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Effect of work on degenerative back disease

A review

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The low-back pain syndromes related to degenerative changes in the lumbar spine form an as yet not clearly defined, but already discernable, part of back diseases. In this paper the term "degenerative back disease" will be used — more for its convenience than for its clarity — to denote disorders, syndromes, diseases, and other comparable entities known to be associated with lumbar degeneration.

The sociomedical importance of degenerative back disease is apparent in most statistics on morbidity, lost workdays, and premature retirement. It has been calculated that three quarters of the world's population will have suffered from low-back pain at some time in their working lives. Absence from work due to back trouble constitutes a considerable part of all sickness absenteeism and varies significantly from occupation to occupation.

In many industrialized countries the morbidity statistics on diseases manifested by low-back pain show a rising trend. In Great Britain, for instance, the incidence of low-back trouble rose by 22 %

and the duration of the spells by 30 % during the six-year period between 1961 and 1967 (71). This rise may be due to the advance of mechanization and automation in work, as well as in transporting and traveling, resulting in static postures which cause general muscular fatigue and weakness (7). The increased incidence of notified low-back pain may also reflect the improvements in social security for the sick and disabled.

Degenerative back disease may be caused by both hereditary and environmental factors. The aim of this review is to evaluate present knowledge of environmental causes, especially the occupational factors.

THE DEGENERATIVE PROCESS

The clear association between increasing age and progressive degeneration of the spinal structures has generally led to the acceptance of age as such as being synonymous with degenerative spinal changes, even though views have been presented arguing that intervertebral disc degeneration may not be an inevitable accompaniment to ageing (63).

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The degenerative process of the lumbar spine has been intensively studied all through this century, and several thorough reviews have been compiled on the subject (65, 67).

The degeneration of intervertebral discs starts as early as the second decade of life through progressive scarring of the blood vessels to the discs, which gradually leads to total disappearance of circulation (15). Disc nutrition now takes place by diffusion through the annulus fibrosus and the cartilaginous vertebral end plates (6, 50). Partly because of this inefficient means of nutrition, the disc is considered to be without real regenerative capacity. As a person ages, biochemical changes take place in the disc. The water and total sulfate ester contents fall, while the glycoproteins and noncollagenous proteins increase, and fibrillation and precipitation of the collagen increases (35, 57).

As the disc height diminishes and the vertebral bodies approximate, the apophyseal joints and their capsular ligaments have to adapt, and secondary degenerative changes may arise in them. Hypertrophic spurs develop on the edges of the vertebrae (65). As shown in fig. 1, radiologically detectable disc degeneration starts earlier in males than in females (41). But it may not progress as an isolated phenomenon after the fifth decade, whereas other signs of degenerative joint disease (osteoarthritis) in the spine tend to increase with age (9). In autopsy studies spondylotic changes have been found in the dorsal or the lumbar spine in 80 % of the males at the age of 49 years and in 60 % of the females of corresponding age (65). By the age of 80 years osteophytes were found in all cadavers (fig. 1).

SYMPTOMS AND SIGNS OF LUMBAR DEGENERATION

The ageing process in the intervertebral discs need not contribute to morbidity and pain if spinal function is otherwise adequate (8). However, the degenerative process in the spine often manifests itself through pain and disability during the later phases of the morphological change; even then the appearance of symptoms seems to be quite arbitrary.

Fig. 1. Thoracic or lumbar spondylosis at autopsy and lumbar disc degeneration at clinical radiological examination in males and females by age. (■ = thoracic or lumbar spondylosis at autopsy, males; ● = thoracic or lumbar spondylosis at autopsy, females; □ = radiologically detectable lumbar disc degeneration, males; ○ = radiologically detectable lumbar disc degeneration, females) (Reproduced with the permission of Georg Thieme Verlag, Stuttgart, 1971, and Blackwell Scientific Publications, Oxford, 1963.)

The symptoms derived from lumbar degeneration are diverse: stiffness, ache, sharp and radiating pain. The concepts "low-back pain syndrome" (8) and "low-back pain" (48) have been found useful to cover these various symptoms. They often appear before the degenerative changes are radiologically detectable.

A strong association between back-hip sciatic pain and moderate or severe disc degeneration of the lumbar spine has been shown by Lawrence (39). Gordon (20) states that back pain may often be due to diverse disturbances seated in several spinal structures ultimately related to the intervertebral disc. After a period of recurrent low-back pain 70 to 80 % of the syndromes have been diagnosed as discogenic (63).

Lumbar insufficiency, lumbago, and sciatica have been found to be more common in males than in females of the same age (21). In younger age groups the prevalence of disc disease was found to be clearly higher in males than in females, but between 35 and 54 years of age the difference was small (59). Treatment for disc disorder was the most common in

males aged 40 to 44 years and in females aged 50 to 54 (33).

Because of the variety of clinical manifestations, degenerative back disease is classified under several different headings in the International Statistical Classification of Diseases (73). Sciatica is grouped together with the neurological disorders, lumbago goes under the heading of rheumatism, and there are still separate categories for displacement of the intervertebral disc and spondylosis. As Wood (72) points out, this differentiation makes conclusions on morbidity due to lumbar degeneration difficult.

HEREDITY

The influence of genetic constitution on degenerative spinal changes is indicated by the considerable interindividual variation in the age at which the first signs of degenerative changes in the musculoskeletal system are found, not only in the general population but also in specific occupational groups. Moreover, the fact that persons with osteoarthritis of the distal interphalangeal joints more commonly have osteoarthritis also in other joints (28) similarly points to the influence of hereditary factors. Persons with cervical disc degeneration are more likely to have degenerative changes in the lumbar discs even when occupational causes are not evident (39). The hereditary significance of a slightly higher prevalence of spinal osteophytes in Caucasians than in Negroes is unclear (56). Inability to demonstrate necessary lifting strength has been associated with an increased risk for back injury (11), but how far this weakness of muscles depends on hereditary factors is unknown. Low-back insufficiency appears with equal frequency irrespective of body height, body weight, or bone size factors (21).

The fact that in females the number of joints affected by multiple osteoarthritis is greater and the severity of the changes more pronounced than in males suggests a sex-linked constitutional factor in the genesis of osteoarthritis (28), while the male predominance in lumbar spine degeneration may be due to greater physical work demands.

More specific knowledge is scarce. An association between Heberden's nodes and

multiple osteoarthritis has been found (28) and the Heberden nodes are known to be inherited by a single autosomal gene (68). In alkaptonuria, the rare congenital absence of homogentisic acid oxidase, there is a premature degeneration of the intervertebral discs and articular cartilages (34).

It is evident that hereditary factors are important in the development of degenerative changes in the spine. However, their effect may often be surpassed by the wear and tear of hard physical work.

EFFECT OF WEAR AND TEAR

The degenerative effect of excessive mechanical stress has been known for a long time, but the mechanism by which degeneration takes place has still not been revealed in detail. Schmorl (64) presented the idea that very minor injuries repeated on frequent occasions will cause disc degeneration. In experimental animal studies it has been shown that continuous slight pressure on the intervertebral disc may cause degeneration of the disc with rupture of the annulus fibrosus (43). Troup (70) considers it probable that degeneration of the spine is hastened by a series of slight injuries of the vertebral bodies and epiphyseal end plates that ultimately cause minor irreversible damage. Mehnert (51) also expresses the opinion that mechanical stress causes "minitraumas" and, through them, increasing tissue wear. Chaffin and Park (11) state that evidence indicates that repeated compressive stresses can cause microfractures in the cartilage end plates which could theoretically alter the fluid transfer to the disc. On the biochemical level it is known that shearing mechanical force can cause alteration in the colloidal state of proteins and thus produce denaturation of macromolecules (20).

There have been many attempts to relate the type of mechanical stress on the back to the quality and location of degenerative changes (16), but the results are so far inconclusive. The osteophytes are considered to be defensive outgrowths of healthy bone, tending to develop where the pressure is greatest (56). They are caused by a nonphysiological pulling irritation of the periosteum (51). Frykholm

(19) divided osteophytes into ventral spurs, considered due to strain on the longitudinal ligament, and marginal spurs, considered to occur only if disc degeneration is present. De Bernardi (4) recognized different forms of spondylosis due to different causes. He distinguished between fatigue spondylosis, dynamic spondylosis, and rheumatic spondylosis and tried to explain the differences in radiological signs between these three forms. MacNab (47) emphasized the special character of the shelf-like "traction spur," which he considered more a reaction to abnormal segmental motion than to loss of disc height as such.

As a result of both experimental and epidemiologic findings, it is now widely accepted that mechanical strain may cause degenerative effects on the spine (8, 12, 65), but much work is still needed to clarify the details of the process.

DEGENERATIVE BACK DISEASE IN DIFFERENT OCCUPATIONS

In examining the epidemiologic evidence for the effect of work on degenerative back disease, I have first evaluated the results of studies on workers in hard physical work in general, then considered the results from investigations of different occupations, and ultimately considered the conclusions that may be drawn about the hazards of specific factors in physical work.

Many investigations have shown that hard physical work promotes the appearance of degenerative back disease (5, 23, 24, 39, 40, 44, 53).

Two of the most thorough studies were made by Hult (23, 24) 20 years ago. In the first, the Munkfors investigation, he studied forest and metal-industry workers from a small rural town in Sweden. Most of the workers had entered the occupation in which they were employed at the time of the study at about 15 years of age (23). In the second study (24) he examined male workers in several different occupations. Only persons employed for five years or more in the job they held at the time of the study were included. Hult showed that the workers in heavy occupations had a higher incidence of symptoms and prevalence of signs than the workers

in physically light occupations, but he concluded that this difference was not of such an order that heavy work might be considered to have decisive significance in the origin of backache (24).

However, Hult's conclusions may be reconsidered on the basis of his original data. The results from the Munkfors investigation are representative for heavy workers in a community where, according to Hult, changing to lighter work because of back trouble was next to impossible. Because the workers could not go through selection to different jobs according to their degree of health, this group will be referred to as "heavy work, no selection." All the workers from heavy occupations in the second study (24) had been in the job they had at the time of the study for five years or more. Already this requirement implies some selection. In addition they were all living in towns where there was a good chance of finding work. Examining his results, Hult mentioned that the higher prevalence of degenerative spinal changes in the Munkfors group ("heavy work, no selection") may be at least partly due to the limited choice of work that existed in Munkfors, but he did not discuss this important question any further.

So as to enable scrutiny of the most important results of Hult's two studies, I have presented his data in tables. Calculated from the age distribution presented in five-year classes, the mean age was 42.0 years for the Munkfors men, 42.7 years for the heavy workers in the second study, and 40.8 years for the light workers from that study. Thus the differences in age distribution are small enough to permit comparison (table 1).

Hult mentioned, but did not emphasize, that the difference between heavy and light workers was much greater for pronounced symptoms and severe changes (table 3) than for the evaluation of all symptoms and signs (table 2). These findings agree with those of Kellgren and Lawrence (27).

The severe or repetitive symptoms and the pronounced signs were two to three times more common among the heavy workers than among the workers in physically light occupations (table 3). This holds true for most of the prominent variables.

Table 1. Characteristics of the three main groups in the Hult studies (23, 24).

Group	Physical demand of work	»Natural» selection	Number of males studied	Age distribution (years)	Mean age (years)	Study
1	Heavy	No selection	277	35—49	42.0	Hult 1954 (23)
2	Heavy	Selection	666	25—59	42.7	Hult 1954 (24)
3	Light	Selection	471	25—59	40.8	Hult 1954 (24)

Table 2. Reported back conditions and radiological signs of lumbar degeneration in workers from heavy and light occupations. Table based on the data of Hult (23, 24). (Numbers in percentage)

Type of work	Insufficiency	Lumbago	Sciatica	Radiologically detectable degeneration
Heavy, no selection	61	53	30	78
Heavy, selection	48	45	21	65
Light, selection	41	32	17	47

Table 3. Reported pronounced or repetitive back symptoms and prevalence of pronounced radiological signs of lumbar degeneration in workers from heavy and light occupations. Table based on the data of Hult (23, 24). (Numbers in percentage)

Type of work	Pronounced lumbar insufficiency	Recurrent attacks of lumbago	Pronounced sciatica	Pronounced radiological signs of degeneration
Heavy, no selection	24	31	12	—
Heavy, selection	9	14	11	16
Light, selection	6	9	6	8

From Hult's results it may thus be stated that physically heavy work adds considerably to the appearance of both the symptoms and signs of degenerative back disease.

Miners

Degenerative back disease in miners has been intensively studied. In a radiological

investigation of male workers aged 41—50 years disc degeneration and osteoarthritis of the lumbar spine were found much more frequently among miners than among office workers. Severe lumbar disc degeneration was found in 43 % of the miners compared with 7 % of the office workers (27). Miners reported more back-hip sciatic symptoms during a five-year period than nonminers. The difference was biggest in the age groups between

21 and 40 years, but was consistent through all age groups. Disc disorders in the form of recurrent low-back pain were reported twice as often by miners as by nonminers (40). Continuous heavy mining work was associated with an increased prevalence of body spurring even in the younger age groups, and this increase indicates the degree of wear and tear to which the spine of the coal miner is subjected (9).

In an Estonian study lumbar spondylosis was frequently found in miners below 40 years of age. Sciatica was present in 25 % of these workers and was especially common in those who brought the material out of the mine in a half-stooped posture (44).

Billenkamp (5) found earlier, more frequent, and more severe spondylotic changes in miners than in laborers working above ground. Spondylosis was found in 49 % of the miners but in only 38 % of the other workers. Miners aged 29 to 38 years had spondylotic changes in 37 % of cases as compared to the 20 % of other workers.

A thorough study not including lumbar radiographs did not show an excessive prevalence of lumbar disc degeneration in West Virginian miners (45), while a Polish study concluded that most cases of low-back pain in miners were due to ligament strain from relaxation of lumbar segments and sacro-iliac joints rather than to nerve root extension or compression (54).

Kellgren and Lawrence (27) considered the increased disc degeneration found in the lumbar spine of coal miners to be associated with something peculiar to the occupation of mining rather than with manual work as such. Heavy lifting and laborious work under awkward conditions, beneath a low roof which tends to keep the spine in a flexed position, and often on steeply inclined floors which make footholds insecure, were thought to frequently cause exceptional stress and thus injury to the lumbar spine.

Foundry workers

Lawrence et al. (42) reported that radiological evidence of disc degeneration in the lumbar spine was more frequent in found-

ry workers than in a control group. The foundry workers also had more frequent symptoms and signs of lumbar disc prolapse. Diagnosed lumbar disc prolapse was found three times as often as expected. Of the foundry workers the molders and general laborers have shown the greatest frequency of moderate and severe disc degeneration (42). Partridge et al. (60) diagnosed lumbar disc disease in 14 % of male iron foundry workers, and an additional 18 % had sometimes suffered from back pain not radiating downwards. The molders had by far the highest complaint rate, especially the younger men. This was mostly due to a higher prevalence of lumbar disc disease.

Miscellaneous occupations

In male stevedores radiological signs of lumbar degeneration were found in 55 % as compared to 27 % in a control group of the same age (46).

Ten per cent of male dockyard workers reported lumbar disc disease, and 23 % reported vague back pain during the last 12 months in a Scottish study. Civil servants reported the same amount of symptoms and disease, but less absence from work (1).

Sixty per cent of male metal-industry workers, aged 35 to 49 years and performing medium heavy and heavy physical work, reported lumbar insufficiency, 55 % reported lumbago, and 28 % sciatica. One or more of these back troubles were reported by 78 %. Lumbar disc degeneration was found in 72 % (24).

Male forest workers, aged 35 to 49 years and exposed to great strain on the back through difficult work positions and heavy lifting, reported previous symptoms and diseases as follows: lumbar insufficiency 63 %, lumbago 55 %, and sciatica 33 %. One or more of these conditions were reported by 82 %. Radiological signs of lumbar disc degeneration were found in 85 % (24).

Male forest workers, aged 28 to 64 years, showed radiologically detectable spondylotic changes in the lumbar spine more commonly (53 %) than a reference group of the same age from the general male population (37 %) (32).

Male tractor drivers, mean age 26 years, exposed to whole body vibration, were found to have degenerative changes in the dorsal and lumbar spine in 71 % of the cases, even under the age of 30 years (61). Male farmers, aged 20—29 years and exposed to whole body vibration in tractor driving, showed an excess of radiological signs of diminished lumbar disc height (31).

Truck drivers and other persons driving motor vehicles for prolonged times have an increased risk of lumbar disc herniation (30).

Merchant seamen, aged 30 to 40 years, showed radiological signs of spinal degeneration in 68 % of the cases examined (66).

In the electronics industry blue collar workers started to have more low-back disabilities than the white collar staff after the age of 35 years. The disability rate among the laborers was higher among the skilled workers than among the unskilled. The turners were especially affected (74).

In female cottonmill workers, mean age 43 years, exposed to static strain on the back because of difficult work positions, low-back pain was reported by 80 % and sciatica by 59 %. Degenerative changes of the lumbar spine were found in 85 % (51).

Excessive strain on the trunk has been reported in certain hospital occupations requiring heavy lifting (14, 17, 48). In female nurses whose work involved heavy lifting, low-back pain reached a peak in the 31—35 year age group. By contrast, the prevalence of low-back pain in teachers increased steadily from age 21 to 65 years (13). In both male and female cotton workers, not engaged in heavy physical work, low-back pain and radiological findings of lumbar disc degeneration were less common than in a control group (37).

Of workers in light industry not subjected to any strenuous physical efforts, disc disease was reported by 12 % of the males and 6 % of the females (59).

OCCUPATIONAL BACK STRAIN FACTORS

The specific factors considered probable causes of or contributors to degenerative

back disease are: injury, heavy lifting and carrying, difficult work postures, too fast a workplace, whole body vibration, and unfavorable climate. Most occupations imply exposure to different combinations of these factors. When the results from epidemiologic studies on different professions with varying exposure to backstrain factors are compared, conclusions can be drawn on the importance of the different factors.

Injury

There are still several views on the influence of trauma on spinal degeneration. Hult (24) found that a lumbago attack often occurs in connection with a sudden and unexpected movement of the lumbar spine. Lawrence (36) stated that the importance of trauma in disc degeneration has long been recognized. In his own investigation radiological changes were increased almost to the same extent in those giving a history of a blow on the back as in those whose injury was described as strain. Though radiological changes were more frequent and more severe in those with a history of injury, they were nevertheless quite considerable in those without such a history. Caplan et al. (9) considered trauma the single most important element in the development of disc narrowing.

According to Troup (70) only a small proportion of low-back disorders can properly be attributed to accidents. Low-back pain causation cannot simply depend on when the pain first developed (11). The findings in aircraft pilots saving themselves by catapult ejection argue against the degenerative effect of accidental strong trauma; even though 13 of the 55 men were found to have compression fractures of the vertebral bodies, no degenerative radiological signs were noticed at the time of investigation (22).

Heavy lifting and carrying

The hazardous effects of heavy lifting and carrying depend not only on the weight and form of the object, but also on the lifting posture, the repetitiveness and period of lifting, as well as on the physical build of the worker. Because of the in-

fluence of so many factors it is difficult to define clearly the concept of "heavy lifting and carrying" (10).

In an old study, based on energy consumption in lifting and weight handling in different postures, 50 % of the body weight was considered a reasonable limit for occasional lifting and 40 % for continuous lifting, in some cases with an additional 20 % allowance after suitable training [Cathcart et al., cited by Troup (70)]. Becker (3) defines "heavy work" as a job which calls for lifting or carrying objects weighing from 35 to 100 pounds (16 to 45 kg) for more than 30 % of the work time or an equal exertion of pushing and pulling. The 128th recommendation of the International Labor Office, issued in 1967, concerns the maximum permissible weight to be carried by one worker. It recommends that measures should swiftly be taken to reduce weights of over 55 kg. The 55-kg limit is considered acceptable only for specially selected and properly trained workers under favorable environmental conditions. The maximum weights for women and children should be 50—60 % lower than those for adult men (25).

The effect of heavy lifting or carrying on the back may be immediate and reversible, like the reduction of lumbar lordosis found in Bantu men wearing weights on their heads (26). In occupational health, however, the chronic, mostly irreversible effects that develop from long-time exposure to strain factors are usually the most important.

The incidence of low-back pain is higher in jobs which require good lifting strength, as determined by both the location and the weight of the load (11).

Bad posture may lead to back injury through imbalance between muscles in lifting. Prior development of postural fatigue may render the back liable to subsequent injury (7). Even in a "reasonable" lifting posture the compression forces created in the disc may damage the weight-bearing cartilage in some individuals.

In both mining and other manual work a close relationship has been noted between the duration of heavy lifting and disc degeneration. The number of affected discs showed a progressive rise as the duration of heavy lifting increased. There

were also progressively fewer minimal and more numerous severe radiological changes as experience with heavy lifting increased. Incapacity for work also became greater as the time employed in work with heavy lifting increased. In those who had lifted for more than 30 years, it was four times as great as in those who had lifted for less than 25 years (36). Low-back pain with sciatica was found in 16 % of mail-carriers as compared to 3 % of office clerks (58). Workers who had experienced lumbago reported the pain to have developed in immediate connection with heavy lifting (23).

The prevalence of disc degeneration in a group of weight lifters was definitely lower than in workers in heavy occupations. This difference may partly be due to an especially strong body structure in persons who start practicing weight lifting as a sport, but even so it indicates that the actual lifting of heavy weights need not be a strongly predisposing factor in the origin of disc degeneration (24).

A multiplicity of evidence shows the adverse effects of heavy lifting on the back. Even though some persons may lift heavy weights for long periods without noticeable ill effects, heavy lifting, carrying, pulling and pushing have to be regarded as major occupational factors causing or contributing to both acute and chronic back disorders.

Posture

Pain following unaccustomed and long-continued stooping is a familiar event; postural fatigue is generally recognized as an important element in the production of low-back pain (7, 36, 70).

Electromyographic studies have shown that upright and bent-double postures are primarily maintained by passive muscle tension. For standing straight the erector spinae muscles show slight activity, for bending forward the activity rises sharply, diminishing again nearly to zero for the fully stooped position (18, 74).

The pressure in the intervertebral discs is higher when one sits straight than when one stands straight. Leaning forward raises the pressure in both positions (55).

Different standing and sitting postures are of considerable importance in occu-

pational health. In persons either sitting for prolonged periods of time or unable to sit at all during the workday a high incidence of low-back pain has been reported (49). Both lumbar disc pressure and myoelectric back muscle activity vary with different sitting postures (2). Prolonged sitting has turned out to be more weakly associated with back pain than heavy lifting and whole body vibration (52).

In the standing posture the load on the back primarily depends on the degree of stooping. Rheumatic complaints in miners reached a maximum in work at seam heights of 3 ft. to 3 ft. 5 in. (91—104 cm) and 4 ft. 6 in. to 4 ft. 11 in. (137—150 cm). Workers at 4 ft. 6 in. to 5 ft. 6 in. (137—168 cm) had to adopt a stooping position and did not kneel. Incapacity was 50 % more common among this last group, and prolonged incapacity three times more common than in a control group. Radiological degenerative changes were the most common in those working at a roof height of up to 3 ft. 5 in. (91 cm) and least common in those working at 4 ft. 5 in. (135 cm), but the differences were not statistically significant (36).

Having to work in a stooped position may be a factor which increases the prevalence and severity of disc degeneration in floor molders (60). Female cottonmill workers, mean age 43 years, working in a stooped position with continuously tense back muscles, presumably got minitraumas and degenerative changes of the lumbar spine because of this static load. Sciatica was reported by 50 %, low-back pain by 80 %, and radiological degenerative changes were found in 85 % (51). A high incidence of low-back pain in turners was considered due to work in a standing, slightly stooped posture (74).

When the influence of different occupational factors on the miner's back was compared, stooping was considered less important than injury and heavy lifting (36).

Whole body vibration

The effects of whole body vibration have not yet been thoroughly investigated. Workers exposed to it report low-back pain and other symptoms. In a comparison of exposure to heavy lifting, stooping,

prolonged sitting, and whole body vibration with reported sciatic symptoms, vibration showed the highest correlation (52).

In young tractor drivers an exposure of four years or more to whole body vibration (1—6 Hz, vertical) seemed to cause degenerative spinal changes in most of the workers. The static sitting posture, enhancing the fatigue of the back muscles, may contribute to the unfavorable effect of vibration (61). Young farmers, exposed to whole body vibration of 1—20 Hz during tractor driving, showed an excessive prevalence of diminished intervertebral disc height in the lumbar spine (31).

Climate

The literature contains contradictory evidence about the effect of climate on degenerative back disease.

In Sweden outdoor workers often associated symptoms of lumbar insufficiency with the cold and damp climate of spring and autumn (24), while Tauber (69) found back complaints to occur most frequently during spring and summer.

Thorough studies by Lawrence and others clearly relate wet work conditions to an enhanced incidence of degenerative back disease symptoms (38). Men considering their work conditions to be unusually cold or wet reported more disc disorders than those not complaining of work climate (29). Miners who had worked for more than five years under wet conditions had twice as high an incidence of back-hip sciatic pain as those who had always worked under dry conditions. Loss of work time showed a step-by-step relationship with work under wet conditions. Radiological degenerative changes were slightly more frequent in miners working under wet conditions, but they were seldom severe. A higher accident rate under wet work conditions was taken into account, but a history of back injury was less frequently reported by these workers (36).

On the other hand, cold and dampness did not seem to contribute appreciably to the high incidence of sciatica in Estonian miners (44). Neither did working out-of-doors in Scotland significantly increase the complaint rate of dock workers (1). The monthly fluctuation in the number of

patients treated for disc disorders has been shown to be slight; in April and May there is a small drop below the average level (33).

Foundry workers exposed to radiant heat reported a low rate of rheumatic complaints. The prevalence of symptoms from lumbar discs was, however, high, possibly indicating that pain due to nerve root pressure is less influenced by tissue temperature than referred pain (42). In another study on foundry workers high levels of radiant heat did not reduce the complaint rate or sick leave for rheumatism (60).

The data presented so far shows that wet and cold work conditions may awake or aggravate rheumatic symptoms, while heat may reduce them. It seems, however, that climatic conditions as such do not affect the degenerative process in the spine.

CONCLUSIONS

The low-back morbidity associated with lumbar degeneration develops from a combination of hereditary and environmental causes. The evidence for the hereditary influence is mainly indirect, based on the considerable interindividual variation in morbidity. Several external factors have been found to contribute to the development of "degenerative back disease" from early childhood to old age. In this review the occupational back load factors were examined.

The effect of the occupational factors on the development of "degenerative back disease" is obscured by the biological variation in disposition to disease, the high prevalence of degenerative changes in the general population, and the selection of workers active in different occupations.

Nevertheless, several studies have shown that heavy physical work may cause radiologically detectable spinal degeneration that develops up to ten years prematurely. The symptoms from the degenerative process may be many times more common in heavy occupations than in light ones.

Most occupations involve exposure to several back load factors. Of the specific factors, injury and "heavy" lifting seem to have the strongest degenerative effect. With further study the importance of

whole body vibration may rise. Stooped posture causes fatigue and ache and may also contribute to the acceleration of the degenerative process. Climate affects symptoms, but does not as such hasten degeneration.

The incidence of incapacity due to back disease is rising in many industrialized countries. To prevent unnecessary pain, and to avoid lost workdays, present knowledge on the causes of "degenerative back disease" should be effectively used to improve occupational health in the workplace, and the further study of premature spinal degeneration should be pursued with increasing effort.

REFERENCES

1. ANDERSON, J. A. D. and DUTHIE, J. J. R. Rheumatic complaints in dockyard workers. *Ann. rheum. dis.* 22 (1963) 401—409.
2. ANDERSSON, G., ÖRTENGREN, R., NACHEMSON, A. and ELFSTRÖM, G. Lumbar disc pressure and myoelectric back muscle activity during sitting: I. Studies on an experimental chair. *Scand. j. rehabil. med.* 6 (1974): 3, 104—114.
3. BECKER, W. F. Prevention of low back disability. *J. occup. med.* 3 (1961): 7, 329—335.
4. BERNARDI, E. DE. Aspetti radiologici delle spondilopatie nella patologia del lavoro. *La riforma med.* 9 (1965) 225—235.
5. BILLENKAMP, G. Körperliche Belastung und Spondylosis deformans. *Fortschr. Röntgenstr.* 116 (1972): 2, 211—216.
6. BRODIN, H. Paths of nutrition in articular cartilage and intervertebral discs. *Acta orthop. scand.* 24 (1955) 177—183.
7. BROWN, J. R. Lifting as an industrial hazard. *Am. ind. hyg. assoc. j.* 34 (1973): 7, 292—297.
8. CAILLIET, R. *Low back pain syndrome*. F. A. Davis Company, Philadelphia, Pa. 1968. 134 p.
9. CAPLAN, P. S., FREEDMAN, L. M. J. and CONNELLY, T. P. Degenerative joint disease of the lumbar spine in coal miners — A clinical and X-ray study. *Arthritis rheum.* 9 (1966): 5, 693—702.
10. CHAFFIN, D. Biomechanics of manual material handling and low-back pain. In ZENZ, C. (ed.), *Occupational medicine*. Year Book Medical Publishers, Chicago, Ill. 1975, pp. 443—467.
11. CHAFFIN, D. B. and PARK, K. S. A longitudinal study of low-back pain as associated with occupational weight lifting factors. *Am. ind. hyg. assoc. j.* 34 (1973) 12, 513—525.
12. COBB, S. *The frequency of the rheumatic diseases*. Harvard University Press, Cambridge, Mass. 1971. 147 p.

13. CUST, G., PEARSON, J. C. G. and MAIR, A. The prevalence of low back pain in nurses. *Int. nurs. rev.* 19 (1972): 2, 169—179.
14. DEHLIN, O., HEDENRUD, B. and HORAL, J. Back symptoms in nursing aides in a geriatric hospital. *Scand. j. rehabil. med.* 8 (1976) 47—53.
15. EYRING, E. J. The biochemistry and physiology of the intervertebral disk. *Clin. orthop.* 67 (1969) 16—28.
16. FARFAN, H. F. A reorientation in the surgical approach to degenerative lumbar intervertebral joint disease. *Orthop. clin. north am.* 8 (1977): 1, 9—21.
17. FERGUSON, D. Strain injuries in hospital employees. *Med. j. aust.* 1 (1970) 376—379.
18. FLOYD, W. F. and SILVER, P. H. S. The function of the erectors spinae muscle in certain movements and postures in man. *J. physiol.* (London) 129 (1955) 184—203.
19. FRYKHOLM, R. Lower cervical vertebrae and intervertebral discs: Surgical anatomy and pathology. *Acta chir. scand.* 101 (1951) 345—359.
20. GORDON, E. E. Natural history of the intervertebral disc. *Arch. phys. med.* 42 (1961) 750—763.
21. HIRSCH, C., INGELMARK, B.-E. and MILLER, M. The anatomical basis for low back pain. *Acta orthop. scand.* 33 (1963) 1—17.
22. HIRSCH, C. and NACHEMSON, A. Clinical observations on the spine in ejected pilots. *Acta orthop. scand.* 31 (1961): 2, 135—145.
23. HULT, L. The Munkfors investigation. *Acta orthop. scand. suppl.* 16 (1954) 76 p.
24. HULT, L. Cervical, dorsal and lumbar spinal syndromes. *Acta orthop. scand. suppl.* 17 (1954) 102 p.
25. INTERNATIONAL LABOR OFFICE. *Encyclopaedia of occupational health and safety* (vol. 2). Geneva 1972.
26. JONCK, L. M. The influence of weight-bearing on the lumbar spine: A radiological study. *S. afr. j. radiol.* 2 (1964): 2, 25—29.
27. KELLGREN, J. H. and LAWRENCE, J. S. Rheumatism in miners: Part II. X-ray study. *Br. j. ind. med.* 9 (1952) 197—207.
28. KELLGREN, J. H. and LAWRENCE, J. S. Osteo-arthritis and disk degeneration in an urban population. *Ann. rheum. dis.* 17 (1958) 388—397.
29. KELLGREN, J. H., LAWRENCE, J. S. and AITKEN-SWAN, J. Rheumatic complaints in an urban population. *Ann. rheum. dis.* 12 (1953) 5—15.
30. KELSEY, J. L. An epidemiological study of the relationship between occupations and acute herniated lumbar intervertebral discs. *Int. j. epidemiol.* 4 (1975): 3, 197—205.
31. KÖHL, U. Les dangers encourus par les conducteurs de tracteurs. *Arch. mal. prof. med. travail. secur. soc.* 36 (1975): 3, 145—162.
32. KORHONEN, O., NUMMI, J., NURMINEN, M., NYGÅRD, K., SOININEN, H. and WIIKERI, M. *Metsätyöntekijä: Osa 2. terveys verrattuna ammatissa toimivan väestön terveyteen* (Työterveyslaitoksen tutkimuksia no. 126). Institute of Occupational Health, Helsinki 1977. 100 p.
33. KRÄMER, J. *Biomechanische Veränderungen im lumbalen Bewegungssegment. Die Wirbelsäule in Forschung und Praxis.* Hippokrates Verlag, Stuttgart 1973, pp. 76—92.
34. LA DU, B. N., ZANNONI, V. G., LASTER, L. and SEEGMILLER, J. E. The nature of the defect in tyrosine metabolism in alcaptonuria. *J. biol. chem.* 230 (1958) 251—260.
35. LA ROCCA, H. New horizons in research on disc disease. *Orthop. clin. north am.* 2 (1971):2, 521—531.
36. LAWRENCE, J. S. Rheumatism in coal miners: Part III. Occupational factors. *Br. j. ind. med.* 12 (1955): 3, 249—261.
37. LAWRENCE, J. S. Rheumatism in cotton operatives. *Br. j. ind. med.* 18 (1961): 4, 270—276.
38. LAWRENCE, J. S. The influence of climate on the prevalence of rheumatic complaints. *Manchester med. gaz.* 42 (1962) 14—17.
39. LAWRENCE, J. S. Disc degeneration: Its frequency and relationship to symptoms. *Ann. rheum. dis.* 28 (1969) 121—138.
40. LAWRENCE, J. S. and AITKEN-SWAN, J. Rheumatism in miners: Part I. Rheumatic complaints. *Br. j. ind. med.* 9 (1952) 1—12.
41. LAWRENCE, J. S., DE GRAAFF and LAINE, V. A. I. Degenerative joint disease in random samples and occupational groups. In: M. JEFFREY and J. BALL (eds.), *The epidemiology of chronic rheumatism.* Blackwell, Oxford 1963, pp. 98—119.
42. LAWRENCE, J. S., MOLYNEUX, M. K. and DINGWALL-FORDYCE, I. Rheumatism in foundry workers. *Br. j. ind. med.* 23 (1966):1, 42—52.
43. LINDBLOM, K. Experimental ruptures of intervertebral discs in rats' tails: A preliminary report. *J. bone jt. surg.* 34 A (1952): 1, 123—128.
44. LINNAM, A. T. *Lumbo sacralis radiculitis in brimstone miners in Estonia* (in Russian). Tartu State University, Tallin 1967. 30 p.
45. LOCKSHIN, M. D., HIGGINS, I. T. T., HIGGINS, M. W., DODGE, H. J. and CANALE, N. Rheumatism in mining communities in Marion County, West Virginia. *Am. j. epidemiol.* 90 (1969): 1, 17—29.
46. MACH, J., HEITNER, H. and ZILLER, R. Die Bedeutung der beruflichen Belastung für die Entstehung degenerativer Wirbelsäulenveränderungen. *Z. Hyg.* 22 (1976): 5, 352—354.
47. MAC NAB, I. The traction spur. *J. bone jt. surg.* 53-A (1971): 4, 663—670.
48. MAGORA, A. Investigation of the relation between low back pain and occupation. *Ind. med.* 39 (1970): 11, 465—471.
49. MAGORA, A. Investigation of the relation between low back pain and occupation. 3 physical requirements: sitting, standing and weight lifting. *Ind. med.* 41 (1972): 12, 5—9.
50. MAROUDAS, A., STOCKWELL, R. A., NACHEMSON, A. and URBAN, J. Factors

- involved in the nutrition of the human lumbar intervertebral disc: cellularity and diffusion of glucose in vitro. *J. anat.* 120 (1975) 113—130.
51. MEHNERT, E. Degenerative Veränderungen durch statische Fehlbelastung bei den Einlegerinnen der Baumwollspinnereien — eine vermeidbare Schädigung der Wirbelsäule. *Dtsch. Gesundheitswes.* 24 (1969): 36, 1716—1721.
 52. MELKAS, T., HEIJARI, M., NUMMI, J. and JÄRVINEN, T. *Helsingin kaupungin viiden työntekijäryhmän terveystutkimus: Osa 1. haastattelu* (Työterveyslaitoksen tutkimuksia no. 111). Institute of Occupational Health, Helsinki 1975. 50 p.
 53. MÜLLER, H. Arbeitshygienische Untersuchungen über Zusammenhänge zwischen Umbauerscheinungen am Bewegungsapparat, individueller Disposition und sozialer Exposition bei über 60 jährigen Arbeitern im Schwermaschinenbau Magdeburg (Inaug. Diss.). Berlin 1967.
 54. MUSIOL, A., SZCZEPANIK, E., ST. WOLNY, H., WOZNAKOWSKIEJ, W., ENGEL, M., JASTRZAB, D., IBRAHIMA, O. H. Objawy kliniczne bólów okolicy lędźwiowo-krzyżowej kręgosłupa u górników kopalni W. K. "Zofiówka" w Jastrzebiu Górnym. *Pol. tyg. lek.* 29 (1974): 51, 2211—2213.
 55. NACHEMSON, A. The load on lumbar disks in different positions of the body. *Clin. orthop.* 45 (1966) 107—122.
 56. NATHAN, H. Osteophytes of the vertebral column: An anatomical study of their development according to age, race and sex with considerations as to their etiology and significance. *J. bone jt. surg.* 44-A (1932): 2, 243—268.
 57. NAYLOR, A. Intervertebral disc prolapse and degeneration. *Spine* 1 (1976): 2, 108—114.
 58. NIEMI, M. and VOUTILAINEN, A. Back troubles among Finnish postmen. *International congress on occupational health* (vol. III). 1957, p. 141.
 59. PARTRIDGE, R. E. H., ANDERSON, J. A. D., MCCARTHY, M. A. and DUTHIE, J. J. R. Rheumatism in light industry. *Ann. rheum. dis.* 24 (1965) 332—340.
 60. PARTRIDGE, R. E. H., ANDERSSON, J. A. D., MCCARTHY, M. A. and DUTHIE, J. J. R. Rheumatic complaints among workers in iron foundries. *Ann. rheum. dis.* 27 (1968):5, 441—452.
 61. ROSEGGER, S. Vorzeitige Aufbrauchererscheinungen bei Kraftfahrern. *Z. Orthop. Ihre Grenzgeb.* 108 (1970) 510—516.
 62. ROWE, M. L. Low back pain in industry: A position paper. *J. occup. med.* 11 (1969) 4, 161—169.
 63. ROWE, M. L. Low back disability in industry: Updated position. *J. occup. med.* 13 (1971): 10, 476—478.
 64. SCHMORL, G. Über Knorpelknötchen an den Wirbelbandscheiben. *Fortschr. Röntgenstr.* 38 (1928): 2, 265—279.
 65. SCHMORL, G. and JUNGHANS, H. *The human spine in health and disease*. Grune & Stratton, New York, N.Y. 1971. 504 p.
 66. SESSA, G. L'artrosi della colonna vertebrale nei marittimi. *Fol. med.* 46 (1963) 480—490.
 67. SOKOLOFF, L. *The biology of degenerative joint disease*. The University of Chicago Press, Ltd., Chicago, Ill. 1969. 162 p.
 68. STECHER, R. M. Heberden oration, Heberden's nodes: A clinical description of osteo-arthritis of the finger joints. *Ann. rheum. dis.* 14 (1955) 1—10.
 69. TAUBER, J. An unorthodox look at backaches. *J. occup. med.* 12 (1970):4, 128—130.
 70. TROUP, J. D. G. Relation of lumbar spine disorders to heavy manual work and lifting. *Lancet* 1 (1965): 7390, 857—861.
 71. WOOD, P. H. N. Rheumatic complaints. *Br. med. bull.* 27 (1971) 82—88.
 72. WOOD, P. H. N. Epidemiology of back pain. In: M. JAYSON (ed.), *The lumbar spine and back pain*. Sector Publishing Ltd., London 1976, pp. 13—28.
 73. WORLD HEALTH ORGANIZATION. *Manual of the international statistical classification of diseases, injuries and causes of death* (vol. 1). Geneva 1977. 773 p.
 74. ZUIDEMA, H. Low back pain in work shops. Presented at The 9th European Philips congress on occupational medicine in Hamburg, Germany, October 3rd 1973. 13 p.