

REPORTS

THE SECOND INTERNATIONAL CONFERENCE ON OCCUPATIONAL MUSCULOSKELETAL DISORDERS AND PREVENTION OF LOW BACK PAIN (October 16–18, 1990, Milano, Italy)

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The Conference was held October 16–18, 1990 in Milan, Italy. It was organized for the second time by the Department of Occupational Health Sciences, New York College of Osteopathic Medicine; the New York Institute of Technology represented by *Professor M.A. El Batawi* (coordinator of the Conference); and the Research Unit "Ergonomics of Posture and Movement", Institute of Occupational Medicine, University of Milan, represented by *Professor A. Grieco*. The Conference enjoyed the cooperation and co-sponsorship of the World Health Organization Regional Office for Europe, Copenhagen; the International Commission on Occupational Health; the International Association for Agricultural Medicine and Rural Health, as well as of the WHO Collaborating Centers on Occupational Health in China, Bulgaria, France, Hungary, India, R.O. Korea, Poland, Singapore, USA and USSR.

The debates were organised into 7 sessions. They were very well-planned and created an opportunity to present the most vital issues on the spreading, pathogenesis and prevention of diseases of the musculoskeletal system. Each session was started with a key-note speech. Seven key-note speeches had been prepared by specialists in individual areas at the special request of organisers.

The first session, chaired by *Professor J.A.D. Anderson* (England), *Professor G. Molteni* and *Dr E. Occhipinti* (Italy) was devoted to the significance and incidence of lumbosacral syndrome. The key-note speech was delivered by *Professor M.A. El Batawi*, New York Institute of Technology (USA). He indicated the importance of occupational lumbosacral syndrome, its incidence in various regions of the world and in various occupations. He stated that low back pain (LBP) is not specific for any occupational group. It is induced by many factors, however, physical strain and non-ergonomic working

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conditions (inappropriate body position at work, lifting of heavy objects, persistent physical strain, single great strain or movement and vibrations) are the basic causes. Data on the incidence of lumbosacral syndrome, collected in various countries, are incomparable because of different methodology. For example, in China, LBP confirmed by clinical and radiological examinations, occurs in 21–44% of workers, depending on the kind of job. In France, where a questionnaire survey in workers of the agricultural, paper and silk industries, was performed, incidence of LBP reached 63%. The author stressed higher incidence of this disease in developing countries, where manual work coupled with great physical strain is still predominant, while application of ergonomic principles and promotion of health education on work safety are far from being satisfactory.

The key-note speech was followed by eight findings. They dealt with the incidence of locomotor organ pains in various countries and in various occupations.

The studies carried out in Denmark revealed that diseases of the musculoskeletal system, proved to be the most frequent cause of disability: 4.2 cases per 1,000 persons annually. These included cervicobrachial and lumbosacral syndrome — 57% of all cases; discopathy — 26%; arthropathy — 24%; rheumatic disease — 12%; and osteochondropathies — 7%. (J.V. Verbeek, Coronal Laboratory, University of Amsterdam, the Netherlands). It was also found that the incidence of certain syndromes was related to sex. Discopathy, spondylosis, derangement interne of the knee and osteochondropathies were more common in men, while women suffered more often from osteoarthritis, ligament and muscles disorders, cervico-brachial syndrome, rheumatoid arthritis and deformity of the feet. Apart from differences in body structure and life-styles, the multifarious nature of the job performed and distinct working conditions caused a varied incidence of these diseases in males and females.

Other findings referred to selected groups of workers. Sick absenteeism during a period of one year was analysed in 3,566 French railway workers (D. Leger et al., SNCF, Paris Cedex, France). A total of 52% persons took sick leave; 3,674 certificates of temporary work disability were issued, covering 52,309 days altogether (an average of 21.7 days per one person). Among 14 causes of the sick absenteeism under study, non-traumatic pathology of the locomotor organs proved to be a significant problem. The number of persons absent at work because of this reason took third place; a general number of sick leave days was second while the average number of those days (equal to 13.4) took seventh. That indicated that the discussed sickness did not belong to the very acute ones. Lumbosacral syndrome was diagnosed in 224 out of 393 persons with non-traumatic pathology of the locomotor system. The average number of days of absenteeism in this group was equal to 9.6 days, lower than in other groups of causes of these diseases.

Non-traumatic diseases of the locomotor system occurred more often in blue collar workers in the 30–40 age group but the most serious changes occurred in persons over 50 years of age. This pathology was more frequent in persons



with 16–25 years of employment, however, the most acute cases were observed in persons with 5 years of employment. In order to diminish sick absenteeism among workers, special preventive measures were taken at, and outside, places of employment.

In Germany it was found that in transportation workers the incidence of spondylopathy, mainly lumbalgia, was 26% higher than in the control group (A. Luttman et al., Institut für Arbeitsphysiologie an der Universität Dortmund, Germany). The percentage of spondylopathy increased with age in both groups. Nevertheless, the number of persons with spondylopathy diagnosed during the first year of employment was 3.5 times higher in transportation workers than in the control group. This observations account for the special care of workers employed at strenuous work posts during the first years of their employment.

In workers employed in Italian railway transportation, pains of the cervical spine were, in comparison with the control group, more frequent in the 26–35 age group (3.7%) and even more frequent in the 36–45 age group (12.5%). Occurrence of pains of the thoracic spine was higher by 5.5% and 2.5%, and of the lumbar spine by 24.1% and 27.5%, respectively.

It is the opinion of the authors (G.L. Discalzi et al., Institute Medicine del Lavoro, Torino, Italy) that in this group of workers there is a high risk of these complaints. Analysis of body position, repeated bendings of the lumbosacral spine, manual lifting of loads as well as clinical examinations permits the drawing of such a conclusion. Improvements based on ergonomical principles are essential to decrease the risk.

G.F. Moens et al. (IDEWE Occupational Health Services, Brussels, Belgium) presented the results of a questionnaire survey on back pain in female social workers. The survey covered 4,723 subjects; 73% of them suffered from back pains, at least once during their life; 63% — during past 12 months and 18% reported current pains. According to the estimation, the total incidence of back pain was equal to 44%. In 72% of female respondents, repeated episodes and in 9%, continued pain, were observed during the past year. There were 82% of persons suffering from pain of the lumbosacral spine; in 72% pains were more intense at work but only 29% of persons had been on sick leave, lasting an average 36 days. It was stressed that the frequency of complaints was related to the region of abode, sex and living conditions of respondents; and additionally to individual and subjective assessment of work load.

Periodical studies carried out by M. Nardinii et al. (Servizio Sanitario Aziendale Gruppo Enimont, Ferrara, Italy) in chemical industry workers (18–55 age group) revealed that 18% of workers suffered from diseases of the locomotor system. This percentage was identical with that of the incidence of chronic, degenerative diseases of the locomotor system in males of the same age, and pains in the lumbosacral spine were most frequent. No relationship between age and incidence was found. Promotion of education on appropriate positions of body at work and adjustment of work posts to workers' health conditions were strongly recommended.



The results of a questionnaire survey on work related LBP in occupational groups at high risk (nurses and mail workers) were presented by *A.M. Feyer et al.* (National Institute of Occupational Health and Safety, Sydney, Australia). They reported that 87% of female respondents suffered from LBP currently or during the past year, 75% persons with pains could not lift heavy objects without additional pain and only 13% managed to avoid sick leave. Both groups of persons with and without LBP showed no difference between the frequency of psychological dysfunctions and dissatisfaction with jobs performed. The methodology of presented studies was criticised because of the specific formulation of the questionnaire questions addressed to given occupational groups (nurses) and lack of prospective information.

J. A. Indulski et al., (Institute of Occupational Medicine, Lodz, Poland) presented results of the questionnaire survey and medico-laboratory examinations performed on groups of males employed at posts proved to be pathogenic for the locomotor system because of load lifting, vibrations and shaking, changeable microclimate conditions and non-ergonomically designed seats. Concreters and drivers of heavy vehicles were particularly exposed to these factors. LBP was observed in 20% of persons of the 20–29 age group and its incidence increased with age to such an extent that in the 50–59 age group 75% of persons already suffered from low back pain. LBP was observed in 55% of concreters 20–29 years old but the per cent increased to 90 in the 50–59 age group. The incidence of LBP in older groups did not differ from that observed in reference groups. Significant differences were noticed only in younger groups, which indicated an apparent effect of an occupational factor. A forced body position, most often bent over machines (machine-building, ceramic and paper industries), was another negative factor; 70% of the total males under study worked during two-thirds of their shift in a position which significantly loaded the extensor muscles of the trunk. LBP was observed in 35% of persons in this group whose average age was 47 years.

Laboratory investigations were performed on this group; the projection of the centre of gravity was defined by means of post-urography; electromyography was taken during the dynamic and static exercise test and the strength as well as dynamic characteristics of extensor muscles of the back were identified. It was found that after 8 hrs of work the field of statokinesiography was expanding, while the strength of back muscles and their angular velocity were diminishing, and the spectrum of EMG power density within low frequencies was increasing. The results proved the fatigue of postural muscles after work, therefore, the applied non-invasive and fast method was recommended in the detection of consequences of postural muscle overload.

The second session was focused on the pathogenesis, diagnosis and therapy of low back pain. The session was chaired by *Professor J. Indulski* (Poland), *Professor V. Pietrogrande* and *G. Frigo BSc* (Eng) from Italy. The key-note speech was delivered by *Professor J.A.D. Anderson* (Guys Hospital Medical School, London, England). He reminded us that compression of nerve roots by the prolapse of the nucleus pulposus of the intervertebral disc, or other structures which causes encroachment of the intervertebral foramen of the vertebral canal are the main causes of LBP.



Pains may also be evoked by spine arthritis or compression of the articular capsule by adjacent tendons and muscles. These symptoms may occur when joints are weakened by a long-lasting load or repeated rotations of the trunk. The syndrome of low back pain is often caused by sacroiliac joints. Tendinous junctions of sacroiliac joints may be damaged by a sudden load or repeated displacement of the articular surface and compression of adjacent structures, consequently evoking pain with increasing intensity during an inappropriate position of body. Low back pains may also be caused by diseases of the kidneys, abdominal organs and the minor pelvis.

Back pain episodes are very often caused by traumas or by a strain associated with the lifting of a heavy object especially in an inappropriate position of the body. Load which can be lifted without harm depends on the shape of an object (placement of the centre of gravity), distance from the body axis and the position of the spine itself (inflection and/or twist increase pressure inside intervertebral discs). A long-lasting twisting position of the body, even without any load, is another cause of pain. Environmental factors evoking back pains such as vibration, microclimate changes, and especially cold, should also be mentioned here.

According to *Professor Anderson*, the afore-said group of factors may induce back pains even in a man with a well-structured and properly functioning spine. Thus, the conclusion can be drawn that certain professions associated with this group of factors predispose an early occurrence of pain. This hypothesis has been confirmed by numerous epidemiological studies. Bearing in mind that inappropriate lifting of load is the main cause of pain, in the opinion of *Professor Anderson*, special training of workers according to the principle: getting ready (mentally) of assessing situation and positioning (GRASP) should be strongly recommended. Each worker should be aware of the size of a heavy object, its position and all obstacles which are to be overcome on the way. He should also be able to adopt an appropriate position of body. Such training should be started at school to prevent spine traumas in every day life. It should be the responsibility of employees to secure proper position of body and safety during lifting and transportation of objects through correct organisation of work and work posts.

Non-invasive methods of measurements (surface EMG, radio pills to measure pressure in the abdominal cavity) employed in surveys carried out directly at work posts, and in persons performing various jobs, facilitated identification of harmful posts.

The author also stressed the significance of secondary prevention, designed to reduce the incidence of disease in a population by identifying persons with a higher risk of back pains: persons with increased or limited mobility of the lumbar spine, scoliosis above 10° , insufficient strength of muscles involved in lifting of objects, persons in whom spontaneous lifting of objects evoked excessive pressure in the abdominal cavity, persons with diagnosed development malformations of spine (spondylolisthesis, spinal stenosis detected by ultrasonographic examination), with HLA/27 antigen, associated with the risk of spondylitis ankylopoietica, and persons with



fragility of capillary vessels, associated with higher risk of discopathy. Persons from these risk groups should be advised to avoid jobs involving high load.

Apart from pathogenesis, *Professor Anderson* discussed issues on the diagnosis and therapy of low back pains. He stressed that in about 60% of cases, approximately two months after the sudden onset of disease the pains disappear idiopathically but in about 25% the recurrence of an illness is observed. Therefore, better understanding of back pain pathogenesis may prove to be very helpful in preventing the recurrence.

The key-note speech was followed by a presentation of 10 findings indicating significant pathogenic factors and specifying methods which facilitate early detection of pathological changes in the spine as well as preventive measures and rehabilitation procedures.

K.N. Gavrilovich et al. (Institute of Work Hygiene and Professional Diseases, Moscow, USSR) discussed the clinical progress of degenerative changes in intervertebral discs in digger operators employed in a strip mine. Clinical symptoms of osteochondrosis were found in 84 out of 300 operators observed (28,2%). Symptoms were radiologically confirmed in 53 persons, in the other persons, spondylitis deformans was detected, mainly in operators with a long period of employment. In 261 operators, symptoms of vibration disease were diagnosed apart from back pains. Such a coexistence of symptoms, in the opinion of the authors, reveals the share of vibration in the pathogenesis of osteochondrosis.

A significant role of a whole-body vibration (WBV) in the occurrence of spinal complaints was also indicated by the metaanalysis of data presented in the literature. The analysis was performed by *H.C. Boshuizen* (University of Amsterdam, the Netherlands). In persons exposed to WBV, spondylarthrosis ($OR^* = 1.45$, confidence interval 90% — 1.23–1.71), displacement of intervertebral discs ($OR = 1.64$ — 1.36–1.98), spondylolisthesis ($OR = 1.46$ — 1.00–2.10) were most common diseases. Vertebrogenic pain syndrome was also more frequent in persons occupationally exposed to WBV ($OR = 1.53$ — 1.33–1.77). Sciatic neuritis was also more frequent in those persons. A proportional relationship between the size of exposure and the number of spine pathologies was found, however, this relationship became more complicated since the onset of exposure.

The relationship between body position, outer load at work and diseases of the musculoskeletal system was stressed by many contributors.

R. Stalhammar et al. (Institute of Occupational Health, Helsinki, Finland) presented the results of studies performed in airport workers who loaded aircraft hatches. Back pains were reported by 62%, low back pains by 38%, omalgia by 54% and knee pains by 61%. Porters usually work very long (12–14 hrs/day), they carry about 11 tons during a period equal to only 17% of a shift, and work in sitting, squatting and kneeling positions. EMG examinations revealed that work in the kneeling position was mostly strenuous for back muscles and in the sitting position for shoulder muscles,

* — OR = odds ratio



while the highest pressure in the abdominal cavity was observed in the squatting position. After a shift the body height of porters had decreased by 7 mm. A recumbent position, very favourable for alimentation of intervertebral discs, was strongly recommended during rest breaks.

E. Vingard et al. (Department of Occupational Medicine, Karolinska Hospital, National Institute of Occupational Health, Stockholm, Sweden) identified, on the basis of the case control investigations, hard physical work as an early retirement risk caused by diseases of the musculoskeletal system. The risk of earlier retirement in groups of moderate and large work load increases proportionally to the magnitude of the work load. In workers of the building and metallurgical industries, an increased risk of earlier retirement was related to lumbosacral and cervico-brachial syndromes, coxarthrosis and gonarthrosis. In farmers and forestry workers, an increased risk of lumbosacral syndrome and osteoarthritis was observed, while in workers of the building industry (painters and floor tilers) gonarthrosis and cervicobrachial syndrome were the main causes of early retirement.

Four presentations were focussed on new methods of early detection of vertebrogenic pain syndrome. O. Friberg (Research Institute of Military Medicine, Kouvola, Finland) presented unconventional methods of radiological examinations supported by collected data. X-rays of the lumbar spine and hip joints taken in a standing position revealed changes invisible in pictures taken in a recumbent position. Among 700 persons with chronic low back pain, scoliosis of 10° or even higher compensated by an asymmetric position of lower limbs or pelvis was diagnosed in 24%; the "kissing spine" syndrome was found in 9% of persons and forward or backward displacement of vertebrae in 21%. The first thing to be disclosed by this dynamic radiography was instability of the spine. In 50% of patients modern radiological methods facilitated the identification of cause of back pains of unknown etiology. Due to these methods it is easier to apply therapy effective in a given kind of pathology.

Application of a quantitative computer tomography (QCT), a non-invasive technique used in the determination of bone mineralisation, was presented by R. Molinini et al. (Dipartimento di Medicina del Lavoro, Fondazione "S. Maugeri" IRCCS, di Cassano M., Bari, Servizio di Radiologi, Osp. "Casa di Solievo della Sofferenza", S.G. Rotondo, Foggia, Italy). Pictures of 2–10 mm layers of lumbar vertebrae 1–4 were taken and the density of those layers was compared with a solution of known concentrations of minerals. The level of mineralisation was calculated in mg/m^3 . In the course of the examination a patient received 200–300 millirems.

Preliminary examinations were performed in 5 workers employed in the building industry, exposed to general vibration. The examinations revealed that in all the workers the level of minerals in their spine bones was lower than standard values for their relevant age and sex. Conventional radiological examinations did not show osteoporotic changes as they can be noticed only when the bone mass decrement reaches 30–40%.



Dysfunctions of the spine were investigated by means of "EPM Research Unity" in assemblers of telephone switchboards (*U. Carbone et al.*, Institute Medicine del Lavoro, Napoli, Italy). The most evident changes were observed in the 35–45 age group, employed during a period of 15–20 years. Significant changes were found in the cervical spine. This device detects dysfunctions before the onset of limited mobility of the servical spine diagnosed by means of conventional examinations.

R. Belfanti et al. (Clinica Ortopedica 1° dell Università di Milano, Italy) discussed the application of CYBEX BACK SYSTEM in the objective assessment of the spine capacity and the quantitative determination of strength loss. This device may also be used in rehabilitation training as an isokinetic ergometer.

Methods of comprehensive rehabilitation in persons with low back pain were presented by *K. Milanowska* (Rehabilitation Department, Medical Academy, Poznan, Poland). Rehabilitation is designed to eliminate pain, to stretch the spine, to diminish compression of nerve roots and to strengthen muscles in order to develop the so called "muscle corset", to restore proper position of body and to stabilise the spine. The basic rehabilitation procedures comprise: gradual stretching, analgetic physiotherapy, gradually intensified exercises, instruction of patients how to perform the exercises at home (20–30 min daily) and how to perform properly various activities so as to protect the spine.

A. Golaz et al. (Unité de Médecine du Travail et d'Ergonomie, Institut de Médecine Sociale et Prevention, Université de Genève, Switzerland) highlighted the relationship between low back pain and depression symptoms. They posited that two groups of patients could be distinguished: one with symptoms of depression preceding the onset of low back pain and the other vice versa. These health conditions are usually reflected in occupational activity. Both groups of patients reported more symptoms and they were more dissatisfied with their work posts. Occurrence of both categories of symptoms at the same time is more common in persons whose work is monotonous, requires limited qualifications and is performed under time pressure.

Another session, chaired by *Professor A. Durao* (Portugal) and *Professor S. Boccardi* (Italy) was devoted to other diseases of the musculoskeletal system. Occupational diseases of the musculoskeletal system, upper limbs, shoulders and neck were presented by *Professor M.H. Pope*. He stated that the majority of these health conditions are induced by the character of job, namely its repeatability. By the term "repeatability" it is understood that a given cycle of operations is repeated every second minute or even more often during a whole shift. A cycle lasting 30 minutes or less is considered as a level of high repeatability. Cumulative trauma disorders (CTD) are more common causes of diseases of the musculoskeletal system than accidents at work. CTDs are induced by a number of factors such as considerable effort, a forced and overburdening position of the body, low temperature, vibrations, an ill-equipped working post and gravity interaction. Rotation of workers, diversification of basic functions and detection of early CTD symptoms are the



recommended solutions for this group of disorders. Organisers of work should realise that intensive work with short (1–2 min) breaks is more effective and healthy than hard work during a long period of time followed by a 15–20 min rest.

The author also discussed various diseases and work related causes of CTD.

Disease	Occupational risk factors
Inflammation of tendon sheets of finger flexors	Movements with bent wrist
Inflammation of tendon sheets of finger extensors	Elbow deviation of a side-twisted wrist
Inflammation of tendon sheets of abductor and extensor of the thumb	1. Over 2000 movements/hour 2. Inadequate experience 3. Repeated local burden 4. Direct local blunt trauma 5. Simple repeated movement which requires strength and speed 6. Repeated radial or ulnar bending of wrist especially when connected with great effort of thumb
Ganglion	1. Sudden or improper load of tendon or joint 2. Repeated movement with strained wrist 3. Repeated rotations of wrist
Epicondylitis	Radial bending of wrist with inner rotation
Inflammation of tendons of the arm rotators	Rising of hands
Inflammation of finger nerves	Contact of palms or side surface of fingers with tools
Carpal tunnel syndrome	1. Repeated movements of hands 2. Work requiring repeated bending or extreme extension of wrist connected with intensive pressure
Tension neck syndrome (pain of muscles)	Intensive and repeated movements
Inflammation of the biceps brahi	Trauma
Pain of shoulder muscles	Repeated movements (?)
Winged scapula	Carrying of objects
Serratus muscle pulsy	

Causes and incidence of diseases of the locomotor system (mainly upper limbs) as well as diagnostic methods and analyses of load magnitudes were presented in 11 findings.

N. Draganova (Institute of Hygiene and Occupational Health, Sofia, Bulgaria) discussed the results of studies on women performing light but repeated work. The questionnaire survey indicated that 85% of seamstresses, 32% of computer operators, 63% of assemblers of small elements, 44% of draughtswomen and 78% of computer programming specialists were afflicted with diseases of the musculoskeletal system (neck and shoulders – 63%; low



back pain — 60%; fingers and wrist — 35%). EMG examination of postural muscles and those directly involved in work indicated that significant changes of the integrated EMG amplitude occurred in persons engaged in occupations in which diseases of the musculoskeletal system were most often reported.

S. Prantskyavichus et al. (Kunas Medical Academy, Lithuania USSR) recommended the impulse magnetic field (6 mT, 50–80 kHz) generated by KVARK apparatus as a very efficient therapeutic method for a damaged locomotor system. The method applied in the rehabilitation programme advances the recovery.

J.E. Coe (US Occupational Health, University of Illinois, Chicago, USA) characterised 600 clinical cases of carpal tunnel syndrome (CTS). The syndrome was equally frequent in males and females. In 71% of females and in 49% of males CTS was related to repeated movements at work and in remaining persons it was caused by a single trauma. The therapy and period of work disability were very long and the cost of treatment very high (\$ 20 000 for each case). The authors stressed the significance of early detection of CTS and recommended, besides classic diagnostic methods (interview, measurements of clasp strength), to examine the sensation of vibration (in 80% of CTS patients its level was increased) and conduction rate in the median nerve (in 46% of CTS patients it was lowered). These methods should be employed in systematic screenings.

The results of epidemiological and clinical studies of CTS on chain saw operators (a control group) and other manual workers not exposed to vibration were presented by *M. Bovenzi et al.* (Istituto di Medicina del Lavoro, Università di Trieste, Italy). The statistical analysis indicated an increased incidence of the following syndromes in persons exposed to vibration: pains in upper limbs, inflammation of the suprascapular muscle tendon, epicondylitis, inflammation of synovial sheets in the forearm and wrist, and CTS. It was observed that the incidence of carpal tunnel syndrome in sewers increased together with growing vibration.

K. Gluckert et al. (Department of Orthopedic Surgery, University of Erlangen, Germany) shared their experience about the application of magnetic resonance in identifying causes of occipitoatloid joint instability and in early non-invasive diagnosis of degenerative changes in the cartilage of knee joints.

Incidence and categories of damage to locomotor organs were presented by *H. Blankenburg et al.* (Institute of Occupational Medicine, Humboldt University, Berlin, Germany). Their studies revealed a significant frequency of lowered spine efficiency and limited mobility of joints (twisting of the trunk, bending and stretching of the elbow, adduction and abduction in the wrist) in fishermen. Instability of the spine was trifold and "tennis elbow" 4–5 times higher in fishermen than in the control group. Limited strength of the back and abdomen muscles was also observed in this group of workers.

Robens Occupational Task Analysis System (ROTA) used in measurements and analyses of locomotor organ load was discussed by *B. M. Bulthuis et al.* (Department of Physiology, University of Nijmegen, Arbow, the Netherlands). The Chaffin programme which permits the calculation of the



force of compression of vertebrae L_5-S_1 , was employed in the analysis of data. This system was applied in work load assessment in the building industry.

A. J. Van der Beek et al. (Study Centre Work and Health, Faculty of Medicine, University of Amsterdam, the Netherlands) displayed the results of the questionnaire survey on the health effects of employment in transportation. The analysis of work conditions in this group of workers revealed that apart from physical efforts (frequent lifting and carrying of loads, asymmetric movements, and struggle with an improper location of the steering-wheel), there are other risk factors such as a long period of work under time pressure and long unexpected demurrages. Those factors, and particularly physical load evoke adverse health effects inducing diseases of the musculoskeletal system.

Successful application of a balance chair which facilitates a proper sitting position in the rehabilitation of persons with low back pain as well as the results of an investigation into the incidence of spine-related ailments were presented by S. Gilbertova (Department of Rehabilitation Medicine, Post-graduate Medical Institute, Prague, Czechoslovakia). According to the results obtained, 68% of complaints referred to the cervical spine, 54% to the lumbar and 42% to the thoracic spine. A significant correlation between complaints and the level of work-related bending of the cervical spine was also observed.

The session devoted to epidemiological issues was presided over by Professor G. Wickström (Finland) and Professor G. Arbosti (Italy). A multifarious etiology of low back pain was dealt with by Professor J.D.A. Anderson who stressed, among others, difficulties in collecting information on the incidence of this syndrome. During cross-sectional studies the difficulties resulted from the periodical character of complaints, which consequently forced investigators to refer to the very often misleading memory of patients. An attempt to identify the number of sick persons, and episodes of sickness, is very often hindered in the prospective studies by the fact that one person may experience a number of periods when pain is more intensive while another may be afflicted by several diseases at the same time. When investigating the issue, it is essential to identify not only the incidence of the disease but also time of its onset. Unfortunately, the obtained data are quite often marred by many doubts.

Cohort studies are more reliable, however, a sample of the population is investigated in the same way as in the cross-sectional study: there is an opportunity to register successively the onset of disease (new cases) in sub-groups stratified according to a suspected risk. Such studies facilitate identification of professions, or kinds of jobs, which induce given diseases, occupation risk factors (functions, work conditions, manner of job performance, lifting of heavy objects, adoption of body position) and other variables (sex and age).

Epidemiological studies on back pain are more complicated than those on other disease entities. This is related to the periodical character of pain, as was already mentioned, and with idiopathic subsidence of symptoms. Ambiguous definitions of the site and cause of pain produce additional difficulties. Pain is usually caused by rheumatism of soft tissues, damage of spine joints, dermal



hyperaesthesia, compression of the articular capsule by ligaments and degenerative changes in intervertebral discs. The diversity of causes is reflected in the International Classification of Diseases. In its latest issue one may notice, for example, that lumbago and neurologia are two separate entities.

Studies on morbidity face the same diagnostic difficulties. In the majority of cases, a medical certificate of temporary work disability states that osteoarthritis was the cause of disability while osteoarthritis of the lumbar spine, as well as degenerative changes in lumbar and cervical intervertebral discs, were the real causes of the disease. The analysis of medical certificates issued because of rheumatic diseases revealed that in two thirds of the cases patients suffered from back pain.

In Great Britain, according to data presented, about 50 million working days are lost annually because of back pain in males. Certain regional differentiation was noted, for example in northern England 11.0% of the total sick absenteeism was caused by dorsopathy while in Wales 7.5%, in the south-eastern regions of England — 7.1%, and in eastern England as much as 13.0%. This differentiation results from different climate and kinds of jobs predominating in a given region.

The author also stressed that sick absenteeism without medical certificate (practiced in the UK) should be taken into consideration as well, in the analysis of the relationship between sick absenteeism and kind of work performed. The consequences of pre-selection of workers, avoidance of, or entering certain employment by persons with given predispositions should not be neglected. Additional burdens, outside profession, especially in women running households also play a significant role. Chronic diseases very often become the reason why people change their jobs. This is one of the mechanisms of autoselection. Age of retirement because of health reasons may also be considered as a useful indicator of the discomfort caused by the afore-said diseases.

From the epidemiological point of view, the greatest problem is that low back pain is in fact only a symptom. Studies carried out in 2,694 blue collar workers revealed low back pain in 30% of workers while 76% of workers suffered from discopathy or pains of undertermined diagnosis. In the group under study an increasing incidence of rheumatic diseases was observed in those below 55 years of age while it was decreasing in elder groups. The incidence of discopathy increased with age, and pain of undertermined diagnosis was less frequent in older persons. Hence, the significance of analysis of age differences in groups under study.

The seriousness and duration of low back pains should be also considered and the following groups of patients could be distinguished:

- a. patients treated in a hospital or absent at work during a period exceeding 6 weeks;
- b. patients with serious pains lasting over one year;
- c. patients under medical care (constant or increasing pain).

Low back pains have become a great health problem only in these groups of patients.



There is another group of persons who accept back pain on unknown etiology as an excuse for being absent from work and ask for a medical certificate of temporary work disability. Such a possibility finds its confirmation in the results of the study. The comparison was made between the number of sick leaves in groups with back pain and with other diseases. It was found that the sick absenteeism because of other reasons was higher in persons below 45 with back pains, while in the group above 55 years of age, sick absenteeism because of other diseases was lower than in the control group, which means that absenteeism due to back pain becomes something of a substitute.

Four other reports on low back pain were presented during the session.

F. Carnevale et al. (SPISSL — USL 10/D, Florence, Italy) reported the results of analysis of accidents at work in health service workers. In the group of 5,000 workers, 131 out of 1,062 cases were defined as lumbosacral pain syndrome according to AIL classification (Accident National Insurance). Those accidents occurred more often in "high risk" wards where the staff rendered services to immobilized patients. Authors drew attention to the selection of workers and to the transfer of workers with LBP from "high risk" wards to easier jobs.

P. M. Bongers et al. (Coronel Laboratory, Department of Occupational Health, University of Amsterdam, the Netherlands) focussed attention on the increased risk of LBP related to exposure, of various durations, to pain inducing factors. They observed a 4.2 times higher incidence of LBP in harbour workers of Rotterdam and in drivers of container transporters in the age group below 35, while in operators of circular loading machines, the highest risk of LBP (3.6 times higher than in the control group) was found in persons over 40. In both groups, exposure to vibration exceeded an eight-hour limit.

The education programme "Healthy Back" was described by *T. Suurnakki* (Centre for Occupational Safety) and *V. Louhevaara* (Institute of Occupational Health, Helsinki, Finland). Aging of the working population and the increasing number of persons afflicted with diseases of the musculoskeletal system forced the implementation of such a programme in 305 out of 410 questionnaired enterprises. Physical exercises, supervised by instructors, and recreation days were organised. Besides, workers were trained how to use properly their locomotor organs. The programme stimulated cooperation between workers, the occupational health service and staff responsible for work safety. The results of the programme were found very successful in 32% of enterprises and fair in 62%.

G. Fabbri et al. (Istituto Medicina del Lavoro, Università Cattolica, Rome, Italy) presented the results of studies carried out among drivers of electric-fork-lift trucks. Although, the work of this group of drivers was much easier than those who drove heavy vehicles, low back pain was observed in 30% of subjects after 5–6 hours of effective work, and half of them were on sick leave. No cases of discopathy were found in this group of workers. Frequent twisting of the trunk and vibration insufficiently suppressed by a driver's seat were the main causes of pain, confirmed by the analysis of video tapes.



The session on the epidemiological evaluation of intervention programmes was chaired by *Professor P. F. Fleisher* (USA) and *Dr E. Occhipinti* (Italy). *Professor G. Wickström* from Finland presented principles of implementation and evaluation of intervention programmes. He stated that various forms of intervention were applied simultaneously because of the diversified etiology of diseases of the musculoskeletal system. Nevertheless, precise matching of groups under study and controls, standardised methods of evaluation of exposure and effectiveness of applied measures are indispensable in each case as well as identification of a properly sized sample and duration of observations.

The author exemplified difficulties and possible mistakes at every stage of the investigations, starting with planning, through evaluation of results. Proper matching of control samples should eliminate the impact of other factors. Therefore, groups should be selected not only according to age and sex but also according to the branch of industry, occupation, duration of exposure, structure and methods of management in the working place. An intervention programme should embrace all persons. Its limitation only to volunteers hinders the formulation of objective conclusions.

In order to achieve a final goal, namely the decreased incidence of musculoskeletal diseases, individual actions should be oriented towards improvements in both, the work methodology and the capacity of workers. The programme should comprise the following stages:

- a. recognition of the problem (workers are informed about the problem and their role in finding the best solution);
- b. education (workers acquire basic knowledge of anatomy, physiology and biomechanics);
- c. cognition of relationships (workers begin to recognise adverse operations in their work);
- d. application (workers plan how to "use" their body);
- e. observation (monitoring of attained changes).

The effect of the intervention programme can be evaluated when it is in progress by selecting appropriate variables. Measurement of these variables must be performed in exactly the same way in each phase of the study, hence required repeatability of applied methods. Positive responses to questions included in questionnaires, positive results of the study, and other objective measurements may be used in evaluation of the programme. Sick leaves can be also registered but one should be aware of other factors affecting their number. In such case, a specific rate of exposure and a sensitive index of accomplishments should be selected. Impact of other factors occurring simultaneously such as changes in production process, work organisation and employment of new methods of work, may impede the formulation of conclusions.

An increased incidence of diseases or complaints is a common observation during the first stages of the programme. This results from improved health education among workers and from earlier reports on health problems. Lower



acuity of new cases proves that the programme has been accepted by workers. A successful programme should limit the number of new cases.

Closing his presentation, *Professor G. Wickström* enumerated the targets of further studies:

- a. to search for means aimed at decreasing the number of traumatical disorders of the musculoskeletal system;

- b. to eliminate work overload associated with pulling, pushing and lifting of various heavy objects at work;

- c. to modify organisation of work in order to eliminate, or at least limit, operations which require an unchanging and forced position of the body, and monotonous movements;

- d. to provide facilities for regular physical exercises particularly for those workers who perform a monotonous kind of work and whose musculoskeletal system is not properly used in the course of work.

It was also stressed that people involved in the implementation of intervention programmes should improve their understanding of the cost-effectiveness evaluation. The lower incidence of diseases of the musculoskeletal system, the better the economy.

The key-note speech was followed by five findings. The first three enumerated conditions which determine the LBP occurrence in nurses and denoted the application of preventive measures. *P. Tamminen* (Turku Regional Institute of Occupational Health, Turku, Finland) compared two preventive measures. One depended on muscle-training and education on how to lift patients, the other comprised lectures on principles and techniques of the safe lifting of patients and instructions of self-training. Positive results were observed only in the group of nurses following an intensive training. The incidence of low back pain declined from 43 to 24% and a more limited number of spine injuries was also observed. The comparison of video tapes registered before and after introduction of the programme showed significant positive changes in techniques of patient's lifting used by nurses.

Pilot studies on diseases of the musculoskeletal system and LBP in nurses were presented by *U. Stoessel* et al. (University of Freiburg, Germany). They postulated that low back pain occurs already in students of nursing schools and that it increases with years of employment. In students studying general nursing BP was observed in 40% during the first year, in 70% during the second and in 60% during the third year of studies. In students of pediatric nursing the incidence was equal to 20%, 28% and 58%, respectively. These results inspired broad prospective and retrospective studies, and a preventive programme was initiated.

F. Larese and *A. Fiorito*, Istituto di Medicina del Lavoro, Triest, Italy) presented the results of their studies carried out in two groups of nurses, one employed in a general and the other in an oncological hospital. The relationship between the number of nurses and the number of patients was adopted as a work-load measuring tool. In the general hospital, the relation was equal to 0.57 and in the oncological hospital 1.27. LBP was observed in 48% of general hospital nurses and in 33% of oncological nurses. These figures



showed that work load was a more significant factor than age and duration of employment.

A group of Italian authors (Istituto di Medicina del Lavoro USL 19 and Istituto di Medicina del Lavoro, Universita di Siena, Italy) discussed the results of a questionnaire and medical studies performed on workers employed in a coking plant and in the ceramic industry. They analysed the incidence of cervical, thoracic and lumbar spondylosis. Standard morbidity and risk rates were calculated in four age groups. The highest incidence of cervical spondylosis and a significant growth of other rates, when compared with the control group, were found in younger workers below 35.

The succeeding session was focused on ergonomic LBP prevention. The session was presided over by *Dr V. H. Hildenbrandt* (the Netherlands) and *Professor A. Pedotti* (Italy). The significance of ergonomics and prevention of occupational back pain was discussed by *Professor A. Grieco* (Italy). In his opinion damage to the musculoskeletal system results most frequently from the manual lifting and carrying of objects, and the risk increase when:

- a. a lifted object is heavy;
- b. a lifted object is large;
- c. an object is lifted from the floor;
- d. frequency of lifting is high.

The possibility of damage is also related to the body position. It is essential to consider the duration of a given position as well as the space and conditions in which people work. A body-position proves to be appropriate when a person does not feel any discomfort, fatigue or pain after a short period of work and no distant disorders in the structure or functions of the locomotor organs are observed.

Among various methods of assessing body-positions, one should select those which satisfy the aims of the study. Psychophysical methods are usually employed in the identification of the maximum load which can be lifted by a person in given conditions. Tests of muscular power and endurance are very useful in designing work techniques to be applied during risk operations. The analysis of the spectrum of EMG signal frequency helps to assess muscle fatigue and facilitates the identification of limits of lifted and carried loads as well as efforts connected with the pushing and pulling of heavy objects.

The biological analysis of movement is important in prevention, but it should be remembered that its accuracy is inversely proportional to its practical application.

This analysis is useful in the calculation of intervertebral disc compression. According to NIOSH instructions, no actions are required when the force of compression during lifting is lower than 350 kg. Maximum permissible value is equal to 650 kg. If the spine load falls within these limits during the work process, an ergonomic correction of the work place is recommended, and workers should be accordingly selected and trained.

The determination of compression force employs the full gamut of more or less sophisticated methods of measurement, from simple schemes and equations, through a computer analysis of position registered by means of a video record.



Various measurements prove that the spine load during manual lifting can be diminished by:

1. minimising the weight and size of lifted objects;
2. minimising the distance between the centre of object gravity and person lifting an object, and the distance of object dislocation;
3. extension of lifting time and examination of intervals between consecutive lifting operations.

A fixed body position, for example, a sitting position, which is quite common, proves to be another considerable risk. Repeated movements coupled with great effort belong also to adverse factors.

Analysis of fixed positions and evaluation of hard manual work employ practically the same methods, however, in the former case, duration of the fixed position should be additionally taken into consideration.

In order to prevent adverse health effects of a fixed body position, maximum mobility and comfort should be provided, and the effort of locomotor organs should be minimised during a predominating position. The latter aim could be accomplished through:

- a. organisation of work posts according to ergonomic criteria;
- b. proper organization of work (10 min of "alternative position" after each 45–50 min period of work);
- c. provision of training and appropriate information.

Studies on the fixed position of the body are still very limited, while the results of such studies are very much desired in view of the changing character of work. Future studies on these issues and clinical investigations should highlight cause-effect relationships, advance our knowledge on the dimensions of working places and provide information on optimum duration of a given position, length of breaks and time used for "alternative positions".

Application of ergonomic principles in LBP prevention was presented in six reports.

An ergonomic analysis of basic functions performed by operators pushing and pulling levers was performed by *D. Roman* and *J. Bugajska* (Central Institute for Labour Protection, Warsaw, Poland). In the analysis, an unconventional method was used to measure tiredness, namely all levels of physiological, physical and psychological parameters were totalized. It was found that the electromyogram proved to be the most sensitive indicator of tiredness. The results revealed that pulling of the lever was more convenient than pushing and the point which is 30° from the sagittal plane caused less fatigue for the subject than the point located 60° from this plane.

A group of authors from the Control Laboratory, Faculty of Medicine, University of Amsterdam, presented two reports on ergonomic studies aimed at adjusting table height to new requirements resulting from changes in the body dimensions in pregnant women. It was revealed that pregnant women preferred a standing position at work and favoured tables which were lower than those designed according to ergonomic standards. The difference was equal to 6.8 cm. Thus, a table used by pregnant women who worked in the standing position should be 16–21 cm below the elbow. Bearing in mind



this observation, it is necessary to include anthropometric measurements of pregnant women in ergonomic data.

Studies presented by *D. Coggon* et al. (MRC Environmental Epidemiology Unit, Southampton, United Kingdom) aimed at identifying the impact of body height and kind of occupational activity on LBP incidence. It was indicated that the onset of low back pain was related to the lifting of heavy objects at work (both in males — relative risk (RR) = 2.0 and in females — RR = 2.2). In males it was also related to digging (RR = 1.6). A relationship between LBP risk and body height was found only in males ($p < 0,0001$). The susceptibility of tall men to spondylarthrosis did not result from mechanical load of the spine since it was higher in short men who performed the same jobs (digging and carrying heavy objects).

J. T. Begemann-Meijer et al. (Department of Physiology, University of Nijmegen, the Netherlands) discussed optimal working conditions for bricklayers. They used, in their studies, measurements of oxygen consumption, monitoring of cardiac contraction and a questionnaire survey of tiredness. It was found that among various combinations and sizes of elements and levels of brick laying, a level raised by 30 cm in comparison with the traditional one, diminished tiredness.

Professor M. Pope (USA) and *Professor A. Lanzetta* (Italy) chaired the session devoted to preventive medicine.

A key-note speech, stressing among others the significance of screening in the prevention of back pain, was given by *Dr V.H. Hilderbrandt* from the Netherlands. In his opinion, there are the three following targets for medical screening:

1. primary prevention — pre-selection of candidates for a given profession or occupation (it is possible if the information on individual predispositions increasing the risk is available);
2. secondary prevention — early detection of diseases (an appropriate screening programme prevents the exacerbation of a disease and its transition from an acute to a chronic condition);
3. tertiary prevention — re-integration of workers (it is possible only if individual factors which may afford possibilities of success are well known).

Thus, the main goal of modern screening is to identify individual risk factors. The following questions should be answered then if this goal is to be accomplished:

1. which factors are significant?
2. which variables should be measured?
3. which methods are appropriate?
4. how should the results be interpreted?

Thus far, the following individual risk factors of back pain have been identified:

- a. constitutional (age, sex, body height and weight, strength of trunk muscles, mobile capacity of the lumbar spine, narrowness of the vertebral canal, genetic factors);
- b. associated with the position of body (scoliosis, uneven length of limbs);



- c. radiographical (specific damages);
- d. medical (number of pregnancies and deliveries);
- e. psycho-social (depression, restlessness, emergencies, family problems, personality, hypochondria, great responsibility and mental concentration, worse intellectual abilities, diminished ability to keep emotional relations);
- f. demographic — (socio-economical conditions, education, place of residence);
- g. miscellaneous (sport, physical activity, gardening, smoking, alcohol consumption, professional experience).

The following factors are important in the forecast of the likely course of back pain:

- a. back pain in the past;
- b. strength of muscles in relation to the required strength at a given post;
- c. physical capacity — although it is logical that sufficient capacity reduces LBP risk, verified methods of assessment applied in numerous studies in this field make it difficult to draw explicit conclusions;
- d. stress — onset of low back pain is very often related to stressful situations;
- e. spine mobility — results of studies are ambiguous;
- f. narrowness of the vertebral canal — some ultrasonographic examinations indicate a predictive value of this factor, however, more comprehensive studies and more reliable results are required to draw final conclusions;
- g. smoking — it is suspected that smoking impairs alimentation of intervertebral discs (predisposition to discopathy);
- h. body height and obesity — only few studies confirm a positive relationship.

Discussing various methods of measurement, the author turned special attention to measurements of spine mobility. He indicated that analyses of movement, lower speed and acceleration attained in the course of movement are of greatest value.

Closing his speech, *Dr V. H. Hilderbrandt* stressed that medical screening, in its present stage of advancement, may only supplement preventative activities and its results have always to be interpreted in relation to a clearly defined work post.

Additional comments in this regard were included in findings presented by *O. Woolf* et al. (Hadassah University Hospital, Jerusalem, Israel). They compared the efficiency of two intervention programmes applied during the period of one year (CAL physical exercises twice a week for three months and five sessions of "back school" programme) in persons with low back pain occurring at least three times a year. The authors observed an improved backward and forward flexibility of the trunk as well as an increased strength of abdominal muscles in the CAL group after three months, and after the subsequent six months, differences in the pliability and the strength of muscles diminished. The analysis of ailments carried out every month revealed that the number of months with LBP in persons from the CAL group was 4.5 while in the "back school" group and in controls the number was equal to 7.3 and 7.4,



respectively. Therefore, authors recommended CAL programme which proved to be both inexpensive and effective.

The application of the "back school" preventive programme among forestry workers employed in Alpine conditions was presented by *A. Cristofolini et al.* (Unita di Medicina del Lavoro, Trento, Italy). They postulated that a health education programme be provided for all workers in order to teach them how to avoid movements at work which might impair the spine. Persons with spondylosis should undergo a special educational programme joined with rehabilitation, which should also embrace physical exercises to be performed at home.

P. Leino (Department of Public Health, University of Tampere, Finland) presented the results of studies on the relationship between diseases of the spine and non-occupational physical activity of blue and white collar workers. The physical activity was measured in kcal/h, and the value over 500 kcal/h indicated intensive activity. The capacity of the spine was assessed on the basis of clinical examinations and frequency of pains. A ten-year observation revealed a negative correlation between the clinical condition of the spine and the value of non-occupational physical activity in past years. On the other hand, an increased number of symptoms and LBP cases observed during the period of the last five years was not related to a mean level of activity during previous years.

M. Jager et al. (Institut für Arbeitsphysiologie an der Universität, Dortmund, Germany) discussed a dynamic model 3D "Dortmunder" employed in the measurement of the locomotor system load. The model comprised 30 body elements and two kinds of load.

The final session was chaired by *Professor A. Grieco* (Italy) and *Professor M. A. El Batawi* (USA). During the session, general conclusions were presented as well as directions and areas of further studies outlined.

The conference was accompanied by an exhibition of research equipment (used in measurements of locomotor functions, analyses of body position at work, measurements of muscle strength, body movements) and patterns of work posts designed according to ergonomic principles with special reference to properly constructed chairs.

