine occupational diseases, caused by the special strains imposed by heavy work. If so, persons disabled by these symptoms would be eligible for insurance benefits as in the case of other recognized occupational diseases. To find an answer to the problem, LO turned to Professor Friberg in 1951.

In view of the socio-economic importance of the problem, Friberg suggested that a special study be made to determine whether the incidence of back trouble differs according to occupation. In an investigation in 1949, Friberg and Hirsch had found some evidence that persons with heavy work were not to any great extent more prone to low back trouble than others, but they pointed out that no "normal" material was available for comparison. In collaboration with Professors S. Forsman and A. Ahlmark of the State Institute of Public Health, Professor K. Lindblom of the Roentgen Department of *Karolinska Sjukhuset*, Docent C. Hirsch of the Orthopedic Department, and Dr. Tage Larsson as statistician, and with the guidance of the results of the Munkfors Investigation, Friberg therefore planned the present

study of a series of "normal" persons in different occupational groups and gave me the assignment of carrying it out. The roentgen examination was planned and supervised by Professor K. Lindblom, who also evaluated the roentgenograms. The Swedish Parliament appropriated the funds for the investigation.

II. Historical Review

1. Brief survey of the concepts of muscular rheumatism, spondylosis deformans, disk degeneration and spinal syndromes.

The word rheumatism has long served as a collective term for the diseases that give rise to ache, pain and stiffness in the muscles and joints. At a relatively early stage, we learned to recognize genuine acute and chronic rheumatic arthritis and arthritis deformans. Around the turn of the century, spondylarthritis ankylopoetica or Bechterew's disease, too, was recognized as a specific disease. What remained of the concept of rheumatism was called muscular rheumatism, because of the site of the symptoms. The genesis of muscular rheumatism was unclear, though the symptomatology was relatively uniform, being characterized by ache, pain and stiffness, particularly in the neck and shoulders and in the low back, often combined with radiating pain in the arms and legs.

Leyden (1875) appears to have been one of the first to describe the clinical picture of muscular rheumatism based on a series of cases. He also correlated his observations with the condition known as spondylosis deformans, which had been described by anatomists and others. Leyden considered that the radiating pain and the neurologic signs were due to irritation of the nerve roots passing through the intervertebral foramina, caused by pressure of osteophytes on the margins of the vertebral bodies and by chronic inflammatory involvement of the cell tissue in the neighborhood of the nerve roots. This line of reasoning was also followed by a number of other workers, particularly after 1900 when the X-ray began to reveal spondylosis deformans in numerous patients with various combinations of the symptoms in question.

Kahlmeter (1918) submitted a relatively detailed report of the symptom picture in spondylosis deformans. He described the radiating pain in the arms emanating from the cervical spine, the intercostal neuralgia from the dorsal spine, and, especially, the lumbago, sciatica and insufficiency originating in the lumbar spine. He stressed the chronic-intermittent course of the disease, as well as the fact that it seemed to be more common in laborers with heavy jobs. On the basis

of certain patho-anatomic observations, Kahlmeter concluded, like Beneke (1897), that spondylosis was secondary to degenerative processes in the intervertebral disks.

Beneke considered, on the basis of roentgen and patho-anatomic investigations, that spondylosis deformans is caused by a combination of two factors, namely: degenerative changes in the intervertebral disks and mechanical strain on the spinal column. Beneke also wrote that osteophytes are nature's attempt to create a new supporting system to replace the impaired disk function.

It is interesting to note that the frequency of spondylosis deformans in persons who had never had painful symptoms was not studied in any of the many reports on spondylosis deformans and osteophytes and their symptoms published at the beginning of the century. Schmorl's pioneer works on the pathology of the intervertebral disks, published in the latter half of the twenties, give us our first real picture of the incidence of spondylosis deformans, of the degenerative processes in the intervertebral disks, of radial ruptures and the "*Hintere Knorpelknötchen*" which protude from them. On the basis of patho-anatomic examinations of more than 4000 dorsal and lumbar spines, Schmorl and Junghanns (1932) reported the frequency of spondylosis deformans to be as shown in Figure 1 below:

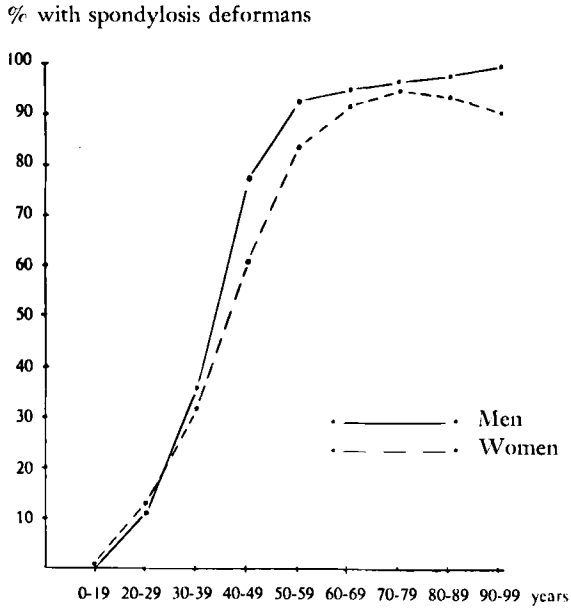

Figure 1. The frequency of spondylosis deformans in different ages (taken from Schmorl - Junghans 1932).

We see that the rate increases rapidly with age, and by the age of 50 to 59 years, 93 per cent of the men and 84 per cent of the women showed evidence of spondylosis. The relatively small difference in incidence between the sexes is also revealed. Meantime, Schmorl and Junghanns had no clinical data about the backs they examined, and their investigations therefore yielded no clue as to the connection between spondylosis deformans or disk degeneration and clinical symptoms in the form of pain and ache. On the other hand, they pointed out that osteophytes seldom were found on the posterior aspect of the vertebral margins facing the spinal canal, but that Schmorl's nodes were found there. They also noted the connection between spondylosis deformans and disk degeneration, and pointed out that they never observed osteophytes without macroscopic disk degeneration.

Keys and Compere (1932) and Lob (1933) produced spondylosis deformans experimentally by damaging the disk.

Before Schmorl's time, the literature contains occasional reports of single cases operated on for so-called chondroma or enchondroma which pressed on the medulla or the nerve roots. The first to recognize the true nature of these enchondromas appear to have been Alajouanine and Petit-Dutaillis (1930), who identified them with Schmorl's posterior nodes. The most significant contribution, however, was made by Mixter and Barr (1934), when they published eleven cases of sciatica, successfully operated on for disk herniation. This was the first time that a definite and common cause of sciatica had been demonstrated, namely, protrusion of herniated disk tissue that pressed on one or more nerve roots in the spinal canal. This has later been verified by other workers in various parts of the world by means of operations for lumbar disk herniation and also by studies of the pathology and physiology of the intervertebral disks. These publications include significant Swedish contributions by Friberg (1941, 1948), Lindblom (1941, 1944, 1950, 1951, 1952), Norlén (1944), Friberg and Hirsch (1946, 1949), Hirsch (1949), Wiberg (1950), Hirsch and Schajowicz (1952).

As with the lumbar spine, operations during the last two decades have shown that cervical disk herniation is a common cause of brachialgia (Gutzeit, 1928; Elsberg, 1931; Stookey, 1940; Semmes and Murphey, 1943; Spurling and Scoville, 1944; Michelsen and Mixter, 1944; Snellman, 1945; Browder and Watson, 1945; Josey and Murphey, 1946; Frykholm, 1951; et al.). Josey and Murphey described three cases with troublesome pseudo-angina pectoris, in which the symptoms disappeared in direct connection with an operation for herniation of the sixth or seventh cervical disk on the left side. Frykholm, in experiments during operations, showed that the typical deep pain in brachialgia

could be elicited by cautious mechanical irritation of a compressed or inflamed ventral root, and paresthesia and radiating pain in the fingers by similar irritation of a dorsal root. In two or three cases operated on for cervical disk herniation, Frykholm observed that shoulder stiffness of the humeroscapular periarthritis type disappeared without special treatment shortly after the operation.

It appears from the foregoing that it has been proved during the past twenty or thirty years, that some of the symptoms of so-called muscular rheumatism, i. e. the neuralgic pain of sciatica and brachialgia, are frequently caused by disk herniation secondary to lumbar or cervical intervertebral disk degeneration. It has also been shown that pseudo-angina-pectoris may be caused by disk herniation and that the deep pain in brachialgia can often be elicited by irritation of a compressed ventral nerve root in the cervical spine.

As a result of these investigations, the degenerative changes in the intervertebral disks – disk degeneration – came to be blamed for most of the symptoms associated with muscular rheumatism. This seems reasonable, since backache is often combined with sciatica and neck-shoulder pain with brachialgic pain in the arms. We have no final proof that this view is correct, although there is a great deal of evidence to support it. For instance, Hirsch (1949) and Lindblom (1948) showed that in certain cases puncture of a degenerated disk in the lower lumbar spine and injections of fluid under pressure brought on symptoms of lumbago and that in lumbago cases the injection in a disk of a small quantity of procaine caused the pain and muscular contraction to disappear.

In this connection it is interesting to note that Friberg and Hirsch, through comparative pathologic and roentgen investigations, and Lindblom, through discography, found that relatively advanced disk degeneration with gross radial ruptures may be present even though ordinary roentgenograms reveal no pathologic signs. Hirsch and Schajowicz (1952) demonstrated that radial ruptures particularly in the two lowest lumbar disks are most common in the age group 30 to 50 years, or the very years when lumbago and sciatica are most frequent. They therefore concluded that the radial ruptures and granulation tissue growing into them represent the phase of disk degeneration that causes most of the symptoms. Lindblom (1951) wrote: "Through a primarily radial rupture of the annulus fibrosus, the disk tissue herniates toward the surface of the disk, where an inflammatory reaction is produced, digesting the herniated mass and involving adjacent structures such as the posterior longitudinal ligament, roots, ganglia and nerves. This inflammatory reaction is probably essential in producing pain, as pressure

alone on nerves and ligaments is only slightly painful." Later (1952), Lindblom described experimental radial ruptures in the disks of rat tails, produced by fixing the tails in flexion.

Various other explanations of the signs and symptoms in muscular rheumatism have been suggested. One theory is that static postural deformities cause the symptoms, due to abnormal strain on the muscles. This view is based on the fact that static postural deformities, such as kyphosis or lordosis, scoliosis, unequal length of the legs (Butler 1946), etc., have been observed in a certain number of cases with the symptoms in question. However, no study appears to have been made to determine either the frequency of these postural faults or whether persons with them more often have spinal symptoms than others. In the Munkfors Investigation, I found that persons with moderate static deformities were not more prone to back trouble than others, which indicates that these deformities are not of decisive importance in the origin of such symptoms.

Other workers have expressed the opinion that the cause of the symptoms is to be found in the muscles themselves, on the grounds that local contractions or tender indurations in the muscles, e. g. myositis, myogelosis, "*Muskelhärten*" etc. (F. Lange, 1921; Schade, 1921; M. Lange, 1931), can often be palpated in persons with symptoms. No definite pathologic changes corresponding to these palpation findings have ever been found, and it has therefore been assumed that they represent colloid changes in the muscular tissue itself or functional conditions caused by chronic over-strain on the muscles in question. Another explanation is that the cause is some kind of inflammation of the "white fibrous tissue", or fibrositis (Gower, 1904; Stockman, 1904 and 1920; et al.). This theory is also based on the palpation of tender, fibrous indurations in patients with symptoms, but it, too, is unsupported by definite pathologic evidence. Copeman and Ackerman (1944) considered that they had proved that a kind of fatty herniation "lying in the deep fibro-fatty tissues" of the lumbar region is frequently the cause of back trouble.

As long ago as 1875, Leyden noted that the muscular rheumatic symptoms were not seldom combined with signs of irritation of the vegetative nervous system (sense of cold, circulatory disorder, increased sweat secretion, etc.).

Barré (1926) described "le syndrome sympathique cervicale postérieur", which Bärtschi-Rochaix (1949) treated in detail, with particular reference to post-traumatic conditions in the neck. The syndrome includes headache, neck ache, visual and auditory disturbances, vertigo, pharyngeal symptoms and psychogenic symptoms, combined in varying

degree with radiating pain in the arms. It is believed to be related to compression of the vertebral artery and irritation of the accompaning sympathetic nerve fibers (vertebral nerve) caused by cervical disk degeneration and spondylosis.

Reischauer (1949 gave a detailed report of the brachialgia syndrome as a whole on the basis of a series of cases. He stressed the fact that brachialgia is often combined with humeroscapular periarthritis, pseudo-angina pectoris and headache. All these symptoms were already described in the twenties as probable sequels of cervical spondylosis (cf. Chapter IV, *The Munkfors Investigation*), but they do not appear to have been treated as one syndrome hitherto. Reischauer referred both deep pain and the symptoms mentioned above to irritation of the sympathetic nervous system caused by cervical spondylosis or disk herniation.

In the Munkfors Investigation in 1949, in which brachialgia was very common, I verified that pseudo-angina pectoris, headache and humeroscapular periarthritis so often appeared together with the usual deep pain of brachialgia that there could be no doubt that the symptoms were often component parts of the brachialgia syndrome. Furthermore, certain therapeutic experiments made at the same time also revealed that blocking the sympathetic nervous system – either with paravertebral injections of procaine or intravenous administration of tetra-ethyl-ammonium bromide[1] – very often led to immediate relief from these symptoms. The same was true to some extent of low-back symptoms. There thus appears to be no doubt of the importance of the sympathetic nervous system in producing the symptoms of muscular rheumatism.

Säker (1952) and Bente and Schmid (1952), through analysis of a large series of brachialgia cases, confirmed the complicated nature of the syndrome and even added to it the syndrome described by Barré and Bärtschi-Rochaix. They also stressed the significance of irritation of the sympathetic nervous system, which they verified by the favorable therapeutic effect of a new drug[2] with a specific sedative effect on the sympathetic nervous system. I can also testify to the beneficial effect of this drug, having tested it in several cases during the past two years.

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1. Etamonin, manufactured by ASTRA.
2. Hydergin, manufactured by SANDOZ.

2. Earlier investigations on the incidence of muscular rheumatic symptoms and back trouble.

Gorn (1928) reported on rheumatic diseases in German miners, who were retired on disability pension if they were unable to work or at the age of 50 years after 25 years of service. Of 2648 cases of disability pension, 70 to 75 per cent were due to muscular rheumatism, mainly in the low back and the shoulder girdle. Gorn pointed out that after the First World War, incapacitating muscular rheumatism appeared at an earlier age (five to six years) than previously, which he considered was due to an appreciably harder working pace.

Gantenberg (1930) examined 1200 persons in different occupational categories for spondylosis deformans and back trouble. The choice of material can be criticized in certain respects. For example, the miners appear to have been examined in connection with applications for disability pension, while the others were selected at random and showed a relatively uneven age distribution. Gantenberg found a considerably higher rate of spondylosis deformans in miners than in the other occupational groups. The figures for spinal symptoms – he did not define the term precisely – were as follows: miners, 71 per cent; factory workers, 50 per cent; skilled workmen, 38 per cent; agricultural workers, 45 per cent; salaried employees, 31 per cent; women and children under 14 years, 26 per cent. He pointed out that spondylosis began at the age of 20 to 30 years in all occupational groups and that there was no correlation between the degree of spondylosis and of the symptoms. Some cases had back trouble with no apparent spondylosis, while others had spondylosis but no back trouble. He considered that arteriosclerosis probably was of significance to spondylosis and spinal symptoms.

Friberg and Hirsch (1949) wrote that of 3672 patients who were admitted to the Orthopedic Department of *Karolinska Institutet* for low back and sciatic pain and who exhibited roentgenologic signs of disk degeneration the majority were in the age group 30 to 50 years. The incidence in the women was scarcely lower than in the men; 74 per cent of the men did heavy work, while 26 per cent had light occupations. They commented: "The percentages 74 per cent and 26 per cent represent roughly the proportions of manual laborers and others in the community at large", from which they deduced that heavy manual labor is not of decisive importance to back trouble.

Unander-Scharin (1950) reported that of the members of the Stockholm Health Insurance Society between 25 to 59 years, 2.64 per cent of the men and 1.83 per cent of the women had been on sick-leave for lumbago or sciatica in the year 1948.

Lindeman and Kuhlendahl (1953) wrote that of the members of health insurance societies in certain districts of Germany, 4.5 to 5 per cent per annum were disabled with muscular rheumatism, lumbago, neuralgia, etc. The incidence among miners who worked underground was considerably higher, 8.02 to 8.31 per cent, than the corresponding figure for miners who worked above ground, 3.8 per cent. As a comparison, the incidence of pneumonia was 0.33 per cent and of other respiratory diseases, including influenza, 6 per cent. Furthermore, a clinical survey of 1200 patients with lumbago – sciatica revealed that the symptoms first appeared at about 30 years in the majority of cases and before the age of 45 years in 87 per cent, which is in accord with my findings in the Munkfors Investigation.

III. The Present Material

Since the aim of the investigation was primarily to determine whether persons with heavy occupations are especially prone to symptoms from the low back and the neck and shoulders, the cases were selected as far as possible from two main categories: heavy manual labor and light manual labor. The two categories were then compared. Men in the age group 25 to 59 years were examined and classified in seven five-year groups.

Various corporations supplied us with lists of the names, ages and dates of employment of all their employees. We then selected our experimental subjects from these lists at random but in such a way as to ensure as even an age distribution as possible. Persons employed for less than five years were excluded, and we tried to avoid those who had alternated between heavy and light occupations.

Altogether 471 men with physically light work were examined. All of them worked in an even indoor temperature and were never, or practically never required to lift heavy weights or to work in especially uncomfortable positions. This group includes three different categories:

1) 164 shop assistants, comprising the entire male personnel of two department stores in Stockholm (NK and PUB). Their work was relatively rushed at times and most of them had to be on their feet all day long.

2) 197 workers at the ASEA company (manufacturers of electrical equipment) in Västerås, with light industrial work, according to the scale established by the Company.

3) 110 workers and employees of the ASEA company in Västerås with physically light, mostly sedentary jobs.

Altogether 666 men with heavy occupations were examined. Four different occupational groups were included:

1) 97 stevedores from the Port of Stockholm. The accident risk in this work is rather great, particularly in wet or subzero weather.

2) 146 workers in the food industry, including some in the slaughter houses and some in the meat packing departments. The first group have definitely heavy work, consisting mainly of carrying carcasses often weighing 200 pounds or more, on one shoulder. Only men who can learn the correct technique of lifting and carrying stand up under the strain of this job. The men in the packing departments had more than medium-heavy jobs. Characteristic of this group was the hazard of stumbling on the slippery floors.

3) 177 construction workers, mainly unskilled building workers and carpenters.

4) 246 men in heavy industrial work, including foundry laborers and metalworkers employed by ASEA and *Svenska Metallverken* in Västerås.

To study the significance of heavy lifting, we also examined a group of 56 weight-lifters in the age group 30 to 44 years. Finally, we used part of the Munkfors material for comparison. These cases comprised 277 men of 35 to 49 years, 163 of whom had heavy work in industry and 114 of whom were forest workers. Consequently all of them, particularly the latter group, had very heavy and strenuous occupations.

The material thus consists of men in the age group 25 to 59 years, 471 with physically light work and 666 with heavy jobs. In addition there were 56 weight-lifters and 277 men with heavy occupations who had been examined in another connection. The age distribution of the material is shown in *Table 1*.

Table 1: Number investigated in the different age and occupational groups.

Occupational groups:	25–29 years	30–34 years	35–39 years	40–44 years	45–49 years	50–54 years	55–59 years	Total
Retail trade	29	28	22	26	23	29	7	164
Light industry	27	31	29	27	29	27	27	197
Sedentary occupations .	18	19	17	18	15	18	5	110
Total light work	74	78	68	71	67	74	39	471
Stevedores	9	14	15	15	14	15	15	97
Food industry	19	23	21	22	22	20	19	146
Construction	9	15	33	30	37	28	25	177
Heavy industry	35	35	36	38	33	33	36	246
Total heavy work	72	87	105	105	106	97	95	666
Weight-lifters		20	20	16				56

IV. Method

The point of departure of the present investigation was the reports of symptoms made by our subjects themselves. By careful notations of the case histories, we disclosed past illnesses and accidents, with special reference to former or current symptoms emanating from the upper or lower extremities and the spine. In this way we learned the incidence and nature of symptoms of muscular rheumatic type and of other illnesses and conditions in different occupational and age groups. To this we added objective observations of various kinds. For example, by measuring height and weight, we were able to arrive at the Rohrer index as a standard for bodily type. By clinical examination of the joints of the extremities and of the spine, we recorded the incidence of static deformities, limitation of motion, muscle spasm, et cetera, and by roentgenologic examination of the spine, we determined the incidence of disk degeneration and roentgen-anatomic anomalies. These objective findings were correlated with the symptoms reported by the patients themselves.

From the statistical point of view, it was essential that the selection of experimental subjects be done in such a way as to ensure a "normal" material. The method of selection as already described, eliminated as far as possible the risk of a bias.

The usual criteria of significance (standard error, chi-square test) were applied in comparing the differences observed. In cases in which we had to consider the age factor, we simply calculated the frequency for each age group, after which the mean of the frequencies so calculated were reported as the age-standardized frequency. This means that the different age groups were given equal value in the calculation of the mean, which was appropriate in view of the fact that the number of cases in the different age groups did not vary to any great extent.

V. Results

In the Munkfors Investigation, as in the present study, careful analysis of the symptom picture as reported by the subjects themselves revealed that so-called muscular rheumatic symptoms were very common. In contrast, we found that arthritic symptoms in the joints of the extremities and specific rheumatic diseases were rare (3.5 per cent of the total). The favorite sites of the muscular symptoms were the neck and shoulders, with radiating pain in the arms, and the low back, with radiation to the legs. These symptoms could be roughly divided into three syndromes, two common and one less common. The first two were the stiff neck – brachialgia and the lumbar insufficiency – lumbago-sciatica syndromes, while the less common, though clearly defined syndrome consisted of the symptoms concentrated in the dorsal spine with or without radiation along the ribs, as intercostal neuralgia, or in the flanks or the anterior aspect of the abdomen. Each of these syndromes will be treated separately in the following.

The Stiff Neck - Brachialgia Syndrome

1. Symptoms.

With *stiff neck* or wry-neck, often known as rheumatic torticollis, the patient keeps his head bent or twisted to one side, and all attempts to move the head are painful. The symptoms may come on suddenly in connection with a sharp turn of the head or with a trauma, just as lumbago sometimes results from stumbling. Cold draught is often said to be the cause, but usually the patient awakens with a stiff neck and blames the attack on an uncomfortable sleeping position. Stiff neck seldom prevents the victim from working, and the symptoms sometimes disappear in a few hours, although they usually persist for two or three days and occasionally for a week or so. All degrees of stiff neck are seen, from a sudden acute pain to scarcely perceptible stiffness in the

neck. Sometimes the subject has only had one or two attacks, although repeated attacks are more common. The painful fixation of the neck is not seldom accompanied by pain in one or the other shoulder, while full-fledged brachialgia with or without nerve root pain sometimes appears in connection with stiff neck.

Brachialgia, which actually means pain or ache in the arm, has gradually come to have another connotation and to cover pain or ache of a certain type with a wider range than the arm alone. It comprises two elements, so-called deep pain and typical dorsal nerve root pain as in sciatica. *The deep pain* usually appears first, and most cases never develop the typical dorsal nerve root pain. The deep pain is experienced as a stubborn nagging or radiating pain usually in the dorso-lateral aspect of the shoulder and upper arm, which seldom extends further than the elbow but often reaches back under the shoulder blade. A characteristic of the deep pain is that it often disappears at work and returns when the subject is at rest or when he awakens in the morning. Work appears to have a deleterious effect in the sense that the symptoms at rest are more severe after a hard working day. In some cases the deep pain is accompanied by radiating ache in the pectoral region. If this pain is on the left side, we have a picture of pain in the heart area and the left arm, or so-called *pseudo-angina pectoris*, (Gunther and Sampson, 1929). Since this condition is sometimes confused with true angina pectoris, in which the attacks are brought on by exertion or excitement, it should be stressed that the symptoms of pseudo-angina pectoris, usually do not appear in connection with exertion but are most severe when the patient is at rest and are not influenced by nitrites.

Certain types of persistent *headache* are undoubtedly part of the brachialgia syndrome. Many of the persons examined stated unequivocally that they had typical neck symptoms or deep pain in the shoulder and upper arm in connection with headache. In these cases the headache often radiated to the forehead and the bridge of the nose.

Moreover the deep pain was not seldom accompanied by stiffness and limitation of motion in the shoulder of the type usually known as *humeroscapular periarthritis*, while in two of our subjects with current brachialgia there was tenderness of epicondylitis type.

Radiating pain and paresthesia in the fingers appeared to be relatively late symptoms in relation to deep pain. Neurologic signs, generally noted in severe cases only, were relatively unusual in this material, as might have been expected in a series of able-bodied individuals.

Brachialgia of the type described above – most of the subjects complained of deep pain only – was a relatively benign condition, at least as far as work disability was concerned. The symptoms were perodical,

often appearing in the spring and autumn and in varying degrees of intensity. Sometimes they only lasted for a week or so, sometimes for six months or longer.

2. Incidence.

At least one attack of *stiff neck* was reported by 45.3 per cent of the subjects with light work and by 43.0 per cent of those with heavy work (Table 2). The curves in Figure 2 reveal that the frequency at the age of 25 to 29 years was about 30 per cent, after which it rose with age until it was slightly above 60 per cent at 55 to 59 years. No difference could be found, between the incidence in the groups, light work and heavy work, but the definitely higher frequency in the Munkfors material is worthy of note.

Table 2: Incidence of stiff neck or brachialgia.

		Stiff neck	Brachialgia	Stiff neck or brachialgia
Light work	471 cases	45.3 % ± 2.3	21.9 % ± 1.9	50.6 % ± 2.3
Heavy work	666 cases	43.0 % ± 1.9	23.8 % ± 1.7	51.1 % ± 1.9
Munkfors Investigation	277 cases	66.7 % ± 2.8	49.0 % ± 3.0	80.0 % ± 2.4

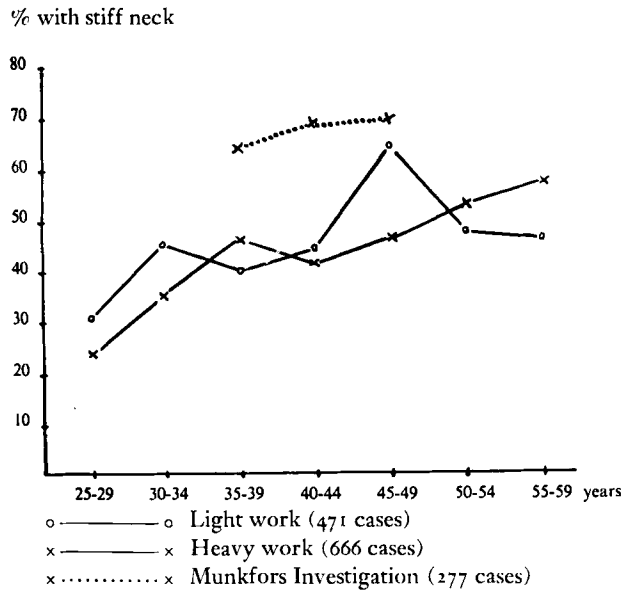

Figure 2. Incidence of stiff neck in the different age groups.

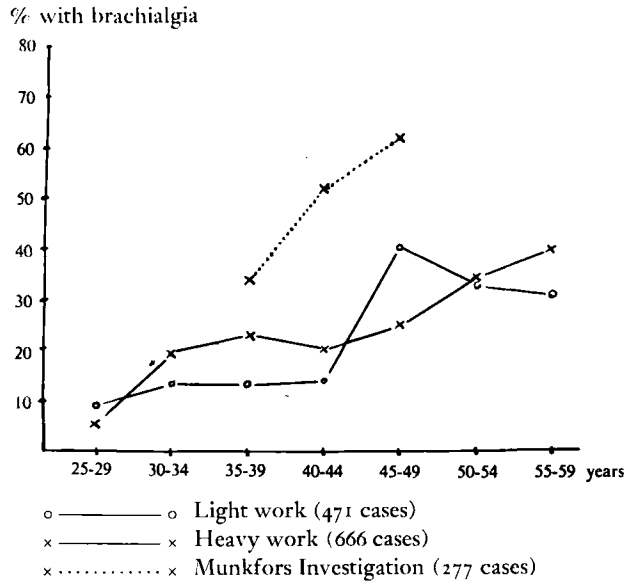

Fig. 3. Incidence of brachialgia in the different age groups.

Symptoms of *brachialgia* at some time were reported by 21.9 per cent of those with light and 23.8 per cent of those with heavy occupations. The curves in Figure 3 show that the incidence was approximately 7 per cent in the age group 25 to 29 years, that it rose appreciably at the age of about 45 years, and that it was over 35 per cent at the age of 55 to 59 years. There was no real difference between heavy and light work in the present material; the rate in the Munkfors Investigation was definitely higher than in this series. *Table 3*, which covers all

Table 3: Incidence of stiff neck or brachialgia.

	No. of cases	Stiff neck	Brachialgia	Stiff neck or Brachialgia
Retail trade	164	50.8 % ± 3.9	24.8 % ± 3.3	59.0 % ± 3.8
Light industry	197	44.6 % ± 3.6	19.8 % ± 2.8	47.1 % ± 3.5
Sedentary occupations	110	34.6 % ± 4.5	18.6 % ± 3.7	42.6 % ± 4.7
Total light work	471	45.3 % ± 2.3	21.9 % ± 1.9	50.6 % ± 2.3
Stevedores	97	29.4 % ± 4.6	18.5 % ± 4.0	39.2 % ± 4.9
Food industry	146	52.5 % ± 4.1	36.8 % ± 4.0	60.7 % ± 4.0
Construction	177	47.4 % ± 3.7	20.8 % ± 3.1	53.0 % ± 3.7
Heavy industry	246	42.0 % ± 3.1	20.7 % ± 2.6	50.5 % ± 3.2
Total heavy work ...	666	43.0 % ± 1.9	23.8 % ± 1.7	51.1 % ± 1.9

Table 4: Connection between stiff neck and brachialgia.

	Number	Percentage with brachialgia
Cases with stiff neck	504	36.1 % ± 2.2
Cases without stiff neck	633	12.6 % ± 1.3

the occupational groups included, discloses the interesting circumstance that the incidence among the workers in the food industry was definitely higher than among the other groups (37 per cent as compared with 21 to 22 per cent).

Table 4 shows that the incidence of brachialgia was distinctly higher in persons who had already had stiff neck than others. This suggests a connection between stiff neck and brachialgia. Stiff neck began relatively early and was relatively frequent at the age of 25 to 30 years. Brachialgia, on the other hand, developed later, in most cases after the age of 45 years.

The curves in Figure 4 and Table 2 show the persons who had a history of either stiff neck or brachialgia. Symptoms of one or the other disorder were reported by more than 50 per cent of the cases in the present material and by 80 per cent of the Munkfors series.

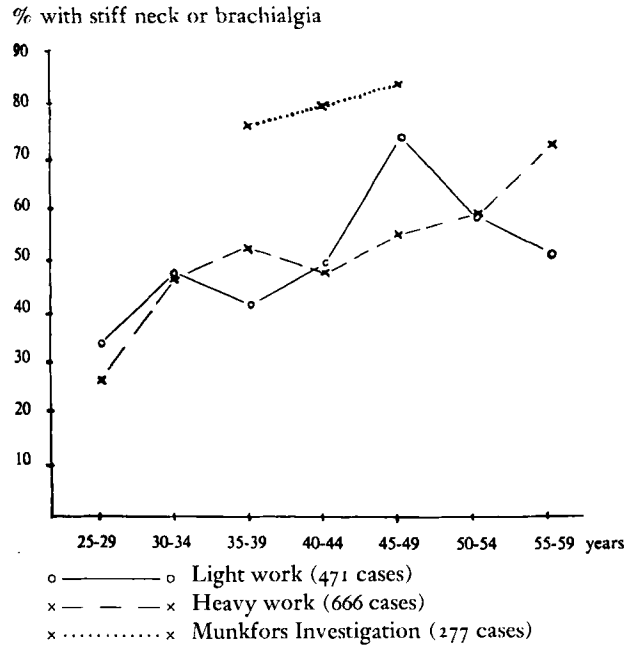

Fig. 4. Incidence of stiff neck or brachialgia in the different age groups.

The relatively high rate of brachialgia among the workers in the food industry may possibly be due to the fact that they, more than other occupational groups, were exposed to greater strain on the shoulders and neck in connection with the carrying of carcasses. The higher frequency in the Munkfors material is difficult to explain. The men in this series, particularly the forest workers, may have had somewhat heavier jobs than those in the present material with heavy work. However, this is not sufficient to explain the difference, particularly since there is no difference in frequency between those with light and those with heavy work in the present material. Having conducted the two investigations myself, I am convinced that both stiff neck and brachialgia were considerably more common in the workers in Munkfors and that the actual symptoms of brachialgia were much more intense than in the present material. A contributory factor may be that, in larger communities like Stockholm and Västerås, persons who early show themselves to be prone to these symptoms have better opportunities to transfer to lighter occupations which do not provoke the symptoms to the same extent.

*

The 262 persons in the present material who reported brachialgia symptoms can be classified as follows (Table 5):

Table 5: Incidence of various symptoms in 262 cases of brachialgia.

Cases with:	Light work 99 cases	Heavy work 163 cases	Total 262 cases
Brachialgia at examination	20 %	12 %	15 %
Radiating pain in the fingers	27 %	37 %	33 %
Radiating pain in the chest	11 %	15 %	14 %
Headache	15 %	9 %	11 %
"Frozen shoulder"	25 %	30 %	28 %
Epicondylitis	2 %	2 %	2 %
Incapacity for work	11 %	31 %	23 %
Trauma	3 %	15 %	10 %

Symptoms of brachialgia at examination: 15 per cent (40/262) or 3.5 per cent of all those examined had symptoms at the time of examination.

Radiating pain or paresthesia in the fingers: 33 per cent (87/262) reported that they had had radiating pain or paresthesia in one or more fingers of the same type as in the leg in sciatica.

Radiating pain in the pectoralis region and pseudo-angina pectoris were reported in 14 per cent (36/262). Several of those who had had left-sided pain had feared a heart condition, and five of them had been on sick leave for long periods because of suspected heart disease. In view of the importance of differentiating between pseudo-angina pectoris and true angina pectoris, it should be stressed that the symptoms of pseudo-angina usually are most pronounced when the patient is at rest and often disappear while he is working. In the five cases in question, it was quite clear that the symptoms had been worst at rest, while they usually regressed during the day when the patients were at work.

Headache: 11 per cent (29/262) stated definitely that their neck and shoulder symptoms were often accompanied by headache, which sometimes radiated from the neck to the forehead and sometimes were confind to the forehead. This headache was also occasionally reported without radiating pain in the arm, which is important to remember when studying the genesis of a case of headache. If headache is to be regarded as a component symptom of brachialgia or of cervical background, either the case history should reveal that it has earlier been associated with other symptoms of brachialgia or else local symptoms in the cervical spine in the form of pressure tenderness or pain should be present.

"Frozen shoulder": 28 per cent (74/262) reported that they had often had shoulder stiffness with difficulty in abduction in connection with neck symptoms and deep pain. This shoulder stiffness usually disappeared spontaneously together with the other symptoms. Some of these cases, in which brachialgia was brought on or exacerbated by a definite trauma, undoubtedly also had a genuine disorder of the shoulder. Quite naturally, a trauma to the shoulder may both cause a genuine injury and an exacerbation of a more or less latent brachialgia, whereupon the symptoms will become inextricably mixed up with each other. Apart from these cases, however, it appears that the cases of frozen shoulder from brachialgia can usually be differentiated from those with a genuine disorder in the shoulder. Of the 1137 persons examined, 63 stated that they had had shoulder symptoms without concurrent brachialgia. Of these 63 cases, 41 had suffered a definite injury to the shoulder and 22 had not. The trauma usually consisted of a contusion (the patient fell on his shoulder or was hit by a falling object) or of a fall on the extended arm. Eight had had dislocations. The nontraumatic disorders resembled peritendinitis, periarthritis, and bursitis, and the course was generally brief. Pain on moving the shoulder, was common to all these cases, but ache at rest was seldom noted and if it was it present was confined to the shoulder joint. This was

confirmed by three patients who had had both brachialgia and true shoulder disorders (peritendinitis in two and contusion in one), but on different occasions. They all reported that there was a distinct difference between the syndromes: stiffness and stubborn aching deep in the shoulder and down the arm in brachialgia; mainly pain on certain movements or attempts to move the shoulder with lesion in the shoulder.

Epicondylitis: Of the 1137 persons examined, 15 stated that they had at some time had symptoms of epicondylitis. Five of them had had brachialgia at the same time, and in these cases it does not seem unlikely that the epicondylitis actually was a symptom of the brachialgia. Five other cases had a clear history of trauma, and the rest had a somewhat unclear genesis. Conceivably a patient with brachialgia might develop genuine epicondylitis, but it is also possible that epicondylitis might constitute the only symptom of brachialgia. The present material offers no proof in this respect, but I believe there is reason to bear in mind the brachialgia syndrome in certain cases of epicondylitis.

Work incapacity: Only 23 per cent (61/262) of the persons with symptoms of brachialgia had ever been disabled by the condition. Sick leave was more common among persons with heavy work. Of the 61 cases who had been incapacitated, 37 had been on sick leave for three weeks to six months and eight cases for more than six months. Three of the eight had been certified as "heart disease". Of all the persons examined, 2.2 per cent of those with light work and 7.5 per cent of those with heavy work had at some time been incapacitated by brachialgia.

Trauma: Ten per cent (27/262) reported trauma as the immediate cause of the symptoms of brachialgia. This cause was clearly more common in persons with heavy work, particularly stevedores, of whom almost 50 per cent reported trauma.

A survey of all the brachialgia cases revealed that most of those definitely caused by a trauma ran a longer and more severe course and were on sick leave for longer periods than the cases in which the symptoms appeared without apparent cause. Theoretically, this might be interpreted to mean that the tendency to brachialgia intensifies the sequellae of a trauma. Practically speaking, however, it is much more likely that the trauma exacerbated the brachialgia. This does not, of course, apply to more or less dubious pseudo-traumas, but only to definite ones, such as a bicycle spill, when the subject falls on the shoulder, or a blow from a falling object. These facts are of interest from the point of view of insurance.

3. Clinical signs.

The configuration and mobility of the cervical spine, the presence of tenderness of the spinous processes and of evocable pain were recorded. No real deviations from normal configuration were found. The degree of cervical lordosis usually had a certain relationship to dorsal kyphosis. However, since we have no objective method of evaluating this condition and since it apparently had no connection with the stiff neck – brachialgia syndrome, it was not analyzed in detail. The motion of the cervical spine was recorded as normal or restricted. It was sometimes difficult to differentiate between slightly restricted and normal movement, which detracts from the value of this sign. Pressure tenderness of the spinous processes, on the other hand, was usually so distinct that there was seldom any doubt as to the presence of this sign. Evocable pain was tested by pressure on the head, both with the head held erect and with it bent to the right or left. If this pressure elicited pain in the cervical spine or radiation to one shoulder or arm, evocable pain was assumed to be present.

From the neurologic point of view we studied the biceps and triceps reflexes, the sensibility and the strength of the hand-grip.

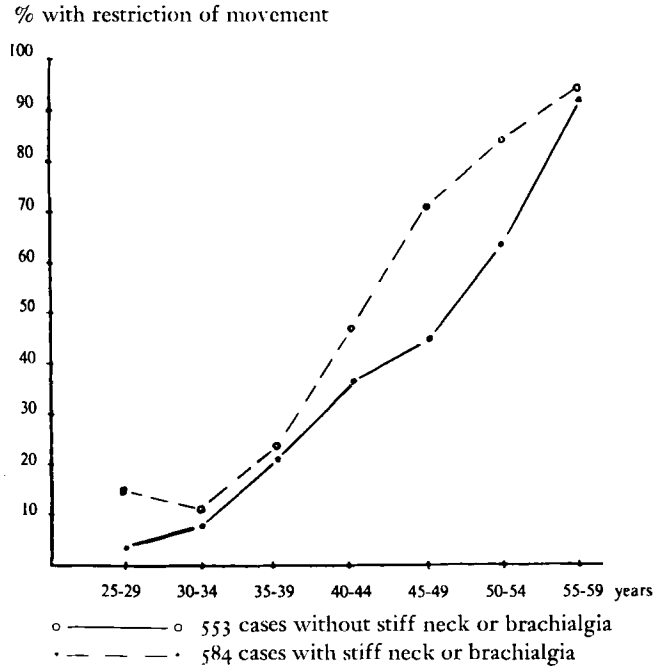

Fig. 5. Incidence of restriction of movement in the cervical spine.

Table 6: Clinical signs in cases with and without stiff neck – brachialgia.

Cases with:	No. of cases	Restriction of movement	Pressure tenderness of the spinous processes	Evocable pain	Neurologic signs	Total with clinical signs
No symptoms	553	32 %	0.5 %	0.2 %	0.2 %	32 %
Stiff neck only	322	47 %	5 %	2 %	0.9 %	48 %
Brachialgia	262	64 %	20 %	16 %	7 %	70 %
Brachialgia at examination ..	40	80 %	65 %	70 %	22.5 %	93 %

Finally, the range of movement, as well as any tenderness in the joints of the upper extrimities was recorded.

The incidence of restricted movement in the cervical spine appears from Figure 5. This sign was clearly dependent on age, becoming more and more common with increasing years, even in the absence of pain emanating from the cervical spine. However, it was definitely somewhat more usual among persons who had had symptoms of brachialgia, which indicates a certain relationship between restriction of movement in the cervical spine and symptoms of brachialgia.

The other signs emanating from the cervical spine – pressure tenderness of the spinous processes, evocable pain and neurologic signs – showed no definite connection with age, although they did reveal a clear correlation with the incidence of brachialgia symptoms (Table 6). These signs were scarcely ever found among persons who had never had symptoms, but were not uncommon among those who had a history of brachialgia. They were especially frequent, however, among the 40 subjects with brachialgia at examination, which constitutes strong evidence that brachialgia symptoms originate in the cervical spine. Among the 22 cases with neurologic signs, the triceps reflex was impaired in nine and the biseps reflex in five, while there was decreased sensibility in seven cases, impaired strength of the hand grip in four and radial-type paresis in one case.

Limitation of motion and pain in one or other of the shoulder joints, of the kind found in periarthritis, were demonstrated in four of the 40 cases with current brachialgia. In these four cases the appearance of the periarthritis symptoms was definitely associated with the other brachialgia symptoms. No symptoms emanating from the joints of the upper extremities could be found in the remaining cases with brachialgia. The few non-brachialgia cases with pathologic signs in these joints were explained by other causes and will not be described here.

To summarize, it may be stated that tenderness of the spinous processes and evocable pain were present in a very high percentage of

the cases with current brachialgia, but scarcely ever in the group "entirely free from symptoms". This suggests that the symptoms of brachialgia are usually associated with changes in the cervical spine.

4. Roentgenologic signs of disk degeneration in the cervical spine.

The roentgen examination of the cervical spine comprised one frontal, one lateral and two oblique views to visualize both aspects of the intervertebral foramina. Osteophytic deposits on the margins of the vertebral bodies and narrowing of the intervertebral space were regarded as signs of disk degeneration. Evidence of disk degeneration was classified as moderate (osteophytes only) or pronounced (osteophytes plus narrowing of the intervertebral space).

The frequency of roentgenologic signs of disk degeneration in the various age groups is shown in figure 6. The age factor was of decisive importance. At the age of 25 to 29 years, about five per cent exhibited

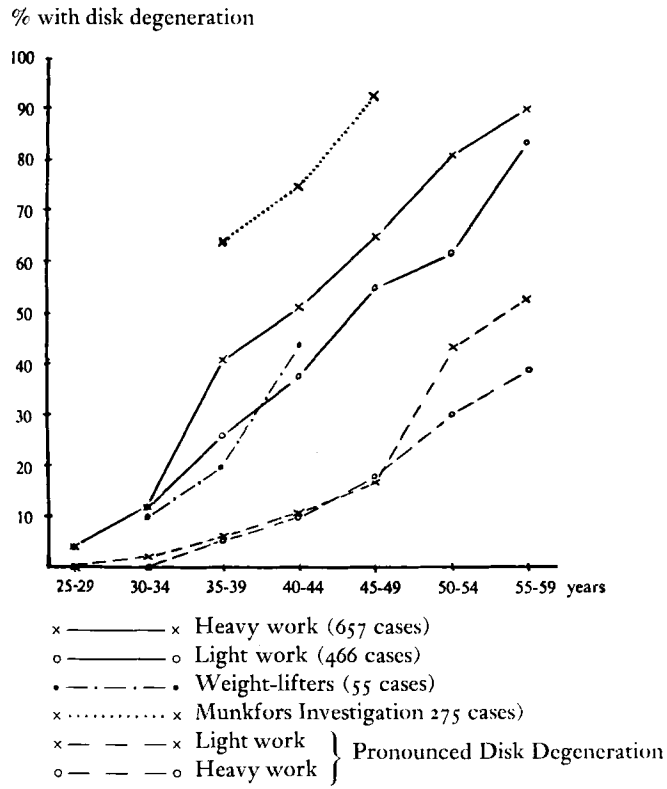

Fig. 6. Incidence of roentgen signs of disk degeneration in the cervical spine in the different age groups.

Table 7. Incidence of roentgen signs of disk degeneration in the cervical spine.

	No. of cases	Percentage with disk degeneration	Percentage with pronounced disk degeneration
Retail trade	163	44.2 %	9.7 %
Light industry	193	34.9 %	16.0 %
Sedentary occupations ...	110	41.6 %	14.2 %
Total light work	466	40.0 % ± 2.3	14.6 % ± 1.7
Stevedores	97	54.1 %	21.1 %
Food industry	146	50.8 %	16.3 %
Construction	176	53.8 %	17.8 %
Heavy industry	238	41.9 %	20.3 %
Total heavy work	657	49.1 % ± 1.9	18.9 % ± 1.5

disk degeneration while at 55 to 59 years, the figure had risen to approximately 90 per cent. Obviously, therefore, disk degeneration must be regarded as a more or less physiologic sign of age. Those subjects with heavy occupations showed a consistently higher frequency than those with light jobs, and the difference is statistically significant (Table 7), though moderate. If we take only the cases with pronounced disk degeneration, the difference is so small that it is no longer statistically significant. Since everyone, regardless of occupation, apparently develops disk degeneration eventually, the difference between the occupational categories can be interpreted to mean that roentgen signs of disk degeneration develop somewhat earlier in persons with heavy than with light occupations. The high incidence among the forest and industrial workers in the Munkfors series corresponds well with the high rate of brachialgia found among them in the previous investigation, but is in itself difficult to explain.

The relative frequency of disk degeneration in the various cervical disks appears from Figure 7, which shows the percentages of all those examined who revealed disk degeneration in each separate cervical disk.

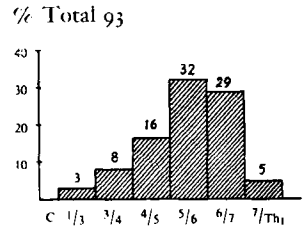

Fig. 7. Incidence of roentgen signs of disk degeneration in the various cervical disk.

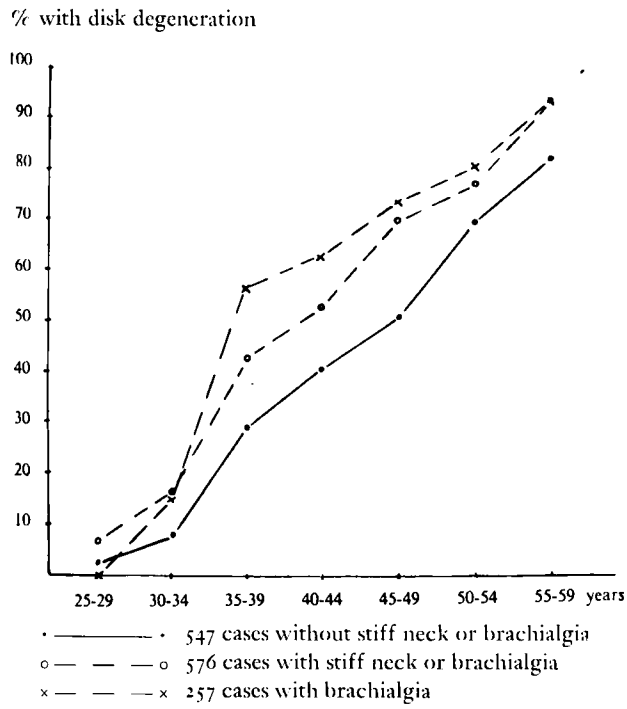

Fig. 8. Roentgen signs of disk degeneration in the cervical spine in cases with and without stiff neck - brachialgia.

The fifth cervical disk most often showed signs of degeneration (32 per cent), after which came the sixth (29 per cent), the fourth (16 per cent), the third (8 per cent) and the seventh (5 per cent). The distribution was the same in all age and occupational groups. According to Bakke (1931), maximum motion takes place between the fifth and sixth cervical vertebra, which probably explains the fact that disk degeneration is most common between these two vertebrae.

The incidence of disk degeneration in the cases with and without stiff neck – brachialgia is shown in figure 8 and table 8. It will be noted that the incidence was consistently somewhat lower in the cases

Table 8. Correlation between disk degeneration and stiff neck - brachialgia.

	No. of cases	All cases with disk degeneration	Cases with pronounced disk degeneration
Without stiff neck - brachialgia ...	547	39.9 % ± 2.1	13.4 % ± 1.4
With stiff neck or brachialgia	576	50.2 % ± 2.1	20.1 % ± 1.7
Difference		10.3 % ± 3.0	6.7 % ± 2.2

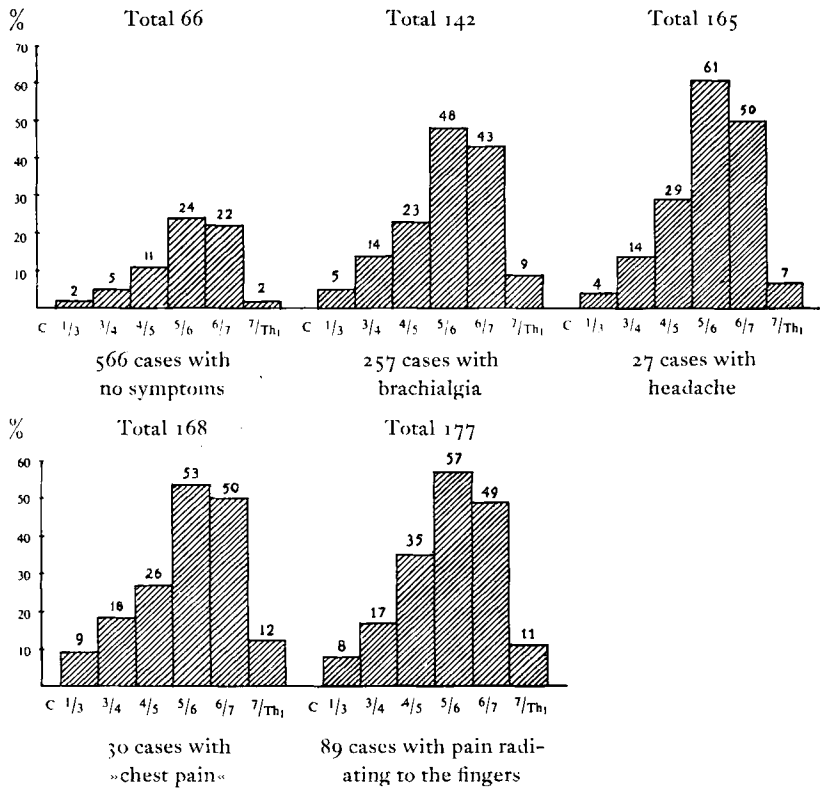

Fig. 9. Incidence of roentgen signs of disk degeneration in the various cervical disks in some special cases.

without subjective symptoms and that the difference, though small, was statistically significant. There was thus a correlation between disk degeneration in the cervical spine and stiff neck - brachialgia. Nevertheless, several cases with symptoms had no signs of disk degeneration. This is not surprising, since we know that disk degeneration must be relatively pronounced before it can be visualized on ordinary roentgenograms. Of greater interest is the fact that several cases with pronounced signs of disk degeneration had never had any trouble at all and that many cases with strongly pronounced roentgenographic changes had only had very slight and highly transitory trouble. Since there is nevertheless a distinct connection between disk degeneration and the stiff neck - brachialgia syndrome, the symptoms are probably caused by changes secondary to disk degeneration.

The distribution of disk degeneration between the cervical disks in cases with different symptoms of the brachialgia syndrome is shown in figure 9. We see that the distribution is approximately the same both

among the cases without symptoms and all those with brachialgia as in those with headache, pain in the chest or radiating pain in the fingers. The fifth cervical disk invariably showed the highest incidence.

The Lumbar Insufficiency - Lumbago - Sciatica Syndrome

1. Symptom picture.

The anamnestic study of back trouble yielded three main types, which can be more or less clearly differentiated:

a. Lumbar insufficiency.

Lumbar insufficiency may be defined as fatigue or pain in the small of the back of more or less intermittent character. These symptoms are frequently provoked only by certain forms of exertion, particularly work in a bent-forward position. The patient with lumbar insufficiency then has pain resembling a tight band across the small of the back or sometimes feels that his back "is broken in two". He finds it difficult to straighten his back when he tries to stand up. At times these symptoms are experienced when the patient has been sitting or standing for a long time in the same position, or he may report that the small of his back feels stiff, when he gets up in the morning. These patients often state that they try to refrain from lifting heavy weights to avoid bringing on their symptoms. The variation in intensity is characteristic of these symptoms. Periods of rather pronounced discomfort alternate with either insignificant symptoms or none at all. The attacks also vary in duration from a few weeks to a year or more. Some report that their symptoms are regularly accentuated in the spring and autumn, and the outdoor workers were often prone to associate these exacerbations with cold and dampness. Insufficiency symptoms frequently resemble the stiffness and pain following unaccustomed exercise, but differ in that they do not disappear with continued training but instead grow more severe. These patients were divided into two groups: those whose symptoms periodically disrupted their work or normal existence and perhaps incapacitated them for work, and those whose symptoms were so mild that they did not interfere notably with work.

b. Lumbago.

Lumbago may be defined as aching and pains of various types in the lower back. The most characteristic is the acute lumbago attack. When

this occurs the patient experiences sudden – like a shot, the Germans' Hexenschuss – severe pain in the low back. He can scarcely move because of the pain, with resultant pain-fixation or locking of the back in an oblique or forward-flexed position. Not infrequently the pains are so severe that the patient cannot move or must crawl on hands and knees from the place where the attack occurs. The attack almost always occurs in connection with a movement of the lumbar spine. This movement may be a sudden and unexpected twist, such as in an attempt to regain one's balance after stumbling or slipping, or it may be an ordinary stooping over, such as in tying the shoe laces in the morning or in reaching for an object while sitting at the table. Not infrequently the attack is associated with a particular strain on the back, e. g. lifting a heavy object. The symptoms sometimes subside after one or two days; usually they endure for from one to two weeks and, occasionally, they may persist over a long period. A somewhat different type of lumbago is that where the subject remarks that "something happened to his back" in connection with the aforementioned movements or strain of the lumbar spine, but where the symptoms are so minor that they are disregarded. These may subsequently disappear or, after a few days, – especially if the subject continues the back-straining work – they may change into a more or less typical acute lumbago attack, forcing the patient to stop working. Finally, there is a more chronic type of lumbago symptoms, which shows a smooth transition into the more severe forms of lumbar insufficiency described earlier. It is not at all unusual that lumbago attacks are preceded or succeeded by insufficiency symptoms from the lumbar spine. Sometimes lumbago appears in combination with sciatica, or a transition takes place from lumbago to sciatica. Some patients have only a single and rapidly transient lumbago attack, but it is more common that the symptoms recur once or many times. In some cases they recur yearly or even several times a year. Incapacitation for work during periods of varying length is a common occurrence, especially in patients engaged in heavy work, although, on the other hand, the symptoms by no means always lead the patient to seek medical advice.

In the present material, information was obtained concerning the age at which the first attack occurred and whether or not there had been recurrences; if the patient had been incapacitated for work and, if so, the length of his absence from work (< 3 weeks, 3 weeks to 6 months, > 6 months); and if the lumbago had appeared without apparent cause or had occurred in connection with heavy lifting or an accident.

c. Sciatica.

Sciatica was considered to have been present if the patient had ever had pain definitely radiating into either leg, usually down the posterior or lateral aspect of the thigh and lower leg, and frequently in combination with numbness or tingling in the foot and toes. In most cases the patient described a clear, unequivocal picture of sciatica with regard to both symptoms and course. The sciatica patients were divided into two groups: those with mild or transitory symptoms and those with more pronounced or recurrent sciatica with truly incapacitating effect. The more detailed symptomatology of the different types of sciatica will not be discussed as it does not lie within the scope of the present investigation.

2. Incidence.

Some type of back trouble occurred at some time in 52.7 per cent of the 471 employees with light work and in 64.4 per cent of the 666 engaged in heavy work (Table 9). The curves in figure 10 show the incidence in the different five-year age groups into which the material was divided. It may be seen that the incidence increased with age. In the group between 25 and 29 years slightly more than one-third had a history of back trouble, and in the group from 55 to 59 years almost four-fifths reported such symptoms. It is evident, moreover, that low back symptoms were common both among those engaged in light work and among those doing heavy work, but that the latter exhibited a higher incidence in all age groups. The difference is significant, but not of such an order that the heavy work may be considered to have decisive significance in the origin of backache.

If only the more pronounced forms of low back symptoms are considered, i. e. those causing incapacity for work of long duration or transfer to another type of work, the difference between those engaged in light and heavy work becomes somewhat less marked. In 6.8 per cent

Table 9. Incidence of low back trouble.

	Number investigated	Percentage with back trouble	Percentage with pronounced back trouble
Light work	471	52.7 % ± 2.3	6.8 % ± 1.2
Heavy work	666	64.4 % ± 1.8	10.6 % ± 1.1
Munkfors investigation	276	79.7 % ± 2.4	–

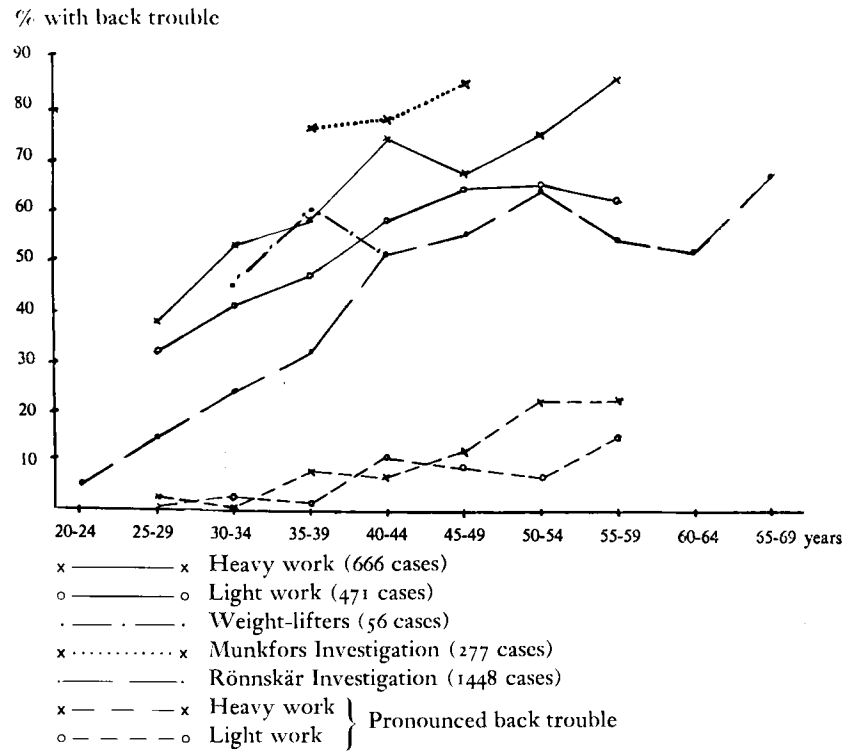

Fig. 10. Incidence of low back trouble in the different age groups.

of the light-work group and 10.6 per cent of the heavy-work group such symptoms were reported.

For the purpose of comparison the frequency curves obtained in the Munkfors investigation in 1949 and the Rönnskär investigation in 1945 are included in the diagram. The Munkfors material clearly shows somewhat higher values. As pointer out earlier, in the discussion of the symptoms of brachialgia, this higher incidence may be at least partially due to the limited possibility of choice of work existing in Munkfors (page 26).

The Rönnskär investigation, which comprised 1448 smelting works employees of the Boliden Mining Industries, aged between 20 and 70 years, was actually a study of the incidence of gastric symptoms. However, as a secondary observation the incidence of lumbago and sciatica was recorded. The incidence figures obtained there agree closely with those in the present material.[1] The somewhat lower incidence may be

1. The figures from the Rönnskär investigation, which have not yet been published, were made available to the writer by Dr. K. D. Lundgren of the Outpatient Department of Occupational Medicine, Karolinska sjukhuset.

explained entirely by the interrogation of the patients, which was not directed with the same intensity towards the problem of back trouble as in the present investigation. Consequently, without doubt, some cases were not included, particularly those with slight to moderate insufficiency symptoms.

Accordingly, on the basis of the present material and the results of the earlier investigations in Munkfors and Rönnskär it is possible to state that back trouble is exceptionally common in men, regardless of whether they perform light or heavy work. The incidence is definitely higher, however, in the groups doing heavy work.

*

Examining the incidence of the different types of back trouble we find that lumbago occurred at some time in 31.6 per cent of those engaged in light work and in 44.9 per cent of those with heavy work (Table 10). In the former group 9.1 per cent and in the latter group 13.9 per cent had repeated attacks of lumbago (on three or more occasions). The high incidence in the Munkfors material is especially evident here in that not less than 31 per cent had repeated lumbago attacks.

The curves in figure 11 show the incidence in the different age groups. It may be seen that the incidence rises with age and that it is higher in all age groups of those engaged in heavy work. Although the lumbago incidence is relatively high among those with light work, it is undoubtedly still higher in those with heavy work, indicating that one or several factors in the heavier occupations must therefore contribute to the origin of lumbago. (See also page 48 on accidents and heavy lifting as the cause of lumbago). If the curve for those doing light work is shifted two age groups (10 years) to the left in the diagram, the curves for light work and heavy work almost coincide. Accordingly, it might be said that the employees engaged in heavy work are 10 years older from the point of view of lumbago than those with light work.

Table 10. Incidence of lumbago.

	Number investigated	Percentage with lumbago	Percentage with 3 or more attacks of lumbago
Light work	471	31.6 % ± 2.1	9.1 % ± 1.4
Heavy work	666	44.9 % ± 1.8	13.9 % ± 1.3
Munkfors investigation	277	53.0 % ± 3.0	31.0 % ± 2.8

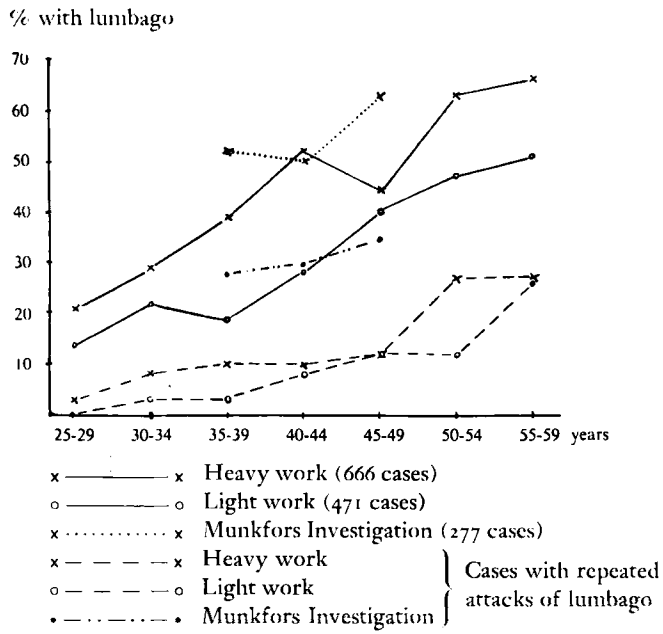

Fig. 11. Incidence of lumbago in the different age groups.

Symptoms of lumbar insufficiency (Table 11) were reported by 40.9 per cent of those doing light work and by 47.8 per cent of those with heavy work. Pronounced insufficiency symptoms, i. e. symptoms so severe that they periodically reduced the normal working capacity, existed in 5.7 and 8.6 per cent of the respective work groups (Munkfors: 23.7 per cent). The curves in fig. 12 show the incidence in the age groups. The difference between the light and heavy occupations is remarkably small. Even if a slight difference may exist, it is clear that it is less than in lumbago.

Table 11. Incidence of lumbar insufficiency.

	Number investigated	Percentage with lumbar insufficiency	Percentage with pronounced lumbar insufficiency
Light work	471	40.9 % ± 2.3	5.7 % ± 1.1
Heavy work	666	47.8 % ± 1.9	8.6 % ± 1.0
Munkfors investigation	277	61.0 % ± 2.9	23.7 % ± 2.7

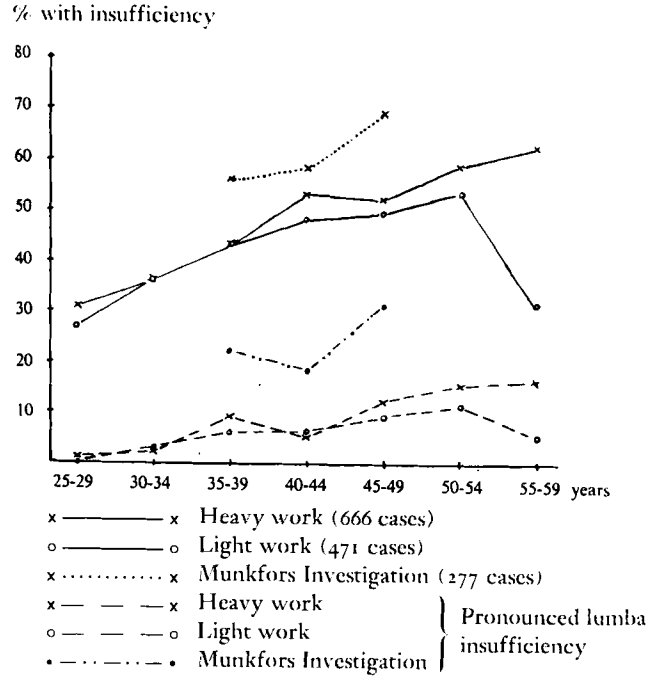

Fig. 12. Incidence of lumbar insufficiency in the different age groups.

Table 12, and the curves in figure 13, show the sciatica incidence. Such symptoms occurred at some time in 17.1 per cent of those with light work and in 21.0 per cent of those with heavy work or, in round figures, in one-fifth of the employees examined. More pronounced sciatica leading to incapacity for work on one or several occasions was reported by 6.4 and 11.0 per cent of the two work groups, respectively (Munkfors: 11.7 per cent). The curves show that the incidence in all age groups is somewhat higher among those with heavy work, and that the difference between the occupational groups is more obvious if only pronounced sciatica is considered. The figures from the Rönnskär in-

Table 12. Incidence of sciatica.

	Number investigated	Percentage with sciatica	Percentage with pronounced sciatica
Light work	471	17.1 % ± 1.8	6.4 % ± 1.2
Heavy work	666	21.0 % ± 1.5	11.0 % ± 1.2
Munkfors investigation	277	30.0 % ± 2.8	11.7 % ± 2.0

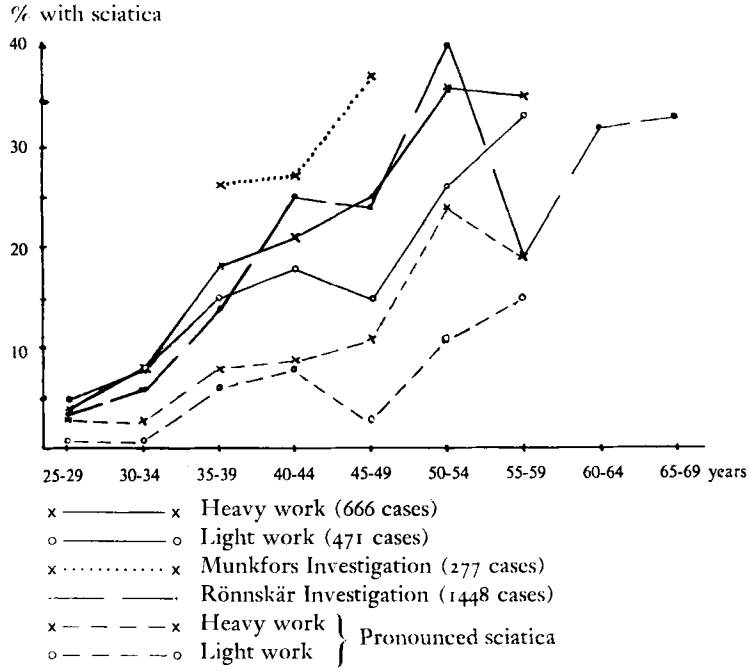

Fig. 13. Incidence of sciatica in the different age groups.

Table 13. Lumbago, lumbar insufficiency and sciatica in the different occupational groups.

Occupational group	No. of cases	Lumbago		Lumbar insufficiency		Sciatica	
		All cases	3 attacks or more	All cases	Pronounced lumbar insufficiency	All cases	Pronounced sciatica
Retail trade	164	26.5 %	7.5 %	45.9 %	4.6 %	17.1 %	7.5 %
Light industry ..	197	31.1 %	9.8 %	38.7 %	6.1 %	19.2 %	8.3 %
Sedentary occupations	110	34.9 %	5.7 %	35.6 %	4.9 %	9.6 %	0.8 %
Total light work	471	31.6 %	9.1 %	40.9 %	5.7 %	17.1 %	6.4 %
		± 2.1	± 1.4	± 2.3	± 1.1	± 1.8	± 1.2
Stevedores	97	48.5 %	13.4 %	37.4 %	10.5 %	16.4 %	7.6 %
Food industry ..	146	50.1 %	15.2 %	56.0 %	10.9 %	17.4 %	11.9 %
Construction ...	177	41.4 %	17.0 %	51.8 %	10.2 %	25.5 %	11.1 %
Heavy industry .	246	43.6 %	10.4 %	45.7 %	5.7 %	18.6 %	11.4 %
Total heavy work	666	44.9 %	13.9 %	47.8 %	8.9 %	21.0 %	11.0 %
		± 1.8	± 1.3	± 1.9	± 1.0	± 1.5	± 1.2

vestigation agree very closely with those in the present material, while the incidence in the Munkfors material is somewhat higher as is the incidence there of other types of spinal symptoms.

Table 13 shows the incidence of the different types of back trouble in all occupational groups investigated. However, it does not offer any information additional to that in the earlier comparisons between workers engaged in light and heavy occupations.

3. The relation between the different types of back trouble.

It has long been observed clinically that the different types of back trouble (lumbago, insufficiency symptoms and sciatica) frequently occur in the same patient, either concurrently or individually on different occasions. Often a lumbago or sciatica attack is preceded or followed by insufficiency symptoms. Moreover, a lumbago attack may change into or be combined with severe sciatica after a few days. This leads to the assumption that lumbago, insufficiency symptoms from the lumbar spine and sciatica frequently comprise different phases of the same disease, or, in other words, that the pathogenesis is often similar. On the basis of the incidence figures obtained in the present material it is possible to estimate the frequency with which the different combinations should occur in the same patient if the three types of back trouble were independent of each other. If these estimated frequencies are compared with the actual incidence of the different combinations (Table 14), it may be seen that the incidence in the present material is higher throughout than the estimated figures. The differences are so large that it can be stated definitely that the combinations occur considerably more frequently than they would by chance. This indicates that the basic cause of lumbago, insufficiency symptoms and sciatica is frequently identical or at least similar. Inasmuch as we now know from clinical and patho-anatomic experience that sciatica is usually caused by certain types of degenerative changes in the intervertebral disks, it would seem probable that lumbago and symptoms of lumbar insufficiency are associated, as a rule, with similar lesions of the disks.

Table 14. Incidence of combined forms of low back trouble.

	Estimated incidence	Observed incidence
Lumbago + insufficiency	17.9 %	26.3 % (299/1137)
Lumbago + sciatica	7.4 %	13.8 % (157/1137)
Insufficiency + sciatica	8.7 %	15.2 % (173/1137)
Lumbago + insufficiency + sciatica	3.4 %	10.7 % (122/1137)

4. Age at onset.

Clinical experience from myelographic studies and operations has shown that sciatica resulting from intervertebral disk herniation may occur occasionally even before 15 years of age. Since it is of great interest to know the age at onset of low back trouble, the workers with such symptoms were questioned concerning this factor. More than two-thirds of those who had a history of back trouble were able to give comparatively exact data on the age at which they experienced the first symptoms. However, almost one-third, most of whom had had relatively mild symptoms, could give only the approximate age at onset. Consequently, it is somewhat difficult to evaluate these age data. Therefore, the percentual increase in incidence in the different age groups has been given instead in figure 14. The age at onset data given by the patients were used only in the two youngest age groups in the figure. It is evident from the present material that back trouble occurs at all ages, but that in the majority the onset was before 40 to 45 years of age. In a remarkable proportion the symptoms started between 25 and 29 years of age. These data agree closely with those obtained by the writer in the Munkfors investigation and with the reports cited earlier published by Friberg and Hirsch (1949) and Lindemann and Kuhlendahl (1953). To summarize, back trouble begins early, very often before or about 30 years of age.

The increase per age group in the incidence of the different types of back trouble is presented separately in figure 15. In order to avoid unevenness in the curves so-called sliding mean values were used. It is evident that the insufficiency symptoms began early, as a rule, and that there was no notable difference between occupational groups. Lumbago

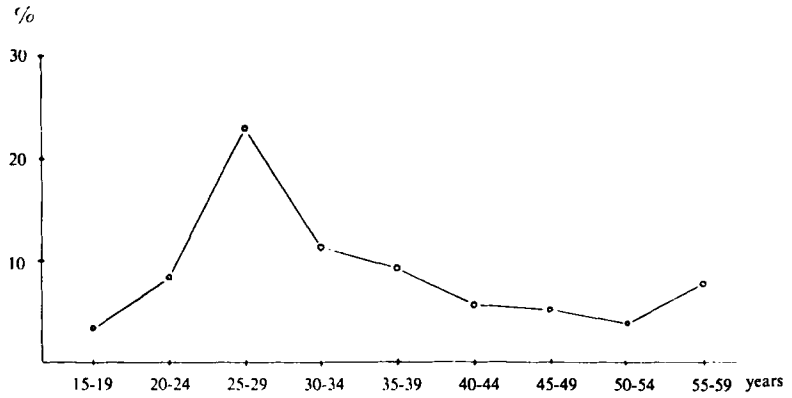

Fig. 14. Age at onset of back trouble showing the percentual increase in incidence per age group in the entire material.

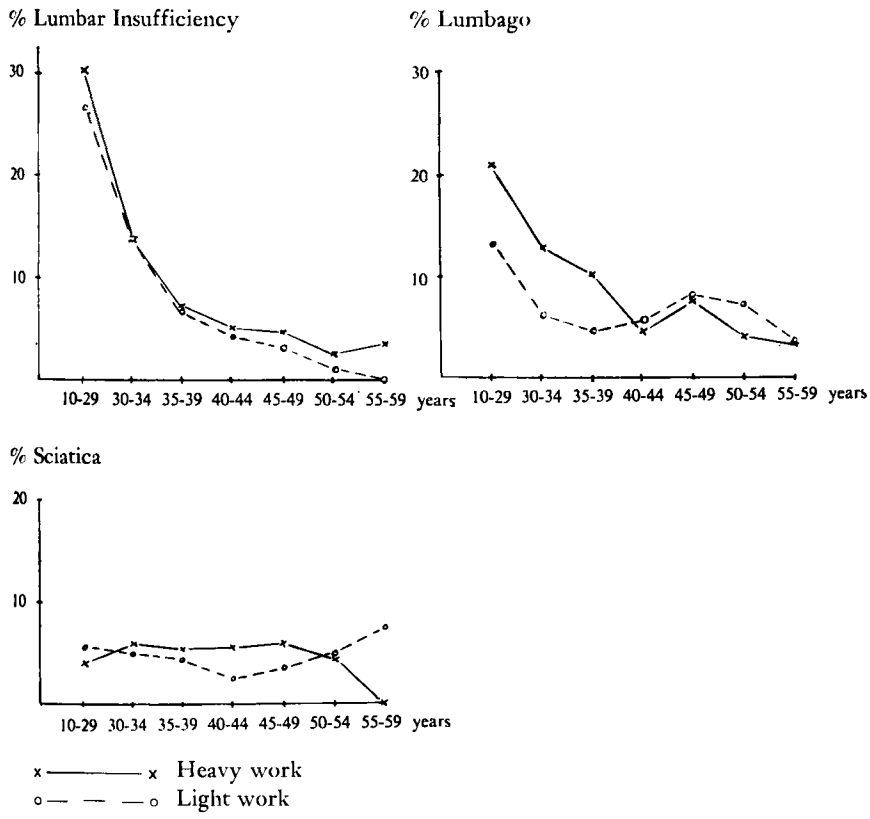

Fig. 15. Percentual increase in incidence of different types of back trouble per age group.

would also seem to start relatively early, especially in those doing heavy work. Sciatica, on the other hand, showed an even rise in frequency with age, indicating that relatively speaking it is a late symptom in the back trouble syndrome.

5. Effect on working capacity.

From the foregoing discussion it is evident that low back symptoms are very common in employees engaged in both light and heavy occupations. It then becomes extremely interesting from the socio-economic point of view to determine the frequency with which such symptoms are sufficiently severe to cause absence from work for periods of varying length. Table 15 shows the incidence of back trouble in workers engaged in light and heavy occupations and the incidence of incapacity for work resulting from such symptoms. With respect to the incapacity for work the table shows the incidence of incapacity of ≥ 1 day, > 3

Table 15. Incidence of back trouble and incapacity for work.

Occupational group	No. of cases	Percentage with back trouble		Percentage with incapacity for work		
		I	II	≧ 1 day	> 3 weeks	> 6 months
Retail trade	164	53.7 %	3.8 %	20.2 %	10.8 %	0 %
Light industry	197	50.0 %	8.3 %	26.1 %	21.6 %	4.2 %
Sedentary occupations	110	52.1 %	5.4 %	27.2 %	8.9 %	0 %
Total light work	471	52.7 %	6.8 %	25.5 %	12.1 %	2.3 %
		± 2.3	± 1.2	± 2.0	± 1.6	± 0.8
Stevedores	97	56.9 %	18.2 %	46.3 %	23.1 %	9.7 %
Food industry	146	71.7 %	11.0 %	47.3 %	25.0 %	4.1 %
Construction	177	68.3 %	9.9 %	43.4 %	18.1 %	3.4 %
Heavy industry	246	61.6 %	7.9 %	40.8 %	15.2 %	5.7 %
Total heavy work	666	64.4 %	10.6 %	43.5 %	25.3 %	5.4 %
		± 1.8	± 1.1	± 1.8	± 1.6	± 0.9
Total	1137	60 %	9 %	36 %	20 %	4 %

I = all cases with back trouble.
II = cases with pronounced back trouble.

weeks and > 6 months. The aggregate incapacity from one or more attacks of back trouble is given.

It is evident (Table 15) that, while 60 per cent of all workers examined had a history of back trouble, only 20 per cent reported more than three weeks aggregate incapacity for work. This means that 40 per cent of the workers investigated had had such mild symptoms that they were either not incapacitated at all or for not more than three weeks altogether. Thus, even if the incidence of back trouble was high, the symptoms were frequently so benign that the socio-economic significance in two-thirds of the cases was slight. The remaining one-third of the workers with back trouble had had such pronounced symptoms however, that the great sociologic and economic importance of back trouble is only too clearly evident. Of all those investigated 16 per cent had been incapacitated for work for from three weeks to six months and 4 per cent for more than six months.

The higher incidence of incapacity for work among the workers engaged in heavy occupations is due both to the higher incidence of back trouble in this group and to the fact that appreciably more of those doing heavy work were incapacitated by their symptoms.

The curves in figure 16 show the percentage incapacitated of those with back trouble in each age group. The solid-line curves represent

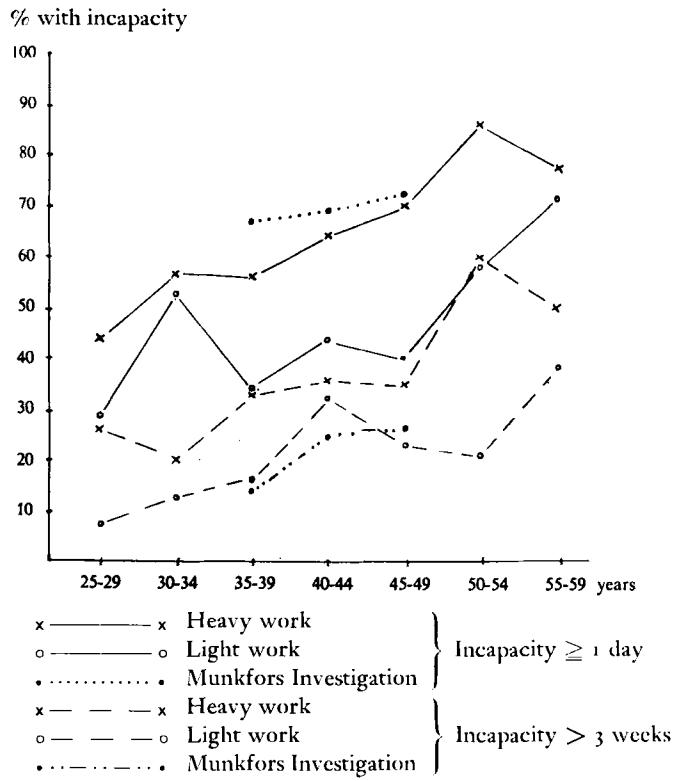

Fig. 16. Percentage incapacitated of those with back trouble in the different age groups.

all with incapacity; the dashed-line curves represent those with > 3 weeks' incapacity. It is clearly evident that among those with back trouble the incidence of incapacity for work rose with rising age. The symptoms in the younger workers were frequently relatively mild and transient, while they became more severe and persistent with increasing age, resulting in a higher incidence of incapacity for work. It may also be seen that in all age groups with back trouble a higher proportion were incapacitated of those doing heavy work than of those doing light work. This need not mean that the workers engaged in heavy occupations had more severe symptoms, however, but is probably due largely to the fact that it is more difficult to carry on heavy than light work while suffering from backache. The Munkfors material shows remarkably few who were incapacitated for work for more than three weeks. This is probably partially due to the fact that the forest worker has the possibility of adapting his tasks and working tempo to suit himself. In consequence they frequently worked, despite having backache, to the extent they were able. In contrast to this are the construction and

transportation workers in particular, who work on a team production agreement, where it is considered unfair to hold back the team production by partial working capacity. Furthermore, one gained the impression that the will to work itself was greater in the more rural Munkfors material than in the urban Stockholm-Västerås material.

Thus, incapacity for work as a result of back trouble is to some extent a relative conception, dependent upon the type of work and the individual will to work. If it were possible to assign a light occupation to those ordinarily engaged in heavy work during periods of backache, many working days would certainly be won. This presents great practical difficulties. However, if such a solution to the problem were possible, it would be the most effective way to combat prolonged incapacity resulting from back trouble. On the other hand, it is remarkable that many who have almost yearly recurring attacks of backache with from a few days to several weeks of incapacity for work were practically completely symptom-free in the intervals notwithstanding the performance of heavy work.

The inference we may make from the foregoing discussion is that even if the difference in the incidence of back trouble in workers in light and heavy occupations is comparatively small, the socio-economic significance represented by lost working days is considerably greater among those engaged in heavy occupations.

6. Accidents and heavy lifting as contributory factors in lumbago and sciatica.

The accident factor in its application to the origin of acute backache is usually a matter of stumbling, which results in a sudden twist of the lumbar spine when the patient attempts to regain his balance, or of an extra strain in connection with heavy lifting when a coworker loses his hold on the object or for some other reason a sudden and unexpected change of balance arises. Accidents of this type are common in daily life. Moreover, it is characterististic that they only occasionally result in acute symptoms; just as often or perhaps more often they give rise to no symptoms at all. More serious accidents that with comparative certainty lead to backache (e. g. falls from a height of several meters or severe blows) are in the minority.

The percentage in whom acute symptoms of lumbago-sciatica type arose in connection with accidents of the aforementioned type or with heavy lifting not associated with an accident is shown in table 16. The evaluation is made somewhat difficult by the fact that many of those who had lumbago or sciatica had had several such attacks, and that in

Table 16. Accidents and heavy lifting as causes of lumbago or sciatica.

	Number with lumbago or sciatica	Percentage with accident as cause		Percentage with accident or heavy lifting without accident as cause	
		a[1]	b[2]	a[1]	b[2]
Light work	166	13.9 %	10.2 %	31.3 %	17.5 %
Heavy work ..	345	26.7 %	18.3 %	49.3 %	30.0 %
Total	511	22.5 %	15.7 %	43.4 %	25.8 %

[1] = All cases in which lumbago or sciatica occurred at some time in connection with an accident or with heavy lifting without accident.

[2] = All cases included in [1] except those in which, despite an attack due to such causative factors at some time, the symptoms usually arose without any such causative factor.

the same individual only one or two attacks had been associated with any of the aforementioned factors (columns a and b in the table).

In 22.5 per cent of those who reported lumbago or sciatica at least one of the attacks occurred in connection with a definite accident and in 43.5 per cent in association with an accident or with heavy lifting uncomplicated by accident. If the cases in which these causative factors were of minor importance (column b) are not included, 15.7 per cent reported accidents and 25.8 per cent reported accidents or only heavy lifting as the causative factor. This means that accidents, in the legal sense, as the cause of lumbago and sciatica occurred in not more than one-fifth of the cases, and either accidents or heavy lifting in 30 to 40 per cent of the cases. Accordingly, in 60 to 70 per cent of those with lumbago or sciatica the symptoms arose without apparent external cause.

A comparison between the men engaged in light and heavy work shows that both accidents and heavy lifting as the causative factor were considerably more common in the latter group. This is natural, since those doing heavy work are more frequently exposed to such strains. If the cases of lumbago and sciatica provoked by such factors are not included (Table 17), the difference in the incidence of such symptoms between the light-work group and the heavy-work group becomes smaller but still sufficient to be statistically probable ($p = 0.01$).

Thus the higher incidence of lumbago and sciatica in the heavier occupations can be correlated with the greater frequency of accidents and heavy lifting and with the heavier work itself to a certain extent.

From the insurance point of view it is of interest to observe that heavy lifting of certain types can cause backache even if no accident factor is involved. In occupations where such lifting, which undoubt-

Table 17. Incidence of lumbago or sciatica with and without accident or heavy lifting as a cause.

	Number investigated	Percentage with lumbago or sciatica		
		with accident or heavy lifting as a cause	without accident or heavy lifting as a cause	Total
Light work	471	6.2 %	29.0 %	35.2 %
Heavy work ...	666	15.5 %	36.3 %	51.8 %

edly introduces greater risks, is necessary, it would be reasonable to award compensation even if an accident factor, in the legal sense, does not exist. In this connection it is probably of minor importance whether or not the worker is accustomed to heavy lifting.

Further information on these factors was obtained from an investigation of athletes who engaged in weight-lifting as a sport. Two-thirds of this series were employed in heavy occupations and one-third in light, and all had been weight-lifting at least five years and the majority from 10 to 20 years. Usually they trained three or four evenings a week, lifting as a rule altogether from five to fifteen tons, i. e. as much or more than the weight lifted daily in heavy work. If heavy lifting in itself causes back trouble, a high incidence of such symptoms could be expected in this group. A comparison (Table 18) between the weight-lifters and the corresponding age groups (30 to 44 years) of the workers with light and heavy occupations shows that such is not the case.

This may be due to the fact that the weight-lifters perform their lifting with good technique and in postures that reduce the strain on the back to a minimum. That heavy lifting by ordinary workers undoubtedly provokes acute back trouble at times is therefore probably dependent in part on concurrent accident factors, in part on faulty lifting technique and in part on their not infrequently being forced to lift heavy objects in postures exerting excessive strain on the back. By

Table 18. Incidence of different types of low back trouble in persons with light and heavy work and in weight-lifters.

Age group 30–44 years	Number investigated	Lumbago	Lumbar insufficiency	Sciatica	Total low back trouble
Light work	217	23 %	42 %	13 %	48 %
Heavy work	297	41 %	44 %	16 %	62 %
Weight-lifters ...	56	36 %	29 %	16 %	52 %

Table 19. Incapacity for work and accidents or heavy lifting as a cause of lumbago – sciatica.

Duration of incapacity	Number with lumbago or sciatica	Percentage in which lumbago or sciatica at some time arose in connection with accident or heavy lifting	Percentage in which lumbago or sciatica usually arose in connection with accident or heavy lifting
No incapacity	115	19 %	16 %
Incapacity ≦ 3 weeks	176	46 %	36 %
Incapacity > 3 weeks – 6 months	176	51 %	24 %
Incapacity > 6 months	44	66 %	16 %
Total	511	43 %	26 %

endeavoring to remove hazards that introduce the accident factor and by providing instruction in correct lifting technique as well as concerning the type of lifting that involves the greatest back strain, it would perhaps be possible to decrease the socio-economic significance of back trouble to some extent.

An attempt was also made to determine if lumbago or sciatica symptoms occurring in connection with accidents or heavy lifting resulted in more prolonged incapacity for work (Table 19). If so, the importance of these factors would be greater than shown by the figures. The group with > 6 months' aggregate incapacity for work is especially interesting here. Sixty-six per cent of this group reported at least one attack that arose in connection with heavy lifting or accident. However, if the cases in which these causative factors were of minor importance are not included, we find only 16 per cent in which the incapacity was provoked by accidents or heavy lifting. These figures compared with those of the groups with less incapacity show that the accident factor or heavy lifting as cause of lumbago or sciatica was in reality not particularly common in the group with more than six months' aggregate incapacity. The comparison also demonstrates that in that group, which unequivocally comprised those with the weakest backs, the tolerance for accidents and heavy lifting was definitely lower. In other words, a person with a strong back tolerates great strains, while the weaker the back the smaller the strain necessary to evoke symptoms. The basic cause of back trouble is therefore usually to be found in pathologic changes in the spine itself. Heavy lifting and minor accidents are only secondary causes that occasionally evoke the symptoms.

7. Clinical signs.

a) Static spinal deformities.

The deformities recorded are pelvic tilt, kyphosis, lordosis and scoliosis. Inasmuch as such deformities are frequently considered to be the cause of spinal symptoms, it seemed pertinent to determine the frequency with which they occured and the extent to which a correlation with back trouble could be demonstrated. With one or two exceptions no grave deformities that could be described as disabling appeared in the present material.

Pelvic tilt, i. e. obliquity of the pelvis resulting from inequality in the length of the legs, is determined by measuring the length of the legs from the anterior superior iliac spine to the lower border of the internal malleolus. The measurements were controlled by inspection of the subject in standing position, with comparison of symmetric points on both anterior and posterior aspects of the pelvis. If the measurements did not agree with the observations in the inspection, which occurred in isolated cases, the pelvis was considered asymmetric and these cases were not included among those denoted as pelvic tilt. A difference of less than one centimeter in the length of the legs cannot be determined with certainty. Therefore, this was the minimum difference recorded.

The tilt of the pelvis obtained with varying differences of leg length can be easily computed. If the mean distance in the frontal plane between the two anterior superior iliac spines is assumed to be 23 centimeters, a pelvic tilt of $2\frac{1}{2}^\circ$ is obtained with 1 centimeter difference in leg length, 5° with 2 centimeters, $7\frac{1}{2}^\circ$ with 3 centimeters, 10° with 4 centimeters, et cetera. The pelvic tilt should cause a static scoliosis in the lumbar spine with the convexity towards the shorter leg. Roentgen examination of an experimental subject with and without a lift of one centimeter under one heel revealed that a difference of one centimeter caused such slight static scoliosis that it could scarcely be visualized with certainty in the roentgenogram. A lift of two centimeters or more, on the other hand, gave rise to a clear static scoliosis. A study of the roentgenograms from the patients with pelvic tilt showed that this condition was sometimes compensated by an asymmetry in the frontal plane of the fifth lumbar or first sacral vertebrae or the disk between them. This compensation was so pronounced in isolated cases that the patient had a lumbar scoliosis with the convexity towards the "wrong" side. In the 57 patients with pelvic tilt from a difference of $\geqq 2$ centimeters static scolisis in agreement with the pelvic tilt was visualized roentgenographically in only about half.

Pelvic tilt was so common that it occurred in one-third (33.3 per

Table 20. Incidence of pelvic tilt in 1137 workers.

Difference in leg length	Number and percentage of cases of pelvic tilt		
	To right	To left	Total
1 – 1½ cm	215	106	321 = 28.3 %
2 – 2½ cm	34	15	49 = 4.3 %
3 – 4½ cm	3	5	8 = 0.7 %
Total	252 = 22.2%	126 = 11.1 %	378 = 33.3 %

cent) of the workers examined (Table 20). The distribution was very even in all age and occupational groups. The right leg was the shorter twice as frequently as the left, an observation that is difficult to explain. The incidence figures agree almost exactly with those obtained in the Munkfors investigation. In the great majority the difference in leg length was between one and one and a half centimeters. Table 21 shows the incidence of back trouble and disk degeneration in the lumbar spine in the cases of pelvic tilt. The age distribution in the three groups with pelvic tilt is in complete agreement with the normal distribution, and the figures are therefore directly comparable with the incidence of back trouble and disk degeneration in the entire material. It is clearly evident that the groups with pelvic tilt exhibited no higher incidence of either back trouble or lumbar disk degeneration. The Munkfors investigation showed analogous results. It is therefore evident that at least moderate pelvic tilt is not a factor in the origin of back trouble.

Whether or not this also applies to pelvic tilt contracted during adult years through an accident or similar cause cannot be definitely stated. Among those with pelvic tilt due to a difference of two or more centimeters in leg length seven had contracted the condition as adults. In one of these, backache had appeared one year after the inequality

Table 21. Pelvic tilt, low back trouble and disk degeneration in the lumbar spine.

Pelvic tilt	Number of cases	Percentage with low back trouble	Percentage with disk degeneration
1 – 1½ cm	321	53.9 %	52.2 %
2 – 2½ cm	49	59.2 %	53.1 %
3 – 4½ cm	8	12.5 %	37.5 %
Total	378	53.7 % ± 2.6	51.3 % ± 2.6
Entire material .	1137	59.9 % ± 1.4	57.6 % ± 1.5

Table 22. Lordosis, low back trouble and signs of disk degeneration in the lumbar spine.

	Number	Percentage with:	
		back trouble	signs of disk degeneration
Lordosis	104 (9.1 %)	50.2 % ± 4.9	47.3 % ± 4.9
Entire material ..	1137	59.9 % ± 1.4	57.6 % ± 1.5

in leg length had been acquired; in one there had been spinal symptoms prior to the difference in leg length, one developed such symptoms 10 years after, and four had had no back trouble whatsoever either before or after acquiring pelvic tilt. Judging from these few cases it would therefore seem as if a difference in leg length acquired in adult years has no decisive significance in the origin of backache.

Kyphosis and lordosis have been impossible to measure by any objective method, being instead estimated subjectively by the investigator. The limit between the normal and the abnormal is fluid and it is sometimes difficult to determine whether or not abnormality shall be considered to exist. The incidence figures given therefore become dependent to a certain extent upon the personal opinion of the investigator.

Abnormally increased lumbar lordosis was considered to be present in 9.1 per cent (104/1137) of the material investigated, varying little with age or occupation. The incidence of back trouble and lumbar disk degeneration was not higher in the subjects with lordosis than in the entire material (Table 22).

Abnormally increased dorsal kyphosis was diagnosed both by clinical examination and by study of the roentgenograms. The results of these estimations, carried out entirely independently, do not agree completely, which is natural considering the aforementioned difficulties in establishing the borderline between the normal and the abnormal. In the clinical estimation 12.9 per cent were considered to have increased

Table 23. Incidence of dorsal kyphosis diagnosed clinically and roentgenologically.

	Light work 471 cases	Heavy work 666 cases	Total 1137 cases
Clinical kyphosis	13.3 % ± 1.5	12.5 % ± 1.2	12.9 % ± 1.0
Roentgenologic kyphosis..	15.5 % ± 1.7	21.8 % ± 1.6	19.4 % ± 1.2
Both clinical and roentgenological kyphosis	8.0 % ± 1.2	8.0 % ± 1.0	8.0 % ± 1.0

Table 24. Low back trouble and disk degeneration in the lumbar spine in the kyphosis cases.

	No. of cases	Percentage with low back trouble	Percentage with disk degeneration
Clinical kyphosis	146	44.8 % ± 4.1	45.5 % ± 4.1
Roentgenologic kyphosis	218	54.5 % ± 3.0	57.9 % ± 3.1
Both clinical and roentgenologic kyphosis	91	42.2 % ± 5.2	47.1 % ± 5.3
Entire material	1137	59.9 % ± 1.4	57.6 % ± 1.5

dorsal kyphosis, with inconsiderable variation in the different age and occupational groups. In the roentgen estimation 19.4 per cent were considered to have increased dorsal kyphosis, and there was a somewhat higher incidence in the workers in heavy occupations in the four highest age groups. The most definite cases exhibiting the greatest kyphosis were those in which both clinical and roentgenologic investigation showed this deformity. These cases comprised 8.0 per cent of the entire material (Table 23).

It is evident from table 24 that the incidence of low back trouble was not higher among those with dorsal kyphosis than in the material as a whole, whether the clinical or roentgen evaluation is used for comparison. Nor was the incidence higher among the most definite cases of kyphosis, i. e. those established both clinically and roentgenologically. The same was true with respect to lumbar disk degeneration. The results with respect to lordosis and kyphosis show close agreement with those obtained in the Munkfors investigation. It should therefore be reasonable to assume that at least moderate lordosis and kyphosis are not of decisive significance in the origin of low back trouble. They are rather to be regarded as a possible cosmetic deformity without notable functional significance.

Scoliosis was clinically diagnosed in 30 cases (2.6 per cent). In all cases there was clearly evident but slight scoliosis in the dorsal or lumbar spine, or in both. The incidence of spinal symptoms among these subjects was the same as in the entire material.

The incidence of scoliosis in the lumbar spine was also determined roentgenologically. The scoliosis was clearly visualized but in some instances of relatively mild degree. In some cases the observations may have depended upon the subjects' having assumed a crooked posture during the roentgen examination, but in the great majority of the cases there was probably a permanent curvature. Such scoliosis occurred in

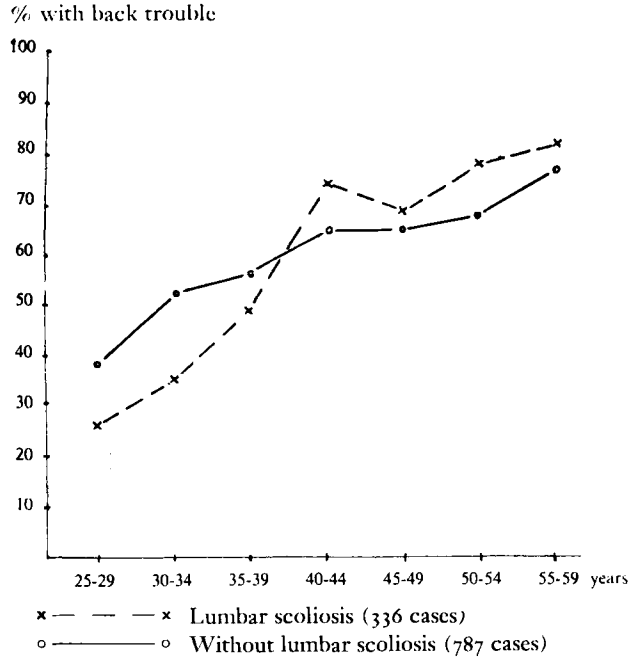

Fig. 17. Incidence of low back trouble in the different age groups with and without lumbar scoliosis visualized roentgenologically.

about one-third of the material investigated. There was no percentual difference in the occurrence in light and heavy occupations. The incidence tended to rise with age. Lumbar scoliosis convex to the left was almost twice as common as that convex to the right. It is evident from the curves in figure 17 and table 25 that the incidence of back trouble in these cases also did not differ from the normal.

To summarize it may be said that moderate degrees of static deformities such as pelvic tilt, kyphosis, lordosis and scoliosis have no decisive significance in the origin of low back trouble.

Table 25. Lumbar scoliosis visualized roentgenologically, low back trouble and disk degeneration.

	Number of cases	Percentage	
		with low back trouble	with disk degeneration
Lumbar scoliosis	336	59.0 % ± 2.7	60.1 % ± 2.7
Entire material	1137	59.9 % ± 1.4	57.6 % ± 1.5

b. Restriction of movement.

The range of movement of the lumbar spine is frequently reported in terms of the ability to bend the trunk forward, with measurement of the distance of the fingertips from the floor. This is no real indication of the flexibility of the spine, however, since the movement takes place principally in the hip-joints. Not infrequently persons who are completely stiff-backed are able notwithstanding the rigidity to bend forward and place their palms on the floor. In these cases the movement occurs entirely in the hip joints. The fact that this forward flexion is nevertheless often restricted in cases of acute backache is due to inhibitory pain and the presence of Lasègue's sign. Lateral and backward flexion give a better picture of the range of movement of the lumbar spine. In using forward flexion as an indicator of lumbar spinal movement, the thumb of the examiner is placed on the spinous process of the first sacral and the forefinger on that of the first lumbar vertebra.

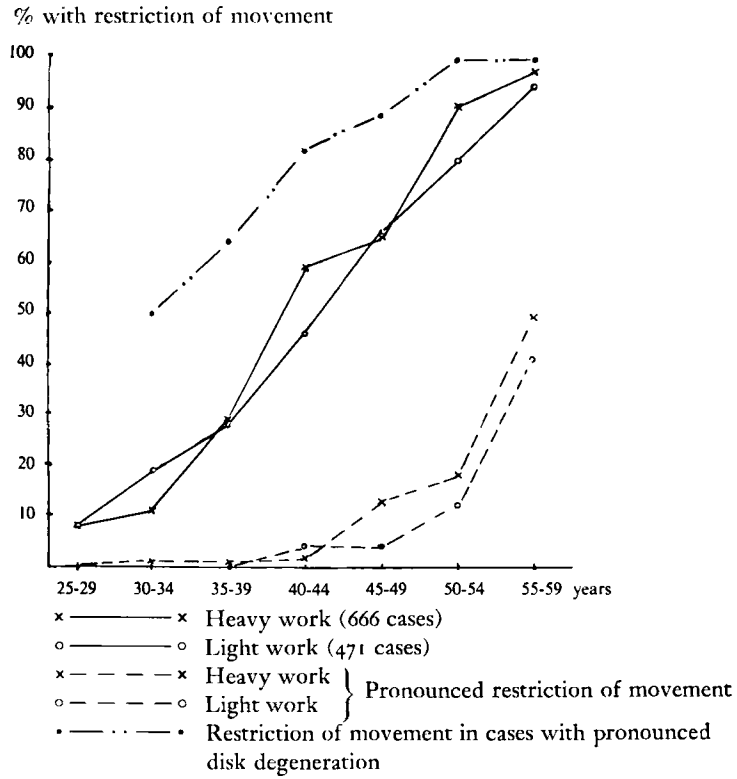

Fig. 18. Restriction of movement in the lumbar spine in cases with light and heavy work and in cases with pronounced disk degeneration.

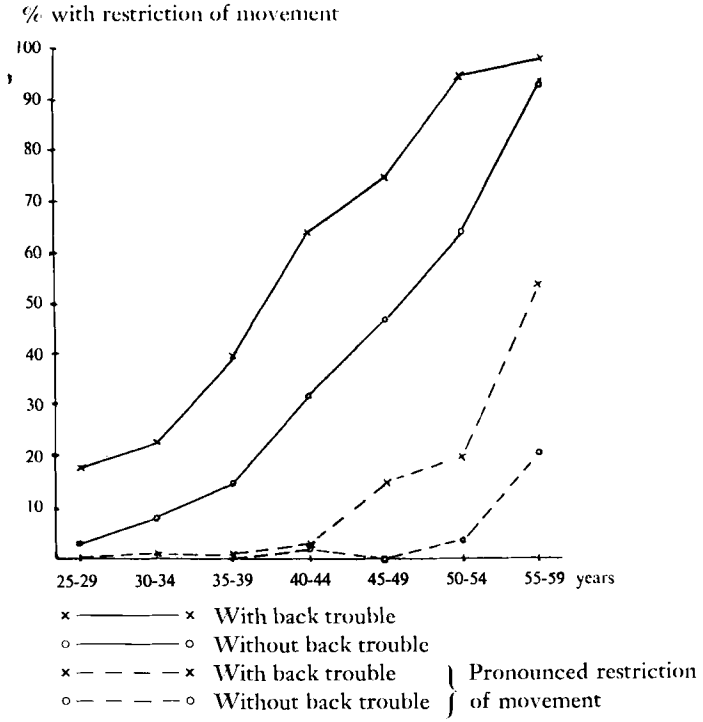

Fig. 19. Incidence of restriction of movement in the lumbar spine in cases with and without low back trouble.

The patient is then instructed to bend forward and to rise again. The examiner notes the change in distance between thumb and forefinger during the patient's movement. The rising movement is the more satisfactory since it is sometimes difficult to keep the fingers in place while the patient bends forward.

Although a pronounced restriction of lumbar movement is obvious and easy to demonstrate, the milder grades are sometimes difficult to differentiate from the normal. Therefore the given incidence figures become dependent to some extent upon subjective observations, somewhat decreasing the value of the sign. It would have been desirable to carry out roentgen measurement of the flexibility of the lumbar spine, but that procedure was impossible in this field investigation.

The incidence of restricted lumbar movement is shown by the curves in figure 18. While the difference in incidence in those with light and heavy work was slight or nonexistent, the age factor proved significant. In the group aged between 25 and 29 years, 10 per cent exhibited restriction of movement. In the 55 to 59 year group between 95 and 100 per cent showed such restriction. The increase with age is similar to that

Table 26. Restriction of movement in the lumbar spine and low back trouble.

	456 cases without back trouble	681 cases with back trouble
Percentage with restriction of movement	37.4 % ± 1.9	59.0 % ± 1.6
Percentage with pronounced restriction of movement	3.9 % ± 1.2	13.4 % ± 1.0

of roentgen signs of disk degeneration (see Fig. 24), and it is conceivable that restriction of movement in the lumbar spine is usually associated with disk degeneration. Supporting this assumption is the fact that in those with pronounced signs of disk degeneration the incidence of restriction of movement is definitely higher (Fig. 18). The patients with roentgen signs of pronounced disk degeneration in whom restriction of movement was not observed had pronounced degeneration in only one disk.

The incidence of restriction of movement in patients with and without back trouble is shown by the curves in figure 19 and in table 26. It is evident that restriction of movement was more common among those with a history of back trouble. However, the incidence at the higher age levels was high even among those who had never had back trouble. Restriction of movement in the lumbar spine is therefore not analogous with the present or past existence of back trouble. However, restriction of movement may be considered a sign of changes in the spine that increase the possibility of the occurrence of spinal symptoms.

c. Muscle spasm.

It is even more true of spasm of the long muscles in the lumbar part of the spine than of restriction of movement that differentiation between the normal and the milder degrees of abnormality is difficult. Even if a certain percentual error in the incidence figures must be expected because of this difficulty, these figures afford some conception of the occurrence of the sign at different age levels and with or without accompanying back trouble. Electromyographic investigation, permitting more exact evaluation of muscular contraction, was unfortunately impossible. As shown by the curves in figure 20, there was no significant difference in the incidence in workers engaged in light and heavy work, but as did restriction of movement and disk degeneration, the sign exhibited a pronounced increase in incidence with rising age and occurred with appreciably greater frequency in those with a history of back trouble than in those without (Fig. 21 and Table 27).

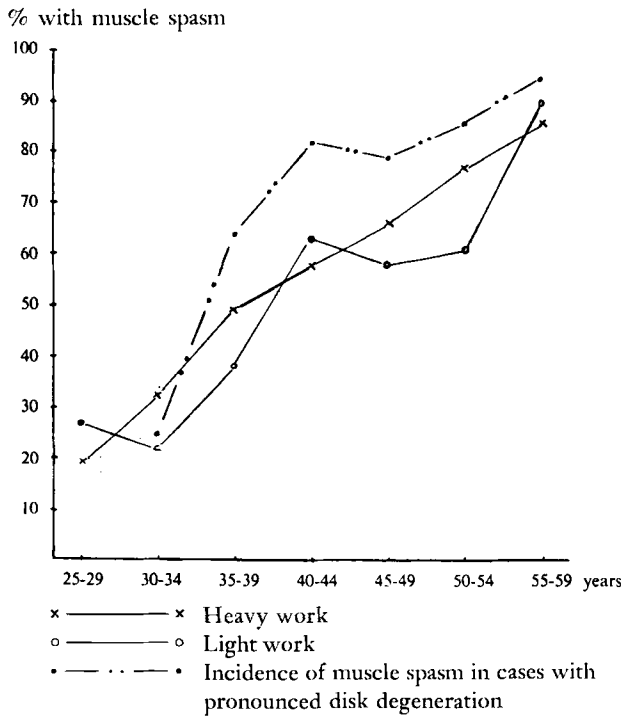

Fig. 20. Incidence of muscle spasm in cases with light and heavy work and in cases with pronounced disk degeneration.

Inasmuch as there are many – in Sweden primarily the physical therapists – who maintain that spasm of the muscles of the back is frequently the cause of backache, it is of great interest to note that this sign occurred in so many cases where there was no history of backache. In the entire material there were 40 cases of pronounced muscular spasm. Of these, four had never had back trouble, and of the other 36 only a few had current symptoms. Since even in the patients with pronounced muscular spasm only very few had current symptoms, it is justifiable to assume that the muscular spasm itself does

Table 27. Muscle spasm in the lumbar spine and low back trouble.

	456 cases without back trouble	681 cases with back trouble
Percentage with muscle spasm	39.4 %	62.5 %
Percentage with pronounced muscle spasm	1.4 %	4.5 %

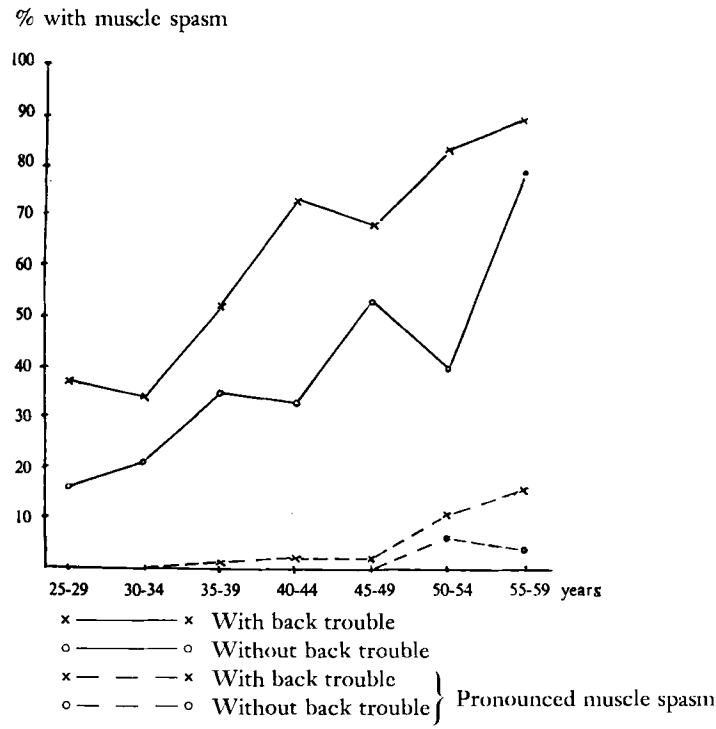

Fig. 21. Incidence of muscle spasm in cases with and without low back trouble.

not, as a rule, cause either aching or pain and cannot thus be considered as the cause of backache. In analogy with restriction of movement, muscular spasm must be regarded instead as a sign secondary to changes in the spine that increase the disposition to back trouble. The higher incidence of both muscular spasm and restriction of movement in the cases of pronounced disk degeneration points to a correlation between these signs and disk degeneration.

d. Tenderness to pressure on the spinous processes of the vertebrae.

Tenderness to pressure on the spinous processes or the interspinous spaces was tested by firm pressure with the thumb on one spinous process at a time. The sign occurred actually only in those who had at some time had back trouble and particularly in those with current, recently subsided or more or less latent symptoms. The sign is easy to elicit and usually the subjects examined were able to report definitely if abnormal tenderness existed. Earlier clinical experience has given reason to believe that this sign indicates the level from which the symptoms originate. In the majority with such tenderness it was localized

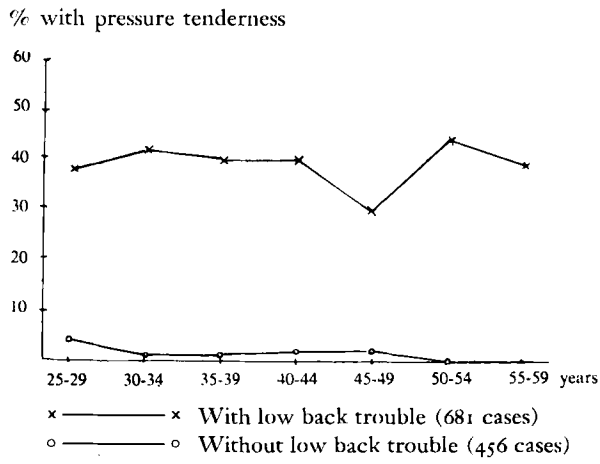

Fig. 22. Incidence of tenderness to pressure on the spinous processes in cases with and without low back trouble.

to the region between the fourth lumbar and first sacral vertebrae. Only occasionally did it occur higher up in the lumbar spine, and in these cases the symptoms were also localized higher in the back than usual. The sign was reported in 39.3 per cent of those with a history of back trouble and in 1.8 per cent of those without. The incidence in workers with and without back trouble in the different age groups is given in the curves in figure 22. It may be seen that the sign occurred with approximately equal frequency in those with back trouble regardless of age. Contrary to restriction of movement and muscular spasm, accordingly, tenderness to pressure is more directly allied with the occurrence of back trouble.

e. Lasègue's sign.

Lasègue's sign was positive in 2.3 per cent (11/471) of the workers in light occupations and in 1.8 per cent (12/666) of those with heavy occupations. All who exhibited this sign had sciatica at the time of examination.

f. Neurologic signs.

The neurologic signs recorded were loss or diminution of knee or ankle jerk, paresis of the extensor of the great toe, of the peroneus or of the triceps surae and sensory disturbances in the leg. The few cases with such signs as sequelae of poliomyelitis or trauma were not included.

Neurologic signs were demonstrated in 6.3 per cent (72/1137) of the entire material. The great majority who had such signs had at some

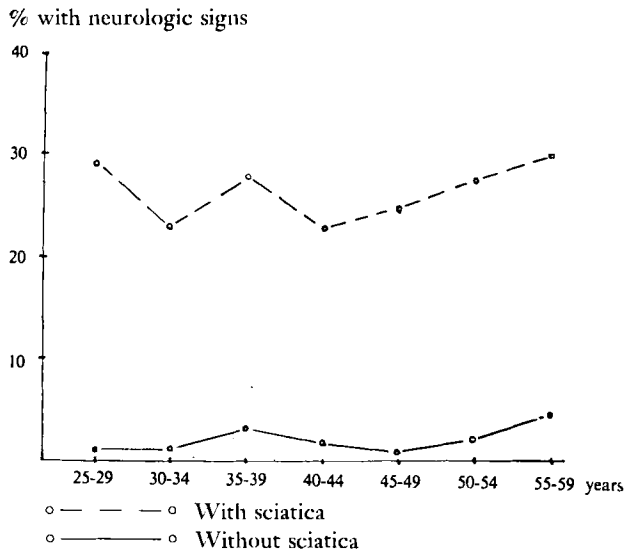

Fig. 23. Incidence of neurologic signs in cases with and without sciatica.

time had pain of sciatica type, as shown by the curves in figure 23. It is interesting that the incidence of neurologic signs in cases of sciatica was approximately equal in all age groups. Thus, unlike restriction of movement and muscular spasm and in accordance with tenderness to pressure on the spinous processes, the age factor did not influence the occurrence of neurologic signs. They appeared to be conditional, as a rule, upon the existence at some time of pain of sciatica type. Neurologic signs were demonstrated in approximately one-fourth of the 220 who reported sciatica symptoms (Table 28).

It is particularly noteworthy that 16 of the patients with neurologic signs – impairment of the ankle jerk or paresis of the extensor of the

Table 28. Incidence of the different neurologic signs.

Neurologic sign	220 cases with sciatica	917 cases without sciatica	Total
Impaired knee jerk	0	1	1
Impaired ankle jerk	31	8	39
Impaired sensibility	24	1	25
Paresis of the extensor of the great toe	21	10	31
Paresis of triceps surae	1	0	1
Total number of cases with neurologic signs	56 25.4%	16 1.8%	72 6.3%

great toe in the majority – reported that they had never had sciatica symptoms, and half of these patients also stated that they had never had back trouble of any type. No other diseases explaining these neurologic signs could be demonstrated. Two similar cases were found in the Munkfors material. Since such signs probably indicate changes in or about the fifth lumbar or first sacral nerve roots, it is conceivable that they were caused by herniation of the lower lumbar disks. If this be the case, it is extremely interesting to note that such changes, which even cause nerve root compression, need not necessarily be associated with pain of sciatica type or with any pain at all.

On the basis of the observed neurologic signs it was possible to assume that of these 72 patients, 3 had affections of the fourth lumbar root, 25 of the fifth lumbar root, 36 of the first sacral root and eight of both the fifth lumbar and the first sacral roots.

g. The significance and evaluation of the clinical signs.

Positive Lasègue's sign was observed only in patients with current symptoms of lumbago-sciatica. Tenderness to pressure on the spinous processes occurred on the whole only in those with current or latent back trouble. Neurologic signs were found mainly only in those who had at some time had lumbago-sciatica symptoms, however, they did not necessarily mean that the symptoms were current, but could indicate residual effect following earlier attacks. All these signs are of great value in the clinical diagnosis of cases of active symptoms. Tenderness to pressure on the spinous processes presumably indicates the level from which the symptoms originate; a positive Lasègue's sign often indicates irritation of some nerve root; and the neurologic signs show the one or more nerve roots that are or possibly have been affected.

In opposition to the foregoing signs at least moderate grades of restriction of movement and muscular spasm occur relatively often in persons who have never had back trouble. Instead, these two signs show a marked correlation with the age factor, but, since they are clearly more common in those who have a history of back trouble, they presumably indicate the existence of changes in the lumbar spine predisposing to back trouble. A correlation exists between these signs and roentgenologically demonstrable disk degeneration, and it is probable that restriction of movement is generally associated with a reduced elasticity in the disks due to disk degeneration, as well as that the muscular spasm is often reflected from some change in or about the outer layer of the disk due to the disk degeneration.

It would naturally be desirable to be able by investigation of persons between 15 and 25 years of age to determine whether or not a

disposition to back trouble existed, and thereby to arrive at a basis for suitable vocational counsel. The aforementioned signs are of limited value in this connection particularly since they first appear after the onset of subjective symptoms. If they are present, however, they provide strong objective confirmation of the actuality of the symptoms reported by the individual. The absence of objective symptoms does not preclude the possibility, however, that the back trouble may be of such severity that the individual is unsuited for heavy work.

It was formerly often suggested that the presence of static deformities involved increased risk of back trouble. The results of the present investigation do not support this contention, showing on the contrary that moderate degrees of pelvic tilt, kyphosis, lordosis and scoliosis do not involve disposition to back trouble. Therefore, individuals with such deformities are not usually less suited than others to heavy work. Only those with grave static deformities or those with insufficiency symptoms or stubborn backache in early years can primarily be regarded as unsuited for heavy work.

8. Roentgenologic signs.

The roentgen investigation of the lumbar spine was carried out under the direct supervision of Professor K. Lindblom of Karolinska sjukhuset. He also interpreted the roentgenograms. Two frontal and two lateral views were taken. Signs of disk degeneration, lumbarization and sacralization, asymmetric fifth lumbar vertebra, spondylolisthesis and lumbar scoliosis were recorded.

a. Incidence of disk degeneration.

Signs of disk degeneration were considered to be osteophytes on the margins of the vertebrae, with or without narrowing of the intervertebral space. Those with osteophytes alone were grouped together, while those with osteophytes in combination with clearly decreased disk height were included in the group denoted as "pronounced roentgen signs of disk degeneration". In this connection reference is made to the observation cited earlier from Schmorl and Junghann's patho-anatomic study that osteophytes occur only in association with such disks as exhibit macroscopic degenerative changes. Reference is also made to the investigations of Friberg and Hirsch and of Lindblom, which demonstrated that the disk degeneration must be comparatively advanced, as a rule, before it can be visualized in conventional roentgenograms. This fact was illustrated by two cases in the present material, in which the patients had undergone operation for verified disk herniation several years earlier, but in which no signs of disk degeneration were observed

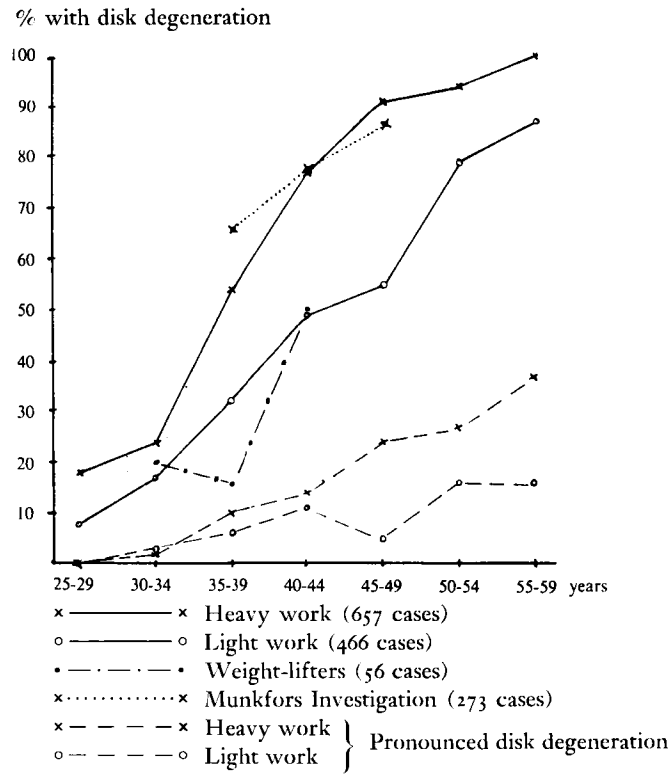

Fig. 24. Roentgen signs of disk degeneration in different age groups.

roentgenographically in this investigation notwithstanding their history. Therefore, degenerative lesions are probably present in the intervertebral disk several years before the first signs can be observed in conventional roentgenograms. Consequently, the incidence figures given for disk degeneration may be regarded as relative only, with the absolute incidence certainly lying somewhat higher, particularly in the younger age groups.

The incidence of roentgen signs of disk degeneration in the lumbar spine is apparent from the curves in figure 24. It is evident – as in disk degeneration in the cervical spine – that the age factor is decisively significant. While about 15 per cent of those examined between 25 and 29 years of age had signs of disk degeneration, more than 90 per cent of those between 55 and 59 years exhibited such signs. Inasmuch as all have disk degeneration at a sufficiently advanced age, as far as we can judge, it can scarcely be interpreted as a pathologic change. On the contrary, it may be regarded as a more or less physiologic sign of approximately the same type as arteriosclerosis.

Table 29. Incidence of roentgen signs of disk degeneration in the lumbar spine in the different occupational groups.

Occupational group	Number investigated	Percentage with roentgen signs	Percentage with pronounced roentgen signs
Retail trade	163	55.7 %	4.5 %
Light industry	193	39.7 %	10.1 %
Sedentary occupations	110	46.1 %	6.4 %
Total light work	466	46.7 % ± 2.3	8.1 % ± 1.3
Stevedores	97	73.9 %	21.3 %
Food industry	146	58.6 %	11.3 %
Construction	176	65.3 %	13.3 %
Heavy industry	238	66.0 %	19.5 %
Total heavy work	657	65.4 % ± 1.9	16.2 % ± 1.0
Total	1123	57.6 % ± 1.5	13.2 % ± 1.0

The curves also show that the incidence was definitely higher in those doing heavy work. Accordingly, this occupational group showed an incidence of 54 per cent in the age group from 35 to 39 years and of 90 per cent in the group from 45 to 49 years, while the corresponding incidence figures from those engaged in light work were 32 and 55 per cent. Inasmuch as practically all gradually show signs of disk degeneration, this means that those in heavy occupations are exposed to strains of a type that cause the roentgen signs of disk degeneration to develop earlier and to become more pronounced. Table 29 shows that 46.7 per cent of those with light work and 65.4 per cent of those with heavy work exhibited roentgen signs of disk degeneration.

The incidence of disk degeneration in the group of weight-lifters was comparatively low, and definitely lower than in the workers in heavy occupations in corresponding age groups (Fig. 24). Notwithstanding that this may largely depend upon the fact that persons who pursue weight-lifting as a sport are usually those with the strongest backs, it still indicates that the actual lifting of heavy weights need not be a strongly predisposing factor in the origin of disk degeneration.

The diagrams in figure 25 show the incidence of degenerative changes in each lumbar disk. The material was divided according to light or heavy occupations; and since correction was made for the difference in age distribution in the two groups, the results are directly comparable. The higher incidence in the heavy-work group is evident. On the other hand, the percentual localization to the different disks was

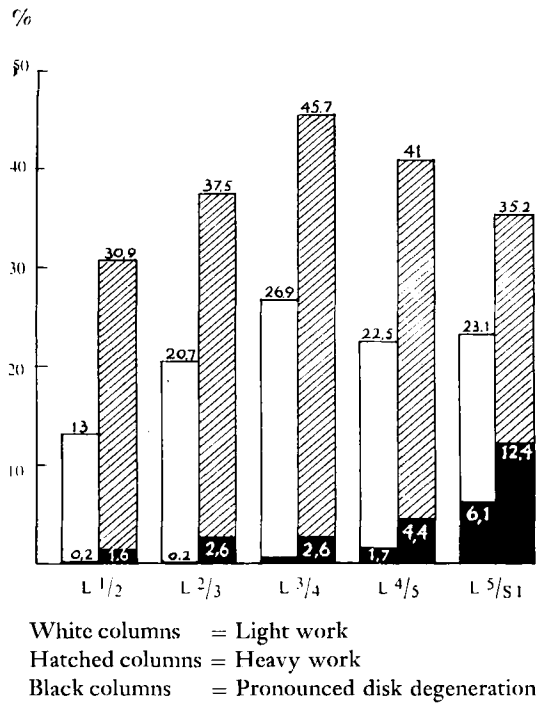

Fig. 25 Incidence of disk degeneration in the different lumbar disks in light and heavy work groups.

dissimilar. The third lumbar disk (L 3/4) showed the highest incidence, followed in order of incidence by the fourth (L 4/5), the second (L 2/3), the fifth (L 5/S 1) and the first lumbar disk (L 1/2). In the workers in light occupations, however, the incidence was relatively high in the fifth disk. The cases of pronounced disk degeneration (black columns) showed a different distribution. The fifth disk here had the highest incidence followed in order of frequency by the fourth, and then the second and third with about the same frequency.

b. Disk degeneration and back trouble.

The relation between roentgen signs of disk degeneration and back trouble is shown in figure 26 and table 30. The incidence of disk degeneration in the workers with a history of back trouble was higher in all age groups than in those who reported no such symptoms. The figures in table 30, which have been corrected for age since the incidence of both back trouble and disk degeneration is higher in the higher age groups, show that disk degeneration is more common in those with

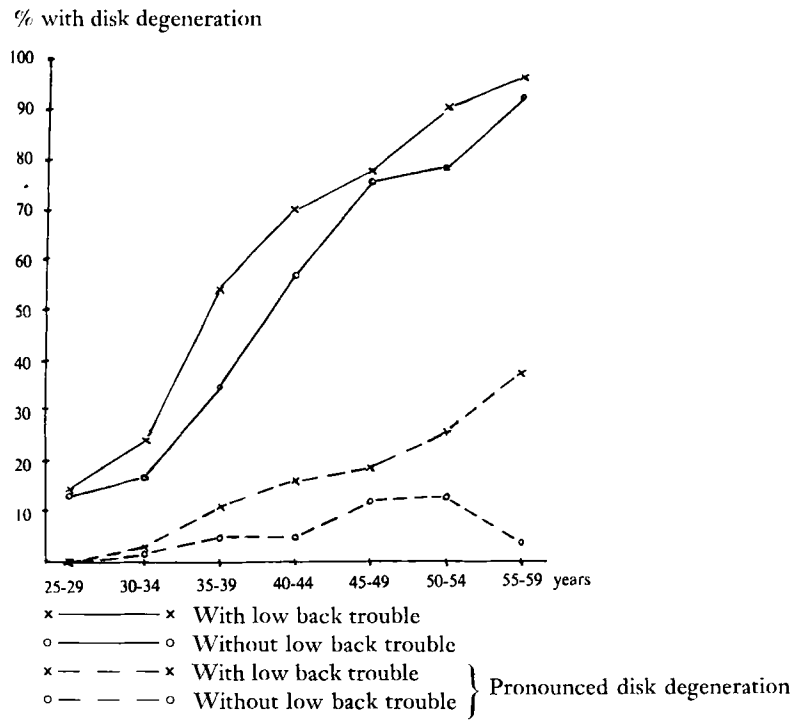

Fig. 26. Incidence of roentgen signs of disk degeneration in cases with and without low back trouble.

than without a history of back symptoms. The difference was moderate but definite. If the cases showing pronounced roentgen changes are considered, the difference appears more clearly. Thus, it is possible to demonstrate a relation between roentgen signs of disk degeneration and back trouble.

Correlation of the roentgen signs of disk degeneration with the different types of back trouble (insufficiency symptoms, lumbago and sciatica) provided no additional information.

Table 30. Roentgen signs of disk degeneration and low back trouble.

	Number of cases	Percentage with roentgen signs	Percentage with pronounced roentgen signs
Without back trouble	451	53 % ± 2.3	5.9 % ± 1.1
With back trouble	672	61 % ± 1.9	16.2 % ± 1.4
With pronounced back trouble ..	100	68 % ± 4.7	30.1 % ± 4.6

Clinical experience has shown that the disk herniation that causes sciatica generally originates from the fourth and fifth lumbar disks, and occasionally even from the third. The incidence of disk degeneration in each lumbar disk individually in the workers with and without back symptoms and in those with sciatica was therefore of interest. The curves in figure 27 show this incidence for each age group, and table 31 gives the total incidence in each lumbar disk with correction for the age factor. It is evident that those with back trouble showed a somewhat higher incidence throughout, but the difference was obvious only in the two lower lumbar disks (L 4/5 and L 5 / S 1). In the sciatica cases this difference was even more marked, which agrees with the clinical observations.

*

Roentgen signs of disk degeneration were occasionally demonstrable in the group between 25 and 29 years of age and the incidence rose rapidly with age. Inasmuch as it is known that these roentgen signs probably first appear several years after the degenerative changes in the disks have started to develop, there is reason to assume that the disk degeneration in some cases starts even before 20 years of age, and that the incidence, especially from 25 to 35 years, is considerably higher than shown in the curves. This may explain why a relatively large proportion of those with back trouble in the younger age groups did not have any disk degeneration demonstrable in conventional roentgenograms. This means also that the disk degeneration develops and shows a rapidly increasing incidence in the very ages when the onset of back trouble is most frequently reported. This further confirms the correlation between these factors.

Table 31. Roentgen signs of disk degeneration in each lumbar disk correlated with low back trouble and with sciatica.

	L 1/2	L 2/3	L 3/4	L 4/5	L 5/S 1
451 cases without low back trouble	20.0 % ± 2.0	26.6 % ± 2.1	35.6 % ± 2.1	30.4 % ± 2.2	22.7 % ± 2.1
672 cases with low back trouble	25.9 % ± 1.7	33.3 % ± 1.4	39.9 % ± 1.5	36.4 % ± 1.6	32.2 % ± 1.6
219 cases of sciatica	26.0 % ± 2.3	31.7 % ± 2.2	41.3 % ± 3.2	39.7 % ± 2.8	38.1 % ± 2.5

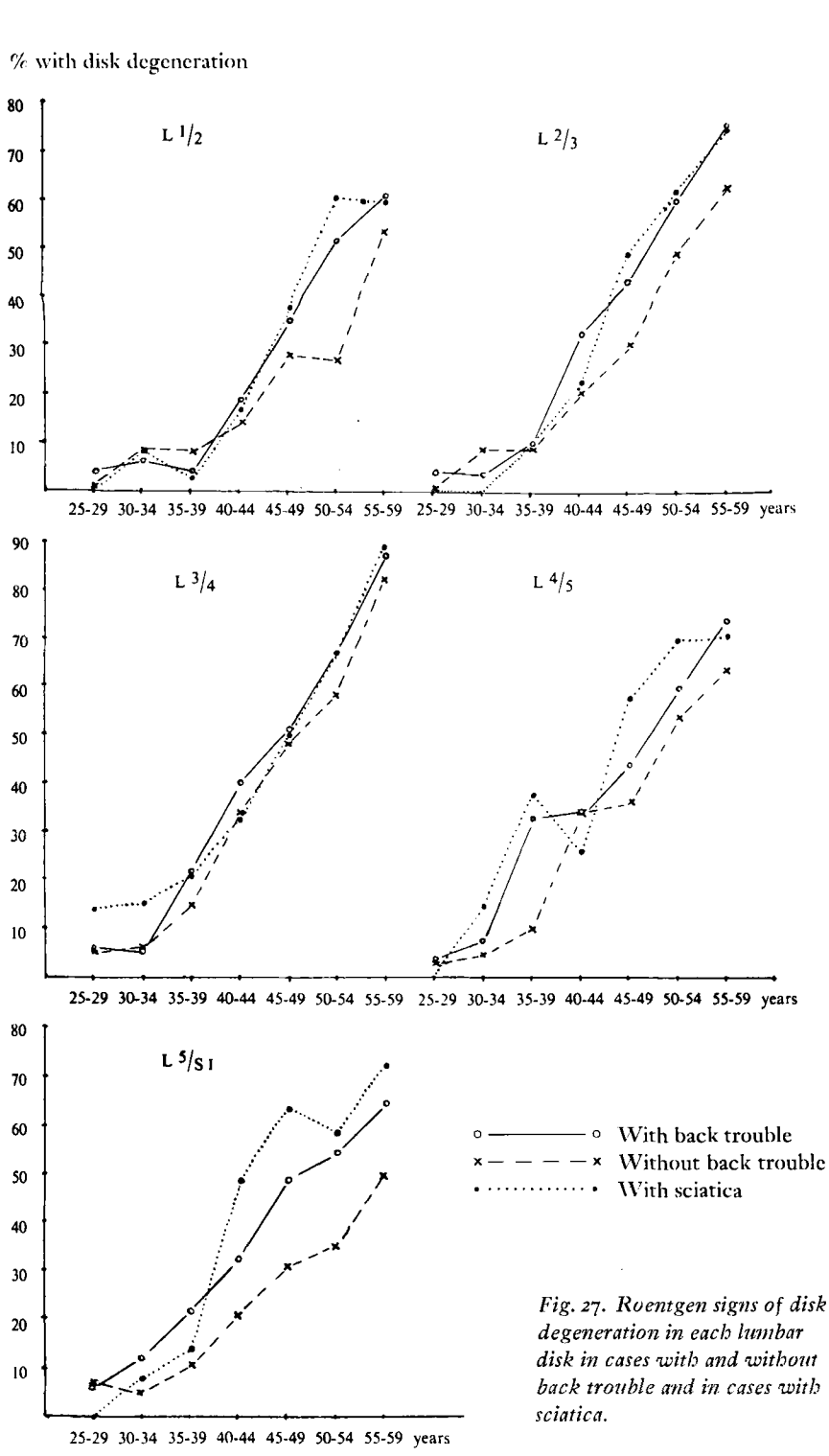

Fig. 27. Roentgen signs of disk degeneration in each lumbar disk in cases with and without back trouble and in cases with sciatica.

On the other hand, although it is obvious it should be pointed out that disk degeneration and back trouble must not be considered analogous. This was emphasized by the fact that there were altogether too many with disk degeneration, even pronounced disk degeneration, with no history of back trouble. It may be seen from the curves in figure 26 that among those with "symptom-free backs" 56 per cent between 40 and 44 years and not less than 92 per cent between 55 and 59 years of age exhibited roentgen signs of disk degeneration. Moreover, in many of those who had had back trouble at some time and exhibited disk degeneration, the back symptoms had been slight and rapidly transient. *Disk degeneration should therefore be interpreted as a more or less physiologic change coming with age, and which in itself need not give rise to symptoms, but which presumably lays the foundation for the changes that usually cause back trouble.*

According to the investigations cited earlier carried out by Friberg, Hirsch and Lindblom, inter alios, the radial rupture, its direction, the resultant degree of inflammatory reaction, and the disk herniation sometimes arising from it are considered to be of specific predisposing significance in the origin of back trouble. These specific changes cannot be visualized in conventional roentgenograms, which probably explains why the correlation demonstrated in the present material between disk degeneration and back trouble was not so convincing as might have been expected. Further support for this hypothesis is found in the observations in the study of the dorsal spine (see page 83). The incidence of roentgen signs of disk degeneration in the dorsal spine was the same as that in the cervical and lumbar spine, while the incidence of subjective symptoms was considerably lower in the dorsal spine (approximately 5 per cent of those examined). This may probably be correlated with the variation in the patho-anatomic conditions disposing to radial rupture and disk herniation causing spinal symptoms. In the dorsal spine the mobility is less and the disks are thinner. Moreover, radial rupture and disk herniation show a predilection for development towards the concave side of a curvature, i. e. ventrad in the normally kyphotic dorsal spine where the tissues are probably less sensible to pain, while in the lordotic cervical and lumbar parts of the spine the development is usually dorsad and dorsolaterad towards nerve roots and pain-sensible tissues about the spinal canal.

It is clear that conventional roentgenograms of the spine give an incomplete and summary conception of the changes in the disks assumed to cause the spinal symptoms. The method of investigation (discography) that could provide better information on such changes is unfortunately not adapted to a field investigation of the present type.

From the practical viewpoint it is important to realize that existing back trouble may be related to disk degeneration with no signs demonstrable by coventional roentgen technique, and also that even pronounced roentgen signs of disk degeneration occur not infrequently with no accompanying subjective symptoms whatsoever.

c. Lumbarization, sacralization, asymmetric fifth lumbar vertebra and spondylolisthesis.

The incidence of lumbarization or sacralization, asymmetric fifth lumbar vertebra and spondylolisthesis is given in table 32. No difference in incidence in the light and heavy work groups was observed. Possibly the incidence of spondylolisthesis was somewhat higher in those engaged in heavy work, but the figures are too small to show a significant difference.

Table 33 shows that the incidence of back trouble and roentgen signs of disk degeneration in the cases of lumbarization or sacralization and asymmetric fifth lumbar vertebra did not differ from that in the material as a whole. Therefore, it would seem that there is no demon-

Table 32. Incidence of lumbarization or sacralization, asymmetrical fifth lumbar vertebra and spondylisthesis

	Number investigated	Lumbarization or sacralization	Asymmetric L 5	Spondylolisthesis
Light work .	466	6.4 % ± 1.14	18.0 % ± 1.8	1.5 % ± 0.57
Heavy work	712	5.5 % ± 0.85	22.9 % ± 1.6	2.5 % ± 0.58
Total	1178	5.9 % ± 0.70	21.4 % ± 1.2	2.1 % ± 0.41

Table 33. Incidence of back trouble and disk degeneration in cases with certain roentgenologically demonstrated anomalies.

	Incidence in entire material	Incidence in		
		Lumbarization or sacralization 69 cases	Asymmetric L 5 247 cases	Spondylolisthesis 25 cases
Percentage with low back trouble	59.9 % ± 1.4	68.1 % ± 5.6	62.3 % ± 3.1	84.0 % ± 7.3
Percentage with disk-degeneration	57.6 % ± 1.5	53.6 % ± 6.0	60.3 % ± 3.1	88.5 % ± 6.3

strable correlation between these anomalies and back trouble or disk degeneration. In spondylolisthesis, on the other hand, there was a clearly increased incidence of both backache and disk degeneration. The symptoms in the relatively moderate cases of spondylolisthesis that occurred in the present material had no specific character, and only 4 of the 25 with spondylolisthesis had a history of more pronounced back trouble. A prerequisite to the origin of spondylisthesis is presumably the existence of disk degeneration in addition to spondylolysis. Therefore, it is probable that disk degeneration was present in all cases, although it could not be visualized in conventional roentgenograms.

9. Body type and back trouble.

In the Munkfors investigation no correlation between body type and back trouble was demonstrated. Since that material was not very extensive, it was impossible to be certain that this observation applied generally. A study of the present material from this point of view was therefore considered desirable.

The body type is given according to Rohrer's index, i. e.

$$\frac{\text{Body weight in grams} \times 100}{(\text{Height in centimeters})^3}$$

The index for the tall thin individual will be low; that for the short fat person will be high. The index varied in the present material between 0.9 and 2.3 (one case with an index of 2.65 was not included). Ninety-one per cent of the values lay between 1.1 and 1.7. The mean index for each age group is given in the curves in figure 28. It may be seen that the index rises with age, and that it is higher in the heavy-work groups. This means that the latter are somewhat larger and more heavily built, on the average, than those in the light occupations. The extent to which this difference should be ascribed to a more or less natural predilection of the brawny for the heavier occupations and the degree to which it should be considered due to greater muscular development as a result of increased muscular function cannot be determined. However, both factors are probably of importance. The weight-lifters, who represent a definitely selected group of broad-shouldered, strong and frequently relatively short men, showed an appreciably higher index than the rest, as was to be expected.

Corresponding index curves were also plotted in the diagram for those who reported back trouble. It is clearly apparent that these curves do not differ from those of the material as a whole, demonstrating that

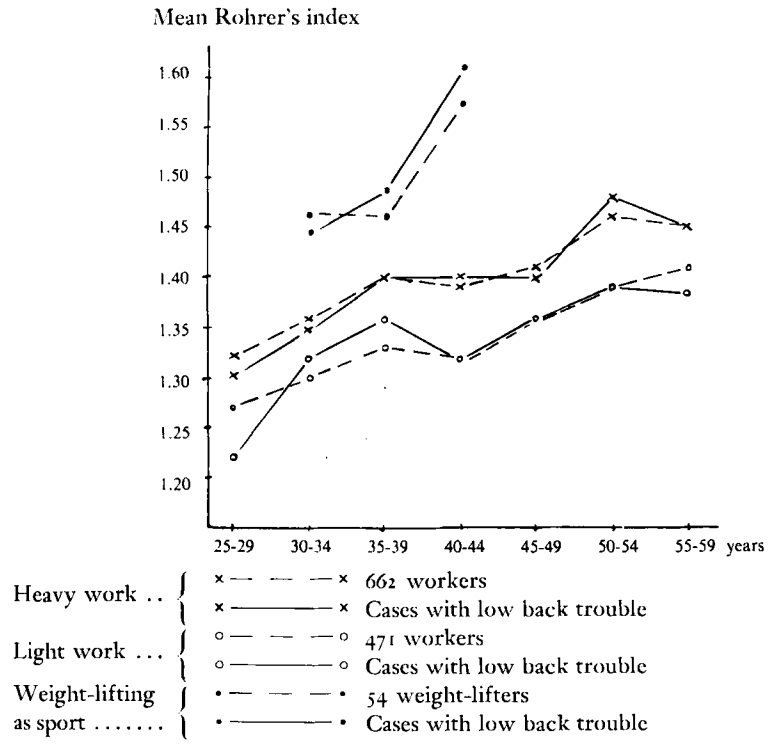

Fig. 28. Mean Rohrer's index in the different age and occupational groups and in cases with back trouble.

the body type according to Rohrer's index cannot be correlated with the occurrence of back trouble. This indicates that the tendency to back trouble is equal in tall thin and short fat individuals respectively.

10. Flatfoot, foot fatigue and back trouble.

Flatfoot is difficult to measure objectively. Therefore, this condition was only subjectively evaluated in the present material. The limit of the normal is undefined, and classification was sometimes difficult. Pronounced flatfoot was differentiated from mild to moderate flatfoot.

By foot fatigue is meant aching, pain and fatigue of the feet as a result of considerable walking or standing.

It is evident from table 34 that flatfoot occurred in about 22 per cent of the material, with fairly even distribution in the different occupational groups. Approximately 1 per cent were considered to have pronounced flatfoot. Foot fatigue was reported by 7 per cent. Those employed in retail trade exhibited a relatively high incidence (18 per

Table 34. Incidence of foot fatigue and flatfoot.

	Number of caces	Percentage with		
		flatfoot	pronounced flatfoot	foot fatigue
Retail trade	164	25 %	1.8 %	18 %
Light industry	197	20 %	0.5 %	5 %
Sedentary occupations	110	19 %	0 %	6 %
Stevedores	97	22 %	0 %	4 %
Food industry	146	25 %	1.4 %	8 %
Construction	177	23 %	0.6 %	7 %
Heavy industry ...	246	19 %	1.7 %	4 %
Entire material	1137	22 %	1.0 %	7 %

Table 35. Correlation between flatfoot and foot fatigue.

	Number of cases	Percentage with foot fatigue
No flatfoot	892	3.5 %
Moderate flatfoot	234	20 %
Pronounced flatfoot	11	64 %

Table 36. Correlation between low back trouble, foot fatigue and flatfoot.

	Number of cases	Percentage with low back trouble
Foot fatigue	85	68 % ± 5.0
Flatfoot	245	60 % ± 3.1
Entire material	1137	59.9 % ± 1.4

cent) in comparison with the rest of the material. Table 35 shows that there was some relation between flatfoot and foot fatigue, but that they were far from analogous.

Hallux valgus occurred in 4 per cent and hallux rigidus in 1 per cent of the material. As a rule, these deformities did not cause notable discomfort.

Table 36 shows that the incidence of back trouble was not definitely higher in the cases of flatfoot or foot fatigue than in the material as a whole. Accordingly, *no correlation between these foot conditions*

and back trouble could be demonstrated. The fact that patients sometimes maintain positively that backache has been alleviated by the use of arch supports is probably due to the fact that it is possible to some extent to alter the statics in the spine with such a support, with resultant reduction of the load on the center of pain.

11. Other diseases and back trouble.

Inasmuch as a conception of the frequency with which certain diseases and abnormal conditions occur in a normal material of the type in the present investigation is of interest, the subjects were questioned with this in mind. Naturally these subjective data cannot be regarded as exact, but they should afford a general conception (Table 37).

The criterion for the existence of gastric or duodenal ulcer was reported roentgen diagnosis of this condition. The number in which gastric resection had been done was recorded separately. The incidence of this operation was astonishingly high, in the opinion of the writer, but it was approximately the same in all occupational groups, i. e. about 4 per cent. Of 47 who had undergone operation, 45 were completely symptom-free and 2 still had slight symptoms. The majority reported that their only regret was that the operation had not been done earlier. Accordingly, the present material gave the impression that the results of this operation are excellent.

The presence of varicose veins was recorded at the clinical examination. In the majority this condition gave few symptoms; a few complained of mild fatigue in the legs, and in isolated cases there were more pronounced symptoms and a tendency to varicose ulcer, for which therapy was indicated.

Hernia was considered to exist in those revealing this condition at examination or in those who had earlier undergone operation for hernia. In the majority it was the common inguinal hernia.

The criterion for commotio cerebi was reported hospitalization under that diagnosis following an accident.

Polyarthritis was considered to exist in those who had a history of acute rheumatic fever with definite joint symptoms or in those who reported one or more bouts of chronic polyarthritis. As a rule, the latter could be verified at the clinical examination.

Seven of those examined had residual paresis as a sequel of poliomyelitis. In two of these there was relatively pronounced paresis of the abdomen and legs. The others had more or less pronounced paresis of the feet or one leg.

Of the 58 comprising the tuberculosis group, 28 had a history of

Table 37. Incidence of certain diseases and abnormal conditions and their correlation to back trouble.

	Percentage of entire material	Percentage with back trouble
Entire material	(1137)	59.9 % ± 1.4
Peptic ulcer	10.2 % (116)	65.8 % ± 4.4
Gastric resection for peptic ulcer	4.1 % (47)	76.6 % ± 6.5
Varicose veins	7.7 % (87)	56.6 % ± 5.3
Hernia	8.3 % (94)	62.9 % ± 5.0
Commotio cerebri	4.1 % (47)	63.8 % ± 7.0
Polyarthritis	3.4 % (39)	56.1 % ± 7.9
Poliomyelitis	0.6 % (7)	57.1 % ± 18.7
Tuberculosis	5.1 % (58)	58.6 % ± 6.4
Diabetes	0.7 % (8)	37.5 % ± 17.2
Appendectomy	15.0 % (171)	–

pleuritis or erythema nodosum, 20 had received sanatorium care for pulmonary tuberculosis and 10 had a history of some type of surgical tuberculosis treated operatively. Three in this latter group had had spondylitis tuberculosa and five had had tuberculosis of some joint.

No relation between these diseases or conditions and the occurrence of low back trouble could be demonstrated. The relatively high incidence of back trouble in the group where gastric resection had been done is only apparent, since these operations did not occur in the two lowest age groups and the mean incidence of back trouble in the five highest age groups was 73 per cent. The relation between gastric symptoms and back trouble was also investigated in the earlier-mentioned Rönnskär material (page 38). There, too, no correlation was demonstrable.

12. Similarity between the stiff neck - brachialgia and lumbago-sciatica syndromes.

There is undoubtedly great similarity between the stiff neck – brachialgia syndrome and the lumbago – sciatica syndrome. The analogy is striking between stiff neck and lumbago as well as between the nerve root symptoms in brachialgia with pain radiating to the fingers and those in sciatica with pain radiating into the leg. Less tangible, however, is the similarity between the deep pain of brachialgia and chronic lumbago or lumbar insufficiency. The frequency with which the two syndromes occurred in the present material was high and of about the

Table 38. Incidence of low back trouble in subjects with and without stiff neck – brachialgia.

	Number	Percentage with back trouble
Without stiff neck – brachialgia	553	47.1 % ± 2.1
With stiff neck – brachialgia	584	72.3 % ± 1.8

same order. The onset of the different symptoms was observed at about the same age levels also. Accordingly, stiff neck and lumbago occurred early, not infrequently before or shortly after 20 years of age, while brachialgia and sciatica occurred later, with the greatest increase in frequency after 30 to 40 years. Such signs as were observed in patients with subjective symptoms at the time of examination indicate that the attacks were generally caused by changes in the cervical or lumbar spine, i. e. the lordotic and most flexible parts of the spine and in which the major nerve trunks to the upper and lower extremities leave the dural sac and emerge through the intervertebral foramina. Roentgen signs of disk degeneration in the cervical and lumbar spine could be related to a certain extent to the stiff neck – brachialgia and lumbago – sciatica syndromes respectively. There is also reason to assume, as pointed out earlier (page 70), that the degenerative lesions in the intervertebral disks begin to appear at just the age levels when the first symptoms of stiff neck – brachialgia and lumbago – sciatica occur. All this indicates a similar origin of the two syndromes, and that their pathogenesis is associated, as a rule, with changes in the cervical or lumbar spine. It might also be expected that low back trouble would be more common in persons with a history of stiff neck – brachialgia than in those without. That this proved true is evident from table 38.

The Dorsal Spine Syndrome

1. Symptom picture and incidence.

Symptoms localized to the region of the dorsal spine were relatively rare in comparison with the stiff neck – brachialgia and lumbago – sciatica syndromes. In some cases these symptoms were comparatively vague, transient and undefined; in others they were more clearly of such a character that there was reason to assume an association with changes in the dorsal spine in a manner similar to the aforementioned relation between the stiff neck – brachialgia or lumbago – sciatica syndromes and changes in the cervical or lumbar spine.

In the 52 cases in which there was history of dorsal spinal symptoms, the following observations were made.

Twenty-six reported fatigue, aching or pain localized to a definite region in the dorsal spine on one or more occasions. These symptoms occurred most frequently between or under the shoulder blades. They were of short duration, as a rule, and caused slight distress. Only in very few cases had the symptoms caused absence from work for a day or two. Ten cases have been classified as kyphosis. In these cases the symptoms resembled most closely the so-called insufficiency type, and were presumably associated with the deformity. However, the symptoms did not seem to comprise a particular handicap with respect to work (four were engaged in heavy and six in light work).

Five of the 52 reported one or more acute attacks of lumbago-like symptoms in the dorsal spine, occasionally with radiation towards the flank. As a rule, the symptoms occurred in association with a particular strain, e. g. heavy lifting with or without loss of balance. Three of these had been incapacited for work for brief periods.

Fifteen (three with kyphosis) reported aching or pain on one or more occasions, localized to a definite region in the dorsal spine and associated with unilateral or bilateral radiation along the ribs in that segment down into the flank or forwards to the epigastrium. Some patients reported little or no trouble in the dorsal back and only pain resembling intercostal neuralgia such as just described. Others stated that at the time they had active symptoms there had been a tender spot somewhere on the chest or flank. Five had been incapacitated for work for short periods as a result of these symptoms.

Of the remaining workers with a history of symptoms localized to the region of the dorsal spine, three had had spondylitis tuberculosa, one had undergone thoracoplasty, one had Bechterew's disease and one had had a fracture of the twelfth thoracic vertebra. Two of the three with spondylitis tuberculosa had been symptom-free for many years, while one with a definite gibbus had slight insufficiency symptoms.

On the whole it may be said that symptoms localized to the dorsal spine were benign, only occasionally causing the patient to seek medical advice and rarely leading to incapacity for work. Altogether 4.7 per cent of the material reported such symptoms, i. e. 3.6 per cent of those in heavy occupations and 5.9 per cent in light. The difference in incidence in the two occupational groups was too small to be significant. The incidence of such symptoms was approximately the same in the Munkfors material (4.3 per cent). *It is clear that the incidence of subjective symptoms localized to the dorsal spine was considerably lower than that of stiff neck – brachialgia or lumbago – sciatica.*

2. Tenderness to pressure on the spinous processes.

Distinct tenderness to pressure on one or occasionally several spinous processes in the dorsal spine was demonstrated in 12 of the subjects with active or latent symptoms. The tenderness was consistently localized to the same segment as the symptoms, supporting the contention that these were caused by changes within the spine. None of the three who had had spondylitis tuberculosa exhibited demonstrable tenderness, but in all three cases the lesions were healed, with roentgenologically visualized adequate bone repair.

In an additional six cases, where no symptoms from the dorsal spine were reported, tenderness to pressure on the spinous processes in the upper half of the dorsal spine was demonstrated. All these patients had a history of brachialgia (deep pain). Of the 18 who exhibited tenderness to pressure in the dorsal spine, 14 or 78 per cent had a history of brachialgia. A similar correlation between tenderness to pressure in the upper part of the dorsal spine and brachialgia was demonstrated in the Munkfors material, indicating that pain of brachialgia type may possibly originate in the upper dorsal spine as well as in the cervical spine. This agrees closely with observations of the correlation between deep pain of brachialgia and the sympathetic nervous system (see page 15), since the sympathetic innervation of the arm arises largely from the upper dorsal segments.

3. Kyphosis.

Clinical observation revealed kyphosis in 12.9 per cent of the material (see page 54). In the great majority this deformity was a long curving kyphosis of Scheuermann type. The incidence was about the same in the Munkfors material (14 per cent). The incidence there was clearly higher in the forest workers, leading to the assumption that it might be correlated with the performance of heavy work at or before 15 years of age. The present material did not permit similar conclusions since the incidence was about the same in the heavy and light-work groups.

The symptoms that might be ascribed to kyphosis are of greater interest. In the Munkfors material no obvious symptoms could be shown in those with kyphosis, and in the present investigation it has been shown that low back trouble was no more common in the kyphosis group than in the material as a whole (page 55). With respect to the dorsal spine, 10 of the 146 classified as kyphotic reported some periodic insufficiency symptoms. Three others had a history of pain radiation resembling that in intercostal neuralgia as well. This indicates that such symptoms would seem somewhat more common in the kyphotic, but

Table 39. Incidence of roentgen signs of disk degeneration in the dorsal spine.

	Percentage with disk degeneration		
	Entire material	Cases with symptoms from the dorsal spine	Cases with kyphosis
Light work	55.2 % ± 2.3	68.3 % ± 8.8	76.4 % ± 5.4
Heavy work	71.4 % ± 1.8	89.3 % ± 6.4	85.6 % ± 3.9
Total	64.7 % ± 1.4	76.1 % ± 5.9	80.6 % ± 3.3

the mild character of the trouble is worthy of note. These workers' symptoms did not seem to have influenced their choice of occupation, however, and did not appear to affect their working capacity to a noteworthy extent. *Thus, there is no reason to assume that kyphosis as represented by the present material, i.e. particularly curvature of Scheuermann type, gives rise to symptoms of such severity that the working capacity is affected in either light or heavy occupations.*

Roentgenologically demonstrable disk degeneration (osteophytes) in the dorsal spine was clearly more common in the kyphotic than in the material as a whole (Table 39). It is impossible to say whether or not this may be ascribed to an increased mechanical strain resulting from the increased curvature of the spine or should be considered secondary to the so-called Scheuermann changes frequently underlying the kyphosis. Presumably, both factors are significant.

4. Roentgen signs of disk degeneration.

One frontal and one lateral roentgenogram of the dorsal spine were taken. Osteophytes on the vertebral margins with or without narrowing of the intervertebral space were considered signs of disk degeneration. Evaluation of the latter sign is difficult considering the normally thin disks in the dorsal spine. Therefore, it could be used as criterion in a few cases only.

The incidence of roentgen signs of disk degeneration is presented in figure 29. As may be seen, it was of the same order as the incidence in the cervical and lumbar spine (figures 6 and 24) and shows the same correlation with the age factor. The only difference is that the incidence was somewhat higher in the dorsal spine in the younger age groups, indicating that disk degeneration, or at least spondylosis, starts earlier in the dorsal spine.

Those engaged in heavy work showed a somewhat higher incidence throughout. It is evident from table 39 that the difference between the

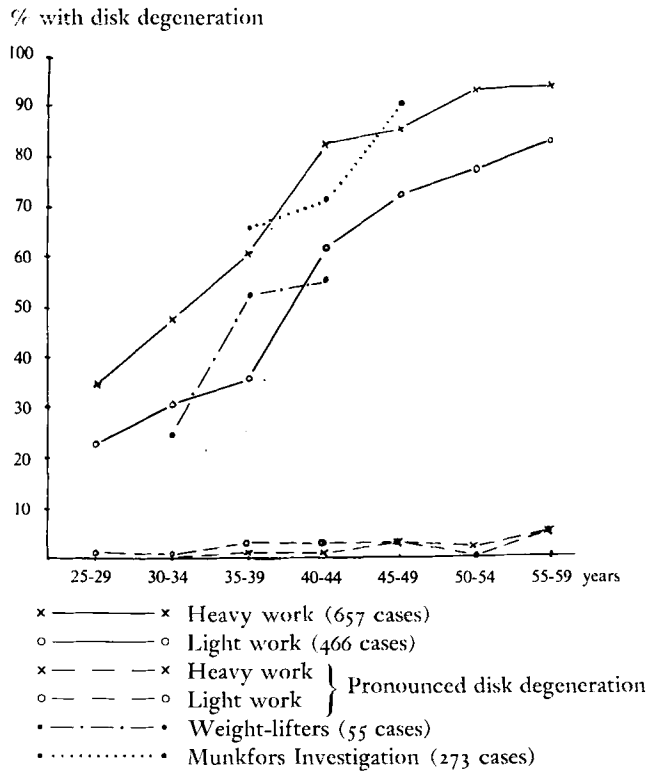

Fig. 29. Incidence of roentgen signs of disk degeneration in the dorsal spine in the different age groups.

incidence in the two occupational groups was significant. The particular strains associated with the heavy occupations would thus seem to lead to a somewhat earlier appearance and somewhat higher incidence of osteophytes in the dorsal spine. The same condition was demonstrated earlier in the cervical and lumbar spine. The weight-lifters did not exhibit an especially high incidence, but the incidence in the Munkfors material agreed with that in the heavy-work group of the present material.

Those who reported subjective symptoms from the dorsal spine possibly showed a somewhat higher incidence of disk degeneration, but there were too few cases to permit demonstration of a significant difference. It is more interesting that, despite the fact that the incidence of roentgen signs of disk degeneration was approximately equal to that in the cervical and lumbar spine, the incidence of symptoms that could be attributed to the dorsal spine was appreciably lower. The roentgenologically demonstrable osteophytes are signs of disk degeneration, but

it is obvious that they give an incomplete picture of the degenerative changes assumed to cause symptoms, i. e. radial rupture and disk herniation directed posteriorly or posterolaterally. Actually, the low incidence of symptoms from the dorsal spine supports this hypothesis of the origin of the symptoms. The patho-anatomic prerequisites for the origin of such radial ruptures and disk herniation as are assumed to cause symptoms are less pronounced in the dorsal spine, due in part to the slight flexibility of this part of the spine in comparison with the cervical and lumbar spine and in part to the fact that radial rupture and disk herniation show a predilection for development towards the concave side of a spinal curvature. That is to say, in the normally kyphotic dorsal spine they develop preferably ventrad where there is probably little painsensible tissue, while in the lordotic cervical and lumbar segments of the spine the development is preferably dorsad and dorsolaterad towards the nerve roots and pain-sensible tissue about the spinal canal.

VI. Back trouble in an insurance material

Data were obtained from The Industrial Injuries Insurance Office (I. I. I. O.) for 1949 and from The Folksam Insurance Company (FIC) for 1952. The I. I. I. O. material comprises cases of back trouble accepted as sequelae of accidents and classified under the diagnoses: lumbago, lumbago-sciatica, dorsal distention or distortion et cetera. The Folksam Insurance Company has developed a special form of insurance covering types of back trouble not accepted as sequelae of accidents. Their data together with those from the Insurance Office therefore give a conception of the total incidence of back trouble that causes incapacity for work. The data are collocated in table 40, showing that the two institutions together reported 2.93 cases of back trouble per 100 man-years. The mean number of days of temporary incapacity per case was somewhat more than 30 (I. I. I. O.: 24.1 and FIC: 38.7). On the basis of these data it can be calculated that the temporary incapacity was almost one day per man-year. According to the 1945 census Sweden had 2.24 million men able to work. *Thus, it may be calculated that almost two million working days for men are lost yearly because of back trouble.*

A striking observation is the high incidence in workers engaged in ore mining (9.75 cases per 100 man-years), and the low incidence in the commerce and storage groups (1.06). Seen in the light of the present investigation it would seem that this might be ascribed largely to the fact that because of the character of the work the miners are unable to carry out their work even with slight to moderate back trouble, while the office workers can frequently work even with comparatively severe symptoms. The appreciably greater socio-economic importance of back trouble in the men engaged in heavy occupations becomes especially apparent here, however. The incidence was surprisingly low in the group comprising agriculture and forestry. In the I. I. I. O. data this group had been broken down into two: agriculture with 0.37 cases, and forestry with 1.17 cases of back trouble due to accidents per 100

Table 40. Back trouble in insurance material.

	Industrial Injuries Insurance Office			Folksam Insurance Company			Total cases per 100 man-years
	Man-years	Cases per 100 man-years	Mean temporary incapacity in days	Man-years	Cases per 100 man-years	Mean temporary incapacity in days	
Ore mining etc.	2223	4.72	25.5	4308	5.03	36.3	9.75
Basic metal industries	7368	2.17	19.8	3420	3.30	31.4	5.47
Manufacture of metal products	103098	0.99	21.7	39694	3.40	34.5	4.39
Stone, clay, sand, coal and peat industry	20238	0.87	20.4	2810	4.80	39.5	5.67
Agriculture and forestry	29365	0.82	25.1	50897	1.56	38.9	2.38
Wood working industry	33505	0.72	21.2	1718	2.73	38.4	3.45
Paper and printing industry	21294	0.67	22.1	8358	2.48	43.2	3.15
Food, beverage and tobacco manufacture	19494	0.98	23.8	38571	2.50	38.3	3.48
Manufacture of textiles	10771	0.31	27.3	9875	3.48	42.2	3.79
Leather, rubber and fur industry	12522	0.55	20.6	3909	3.63	38.1	4.18
Manufacture of chemical products	10536	1.44	24.9	3328	1.74	48.5	3.18
Construction	74444	1.41	27.1	47562	1.36	39.7	2.77
Public utilities	13405	0.79	25.5	1224	3.10	31.8	3.89
Communication and transport	23121	1.16	24.5	3090	4.53	43.0	5.69
Commerce and storage	112482	0.21	27.8	84442	0.85	43.3	1.06
Total	493866	0.98	24.1	303206	1.95	38.7	2.93

man-years. Considered in relation to the high incidence in the forest workers in the Munkfors investigation, however, the latter figure is also low. This may possibly be attributed to low average age of the forest workers in the insurance material. This assumption is supported by data on the age distribution among forest workers obtained in the 1945 census.

Inasmuch as the detailed composition of the groups given in the insurance material is not known, caution should probably be observed in drawing any comprehensive conclusions from the figures in the table.

Table 41. Number of cases of back trouble accepted as accident sequelae in different age groups (I. I. I. O. 1949).

Age groups	< 20 yr.	20–29 yr.	30–39 yr.	40–49 yr.	50–59 yr.	60–∞ yr.	Total
Estimated thousands of man-years	47	129	138	116	95	54	579
Number of cases of back trouble	159	1047	1480	1110	479	180	4455
Mean temporary incapacity in days ...	14.7	20.2	25.6	28.5	28.5	30.7	25.2
Percentage with back trouble	0.33 %	0.81 %	1.07 %	0.96 %	0.50 %	0.33 %	0.77 %

I. I. I. O. data also includes the number of cases of back trouble due to accidents in different age groups (Table 41). The age distribution in the 579,527 man-years included in the material is not given, on the other hand. It has been estimated approximately on the basis of data from the 1945 census. It may be seen that the mean temporary incapacity increases with age. Further, it is evident that types of back trouble accepted as accident sequelae and causing incapacity for work occurred with the greatest frequency in the age groups between 20 and 49 years, and that there was a marked decrease in frequency after 50 years of age.

VII. Discussion

From the socio-economic point of view an important question is the extent to which heavy work and mechanical strains contribute to the origin of back trouble and so-called muscular rheumatic symptoms. Also of importance is the choice of a basis for the evaluation of these conditions from the point of view of insurance benefits. Inasmuch as resolution of these problems has been one of the principal aims of the present investigation, the conclusions that may be drawn from earlier experience and the present investigation will be briefly reviewed here.

1. The spinal syndromes.

Data reported by the subjects comprising the present material have shown that the so-called muscular rheumatic symptoms may be classified under three main headings: 1) symptoms from the neck and shoulders with or without radiation to the arms (stiff neck – brachialgia syndrome), 2) symptoms from the region of the dorsal spine with or without radiation along the ribs or out into the flanks (dorsal spine syndrome) and 3) low back trouble with or without radiation to the legs (lumbar insufficiency – lumbago – sciatica syndrome).

The investigation has demonstrated that symptoms from the dorsal spine are relatively uncommon (5 per cent of the material), and that they are usually benign, leading only exceptionally to medical care and incapacity for work. The stiff neck – brachialgia symptoms are considerably more common (51 per cent of the material) and had caused incapacity for work in 5.4 per cent. The most common is low back trouble, having occurred in 60 per cent of the material with 36 per cent incapacitated for work for periods of varying duration.

A comparison between those engaged in light and heavy work shows that symptoms from the dorsal spine and of the stiff neck – brachialgia type occur with approximately the same frequency in both occupational groups. More of those doing heavy work had been incapacitated,

however, as a result of brachialgia (7.5 per cent as opposed to 2.3 per cent of the light-work group). Low back trouble is common in both occupational groups, but the incidence is definitely somewhat higher in the heavy-work group (64.4 per cent opposed to 52.7 per cent). The difference between the two groups is more marked if the incapacity for work resulting from low back trouble is examined; i. e. 43.5 per cent of the heavy-work group and 25.5 per cent of the light-work group had been incapacitated.

The fact that symptoms from the dorsal spine and of the stiff neck – brachialgia type occurred with about the same frequency in the light and heavy-occupation groups and that only a moderate difference in frequency with respect to low back trouble exists indicates that the heavy work itself is not a fundamental factor in the origin of the changes causing spinal symptoms. The higher incidence of back trouble does indicate, however, that certain strains in the heavy work contribute to the provocation of symptoms. This is particularly evident in the insurance material (Table 40), where the workers engaged in ore mining are shown to be incapacitated due to back trouble considerably more often than other workers. Even if the difference in the frequency with which back trouble occurs in those engaged in light as opposed to heavy occupations is comparatively moderate, it is clearly evident that the socio-economic significance in the form of lost working days is appreciably greater in the heavy-occupation group.

2. The pathogenesis of the spinal syndromes.

The stiff neck – brachialgia and lumbago – sciatica syndromes present such great similarities in fundamental aspects that it seems probable that the pathogenesis is similar. Although admittedly many conditions may give rise to these symptoms (spondylitis, tumors, kidney diseases and others), earlier clinical and patho-anatomic studies and observations in the present investigation provide a basis for the assumption that certain types of degenerative changes in the intervertebral disks are usually the basic cause of these symptoms.

Both this and earlier investigations have demonstrated that disk degeneration eventually appears in all persons regardless of their occupation. Therefore, it must be regarded as a physiologic sign of aging to a certain extent. The biochemical processes leading to disk degeneration are as yet incompletely understood. Moreover, it is unknown if metabolic disturbances, hormonal influence or mechanical factors play the greatest role.

Roentgen signs of disk degeneration were observed in the present

investigation with definitely higher frequency in all parts of the spine in those engaged in heavy occupations. The sign serving as criterion in this investigation was primarily the presence of osteophytes on the margins of the vertebrae, i. e. spondylosis. If spondylosis caused pain symptoms, a higher incidence of symptoms should be observed from the cervical, dorsal and lumbar spine in the heavy-work group. Such was not the case, however. Therefore, the spondylosis is probably not an essential factor in the origin of the symptoms. Earlier clinical experience also confirms this assumption. The spondylosis probably results from two coactive factors, i. e. disk degeneration and mechanical strain on the spine (Beneke, 1897). Under such conditions it is natural that those engaged in heavy work, who are undeniably exposed to greater mechanical strains, should have a higher incidence of spondylosis.

The changes in the disks that are considered essential to the occurrence of symptoms are radial ruptures directed posteriorly and posterolaterally towards nerve roots and pain-sensible tissue about the spinal canal. As long as the degenerative lesions remain within the disks themselves, it is probable that the prerequisites for pain symptoms are lacking inasmuch as the disks have neither nerves nor vessels. It is not until a radial rupture extends out to or protrudes through the posterior surface of the disk that conditions are present for the origin of pain and aching. Symptoms may then arise gradually through the encroachment of the inflammatory irritation (edema, hemorrhage, et cetera) caused by the rupture upon adjacent pain-sensible tissues. It is probable that this "ulcer" at the posterior surface of the disk is the reflex cause of both restriction of movement and muscular spasm, and that it also gives rise to local tenderness observed in attempts to displace a vertebra or a disk (e. g. tenderness to pressure on spinous processes). The severity of the aching or pain experienced depends upon the range and localization of the inflammatory irritation and upon the patient's sympathetic tonus and threshold of pain. The sympathetic tonus and the threshold of pain may be influenced by numerous factors such as exposure to cold draughts, psychologic factors and infectious diseases. Sudden, severe sciatica may arise from the herniation of a bit of the disk, freed by the degeneration, out through the rupture, where it becomes compressed against a nerve root. An acute lumbago probably arises through a corresponding compression against pain-sensible tissue at the posterior surface of the disk.

Radial rupture of the aforementioned type may occasionally occur in the disks before 15 years of age, but is most common from 25 to 50 years (Hirsch and Schajowicz, 1952), i. e. in the ages when lumbago and sciatica occur with the greatest frequency. Through ingrowing

granulation tissue and connective tissue the radial rupture may gradually heal, becoming a firm, fibrous cicatrix. New radial ruptures may occur and, as the disk degeneration progresses, more or less extensive portions of the disk are transformed into a fibrous, cicatricial tissue that has lost its elasticity and where the conditions prerequisite to the aforementioned pain-provoking lesions are slight. It is probably for this reason that lumbago and sciatica attacks are less common after the age of 50 years. The back trouble occurring then more closely resembles chronic insufficiency and is of the same type as chronic arthrosis in other joints.

Viewed against the background of the aforementioned observations and hypotheses it becomes evident that it is largely a matter of chance whether or not symptoms appear from disk degeneration. In the lower cervical and lower lumbar spine the patho-anatomic possibilities for the occurrence of radial ruptures directed posteriorly and posterolaterally are especially great, which may be assumed to explain the high incidence of symptoms from these regions in comparison with other parts of the spine.

Osteophytes on the margins of the vertebrae (spondylosis) and narrowing of the intervertebral space, which are taken in conventional roentgenograms as criteria of the existence of disk degeneration, do not necessarily indicate the presence of such changes in the disk as cause symptoms. These latter changes, which are not visualized in conventional roentgenograms, develop, as a rule, several years before spondylosis and decreased disk height can be observed, and they may be more or less "healed" by the time severe spondylosis or narrowing of the intervertebral space is shown. Spondylosis and narrowing of the intervertebral space probably indicate the presence of a lowered resistance in the spine against strains of various types, but does not necessarily mean that subjective symptoms will exist in the individual case. Accordingly, in the present material it was shown particularly in the higher age groups that a large proportion of those with no history of back trouble had roentgenologically demonstrable spondylosis and narrowing of the intervertebral space. Thus, the value of conventional roentgenograms in assessing the correlation between existing back trouble and disk degeneration in the individual case is limited. Such roentgenograms are frequently necessary, however, to preclude the possible presence of specific changes of other types which may at times cause back trouble (spondylitis, tumor, spondylarthritis ankylopoetica, et cetera).

3. The significance of heavy work and mechanical strain.

With our present knowledge we regard the spinal syndromes to a great degree as diseases without actual causal relation to the performance of heavy work and as arising more often without demonstrable external cause such as an accident or extraordinary strain. The unequivocally higher incidence of back trouble in those engaged in heavy occupations may probably be attributed primarily to the following factors.

Patho-anatomic changes in the spine that predispose to the occurrence of spinal symptoms are undoubtedly common in all persons regardless of occupation. These changes probably cause lowered resistance to strains of various types. Under such conditions it is natural that persons engaged in heavy and "back-straining" work more frequently develop such symptoms than those performing physically light tasks. An analogous relationship is found in the patient with a weak heart and a predisposition to cardiac insufficiency. At rest or during slight physical exertion he experiences little or no distress from his weak heart, but under greater strain, which demands an increased heart function, the insufficiency symptoms immediately appear.

Especially significant to the higher incidence in the heavy occupations are the so-called accident factors, particularly stumbling and loss of balance, and heavy lifting in postures involving strain. In 25 to 40 per cent of the cases of lumbago or sciatica such factors existed as the immediate cause, leading to the assumption that the symptoms would not have appeared – or at least not at that particular time – had the patient not been subjected to such a strain. We know that a great force is necessary – great enough to cause vertebral fracture, as a rule – to injure a normal disk. It is therefore improbable that the aforementioned disk changes (radial rupture, inflammatory reaction, disk herniation), which are considered to be the most common causes of back trouble, could arise as a result of the relatively moderate force exerted by the aforementioned stumbling or loss of balance, et cetera. However, if such changes already exist or are under the process of development, it is probable that a more or less severe strain, such as that involved in stumbling or heavy lifting, could influence them or possibly cause an exacerbation with the resultant appearance of pain symptoms. It is conceivable that the healing powers in the body would have "cleared up the condition" in some cases if this sudden strain had not interferred with the course of nature; in others the exacerbation due to the accident factor is so negligible that the symptoms would have developed anyway. Which course applies in the individual case

can never be definitely determined. The law of probability must always enter into the determination of whether or not such strains shall be regarded as causative.

4. The principles underlying the benefits provided under the Industrial Injuries Insurance Act.

In determining whether or not compensation shall be paid under the provisions of the Industrial Injuries Insurance Act, the severity of the accident factor in the reported strain is primarily decisive. It is improbable that anyone would contend that a sneeze, which not infrequently provokes an acute lumbago or sciatica attack, is acceptable as a causative accident factor. On the other hand, however, there is probably no one who would deny that back trouble arising immediately after a fall from a height of several meters should be accepted as an accident sequel. The magnitude of the force involved is sometimes extremely difficult to estimate. For example, we know that the intense straining of the back muscles caused by a sudden defensive movement may on rare occasions exert such force that a vertebral fracture results (cf. vertebral fracture in electric shock treatment). The accident factor and the appearance of the symptoms in connection therewith must be carefully assessed in each individual case, and an attempt must be made to establish the degree of strain a back ought to be expected to tolerate. The estimation is exceedingly difficult in many cases, not being facilitated by the fact that the data are often incomplete and the report of the "accident" frequently more or less subconsciously colored by the subject. The information given at the first medical examination is important in the evaluation; later alterations and corrections always arouse suspicion of opportuneness. Data on earlier back trouble and changes visualized in conventional roentgenograms provide a more complete picture of the situation and may thereby facilitate the decision, but especially the latter are usually of limited value in the determination of whether or not the current symptoms are related to the reported accident. It is necessary in each individual case to decide if a true correlation exists, if only an exacerbation has resulted, or if the exacerbation due to the reported causative factor shall be considered so negligible that no correlation is acceptable. On the whole the following principles may be proposed:

1) *Qualified accidents* (falling from a height, severe blows causing grave contusions, et cetera): Such cases are in the minority in back trouble. The symptoms that arise in connection with such traumas must

always be regarded as accident sequelae. Even if clinical and roentgen examinations fail to demonstrate positively that the trauma caused patho-anatomic grounds for the symptoms, the possibility of resultant internal injuries to soft tissues cannot be precluded as the source of the symptoms. If degenerative changes in the spine of the type predisposing to such symptoms were present before the accident, the exacerbation caused by the trauma must nevertheless be regarded as sufficiently significant evidence of true correlation. Compensation should therefore be awarded until such time as the patient is able to return to his former work or to another suitable occupation. Disability benefits may be paid if the symptoms persisting after the injury benefit period are of a character to justify continued compensation.

2) *Moderate accidents* (stumbling with or without concurrent heavy lifting, excessive unexpected strains, et cetera): The majority of the cases of back trouble that come up for evaluation fall into this category. The character of the reported trauma here is such that the tissue damage that may conceivably occur should cause only transient symptoms. As a rule, the symptoms that occur are predominantly ascribable to degenerative changes already existing in the spine before the accident. And the slighter the trauma involved is, the greater the proportionate effect of these changes becomes in the origin of the symptoms. Therefore, it is customary in these cases to speak of a so-called exacerbation correlation, which means in point of principle that benefits can be awarded for a limited period only. If the injured person is able to return to his former work within a reasonable period, benefits should be paid during that period; if not, benefits should be continued until such time as work can be arranged of a type that the injured person is able to perform despite his residual back trouble. If the exacerbation correlation is adjudged slight, the benefits may sometimes be stopped even if such work cannot be arranged. The injured person should be informed in advance in this case to give him an opportunity to arrange his affairs himself. Retroactive withdrawal of compensation should be avoided if possible, since it involves complications for all parties. In cases of exacerbation correlation, back trouble persisting after the injury benefit period is not usually accepted as justifying payment of permanent disability benefits.

3) *Heavy strains unavoidable in the work which involve increased risks of back trouble without an added accident factor:* Under the Industrial Injuries Insurance Act in its present form compensation is not awarded for back trouble caused by such factors, as a rule. In principle

these strains involve the same exacerbation correlation from the medical point of view as the aforementioned stumbling accidents, and it is probably of minor importance here whether or not the individual is accustomed or unaccustomed to such strains. It would therefore be reasonable if compensation were to be awarded in these cases also. Such a change in the law, however, would further complicate an already difficult problem of evaluation. In Sweden the problem of awarding benefits in back trouble will be solved by the pending enactment of the General Health Insurance Act, thus making such a change unnecessary. When this reform has been carried out, the Industrial Injuries Insurance need cover only back trouble caused by qualified accidents.

We are unable with our present medical knowledge to prevent the occurence of disk degeneration and the resultant changes that are considered the most common causes of back trouble. We must accept the fact that many persons have such changes and consequently have such weak backs that certain types of heavy work involve considerable risks that the back trouble will be intensified to such an extent that the individual becomes incapacitated for such work for a shorter or longer period or perhaps even for the rest of his life. As long as such work must be carried out, it is only reasonable that those who are forced to perform it should be protected against the risks involved. The General Health Insurance Act to be enacted in Sweden in 1955 will provide a suitable form of compensation for short periods of incapacity for work. In the case of more prolonged incapacity due to back trouble it is important to understand that this incapacity is relative and greatly dependent upon the character of the work. A forestry or mining worker with such severe back trouble that he cannot continue his heavy work is often quite able to perform somewhat lighter work. In the opinion of the writer the most important practical goal at the present time is the development of better opportunities for obtaining a suitable occupation when an individual cannot return to his former heavy work because of back trouble. Those with back trouble will then cease to be dependent upon any form of compensation, becoming instead productive members of the community, able to support themselves and their families through their own efforts.

VIII. Summary

The purpose of this investigation has been to complement earlier knowledge of various aspects, including incidence and pathogenesis, of the different types of low back trouble and other spinal symptoms, through investigation of a normal material of working men. Altogether 1193 male workers aged between 25 and 59 years in different occupational groups have been investigated. For the specific purpose of determining the significance of heavy physical work in the origin of these conditions a comparison has been made between the groups engaged in such occupations and those performing light work. The investigation has also been complemented with data on the incidence of back trouble in an insurance material.

While true rheumatoid arthritis and symptoms of arthrosis from the joints of the extremities proved to be comparatively uncommon (3.5 per cent) in the material, so-called muscular rheumatic symptoms occurred with high frequency. Careful evaluation of the information given by the workers concerning their subjective symptoms showed that, on the whole, these symptoms could be classified as belonging to one of three syndromes, two common – the stiff neck – brachialgia syndrome and the lumbar insufficiency – lumbago – sciatica syndrome, – and one less common – the dorsal spine syndrome.

The stiff neck – brachialgia syndrome, with its heretofore little noted, many-sided symptom picture, is described on the basis of the data reported by the workers. Particular attention is called to *pseudo-angina pectoris*, which is frequently misinterpreted as true heart trouble, and to *headache*, *humero-scapular periarthritis* and *epicondylitis* as symptoms belonging to the syndrome. A history of stiff neck or brachialgia occurred in 51 per cent, and of brachialgia alone in 23 per cent. The incidence was about the same in those doing light and heavy work. The symptoms were frequently benign, and only 5.4 per cent of the entire material had been incapacitated for work as a result of such symptoms.

The dorsal spine syndrome comprised symptoms from the region of the dorsal spine with or without pain radiation along the ribs or into the flanks. The symptoms were comparatively vague and transient in some cases, but in most their character led to the assumption that they were caused by changes within the dorsal spinal column. There was a history of this syndrome in only 5 per cent of the material. The symptoms were mild, as a rule, and caused brief incapacity for work in isolated cases only.

The lumbar spine syndrome is described as comprising insufficiency symptoms, lumbago and sciatica. There was a history of such symptoms in 60 per cent of the material. The incidence was high in all occupational groups, but was definitely higher in those engaged in heavy work (64.4 per cent) than in those in light occupations (52.7 per cent). The symptoms usually appeared at or before 30 years of age. Incapacity for work because of back trouble on one or more occasions was reported by 36 per cent of the entire material; 20 per cent having had > 3 weeks aggregate incapacity and 4 per cent > 6 months. Such incapacity was clearly more common in those doing heavy work, (43.5 per cent) than in those engaged in light occupations (25.5 per cent), demonstrating that the socio-economic importance manifested in lost working days was appreciably greater in the heavy occupations.

In a maximum of 20 per cent of those with a history of lumbago or sciatica the symptoms were provoked by an accident; in an additional 15 to 20 per cent they appeared in connection with heavy lifting or a similar strain. This means that in 60 to 65 per cent of those who had had lumbago or sciatica attacks the symptoms had appeared without such external causative factors.

On the basis of data from the Industrial Injuries Insurance Office and The Folksam Insurance Company it is possible to estimate that in Sweden approximately two million working days yearly are lost by men because of back trouble. The insurance data also show that workers engaged in ore mining are incapacitated for work because of back trouble with appreciably greater frequency than workers in other occupations.

Static deformities such as *differences in leg length, kyphosis, lordosis* and *scoliosis* had no demonstrable significance in the origin of low back trouble in the present material. With a few exceptions, the deformities that occurred were not sufficiently grave to be classified as crippling. Of 146 persons denoted as kyphotic, 13 reported slight occasional symptoms from the dorsal spine. These were not, however, as a rule, of sufficient severity to affect their choice of work or working capacity. Nor did persons with roentgenologically demonstrable *lumbarization*

or *sacralisation* and *asymmetric fifth lumbar vertebrae* exhibit an increased tendency to low back trouble. The cases of *spondylisthesis*, on the other hand, showed a higher incidence of both back trouble and roentgenologically demonstrable disk degeneration.

Low back trouble showed no correlation with the *body type* determined according to Rohrer's index, nor with *flatfoot, foot fatigue, gastric or duodenal ulcer, varicose veins or hernia.*

In view of the high incidence of spinal symptoms in all occupational groups and the moderate difference between light and heavy occupations the conclusion may be drawn that *heavy work cannot be a fundamental cause of the changes causing these symptoms.* The significance of heavy work, mechanical strains and accidents as causative factors is discussed in chapter VII. In connection with this discussion a brief summary is given of the principles followed in the awarding of benefits in such cases under the Industrial Injuries Insurance Act.

A close resemblance was observed between essential aspects of the stiff neck – brachialgia syndrome and the lumbago – sciatica syndrome; i. e. the analogy between stiff neck and lumbago and between brachialgia and sciatica, the association of the symptoms' occurrence with the two lordotic and most flexible parts of the spine, the age at onset and the intermittent occurrence of the symptoms, the high frequency with which both syndromes occur, et cetera. These similarities indicate a similar pathogenesis.

The objective clinical symptoms (restriction of movement, muscle spasm, tenderness to pressure on the spinous processes, evocable pain and neurologic signs) especially as observed in patients with subjective symptoms at examination, indicate that *changes in the cervical, dorsal and lumbar spine respectively are the most common cause of the three syndromes described. Muscle spasm in the lumbar spine* was more common in cases where there was a history of back trouble, but even pronounced muscular spasm occurred in some cases where there had never been such symptoms. Thus, the conclusion may be drawn that muscular spasm cannot, as a rule, be a primary cause of back trouble. In analogy with restriction of movement, it should probably be regarded as a sign that is secondary to changes in the spine giving rise to spinal symptoms.

Roentgenologic signs of disk degeneration (osteophytes and narrowing of the intervertebral space) occurred with approximately the same frequency in the cervical, dorsal and lumbar spine. The incidence increased markedly with rising age, with about 90 per cent of those in the age group between 55 to 59 years having signs of disk degeneration in the cervical and dorsal as well as lumbar spine. *Disk degeneration*

should therefore be interpreted as a more or less physiologic process, which begins early in some but eventually develops in all regardless of occupation. The incidence was higher throughout in those engaged in heavy work, indicating that osteophytes appear earlier and are more pronounced in that group than in those in light occupations.

To a certain extent it was possible to demonstrate a relation between the stiff neck – brachialgia syndrome and disk degeneration in the cervical spine and between the lumbago – sciatica syndrome and disk degeneration in the lumbar spine. The relation was not complete, however. Several cases, particularly in the younger age groups, with stiff neck-brachialgia or lumbago – sciatica symptoms exhibited no disk degeneration demonstrable in conventional roentgenograms. Moreover, in many cases with demonstrable disk degeneration, especially in the higher age groups, there was no history of such subjective symptoms. *Thus, disk degeneration may develop and even attain advanced stages without ever having given rise to pain symptoms.*

The changes in the disks that are considered to be of primary significance in the occurrence of spinal symptoms are radial ruptures directed posteriorly or posterolaterally (page 72). These changes are not visualized in conventional roentgenograms, and start to develop several years before signs of disk degeneration can be demonstrated with conventional roentgen technique. This presumably explains the incomplete agreement in the present material between the incidence of roentgen signs of disk degeneration and subjective spinal symptoms. An interesting confirmation of the significance of the posteriorly directed radial ruptures is to be found in the low incidence of pain symptoms from the dorsal spine, i. e. the conditions are much less favorable to the occurrence of these posteriorly directed radial ruptures in the dorsal spine than they are in the lower cervical and lower lumbar spine (page 72).

Accordingly, on many fundamental points the results of the investigation support the hypothesis that the conditions described by the layman as back trouble and muscular rheumatism are most frequently caused by changes within the spinal column that are secondary to disk degeneration.

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